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INTIB

Energy and Environment Series, No. 6/7

**WASTE MINIMIZATION
IN
INDUSTRY**

Compiled by

Peter Pembleton



Industrial and Technological Information Bank

United Nations Industrial Development Organization
Vienna, 1995

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Energy and Environment Series, No. 6/7: Waste Minimization in Industry

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PREFACE

The *Energy and Environment Series* of the Industrial and Technological Information Bank (INTIB) ends its second year of production with this special number.

The number is special in many ways:

- it is a 'double' issue—i.e. it contains many more references (almost 1,000) than previous numbers;
- it covers a key topic, that of waste minimization, also known as cleaner production or pollution prevention. This topic is central to the industrial programmes of the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP) and is highlighted by the joint 'National Cleaner Production Centres' (NCPC) programme;
- it presents abstracts of the papers presented to the first and the third seminars on cleaner production;
- it provides the full text of over 100 case studies on cleaner production, providing technological, materials balance and economic data;
- there is a section of abstracts in Spanish (the keywords are available in English), obtained from an INTIB partner centre in Peru.

UNIDO and UNEP/Industry and Environment have embarked upon the joint NCPC project (as mentioned above) to bring the concept of cleaner production to a few developing countries in each geographical region—more details are presented in the following pages which present the cleaner production programmes of both organizations.

Information acquisition and dissemination will be an important part of these pilot activities and this publication shows that there is a wealth of data already available, from commercial and non-commercial sources.

However, this information may not always be so easily extracted, as was evidenced by the work involved in preparing this volume. For instance, the terminology used in existing data bases is a barrier—'cleaner production' is not a term in most existing data systems. In addition, the concept still has varying interpretations and the material 'classified' by this terminology reflects these variations—i.e. one may find the term 'waste

minimization' or 'pollution prevention' but, when one reviews the abstracts, these are often not about waste reduction at source.

Nevertheless, the commercial data systems, as represented by the first three data sections in this volume, have a great deal to offer and show that industry is already implementing the concept of 'cleaner production'—in fact, a review of the abstracts of such data bases show that this concept is not new to industry. Quite the contrary, it has been around for many years, but under the guise of 'process optimization' or 'process efficiency'.

Considering that

...there is no internationally agreed definition of clean technology...¹

the methodology applied to select abstracts for the first three sections of this volume was to consider

...the treatment and disposal of process wastes...

as outside the scope of this review, in line with the conclusion of the above-quoted paper.

This led to the inclusion of material on recycling, specifically 'on-site' recycling, but also 'off-site' recycling, as the life cycle of a product requires off-site recycling (e.g. for automobile and electrical product components) to succeed.

Special thanks for contributions to this volume go to: UNEP/Industry and Environment, which provided the case studies from their ICPIC system; the Pan American Health Organization's, Centre for Sanitary Engineering and Environmental Sciences, which provided over 200 references in Spanish from their data system; and, as always, to Materials Information which provides three major international data bases to UNIDO/INTIB, from which the first three data sections were prepared.

All of the data provided in this and previous volumes of the *Series* are available in INTIB's system of data bases.

UNIDO ACTIVITIES

IN THE FIELD OF

CLEANER PRODUCTION

The reduction of industrial pollution by means of cleaner production has been identified as the key to ecologically sustainable industrial development. Cleaner production, also referred to as pollution prevention and waste minimization, improves environmental quality and often enhances profitability by eliminating waste at the source. It has been accepted, following the Conference on Ecologically Sustainable Industrial Development (ESID) in 1991 and the United Nations Conference on Environment and Development (UNCED) in 1992, as one of the primary tools for industry to achieve environmental improvements while remaining competitive and profitable.

Cleaner production requires the continuous application of an integrated preventive environmental strategy to processes and products with a view to reducing risks to humans and the environment. The key issue is how to improve the efficiency of industrial production by reducing waste and redesigning products to make them less polluting and easier to recycle. The need is particularly great in small and medium-sized enterprises. The need for action is threefold:

- Government policies must be developed that encourage environmental management with an emphasis on pollution prevention as the first step in reducing wastes.
- Institutions must be supported that can effectively implement cleaner production programmes based on process optimization.
- Demonstration projects must be implemented that show that the environmental and financial benefits of cleaner production are as applicable to small and medium-sized enterprises in developing as in developed countries.

Developing countries are seeking to improve the productivity of their industrial processes. They are requesting assistance in conducting waste minimization studies, both at the entrepreneurial level and in individual subsectors, in order to examine the use of chromium in leather tanning, colour dye matching in textiles manufacturing, black liquor recovery in the agro-based pulp and paper industry, etc.. Requests submitted are for technical experts as well as technical information.

The role of UNIDO

Cleaner production, one of the four subprogrammes of the UNIDO environment programme since 1990, was endorsed by UNIDO member States in the conclusions and recommendations of the Conference on Ecologically Sustainable Industrial Development (ESID), organized by UNIDO in 1991.

With its emphasis on process improvements, cleaner production is similar to process optimization, which aims to reduce waste generation in order to increase the competitiveness of industry. Cleaner production builds on process optimization by justifying process improvements on environmental as well as on financial grounds. UNIDO has the capacity and experience to provide technical assistance in the field of process optimization, both at the sectoral and at the sub-sectoral level.

UNIDO activities

UNIDO has assisted several large- and medium-scale enterprises in process optimization in textile dyeing, printing and finishing. An example of such assistance is that provided to the

Brazilian textile sector through the Applied Research Unit of the *Servicio Nacional de Aprendizagem Industrial (SENAI)* and the *Centro de Tecnologia da Industria Quimica e Textil (CETIQT)*, now a self-financed trust fund project administered by UNIDO. The activities were aimed at computerizing colour-metering, recipe optimization and dye-house automation. The goal was to achieve a cost reduction by reducing dyestuffs and auxiliaries as well as energy consumption and process time. A by-product of the optimization was a considerable reduction in the amount of polluting effluents. The cost reductions achieved, depending on the recipes, were as high as 40 per cent for dyestuffs and auxiliaries.

Another example of such assistance is that provided to the leather sector. Through the Leather Development Centre in Kenya, UNIDO has assisted enterprises in enhancing process and product technologies that have boosted their domestic and export potential and at the same time reduced the volume of pollution generated. These process changes have included the following: the use of air rather than salt drying to preserve hides and skins, alternative chromium formulations that favour better chromium uptake in the tanning of leather, and the use of water-based rather than solvent-based top coats for finishing.

A third example is the work undertaken by UNIDO in chemical process sectors using hazardous or toxic chemicals. In Poland, UNIDO has assisted in a pilot-scale demonstration of cleaner production for cereal herbicides. In India, it has assisted in a pilot-scale demonstration of applicator- and environment-friendly pesticide formulation. That project involves integrated safety disposal of wastes and promotion of safer pesticide formulations, including biobotanical pesticides and more efficient application technologies.

UNIDO also has the capacity and experience to assist countries in formulating policies that encourage cleaner production and enhance the capacities of national productivity and environmental institutions to carry out cleaner production programmes. Providing technical assistance in the field of cleaner production involves several types of capacity building, depending on whether the assistance is at the policy, institutional or enterprise level. At the policy level, UNIDO has capacity and experience in devising industrial policies and strategies into which environmental considerations are incorporated. At the institutional level, UNIDO has worked in designing and supporting programs of institutional strengthening, combining technical advice, technical information, training, study tours and the provision of equipment. At the enterprise level, technical assistance builds on the expertise of UNIDO in the field of waste minimization auditing and in the technical aspects of individual subsectors as well as on its extensive library of technical information.

ESID Strategies and Policies for Cleaner Production

Existing government policies often encourage the excessive use of resources by incorrect pricing or subsidies, or they assign preference to traditional end-of-pipe pollution control over pollution prevention. UNIDO is working with a number of countries in the preparation of ESID strategies aimed at formulating government policies and programmes that would promote

cleaner production as an essential element of sustainable development plans. These efforts include reviews of existing industrial, environmental and technology policies to identify those policy components that are discouraging cleaner production and to formulate alternative, proactive policies that would encourage cleaner production.

UNIDO is cooperating with the United Nations Environment Programme (UNEP) and the World Bank in the preparation of guidelines for pollution prevention and abatement in more than 50 industrial sectors, and it is contributing to in-depth UNEP technical reports on cleaner production.

Economic growth with clean production

An international conference on economic growth with clean production was organized in 1994 by the Commonwealth Scientific and Industrial Research Organization and UNIDO at Melbourne, Australia. Representatives of Governments, industry and scientific and technological institutions participated in three days of debate and discussion during which practical approaches to ESID, were identified. Cleaner production issues specific to 12 industries, including leather, textiles, mineral-processing, metal-finishing and mining, were discussed in detail in separate workshops within the framework of the conference. A set of 10 guiding principles for the achievement of sustainable development were drawn up by the conference. The Melbourne Principles emphasize as prerequisites to the achievement of ESID, the specific roles of all concerned parties and the importance of cooperation between Governments, industry and research institutions in both developed and developing countries.

Building institutional capacities for cleaner production

At the institutional level, UNIDO recognizes the importance of well trained, equipped and informed public- and private-sector institutions promoting cleaner production. It is providing institutional support and information about cleaner production to governmental and non-governmental organizations.

National cleaner production centres

UNIDO, in cooperation with UNEP, is beginning to work with industry-oriented institutions such as national productivity councils and chambers of commerce and industry. A new programme has been launched to support national cleaner production centres (NCPCs) in approximately 20 countries for a five-year period. NCPCs will play a coordinating and catalytic role in cleaner production by providing technical information and advice, stimulating the demonstration of cleaner production techniques and technologies, and training industry and government professionals. During the first phase of the programme, 1994-1997, support will be provided for eight such centres in developing countries and economies in transition.

Capacity - building for cleaner production in Sri Lanka
Activities of UNIDO at the institutional level include support for cleaner production programmes within environmental management agencies. UNIDO is working on such a project with the Central Environment Authority of Sri Lanka. It is building the capacity of the Authority to use waste-reduction measures as the first step in achieving industrial compliance with environmental norms, and is also providing seed money from a revolving loan fund for low-cost cleaner technologies. UNIDO is starting a similar effort with the environmental authority of Nepal.

Introducing cleaner production in enterprises

UNIDO supports individual sectors that are interested in introducing cleaner production programmes into their activities. Some recently completed activities are in the cement sector in Egypt and the cane sugar sector in Mexico. A demonstration in the metal-finishing sector is currently under way in Pakistan. Demonstrations in other Asian and Latin American countries will be initiated during 1994-1995.

Cleaner production at the Suez Cement Company in Egypt

UNIDO has just completed a cleaner production project that assisted the Suez Cement Company in Egypt to achieve significant pollutant reductions through source reduction. These include reduction of 12 tons per day of clinker loss to the air from its Quattamia cement kiln, reduction of 20 tons per day of material loss from the raw materials area of its Suez plant and an apparent material loss reduction of 152 tons per day from that plant's kiln.

Cleaner production in India

For the past two years, UNIDO has been working with the National Productivity Council of India on the project Demonstrations with Small Industries of Reductions in Emissions and Wastes (DESIRE). UNIDO has supported demonstrations of the potential of waste minimization in three sectors: agro-based pulp and paper, pesticide formulation, and textile dyeing and finishing. The 12 plants that participated implemented 210 options with an investment of approximately US\$ 300,000 which in turn resulted in monetary savings of approximately US\$ 3 million. In the case of the pulp and paper and textile sectors, there was a significant reduction in volume of water used and organic matter discharged into the environment, and in the case of pesticides formulation, there was a significant reduction in toxic fugitive emissions and health hazards risk.

NEXT PAGE(S)

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CLEANER PRODUCTION:
AN OPPORTUNITY FOR INDUSTRY
UNEP Industry and Environment

1. Summary

The cleaner production concept was coined by UNEP in September 1990. This paper explains the cleaner production concept, why it is important, what are the benefits, what are the barriers to adoption, and what can be done to promote it. The final sections focus on the objectives and activities of UNEP's Cleaner Production Programme and highlights two ongoing activities, to illustrate how UNEP is promoting its implementation. One of these activities is the joint UNIDO/UNEP National Cleaner Production Centre Programme which aims to establish approximately 20 national centres in developing countries and economies in transition to promote cleaner production activities on the national level.

2. What is Cleaner Production?

Cleaner production means the continuous application of an integrated preventive environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment.

- **For production processes:** cleaner production included conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes before they leave a process.
- **For products:** the strategy focuses on reducing impacts along the entire life cycle of the product, from raw materials extraction to the ultimate disposal of the products.
- **For services:** Cleaner Production reduces the environmental impact of the service provided over the entire life cycle, from system design and use to the entire consumption of resources required to provide the services.
- Cleaner production requires applying know-how, improving technology, and changing attitudes.

Many preventive terms - such as eco-efficiency, pollution prevention, waste minimization, source reduction - are in use today. At UNEP, the term "cleaner production" was chosen to encompass a comprehensive approach to production. Thus cleaner production covers both processes, products and services and impacts of all, including their design, utilization and usage

of raw materials and energy. It covers all wastes - hazardous/toxic or not - whether emitted into the air, water or onto the land. The term acknowledges that cleaner production requires not only improving efficiency and material substitution - using tools such as technology and know-how - but new managerial skills and policies as well. It also acknowledges the importance of design and use of products as well as services. The cleaner production strategy is schematically shown as figure 1.

3. Why is Cleaner Production Important?

In the long run, cleaner production is the most effective way to design and operate industrial processes and to develop and produce products and services. The costs of wastes and emissions, including negative environmental and health impacts, can be avoided or minimized by applying the cleaner production concept from the beginning and apply it continuously and throughout the entire life cycle.

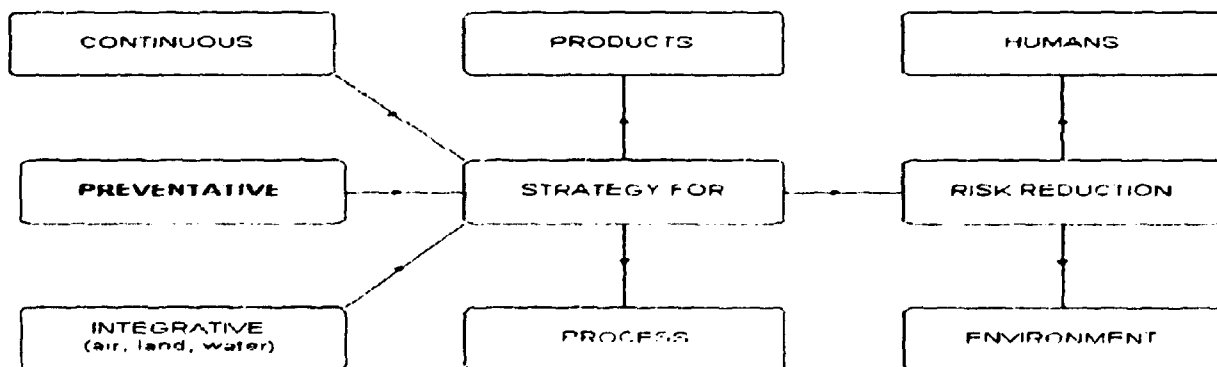
The costs of the traditional, reactive environmental strategy - the end-of-pipe strategy - are well known. For example, in the United States, industry and government spend an estimated \$115 billion each year, according to a U.S. government report "Environmental Investments: The Cost of a Clean Environment" (1991). The World Bank estimated in 1992 that East Asian countries would spend up to \$20 billion a year during the 1990's to clean up environmental damage brought about by rapid industrialization and population growth. Worldwide it has been estimated that over 300 billion is being spent each year for environmental projects, mainly for purchasing and maintaining end-of-pipe technologies.

For manufacturing firms these costs do not add value to the products produced. In contrast, when cleaner production is applied, processes become more efficient because they require fewer raw materials and/or generate less waste.

4. What are the Benefits of Cleaner Production?

As mentioned earlier, cleaner production is good business, good for both government and industry. The lesson from the past is

FIGURE 1. Essential elements of a cleaner production strategy



simple: it is less costly to prevent pollution at the source than to clean it up after it has been produced.

Implementing cleaner production may not solve all environmental problems at a facility, but it will decrease the need for end-of-pipe equipment and create less toxic waste to treat and dispose. It often reduces workers' exposure to hazardous chemicals, and usually reduces the incidents of accidents that can harm surrounding areas. Products that are designed and produced with cleaner production in mind are often less harmful for consumers to use, and their residuals are normally less of a burden to waste streams.

Following are three brief examples of cleaner production applications that have been collected by UNEP's Cleaner Production Programme. They are from the International Cleaner Production Information Clearinghouse, discussed in Section 6.4.

Example 1:

A leather tannery installed a simple six step chrome recovery procedure. The six steps included: collect spent tanning liquor, add magnesium oxide and poly electrolyte, control acidity and stir, stop stirring and settle, decanting, add sulfuric acid, control acidity and stir - ready for use as tanning agent. The investment cost was US\$40,000 but annual savings were US\$43,550 within the first year. The payback period was 11 months.

Example 2:

A textile company reduced its dye, water and energy use, and volume of waste water discharge releases by reusing dye baths at the end of a cycle to prepare for the next cycle. Investment costs were US\$15,000 but annual savings were US\$100,000, so the payback period was only 2 months.

Example 3:

A combination of 8 process changes in a brewery reduced the overall COD and suspended solid loads to its waste water facility by 19% (a combined measurement in cubic meters). The savings in effluent charges alone were US\$ 96,900 per year.

Example 4:

A furniture manufacturer implemented cleaner production already in the design phase of the development of a new office chair. Material substitutions included the elimination of heavy metals in the plastic pigments and changing the base coating from polypropylene-coated steel to fiberglass-reinforced nylon. The seat cover is now held on with a draw string for disassembly before recycling. The supplier of the gas piston and castors were asked to take their products back after use and dismantle for recycling. The savings in energy consumption are approximately 50% and the emissions of carbon dioxide, phenols and fluorine were reduced by 40-80%. The production cost per chair was reduced by US\$ 3 not including potential savings in environmental cost.

5. If It Is So Good, Why Isn't Everybody Doing It?

The main reason people resist cleaner production is entrenched habits and a reluctance to change. But other reasons have been documented as well. They include:

- costs of end-of-pipe treatment strategies have been accepted as a cost of doing business, since in many cases—especially in good economic times—these costs are not very high in relationship to other costs of production;
- regulatory systems overwhelmingly focus on end-of-pipe solutions;
- mismatches exist in responsibilities between the people who can change processes and redesign products and the people who manage the wastes they generate; and
- there is a lack of knowledge that alternatives exist.

The difficulty of implementing cleaner production is in adoption. It is not always a problem to find the right or new technology. But it does always require changes in attitude at all levels of a firm, from top management to shop floor. Cleaner production is a corporate cultural shift, from the "pollution control culture" to the "waste reduction ethic."

Firms that do get serious about cleaner production have managers who have announced that cleaner production is a top priority of the company and have followed through with corporate programmes to make it happen. The programmes have explicit incentives, often financial, for employees to come up with ideas that work. Some programmes have cleaner production experts who roam the plant sometimes offering technical advice but more often simply spreading the message. These experts try to get people to think differently about the unit processes they operate everyday. They ask "why" questions and do not accept "because it always has been done like that" or "it isn't broken" answers.

Example:

Some employees of a DOW chemical plant in the United States asked why the process they operated had a step requiring frequent extraction of a waste product. The process engineers analyzed the situation and discovered that the step was not necessary and eliminated the step and the waste.

Outside pressures can help make cleaner production happen, especially as regards the products themselves. Consumers in Canada have created a booming market for cloth shopping bags. In many areas of the world, phosphates have been removed from detergents. Automobile designers are, once again, making automobiles smaller, lighter and reconfiguring them. The Montreal Protocol has brought a sunset to the worldwide use of chlorofluorocarbons. Negotiations are underway to make reductions or changes in energy use so as prevent global warming.

Innovative firms are not waiting for the axe to fall. Innovative governments set up programmes and regulations to support cleaner production activities in their countries. UNEP IP provides all stakeholder with help and support in their actions, whether they be national, regional, local or company specific.

6. UNEP IE's Cleaner Production Programme

One of the main barriers to the adoption of cleaner production by governments and industry is a lack of information. Helping eliminate that barrier is the UNEP IE Cleaner Production Programme.

The programme has roots that date back to IE activities in the mid 1970's on low- and non-waste technologies. The Programme was not formalized, however, until 1989 in response to directives issued by the UNEP Governing Council meeting that year. The Programme was officially launched in 1990 at the Canterbury Seminar in the United Kingdom. In 1991, Directives of the UNEP 16th Session Governing Council effectively institutionalized the Programme. The Programme has also been strongly endorsed in Chapters 20 and 30 of Agenda 21. Its current workplan follows a decision taken at UNEP's 17th Governing Council held in May 1993, and further expansion in 1996 and 1997 is following directives of the 18th Governing Council (May 1995).

The traditional way of dealing with environmental impacts has been to, in essence, stand at the back end of industrial plants, collect the waste by-products and try to control them in various ways—sometimes by treating them through dilution or detoxification or solidification—or simply by trying to contain them in barrels or landfills.

Another aspect of this traditional management or control strategy is to view wastes in narrow and separate terms and under different regulatory schemes based on where they end up—in the air, in waterways, or on the land. Thus, some people are concerned about air pollutants, others about waste water emissions, and others about solid wastes.

Cleaner production is quite different. It is applied at the front end of processes and at the design stage of products. Cleaner production is, thus, preventive rather than reactive. In a cleaner production mode, one worries about the totality—the entire system—rather than just focusing on one component, just one output.

With this in mind, the objectives of the Cleaner Production Programme are:

- to increase worldwide awareness of the preventive environmental protection strategy embodied in cleaner production, and
- to help government and industry develop cleaner production programmes and activities that will expand the adoption of cleaner production now-how and management approaches.

These objectives are met by carrying out activities under several closely related elements:

- Training and Technical Assistance,
- Publications,
- Working Groups, and
- International Cleaner Production Information Clearing-house (ICPIC).

6.1 Training and Technical Assistance

Over the next two years, the activities of the Cleaner Production programme will increasingly focus on promoting self-sustaining cleaner production programmes in developing countries. Building capacity within an organization, governmental or pri-

vate sector, is the most effective way to ensure that the cleaner production philosophy is implemented.

The process started in Paris in September 1991 when UNEP IE held a workshop so that industry and government experts from developing countries could meet and discuss their needs with experts from countries that already have programmes underway. Developing country participants came from China, India, Malaysia, the Philippines, Egypt, Poland, Russia, Mexico, Venezuela, Ecuador and Brazil. By the end of the workshop, participants drafted cleaner production action plans either on a regional or country basis. The China Cleaner Production Programme, developed in cooperation with UNEP IE and partly funded by the World Bank, is an outcome of this meeting. (See Section 8).

In turn, the Cleaner Production Programme drafted a strategy to support the needs identified at the workshop to make the action plans a reality. Ultimately, IE hopes to further support:

- Industry demonstration projects,
- National Cleaner Production centres in developing countries (see Section 7),
- Technical, managerial, and policy workshops and training sessions.

To aid the Cleaner Production Programme's training activities, as well as to support those of other organizations, the Programme is in the process of developing a cleaner production training manual.

6.2 Publications

Through various publications, the Cleaner Production Programme provides information on specific subjects and reaches people who do not have the necessary equipment to use ICPIP or who do not need frequent contact.

One of the latest publications is a booklet on Government Strategies and Policies for Cleaner Production. The booklet aims to explain to leaders in government and industry that cleaner production is likely to lead to economic benefits as well as environmental ones, that there is now an important window of opportunities that should be seized, and that cleaner production is the best way of fulfilling the requirements of Agenda 21. The booklet emphasizes the importance of the development of strategies and policies to implement cleaner production. It spells out an effective overall strategy in beginning a cleaner production programme, and describes some of the instruments that are available to governments for implementing cleaner production policies.

The most recent publication in the series of cleaner production technologies implemented in industry is the booklet Cleaner Production Worldwide II published in cooperation with the United Kingdom. The booklet is the third in this series. The booklet contains 23 examples of cleaner production techniques and procedures implemented all over the world. It shows that cleaner production works and is good business in developed and developing countries.

The Cleaner Production Newsletter, published twice a year in the spring and the fall, is available in English, French, Spanish, Chinese and Polish. It provides updates on the Programme's activities and the latest cleaner production news worldwide.

Other recent publications include: Cleaner Production in the Asia Pacific Economic Cooperation Region (in cooperation with US EPA); Cleaner Production Worldwide (in cooperation with UK); The Audit and Reduction Manual for Industrial Wastes (in cooperation with UNIDO); and the Climate Change and Efficiency in Industry (in cooperation with IPIECA).

A new series of booklets on cleaner production in specific industry sectors are under development. In 1996, booklets on cleaner production in the following industry sectors will be published:

- *Food Processing Industry
- *Leather Tanning Industry
- *Metal Manufacturing Industry
- *Textile Industry

6.3 Working Groups

The working groups link the Programme with cleaner production technology and policy development experts. The Programme currently has eight formal groups. Two groups cover issues on education, and policies strategies and instruments. The six others are organized by specific industrial sectors:

- Metal Finishing
- Textiles
- Leather Tanning
- Biotechnology
- Food
- Sustainable Product Development
- Policies and Strategies
- Education

The members of the working groups volunteer their time and talent. Some groups are supported with funds or in-kind services by associated groups. For instance, the Sustainable Product Development Working Group has been financed by the Dutch Ministry of Environment, the City of Amsterdam, and the Province of North Holland.

Working groups support the Cleaner Production Programme with experts from around the world and provide technical reviews for publications and information that goes into ICPIIC. They have been instrumental in providing new case studies.

Working groups also help disseminate information. The Textile Working Group publishes its own newsletter and has written a technical guide. The Policies and Strategies Working Group has been organizing seminars in Sweden, Lithuania, the Netherlands and United Kingdom. The Education Working Group has also organized a training workshop for NCPC directors.

6.4 International Cleaner Production Information Clearinghouse (ICPIC)

ICPIC has been developed by the U.S. Environmental Protection Agency to share information on Cleaner Production electronically. The original on-line system contained case-studies, publication abstracts, a bulletin of events, and a message centre.

In 1994, UNEP IE initiated a number of efforts to review and improve ICPIIC. As a result of quantitative and qualitative reviews of the on-line system, ICPIIC was taken off-line. Efforts was initiated to create new and expand existing information dissemination mechanisms. These efforts include: a diskette version of the database, an e-mail and a World Wide Web

connection via Internet, and additional hardcopy publications such as the Cleaner Production Newsletter, and the series Cleaner Production Worldwide.

The diskette version of ICPIIC will contain much of the same information as the on-line system. The major difference is that the on-line message centre will be replaced with the connection through Internet. The diskette version will be available by January 1996. The World Wide Web information is also under development.

6.5 Future of the Programme

In addition to these activities, the Cleaner Production Programme will be expanding its information dissemination efforts. For instance, the Cleaner Production Newsletter will be translated into more languages, including Russian and Arabic. ICPIIC is being technically and substantively upgraded. For example, the bulletin section has been modified and now carries the same information as the newsletter. The key consideration is to develop the latest and current means of information transfer (internet, etc.) while maintaining and maximizing the traditional methods of transfer such as publications.

7. Implementing Cleaner Production: The National Cleaner Production Centres Programme (NCPC)

The United Nations Industrial Development Organization (UNIDO) and UNEP IE have jointly launched a new project to promote cleaner production. This new programme is aimed to support National Cleaner Production Centres (NCPCs) in approximately 20 countries over a five year period. The NCPCs are to play a catalytic role in promoting cleaner production by providing technical information and advice, stimulating demonstrations of cleaner production techniques, and training in industry and government professionals. The centres are designed to be managed by experienced country nationals and hosted preferably in existing non-governmental organizations. Support for the project has come from the governments of Austria, Denmark, the Netherlands and UNEP.

In Phase One of the programme (started late 1994), NCPCs have been established and in operation in the following countries:

- *Brazil
- *China
- *Czech Republic
- *India
- *Mexico
- *Slovak Republic
- *Tanzania
- *Zimbabwe

On 13-15 December 1995 UNIDO and UNEP will host the first annual experience exchange meeting between the partners of the NCPC programme. The achievements of each NCPC will be accessed and the joint UNIDO/UNEP initiative will be evaluated. The expected outcome of the meeting is a improved strategy for the joint programme.

7.1 Why NCPCs?

Several compelling reasons are evident for UNIDO and UNEP to support the establishment of NCPCs in developing countries.

There are needs to:

- Change national policies and industrial approaches in developing countries regarding industrial environmental management if they want to achieve ecologically sustainable industrial development. Current policies and approaches reflect earlier strategies of environmental management from industrialized countries. The strategies rely on dilution as the solution to pollution, and pollution control as an option in some environmentally degraded situations.
- Stimulate better information and technology transfer/adaptation from industrialized and developing countries to industrial enterprises and environmental management agencies in developing countries. These needs were voiced at the Rio Conference.
- Demonstrate in developing countries the environmental and financial advantages of cleaner production techniques and technologies. Show that cleaner production techniques and technologies are appropriate to their specific situations. Success of this approach has been illustrated in the IE supported Cleaner Production Programme in China, described in the following section.
- Coordinate the promotion of cleaner production amongst international organizations such as UNIDO and UNEP (as well as bilateral and multilateral organizations). Both UNIDO and UNEP have several activities that are encouraging cleaner production. These activities reflect individual requests coming from countries and single purpose initiatives of UNIDO and UNEP rather than a more objective, strategic approach to specific needs of a country.
- Establish the capacity to develop and implement cleaner production. To enable this shift the NCPC project supports country initiatives that would formulate and implement a coordinated and integrated programme for cleaner production.

7.2 Draw on the Experience of Others

In designing and implementing the NCPC project, UNIDO and UNEP are drawing on the experiences of European and North American countries as well as UNIDO and UNEP experience from field projects. Of particular relevance are the PRISMA project in the Netherlands, the Landskrona Project in Sweden, the Norwegian-funded cleaner production project in Poland, the UNIDO projects in India on cleaner production, and the joint World Bank/UNEP/China Cleaner Production programme. All of these projects identified cleaner production techniques and technologies for companies based on results of waste reduction audits.

7.3 Follow-up to the UNCED Conference

UNIDO and UNEP believe that the NCPC project has the potential to be a significant and substantive follow-up to the Earth Summit. UNIDO and UNEP see NCPCs as playing an effective role in the transfer of technical information and technology from developed countries to industrial enterprises and environmental management agencies in developing countries.

More information about the joint UNIDO/UNEP NCPC programme can be obtained either from UNIDO, Environment and

Energy Branch, Vienna, Austria or from UNEP IE (address at the end of the document).

8. Implementing Cleaner Production: The China Project

The China Cleaner Production project is a component of a World Bank Technical Assistance Programme to China's National Environmental Protection Agency (NEPA). UNEP IE was requested by NEPA to assist in the design and development of a national cleaner production plan.

The plan will outline the priorities and steps to be taken for investment to be made over the next 3-5 year period.

The project was designed to:

- Develop and test a systematic approach to cleaner production in China.
- highlight the potential for cleaner production in 25-30 Chinese companies.
- develop effective cleaner production Policies, and to
- disseminate cleaner production in Chinese society in general.

The World Bank loan will finance technical innovations in some of the companies that take part in the project and disseminate the results to other industrial sectors in China and worldwide.

The project has four phases carried out over a three year period.

- **Preparation Phase:** In this phase documents available on cleaner production methodologies were translated into Chinese, three training seminars were held to train future trainers, and future trainers put their skill into practice conducting test audits in selected companies.
- **Demonstration Phase:** During this phase, three demonstration projects will be launched, these projects will consist of doing an audit, generating alternatives and implementing options, the experience gained, what the effective measures are and what the barriers are to implementing cleaner production, will be documented and the results publicized.
- **Policy Research Phase:** Concurrent to the demonstration projects, a set of policies to promote cleaner production will be developed by analyzing existing environmental and industrial policies, and their effects on cleaner production, and an evaluation of the existing effective cleaner production policies. Furthermore, obstacles that are identified during the demonstration projects will be fed into the final recommended options.
- **Information Dissemination Phase:** Results from the project will be disseminated throughout Chinese institutions, the Ultimate goal is to have 3000 companies working on cleaner production within the next five years.

The Preparation Phase was completed in 1993, and even in this early stage, substantial economic and environmental benefits have been identified.

- Sixty-seven cleaner production options, varying from managerial changes to process modifications were implemented. Most of them were low- and no-cost.
- Less than \$16,000 (US) was invested and over \$350,000 was saved.

- An average of more than 50% of the COD load in the waste water was eliminated.

During 1994 and 1995, the Demonstration Phase and the Policy research Phase will be completed. During this period, more experts will be trained, the "Chinese Cleaner production Assessment Manual" will be finalized, three industry specific manuals will be prepared, 30 company specific demonstration project will be completed, three models for disseminating the cleaner production concept will be drafted, and five policy studies with recommendations for improvements to existing policies and legislation. In addition, training materials and videos will be available for Chinese experts to assist in their efforts to disseminate the result of the project throughout China.

One of the great challenges in the future development of the Chinese Cleaner Production Programme will be to shift the investment policy from end-of-pipe equipment to the integrated cleaner production approach. This change in investment policy will generate industrial growth together with environmental improvements, a significant step forward in China's efforts to move towards sustainable development.

9. Conclusion

The agenda for the 21st century will be cleaner production. Together with industry, governments and other international organizations UNEP IE will continue to play a key role in setting the preventive strategy to help assure that our common future truly is sustainable. There is an urgent need for a shift in the traditional single media approach (e.g. air, water and energy) to

the preventive integrated multimedia approach of cleaner production.

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HOW TO USE THIS PUBLICATION

The *Energy and Environment Series* consists of a recent technical report on a current topic (in this case, waste minimization), followed by two sections containing abstracts of technical material.

The first section is entitled "Waste Minimization" and contains almost 500 abstracts of papers taken from three leading international databases on materials technology. The abstracts are arranged under three topics: metals, advanced materials and business aspects of materials technology.

The second section is entitled "CLEANTEC DATA" and contains a similar number of abstracts of technical reports (mostly unpublished), obtained and processed by UNIDO in the course of its energy and environment information activities. CLEANTEC DATA is the former name of the system of databases established by INTIB.

This latter section is subdivided according to the source of the information as follows: UNEP/IE (abstracts of material generated by the activities of the Industry and Environment office of UNEP); CEPIS/REPDISCA (data obtained from the Pan American Health Organizations' Centre for Sanitary Engineering and Environmental Sciences in Peru)—in Spanish: ENSIC (abstracts of theses from the Asian Institute of Technology); and ICPIIC Case Studies (reformatted from the originals provided by UNEP/IE).

All the abstracts include:

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- The title of the document in upper-case letters.
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The case studies have a more complex format in order to provide the necessary level of technical detail.

Three indexes are available, covering both data sections, using subject descriptors from the *Thesaurus of Metallurgical Terms* and *Thesaurus of Engineered Materials*, published by Materials Information, and the *Thesaurus of Industrial Development Terms*, published by UNIDO. Therefore, there may be variations in the application of terminology: from the three thesauri in some cases the use of singular or plural varies, in others American English spelling is used.

NB: Please note that the following terms will not be found in the subject index, as they are the main subject of this issue: cleaner production; low-waste technology; pollution prevention; recycling; or variations thereof.

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Unless otherwise specified, all abstracts presented in this volume have been prepared from documents available at the source of mentioned on the header for the respective sections. Should you be interested in a copy of the full text articles/reports presented here as abstracts, please send requests to the following addresses:

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Anyone wishing to obtain more details should contact UNEP/IE (see above) or write to the contacts given at the end of each item.

Waste Minimization:
The Case of Chlorinated Solvents in the Paint, Coating and Metal Cleaning
Industries

EXPLANATORY NOTES

- Besides the common abbreviations, symbols and terms, the following have been used in the present article:

CAA	Clean Air Act
CWA	Clean Water Act
CAS	The American Chemical Society's Chemical Abstract Service Number
CERCLA	The Comprehensive Environmental Response Compliance and Liability
EC	European Community
CFR	Code of Federal Regulations
CTRL	Chronic Toxicity Reference Level
FAO	Food & Agriculture Organization of the United Nations
ICPIC	International Production Information Clearing House
IACT	International Association For Clean Technology
IARC	International Agency for Research on Cancer
INFOTERRA	International Referral System
IRPTC	International Register of Potentially Toxic Chemicals (UNEP)
IUPAC	International Union of Pure and Applied Chemistry
NIOSH	National Institute for Occupational Safety and Health
OECD	The Organization for Economic Cooperation and Development
OSHA	Occupational Safety and Health Administration
OTA	Office of Technology Assessment (US Congress)
PER	Pollution emission register
PPIC	Pollution Prevention Information Clearinghouse (US/EPA)
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act (1986)
TLCP	Toxicity Characteristic Leaching Procedure
TRI	Toxic release inventory
UNEP/IEO:	Industry and Environment office of the United Nations Environment Programme
USACERL	U.S. Army Construction Engineering Research Laboratory
VOC	Volatile Organic Compound

This document was prepared for: UNIDO by Christina Ruiz

PREFACE

This information package has been prepared to describe the current situation of cleaner technologies and some specific aspects related to it such as chlorinated solvents and methods to reduce their use in the paint and coating as well as metal cleaning industries. The package consists of a short summary taken from different journals, conferences papers, and reports—reference to the original literature, contained in the bibliography, will provide more depth to this review.

An information package is intended as a time-saving tool which supplies primary information selected from a wide variety of existing sources which usually may not be readily accessible to developing countries.

I. INTRODUCTION

Environmental protection is now, more than ever, of high significance to nearly all countries. Regulations are being imposed to limit releases from industrial plants, and pollution control as a waste management measure no longer provides the solution to maintain a healthy environment and profitable industries.

Waste minimization and its many related synonyms are today's interpretation of waste management, that is, to prevent or reduce wastes at their source instead of treating the waste after generation, as is the case with conventional pollution control methods.

Waste treatment methods produce a large amount of new chemicals. For example, the United States Environmental Protection Agency (EPA) [1], estimates that incomplete combustion of waste produces thousands of new chemicals of which only about 100 have been identified. Furthermore, disposal methods are very often unsatisfactory as the waste as such still remains, even though in another form, hazardous to the environment.

Waste minimization brings several benefits to industry such as more efficient use of resources, less or no costs for waste treatment, elimination of future disposal-related liabilities, safer working conditions, and a positive public image. Experience has shown that the investment required to implement waste minimization methods can be returned within 3 years or even less, based on the factors indicated above [2].

Waste minimization will also reduce the (legal and illegal) traffic in hazardous wastes, which are frequently exported to developing countries for disposal. Around 3 million tonnes [3] of toxic wastes have been transported from Western Europe and North America to other countries in the last six years. Regulations, the increasing costs of pollution control methods and fines for non-compliance are, however, slowly forcing industrial sectors towards waste minimization strategies.

Over 400 million tonnes [3] of hazardous wastes are generated annually, mostly by developed countries. The chemical industry, in particular, is responsible for 50% of the wastes generated. This result would predicate that short rather than long term

measures should be the main concern in this industrial sector, with special attention given to wastes containing hazardous substances such as chlorinated organic compounds, heavy metals, cyanides, and radioactive elements.

The competitive nature of this sector would also favour waste minimization, since this is a cost-effective method. Such is the case in the paint and coating industry where companies have merged due to harsh regulations forcing them to spend more on pollution control, which also led to the closure of small coating manufacturers. Waste minimization can be achieved by simple and inexpensive procedures, such as housekeeping (e.g. careful control of raw materials and energy).

Several companies in the United States are now involved in complete waste minimization programmes: 3M with its successful programme "Pollution Prevention Pays", Dow Chemical Co., whose programme "Waste Reduction Always Pays" (WRAP) won in 1989 a international award and AMOCO Chemical Co., just to mention a few.

Despite the proven benefits of waste minimization, governments have been reluctant to support this approach. For example, in the United States, a leader in environmental issues, less than 1% [4, p.621] of the 1988 federal budget was devoted to this subject whereas international organizations such as EC, OECD, UNIDO, UNEP have included waste minimization programmes in their main activities. Strong public concern about environmental issues is one of the most powerful means to force industry to take preventive action in pollution control.

Waste minimization is, however, facing many obstacles in spite of the benefits it would bring. For instance, lack of information on all levels in industry and government hampers the spread of waste minimization techniques.

This is especially true in developing countries. An important factor here is the high cost of telecommunications resulting in a heavy information deficit on the latest advances in environmental technologies. An example of where such information is badly needed is at the level of national legislation. In most developing countries it is not even possible to ensure safe working conditions, especially in the mining, chemical, metallurgical, and electroplating industries, all of which are sources of hazardous wastes.

This report attempts to describe the current state of knowledge in relation to the different approaches to pollution prevention and minimization of wastes containing chlorinated solvents. In addition, three specific (hazardous) chlorinated compounds which are of main concern for relevant industrial sectors were selected for review: 1,2-dichloroethane, methylene chloride and pentachlorophenol.

The paint and coating as well as metal cleaning industries, where considerable efforts have been undertaken to minimize wastes, will be highlighted in this paper and illustrated by numerous examples available in current literature. Supplementary information covering a variety of related aspects of waste minimization is available from UNIDO upon request.

II. DEFINITION OF POLLUTION PREVENTION

The only possible way to protect the environment is to change from pollution control to pollution prevention options. The former means handling wastes after they are generated. The latter means avoid, eliminate, or reduce wastes.

The concept of reducing the generation of hazardous wastes during the production process has adopted several synonyms according to the different environmental organizations dealing with the subject. Most common are:

- Pollution prevention: used by EPA
- Waste minimization: used in the United States
- Waste reduction: long-used term
- Cleaner production: used by UNEP
- Low- and free-waste technologies

"Waste reduction" was used a long time ago, and it is more related to United States governmental actions in this matter. It always referred to cutting waste at its source (source reduction). This term will be used the most in this report.

However, there is an on-going confusion about what is termed waste minimization. Because environmental organizations are still at the developing stages in this matter, indications about the priority of waste minimization sometimes appear discordant. That is particularly certain when recycling is the option being considered.

To the Office of Technology Assessment (OTA), waste reduction is the way to avoid, eliminate or reduce wastes in a plant—a substantial benefit to the worker, company and the environment [5]. This can be achieved at various levels through changes in technology, process, and operating procedures. OTA's definition does not refer to recycling techniques as waste reduction, unless the wastes are recycled in the same production process. According to it waste reduction does not include for example, incineration, stability or storage [6, p.4], even though these methods are preferable to land disposal. OTA's definition, in general terms, excludes pollution control methods as they only transfer pollution from one medium to another.

Waste minimization, as defined by EPA [3], includes the first option of waste reduction plus recycling (fig.1). The former looks similar to the OTA definition. EPA includes the following definitions:

Waste minimization: The reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, stored or disposed of. It includes any source reduction or recycling activity undertaken by a generator that results in either the reduction of total volume or quantity of hazardous waste[7] or the reduction of toxicity of the hazardous waste[8], or both, so long as such reduction is consistent with the goal of minimizing present and

future threats to human health and the environment.

Source reduction: Any activity that reduces or eliminates the generation of hazardous waste at the source, usually within a process.

— (EPA's Report to Congress, 1986, EPA 530-SW-86-033)

However its definition of recycling lacks clearly defined borders and could be understood as different recycling options and even as waste treatment.

As an illustration of the still unclear concept of waste reduction, Hirschhorn[9] mentions that in a conference, representatives of Olin Corp. described "four important achievements in waste reduction: a wastewater treatment plant, a cyanide-waste treatment plant, an incinerator, and a facility to turn wastes into concrete-like material that can be buried". They even showed savings applying the "new technique". However, according to the basic concept, they are waste management methods, not waste reduction.

III. ORGANIZATIONS INVOLVED IN POLLUTION PREVENTION

A. International organizations

1. United Nations Environment Programme (UNEP)

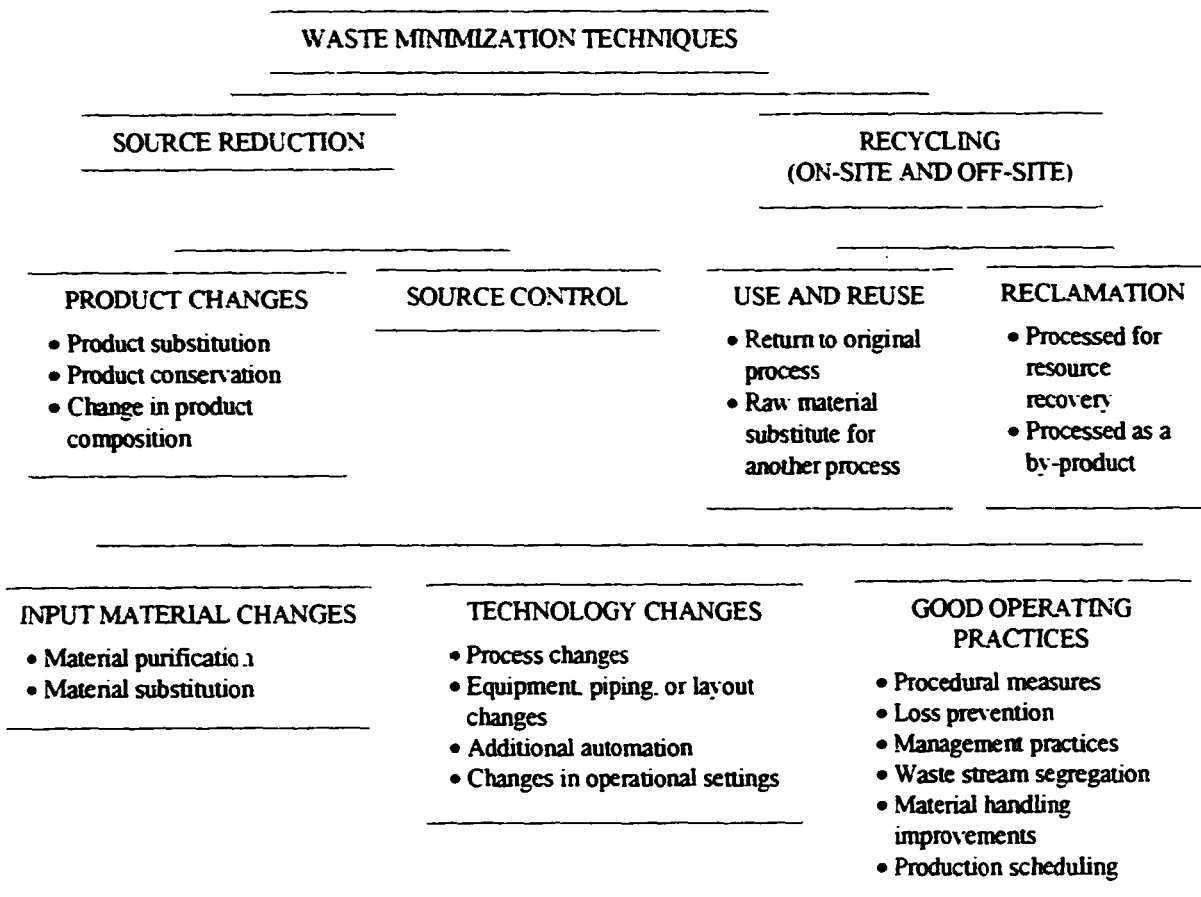
UNEP was created as a result of the United Nations Conference on the Human Environment, Stockholm. Its main concern is a programme of global environment quality monitoring.

Hazardous wastes, an unfortunate aspect of industrial development, have been recognized as the major threat to environmental quality. Therefore, UNEP plays a key role in promoting strategies of hazardous waste management along with legal mechanisms to protect the global environment from waste generators.

Since the 1980's, through its Cleaner Production Programme, UNEP is reorienting the environmental protection principle from traditional pollution control to waste reduction in all industrial activities. For such purposes, help is given to developing countries to adopt the use of waste reduction methods where possible. Main activities to meet this objective are information gathering and dissemination, increasing awareness of the subject, training, and cooperative projects.

Through its different surveillance facilities, Earthwatch, and the United Nations world-wide network, UNEP collects data which is made into practical information useful to decision making for environmental policy and general purposes. The Earthwatch system includes the International Register of Potentially Toxic Chemicals (IRPTC), the International Referral System (INFOTERRA), and the Global Environmental Monitoring System (GEM). Several publications about the subject are available from UNEP.

Figure 1. Waste minimization techniques



— Source: EPA, ref. 50

- **Montreal Protocol:** an agreement signed in 1987 by thirty governments and the European Community. Its main objective is to protect the ozone layer and assess the impact of chlorofluorocarbons (CFCs). The Protocol came into force in 1989, by establishing short-term objectives, such as the gradual reduction of CFCs consumption up to 50% by 1999.

Additional ozone-depleting chemicals, such as halons, carbon tetrachloride, and methyl chloroform, are also to be phased out around the year 2000. To cope with the phasing out, CFC producers in developing countries will be supported financially to aid development of alternative technologies.

Under the agreement UNEP is responsible for promoting its objectives, education and training work, holding and sponsoring conferences, cooperation reinforcement among governments, industry, and non-government organizations, permanent assessment of alternative options as well as data collection and clearing-house functions.

- **Basel Convention:** Transfer, handling and disposal of hazardous wastes is a priority area of work in UNEP which caused in 1989 the adoption of the Basel Conven-

tion on the Control of Transboundary Movement of Hazardous Wastes and their Disposal.

The Basel Convention, signed by 116 countries and the European Community, refers to the restriction and controlling measures of international transport of hazardous wastes and their disposal. The agreement seeks to reduce hazardous waste generation by reducing the transfer of wastes to developing countries for disposal. Some aspects of the treaty include:

- Countries under agreement may not send their hazardous wastes to countries where they have been banned, or countries where are not signatories of the treaty.
- Free decision of countries to accept or reject the transfer of them.
- Full information about background and composition of wastes to be exported.

The Basel Convention includes a list of 45 categories of non-radioactive wastes that are considered wastes. Among the most important are heavy metals, organic cyanides, phenols, and phosphorus compounds. Industrial solvents, a main subject to be dealt with in this report, are under the scope of UNEP's Cleaner Production Program.

UNEP is responsible for promoting the use of new routes in production processes and products using solvents to reduce emissions and wastes. A working group is devoted to halogenated solvents. Its objective is to identify and disseminate successful examples of substitution and reuse of halogenated solvents.

UNEP has developed several computerized information sources helping signatory countries involved in UNEP programmes such as the Information Source Ozone Action Information Clearing House and the International Production Information Clearing House (ICPIC).

2. United Nations Industrial Development Organization (UNIDO)

UNIDO is a specialized United Nations agency devoted to promoting and strengthening industrial development in developing countries.

A top priority of UNIDO's activity has usually been the reduction of waste in order to improve efficiency, commonly referred to as "process optimization". Developments achieved in the textile and leather sectors are examples in this field. An increasing percentage of projects carried out in developing countries are concerned with environmental issues. UNIDO is working in many developing countries on cleaner production projects with the aim to demonstrate dual benefits to the company and to the environment applying this concept. Some examples include the cement sector (Egypt), sugar cane sector (Mexico), metal finishing (Pakistan), and the pulp and (India) paper sector.

Coordination of UNIDO with environmental agencies increases its scope of assistance on the subject. A program covering a five year period with UNEP has been initiated to support National Cleaner Production Centres (NCPCs) in approximately 20 countries. However, UNIDO is conscious that government's policies and lack of information are barriers to the advancement of cleaner technology in those countries. Therefore, it will endeavor to identify those aspects of industrial policies which are restraining the choice of cleaner technologies and seek suitable alternatives.

Information is being provided by UNIDO to developing countries, and guidelines are being drawn up in over 50 sectors with help from the World Bank and UNEP. Likewise, UNIDO is supporting specialized technical reports from UNEP on cleaner production in several industrial sectors. Major information products and symposia supported by UNIDO related to this approach are available from UNIDO upon request.

Future work of UNIDO will involve the evaluation of the environmental impact from hazardous waste management projects, training in hazardous wastes management, and hazardous waste reduction.

The promotion of environmentally sound management of toxic chemicals is another field of work of UNIDO. Therefore, it is constantly in touch with several organizations in order to achieve this. Amongst them, we can mention the World Health Organization (WHO), World Bank, FAO, and IUPAC.

Through its Environment Programme, UNIDO is supporting cleaner production activities. Being conscious of the value of

information related to these goals, an overall information program was developed, making use of all existing information resources available in UNIDO. In order to provide information services and products to industries, UNIDO has established computerized information systems and networks under the supervision of UNIDO's Technological Information Bank (INTIB).

a. Industrial and Technological Information Bank

Through its Industrial and Technological Information Bank (INTIB), UNIDO has access to the latest developments in the industrial sphere.

In order to promote to small industries in developing countries the practice of cleaner technologies, INTIB maintains the Energy and Environment Information System (EEIS). This task is coordinated with key institutions in those countries which facilitate the flow of information to small and medium-size industries.

The EEIS provides many cost-effective information services covering a wide range of sources, such as directories (institutions, experts), available technologies, state of the art reports, and information packages. This work is extremely valuable taking into account that a major barrier for these countries is the high cost of commercial computerized information systems. INTIB databases include:

- Industrial Development Abstracts (IDA): abstracts from reports on UNIDO's technical assistance activities.
- Referral Database on Energy and Environment (REED): a multipurpose database including institutions, experts, training, bibliographies, industrial process descriptions, environmental audit, etc.

B. United States environmental regulations

Industrial hazardous wastes are a high priority concern for developed countries' governments. The United States is no exception, having an enormous task in environmental protection. Many organizations such as the Congress Office of Technology Assessment (OTA), the National Academy of Sciences (NAS), and EPA's science authorities strongly support the adoption of waste minimization strategies.

Subsequently, many items of United States environmental legislation have been passed: the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA), the Clean Water Act (CWA), and the Comprehensive Environmental Response Compliance and Liability (CERCLA). According to current United States environmental policy, 3 federal programmes to reduce pollution have been established: the Pollution Prevention Act (1990), the EPA's 33/50 Program (Voluntary Reduction Program), and the Clean Air Amendments' Early Reduction Program. Nearly half of the states have already established or proposed pollution prevention legislation.

Pollution prevention is gaining acceptance worldwide. The revolutionary concept of sustainable development as a priority element to be included in national plans is an effective alternative to waste management. In the international sphere, organizations such OECD, UNIDO, and UNEP have reinforced this

approach by elaborating complete studies on the matter and holding relevant conferences on sustainable development.

Other countries have also developed pollution prevention programmes, some of them more stringent than those in the United States. Significant examples to mention are the Japan Air Pollution Program and the Netherlands Hazardous Waste Program. Canada has also implemented a pollution prevention program (Green Plan).

1. The United States Environmental Protection Agency (EPA)

The EPA was established in 1970. Its directives are nationwide. Even though its policy was clear about waste reduction as a first choice of waste management, the government never followed these measures with effective programmes. On the contrary, the emphasis was put into pollution control rather than pollution prevention.

Nevertheless, United States industries recognized benefits from preventing wastes at the source rather than facing large costs for pollution control or legal actions for health injuries.

RCRA (1976), which deals directly with hazardous wastes, is under EPA administration. By this law industry is required to design a system able to track wastes from their source to final site of treatment, storage, and disposal. In the United States, the hazardous and solid waste amendments of 1984 require that all generators establish waste minimization programmes. They are also required to submit an accounting of waste minimization activities along with effective reduction achieved in terms of toxicity and waste volume. An important EPA program designed to reduce hazardous waste is the Superfund Program created under authority of the CERCLA.

The Emergency Planning and Community Right to Know Act, commonly named TITLE III of the Superfund Amendment and Reauthorization Act (SARA), was adopted in 1986. The law came into force in 1987 and requires that United States manufacturers report annually to EPA their total toxic chemical releases. To that purpose, the Toxic Release Inventory (TRI) has been established containing information on more than 300 chemicals. The TRI is divided into 20 categories of chemicals released into the air, water, and soils by manufacturers. In this way, the TRI provides to the public information about emissions and other toxic chemical releases spread within the entire country.

IV. ECONOMICS OF WASTE REDUCTION

This aspect is the key element in achieving the "go ahead" for waste reduction projects. The economic evaluation of a waste reduction project through its different aspects allows the company to estimate and assess financial costs and benefits. This information can be compared to the costs of conventional waste management.

Factors such as increasing costs of waste management and its disposal liabilities are decisive in determining whether companies should devote efforts towards waste reduction alternatives.

These options are now being given priority by many companies, particularly those with a high level of waste production,

for example, electroplating, steelmaking or those who have already had legal confrontations due to violation of environmental regulations [10]. For those plants where waste management is minimal, the economics will not be relevant at this stage.

A. Importance

Competition for funds, as always, is high, especially when the waste reduction practice is still unknown. The allocated budget is more likely to be used for a more familiar, reliable waste treatment technique, where equipment is "in place" and operators are already trained. In order to be considered, it must be demonstrated that the new option is technically and economically feasible. The cost reduction at each stage of the process should be apparent. Because of the severity of environmental regulations, waste treatment costs play an important role in day to day running costs, so any reduction in these will influence the chances of a waste reduction project being installed.

B. Some economic considerations

It is important how companies allocate their resources in the day to day planning of waste management, as it can seriously affect the way decisions about waste reduction are made. The key point is exactly how they assign the waste treatment costs to the process or plant producing the wastes. For example, when these costs are included in the plant's manager's budget as production costs and therefore come under his scrutiny, they will serve as an incentive for cost reduction, thus indirectly influencing the choice of waste reduction alternatives.

Companies assessing a waste reduction project often only account for direct costs, such as process equipment, raw materials, labor and waste disposal. Significant indirect costs such as waste treatment, permits and training and less tangible costs such as company image and consumer response are usually omitted.

However, according to EPA [11], with severe environmental regulations, the initial permit costs must now be included in the capital costs for many of the recycling and existing waste management techniques. Many of the new waste reduction options have the advantage that environmental permits are not required. For a new company, the inclusion of waste reduction techniques is obviously beneficial. It is also important to consider that any cost/benefit analysis will be valid for a fixed time, due to fluctuating raw material costs, liabilities, etc.

C. General analysis procedures

Many methods of financial analysis are available to help managers to assess the real value of a capital investment if a waste reduction project is being assessed. Firms (especially the new ones) can presently show economic benefits if they do not have any cost for waste treatment or disposal units. Capital and operation costs are two major components in waste reduction projects. Data on these can be obtained from different sources, such as EPA's Data Banks, vendors, and conferences.

To cope with all those "hidden" costs, usually omitted in a conventional project financial analysis, Freeman [4, p.637], mentions the Total Cost Assessment (TCA), prepared by the Tellus Institute for the Northeast Waste Management Officials

Association (NEWMOA). TCA allows the decision-makers to have a wider perspective on waste reduction investments than those supplied by traditional financial analysis methods.

The TCA has been designed for long-term costs and savings paybacks for waste reduction options, assessing, in particular, all those omitted costs along with liabilities costs. It is claimed to be a simple method to learn and use, requiring only basic knowledge of computers, financial language and calculations. The extensive collection of data required by a TCA constitutes an invaluable source of information on waste composition and management costs which is rather difficult to get for other systems.

Another method available is by EPA. Profitability is estimated using standard indicators such as the payback period and discounted cash flows, return on investment, and net present value. A summarized list of items for capital and operation costs from this method includes:

1. Capital costs:

- (a) Purchased process equipment
- (b) Materials
- (c) Utility connection
- (d) Site preparation
- (e) Estimated installation
- (f) Engineering and procurement
- (g) Start-up
- (h) Training
- (i) Initial catalysts and chemicals
- (j) Working capital
- (k) Equipment salvage value

2. Incremental operating costs and revenue:

- (a) Waste disposal
- (b) Raw material consumption
- (c) Ancillary catalysts and chemicals
- (d) Labor costs
- (e) Maintenance and supplies
- (f) Insurance and liability
- (g) Increased/decreased production
- (h) Marketable by-products

— Source: Freeman, H., et al. (1992) *J. Air Waste Manage. Assoc.*, Vol. 42, No 5, p.638, May 1992

Relevant costs such as disposal, shipping, waste treatment charges, raw materials costs, operating and maintenance costs, must be prioritized when assessing a waste reduction project. They are very easy to calculate, and savings on these costs are of great significance in assessing a waste reduction project economically.

In this method, to obtain profitability data, one must use the estimated net cash flows for each year of the project's life, for example, the difference between the cash income and outlays. If the capital is not represented in a project, cost-effectiveness can be assessed by operating costs. However, for projects with large costs, a more exhaustive evaluation must be done.

The payback period is a technique to assess profitability. It refers to time in which a project can recover the initial cash outlay. Usually given in years, the general formula [11] is:

$$\text{Payback period (in years)} = \frac{\text{Capital investment}}{\text{Annual operating cost savings}}$$

The payback method is recommended for a quick assessment of profitability. For low-risk investments, a payback period from 3-4 years is considered acceptable. The remaining discounted cash flows techniques (IRR: internal rate return, NPV: net present value), are more useful for projects that have to compete for funding. According to EPA, for projects with a low level of risk, an IRR (after tax) from 12-15% is normally acceptable.

Although a waste reduction project reduces environmental pollution and is a safety risk for a company, one cannot be certain that this method can totally eliminate liabilities.

The EPA method includes worksheets to collect the different data required to prepare the financial study. Worksheet No.15, includes a checklist of capital and operating cost items. Sheets No.16,17 explain how to find a simple payback, IRR and NPV for projects requiring capital investment. Sheet No.9 is also included to calculate payback, capital and operating costs if a simplified, assessment is needed.

For more detailed information, refer to the EPA manual [11].

- Freeman reviews another relevant method of cost analysis, "The economic analysis model for hazardous waste minimization", prepared by the United States army (USACERL). This technique allows the user to evaluate the life cycle costs for different hazardous waste reduction options and finally to compare this result with the life cycle cost of the current process. Priority is given to source reduction, recovery and/or reuse, and treatment, respectively.

This system has been designed to assess the financial costs of six waste streams of more concern for the United States Army: waste solvents, electroplating operation wastes, paint-stripping wastes, industrial wastewater sludges, used oils, and batteries.

This method is widely used in over 60 army installations in the United States. It also allows assessment of waste reduction options in other waste-streams. Dharmavaram et al [12] provide more detailed information about this method.

- Another EPA method of cost analysis has been prepared by the Office of Solid Wastes and contained in the "Pollution Prevention benefits Manual". Here, costs are compared between different waste reduction options and the current process practice. The assessment is carried out according to cost level (Tier 0,1,2,3) as named by McHugh [13].

Tiers 0,1,2 and 3 are referred to normal as costs, hidden costs, liability, and intangible costs, respectively. In this method, at each incremental Tier, estimated costs of waste reduction option are compared with all the cost savings resulting from the waste reduction option over the current process. These costs are financially treated to determine whether the project is cost-effective, for example, at Tier 0 (normal or usual costs). Depending on the results, the analysis might be broadened to other alternatives (Tier 1,2,3)

Financial assessment at Tier 0 could be enough, for example, with new plants, which are just starting with the implementation of a waste reduction project. They can directly show economic benefits as they do not have any expenses for waste treatment or disposal units.

Tier 1 adds benefits to Tier 0, such as avoided regulatory costs which can be omitted if the waste reduction option is implemented. Tier 2 adds avoided potential liability costs to Tier 1. It could refer to any kind of penalties or failure which could be disastrous for the company. Tier 3 adds intangible costs to Tier 2, such as the company's image, for example. Beyond Tier 3, there still is still not a valid assessment, as McHugh states.

- Doerr [14] also proposes a method that can be used by CPI companies, when a technical and economic assessment for different options is needed.

V. BARRIERS

Barriers interfering with progress in waste reduction are well documented. Freeman [15] identifies barriers as governmental or corporate. The former are related to regulatory impediments, actions in pollution prevention, and precision in concepts in this opinion.

According to Palmer, as quoted in Hunt [16], the main barriers for waste reduction are political and financial accounting. Both of them account for 90% of the total obstacles. The remaining 10% is accounted for by technical aspects. Table 1 breaks down components of the main factors.

Huisingsh [16], has shown that these percentages are different from firm to firm and for industrial branches as well. He highlights that of EPA's 1988 budget, pollution prevention accounted for nearly 1% of the budget devoted to pollution control. Some of these obstacles identified by experts are mentioned:

A. Lack of information

This is the main barrier to waste reduction. It is of crucial importance that different levels of staff in industry have access to information about the benefits of a waste reduction programme to the company, worker health, and to the environment.

Price [17] points out that insufficient dissemination of information makes it difficult for manufacturers to be aware of the trend of waste reduction. Therefore, they are unable to identify the options open to them regarding waste reduction within their operations. He also mentions the lack of centralized information about waste reduction options and complains that the collection of information is rather difficult.

Lack of information exists at different levels within the industry, where sometimes no exchange is done. In other cases, information exists but companies consider their results confidential.

Personnel are not educated to a sufficient degree about waste reduction and usually refer to it as waste treatment. A survey [9] reported that 75% of companies questioned mentioned improved waste treatment as "achievements" in waste reduction.

A very important study, carried out by INTTB [18] to assess the current supply of industrial information in developing coun-

tries, mentioned that there are very few systems working there, and these are not targeted to small industries. Nevertheless, information demand in this sector is increasing. It must be taken into account that small industries in these countries are responsible for a considerable part of the total industrial output.

B. Ambiguous environmental policies and regulations

Advantages of waste reduction in the United States were recognized only ten years ago, and then only in theory [17]. The federal environmental policy was a main factor in this trend. Experts state that there is not enough data about wastes generated by industries, which would help the governments' decision-making bodies to implement policies about the future of pollution prevention.

Environmental regulations have been strongly criticised by specialists in the subject such as Byers [19], Smith [20], Frosch and Gallopoulos [21]. They state that regulatory barriers constitute the largest obstacle to a waste reduction program in the industry. To them, these laws make waste reduction more diffi-

TABLE 1. Obstacles to waste reduction

Political (60%)	
20%	Bureaucratic resistance
10%	Human conservatism
10%	Piecemeal legislation
10%	Media sensationalism
10%	Public ignorance and misinformation
Financial (30%)	
10%	Disposal "subsidies"
10%	Scarce money
10%	Entrenched disposal industry
Technical (10%)	
5%	Lack of centralized
5%	Lack of assistance with the application of waste reduction approaches to individual needs/uses

— Source Huisingsh, D., *Env. & Ind.*, vol 12, No 1, 1989, p 4

cult than disposal. Special criticism is directed at the RCRA. Byers suggests at this point that:

a new RCRA pollution prevention waste minimization subtitle is proposed to eliminate or minimize these barriers.

Byers provides examples about how legislation has blocked the success of waste reduction for most important industrial wastes. EPA has recognized its limitations in this new and relevant field of technology. Therefore, cooperation of generators is necessary to attain a long term policy.

C. Cultural barriers

Cultural barriers or attitudes are the biggest impediments to the implementation of waste reduction measures by industry. This is also a factor of special concern to the EPA. A main aspect in attitudes is resistance to change. Companies believe that a change in the usual process can affect the quality of the product. 3M has experienced this problem and had to go back to the previous process because the product was not accepted in the market.

Attitudes affect all different levels of staff in the company, from top managers to workers. Administrative obstacles and reluctance to allocate resources to this purpose are mentioned as examples of negative attitudes toward waste reduction [6].

Here, 3M is also mentioned as an example of good attitudes toward pollution prevention: in spite of problems faced through the setting of a waste reduction program, it has made a considerable effort to openly support these methods as the best alternative to pollution control.

Pollack [22], points out some aspects making the change to the new option difficult: engineering studies only encompass pollution control methods, banks only prioritize investment for pollution control projects, and facilities with this method are also required by environmental laws. According to the author, licensors selling technology for pollution control methods are another obstacle to the new option, taking into account that they represent an industry of US\$ 200 million.

People can be influenced by different factors [10]. Public opinion is an important element to influence decision makers' in companies. In this case, public opinion can be a stimulating or frustrating factor for managers. News about industrial disasters usually has higher impact than news about waste reduction methods.

A training program is necessary for staff so that they are made aware of the advantages and benefits of the change to waste reduction. This subject must be viewed broadly in order to understand how crucial this method is to the long term support of life in the world. PPG industries [23] makes use of video programmes to motivate its employees. They show results achieved in the practice by waste reduction using practical examples.

D. Financial barriers

Resources for this purpose are very difficult to obtain due to the lack of funds, especially for infrastructure projects. This is more difficult for environmental issues. To describe this situation in the United States, Domenici [24] says that funds for public services decreased from 2.3% of GNP in the 1960's to 1.1% in the 1990's. Therefore, new financial means have to be found to overcome government's attitudes. The EPA is working in this sense by creating incentives to provide funds for environmental programmes.

The EPA has identified barriers which affect resource availability. It recognizes obstacles such as tax policies, regulations, doubts about future requirements in environmental protection and the crucial resistance to change. For some companies the relatively high start-up cost of some waste reduction projects creates a barrier to investment. Even if companies are conscious of its cost-effectiveness in the long term, they prefer short term waste reduction projects because they are an easy and low-cost option.

E. Research and Development

R&D is another key factor responsible for advances in waste reduction. Even more is needed to develop this area because in general, there are not available technologies. R&D efforts can help greatly reduce wastes.

Because environmental technology is a new field, there is a shortage of experts to cope with waste reduction techniques. Apart from that, technical staff has been reduced because of the critical situation in many industries. Another barrier is created by licensors of technologies for waste management equipment. For them, waste reduction is a threat to their business.

VI. WASTE REDUCTION TECHNIQUES

This section briefly reviews techniques to reduce wastes and will be based mainly on reports from Hunt [9] and EPA [11], which describe exhaustively all of these aspects. The concept has been well known throughout industry for several years. It can range from very simple changes (housekeeping) to sophisticated recovery equipment. To select a technique, one must bear in mind the existing levels of waste reduction previously mentioned: one should therefore assess the benefits and advantages of the first option, source reduction, which is the most environmentally healthy technique to reduce waste.

There exist four main levels of waste reduction options: inventory management, production process modifications, source segregation, and on-site recovery. Some aspects mentioned here are considered good housekeeping practices. They include inventory management, preventive maintenance, and source segregation. Good housekeeping practices must be applied not only to the production process but to the whole plant as well.

Hunt [25] recommends an evaluation of the effects of the selected option on all the waste streams before its complete implementation. To evaluate a waste reduction technique, it is of great importance to gather the necessary information, which

is available through technical literature, such as, journal articles, conferences, vendors manuals, and consultants.

A. Inventory management

This can be considered as the first step in waste reduction. Adequate stock control should be taken of incoming raw materials, intermediates, products, and wastestreams, and hence, considered as a technique of waste reduction. Thus saving the disposing costs of these materials, and also costs involved in keeping useless materials.

Two aspects should be considered:

- The control of the types and amounts of materials used in the plant inventory: inventory control
- The control of handling of raw materials, end products and wastestreams in the production facility: material control.

It is very important to handle a waste as if it were a product. This will favour waste reduction, while improving options to recover it.

1. Inventory control

This can only be carried out with trained personnel, particularly in the purchase department. They should be conscious of the extra costs required to dispose of excess raw materials. Various examples plus ideas for improvement are given by Hunt.

Although widely used in industry, the relevance of inventory control as an effective waste reduction technique is still overlooked.

However, there is at present a new method called Just-In-Time (JIT) manufacturing techniques, whose main feature being that any intermediary storage is avoided. Raw materials are transferred directly from the receiving dock in the plant for immediate use. The technique eliminates inventory. In practice 3M reduced their wastes from 25% to 65% in its individual plants [26].

Developing review procedures is also a technique to improve inventory control. Materials should be evaluated before purchase for their hazardous content.

2. Material control

Material losses can be due to leaks, spills, or contamination. Some examples are given by Hunt. An adequate method of material control ensures that the raw material will be correctly handled to ensure no loss before it enters the manufacturing process. Typical problem areas are the loading, storage, and processing areas. Again, workers should be sufficiently trained and taught to deal with waste as though it were a product. According to the author, at least one person should be responsible for this.

B. Preventive maintenance programme

This is one of the most ignored areas in the plant, along with operation procedures. Traditional practices in maintenance make the transition to the use of preventive methods quite difficult, even though changes in these areas are usually simple and cost-effective. Any change must be supported by a great

deal of information about the sources and causes of waste in the process.

In order to avoid waste from deficient equipment, operating procedures must include a good maintenance program.

Tight inventories and accurate maintenance activity reports should be kept. Typical inventories should be of equipment, operating-time limits, maintenance inventory, product and equipment inventory problems and their solutions, maintenance manuals, etc.

Computerized maintenance programs are available from vendors.

C. Production process modifications

The greater the efficiency achieved in a production process, the fewer wastes generated. The principle methods to reduce wastes in the production process are changes in materials, equipment, and operation procedures. Examples are included in Freeman [4, p.630].

1. Material change

Formulations containing hazardous compounds can be replaced by less hazardous or non-hazardous compounds. This is a complex task, involving a great deal of work and research to ensure the quality of the product. A good example is the transition from solvent-based paint to water-based paint. Not only are the wastes in the production process reduced, but also in the application of the end product. Other examples include removing pigments containing heavy metals from paints, inks and dyes.

The replacement of solvent-based by water-based products is a good example and is now commonly used among manufacturers of paints, inks and coatings, and cleaning products.

Using this substitution [27], a diesel engine manufacturing facility replacing its solvent-based cleaning products with water-based cleaning products could reduce its costs around 40%. Additional benefits were that a cleaning step was eliminated, and machine filters lasted longer, that is, a reduction in material and labor costs.

There is a danger, however, when the change is not documented well enough, the process, product and waste reduction can be adversely affected. The latter is usually ignored when any modification is carried out and the whole waste-stream produced by the plant is often not taken into account. Before any change, a careful evaluation must be done to know the potential effects of the substitution on the process, the product, the costs involved and waste management. Potential health risks must also be taken into account. A pilot-scale work is recommended [25] before project implementation.

In the previous substitution example, volumes of wastewaters can increase, which in turn alter normal wastewater treatment systems. Limits of undesirable substances can be exceeded and sludge volume increased.

Examples quoted by Hunt [25] illustrate this technique.

2. Process equipment change

The installation of more efficient equipment or the modification of current equipment can result in significant savings to the company and a reduction in waste generation. Sometimes the

changes required are quite simple and inexpensive, but the result is more efficient and also reduces or avoids waste or material/product loss. All these measures can reduce the company's operating costs.

Examples can be found in drag out reduction in electroplating by modifying the parts racks, reducing leakages by using safer sealing devices in the equipment, or using containers to collect leakage for reuse [28, 29].

The production process and wastestream generation should be investigated and fully understood before changes to the equipment are made. Such changes and equipment replacement obviously may require capital investment for equipment, facility modification and staff training. However, if implemented correctly, the efficiency and subsequent savings by the new process will recoup the initial investment.

Huising [30] reports an electroplating company that changed over from a manual to an automated system. This cut downtime from 8% to 4% and resulted in more efficient use of raw materials (US\$ 8000 savings/year), water use (US\$ 1100 savings/year). Plating wastes decreased from 204kg/day to 163kg/day, so water treatment costs were reduced by 25% plus an annual savings of US\$ 35000/year in maintenance and personnel costs. The automated system also avoided exposure of workers to high risk chemicals, such as acids and caustics.

A production process is unaltered by any equipment modification where it is intended primarily to correct equipment deficiency. Price [17], gives some examples.

More efficient equipment and better trained staff reduces the risks of rejected and off-specification products, thus producing savings by eliminating the need for their disposal costs. For example, rejected products from electroplating or paint companies require chemicals (often hazardous substances) to strip off coatings before they can be recoated.

3. Operational procedures

Examples are shown in table 2. Most of them are simple to apply and are inexpensive. The technique should make optimum use of raw materials during the manufacturing process and can cut unnecessary steps, reducing waste generation. Methods can be applied to any type or size of facility.

As is important in most new processing operations, a training program in waste reduction is the basis of improved methods in operation procedures. These programs should be extended to all levels of personnel. People should be aware of the significance of waste reduction to the company and to the environment. In applying a training method (videotaped materials) a company improved its coating methods by first reducing the cost of coating material and then reducing the amount of cleaning spray waste. The result was a reduction of air emissions and a saving to the company of approximately US\$ 60,000 in material costs [31].

Union Carbide knows the importance of good operation procedures. In the beginning of the 1970's, its image had deteriorated. One of its plants in West Virginia was considered "the smokiest factory in the world". Since then, a computerized system keeps details of all the processes and products and can

then estimate the concentration of wastes in the stack or in the effluent.

D. Source segregation

A very important concept to bear in mind is wastestream segregation, which means the capturing and separation of wastes at the production unit level and subsequent processing as a separate waste-stream. For example, in solvent waste-streams, both at the source of generation and at the recycling plant, solvents are contaminated in different ways. The recovery cost is therefore different. Segregation is thus important to the effective recycling and management of wastes.

As an example, studies report that the electronics industry requires highly purified solvents. Solvent wastes generated here are slightly contaminated and can be used by industries requiring lower quality levels, such as industrial painters. Moreover, sometimes it is possible to combine some solvent wastes if they are small in volumes and generated from similar uses, such as solvent wastes from other painters.

In many cases segregation of wastes allows certain wastes to be recycled or reused. For example, a company using both chlorinated and non-chlorinated solvents should separate its wastes. More information and examples can be seen in refs. 32,33,17.

E. On site recycling

The most suitable place to recover process wastes is within the production facility itself. Wastes can be more efficiently recovered from the generating source as they are not contaminated with other wastes. Ease of recovery helps to reduce raw material consumption as well as waste disposal costs. Where the contamination is slight, the waste-stream can be reused directly in the process as raw materials or in other operations in which the

TABLE 2. Operational Procedures: some chances to reduce waste generation

- | |
|--|
| • Reduce raw material and product loss due to leaks. |
| • Schedule production to reduce equipment cleaning. |
| • Inspect parts before they are processed to reduce the number of rejects. |
| • Consolidate types of equipment or chemicals to reduce quantity and variety of waste. |
| • Improve cleaning procedures to reduce generation of dilute mixed waste with methods such as dry cleanup techniques |
| • Segregate wastes to increase recoverability. |
| • Optimize operational parameters (such as temperature |
| • Develop employee training procedures on waste reduction. |
| • Evaluate the need for each operational step and eliminate steps that are unnecessary. |
| • Collect spilled or leaked material for reuse. |

— Source: Hunt

material purity is not so critical. For example, the reuse of solvents from microelectronic industries for metal degreasing.

Residues generated by most on-site recovery systems can be treated to recover more of the desirable product (i.e., solvent) or disposed of according to permitted limits.

Even though on-site recovery is a valid pollution prevention option, it is given low priority among all waste reduction techniques.

Some wastes can be recovered by additional physical and chemical treatment. However, this practice is not considered within the current EPA definition for waste minimization. Information and examples can be found in refs. 32,34.

VII. ORGANIC SOLVENTS

In a broad sense, solvents are those elements which are not modified when a chemical reaction occurs. However, they are referred to by industry as "organic solvent agents" [35]. Solvents include a large number of both organic and inorganic compounds. The former includes both halogenated (i.e. molecules containing chlorine, bromine, fluorine) or non-halogenated solvents. Chlorinated organic compounds account for 90% of halogenated organic compounds [1].

Organic solvents, in particular, are a matter of environmental concern due to their toxic properties, which give rise to hazardous wastes, thus having an adverse effect on health and the environment. These solvent wastes can vary in composition even from the same plant or process and are normally classified [36] as follows:

- High solvent content
- High organic content
- Low organic content
- Sludges or solid wastes

In most developed countries, legislation plays a key role in promoting good work practices in industry and substitution of halogenated solvents.

A. Uses

Solvents in industry can be used in product formulation or as a cleaning agent for equipment. According to Hampson [37], at present over 200,000 companies in Europe are using more than 700,000 tons of solvents for cleaning and degreasing of metals and electronic equipment. They are also used in inks, paints and coating formulations as well as in the pharmaceutical and food industries.

Solvent production started as early as the 1800's but gained widespread use in this century. They are used in a variety of industries such as petroleum, plastics, and pharmaceutical industries. Most of these industries recycle spent solvents.

A well-known use is as cleaning agents in dry-cleaning establishments. The most common are methylene chloride, perchloroethylene, trichloroethylene, and 1,1,1-trichloroethane, which are recycled.

B. Toxicity

Solvents are characterized, because many of them are flammable, as volatiles. The vapors generated can be toxic, and in

certain conditions, explosive. They can be more or less dense than water. Solvents can have adverse effects on human health and the environment. Workers are frequently exposed to fire, explosion or asphyxiation dangers, plus narcotic effects. Likewise, some solvents show carcinogenic and mutagenic properties. As wastes, they cause disorders in both humans and the environment, polluting air, water and soils. Hazards of solvents to human health and environment are fully documented. Research must be devoted to find new ways in all industrial activities where solvents are involved, to reduce or eliminate wastes.

C. Chlorinated solvents

Usage of chlorinated solvents was greatly enhanced by the invention of the vapor cleaning process in 1930 by ICI. This process made use of the excellent properties of solvents: high vapor density and non-flammability. New cleaning applications followed in the automotive, electronic, aerospace, and medical industries. Approx. 667,000-800,000 tons of chlorinated solvents have been used in the European Community [38], the main users being Germany, France, the United Kingdom, and Italy.

However, since they have been proven toxic to humans and a pollutant, especially to water supplies, where they are very difficult to remove, there is a trend to replace them. This trend has increased since the 1970's, when environmental concerns began to exert more pressure. Since 1974 chlorinated solvent consumption has decreased by 50% [39]. While most are being phased out, usage of some chlorinated solvents persists. This reduction is due partly to the substitution of other substances but also to the introduction of pollution prevention methods, better working practices, closed systems and recycling. This accounts for a reduction by 15-20% of virgin solvent usage [39].

A growing area of concern has been the occupational risk for the worker because of the danger of inhalation in the cleaning process. Standards have been established throughout the world to ensure workers minimum levels of exposure with no health risks.

1. Greenpeace's position

According to Greenpeace [1], the use of chlorinated solvents is the "direct antithesis" of what it is understood as a clean process or product. This concept is supported, according to them, by taking into account chlorinated solvents' life cycle, which starts when chlorine is produced. Even here, in the less-polluting chlor-alkali process, in addition to chlorine, other toxic by-products are produced.

Chlorinated solvents are emitted to the air via evaporation, fugitive emissions or wastewater discharges. Estimated losses in Europe for 1990 are around 460 thousand tons.

Greenpeace states that these solvents can affect not only water drinking supplies but can contaminate groundwater, producing undesirable products worse than the original product. Perchloroethylene (PER) can be subjected to slow degradation in groundwater, building up vinyl chlorides, which are more carcinogenic than PER.

Greenpeace claims that chlorinated solvents must be phased out all over the world. They hope to make the public aware of

these dangers and provide access to information about the risks involved in their production and use.

Because of problems posed by chlorinated solvents, many industries are modifying current processes by switching to aqueous, semiaqueous or mechanical alternatives.

D. Substitution

Substitution, although it eliminates the risk of contamination at certain stages and of exposure for workers, is not particularly easy, since the quality of the end product can be affected.

Considerable research was required for the development of water-based paints in order to achieve the same quality in terms of colour and durability as the solvent-based products. Most of these processes now have been changed to water-based processes.

Organic solvents have also been replaced by inexpensive inorganic acids and bases, especially in the pharmaceutical industry. Companies such as Merck and Sharp and Dohme report that this substitution has cut their costs by reducing the amount of solvent used [10].

Some industries, such as the dry cleaning sector, have faced many problems to find alternatives for chlorinated solvents. Usually, the best alternative has been the extensive use of closed systems. However, according to Greenpeace, by analyzing the complete life cycle of the product plus support by more recent research, dioxin formation has been found in the distilled PER found in closed-loop systems.

VIII. POLLUTION PREVENTION IN THE METAL CLEANING INDUSTRY

Metal cleaning is the largest application for chlorinated solvents due to their ability to dissolve oils, fats and greases. Solvent cleaning encompasses two processes: cold cleaning and vapor degreasing operations. The former is carried out at room temperature and includes the following: wiping, dipping, spraying, and ultrasonic agitation. The vapor degreasing operation is usually performed at the boiling point of the solvent, thus producing vapors into which metal parts to be cleaned are brought. This is the more efficient cleaning method of the two.

Common solvents such as CFC 113 and 1,1,1-trichloroethane are used to remove oil and grease from metal parts. This operation is carried out throughout production, maintenance and unscheduled repair. This is the most important use of 1,1,1-trichloroethane. In developed countries, almost 50% of its total consumption during 1988 was devoted to metal cleaning processes [8]. Additional chlorinated solvents used include trichloroethylene, methylene chloride and perchloroethylene. However, according to EPA regulations, nearly all solvent-based cleaning agents are considered hazardous wastes. Similarly, RCRA classifies cold spent solvent wastes from cleaning operations in the same group. Therefore, new routes are being investigated to meet these regulations.

Typical waste-streams in the metal cleaning and miscellaneous (e.g., road maintenance) industries include solvents with, in some cases, up to 80% metal particles, dissolved oils, greases

and waxes. The hazardous nature arises from the usual phenol and cresol content of the degreasing mixture [40].

As was mentioned in the previous chapter, alternatives to chlorinated solvents are aqueous, semiaqueous, or mechanical cleaning.

A. Aqueous solvents

Water-based cleaners are aqueous solutions usually containing detergents, wetting and anti-corrosive agents, and water. Ingredients are carefully selected according to foaming, wetting, and soil removing properties [41].

Modine Manufacturing Co. [42], with the use of an aqueous cleaner in an automated washer system, avoided the vapor degreasing stage and consequently reduced the 1,1,1-trichloroethane required by 25%. Metal parts are initially sprayed with the cleaner, washed in the washer, rinsed and then dried. The effluents are also pretreated before disposal.

The system, still in early development stages, is not yet as effective as the solvent cleaning method. However, development is on-going as 1,1,1-trichloroethane faces complete phase-out in developed countries by January 1996 [39].

Goldschmidt and Larsen [43] cite an example of alkali cleaning, one of the most extensively used aqueous methods for the substitution of organic solvents. Since the 80's the metal company, Danfoss A/S (Denmark) switched gradually from trichloroethylene over alkaline solutions for degreasing, reducing costs by approx. 50%.

Although many companies are replacing their organic cleaners with alkaline ones, the method is not totally accepted by all: the large amounts of effluents generated cause fear of future health risks and environmental regulations.

A further argument against water-based alternatives is not only the difference in formulation terms but also the cleaning method. For example, in the case of surfactant solutions, due to the rising process, complex cleaning installations are required. Alternatively, the use of halogen-free solvent in aqueous dispersions requires small and simple equipment compared with water-base surfactant solutions [44].

Zarno [45] states that according to the composition of the resulting wastes, some detergents are not affected by normal effluent treatments because they are not easily diluted. Therefore, additional expenditures will be involved to remove this contaminant from effluent before disposal.

B. Semi-aqueous solvents

According to Zarno, this modern method is "a combination of solvent wash and aqueous rinse" the advantage being the small and simple equipment required compared with water-based cleaning solutions. DuPont produces a cleaning agent of this type, which is formed by hydrocarbons and surfactants. It is claimed to be harmless to the environment.

Some mixtures of chlorinated solvents that are less harmful to the ozone layer have been proposed, for example, hydrochlorofluorocarbons (HCFCs), which are seen as an alternative to the banned chlorinated solvents. However, they are still under study for potential health risks and environmental dangers.

HCFCs have been proposed (Montreal Protocol) to be phased out by 2040 [45].

Andersen [8] mentions the use of aliphatic hydrocarbons, which involved steps similar to aqueous cleaning systems, with relatively few changes in the equipment used. Naphthas and kerosene are the most commonly used, but moderate care in their use is recommended.

C. Non-halogenated solvents

This option is being used when the previous methods are not considered viable options for cleaning. For example, the Oak Ridge Y-12 Plant [46], which has been working since 1982 to replace the use of chlorinated solvents for metal cleaning, is conducting work using this method.

D. Mechanical cleaning

Mechanical cleaning (brushing, wiping, or spraying) is recommended as an alternative to decrease solvent wastes. However, this is not a reliable method if high levels of cleaning are necessary.

E. Additional alternatives

Other recommended methods entail the use of thermal vacuum systems to remove oils from metal parts and the use of lubricants for special purposes [8].

F. Good housekeeping practices

Good operating practice is an easy and rapid way to reduce solvent consumption in cleaning and degreasing operations. The main consideration here is solvent losses because of spillage, leakage, drag out and other losses occurring throughout the process. Dharmavaram [12] suggests some good operation practices:

- The reduction of solvent air emissions: The use of covers or lids for tanks while not in use.
- An increase in the distance between the top of the solvent (liquid) and the top of the tank. According to ICF Associates (1986), this improvement reduces solvent emission from 27% to 46%.
- The use of a refrigerant-free board on vapor degreaser units. Solvent consumption can be reduced by 60% (ICF).

IX. POLLUTION PREVENTION IN THE PAINT AND COATING INDUSTRY

The most important forces responsible for new cleaner manufacturing routes have been environmental regulations and the health risks related to solvents used in paint and coating manufacturing. Considerable efforts have been made by professionals working in this sector, and new products (water-based, high solids, powder, etc.) have been developed to meet these regulations.

Experts agree that more research must be done to achieve a more environmentally friendly technology. They state that only through R&D can new products and processes with significantly lower waste levels be developed. Hirschhorn [9] quotes the example of Westinghouse, which developed new UV radiation-

based paint systems. This improvement saved the company from the use of large quantities of hazardous solvents.

The scope of applications in the paint and coating industry is enormous. Paints and coatings are mainly used for decorative and protective purposes as well as maintenance of structures and products. Table 3 shows estimated sales for 1990 given by industry segment. These values reveal the strong economic position of coating industries, with a total value of US\$ 500 billion. Sales in the paint and coating industry amount to for more than US\$ 14 billion per year [47].

This section, mostly based on Randall's paper [48], will briefly describe some processes of paint and coatings manufacture, their applications, and the wastes generated. Pollution prevention techniques related to these processes are also included.

A. Environmental regulations

The main reason for the reduction of solvents in this sector has been stringent environmental regulations (especially air pollution laws), particularly in the United States and European countries. Improved efficiency of the production process is another important aspect supporting this decision.

VOC, a term coined by the EPA, refers to the measure of the emission of volatile compounds present in paints. Emissions are regulated if they exceed a vapor pressure of 0.1 mm Hg at 25°C [48]. VOC emissions are at present the only compounds subjected to EPA regulations. Hence, the paint and coating industry is being forced to reduce them drastically in its processes.

However, solvents such as dichloromethane and 1,1,1-trichloroethane are still not controlled, even though they are widely used in modern processes (high-solids and radiation-curing systems). More research into these solvents could possibly identify them as contaminants, thus contributing to their removal as coating components.

In Europe, Germany has been the leader by enforcing its federal emissions law from 1974. Volatiles are grouped in three classes, of which class I is the strictest. Most solvents now used in German industry are class II and III.

According to Seymour [49], the annual demand presently for water-based paints in Western Europe will keep growing at a rate of 6%. United States' demand will increase at a rate of 4% per year.

B. Paint manufacturing processes

According to Randall [48], the number of producers has been gradually reduced in United States since the 60's. At present, there are approx. 900 producers compared with 1459 in 1967. This is mainly due to mergers and acquisitions, which were probably caused by severe governmental regulations (RCRA, OSHA, etc.). In brief, a liquid paint is formed by three main components, the pigment, which is finely dispersed in the liquid part, or vehicle. Normally the liquid encompasses the resin (binder) and a volatile solvent. Fillers and extenders are used in varying quantities to reduce manufacturing costs and improve properties such as durability. Numerous synthetic resins are used and are selected according to the properties required for a particular application.

TABLE 3. Coating industry, partial value.

Industry segment	Value (millions of US\$)
Industries that sell the coated product directly:	
Paints and coatings (SIC 2851)*	14.658
Adhesives and sealants (SIC 2891)	5.462
Printing and publishing (SIC 27)	168.514
Paper:	
Sanitary Food Containers (SIC 2656)	2.282
Bags, plastic-laminated and coated (SIC 2673)	5.215
Papers coated and laminated (SIC 2671)	2.672
Papers coated and laminated (SIC 2672)	5.355
Photographic films (worldwide)	25.000
Inorganic coatings (Europe)	1.000
Magnetic media:	
Floppy disks	12.400
Standard-Magnetic Disks	258
Total	247.967
Industries in which coating is the key component technology:	
Electronics:	
Printed circuit boards (SIC 3672)	5.151
Recorded music	8.020
Household audio and video (SIC 3651)	6.708
Computers and peripherals	72.500
Total	92.379

* Values shown are estimated for 1990 in 1987 dollars. SIC is the standard industrial classification

— Source: Cohen, E. (1990)

Acrylic and alkydic resins are the most used, the former due to their chemical nature. They have excellent properties, such as hardness, durability, impact strength, high resistance to degradation by UV radiation and moisture, plus other properties for more specific applications. They can be used as dispersions (latex paint) or solutions (solvent-based coatings). Examples include polymers and copolymers of acrylic or methacrylic acids or their esters.

Alkydic resins are a type of polyester resin with good adhesive properties. They can be formulated as solutions or molded into a variety of shapes. Main uses include exterior and interior paints, equipment and electrical insulations. However, for architectural coating applications, they are gradually being reduced because of VOC regulations.

Additional synthetic resins include epoxies, which can be hardened using cross-linking agents such as amino resins. Their properties are toughness, adhesion, resistance to chemicals and dielectrical characteristics.

Polyvinyl resins, especially polyvinyl acetate (PVA), are important because they cost less than acrylics. Polyurethanes due to their excellent properties, as well as polyester, polyethylene and polyamide resins, are again used for the same reason.

Originally, the consumption of solvents in the paint industry was quite significant, because of their qualities in making paint formulation suitable for application. However, their use is declining and now accounts only for 27% of the United States architectural paint market [48].

C. Manufacturing processes

Production paints are a mixture of ingredients where all the components are mixed and dispersed rather than a chemically combined. The general processes include pre mixing, dispersion, thinning, adjustments, filtration and packaging. Dispersion is not normally used to prepare lacquers.

To start the process, accurate quantities of pigments, resins and solvent are mixed to obtain a homogeneous mixture (pre-mixing). Dispersion of this mixture to separate the pigments' particles occurs in different types of mills according to the class of pigments. Ball mills are still an effective equipment for dispersion. Then the dispersed mixture is sent to tanks where it is thinned with additional solvents and adjusted to the end product by using additives. The end product is finally filtered according to the required specifications before packaging.

For water-based paints or latex, the process is similar but water is used as solvent. All the ingredients are mixed, ground, mixed with additional ingredients such as resins, antifoaming agents, plastifiers, and preservative solutions, then screened and mixed before finally packaging.

1. Wastes

A typical waste-stream for this industry is shown in table 4. Usually the common ways to manage it are on- or off-site recycling, treatment and disposal.

According to Randall, on-site recycling is the most cost-effective method for large companies who produce more than 35,000 gallons of solvent wastes per year. Small enterprises send their wastes for off-site recycling. Approx. 80% [50] of

TABLE 4. Paint manufacturing process wastes

Type of waste	Source
Raw material packages, bags, containers	Unloading of materials into mixing vessels
Pigment dusts from control devices	Unloading of pigments into mixing vessels
Solvent emissions	Storage tanks
Off-spec. paints	Color matching problems or customers returns
Spills	Accidental discharge
Rinse water	Equipment cleaning using water or caustic solutions
Paint sludge	Equipment cleaning
Filter cartridges	Undispersed pigment

— Source: Randall, P. (1992)

these wastes account for equipment cleaning wastes as this process is necessary to preserve the product from contamination.

Regulations force paint manufacturers to consider the "environment" in planning their total process. Traditional waste treatment is no longer a sufficient tool for waste management.

2. Methods to reduce wastes

The most appropriate method to prevent pollution is reduction at the source, which can be achieved through changes to the whole process, raw materials, or simply through good house-keeping practices, this being the easiest and most direct way to reduce wastes. Recycling of wastes is considered a possible prevention method, but it should be used as a last resort.

Randall mentions some good work practices for source reduction in the paint industry:

- The use of a schedule board to improve planning and scheduling methods. The numerous and varying paint formulations each require a separate production run. The schedule board coordinates and registers the correct mixing of these batches.
- All elements of the production process: process, purchasing, sales, and personnel management, must be regularly coordinated and controlled.
- The use of inventory control for raw materials avoids overstocking and possible product shelf life expiration, which would create a new source of waste.

Denny Cok Beroiz [22], the Director of Quality Assurance for Northrop Co. points out:

By managing inventories wisely, paints, epoxies, resins, and other chemicals with a limited shelf life don't age out. They get put into the aeroplane and won't have to go into the waste-stream.

- Product formulators must be able to ensure the reuse of containers, avoiding generation of wastewater through rinsing or residues in containers considered as hazardous wastes.

Exxon Chemical Americas [9] installed floating roofs over tanks of volatile solvents in one of its operations. By reducing air emission, solvent loss was greatly reduced. The company recuperated the cost of the roofs in one year.

Good housekeeping will be effective if personnel are sufficiently trained and made aware of the effects of the practice, not only for the firm but also for the environment. The training programmes should include loss and spoil prevention and in house preventive maintenance, helping to ensure maximum efficiency and optimum use of all equipment. Effective training, along with good quality control, helps prevent the production of off-specification paints.

Discarded materials such as obsolete paints, customer returns and expired shelf-life products can be added and mixed in small quantities to the new batches of paints. Through inventory control and careful production planning, obsolescence can be reduced. Any remaining older products could be offered at discount rates.

Human resources in the company are a powerful waste reduction tool. Employees can be motivated either as single persons or as teams to develop methods for changing the traditional processes. Motivation is possible through premiums, incentives, prizes, etc.

3. Process production changes

As mentioned before, equipment cleaning wastes are the most significant in the paint industry. Reuse of cleaning solutions or less frequent tank cleaning can help reduce wastes. The use of mechanical methods to replace manual work for tank cleaning will save not only labour costs but cleaning solutions as well. The use of tanks lined with special materials, e.g. Teflon, will ensure a minimum adhesion between the walls and the mixture [51].

A high-pressure wash system to clean water-based paint tanks can replace the old technique, which uses hoses. According to studies, this system can reduce the consumption of water from 80-90% [52].

Manufacturing processes can be improved in different ways, one of them being the waste-stream segregation technique, where the wash solvents (e.g. solvent-based paints) are recycled in the production of similar paints, thus avoiding the use of virgin solvents. Countercurrent rinsing systems are another means to prolong the cleaning solution life and prevent waste.

Computerized control systems are being used extensively in the different stages of the production process. This is a substantial improvement applied in paint manufacturing, which, in addition to other advantages, prevents operational defects. This trend will increase if costs for plant automation systems decrease.

4. New products

Yaseen and Raju [53] have published a list of new products whose improved properties assist in the effort to minimize wastes. Some of them are mentioned below. ICI Resin (United States) has developed a polyurethane resin (NeoRez R-9402) for water-based coatings which can be used as a crosslinking agent for wood floor applications. Tefcote is a water-based paint that includes teflon compound in its composition. It has been developed in the United Kingdom (Tefcote United Kingdom & H. Marcel G.), Macpherson Paints Ltd., United Kingdom, substituted the acrylic system for the solvent in their solvent-based gloss paints.

Among developments in pigments, synthetic iron pigments maintain significant sales volumes, and new formulations to cope with new environmental regulations are available. A new product, micaceous iron oxide (MIO), shows excellent anticorrosive properties for coating formulations.

Certain new formulations in the paint and coating industry are not only meeting environmental regulations but also have resulted in improved product performance and an increase in sales volumes.

Some examples include aluminium pigments in automotive finishing, titanium dioxide pigments, aluminum pastes in water-based systems, and lithopone pigments, which increase film and compound performance. Other developments have occurred in crosslinking agents, adhesives and additives for water-based coating areas.

D. Paint applications

Methods to reduce wastes are not only relevant to paint manufacture, but also to paint application. A number of waste reduction options are available, the most common of which are shown in refs. 54,48,11.

Prior to the painting process, surface treatment is extremely important to obtain good adhesion when the paint is applied:

- Surface smoothness: usually achieved by mechanical methods, such as grinding, abrasion or blasting.
- Cleaning: achieved by mechanical, solvent or chemical methods, dictated by the metal substrate to be cleaned. Sulphuric or hydrochloric acids are usually used for steel and zinc surfaces and nitric acid for aluminium, although it is also possible to use alkaline solutions. Chlorinated solvents are used extensively to remove organic impurities.
- Degreasing: Solvents such as trichloroethylene or even Freon are mainly used for this purpose. The solvents generally evaporate during degreasing. However, they can be recovered through a series of small heat exchangers and reused. Cleaning solutions in tanks are conventionally reclaimed by distillation, as they are mainly

contaminated with grease and oil impurities. When degreasing is by aqueous media such as alkaline, neutral or acid solutions, the metal parts are then rinsed with large quantities of water.

Further paint-metal adherence can be achieved by coating methods such as phosphating.

1. Wastes

Paints are usually applied by a liquid spray system. Here, the paint is combined with a carrier. Organic solvents are normally used for this purpose. As the above steps show, large volumes of solvents are used, plus those to clean the equipment used in painting, as solvent-based paints are still in use. Common solvents used for cleaning are 1,1,1-trichloroethane, methyl ethyl ketone, xylene, toluene and alcohols.

An initial step, as always, in waste reduction is the use of good operating procedures. An interesting problem to solve is to reduce the amount of paint lost when spraying: only 50% actually arrives on the surface to be covered; the remaining, known as overspray, is lost to the air.

An improvement over conventional spray methods, whose transfer efficiency is 30-70%, is the electrostatic system with a performance of 85-95% [48]. One could say that powder coatings applied by an electrostatic system can be considered a model of waste elimination, as air, water, and soil pollution are avoided.

Minimizing the amount of paint used for coating purposes would reduce the sludge generated. This sludge is poured into drums and subjected to conventional hazardous waste disposal. Bulk buying instead of special paints in cans or small containers helps also in waste reduction, as the containers can be returned to the manufacturer for reuse.

It is also expected that water-based paints can gradually replace solvent-based paints for most applications.

E. Alternative technologies

Developments in the following coating methods have taken place in order to reduce hazardous wastes:

- High solids (25-60% solids/vol): Lower molecular weight paint resins are being used in place of those from solvent-based systems. The main objective is to meet the severe VOC regulations while still using the same equipment and the same application methods.
- Water-based: For high solids coatings, the conventional equipment can be used with the added advantage of waste reuse. Price [17] mentions the Emerson Electric Co., which reported dual benefits using a water-based electrostatic paint system. The firm reduced generation of waste solvent and paint sludge by over 95%.
- Radiation curing systems: UV curing is the most common radiation technique. At present, according to Randall, only UV and electron-beam (EB) curing seem to be of commercial interest.
- Powder coatings: Finely pulverized resins possessing the lowest VOC emissions (compared to the other alternatives) can be used for metal finishes.

Modine Manufacturing Co., Wisconsin, reduced considerable amounts of VOC by adopting powder coatings and water-based coating systems. Heavy metals such as chromium have also been removed from paint formulations. This means that sludges produced are no longer considered hazardous wastes [42].

It is important to mention at this stage the UNICARB Process (Union Carbide). It can be used with a variety of spray-applied paints and coatings, reducing (30-70%) VOC emissions. Advantages and details: ref. 5.

Additionally, it is important to consider any change in the equipment and particularly to achieve improved operation efficiency, e.g. use of electrostatic paint equipment or low-pressure, high-volume guns. Katin [55] recommends proportional paint-mixing equipment to prepare 2- or 3-component paints.

It is also of crucial importance to observe a preventive maintenance program to prevent loss of oil, process and hydraulic fluids.

X. HAZARDOUS CHLORINATED SOLVENTS: CURRENT SITUATION

A. 1,2-dichloroethane

Formula: $C_2H_4Cl_2$

Regulatory Synonyms: Ethane, 1,2-dichloro; ethylene dichloride

EPA Hazardous Waste (HW) No: D028

CAS No.: 107-06-2/NIOSH: K1 0525000 [56]

RCRA Waste No.: U077

Chronic Toxicity Reference Level (CTRL) (mg./L): 0.005

Regulatory Level (mg./L): 0.5

Final Reportable Quantities (RQ): 45.4 kg.

Source: Federal Register, vol. 55, No.61, March 29, 1990

1,2-dichloroethane is commercially available as a pure compound (100%) or as mixtures: Dowfume (70.2%) and Dowfume EB-5 (29.2%). Some important United States producers are ARCO Chemical Co. (TX), Diamond Alkali Co. (TX), Olin Matheson Chemical Co. (KY), Dow Chemical Co. (MI), and Vulcan Materials Co. (LA).

It is a colorless and oily liquid, stable to water, alkalis, acids, and miscible with most common solvents. Its boiling point is 83.5°C, flash point: 13.3°C, and vapor pressure: 60 mm Hg at 20°C. Its decomposition (340°C) mainly produces vinyl chloride, hydrogen chloride, and slight amounts of acetylene.

Of the chlorinated ethanes, 1,2-dichloroethane has the highest production level. Its major consumption is as an intermediary in the production of vinyl chloride monomer. Other uses include the production of chlorinated solvents and organic synthesis in general, fuel additive (lead scavenger), paint and coatings manufacturing, and pharmaceutical products.

1,2-dichloroethane is toxic via all routes. Its vapors produce nausea, depression and anaesthetic effects. It is a strong irritant to eyes and skin and is toxic to the liver. It is considered a potential mutagenic agent and classified as a probable carcinogen (IARC criteria, Class B2).

Biodegradation occurs with a half life of around 30 months at 25°C [57].

Considered as an air pollutant, it is still not on the EPA's list of hazardous air pollutants; in high concentrations it is a threat to the aquatic medium. A HR (hazard rating) of 3 is assigned to 1,2-dichloroethane indicating it to be highly hazardous. HR refers to the relative hazard for toxicity, fire and reactivity [56].

Despite the environmental and toxic effects of the product and its foreseen regulation, information concerning pollution prevention methods was unavailable.

B. Methylene chloride

Formula: CH_2Cl_2

Reg. Synonyms: methane, dichloro

CAS: 75-09-2

RCRA Waste No.: U080

Final RQ: 454 kg

Source: Federal Register, vol. 54, No. 155, August 14, 1989

Methylene chloride is the most versatile of the chlorinated solvents and has been used for 50 years as a substitute for flammable solvents. Main producers in the world are Hoechst, Dow Chemical, and Stauffer.

It is a colourless and highly volatile liquid. Methylene chloride is the only non-flammable commercial solvent with a low boiling point. In high concentrations, it is narcotic but is considered the least toxic of the chloromethanes with inhalation as the main form of exposure.

Methylene chloride is used mainly in metal cleaning and paint stripping, with other uses involving pharmaceuticals, plastic processing, blowing agent in foams, and food extraction. As a remover in paints, it is very effective, especially in its ability to remove polyurethane (PU) and epoxie-based paints. Wet chemical stripping is the most common method used.

Properties such as low toxicity and non-flammability make it a suitable product for blowing agents, replacing CFCs in PU foam manufacturing. Its use allows manufacturers to meet product specifications, reducing the amount of raw materials (especially isocyanates) required because of the blowing agent ability at lowering foam density.

With this solvent, waste is generated mainly in the metal cleaning industry. Methylene chloride is listed as a hazardous waste in 40 CFR 261.33. In general chloromethanes along with many other halogenated compounds are seen as water pollutants and therefore come under water quality regulations.

The microbiological degradation of methylenechloride has recently been established, which might explain its minimum concentration in waters.

Methylene chloride, probably a carcinogen, is included in the hazardous air pollutants list of the Clean Air Act Amendments (CAAA) of 1990. Therefore, because of severe regulations, some manufacturers using methylene chloride have considered waste reduction options to limit air emissions and ensure occupational safety.

In this context, a waste minimization research project [58] has been developed in a PU low-density foam manufacturing plant using methylene chloride as a blowing agent. The project aimed to determine blowing agent losses and propose some changes in the process to maintain good working conditions and at the same time to recover and reuse the auxiliary blowing agent. With the

gathered data, a model has been developed which calculates some parameters related to concentration of the methylene chloride in the tunnel according to formulation used, conveyor speed and air flow.

The Oak Ridge Y-12 Plant, mentioned before [46], is working to replace methylene chloride used for removal of plant wastes such as urethanes from foam guns and epoxies (potting compounds). Common solvents tested for both cases include hexanol, anisole, and N-methyl pyrrolidine. Anisole was considered the most probable replacement in the first case. However, substitution in the case of epoxies was not technically successful due to specific properties of methylene chloride. Nevertheless, testing will continue in the future.

The use of an abrasive blasting technique (plastic blast media), however, has proven to be an effective substitute for the wet chemical stripping method [12] mentioned before.

A study [59] has been carried out assessing land disposal of wastes containing organic solvents and their effect on the groundwater near these hazardous sites. Of the 33 organic compounds evaluated, methylene chloride and 15 other compounds were likely candidates to be banned from land disposal. This study proved that they would be strongly regulated in relation to the quantity to be disposed.

C. Pentachlorophenol (PCP)

Formula: C_6Cl_5OH

Reg. Synonyms: Phenol, pentachloro-

EPA HW No: D037

CAS: 87-86-5/NIOSH: SM 6300000 [56]

RCRA Waste No.: U242

CTRL (mg./L): 1

Regulatory Level: 100 (mg./L)

Final RQ: 4.54 kg.

Source: Federal Register, vol. 55, No. 61, March 29, 1990

Chlorinated phenols, in general, are known for their strong biological effects. Worldwide, the greatest volume is accounted for by Pentachlorophenol (PCP), which has grown greatly since its introduction in 1930, with a world consumption in 1989 estimated at 90,000 tons [60]. PCP and its compounds are strong biocides used mainly in the pulp and paper, wood protection, textile, and leather industries. They are also used as pesticides for agriculture and as an intermediate in herbicide production. Almost 80% of consumption is in the timber industry.

Even though PCP has become a substantial environmental contaminant, its use is still widespread because of its low price and long range of application. Its main use is as a salt (sodium pentachlorofenate) or constituent of organic solutions.

Because of its toxicity and its extensive use, PCP is listed as a hazardous waste and included in the main pollutants list of EPA (CFR 261.31, United States EPA F027), and the European Community. It was also proposed by EPA (1986) to be included in the toxicity characteristic list (40 CFR 261.24) at a level of 3.6 ppm by TLCP. An HR of 3 is assigned to the compound [56].

Therefore, because of its adverse environmental effects and toxicity, its use is now banned in most western countries.

Exposure to humans can cause health disorders and chronic effects, such as skin irritation, sinusitis, rashes, etc.

Few research studies [61] have proven PCP to be a mutagenic, embryo- or phytotoxic agent or a human carcinogen. However, the trend is to eliminate it completely in developed countries from all uses leading to human exposure, regardless of carcinogenicity. More information about the properties, toxicology and environmental behaviour of PCP can be found in the bibliography of this paper [62].

Industrial activities are responsible for the majority of releases of PCP to the environment. They can occur as a result of its direct use in industries (timber and textile industries) or treatment of PCP-containing wastes.

Because of its low volatility, the dissipation of PCP within the environment is mainly to the soil. Food could be the main means by which the population is exposed to this product.

Through microbial degradation, PCP's have a half life in soil of around 20 days [63]. Wild adds that PCP is also lost by volatilization and photodegradation. Additionally, it can be converted to a very stable molecule such as pentachloroanisole [7].

The oral minimum lethal dose for man has been estimated to be 29 mg/kg [7].

In the United Kingdom, a study [62] has been done to predict the total PCP load of different United Kingdom environmental compartments. PCP constitutes the main source of polychlorinated dibenzo-p dioxin (PCDDS) and -furans (PCDFE) to the United Kingdom environment. These products are considered the main source of toxic PCP's. Approx. 25% of the total amount of PCP used by British industry every year is released directly as spillages, volatile matter or wastewater.

Another study [64] mentions that PCP has been banned as biocide in Germany since 1989. The ban also includes products containing more than 5 ppm of PCP in their composition. This decision has aroused enormous controversy in the industrial sectors involved. They claim that:

- A transitional period to cope with the change has not been considered.
- No reliable analysis methods for PCPs have been established.
- To date, no suitable PCP substitutes are available.

However, some alternative products as PCP substitutes have been proposed for tanning leather:

- Benzalkonium chloride
- Chloro-m-cresol
- Phenylphenol
- Benzimidazole

Some trade marks such as Preventol and Preventol WB from Bayer have also been recommended.

The current trend seems to be the use of mixtures of phenolic compounds with less chlorine content and minimum quantities of PCP. Moreover, the INESCOP report reviews the use of biocides in the leather industry.

XI. CONCLUSIONS

From this study the following was concluded:

- In the last few years an enormous amount of information has been disseminated about pollution prevention. It proves that the approach of reducing hazardous waste has been increasingly recognized as the first choice. A general comparison shows that much more has been written on the theoretical aspects of pollution prevention than on experiences with its application in industries.
- Priority has to be given to standardized definitions and environmental terminology. "Pollution prevention" is usually taken as a general descriptor, whereas "waste minimization" or "waste reduction" seem to be the more concrete terms.
- Environmental agencies obviously have to cope with waste reduction. Still, they choose pollution control over pollution prevention as the main item on their agenda with the belief that pollution control is a short-term approach to meet environmental regulations. In fact, pollution prevention is not a priority option for governments of developed countries because of limited funds assigned for this purpose.
- Several economic assessment methods have been described here. The TCA allows an effective assessment, taking into account all those avoidable significant and indirect costs if a waste minimization project is to be implemented. New companies, in particular, are in a better position to gain economic benefits by applying pollution prevention methods as these methods do not involve costs for waste treatment and disposal.
- Promotion of pollution prevention methods has reduced the use of chlorinated solvents throughout the world by 50%. Considerable progress has been achieved by the paint and coating industry, which is replacing chlorinated solvents by water-based or less toxic compounds. However, more research in overall production methods is necessary to improve efficiency. The metal cleaning industry has had many problems finding alternatives to substitution. Complete replacement by water now seems uncertain. That is because the main problem associated with increased amounts of effluents generated is the additional cost of treating them before disposal. Mechanical cleaning has limited applications. Good housekeeping procedures must widely be promoted to reduce wastes, whilst R&D must look for successful replacements.
- The search for alternatives to specific chlorinated solvents has not succeed. Studies to replace 1,2-dichloroethane have not been reported. Alternatives to methylene chloride are still under research and PCP, despite its pollutant nature, is still widely used in developing countries. Only some alternative compounds have been proposed. Additionally, carcinogenic effects from all of them have not been tested.
- Good housekeeping procedures are a practical way to reduce waste in the short term. Beyond this, R&D is normally the long term approach to effectively reduce wastes.
- Developing countries' industrialization efforts are not yet concerned with environmental issues. Being at this stage, however, offers them an excellent opportunity to start from scratch by applying pollution prevention methods already tested in industrialized countries.
- Small and medium industries need better access to information systems in developed countries.
- The lack of information and transmission media is the main barrier to awareness of environmental issues in developing countries. Appropriate information dissemination mechanisms are essential to overcome the situation and replace expensive on-line searches, which raise the costs of services already expensive for medium and small companies in those countries because of the high cost of telecommunications.
- UNIDO's INTIB is a non-profit service, with wide experience and a positive image with industrialists in developing countries and could be considered as a link for access to knowledge. Therefore, INTIB could be an effective channel for medium and small industries, provided that more emphasis is given to value-added information products according to specific needs for information in these companies.
- Many case studies in literature have not yet been compiled. This is necessary as a basis for identification of problems and alternative solutions. Information available in abstracts plays a key role in promoting and motivating industry towards R&D.
- Since the chemical industry is responsible for 50% of hazardous wastes in the world, access to chemical databases is highly important. Therefore, information centres have to consider cooperating with them if effective services are to be developed.

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0721 PHOSPHATE COMPLEXING OF HEAVY METALS. [BIB-199301-42-0001]

The effectiveness of triple superphosphate (TSP), a phosphate fertilizer, and trisodium phosphate to precipitate heavy metals from solution and simultaneously produce a nonhazardous sludge was investigated. The parameters investigated were reaction pH, phosphate source, reaction time, phosphate concentration, order of chemical addition, water hardness, initial metals concentration and mixed metal solutions. The following factors had no effect on heavy metal precipitation: reaction pH (whether it was 8.5 or 9.5), heavy metal source, order of chemical addition, reaction time (for reaction times 5 min) and water hardness. Trisodium phosphate best removed heavy metals from the wastewater. However, leachability tests run on the resulting sludge indicated that phosphate fertilizer was the better phosphate choice. The research indicated that lesser amounts of phosphate removed more heavy metals, and as the initial heavy metals concentration increased, heavy metal removal also increased. Mixed metal solutions affected the removal of heavy metal, but not consistently. The removal of heavy metal ions from solution appears to be a surface reaction phenomenon with the ion capable of settling with the triple superphosphate. A non-EP toxic sludge was obtained when phosphate fertilizer was used. With the addition of phosphate fertilizer to a Zn-bearing wastewater, 99% of the Zn was removed from solution, and 85% of the Zn in the resulting sludge was retained. In comparison, hydroxide addition to the Zn-bearing wastewater caused 97.5% of the Zn to fall out of solution and 8.5% of the Zn in the resulting sludge to be retained. Graphs. 8 ref. (Farrell-Poe, K.; Etzel, J.E.; NINETY-FIFTH ANNUAL MEETING AMERICAN FOUNDRYMEN'S SOCIETY, BIRMINGHAM, ALABAMA, USA, 5-9 MAY 1991. Publisher: AMERICAN FOUNDRYMEN'S SOCIETY, INC., Des Plaines, Illinois 60016-8399, USA, (1991), (Met. A., 9301-72-0001), pp. 133-138 [in English].)

0722 A COMPARATIVE VIEW OF CONTROL AND REGULATING TECHNOLOGIES FOR SOME PRIMARY SMELTING OPERATIONS. [BIB-199301-42-0014]

A survey of regulations and state-of-the-art control technologies is presented relating to the smelting of primary Al, Cu, and recycling of residues. Some costs associated with the alternatives and trends for the coming decade in this sector are identified. 9 ref. (Ahmadzai, H.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), pp. 29-44 [in English].)

0723 COMPREHENSIVE WATER MANAGEMENT PROGRAM FOR A PRIMARY COPPER SMELTER. [BIB-199301-42-0017]

As Phelps Dodge Corporation addresses the environmental challenges of the 1990s, water management has become a key element in an overall waste minimization strategy. The Phelps Dodge Hidalgo Cu smelter has implemented a comprehensive water management program that includes management of both fresh and process water utilized by its pyrometallurgical operation. Two major technological strategies are being implemented. They are the design, construction and operation of a raw water pre-treatment facility to allow increased evaporation within cooling towers thereby minimizing blow down, and the use of a brine concentrator to treat and recycle significant quantities of process water. The end result of this program is a significant reduction in raw water pumped from the underlying aquifer into the facility and a decrease in process water which must be impounded or otherwise treated. 1 ref. (Viecelli, C.P.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), pp. 81-87 [in English].)

0724 SOME ALTERNATIVE APPROACHES FOR THE TREATMENT OF ELECTRIC FURNACE STEELMAKING DUSTS. [BIB-199301-42-0019]

Electric furnace steelmaking dust is a polluting residue that needs to be treated to recover metals contained and to produce an environmentally acceptable residue. Some hydrometallurgical approaches for its treatment have been evaluated: caustic soda leaching followed by electrolytic recovery of Zn, ammonia

leaching followed by Zn compounds' precipitation and acetic acid leaching followed by Pb, zinc hydroxide and gypsum precipitation. 8 ref. (Castro, F.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), pp. 179-186 [in English].)

0725 COPPER EXTRACTION FROM SMELTER FLUE DUST BY LIME-ROAST/AMMONIACAL HEAP LEACHING. [BIB-199301-42-0022]

Copper smelter flue dusts often cannot be directly recycled to the smelting process and accumulate as hazardous wastes requiring environmentally acceptable disposal. Because of the limited amount of flue dust, a separate Cu extraction process must be simple and require a small plant investment. A flue dust process has been developed, consisting of the following steps: roasting a pelletized mixture of hydrated lime and flue dust to fix arsenic and sulfur an insoluble calcium salts; heap leaching the roasted pellets with a buffered ammonia/ammonium salt solution to extract Cu as an ammine complex in a lined cell that is the final repository of the leached pellets; and boiling ammonia from the lixiviant to precipitate Cu. Condensed ammonia and the filtered solution are returned to leaching. Heap leaching in the final repository cell lowers the capital investment significantly compared with competing extraction processes. Chemistry with respect to As, S, and Cu is discussed. Graphs. 11 ref. (Yin, Z.-b.; Caba, E.; Barron, L.; Belin, D.; Morris, W.; Vosika, M.; Bartlett, R.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), pp. 255-267 [in English].)

0726 THE CASHMAN PROCESS TREATMENT OF SMELTER FLUE DUSTS AND RESIDUES. [BIB-199301-42-0023]

Artech Recovery Systems, Inc. has developed a low pressure and temperature leach process called the "Cashman Process" to extract metals from arsenical flue dusts and residues and fix the arsenic in an environmentally stable form as ferric arsenate (scorodite). The process was pilot tested at Hazen Research in an integrated plant including continuous recycle from August-October 1989, during which several tons of flue dust were processed. Based on this pilot program, the process was deemed technically feasible and produced commercially salable products. Residues from this pilot program were subjected to a long-term stability test jointly designed by PTI environmental services and the USEPA. The process, its versatility, and the nature of the products are discussed in some detail. Graphs. 5 ref. (Kunter, R.S.; Bedal, W.E.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), pp. 269-282 [in English].)

0727 HYDROMETALLURGICAL PROCESS OF COPPER CONVERTER DUST AT THE SAGANOSKI SMELTER & REFINERY. [BIB-199301-42-0024]

One of the most essential factors for a custom smelter to strengthen its competitive power is to improve its comparative standing in purchase of concentrates from the world market. It is especially critical for Japanese smelters who depend on import for almost 90% of their raw materials. To accomplish this breakthrough, the development of the new technology which enables treating concentrates containing higher impurities is inevitable. Nippon Mining Company Ltd. intensively researched processing complex ore for three years, from 1979, and successfully developed an original hydrometallurgical process to treat converter dust for eliminating impurities from the Cu smelting circuit. The commercial plant was constructed at the Saganoski Smelter & Refinery in 1982, and its nine years operation has satisfactorily proven the advantages of the technology. The concept of this process and its operational performance are discussed. Graphs. 10 ref. (Iwata, M.; Higashi, M.; Ota, S.; Okamoto, H.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warren-

dale, Pennsylvania 15086, U.S.A. (1991). (Met. A., 9301-72-0019), pp. 283-293 [in English]

0728 AN IMPROVED PYROMETALLURGICAL METHOD FOR THE RECOVERY OF LEAD FROM BATTERY RESIDUE. [BIB-199301-42-0026]

At the present time, pyrometallurgical processes are employed for the recovery of Pb from battery scrap. These processes have serious pollution problems, primarily due to the emission of sulfur dioxide and airborne Pb in the form of dust and fume. In addition, it is necessary to dispose of solid wastes and liquid effluents which contain Pb and in some cases sodium sulfide-containing compounds. An improved process was investigated for the recovery of Pb from battery residue. This involved pelletization of the residue with sodium carbonate and moisture. Then, the pellets were melted without carbon and the sodium sulfate salt was removed. Subsequently, the molten lead oxide was reduced with C. This process minimizes the sulfur dioxide emissions and leads to very low sulfide contents of the sodium sulfate salt. Graphs. 14 ref. (Pickles, C.A.; Toguri, J.M.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, U.S.A. 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1991). (Met. A., 9301-72-0019), pp. 313-330 [in English].)

0729 SLAG HANDLING IN THE IRONMAKING INDUSTRY. [BIB-199301-42-0030]

A review is presented of the development of blast furnace slag handling and processing technology in the ironmaking industry over the past 30 years, with an emphasis on economic and environmental factors. The requirements and practice of air-cooling slag for use as aggregate and of pelletizing and granulating slag for use in cement manufacture are described. The operation of slag pits, slag pots or ladles, the slag pelletizer and early granulation systems are compared with the new continuous granulation, dewatering and handling systems developed in the past decade. Graphs. 32 ref. (Cooper, A.W.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, U.S.A. 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1991). (Met. A., 9301-72-0019), pp. 377-403 [in English].)

0730 A FLUIDISED BED ION EXCHANGE SYSTEM FOR TREATMENT OF EFFLUENT WATER OF COKE OVEN AND BY PRODUCT PLANT. [BIB-199301-42-0035]

A fluidised bed ion exchange method for simultaneous removal of phenols and cyanide from the effluent is described. Use of an eluant enables regeneration of the resin in the continuous operation mode. The breakthrough experiments conducted both on the laboratory scale and on a pilot plant scale have shown that, while the level of phenol can be brought down from 462 ppm to approx 6 ppm, the free cyanide is almost totally removed. An examination of data indicates that the method can serve the twin objectives of pollution control and phenolic compounds recovery. Graphs. 9 ref. (Pandey, H.D.; Gupta, A.; Bhattacharya, S.; Mediratta, S.R.; Das, B.N.; Rao, K.V.K.; Murty, J.S.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, U.S.A. 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1991). (Met. A., 9301-72-0019), pp. 489-496 [in English].)

0731 COMPLEX PROCESSING OF ZINC-CONTAINING THE PRODUCTION WASTES OF VARIOUS INDUSTRIES. [BIB-199301-43-0014]

Possible ways of Zn extraction from low-grade Zn-containing wastes of metallurgical and chemical industries are examined with emphasis on the Waelz process. A Waelz process for Zn extraction from the calciferous sludges of synthetic fiber production is analyzed. Results of laboratory and pilot-plant tests demonstrate the feasibility of the proposed process. Graphs. 8 ref. (Kozlov, P.A.; Saprygin, A.F.; TSUETNYE METALLY, (DEC. 1990), (12), pp. 38-41 [in Russian] ISSN 0372-2929).

0732 NEW TECHNOLOGIES IN COKEMAKING. [BIB-199301-45-0010]

Technologies for increased cokemaking efficiency are discussed with particular reference to the Indian steelmaking situation. Each of these processes is aimed at (i) improvement in coke quality, (ii) use of a wide range of coals without sacrificing coke quality, and (iii) increased production productivity of coke ovens. Particular technologies which appear to be of importance include: high capacity ovens with taller and/or wider chambers; jumbo coking reactors; coke dry quenching; flood coke quenching; compaction of the coke charge inside the ovens; addition of tar pitch to a coal blend; beehive cokemaking in improved type of ovens, and use of solvent refined coal for cokemaking. (Tiwary, M.; STEEL TIMES INTERNATIONAL, (JULY 1992), 16, (4), pp. 41-42, 44 [in English] ISSN 0143-7798)

0733 REMOVAL OF HALOGENS FROM EAF DUST BY PYROHYDROLYSIS. [BIB-199301-45-0028]

In the thermal treatment of electric arc furnace (EAF) dusts, Zn is reduced, volatilized, and ultimately recovered either as liquid metal in a splash condenser or as solid zinc oxide in bag filters. During the process, the dust's Cl and fluorine content also enters the gas phase and condenses as dross in the splash condenser or as salts which contaminate the zinc oxide product. Pretreatment of EAF dust by pyrohydrolysis appeared to offer a means of minimizing the dust's halogen content. Experimental results proved that 97-99% Cl extraction and 80-85% F1 extraction are consistently achieved when EAF dusts are blended with silica and roasted at temperatures 850 °C in a furnace atmosphere of 75% steam (diluted by air). A statistical analysis further established that more than a single optimal point exists, thus affording flexibility in parameter selection (e.g. by increasing temperature, the necessary retention time and additive concentrations are decreased). The findings substantiate the feasibility of pyrohydrolysis roasting in reducing the Cl and F1 in the EAF dust to a level that will obviate industrial concerns about halogen contamination. The end-product of the pyrohydrolysis procedure is a de-halogenated, self-fluxing calcine which can be directly charged to a plasma or flame reactor. Design parameters and flow diagrams illustrating the pyrohydrolysis process integrated with the plasma and flame reactor technologies are included. Graphs. 6 ref. (Downey, J.P.; Hager, J.P.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, U.S.A. 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1991). (Met. A., 9301-72-0019), pp. 187-211 [in English].)

0734 THE COMMERCIAL DEVELOPMENT OF PLASMA TECHNOLOGY: EAF DUST APPLICATION. [BIB-199301-45-0029]

In December of 1987, International Mill Service, Inc. signed an exclusive licensing agreement with Tetronics Research & Development Co. Limited of Farnington, Oxfordshire, England, to commercialize plasma technology which had been demonstrated in an EAF dust processing application. The intent of the process is to reduce and volatilize the zinc, lead, and cadmium oxides inherent in EAF dust and collect these elements as metals in an ISP (Imperial Smelting Process) Zn splash condenser, and to render the resultant slag an inert, non-hazardous material. With these objectives in mind, IMS started commissioning facilities in 1989 at Florida Steel in Jackson, Tennessee, and Nucor-Yamato Steel in Armorel, Arkansas (U.S.A.). The commercial development and progress of the technology at these two installations are described. (Bunney, D.T.; Mazanek, M.S.; Pargeter, J.K.; RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, U.S.A. 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1991). (Met. A., 9301-72-0019), pp. 213-218 [in English].)

0735 REDUCING EMISSIONS IN FOUNDRY OPERATIONS. (MINDERN VON EMISSIONEN IN DER GIESSEREI.) [BIB-199301-45-0062]

Germany contains approx. 440 Fe-based and 660 non-ferrous foundries. These foundries generate emissions from core and mold making, melting and cleaning operations. Control of emissions to conform with environmental regulations is discussed, along with measures that can be taken to remove sources of pollution.

Graphs 61 ref. (Dopp, R., GIESSEREI-PRANIS, (24 ARP 1992), (8), pp 119-130 [in German] ISSN 0016-9781)

0736 CASTING AND ENVIRONMENTAL ADVANCES IN THE FRC PROCESS. [BIB-199301-51-0014]

The free radical cure (FRC) process utilizes sulfur dioxide gas to initiate the rapid coldbox cure of two-component acrylic-epoxy resin systems. Redesign of these systems has eliminated the need for separate addition of third part adhesion promoters, while also improving binder storage stability. These new-generation binders can also provide decreased veining defects and increased erosion resistance in many ferrous applications. Higher tensile strengths in conjunction with the benefits of recent equipment advances allow for the use of lower binder levels. This in turn leads to significant improvements in shakeout rates in nonferrous applications. In addition to improvements in foundry operations, these new-generation binders address the all-important issues of worker safety and compliance with environmental regulations. The number of government-regulated components such as chlorinated solvents is reduced with the new binder systems without sacrificing product performance. Another important development is the achievement of substantial reductions in worker exposure to sulfur dioxide during both coremaking and core storage. This objective was met by curing with sulfur dioxide nitrogen mixtures rather than with pure sulfur dioxide and fundamental changes in resin design. Tests using Al356 are discussed. Graphs 7 ref. (Shriver, H.R., Barnett, K.W., Archibald, J.J., NINETY-FIFTH ANNUAL MEETING AMERICAN FOUNDRYMEN'S SOCIETY, BIRMINGHAM, ALABAMA, U.S.A. 5-9 MAY 1991. Publisher: AMERICAN FOUNDRYMEN'S SOCIETY, INC., Des Plaines, Illinois 60016-8399, U.S.A. (1991). (Met. A. 9301-72-0001), pp. 215-220 [in English].)

0737 THERMAL RECONDITIONING OF CORE SAND IN AN ALUMINUM FOUNDRY: A CONTRIBUTION TO ENVIRONMENTAL PROTECTION. [BIB-199301-51-0016]

Thermal reconditioning of core sand makes a valuable contribution to the topical theme of environmental protection. With the aid of this reconditioning method, used foundry sand can be returned to the condition of usable sand. Construction of the installation was preceded by comprehensive investigations with comparisons of data from several different thermal reconditioning plants. These data were assessed with the aid of an assessment code and provided the basis for the decision of which installation should ultimately be awarded the contract. Presented is a detailed description of the installation and of the process engineering involved. In the cost comparison between fresh sand and reconditioned sand, it is particularly apparent that a considerable proportion of the heat arising can be passed straight on to the plant heating network. This factor has particularly favorable results in overall cost. The efficiency of the installation, currently at 92%, is being improved to 96% by various measures that have already been introduced. Finally, details are given of practical experience gathered in the period since the installation was commissioned. Graphs. (Wesp, S., Engelhardt, W., NINETY-FIFTH ANNUAL MEETING AMERICAN FOUNDRYMEN'S SOCIETY, BIRMINGHAM, ALABAMA, U.S.A. 5-9 MAY 1991. Publisher: AMERICAN FOUNDRYMEN'S SOCIETY, INC., Des Plaines, Illinois 60016-8399, U.S.A. (1991). (Met. A. 9301-72-0001), pp. 227-235 [in English].)

0738 THE EFFECTS OF SAND AND FOUNDRY VARIABLES ON THE PERFORMANCE OF NOBAKE BINDERS. [BIB-199301-51-0041]

Nobake oils were introduced in the spring of 1965. The predecessor paper to this Silver Anniversary paper focused on the effects of binder and catalyst levels, type of sand, moisture in the sand, ambient relative humidity and temperature, nitrogen content of the binder and hot strength of the sand—binder combination on core and mold performance in making castings of various metals. This paper updates the comparisons of nobake oils to furans, including new casting test results, and makes comparisons with the newer binder systems: phenolic urethanes and ester-cured phenolics. Discussion of environmental, health and safety aspects of the various binder systems has been added. Use in casting Al and cast iron is discussed. Graphs. (Robins, J., Tonello, L.L., Schafer, R.J., NINETY-FIFTH ANNUAL MEETING AMERICAN FOUNDRYMEN'S SOCIETY, BIRMINGHAM, ALABAMA, U.S.A. 5-9 MAY 1991. Publisher: AMERICAN FOUNDRYMEN'S SOCIETY, INC., Des Plaines, Illinois 60016-8399, U.S.A. (1991). (Met. A. 9301-72-0001), pp. 623-630 [in English].)

0739 CHEMICALLY BONDED SAND SYSTEMS UPDATED. [BIB-199301-51-0061]

Production of short and medium run quality casting production will come from highly automated chemically bonded sand molding plants, a recent international foundry meeting (BCIRA) predicted. Highlights of the discussions included alkaline phenolic resins, gas curing, sand reclamation, and environmental concerns. Future concerns are largely environmentally connected with emissions and health factors. (Heine, H.J., FOUNDRY MANAGEMENT AND TECHNOLOGY, (AUG. 1992), 120, (8), pp. 21-24 [in English]. ISSN 0360-8999)

0740 BENEFICIAL REUSES FOR SPENT BRIDGE PAINTING BLAST MATERIAL. [BIB-199301-57-0045]

Prior to 1975, Pb-based paints were commonly used in protecting steel structures. Because of the toxic effects of Pb on human health and the environment, their use has been significantly reduced. However, problems with these paints persist when they are removed during normal maintenance by pneumatic blasting with mineral abrasives. Technologies are developed to contain the spent abrasive and paint during blasting operations. A study to identify beneficial reuses for the spent blasting material is reported. Nine samples were gathered from different projects within Pennsylvania. The samples were thoroughly characterized with regard to composition, morphology, and EP and TCLP leach test performance. Potential reuse applications are reviewed with regard to technical adequacy, economics, and environmental constraints. Graphs 9 ref. (Weyand, T.E., RESIDUES AND EFFLUENTS: PROCESSING AND ENVIRONMENTAL CONSIDERATIONS, SAN DIEGO, CALIFORNIA, U.S.A. 1-5 MAR. 1992. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1991). (Met. A. 9301-72-0015), pp. 877-886 [in English].)

0741 SURFACE TREATMENTS OF METALS USING EXCIMER LASERS: POSSIBLE APPLICATIONS FOR THE AUTOMOTIVE INDUSTRY. [BIB-199301-57-0049]

Fundamental investigations of the surface treatment of metals using excimer lasers have been carried out in recent years. Excimer laser systems have now become reliable and handling problems seems to be solved. The results of fundamental experiences and first possible applications, especially for the automotive industry, are presented. An excimer laser working station for three-dimensional materials processing has been built to demonstrate the possibility of treatments on typical materials and parts for the automotive industry. Smoothing of cam shafts, crankshafts, and gear wheels leads to a noise reduction and optimizing of the wear resistance against abrasive wear for those components. Another possible process, which is discussed, is the ablation of deformation layers. This process leads, especially for cast iron cylinder liners or cylinder blocks, to a laying-bare of the graphite inclusions by optical means, avoiding the pollution problems arising from chemical treatments. The opened graphite spherulites or laminae acts as oil reservoirs minimizing the oil usage and improving the running-in phase of the treated motors. Graphs, Photomicrographs 7 ref. (Bergmann, H., Schutte, K., Quetsch, R., LASER APPLICATIONS IN THE AUTOMOTIVE INDUSTRIES, FLORENCE, ITALY, 1-5 JUNE 1992. Publisher: AUTOMOTIVE AUTOMATION LIMITED, 42 Lloyd Park Ave., Croydon CR0 5SB, U.K. (1992). (Met. A. 9301-72-0019), pp. 365-371 [in English].)

0742 ABLATION AND AFTER: THE LAW AND THE PROFITS. [BIB-199301-57-0120]

Since 1974 the market high performance antifoulings has been satisfied with the ablative or self-polishing organo-tin copolymer antifoulings, which have almost totally displaced the prior art. Critical to success of the self-polishing mechanism has been the organo-Sn, particularly tri-butyl Sn, biocides. Organo-Sn and all other antifouling biocides are now subject to approval by national and supra-national regulators, and tri-butyl Sn compounds have been proscribed for some uses (yachts 25 m) for example and are at best tolerated in deep sea marine use only for the lack of a totally satisfactory substitute. Some of the attempts to formulate more environmentally acceptable solutions to the problem are catalogued, mainly by reference to the patents literature, the volume of which alone testifies to the magnitude of the problem, and does so under a number of headings: biocides for antifouling; use continue to be patented, improvements in self-polishing materials continue to appear, as well as alternative self-polishing chemistries. More radical solutions not involving biocides have shown promise.

others, involving mechanical or electrical phenomena, or "natural" solutions to the problem exist, but are not discussed. 149 ref. (Milne, A.; POLYMERS IN A MARINE ENVIRONMENT, LONDON, UK, 23-24 OCT. 1991. Publisher: THE INSTITUTE OF MARINE ENGINEERS, The Memorial Building, 76 Mark Lane, London EC3R 7JN, UK. (1991). (Met. A., 9301-72-0007), pp. 139-144 [in English].)

0743 ADVANCES AND DEVELOPMENTS IN EMISSIONS CONTROL: A REVIEW OF THE 1992 SAE INTERNATIONAL CONGRESS. [BIB-199301-61-0064]

Noble metal catalysts, particularly in gasoline applications, are very much a part of a control system, involving engine management strategies and other engine components. Noble metal catalysts are also finding use in diesel emissions control. The substitution of Pt or Rh by Pd is being examined by a number of companies. 15 ref. (PLATINUM METALS REVIEW, (APR. 1992), 36, (2), pp. 86-89 [in English]. ISSN 0032-1400)

0744 TRIBOLOGY IN FLUIDS OF LOW LUBRICITY: APPLICATION TO FRICTION UNDER WATER. (TRIBOLOGIE DANS LES FLUIDES A FAIBLE POUVOIR LUBRIFIANT: APPLICATION AU FROTTEMENT EN EAU.) [BIB-199302-31-0466]

Applications where lubrication between moving surfaces can only be by water involve safety (mining and steelmaking), pollution (textiles and food), biological compatibility (prostheses) and prolonged immersion (marine and offshore). The advantage of the high thermal capacity of water is offset by its film instability. A number of case histories of friction and wear problems under water are presented together with test procedures adopted to simulate the conditions in the laboratory and the solutions adopted to solve the problems. Future developments are expected to include the increased use of ceramic and cermet components where lubrication by water is involved. Graphs. 6 ref. (Cartier, M.; MATERIAUX ET TECHNIQUES (PARIS), (JAN.-MAR. 1992), 80, (1-3), pp. 19-25 [in French]. ISSN 0032-6895)

0745 KINETIC STUDY OF COPPER DEPOSITION ON IRON BY CEMENTATION REACTION. [BIB-199302-34-0244]

Cementation of Cu on Fe powder was shown to be a feasible process to achieve a high degree of Cu removal over a broad operational range. First-order kinetics were followed for both the Cu concentration and the surface area of Fe. To minimize the effect of copper-hydroxyl formation and excess Fe consumption, the cementation process was found to be more practical in weak acidic conditions. Graphs. Photomicrographs. 11 ref. (Ku, Y.; Chen, C.-H.; SEPARATION SCIENCE AND TECHNOLOGY, (1992), 27, (10), pp. 1259-1275 [in English]. ISSN 0149-6395)

0746 PROGRESS IN DAVY MCKEE FGD INSTALLATIONS. [BIB-199302-35-0347]

In the Wellman—Lord flue gas desulfurization process, the absorbing solution is reused, and the absorbed SO₂ recovered as elemental sulfur, sulfuric acid or pure liquid SO₂. Reductions in power, steam and caustic usage have substantially improved plant running costs. Process intensification has also reduced the capital cost. Developments in materials used in the plants have centered on the absorption system, as conditions in the regeneration plant are relatively mild. The first power plant Wellman—Lord absorbers featured 316 stainless steel valve trays in the absorber tower. Metallic materials currently in contact with the prescrubber solution are Hastelloys or equivalent. 316 stainless steels are used for the shell and internals in the absorption section. In two plants, Wellman—Lord absorbers are constructed of Palatal A 430 glass fiber reinforced vinyl ester resins. 316L, carbon steel, vinyl ester GFRP, and Hastelloy C22 and C276 ductwork corrosion experience is described. Graphs. 7 ref. (Ford, P.G.; UK CORROSION '91 VOL. 1, MANCHESTER, UK, 22-24 OCT. 1991. Publisher: INSTITUTE OF CORROSION, Exeter House, 48 Holloway Head, Birmingham B1 1NQ, UK. (1991). Paper No. 8, (Met. A., 9302-72-0090), p. 19 [in English].)

0747 A NEW PROCESS OF OXIDIZED NICKEL ORE MELTING IN A TWO-ZONE MELTING. [BIB-199302-42-0142]

The results of extended laboratory tests of a new continuous cokeless ecologically-clean process for oxidized Ni ore processing to produce ferronickel in a two-zone unit are considered. The test results for metal extraction and for melt product composition in the process are presented. An estimate for workability of individual assemblies and the unit as a whole, and possibilities to use it to melt both oxidized raw material and sulphides are given. 3 ref. (Ryzhov, O.; Vigdorshik, E.M.; Mostondz, K.I.; Zheldybin, O.I.; Tsybulov, L.B.; Ez'ov, E.I.; Rusakov, M.R.; TSVETNYE METALLY, (JUNE 1992), (6), pp. 19-21 [in Russian]. ISSN 0372-2929)

0748 AN IMPROVEMENT OF ECOLOGICAL SAFETY DURING THE HEAVY REPAIR OF ALUMINUM ELECTROLYZERS. [BIB-199302-42-0144]

The results of analysis of diverse type cathode units in the upper and side current-leads are presented. The ways to decrease the quantity of fluorine-bearing waste when dismantling the electrolyzer to improve the ecological safety during the heavy repair are considered. 3 ref. (Dem'ykina, O.B.; Mntsis, M.Ya.; Tolkanov, B.I.; TSVETNYE METALLY, (JUNE 1992), (6), pp. 37-39 [in Russian]. ISSN 0372-2929)

0749 ADSORBING FLOTATION OF COPPER HYDROXO PRECIPITATES BY PYRITE FINES. [BIB-199302-42-0201]

The removal of Cu ions from dilute aqueous solutions by the addition of mineral (pyrite) fine particles was undertaken by following an adsorbing (scavenging) flotation mechanism. Pyrite generally constitutes a residual or a solid industrial waste by-product in mixed sulfides processing plant. A further utilization for pyrite is suggested. The dissolved-air method was applied for solid liquid separation when the mineral particles were in the fine (subsieve) size range. Various unconventional collectors for pyrite flotation were also examined. Graphs. 24 ref. (Zouboulis, A.I.; Kydros, K.A.; Matis, K.A.; SEPARATION SCIENCE AND TECHNOLOGY, (DEC. 1992), 27, (15), pp. 2143-2155 [in English]. ISSN 0149-6395)

0750 CONTRIBUTION TO APPLICATION OF A NONPOLLUTING COLLECTOR FOR FLOTATIVE SEPARATION OF SULPHIDE MINERALS CONTAINING SILVER. (BEITRAG ZUM EINSATZ EINES UMWELTFREUNDLICHEN SAMMLERS FUR DIE FLOTATIVE TRENNUNG VON SILBERHALTIGEN SULFIDMINERALEN.) [BIB-199302-42-0203]

Investigations were conducted on the flotation of Ag minerals from a sulphide ore containing Ag by employing a nonpolluting complex-forming agent Trimer-capto-s-triazine (TMT-15) and conventional collectors. The metal recovery was determined in relation to reagent and pH value. The flotation results reveal that concentrate contents 1000 ppm Ag can be achieved at a recovery of 78% when using TMT-15. The same results were achieved by a combination of dithiophosphates—xanthates. Of particular advantage here is that, in comparison to conventional collectors, the concentration of dissolved bivalent heavy metal ions in process water is considerably suppressed. Thus this water can be returned into the circuit or discharged. Graphs. 9 ref. (Kinabo, C.; AUFBEREITUNGSTECHNIK, (SEPT. 1992), 33, pp. 515-520 [in English, German]. ISSN 0004-783X)

0751 THE EOS PROCESS: A NEW PROCESS FOR ENHANCED POLLUTION CONTROL IN IRON-ORE SINTERING. (LE PROCEDE EOS: UN NOUVEAU PROCEDE PERMETTANT DE REDUIRE LES EMISSIONS DE CHAINES D'AGGLOMERATION DE MINERAIS DE FER.) [BIB-199302-45-0122]

Iron-ore sintering entails substantial off-gas volumes, the treatment of which causes considerable cost to meet evermore stringent environmental protection standards. The EOS (emission optimized sintering) process is geared to reduce the off-gas volume by 60-80% while conserving or even improving sinter

characteristics. This process opens up completely new perspectives of off-gas cleaning and leads to appreciable cost savings for environmental control measures. Graphs. 1 ref. (Cappel, F.; Weisel, H.; 51ST IRONMAKING CONFERENCE, TORONTO, CANADA, 5-8 APR. 1992. REV. METALL., CAN. INF. TECH., (JUNE 1992), 89, (6), pp. 511-518 [in French]. ISSN 0035-1563)

0752 EFFECT OF ULTRASOUND ON ACIDIFIED BRINE LEACHING OF DOUBLE-KILN TREATED EAF DUST. [BIB-199302-45-0233]

The US steel industry produces approx 500 000 tons/year of electric arc furnace (EAF) dust, which is classified as a hazardous waste. Increasing disposal costs of these dusts have encouraged studies to investigate treatment processes to render the material non-hazardous, and to possibly recover metal values. This research project was designed to examine the hydrometallurgical recovery of Zn from EAF dusts that have been treated by a double-kiln fuming process. The test work consisted essentially of acidified brine leaching of the pelletized calcine to determine the influence of traditional conditions, such as acid concentration, temperature and agitation, plus the application of ultrasound, on the Zn dissolution efficiency and selectivity. Preliminary leaching tests using acidified calcium chloride indicated that selective leaching of Zn over Fe could be attained if ultrasound was employed. The effect of air and nitrogen on the leaching process was investigated and it was established that selective leaching with ultrasound was not dependent upon external agitation or on the availability of oxygen. Without ultrasound, Zn dissolution was enhanced by the presence of O₂, while Fe dissolution was greatly retarded by the absence of O₂. The role of surface area was examined by pellet grinding and it was demonstrated that selectivity was strongly time dependent and Zn recovery and Fe rejection were enhanced at finer particle sizes. The results of the test work permitted possible mechanisms to be established for the acidified brine leaching process, and it is apparent from the results that ultrasound leaching can significantly improve the selective leaching of Zn from double-kiln treated EAF calcine. Graphs. 23 ref. (Barrera-Godinez, J.A.; O'Keefe, T.J.; Watson, J.L.; MINERALS ENGINEERING '92, VANCOUVER, CANADA, 14-16 APR. 1992. MINERALS ENGINEERING, (OCT.-DEC. 1992), 5, (10-12), pp. 1365-1373 [in English]. ISSN 0892-6875)

0753 INCREASE OF EFFECTIVENESS OF ALUMINUM ALLOY DEGASSING BY BLOWING OF INERT GASES. [BIB-199302-51-0293]

An ecologically pure technique for Al alloys degassing was developed. The technique reduces the amount of hexachloroethane released into the atmosphere. Optimal conditions for the processing of hypereutectic Al-Si alloy KS740 were established. The effect of various additions on the hexachloroethane produced was established. Graphs. 3 ref. (Palachev, V.A.; Inkin, S.V.; Belov, V.D.; Kurdyumov, A.V.; LITEINOE PROIZVODSTVO, (MAR. 1992), (3), pp. 10-11 [in Russian]. ISSN 0024-449X)

0754 HYGIENIC ESTIMATION OF LIQUID ALUMINUM ALLOY REFINING. [BIB-199302-51-0301]

A new ecologically safe flux was developed. The flux has a reduced amount of toxic substance evolution. The fluxes were evaluated during their use in melting of Al alloys AK12. The flux was recommended as a cleaner alternative in Al alloy refining. A detailed analysis of the evolved substances was carried out. 1 ref. (Ermolenko, A.E.; Grinberg, A.A.; Savichev, S.A.; Rabinovich, A.M.; LITEINOE PROIZVODSTVO, (MAR. 1992), (3), pp. 25-26 [in Russian]. ISSN 0024-449X)

0755 CONTROL OF VOC EMISSIONS FROM NONFERROUS METAL ROLLING PROCESSES. [BIB-199302-52-0297]

The document was developed in response to increasing inquiries into the environmental impacts of nonferrous metal rolling processes that use oil as a lubricant and coolant in rolling operations. VOC emissions result from evaporative fugitive losses caused by heat generated in the rolling processes. The focus is VOC emission control techniques used by Cu and Al rolling mills. A control cost analysis is also provided for each of the control techniques addressed. The control techniques are carbon adsorption, absorption, incineration, and lubricant substitution (GOV. RES. ANNOUNC. INDEX, (1992), PB92-227677 XAB, Pp 86 [in English]. ISSN 0097-9007)

0756 THE BASE OF POLYMER QUENCHING MEDIUM. [BIB-199302-56-0277]

The structure and function of polymer quenching media are introduced from an organic chemical point of view. The quenching media are based on some water soluble polymers with a degree of polymerization (DP) from 100 to 10 000. Quenching rates of polymers increase with decreasing DP values. The nomenclature and properties are described of the following polymer media: polyvinyl alcohol (PVA), polysodium acrylate (PSA), polyvinyl pyrrolidone (PVP), polyethyl oxazoline (PEOX), and polyallylene oxide (PAO). Use of the AQ251 quenching medium of PAO type, which is non-combustible and stable, results in a crack-free part having a homogeneous hardness. PSA quenching medium can be used for quenching high speed steels, martensitic stainless steels, and patenting high strength steel wires, etc. (Lei, Z.M.; HEAT TREATMENT OF METALS (CHINA), (OCT. 1991), (10), pp. 36-39 [in Chinese]. ISSN 0254-6051)

0757 CHEMICAL COLOURING OF STEEL AT ROOM TEMPERATURE. [BIB-199302-57-0237]

The chemical colouring solution, utilizing the system of CuSO₄-H₂SeO₃, is introduced. It has the advantage of obtaining films on Si steel, 45 or A3 steels with favourable anti-corrosion and wear resistance performances. The technology is simple in operation and is non-polluting for the environment. (Yang, G.L.; Guo, W.Q.; Chao, G.; Wu, D.L.; MATERIALS PROTECTION (CHINA), (MAY 1992), 25, (5), pp. 29-31 [in Chinese]. ISSN 1001-1560)

0758 STEELS' RECLAIM TO FAME. [BIB-199304-42-0439]

Any successful appliance recycling program—current or future—must prove economically viable and, for a number of reasons, steel lends itself well to appliance recycling. When appliance producers decide on the design of an appliance, they are beginning to consider the unit's recyclability as an additional dimension for consideration. From early vendor involvement, throughout the manufacturing system, cooperative efforts between OEMs, suppliers and vendors yield important cost reductions and improved quality with considerations to CFCs. Several appliance producers are interested in using sound damped steel made of a product of constrained layer composites consisting of metal outer skins surrounding a thin viscoelastic core material. A review of appliance recycling internationally covered advances in Japan, Canada, Germany and the US. (Dzierwa, R.; Appliance, (Aug. 1992), 49, (8), pp. 39, 42-45 [in English]. ISSN 0003-6781)

0759 "MEMBRANE-BASED" RECOVERY/TREATMENT SYSTEM FOR GOLD MILL BARREN BLEEDS. [BIB-199304-42-0474]

Recent regulations introduced by the Ontario Provincial Government in the form of the Municipal Industrial Strategy for Abatement (MISA) will force many Au mines to implement more stringent treatment processes for cyanide and metals removal from their mill effluents (barren solutions). These barren solutions contain a multitude of substances including free cyanide and a variety of metal-cyanide complexes. Currently, the cyanide is destroyed by one or two of various processes. If this cyanide could be economically recovered and reused, a considerable savings would be recognized. The objective of this work was to study the feasibility of using hollow fiber gas membrane technology for the recovery of cyanide from acidified Au mill barren bleed solutions. This was accomplished by modelling the hydrogen cyanide mass transfer process, confirming these results experimentally with barren solutions from two Ontario Au mills, and evaluating a complete membrane based recovery treatment system both experimentally and economically. This system included barren solution acidification, cyanide recovery via hollow fiber gas membranes, and chemical precipitation for metals and residual cyanide removal, followed by liquid solid separation. This paper describes the results of an economic analysis performed on the complete recovery treatment system at full scale operations for the two Ontario Au mill barren solutions. Also presented are the cyanide recovery and cyanide and metals removal percentages obtained by this process as determined from bench scale experimentation. Graphs. 11 ref. (Maracle, K.J.; Cte, P.O.; WASTE PROCESSING AND RECYCLING IN MINING AND METALLURGICAL INDUSTRIES, EDMONTON, ALBERTA, CANADA, 23-27 AUG 1992. Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W.,

Montreal, Quebec H3Z 3B8, Canada, (1992). (Met. A., 9304-72-0210), pp. 105-118 [in English].)

0760 REMOVAL OF METAL CATIONS FROM WATER USING ZEOLITES. [BIB-199304-42-0496]

Zeolites from abundant natural deposits were investigated by the Bureau of Mines for efficiently cleaning up mining industry wastewaters. Twenty-four zeolite samples were analyzed by X-ray diffraction and inductively coupled plasma. These included clinoptilolite, mordenite, chabazite, erionite, and phillipsite. Bulk densities of a sized fraction (—40, +65 mesh) varied from 0.48-0.93 g/ml. Attrition losses ranged from 1-18% during an hour-long shake test. The 24 zeolites and an ion-exchange resin were tested for the uptake of Cd, Cu, and Zn. Of the natural zeolites, phillipsite proved to be the most efficient, while the mordenites had the lowest uptakes. Sodium was the most effective exchangeable ion for exchange of heavy metals. Wastewater from an abandoned Cu mine in Nevada was used to test the effectiveness of clinoptilolite for treating a multi-ion wastewater. The metal ions Fe^{2+} , Cu^{2+} , and Zn^{2+} and Ni^{2+} were not. Calcium and NH_4^+ interfered with the uptake of heavy metals. Adsorbed heavy metals were eluted from zeolites with a 3% NaCl solution. Heavy metals were concentrated in the eluates up to 30-fold relative to the waste solution. Anions were not adsorbed by the zeolites. Graphs. 8 ref. (Zamzow, M.J.; Murphy, J.E.; Separation Science and Technology, (1992), 27, (14), pp. 1969-1984 [in English]. ISSN 0149-6395)

0761 METAL ADSORPTION BY ACTIVATED CARBON: EFFECT OF COMPLEXING LIGANDS, COMPETING ADSORBATES, IONIC STRENGTH, AND BACKGROUND ELECTROLYTE. [BIB-199304-42-0497]

Cadmium and Ni adsorption isotherms were performed using three activated carbons in ligand-free systems and in the presence of EDTA, succinic acid, PO_4 (Ni only), NH_4BF_4 (Cd only), competing metals (Ni and Cd), and differing ionic strengths and background electrolytes. Generally, all carbons removed metals from the ligand-free systems. Four scenarios were forwarded which described metal adsorption in the presence of various organic and inorganic compounds. The effect of organic and inorganic ligands on metal removal was dependent on the carbon, metal, and ligand type and concentration. The presence of a second heavy metal did not affect removal of the primary metal ion. Increasing ionic strength decreased metal removal for all carbons and metals investigated while the type of background electrolyte had no effect on metal removal. Graphs. 11 ref. (Reed, B.E.; Nonavinakere, S.K.; Separation Science and Technology, (1992), 27, (14), pp. 1985-2000 [in English]. ISSN 0149-6395)

0762 MAGNOLA—AN INNOVATIVE APPROACH FOR MAGNESIUM PRODUCTION. [BIB-199304-42-0508]

Presented is the proprietary innovative technology adopted by Magnola to produce magnesium metal from serpentine minerals contained in asbestos mining residues. Maps. (Celik, C.; Ghatas, N.E.; Lenz, J.; Letourneau, C.; Santiago, R.; ADVANCES IN PRODUCTION AND FABRICATION OF LIGHT METALS AND METAL MATRIX COMPOSITES, EDMONTON, ALBERTA, CANADA, 23-27 AUG. 1992. Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, (1992). (Met. A., 9304-72-0248), pp. 3-22 [in English].)

0763 PROGRESS IN POLLUTION ABATEMENT IN EUROPEAN COKE MAKING INDUSTRY. [BIB-199304-45-0377]

Recent research and development work that has been carried out on the control of air and water pollution within the European cokemaking industry is reviewed. In the carbonisation process itself, diffuse emissions from battery doors, lids, and ascension pipe seals and from battery operations, such as oven charging and pushing and coke quenching, are significant sources of pollution. Collaborative investigations undertaken by various research groups are reported which demonstrate the effectiveness of modern battery design backed up by good operating practices. In the purification of carbonisation effluents, considerable advances have been made in control of treatment processes. This is highlighted by developments in the control of ammonia stripping operations and by the enhancement of biological treatment facilities to include nitrification and denitrification of the waste water. However, as environmental constraints become tougher, there will be an increasing need to consider new concepts in cokemak-

ing technology and waste water treatment. Graphs. 17 ref. (EPD CONGRESS 1993, DENVER, COLORADO, USA, 21-25 FEB. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992). (Met. A., 9306-72-0303), pp. 449-456 [in English]. ISSN 0301-9233)

0764 PASSIVE TREATMENT METHODS FOR ACID MINE DRAINAGE. [BIB-199306-41-0198]

Acid mine drainage (AMD) occurs at operating and abandoned mine sites as a result of oxidation of sulfide minerals, and is characterized by low pH and heavy metal contamination (e.g. iron, zinc, copper, cadmium, aluminum, manganese). It usually requires treatment before release to meet regulatory requirements. Chemical methods, such as lime neutralization and sulfide precipitation, are commonly used to treat AMD. However, the conventional processes require high capital and operating costs, and constant attention for many years into the future. In addition, the amount of sludge produced by conventional lime treatment processes poses an increasingly significant disposal problem at decommissioned mining operations. There is, therefore, an urgent need to develop passive, cost-effective processes for mitigating AMD and seepages originating from tailings and waste rock areas. Noranda Technology Centre (NTC) has been evaluating various methods being developed by other institutions, and exploring new ideas, to achieve passive in situ processes for treating AMD. These methods include anoxic limestone (ALS), lime-organic mixture (LOM), biosorbents (BIOS) and biotrench (BT). Current investigations at NTC involve preliminary bench-scale testing. Based on the outcome of the bench tests, a field test will be performed at a selected site. Details of the bench tests are discussed. 15 ref. (Kuyucak, N.; St-Germain, P.; EPD CONGRESS 1993, DENVER, COLORADO, USA, 21-25 FEB. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992). (Met. A., 9306-72-0303), pp. 319-331 [in English].)

0765 USING ZEOLITE IN THE RECOVERY OF HEAVY METALS FROM MINING EFFLUENTS. [BIB-199306-41-0201]

Natural zeolites are a less expensive and in certain applications a superior alternative to organic ion exchange resins. Mining and metallurgical waste streams are difficult to treat because the effluents which contain potentially valuable heavy metals such as copper, lead, and silver are often highly acidic and contain significant quantities of suspended solids. Under rigorous operational conditions, certain natural zeolites can remove the metals, which if desired can be recovered by either elution or conventional smelting techniques. There are significant differences in cation exchange rate, selectivity and capacity and resistance to either high or low pH, blocking cations and tolerance to elevated or depressed temperature and pressure not only between different zeolite minerals but between the same mineral from different deposits. Applying natural zeolites to the treatment of mining and metallurgical waste streams depends on matching the specific zeolite to the effluent by characterization of the zeolite minerals. 12 ref. (Eyde, T.H.; EPD CONGRESS 1993, DENVER, COLORADO, USA, 21-25 FEB. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992). (Met. A., 9306-72-0303), pp. 383-392 [in English].)

0766 SECONDARY LEAD SMELTING AT EAST PENN MANUFACTURING CO., INC. [BIB-199306-42-0707]

The recycling of lead-acid batteries in the US has become a challenge as to how to balance ever increasing environmental regulation and cost with efficient operations. East Penn's captive secondary Pb smelter has developed into a recycling facility producing Pb, polypropylene, sulfuric acid, ammonium bisulfite, and non-hazardous discard slag. The emphasis has been to design a facility to comply with environmental regulations, to eliminate wastes, and to produce products, while at the same time, continuing to supply the company's battery manufacturing raw material needs. 6 ref. (Leiby, R.A.; EPD CONGRESS 1993, DENVER, COLORADO, USA, 21-25 FEB. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992). (Met. A., 9306-72-0303), pp. 943-958 [in English].)

0767 INCO ROAST-REDUCTION SMELTING OF NICKEL CONCENTRATE. [BIB-199306-42-0778]

Roast-reduction smelting (RRS) of nickel concentrate, combined with flash smelting of copper concentrate, was in of the process options that Inco consid-

ered as a means of meeting its 1994 sulfur dioxide abatement target at its Copper Cliff operations. RRS involves deep roasting the Ni concentrate in fluid bed roasters. The roaster off-gas is treated in a sulfuric acid plant, and the low S calcine is reduced, smelted with coke in an electric furnace to yield a S deficient matte. The latter material is converted to Bessemer matte in Peirce-Smith converters, with minimal evolution of sulfur dioxide, and the converter slag is reverted to the electric furnace. Excellent Ni and cobalt recoveries are obtained. This paper discusses the development of RRS, including extensive commercial scale testing at Inco's Thompson Smelter and its key operating parameters. Graphs, Phase diagrams. 14 ref. (Diaz, C.; Conard, B.R.; O'Neill, C.E.; Dalvi, A.D.; **EXTRACTIVE METALLURGY OF COPPER, NICKEL AND COBALT VOL. I: FUNDAMENTAL ASPECTS**, DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993), (Met. A., 9306-72-0325), pp. 583-599 [in English].)

0768 ENVIRONMENTAL LEGISLATION AND THE CANADIAN STEEL INDUSTRY. [BIB-199306-45-0575]

Canada has initiated a programme to systematically reduce water pollution in Ontario with enforceable regulations that become more stringent as abatement technology improves. The way in which Dofasco (one of four integrated steel plants in the province and with an annual production of approx 3.9 million to of flat-rolled products) is actively contributing to the objectives of the programme is discussed. The ultimate goal is the virtual elimination of persistent toxic contaminants from all discharges into Ontario waterways. Graphs. (McGuire, T.E.; Lockington, J.N.; Madlen, D.O.; Thoburn, W.; **Steel Technology International**, (1993), pp. 215-222 [in English]. ISSN 0953-2412)

0769 CHALLENGES AND OPPORTUNITIES IN THE STEEL INDUSTRY. [BIB-199306-45-0582]

US steelmaking will face increasing challenges in the next decade from environmental concerns, increasing quality demands, and international competition. Five areas are described in which engineers can make contributions to help meet these challenges. They are: new ironmaking processes such as direct ironmaking (DIOS process) or other coke free methods; increased recycling through better scrap separation, preheating, and use of coal; quality steel production through inclusion, phosphorus, and nitrogen control; near net shape casting of thin slab and strip material; and process modeling and computer control. Graphs. 11 ref. (Fruehan, R.J.; **Iron and Steelmaker**, (Mar. 1993), 20, (3), pp. 59-64 [in English]. ISSN 0097-8388)

0770 EVALUATION OF ENVIRONMENTALLY SAFE CLEANING AGENTS FOR DIAMOND TURNED OPTICS. [BIB-199306-57-0760]

Ellipsometry has been shown to be an effective method for determining surface cleanliness. It is a quick (a single point measurement can be made in approx 10 min), relatively easy, and precise method to use in these studies. It does require that the index of refraction be measured independently and that a model based upon these measurements be developed. This model can be developed in a straightforward manner using a commercial software routine. The data indicate that several of the solvents can be used in place of TCA for cleaning diamond machined copper without sacrificing cleaning ability. Costs must be considered when choosing a solvent, however. (Theye, L.A.; Day, R.D.; Scott, M.; **Gov. Res. Announc. Index**, (1992), DE93000873 XAB, Pp 10 [in English]. ISSN 0097-9007)

0771 A SILVER-PLATING ELECTROLYTE BASED ON TRIS-(HYDROXYMETHYL)-AMINOMETHANE. [BIB-199306-58-0677]

A new silver plating electrolyte has been developed which is based on an ecologically harmless complexing agent, tri-(oxymethyl)-aminomethane. The optimum component concentrations and electrolysis conditions are determined which make it possible to produce high-quality Ag deposits. For a current density of 40-80 A/m², the coating hardness is 1250-1400 mPa. Photomicrographs. 11 ref. (Miftakhova, N.Sh.; Petrova, T.P.; Shapnik, M.S.; **Zashchita Metallov**, (July-Aug. 1992), 28, (4), pp. 681-684 [in Russian]. ISSN 0044-1856)

0772 SELECTION OF AN INSOLUBLE ELECTRODE FOR THE ELECTROPLATING OF DEEP-PRINTING CYLINDERS. [BIB-199306-58-0679]

A new, more efficient, and ecologically cleaner process is proposed for the fabrication of form cylinders for intaglio. In the process proposed here, the barrier layer is not used, and the used copper layer is removed from the cylinder electrolytically in the same Cu plating bath. Details of the process are discussed, and its advantages over the traditional process are demonstrated. Steel and lead were used as substrates. Graphs. 6 ref. (Matyushchenko, L.V.; Melnikov, V.I.; Donchenko, M.I.; **Zashchita Metallov**, (July-Aug. 1992), 28, (4), pp. 684-688 [in Russian]. ISSN 0044-1856)

0773 AVOIDING ENVIRONMENTAL PITFALLS IN THE 1990S: A CONSULTANT'S ROLE. (RETROACTIVE COVERAGE). [BIB-199306-71-0202]

Environmental trends are driving increasingly stringent regulations and posing significant pitfalls for the industrial industry. Companies will face increasing financial liabilities for previous operations, while restrictions on future operations will be more severely regulated. Expansions or relocation projects will be intensely scrutinized and, in most cases, the financial implications will be burdensome. Progressive companies are relying on outside technical consultants to help them move from reactive to proactive environmental management and formulate a systematic strategy for risk management. (Goodrich, H.C.; **PRECIOUS METALS 1990**, SAN DIEGO, CALIFORNIA, USA, JUNE 1990, Publisher: INTERNATIONAL PRECIOUS METALS INSTITUTE, 4905 Tilghman St., Suite 160, Allentown, Pennsylvania 18104, USA, (1990), (Met. A., 9306-72-0318), pp. 29-36 [in English].)

0774 ENVIRONMENTAL CRIMINAL LIABILITY: THE BRAVE NEW FRONTIER AND HOW TO DEAL WITH IT. (RETROACTIVE COVERAGE). [BIB-199306-71-0203]

There is an increasing tendency to criminalize perceived environmental transgressions. Moreover, such criminalization involves conduct traditionally thought to be innocent. The federal and state governments have a dazzling and increasing variety of legal theories at their disposal in crafting a legal strategy to pursue a criminal case against perceived transgressions. For business people potentially threatened with environmental criminal prosecution, the best protection is deterrence. A vehicle for long-term deterrence may be found in the "environmental audit". Also, on a short term or immediate basis, business people should be aware of not only their obligations, but also their rights when suddenly confronted by government inspectors who may be making unreasonable demands. (Holzer, S.T.; **PRECIOUS METALS 1990**, SAN DIEGO, CALIFORNIA, USA, JUNE 1990, Publisher: INTERNATIONAL PRECIOUS METALS INSTITUTE, 4905 Tilghman St., Suite 160, Allentown, Pennsylvania 18104, USA, (1990), (Met. A., 9306-72-0318), pp. 37-52 [in English].)

0775 ATMOSPHERIC EVAPORATION IN WASTE RECYCLING. (RECUPERO MEDIANTE EVAPORAZIONE ATMOSFERICA). [BIB-199305-42-0528]

Atmospheric evaporators offer an advantageous method in recovering precious or toxic components from aqueous solutions resulting from effluents in surface treatment (electroplating) procedures. In atmospheric evaporators, the contaminated solution is sprayed against a large area ("mass-pack"), evaporating water vapors and increasing the concentration of the returning liquid. Principles of complete and partial recovery are outlined, schematizing also the advantages and materials economies. Four typical examples are described covering Cu plating in a barrel (with an economy of 90% of Cu(CN)₂ and 50% of NaCN), Ni plating reducing with approx 40% the added materials and with 16% of the metallic Ni consumption. In acidic Zn plating, up to 90% of salts (ZnCl₂ + KCl + boric acid) and 40% of metallic Zn may be economized. In steel bluing, the consumption of chemical may be reduced by approx 75%. (Val, G.; **Trattamenti & Finiture**, (Jan-Feb. 1992), 32, (1), pp. 38-40, 43 [in Italian]. ISSN 0041-1833)

0776 OPTIMISATION OF METALLURGICAL SINTER PROPERTIES. [BIB-199305-42-0550]

A relationship was established between the hot strength and the FeO content in the sinter. By optimising the FeO content in the sinter produced at Hütte

Kotowicz at 8-9%, the hot strength has been maximised. An added advantage is that the carbon monoxide, CO₂, NO_x, SO₂ and SO₃ emissions have been reduced. Graphs. 3 ref. (Vegman, E.F.; Rutkovski, Y.; Staf', (July 1992), (7), pp. 4-8 [in Russian]. ISSN 0038-920X)

0777 COMPLEX TECHNOLOGY OF ELECTROCHEMICAL WATER TREATMENT WITH REGENERATION OF VALUABLE COMPONENTS IN ELECTROCHEMICAL PLATING PRODUCTION. [BIB-199305-42-0565]

The complex of techniques developed in the MChTI includes electrolysis, electrochemical correction of pH, electroflotation, and electro dialysis, and provides removal of impurities down to the residual concentration of 0.01 mg/l when the initial concentration is not limited. Necessary exposure is approx 10 min for every technique. On the basis of experimental study and computer simulation, the apparatus design and the operation mode of the techniques are optimized. The most important ideas have been patented. Commercial modules having an output of 1-20 m³/h operate successfully at five factories and more modules are under installation. The economic benefit of one module is 100-400 thousands of roubles yearly. 2 ref. (Kolesnikov, V.A.; Shalyt, E.A.; Aarimola, P.K.; ELECTROCHEMISTRY IN MINERAL AND METAL PROCESSING III, ST. LOUIS, MISSOURI, USA, 17-22 MAY 1992. Publisher: THE ELECTROCHEMICAL SOCIETY, INC., 10 South Main St., Pennington, New Jersey 08534-2896, U.S.A. (1992), PV-92-17, (Met. A., 9305-72-0280), pp. 504-507 [in English].)

0778 RETROFIT OF A WET SCRUBBER TO REDUCE PAH EMISSIONS FROM HS SODERBERG POTLINES. [BIB-199305-42-0611]

Reduction of PAH emissions is one of the greatest challenges for an aluminum plant using HSS technology. This challenge can be achieved by reducing anode consumption, utilizing a different anode paste, and by improving the efficiency of existing wet scrubbers through upgrading. This paper describes the retrofit of an industrial wet scrubber by the use of electrostatic technology and mechanical modifications to the Alcan Arvida HSS plant. Development steps, modifications of the scrubber and results are presented. Graphs. 10 ref. (Ganeply, R.; LIGHT METALS 1993, DENVER, COLORADO, USA, 21-25 FEB 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1992), (Met. A., 9305-72-0288), pp. 425-439 [in English].)

0779 RECENT INNOVATIONS AND OUTLINE OF DEVELOPMENT OF CHAGRES SMELTER. [BIB-199305-42-0672]

The Chagres copper smelter was the first in Chile to follow environmental regulations to control sulfur dioxide emissions. Because of this, the operation and development plans have had to incorporate environmental planning as part of its policies for almost three decades. The present article shows the development of the environmental standards applied to its operations, investments, and operational improvements carried out to meet the regulations and improve competitiveness. Results to-date and future plans are outlined, as well as their impact on operations and the environment. Graphs. (Jimenez, M.B.; EXTRACTIVE METALLURGY OF COPPER, NICKEL AND COBALT VOL. II, COPPER AND NICKEL SMELTER OPERATIONS, DENVER, COLORADO, USA, 21-25 FEB 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1993), (Met. A., 9305-72-0289), pp. 1335-1344 [in English].)

0780 TREATMENT OF EFFLUENT WATERS AT KOSAKA SMELTER AND REFINERY. [BIB-199305-42-0638]

The Kosaka Smelter and Refinery produces copper and lead, and has a history of more than 100 years as a metallurgical department of Dow's Kosaka Mine. The smelter treats complex sulfide concentrates which are difficult to smelt. Valuable metals are recovered using various processes developed by Kosaka Smelter and Refinery. Effluent waters from the smelter contain large quantities of heavy metals. This paper describes how Kosaka Smelter and Refinery recovers valuable metals from various effluent waters and handles overall waste waters in order to meet strict environmental standards. 4 ref. (Matsumoto, M.; Inoue, H.; Abumiva, M.; Mitsune, Y.; EXTRACTIVE METALLURGY OF COPPER, NICKEL AND COBALT VOL. II, COPPER AND NICKEL SMELTER OPERATIONS, DENVER, COLORADO, USA, 21-25 FEB 1993,

Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1993), (Met. A., 9305-72-0289), pp. 1599-1612 [in English].)

0781 REMOVAL OF ARSENIC FROM LEAD SLIME BY PRESSURE LEACHING. [BIB-199305-42-0676]

A new technology for the hydrometallurgical treatment of lead slime with high content of arsenic and low contents of gold and silver was advanced. The process consists of pressure leaching to remove As, leaching of antimony, bismuth, copper, and Pb by mixed acids, smelting the residue, electrolysis to obtain product Ag with purity of 99.95%, and extracting Au from Ag anodic slime. 8 ref. (Xiong, Z.G.; Guijinshu (Precious Metals), (1992), 13, (3), pp. 30-34 [in Chinese]. ISSN 1004-0676)

0782 SILVER RECOVERY WITH ION EXCHANGE AND ELECTROWINNING. [BIB-199305-43-0141]

Silver cyanide complexes in wastewater from precious metals electroplating operations can be quite problematic, as the complexed cyanide is somewhat resistant to oxidation by conventional alkaline chlorination. Furthermore, Ag is a valuable metal with a high market value and typical precipitation and clarification techniques do not readily allow recovery of the metal. It has long been recognized that ion exchange systems can be utilized to remove the silver cyanide complex from electroplating rinsewater. These metal complexes are strongly retained by anion resins and are difficult to remove with conventional strong base regeneration, so that often the exhausted resin is simply shipped off site for Ag recovery by incineration, thereby resulting in high operating costs due to resin replacement. The results are presented of bench scale studies which examined the effectiveness of thiocyanate regeneration of the saturated resin for Ag recovery. The spent regenerant was then treated by electrowinning to recover the eluted Ag in a fairly pure state. Projected capital and operating costs for a 2 gpm regenerable ion exchange system were examined. Operating results of a full scale non-regenerated system are presented. Graphs. 5 ref. (Lindstedt, J.; Doyle, M.; SUR FIN '92, VOL. 1, ATLANTA, GEORGIA, USA, 22-25 JUNE 1992. Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, U.S.A. (1992), (Met. A., 9305-72-0264), pp. 467-481 [in English].)

0783 THE ECOLOGICAL BALANCE SHEET: A MANAGEMENT TOOL (L'ECOBILAN: UN OUTIL DE GESTION.) [BIB-199305-45-0470]

Sollac, a French steel producer, presented its first ecological balance sheet in December 1991. It showed how the production of beer and soft drink containers with a steel body and an aluminum lid, and the standard steel food can had caused environmental problems. The manufacture of these articles has resulted in emissions of CO₂ and SO₂, powder releases, and material suspensions in the atmosphere, as well as the production of nitrogen oxides in their transport to the market. Sollac proposed that making lighter containers would result in less pollution because less material would be made and the lighter containers would be transported in fewer trucks. Sollac has presented its conclusions to other manufacturers in Japan and the U.S. Graphs. (Emballage Digest, (Jan. 1992), (40), pp. 12-15 [in French]. ISSN 0013-6557)

0784 REDUCTION OF CO₂ EMISSION IN ALUMINIUM MELTING FURNACES. [BIB-199305-51-0715]

In scrap recycling organic contaminations are removed by thermal processes. The necessary after-burning equipment requires additional fuel and the generation of CO₂ is increased. A new solution has to be found. One way is the mechanical preparation of scrap for reducing the organic components. Most of these materials can be deposited without harmful effects on the environment. This method, however, requires a change in the infrastructure of the recycling industry. (Schmitz, Ch.; LIGHT METALS 1993, DENVER, COLORADO, USA, 21-25 FEB 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1992), (Met. A., 9305-72-0288), pp. 759 [in English].)

0785 DECOATING OF ALUMINUM PRODUCTS. [BIB-199305-51-0742]

Decoating of aluminum products has three very desirable features: recycled Al requires only 5% of the energy to produce new Al for the ore, environmental

pressures are reduced, and clean Al has a significantly lower metal loss than coated material in the downstream melting operation. Described is work carried out by Stein Atkinson Stordy Limited to extend the range of the decoating process to include such material as clean foils, printed foil paper and plastic laminated foil litho plate and food containers, in addition to UBC and NCS, etc. The technology of decoating is presented and process plant designed to meet the strictest environmental regulations is described. Graphs. (Perry, O.H.; LIGHT METALS 1993, DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), pp. 1039-1044 [in English].)

0786 CHLORINATION TECHNOLOGY IN ALUMINUM RECYCLING. [BIB-199305-51-0744]

In the recycling of many aluminum alloys, the use of Cl is both advantageous and necessary for control of magnesium content (demagging for secondary foundry ingot production). Chlorine can also be used for alkali metal impurity removal, hydrogen reduction and improved molten metal cleanliness (inclusion removal by flotation as well). This paper reviews the metallurgical and environmental characteristics of Cl usage in molten Al. In particular, there are environmentally efficient processes such as the gas injection circulation pump used in many remelting applications, and various in-line molten metal treatment devices which exist as best available technology for Cl usage in molten Al processing. Recent data are presented on emissions, efficiency, and plant economics in the remelt demagging process, using Cl in the gas injection pump in secondary Al production. Graphs. Phase diagrams. 10 ref. (Neff, D.V.; Cochran, B.P.; LIGHT METALS 1993, DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), pp. 1053-1060 [in English].)

0787 REMOVAL AND REUSE OF ALUMINUM DROSS SOLID WASTE. [BIB-199305-51-0747]

Aluminum dross wastes produced as by-products from the decommission and salvaging of domestic and military aircraft were studied. Thousands of tons of Al dross accumulate in the US annually. Abandoned and current sites now exist in Arizona where the winds spread light weight Al dross across the landscape. Much of this dross has been classified as hazardous waste due to its leachable lead content. It is a liability to Al sweating operations. MBX Systems was the first to show that Pb can be bioleached from dross and other materials using fermentative heterotrophic bacteria. It is thought that the Pb is solubilized by microbial metabolic end products produced at particle surfaces. Preliminary experiments conducted at MBX on refractory ores containing Pb resulted in a 72% removal of Pb during bioleaching. MBX applied this same biotechnology to Pb removal from Al dross. Metal-solubilizing bacterial isolates were used to leach Pb from Al dross, rendering the product suitable for sale to the Portland Cement industry. Kinetic studies, using a 10% pulp density, indicated which bacteria leached in Pb most rapidly. Solubilization of Pb and other metals were monitored. The most efficient bacteria were identified as Bacillus species. Metallurgical methods, such as direct precipitation, to recover Pb from leachate solutions were investigated. Graphs. Photomicrographs. 10 ref. (Cassells, J.M.; Rusun, P.A.; Young, T.L.; Greene, M.G.; LIGHT METALS 1993, DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), pp. 1075-1081 [in English].)

0788 RECENT PROGRESS OF STEEL WIRE DRAWING TECHNIQUES. [BIB-199305-52-0869]

To meet the increasingly severe wire strength requirement, wire rod must be drawn to a higher strain level while minimizing the loss of ductility in the course of drawing. The tight labor market situation of late strongly demands high efficiency, automation, and labor savings in the wire drawing operation. Environmental control considerations also have led to an increase in the mechanical descaling of rod and wire. These circumstances have combined to urge the development of techniques to draw high-strength and high-performance wire with high efficiency and without environmental pollution. Summarized is the recent progress in the development of technologies for the drawing of wire with higher strength and ductility, mechanical descaling of wire, and for the evaluation of wire drawing conditions as one step forward to the automation of wire

drawing, centering on Nippon Steel's research examples. High carbon steel SWRH82A is discussed. Photomicrographs. Graphs. Spectra. 17 ref. (Sato, H.; Oka, K.; Toshiro, H.; Sasaki, S.; Nippon Steel Technical Report, (Apr. 1992), (53), pp. 107-113 [in English]. ISSN 0300-306X)

0789 REBUILT HAMMER WITH NON-OIL LUBRICATION. [BIB-199305-52-0879]

There were several problems related to a 3t forging hammer for forging of steels: (1) Steam loss was increased. (2) Control mechanism was too complicated. (3) Monthly lubrication oil consumption was 1.2 tons. (4) Pollution due to the oil was very severe. (5) Parts of the hammer needed to be replaced frequently. The hammer was modified twice. First, the control mechanism was simplified. A steam valve was rebuilt. The oil consumption rate was decreased 80%. Second, the piston was rebuilt. A plastic ring with graphite content was utilized, and lubrication oil was no longer needed. The repetition rate of the hammer is 20% higher than the originally designed value. The total number of parts is approx 20% of the original value. (Zhang, M.D.; Cheng, Q.F.; Metalforming Machinery (China), (1991), 26, (6), pp. 28-29 [in Chinese]. ISSN 1001-1951)

0790 WASTE REDUCTION ACTIVITIES AND OPTIONS FOR A MANUFACTURER OF ORTHOPEDIC IMPLANTS. [BIB-199305-53-0317]

The US Environmental Protection Agency (EPA) funded a project with the New Jersey Department of Environmental Protection and Energy (NJDEPE) to assist in conducting waste minimization assessments at 30 small- to medium-sized businesses in the state of New Jersey. One of the sites selected was a facility that manufactures orthopedic implants for use by the health care industry. The parts are produced in a molding operation using stainless steel or Co-Cr alloy. Computer-controlled cutting is used to produce the bearings for the implants according to precise specifications. (Ubrecht, A.; Watts, D.J.; Gov. Res. Announc. Index, (1992), PB93-126217 XAB, Pp 6 [in English]. ISSN 0097-9007)

0791 ACID FREE IN-LINE PICKLING. [BIB-199305-57-0558]

Traditional pickle liquor used for in-line continuous wire cleaning has been hydrochloric acid although sulfuric acid is sometimes used. The ECS system uses an innovative electronic control system to effectively pickle wire in an electrolyte solution of conventional salts. Testing of the ECS system on a galvanizing line has produced clean wire in an electrolyte solution of conventional salts. Testing of the ECS system on a galvanizing line has produced clean wire at speeds 120 m/min at an average power consumption of 2.7 kW/wire. The basic components of an ECS system are three cleaning tanks, a spray rinse tank, electrical supply and control system and filtration system. 3 ref. (Murray, G.A.; 61ST ANNUAL CONVENTION; 1991 REGIONAL MEETING, ATLANTA, GEORGIA, CHARLESTON, SOUTH CAROLINA, USA, NOV. 1991, APR. 1991, Publisher: WIRE ASSOCIATION INTERNATIONAL, 1570 Boston Post Rd., P.O. Box H, Guilford, Connecticut 06437, USA, (1991), (Met. A., 9305-72-0257), pp. 239-241 [in English].)

0792 CRITERIA FOR COMPOSITION OF EMISSIONS IN PAINTING. (CRITERI PER IL CONTENIMENTO EMISSIONI NELLA VERNICIATURA.) [BIB-199305-57-0578]

A synthesis of norms and regulations on polluting emissions from volatile organic compounds and powders is covered along with threshold limits in Italy and particularly in Lombardy. A list of the related norms is included, determining the criteria for evaluation. Concentration limits are quoted. Methods to control the emanations are outlined covering the use of water soluble paints or paints with medium to high solid content, the use of up-to-date technological systems and installations and, eventually, methods like post-burning or catalytic burning of organic volatile compounds. Automobile painting is discussed. (Tammaro, S.; SECOND INTERNATIONAL CONFERENCE ON SURFACE FINISHING AND ANTI-CORROSION PROTECTION IN AUTOMOBILES, MILAN, ITALY, OCT. 1991, Trattamenti & Finiture, (Jan.-Feb. 1992), 32, (1), pp. 44-46-48 [in Italian]. ISSN 0041-1833)

0793 CLEAN OR GREEN? [BIB-199305-57-0582]

The 1990 Clean Air Act limits the emission of ozone depleting chlorofluorocarbons (CFC) and taxes them. Most of the chlorinated solvents are used in vapor degreasers. The electronic industry still needs degreasers to clean assembly boards because the solvent has to wet between small clearance gaps (1-3 mils)

The way to eliminate CFC is to go to a no flux soldering. In the metal cleaning industry, the CFCs are eliminated by going to hydrocarbon or water based cleaners. These cleaners must chemically react with the "dirt" and not corrode the metal. The water based solvent can be recycled. The organic solvent can be combusted to generate energy. (Koelsch, J.R.; Manufacturing Engineering, Mar. 1992), 108, (3), pp. 75-78 [in English]. ISSN 0361-0853)

0794 APPLICATION OF MICROCOMPUTERS AS A TECHNICAL RESOURCE FOR IDENTIFICATION OF POLLUTION PREVENTION OPPORTUNITIES IN METAL FINISHING/ELECTROPLATING OPERATIONS. [BIB-199305-58-0552]

The microcomputer can be an extremely useful tool in the evaluation of pollution prevention opportunities. However, it is important to realize that although the microcomputer is a valuable technical resource that can significantly reduce the amount of time required for the evaluation of a number of alternatives, it is still only a tool. Engineering and process knowledge are required to effectively make use of the computer as a tool for identifying pollution prevention opportunities. 14 ref. (Wilk, L.F.; Capaccio, P.E.; Capaccio, R.S.; SURFIN '92, VOL. 1, ATLANTA, GEORGIA, USA, 22-25 JUNE 1992. Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992). (Met. A., 9305-72-0264), pp. 393-398 [in English].)

0795 WASTE MINIMIZATION VIA SOURCE REDUCTION FOR THE PLATER Pt(III). SOURCE REDUCTION INITIATIVES: THE PREREQUISITE TO CLOSED-LOOP. [BIB-199305-58-0553]

The electroplating shop owner and/or manager is as committed to integrated waste minimization through systematic waste minimization and treatment as they are to "first time right" parts plating, consistent plating quality, satisfied customers, and overall competitiveness are the indirect benefits of waste reduction efforts. The important steps for succeeding at waste minimization, are outlined: waste minimization audit, and utilization of low technology source reduction options. These three steps are essential to lasting waste reduction efforts and are pre-requisite to closing the loop in a cost effective manner. (Pipiani, D.P.; SURFIN '92, VOL. 1, ATLANTA, GEORGIA, USA, 22-25 JUNE 1992. Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992). (Met. A., 9305-72-0264), pp. 443 [in English].)

0796 EVALUATING THE ECONOMICS AND EFFECTIVENESS OF SOURCE REDUCTION OPTIONS IN METAL FINISHING. [BIB-199305-58-0554]

A series of simple experiments evaluates several dragout reduction and water conservation techniques effectiveness; a summary of potential cost savings is also presented. The results demonstrate that source reduction and water conservation are readily achievable in metal finishing operations. Dragout reductions and water conservation of 20 to 90% are demonstrated using various techniques. Most of these techniques are simple and economically implemented and have broad application in other industries. Graphs, 23 ref. (McCullough, M.; SURFIN '92, VOL. 1, ATLANTA, GEORGIA, USA, 22-25 JUNE 1992. Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992). (Met. A., 9305-72-0264), pp. 451-466 [in English].)

0797 UTILIZATION OF CYANIDE WASTE WATERS FROM COPPER PLATING. [BIB-199305-58-0567]

For production of CuCN, from liquid waste after copper plating in a cyanide bath, the Cu-salt is reduced by 40% NaHSO₃ solution. Thus, CuCN may be recovered and at the same time the environment will not be poisoned by heavy metal. Graphs, 6 ref. (Kubiicki, J.; Slawski, F.; Mroglinska, Z.; Wedzicha, L.; Waugora, A.; Rudy i Metale Niezależne, (June 1992), 37, (6), pp. 150-151 [in Polish]. ISSN 0035-9696)

0798 GUIDANCE ON THE OPTIMUM USE OF FILTRATION SYSTEMS FOR FUME EXHAUSTS FROM HOT DIP GALVANIZING PLANTS. [BIB-199305-58-0634]

In hot dip galvanizing, steel parts are pretreated (as a rule by degreasing, pickling, rinsing, and fluxing) and then immersed in molten zinc. During this dipping process, the flux evaporates under the effect of heat; in consequence, there is emission of a relatively large proportion of the ammonium chloride, and Zn compounds contained in the flux. The present work reports current aspects of the operation of collection and filtration systems; it takes account of conditions in West Germany. The work does not examine all the principles of collecting systems and filtration plant (which should be generally known), but confines itself essentially to more recent findings and practical experience. 6 ref. (Marberg, J.; INTERALVA 91: 16TH INTERNATIONAL GALVANIZING CONFERENCE, BARCELONA, SPAIN, 2-7 JUNE 1991. Publisher: EUROPEAN GENERAL GALVANIZERS ASSOCIATION, London House, 68 Upper Richmond Rd., Putney, London SW15 2RP, UK, (1991). (Met. A., 9305-72-0296), pp. GD2 1-GD2 13 [in English].)

0799 ELECTROCHEMICAL PROCESSING FOR THE MINIMIZATION OF WASTES IN THE ELECTROPLATING INDUSTRY—A CRITICAL REVIEW. [BIB-199305-63-0262]

Electrochemical processes can easily be integrated into the electroplating process and in the PCB (printed circuit board) fabrication so that the formation of metal containing effluents can be avoided or drastically decreased. This is the so-called "production integrated environmental protection". Copper is discussed. (Moebius, A.; SURFIN '92, VOL. 1, ATLANTA, GEORGIA, USA, 22-25 JUNE 1992. Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992). (Met. A., 9305-72-0264), pp. 445-449 [in English].)

0800 A VISIT TO FUBA. (VISITE CHEZ FUBA.) [BIB-199305-63-0277]

Fuba, a member of the Hans Kolbe & Co. Group, specializes in printed circuits and has annual sales of DM750 000 000 and a work force of 4300. The factory at Gittelde Harz produces single face, double face with metallized holes, multi-layer and specialized circuit boards. The facility keeps pace with technical developments, is highly automated and favors technology transfers to emerging market areas. Special efforts are made to protect the environment by water treatment and conservation, cleaning of effluent gases, and recycling scrap and waste materials. (Galvano-Organ-Traitements de Surface, (Apr. 1992), (625), (Suppl. Circuits FAB), pp. 27-31 [in French]. ISSN 0302-6477)

0801 METHOD OF MANUFACTURING ZINC-ALKALINE BATTERIES. [BIB-199305-63-0303]

The present invention provides a method of manufacturing a Hg-free zinc-alkaline battery giving no environmental pollution and having an excellent shelf stability which comprises a corrosion-resistant Zn alloy as an anode active material, a compound having appropriate properties, an aqueous alkaline solution as an electrolyte and optionally a fluorine-containing surfactant having the specified chemical structure. The In compound is indium hydroxide or indium sulfide prepared by neutralizing an aqueous solution of an In salt. The surfactant has a hydrophilic part of a polyethylene oxide and an oleophilic part of a fluoroalkyl group. The Zn alloy contains a proper amount of at least one of the group of In, Pb, bismuth, Li, Ca and Al. The indium hydroxide or indium sulfide is present in an amount of 0.005-0.5 wt.%, and the surfactant in an amount of 0.001-0.1 wt.%, based on the weight of the Zn alloy, respectively. Furthermore, the indium hydroxide and indium sulfide in a powder form contain 60 wt.% or more of particles having a particle size of 0.5-8 μm. The indium hydroxide has a weight loss of 18-30 wt.% when thermally decomposed at up to 900 °C and a powdery X-ray diffraction pattern having peaks at 4.71 plus minus 0.10 Å, 3.98 plus minus 0.02 Å, 3.57 plus minus 0.10 Å and 2.66 plus minus 0.02 Å. (Yoshizawa, H.; Miura, A.; Nitta, Y.; Sugihara, S., (1 Dec 1992). [in English]. Patent no. US5168018 (USA) Convention date: 13 May 1991)

0802 THE USE OF INAA FOR THE DETERMINATION OF TRACE ELEMENTS, IN PARTICULAR CADMIUM, IN PLASTICS IN RELATION TO THE ENFORCEMENT OF POLLUTION STANDARDS. [BIB-199307-23-0427]

Many plastic products have relatively short life cycles. Upon final destruction, inorganic additives used for pigmentation, as polymer stabilizer or as flame-retarding agent are being released to the environment. In a rapidly increasing way, governmental authorities are setting limits to the use of inorganic additives, in particular Cd, in plastics. INAA has attractive characteristics which may make authorities decide to select it for the control programs in relation to the enforcement of pollution standards. An evaluation is made of the use of INAA for such analysis. Analysis protocols, sensitivities, and observed levels of other trace elements are being discussed. 2 ref. (Bode, P.; 8TH INTERNATIONAL CONFERENCE: MODERN TRENDS IN ACTIVATION ANALYSIS. II. VIENNA, AUSTRIA, 16-20 SEPT. 1991. Journal of Radioanalytical and Nuclear Chemistry, Articles, (Jan. 1993), 16, (2), pp. 361-367 [in English]. ISSN 0236-5731)

0803 METALLIC LEAD RECOVERY FROM SCRAP BATTERIES: STATE-OF-THE-ART ON ALTERNATIVE HYDROMETALLURGICAL PROCESSES. (RECUPERO DI PIOMBO METALLICO DA ROTTAMI DI BATTERIA STATO DELLE CONOSCENZE SUI PROCESSI ALTERNATIVI DI TIPO MISTO (O COMBINATO) IDROELETTROMETALLURGICO.) [BIB-199307-42-0843]

Technology currently used for lead recovery from scrap batteries is of the pyrometallurgical type. This method has two limits: operating costs and environmental pollution. The second limitation is critical for the growing public and industrial interest in cleaner production installations, new and future standards regarding environmental problems. In this frame Pb producers, in particular for secondary Pb, organize and concentrate their efforts toward innovative alternative solutions that have minimum or at least controlled ecological risk and are economically viable. These lines are of the hydrometallurgical type with final Pb recovery through electrowinning in acid baths with fluorine complexes. The present state-of-the-art is reviewed. 12 ref. (Nidola, A.; AIFM Galvano Tecnica e Nuove Finiture, (Jan.-Feb. 1993), 3, (1), pp. 34-42 [in Italian]. ISSN 0016-4240)

0804 ECOLOGY IN HEAT TREATMENTS AND SURFACE TREATMENTS OF METALS: RECOVERY PROCESSES AND PURIFICATION TECHNIQUES. (ECOLOGIA NEI TRATTAMENTI TERMICI E SUPERFICIALI DEI METALLI: PROCESSI DI RICUPERO E TECNICHE DI DEPURAZIONE.) [BIB-199307-43-0202]

With restrictions growing on emissions and waste products from the heat and surface treatment of metals, the more common types of treatment plants are examined, as well as their relative emissions, various types of purification installations, and principal waste products. These installations utilize: chlorinated solvent degreasing, which produces only one toxic waste product, a mixed solvent oil, and uses modest amounts of solvent; alkaline degreasing; gaseous case-hardening furnaces and either oil or salt quenching; cyaniding; vacuum furnaces, the most ecologically-friendly of the plants; sandblasting; copper plating; rotational vibration; phosphating; and a dust exhaust with Venturi nebulizer. Experience suggests that purification-recovery techniques are best factored in at the design phase of production plants; physical purification-recovery processes are superior in that they add no new elements to the process, but that chemical-physical purification processes are still necessary; and that ion-exchange resin recycling systems are useful only for cleaning out the final traces of pollution. (Moretti, C.; Metallurgia Italiana, (Apr. 1992), 84, (4), pp. 349-352 [in Italian]. ISSN 0026-0843)

0805 DIOXIN POLLUTION PROBLEM FROM SCRAP PROCESSING. [BIB-199307-43-0203]

Dioxins is a popular name of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). This category of trace compounds emerges from steel scrap processing under certain temperature and catalytic conditions. Many years' studies of developed countries have confirmed that the dioxins endanger the health of mankind and harm the environment. The research development of this pollution problem is introduced and the countermeasures

against dioxin pollution are put forward. Graphs. 6 ref. (Hong, N.; Yang, T.J.; Iron and Steel (China), (Oct. 1992), 77, (10), pp. 61-64 [in Chinese]. ISSN 0449-749X)

0806 GERMANY'S SECONDARY ALUMINUM INDUSTRY HAS DESIGNED ITS RECYCLING WITH THE ENVIRONMENT IN MIND. (DIE DEUTSCHE ALUMINIUM-SEKUN-DARINDUSTRIE GESTALTET RECYCLING UMWELTVERTRAGLICH.) [BIB-199307-43-0206]

The economical challenges faced by the German secondary aluminum industry due to the increasing emphasis placed on maintaining an ecologically acceptable manufacturing environment and the unfavorable circumstances in the primary Al industry are discussed. The present cost structure of the German secondary Al industry is 53% fixed costs, 32% variable costs and 15% environmental costs. Production data for primary and secondary Al in Germany for 1970-1992 are presented. Primary Al production in Germany for 1993 is projected to be 550 000 tons, which is expected to be equaled by the secondary Al industry. Measures being taken by the German secondary Al industry to protect the environment, including improved processing of Al scrap, slag and dross handling and the use of regenerative burners are described. Graphs. (Konzelmann, G.; Aluminium, (Dec. 1992), 68, (12), pp. 1058-1062 [in German]. ISSN 0002-6689)

0807 HIGH-TEMPERATURE SOLAR THERMOCHEMISTRY: PRODUCTION OF IRON AND SYNTHESIS GAS BY Fe_3O_4 -REDUCTION WITH METHANE. [BIB-199307-45-0739]

Criteria for selecting thermochemical processes that use concentrated solar radiation as the energy source of high-temperature process heat are reviewed. The system $Fe_3O_4 - CH_4$ is thermodynamically examined. At 1 atm and temperatures 1300K, the chemical equilibrium components consist of metallic Fe in the solid phase and a mixture of 66.7% H_2 and 33.3% carbon monoxide in the gaseous phase. The total energy required to effect this highly endothermic transformation is approx 1000 kJ/mole of Fe_3O_4 reduced. Exploratory experimental studies were conducted in a solar furnace using a solar receiver (with internal infrared mirrors) containing a fluidized bed reactor. Directly irradiated iron oxide particles, fluidized in methane, acted simultaneously as radiant absorbers and chemical reactants, while freshly produced Fe particles acted as reaction catalysts. The proposed process offers simultaneous production of Fe from its ores and of syngas from natural gas, without discharging CO_2 and other pollutants to the environment. Graphs. Phase diagrams. 22 ref. (Stemfeld, A.; Kuhn, P.; Karnu, J.; Energy, (Mar. 1993), 18, (3), pp. 239-249 [in English]. ISSN 0360-5442)

0808 ENVIRONMENT/HEALTH AND SAFETY. [BIB-199307-51-1020]

Environmental and health and safety concerns of importance to the metal casting industry are reviewed. These concerns relate to resource conservation, clean water, clean air, toxic substances, storm water, and liquid materials storage. Solid waste disposal costs US metalcasters \$451 million/year. Foundry solid wastes are mainly non-hazardous but some sand, slag, and emission dust are classified as hazardous. The volume of solid wastes are being reduced by means of reuse and recycling. (Foundry Management and Technology, (Jan. 1993), 121, (1), pp. 13-16 [in English]. ISSN 0360-8999)

0809 EXPERIENCE IN THE OPERATION OF A COMBINED SYSTEM FOR BURNING OF WASTE GASES AND THERMAL SAND REGENERATION IN A CUSTOMER ALUMINUM FOUNDRY. (BETRIEBSERFAHRUNG MIT EINER KOMBINIERTEN ANLAGE ZUR ABGASVERBRENNUNG UND THERMISCHEN SANDREGENERIERUNG IN EINER ALUMINIUM-KUNDENGIESSEREI.) [BIB-199307-51-1094]

The Mandl & Berger foundry in Linz, Germany, was challenged to reduce emissions of odorous gases, noise, and dust due to encroachment of residential buildings in the area of the foundry (annual output approx 6000 t aluminum castings). A system to combine waste gas incineration and sand regeneration was designed and has operated successfully for a time. The system is described in some detail. Values of mandated maximum emissions vs. actual emissions achieved are also given for dust, organic carbon, carbon monoxide, and NO_x . Total organic carbon of 7 mg/m³ was measured, eliminating any odor from the

system. Dust content of 5 mg m^{-3} was achieved via fabric filters. Recovery of regenerated sand is given as 98%. Graphs, Photomicrographs. (Grünss, H., Schroter, K.; Giessler, (17 Aug. 1992), 79, (16), pp. 678-682 [in German] ISSN 0016-9765)

0810 THE NEW EFFICIENCIES OF ANTI-POLLUTANT FURNACES. [BIB-199307-56-1064]

Wellman Furnaces is a leading European furnace design and manufacturing company that produces a full range of metallurgical heat treatment furnaces, low-temperature ovens, kilns, and rolling mill equipment. The equipment is designed for maximum energy efficiency, optimum production rates, and low pollutant emissions. The Supacase is an example of a state-of-the-art sealed quench furnace. It operates at an 80% thermal efficiency with a three-fold increase in temperature uniformity. This is a plus minus 3°C variation compared to a plus minus 10°C variation. A dual product improvement approach has been adopted that upgrades old furnace designs and development of new concepts. Use of convective heating is employed for rapid heating. Start-up from a cold state takes 10 min. Savings of 50% in gas consumption have been demonstrated in addition to improved product quality, productivity, and a cleaner plant environment. A pulse-fired non-modulating regenerative burner developed by Hotwork Development of Dewsbury have shown energy cost savings of $\$22,000$ year, which is a payback of 1.7 years. Ferritic and martensitic stainless steels are annealed. (Ford, E.; Eng. Dig. (Canada), (Feb. 1992), 38, (1), pp. 11-12 [in English]. ISSN 0013-7901)

0811 WATER BASED PAINTS IN CORROSION PROTECTIVE COATINGS. (CICLI DI VERNICIATURA ALL'ACQUA PER ANTICORROSIONE E MANUTENZIONE.) [BIB-199307-57-0873]

The new "Indromaster" system of water based, low permeability resin paint offers an ecological solution in corrosion prevention. With a typical coating thickness of approx 220-250 μm they are characterized by a very low volatile solvent content (2 g/l for primary and mid coat and 64 g/l for finish coat). Comparative data on "Indromaster" and a classical (inorganic zinc coating primary coat and epoxy-vinyl mid and finish coat) are shown in graphic form, emphasizing the advantages of the new system. A chemically stable iron compound forms on the steel surface in contact with primary coat and the very low permittivity of the coating to water vapours result in an excellent corrosion resistance even in salt-spray test. Graphs. (Baruffalki, L.; Lamiera, (Nov. 1991), 28, (1), pp. 105-107 [in Italian]. ISSN 0391-5891)

0812 PROFITING FROM PRE-FINISHED METALS. [BIB-199307-58-0790]

Increased awareness of environmental concerns, along with government-mandated pollution-control regulations, has prompted many metal formers to look more closely at possible changes in their operations. Such evaluation has fueled the trend toward the use of pre-plated and pre-polished metals, i.e. brass-plated steels. A decision to rely on pre-plated metals offers several advantages, which include: the metalformer need not invest in pollution-control equipment; time and cost savings benefits; production cycle is shortened; aesthetic merit; a variety of finishes including rigidized finishes; and existing tooling, in most cases, can be used on the pre-finished metals thus making the change without major capital expenditures. (Hroncich, E.F.; Metal Forming, (Sept. 1992), 26, (9), pp. 62-63 [in English]. ISSN 1040-967X)

0813 PREVENTION OF SLUSH AND SAVING OF RINSE WATER IN ELECTROPLATING BY USE OF ENVIRO-CELL ELECTROLYSIS SYSTEM. (VERMEIDUNG VON SCHLAEMEN UND EINSPARUNG VON SPUELWASSER IN DER GALVANIK DURCH EINSATZ VON ENVIRO-CELLOELEKTROLYSESYSTEM.) [BIB-199307-58-0822]

Due to decreasing supply of raw materials, the desire for cleaning of metal-containing waste water combined with recycling of rinse water is increasing. The enviro-cell Umwelttechnik has been marketing a modular system for waste water scrubbing via electrolysis. The system can treat concentrations of 50 g/l down to 0.05 mg/l. As electrolyte is dragged from the plating bath into rinse tanks on the surface of work pieces, the volume reduction in the bath is made

up with rinse water, which is replaced in turn with fresh water. Concentrations in the rinse are reduced via electrolysis, which destroys the cyanide and cathodically separates the metals. This saves on cyanide-reducing chemicals and minimizes sludge formation. An example of effluent treatment is given, where the cyanide is oxidized while the copper in the solution is reduced to metallic Cu. Three examples of flow diagrams are shown, along with examples of cost comparisons between chemical and electrolytic effluent treatment. (Langefeld, E.; Galvanotechnik, (Nov. 1991), 82, (11), pp. 3936-3941 [in German] ISSN 0018-4232)

0814 EXTRACTION OF NICKEL IONS FROM ELECTROPLATING EFFLUENTS BY MEMBRANE ELECTROLYSIS. (NI-ABREICHERUNG AUS GALVANISCHEN ABWASSERN MITTELS MEMBRANELEKTROLYSE.) [BIB-199307-58-0823]

To avoid the anodic evolution of chlorine during electrolysis of dilute solutions, anode and cathode in the electrolytic recovery cell are divided by a cation selective membrane. Because a chloride-free anolyte is used, no gaseous Cl is evolved. Graphs. (Mayer, M.; Blatt, W.; Heinke, H.; Galvanotechnik, (Nov. 1991), 82, (11), pp. 3942-3943 [in German] ISSN 0018-4232)

0815 COMPLEXING AGENT FOR DISPLACEMENT TIN PLATING. [BIB-199307-58-0868]

An environmentally innocuous effective replacement for thiourea is disclosed for use as a complexing agent in displacement plating processes in which the plating solution is applied to the substrate surface to be plated by immersion or by spraying, cascading, pouring and the like. The replacement complexing agent is an imidazole-2-thione compound having a given formula wherein A and B are the same or different $-\text{R}-\text{Y}$ groups, wherein R is linear, branched or cyclic alkenyl group containing 1-12 carbon atoms and Y is a hydrogen, halogen, cyano, vinyl, phenyl, or ether moiety. Of this class of compounds, 1-methyl-3-propyl-imidazole-2-thione is preferred for immersion tin plating. This class of complexing agents is particularly useful in spray displacement Sn plating for the manufacture of printed circuit boards wherein free Sn metal is added to the plating solution. (Dodd, J.R.; Arduengo, A.J.; King, R.D.; Vitale, A.C.; (23 Mar 1993). [in English]. Patent no.: US5196053 (USA) Convention date: 27 Nov 1991)

0816 SURFACE EFFECTS OF ORGANIC ADDITIVES ON THE ELECTRODEPOSITION OF ZINC ON MILD STEEL IN ACID-CHLORIDE SOLUTION. [BIB-199307-58-0875]

An investigation has been made using scanning-electron microscopy into the effects on the surface effect of some organic additives during the electrodeposition of zinc on low carbon steel in acid-chloride solution. The organic additives thiourea, dextrin, and glycine were used in different combinations the acid-chloride solution. The ultrasonically-cleaned steel surface was analysed by ESCA instrumentation before the electrodeposition process, which was carried out using a dc supply within defined operating parameters. The results obtained indicated a good electrodeposition of Zn on mild steel. Photomicrographs, Spectra. 14 ref. (Luo, C.A.; Olejford, I.; Mattsson, H.; Corrosion Prevention and Control, (Aug. 1992), 39, (4), pp. 82-88 [in English]. ISSN 0010-9371)

0817 A DIRECT METALLISING PROCESS SUBTRAGANTH COMPACT CP. (DIREKT GALVANISIERUNGSVERFAHREN SUBTRAGANTH COMPACT CP.) [BIB-199307-63-0487]

A new direct metallising system for printed circuit boards is described, which uses an electrically conductive organic layer in place of the electroless copper system normally employed. The process uses no heavy metals, organic solvents, or complexants. The conductive layer is formed in a single step so that only a very brief electrodeposition is then required. Using an alkaline activating solution, a manganese dioxide layer is formed on the non-conducting areas of the hole wall and the conducting film is formed only on the resin and glass fibre surfaces within the hole while not depositing on Cu surfaces. This results in a minimum of defects in the through-hole contacting process. The process is environmentally friendly, easy to control and has low operating and effluent disposal costs. Photomicrographs, Graphs. (Bressel, B.; Szimmat, K.; Galvanotechnik, (Nov. 1991), 82, (11), pp. 4003-4009 [in German] ISSN 0018-4232)

0818 ELECTROCOAGULATION. [BIB-199308-34-0995]

Electrocoagulation is defined. The effect is proven to be due to the dissolved ions from the aluminum sacrificial electrodes which then undergo hydrolysis. Operation is found to be influenced by water chemistry and thus such variables as pH, conductivity, dissolved ions and soluble organics are important. The chemical basis for application of similar technologies to several different type of dissolved chemicals is discussed. These considerations were then used as guides to the design of a 2-515 l min pilot plant. Tests of this pilot plant and arising issues, especially about beneficial role of turbulent flow, are presented. The design of a new cell incorporating the experiences from the first cell is discussed. Graphs, Spectra. 12 ref. (Donini, J.C.; Angle, C.W.; Hassan, T.A.; Kasperski, K.L.; Kan, J.; Kar, K.L.; Thind, S.S.; EMERGING SEPARATION TECHNOLOGIES FOR METALS AND FUELS, Palm Coast, Florida, USA, 13-18 Mar. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993). (Met. A., 9308-72-0415), pp. 409-424 [in English].)

0819 CORROSION INHIBITION IN A COOLING-WATER SYSTEM. [BIB-199308-35-1341]

There is a larger amount of inhibitors used in petrochemical cooling-water systems of Gulf Cooperation Council countries. The inhibitors have a potential hazardous effect on the environment when discharged with effluents. Conventional inhibitors and their combinations have also been used in fertilizer units in Kuwait. Corrosion rates and pollution levels in the discharged effluent indicated that very little or no amount of inhibitor is required by using the inhibiting properties of ammonia which is produced by these plants. Ammonia in the range of 600 ppm in the absence of scale-forming salts worked as a perfect corrosion inhibitor. The disposal effluents were more easily removed from the NH_3 than from other inhibitors. This resulted in lower effluent treatment costs. Based on these results, it was recommended that the use of inhibitors be terminated or reduced. Graphs. 4 ref. (Shaban, H.I.; Corrosion Prevention and Control, (Feb 1992), 39, (1), pp. 9-12 [in English], ISSN 0010-9371)

0820 THE ROLE OF EMERGING TECHNOLOGIES IN FLOW-SHEET DEVELOPMENT. [BIB-199308-41-0254]

The need for mining and metallurgical industries to be sustainable requires them to be innovative in their applications of existing technologies within the mining industry, and avail themselves of opportunities to apply proven applicable technologies from other industries or evaluate the role of emerging technologies in their process application. Increasing competition and environmental restrictions demand the process flowsheets to have efficient separation processes to obtain market advantage and be a good corporate citizen. The paper evaluates the need and opportunities of emerging technologies for mining and metallurgical industries. Opportunities for proven metallurgical separation processes in areas outside the metallurgical industries are identified. 11 ref. (Lakshmanan, V.L.; EMERGING SEPARATION TECHNOLOGIES FOR METALS AND FUELS, Palm Coast, Florida, USA, 13-18 Mar. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993). (Met. A., 9308-72-0415), pp. 249-254 [in English].)

0821 POTENTIOMETRIC STRIPPING ANALYSIS AND THE SPECIATION OF HEAVY METALS IN ENVIRONMENTAL STUDIES. [BIB-199308-42-0865]

Potentiometric stripping analysis (PSA) is applied to a wide variety of acidic dissolution reagents to investigate the inherent possibilities of this method in heavy metal speciation studies using various specific extraction media. The nature and the concentration of the acids, pH and ionic strength effects are studied in the pH range 0-6.5 and with ionic strengths ranging from 10^{-2} to 5M. PSA offers serious advantages over other electrochemical methods based on current measurements: the method gives correct analytical signals in a wide pH range (0-6.5) for all types of acidic reagents and in the whole range of ionic strengths. The study is conducted in the goal of permit routine measurements of heavy metal determinations in speciation studies of environmental samples: cadmium, lead, and copper ions have been chosen as heavy metal ions and mercury (II-) is the chemical oxidizing agent and the precursor in Hg film formation onto the glassy carbon working electrode. Graphs. 19 ref. (Lahar, Ch.; Electrochimica Acta, (Apr 1993), 38, (6), pp. 807-813 [in English], ISSN 0013-4686).

0822 MINERALS INDUSTRY FLOWSHEET DEVELOPMENT FOR THE NINETIES: A GREEN PERSPECTIVE. [BIB-199308-42-0873]

Increasing concern over the environment in which we live, the air quality, water quality, dump sites, and even the aesthetic appearance of industrial processing plants, is having a significant effect upon the way in which flowsheets are now designed. The method of disposal of unwanted impurities is important, and in some cases is the most significant factor in the development of new processes, or the rehabilitation of older ones. The recent formation of the International Council for Metals and the Environment (ICME) and the number of conferences and workshops devoted to environmental issues point to this increased awareness in the minerals industry. This paper notes some of the more recent and proposed environmental-based legislation, and considers the consequences that have to be taken into account when designing modern flowsheets. As an illustration, the presence of arsenic in a refractory gold ore is considered, and the implications its presence has in determining an economic, technically viable, and yet environmentally acceptable process for Au recovery. 34 ref. (Harris, G.B.; EMERGING SEPARATION TECHNOLOGIES FOR METALS AND FUELS, Palm Coast, Florida, USA, 13-18 Mar. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993). (Met. A., 9308-72-0415), pp. 237-247 [in English].)

0823 APPLICATIONS OF MOLTEN SALTS IN REACTIVE METALS PROCESSING. [BIB-199308-42-0876]

Pyrochemical processes using molten salts provide a unique opportunity for the extraction and refining of many reactive and valuable metals either directly from the beneficiated ore or from other process effluents that contain reactive metal compounds. This research program investigates the development of a process for the production and recovery of reactive and valuable metals, such as zinc, tin, lead, bismuth and silver, in a hybrid reactor combining electrolytic production of the Ca reductant and in situ utilization of this reductant for pyrochemical reduction of the metal compounds, such as halide or oxides. The process is equally suitable for producing other low melting metals, such as cadmium and antimony. The cell is typically operated 1000 °C temperature. Attempts have been made to produce Ag, Pb, Bi, Sn and cerium by calciothermic reduction in a molten salt media. In a separate effort, Ca has been produced by an electrolytic dissociation of lime in a calcium chloride medium. The most important characteristic of the hybrid technology is its ability to produce metals under "zero-waste" conditions. Graphs. 8 ref. (Mishra, B.; Olson, D.L.; Averill, W.A.; EMERGING SEPARATION TECHNOLOGIES FOR METALS AND FUELS, Palm Coast, Florida, USA, 13-18 Mar. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993). (Met. A., 9308-72-0415), pp. 317-328 [in English].)

0824 ECONOMIC ANALYSIS OF PRETREATMENT STANDARDS: THE SECONDARY COPPER AND ALUMINUM SUB-CATEGORIES OF THE NONFERROUS METALS MANUFACTURING POINT SOURCE CATEGORY. [BIB-199308-43-0253]

The purpose is to analyze the economic impact which could result from the application of alternative Pretreatment Standards to be established under Section 307(b) of the Federal Water Pollution Control Act, as amended. (Gov. Res. Announc. Index, (1976), PB93-167757XAB, Pp 150 [in English], ISSN 0097-9007)

0825 COKE CONCERNS FUEL INTEREST IN PCI. [BIB-199308-45-0797]

Environmental regulations on coke production techniques have prompted many steel companies to adopt pulverized coal injection as a supplement for coke firing of blast furnaces. Coal injection plants now cost half of an environmentally acceptable coke plant. Accounts of experience with PCI at Armco, U.S. Steel's Gary Works, Inland Steel's Indiana Harbor Works are described. U.S. Steel is also embarking on a pulverized coal injection system addition and Bethlehem Steel will use granulated coal instead of pulverized coal. Sources of PCI equipment and systems are also discussed. (Kuebler, G.G.; Thirty-Three (33) Metal Producing, (Apr 1993), 31, (4), pp. 16-18, 20 [in English], ISSN 0149-1210)

0826 TOWARDS A CARBON-FREE STEEL PRODUCTION ROUTE? (VERS UNE SIDERURGIE SANS CARBONE?) [BIB-199308-45-0899]

The anthropogenic greenhouse effect raises the possibility of large climate modifications. The steel industry, which in France emits 26 Mt of CO₂, has several countermeasures at its disposal: energy savings, which have already been put into application to a large extent; recycling of steel, i.e. scrap melting; use of electrical energy, which in France happens to be essentially C-free; and, possibly in the long term, use of hydrogen as a reducing agent, in the form of natural gas for example. The stirring of Usinor Sacilor production routes towards electric arc steelmaking constitutes an adequate answer to the question of reducing CO₂ emissions. Graphs. 20 ref. (Birat, J.P.; Antoine, M.; Dubs, A.; Gaye, H.; Lassat, Y.; Nicolle, R.; Roth, J.L.; Rev. Metall., Cah. Inf. Tech., (Mar 1993), 90, (3), pp. 411-421 [in French]. ISSN 0035-1563)

0827 NEW BINDER SYSTEM BEFRIENDS ENVIRONMENT. [BIB-199308-51-1165]

A new inorganic foundry binder system has been developed. This non-silicate system is comprised of two parts, a liquid component and a hardener in powdered form. This system has the advantage of having a volatile organic emissions during casting, low odor during mixing, and high flowability. Strength development is good, and high quality castings have been made with no veining and little penetration. Surface finish is good and no lustrous carbon defects are formed. Shakeout is significantly better than sodium silicate no-bake systems. The binder system also passes both the volatile and semivolatile TCLP tests and also the TCLP test for toxic metals. Mechanically reclaimed sand exhibited good results in rebonding tests. Initial field trials were successful, producing several large gray iron castings. Graphs. (Bambauer, R.A.; Langer, H.J.; Yunovich, Y.M.; Foundry Management and Technology, (Feb. 1993), 121, (2), pp. 20-24 [in English]. ISSN 0360-8999)

0828 COST EFFECTIVENESS ANALYSIS OF EFFLUENT STANDARDS AND LIMITATIONS FOR THE COPPER FORMING INDUSTRY. [BIB-199308-52-1361]

The paper reports the results of a cost-effectiveness (CE) analysis of alternative water pollution control regulations on the copper forming industry. The primary cost interest is total annualized direct cost incurred by industry in complying with the regulations. (Gov. Res. Announc. Index, (1983), PB93-156719 XAB, Pp 22 [in English]. ISSN 0097-9007)

0829 ARC GAP CONTROL IN CAVITY-TYPE ELECTRIC DISCHARGE MACHINING. PROCESS CONTROL UNDER WATER. (SPALTWEITENREGELUNG BEIM SENKERODIEREN PROZESSREGELUNG UNTER WASSER.) [BIB-199308-53-0553]

The RWTH laboratory of machine tools has studied the effect of the water-soluble dielectric fluid on the process of electrical discharge machining. It was found that the metal removal rate in this process was better than in the case of use of the hydrocarbon dielectrics. However, the process with water-soluble media is very sensitive and requires a very good arc gap control and a dynamic, quickly reacting feed unit. The results also indicate that a stable process of very fine machining is possible in the case of water-soluble dielectrics, if appropriate hardware and software are employed. The fact that the water-soluble dielectrics are, in contrast to the hydrocarbon dielectrics, environmentally friendly is emphasized. 56CrNiMnV7 is the workpiece. Graphs, Spectra. 2 ref. (Weck, M.; Dehmer, J.M.; Technische Rundschau, (1 May 1992), 84, (18), pp. 54-58 [in German]. ISSN 0040-148X)

0830 NO-RINSE PRE-TREATMENTS: THE 'GREEN' SOLUTION. [BIB-199308-57-1005]

No-rinse pretreatment systems are of primary importance when trying to meet today's industrial needs and also those of tomorrow. A number of chemical pre-treatments are available which include chromates, chromate phosphates, iron phosphates, and zinc phosphates. All have the same objective: converting metal surfaces into an adherent inert chemical complex which improves corrosion resistance and surface-adhesion characteristics. The great advantage of no-rinse systems is that they can easily be incorporated into existing processes

plant with little or no system modification while substantially reducing costs. Following application of chemical solution by immersion or spray, excess solution is removed from the component by natural drainage, squeegee roll, or air knives. The use of no-rinse pretreatments are better suited to meet the environmental demands at lower costs. (Marsh, C.; Corrosion Prevention and Control, (Feb. 1992), 39, (1), pp. 5-8 [in English]. ISSN 0010-9371)

0831 ECONOMIC ENAMELING UNDER ECOLOGICAL CONSIDERATIONS AVOIDS SCRAP. (ABFALL NERMEIDEN STATT ENTSORGEN—WIRTSCHAFTLICHES EMAILIEREN UNTER OKOLOGISCHEN GESICHTSPUNKTEN.) [BIB-199308-57-1048]

New developments are described in the enameling industry that concern installations as well as processes and involve ecological considerations. Economical advantages are derived by a more efficient utilization of raw materials, preferably approaching 100%. Furthermore, modern enameling plants can be conceptualized and constructed with a strong bias toward energy savings. The efficiency of various enameling processes is graphically compared. A thorough analysis of the frits is indispensable, and the trend is toward frits without fluorine. Other ecologically beneficial innovations are a reduction of the amount of drainage water without pretreatment and the dominant role of degreasing for such treatment. Another ecological boost lies in the installation of closed systems that prevent contaminated exhaust air escaping. The respective water consumption and waste accumulation during pretreatment are graphically presented for a number of modern enameling systems. Graphs. (der Vliet, W.E.; Maschinenmarkt, (8 Jan. 1991), 97, (12), pp. 39-32, 34 [in German]. ISSN 0341-5775)

0832 RHODIUM ALTERNATIVES IN EMISSION CATALYSTS. [BIB-199308-71-0255]

Rhodium is used in conjunction with platinum to remove the HC, carbon monoxide and NO_x from engine exhaust emissions. The increased use of emissions controls has led to a four-fold price increase in Rh. Potential replacement options for Rh are palladium, ruthenium, iridium and base metals (especially copper). A cost basis equality for Ru and Ir was used as a guideline in candidate (Rh) replacement selection. Current cost of Rh is \$52.00/g. Sweep, light off and Federal Test Procedure (FTP) measurements were obtained for the Ru and Ir. Although initial aging tests (6 h or less) showed promising results, after 75 h of aging the performance of the Ru and Ir alternatives had efficiencies in the low 90% range whereas the Pt/Rh converter had an efficiency in the mid to high 90% range. Graphs. (Fisher, G.B.; Zammitt, M.G.; LaBarge, W.J.; Automotive Engineering, (July 1992), 100, (7), pp. 37-40 [in English]. ISSN 0098-2571)

0833 SIMULTANEOUS DETERMINATION OF HEXAVALENT AND TOTAL CHROMIUM IN WATER AND PLATING BATHS BY SPECTROPHOTOMETRY. [BIB-199309-23-0515]

A new spectrophotometric determination method of hexavalent chromium in waste water and plating baths is described based on the oxidation of beryllion III by Cr(VI) in 0.02M sulphuric acid medium. The decrease in the absorbance of beryllion III was measured at 482 nm with an apparent molar absorptivity of 5.15×10^4 l mole⁻¹ cm. Beer's law was obeyed for Cr(VI) over the range 0-25 µg/25 ml. After the oxidation of Cr(III) to Cr(VI) by ammonium persulphate, total chromium can be determined. Therefore, Cr(III) can be calculated by subtracting Cr(VI) from total Cr. The detection limit is 0.015 and 0.020 µg/25 ml for Cr(VI) and total Cr, respectively. A sensitive spectrophotometric method for trace Cr(III) and Cr(VI) in waste water and plating baths was developed with good precision and accuracy. The reaction is also discussed. Spectra. 7 ref. (Gao, R.-M.; Zhao, Z.-Q.; Zhou, Q.-Z.; Yuan, D.-X.; Talanta, (May 1993), 40, (5), pp. 637-640 [in English]. ISSN 0039-9140)

0834 WASHING PREPARATION WITH TEMPORARY CORROSION PROTECTION PROPERTIES. [BIB-199309-35-1534]

Neutral washing preparations with temporary corrosion protection properties are analyzed. The use of these preparations in industry, their operation parameters, methods of inspection of baths, protection agents applied in operation, and liquid wastes treatment are briefly discussed. The processing of steels is included. (Barkowiak, E.; Powłoki Ochronne, (1993), 21, (1-2), pp. 6-8 [in Polish].)

0835 WORLD COPPER SMELTER SULFUR BALANCE—1988. [BIB-199309-42-0947]

In 1989, the US Bureau of Mines initiated a contract to gather engineering, operating, and environmental cost data for 1988 for 30 major foreign primary copper smelters in market-economy countries. Data were collected for 29 of the designated smelters together with information on applicable environmental regulations. Materials balance data obtained were used with available data for the eight US smelters to determine the approximate extent of Cu smelter sulfur emission control in 1988. A broad characterization of the status of S emission control regulation was made. The 37 US and foreign smelters represented roughly 73.2% of world and 89.3% of market economy primary Cu production in 1988. The 29 non-US smelters attained 55.3% control of their input S in 1988. Combined with the 90.4% control of US smelters, an aggregate 63.4% S control existed. Roughly 1 951 100 mt of sulfur was emitted from the 37 market economy smelters in 1988. Identifiable SO₂ control regulations covered 72.4% of the 29 foreign smelters, representing 66.5% of smelting capacity. Including US smelters, 78.4% of the major market economy smelters were regulated, representing 73.1% of smelting capacity. Significant changes since 1988 that may increase S emission control are noted. Graphs. 7 ref. (Towle, S.W.; US Bureau of Mines Information Circular, (1993), 93-99. Pp 9 [in English].)

0836 STRATEGY FOR THE REDUCTION OF POLLUTANT EMISSIONS FROM CHILEAN COPPER SMELTERS. [BIB-199309-42-1009]

There had been little concern in Chile about the environmental impact of gaseous emissions from Cu smelters until 1990 when the present Government committed itself to face this issue. This paper deals with the policies that are being carried out in order to reduce pollutant emissions from Cu smelters in Chile. These policies are based on a comprehensive diagnosis of present knowledge on emissions and their environmental impact. Also, a review of the Chilean Cu smelting industry is presented followed by an analysis of present environmental regulations on air quality control. Finally, environmental policies for the regulation of sulphur dioxide and particulate matter emissions are outlined so that the development of the Cu smelting industry is consistent with the aim that the industry be in compliance with air quality regulations within the 1990s. Graphs. 9 ref. (Solari, J.A.; Lagos, G.E.; COPPER 91 (COBRE 91), Ottawa, Ontario, Canada, 18-21 Aug. 1991, Publisher: PERGAMON PRESS INC., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A. (1992), (Met. A., 9309-72-0468), pp. (Vol. IV), 295-309 [in English].)

0837 THE CHUQUICAMATA SULPHURIC ACID PLANT PROJECT. [BIB-199309-42-1014]

Codelco-Chile, Chuquicamata Division began operating new sulphuric acid plants in July 1988 with the purpose of diminishing metallurgical offgas emission into the atmosphere and improving environmental conditions in its area of influence. New facilities were built as modulus in two steps and designed to indistinctly process offgases from a Codelco Teniente reactor and/or an Outokumpu flash furnace. Previous good operational knowledge of both smelter units, added to the experience accumulated in sulphuric acid plants in treating those kind of offgases, contributed to a meritorious equipment selection. This paper describes the new offgases treatment facilities, the amount of success achieved and problems which have developed during two and a half years of operation, including solutions to the latter. Graphs. (Capua, S.M.; COPPER 91 (COBRE 91), Ottawa, Ontario, Canada, 18-21 Aug. 1991, Publisher: PERGAMON PRESS INC., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A. (1992), (Met. A., 9309-72-0468), pp. (Vol. IV), 283-293 [in English].)

0838 CHUQUICAMATA FLASH SMELTING PROJECT. [BIB-199309-42-1041]

Codelco-Chile, Chuquicamata Division, began an extensive engineering program during 1976 to evaluate the most modern smelting technologies compatible with existing facilities in order to increase smelting and conversion capacity, to reduce production costs, to reduce atmospheric emissions and to produce cheaper sulphuric acid using metallurgical gases. The Teniente reactor and Outokumpu flash smelting technologies were chosen. The former was put in

operation in 1984. The Flash Smelting Project was initiated during that same year, consisting of engineering, procurement and construction to install an 1818 mt/year Outokumpu flash furnace and ancillary equipment in the Chuquicamata smelter. This paper describes the new smelting facilities, the flash smelting start-up, and successes and problems encountered during the first and second campaign of the furnace. Also, a summary of the metallurgical results is presented. Graphs. 4 ref. (Gonzalez, C.D.; Ruiz, C.A.; COPPER 91 (COBRE 91), Ottawa, Ontario, Canada, 18-21 Aug. 1991, Publisher: PERGAMON PRESS INC., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A. (1992), (Met. A., 9309-72-0468), pp. (Vol. IV), 31-47 [in English].)

0839 COPPER MAKING AT INCO'S COPPER CLIFF SMELTER. [BIB-199309-42-1048]

Inco Limited will reduce its SO₂ emissions, as required by Ontario's Countdown on Acid Rain Program. New milling technology will permit the production of a bulk Cu—Ni concentrate and the rejection of additional quantities of pyrrhotite. The key to the new process strategy at the smelter is the construction of two new Inco oxygen flash furnaces to process the bulk concentrate, leading to the generation of high strength SO₂ off-gases suitable for efficient fixation in a new acid plant. Copper—nickel separation will be carried out at an expanded matte separation plant. Blister Cu will be produced by the flash conversion and pyrorefining of the copper sulfide from matte separation. 14 ref. (Landolt, C.A.; Fritz, A.; Marcuson, S.W.; Cowx, R.B.; Miszczak, J.; COPPER 91 (COBRE 91), Ottawa, Ontario, Canada, 18-21 Aug. 1991, Publisher: PERGAMON PRESS INC., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A. (1992), (Met. A., 9309-72-0468), pp. (Vol. IV), 15-29 [in English].)

0840 EXTRACTION AND RECYCLING OF HEAVY AND PRECIOUS METALS. (RETROACTIVE COVERAGE). (EXTRACTION ET RECYCLAGE DES METAUX LOURDS ET PRECIEUX.) [BIB-199309-43-0311]

Industry is the principal reason for the presence of heavy metals in the aquatic environment, and the removal of these metals has been the subject of a number of publications. One method now in use is that of chelation, in which agents are added to modify the properties of the dissolved metals. Both hydroxides and sulfides have been used for a number of years. The sulfides are less soluble and easier to extract, but they have their own environmental safety problems. Ten types of chelators are described. They work by the exchange of metallic ions between the solution and the chelators with the speed of the exchange being very important, both for economic and productive reasons. In one step the metals are recovered, purified and made ready for recycling. Graphs. 10 ref. (Jeanneret, G.; Surfaces, (Dec. 1990), 28, (218), pp. 22-23, 25-26, 28 [in French]. ISSN 0585-9840)

0841 COREX TECHNOLOGY, TODAY AND TOMORROW. (LA TECNOLOGIA COREX—HOY Y MANANA.) [BIB-199309-45-0928]

The high cost of cokemaking and the environmental problems involved as well as the high price of natural gas for DRI production in many areas of the world were the reasons for the development of the COREX process for the production of hot metal. It has been demonstrated to be both technically and economically feasible on a large scale since 1989, using coal instead of gas of approx 7000 kJ M⁻³ (STP). Due to its high degree of cleanliness and energy, this gas offers a tremendous potential for numerous applications as gas turbine based power generation, DRI-production, and chemical synthesis processes, i.e. for methanol. The possible 100% lump ore input predicts COREX to be an economical completion to existing blast furnaces and future smelting processes on the basis of the fine ore. Due to the fact that cokemaking is no longer needed for the production of hot metal, the environmental impact from a COREX plant is in the range of up to 30% lower than hot metal from the blast furnace. High flexibility with respect to product quality and quantity, combined with environmental compatibility, shows substantial benefits for all mentioned applications. Graphs. (Fleikenschild, J.; Lemperle, M.; Kepplinger, W.L.; Helten, F.; ILAFA 33, Caracas, Venezuela, Nov. 1992, Sidor Hoy, (May 1993), 15, (45), pp. 13-26 [in Spanish]. ISSN 0798-1163)

0842 ENVIRONMENTAL CONTROL BETWEEN AFTERTHOUGHTS AND FUTURE MARKETS—CONCLUSIONS FOR ECONOMIC POLICY AND MANAGEMENT. (UMWELTSCHUTZ ZWISCHEN NACHSORG UND ZUKUNFTSMARKT—SCHLUSSFOLGERUNGEN FÜR WIRTSCHAFTSPOLITIK UND UNTERNEHMENSFUHRUNG.) [BIB-199309-51-1366]

Industry's future significantly depends on securing proper natural living conditions. This brings the political and economic aspects of environmental control in the forefront of considerations. While such factors have been crucial in the chemical industry, the latest example is the textile industry in which the cleanliness of water, air, and grounds, and reduction of noise and vibrations are becoming important. Expenditures are increasing: in Baden-Württemberg 1987, expenses jumped 7.2% from the previous year and reached 2.7% of all investment. A so-called "white foundry" is discussed in which the drastic environmental improvements yielded an absenteeism due to sickness of 2-4% as opposed to industry average of 8-10%. This increased the profit margin by 2%. (Casper, T., Giesserei, (21 Jan. 1991), 78, (2), pp. 49-51 [in German] ISSN 0016-9765)

0843 THE PLANNING AND CONSTRUCTION OF A MODERN LOW PRESSURE ZAMAK DIE CASTING FOUNDRY IN BERLIN FOR THE PRODUCTION OF LOCKSMITH COMPONENTS. (PLANIFICATION ET REALISATION A BERLIN D'UNE FONDERIE SOUS-PRESSION ZAMAK FUTURISTE POUR LA FABRICATION DE PIÈCES DE SERRURERIE.) [BIB-199309-51-1383]

The planning and construction of a Zamak low pressure casting plant for Haebele KG in Nagold is described. Frech Engineering and Schlee assisted in the project which cost approx DM20 million. The plant, built in 1989, has 18 low pressure die casting machines of 20-80 tons closing capacity that consume 2400 t/year of Zamak alloy. It produces various components for locksmiths as well as fasteners and hinges for furniture and cabinetry. The latest air and water pollution equipment and metal recycling methods provide for a clean environment both within and outside the plant. (Bock, U.; Weiler, S.; Guenter, H.; Revue Francaise des Metallurgistes, (Feb. 1993), pp. 40, 45-49 [in French].)

0844 SUBCONTRACTING ACROSS THE RHINE. (DES SOUS-TRAITANTS OUTRE-RHIN.) [BIB-199309-58-1054]

Three companies were visited to learn more about subcontracting in southern Germany. Rieger in Steinheim specializes in chrome plating of mechanical parts and copper plating of cylinders for the textile industry. It also performs nickel-chrome, zinc, and tin plating for automobile factories. The owner, Herr Rieger, has a patent which covers Ni plating of aluminum. There are five coating lines. The waste water recycling system is unique and is regarded as the best for environmental protection. Thoma in Heimerdingen specializes in Ni plating, but also does Zn, chromium, silver, hard chrome, and phosphatation. Their waste water purifying system is based on ion exchange and evaporation. Reismetal specializes in Zn plating and its automatic equipment is one of the more advanced in the industry. The rinse line works very well and uses a minimum of water. They are currently designing a new coating line which is expected to be completed in 1995 (Galvano-Organ-Traitements de Surface, (Nov. 1992), (630), pp. 889-894 [in French] ISSN 0302-6477)

0845 TROUBLESHOOTING PLATING WASTE TREATMENT SYSTEMS. [BIB-199309-58-1095]

Studies of metal plating waste treatment systems have shown that even when companies had proper systems, 5-35% of the systems were not operating at full effectiveness and 2-5% were experiencing grossly excessive discharges of pollutants. Guidelines are given of reestablishing a plan for waste treatment systems and for troubleshooting for existing systems. Problems examined in greater detail include erratic or incorrect pH control, incomplete cyanide destruct, incomplete chromium reduction, malfunction of segregation system (a contaminant is present where it should not be), and incomplete clarification (Gars, S.P., Products Finishing (Cincinnati), (Oct. 1992), 57, (1-A), pp. 296, 298-300, 302-307 [in English] ISSN 0032-9940)

0846 SO₂ REMOVAL FROM CONCENTRATED PROCESS GASES USING THE SULFRED PROCESS. [BIB-199309-71-0271]

Outokumpu Oy has developed a new sulfur dioxide removal process which can be modified for concentrated process gases (SO₂: 2-15%) as well as dilute flue gases (SO₂: 0.1-2%). The main advantages of this Sulfred process are (1) the process is regenerable, (2) it produces valuable elemental sulfur, (3) SO₂ content and gas amount can fluctuate and (4) the process does not produce problematic waste gypsum. The process can be divided into four main stages. In the first absorption stage the gas is washed using OK-scrubbers. The washing reagent, sodium sulfide, is added to the washing solution according to the pH control (pH 2.5-5). The solution contains mainly sodium thiosulfates, sulfates, polythionates and elemental S which all are formed in the absorption reactions. A small bleed of the washing solution goes to the autoclave stage. In this stage all thiosulfates and polythionates are decomposed to liquid S and sulfate solution. This solution is then regenerated back to the sodium sulfide solution in the regeneration stage by adding enough barium sulfide to convert the sodium sulfate to sodium sulfide and to precipitate sulfates as barium sulfate. The barium sulfate precipitate can then be filtered from the sulfide solution and reduced back to barium sulfide by coal in the reduction stage. The Sulfred process has been tested for concentrated and dilute SO₂ gases on a pilot scale (100-10 000 Nm³/h), some of the main results are presented. Graphs. 4 ref. (Roine, A.; Talonen, T.; Metsarinta, M.-L.; COPPER 91 (COBRE 91), Ottawa, Ontario, Canada, 18-21 Aug. 1991, Publisher: PERGAMON PRESS INC., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A. (1992), (Met. A., 9309-72-0468), pp. (Vol. IV), 271-281 [in English].)

0847 TRIVALENT CHROMIUM. (CROMO TRIVALENTE.) [BIB-199310-34-1223]

HARSHAW has developed TRI-CHROME PLUS, a process of electrodeposition using trivalent chromium. The process was found to compare favorably to that of hexavalent Cr, especially with respect to environmental and cost considerations, with waste water treatment savings of up to 90%. Features of the HARSHAW process include improved penetration at higher speeds and the use of a single cell carbon anode. While trivalent Cr electrodeposition was found to be somewhat susceptible to metallic impurities, purification was not found to be excessively time consuming or costly. 5 ref. (Snyder, D.; Oleaga, E.; Metalurgia y Electricidad, (Mar. 1991), 55, (631), pp. 100-103 [in Spanish], ISSN 0026-0991)

0848 WASTE WATER FROM GALVANIC PLATE PRODUCTION MADE ENVIRONMENT SAFE. (UMWELTGERECHTE ABWASSERBEHANDLUNG IN DER LEITERPLATTENFERTIGUNG UND GALVANOTECHNIK.) [BIB-199310-43-0373]

The process introduced to a galvanizing plant to reduce metals and dirt in waste water is described. Recycling is introduced where possible. Precious metals are recovered. (Wagner, B.; Galvanotechnik, (Apr. 1991), 4, (82), pp. 1337-1338 [in German] ISSN 0016-4232)

0849 EFFICIENT NOBLE METAL RECOVERY FROM PLATING SOLUTIONS BY MEANS OF ELECTROLYSIS. (EFFIZIENTE EDELMETALL-RÜCKGEWINNUNG AUS GALVANISCHEN LOSUNGEN MITTELS ELEKTROLYSE.) [BIB-199310-43-0374]

Noble metal waste recovery, in addition to protecting the environment, provides an incentive by the value of the metal recovered. The use of net-type cathodes is particularly effective because of their large active surface. Such cathodes are part of the Aurolaim 20 (Heraeus) apparatus. Each cathode is capable of recovering up to 1000 g of metal in compact form. The extraction of gold and silver from solutions of various concentrations is shown. Graphs. (Dumant, U.; Galvanotechnik, (Feb. 1991), 82, (2), pp. 581-584 [in German] ISSN 0016-4232)

0850 DEVELOPMENT OF ADVANCED MATERIALS IN AUTOMOTIVE INDUSTRIES—APPROACH TO TECHNO-AMENITY. (RETROACTIVE COVERAGE). [BIB-199310-46-0227]

A research director of a large Japanese auto manufacturer reflects upon the efforts to develop emission control technologies. As evidenced in the develop-

ment of the company's ceramic rotors and metal catalytic converters, the role of auto manufacturers has been changing from a mere end user of new materials to a co-developer to meet new demands to maintain a healthy global environment. The role of Japanese industry is considered, which is still trying to gain respect as an original innovator in the worldwide effort to realize further reduction of emission, improved fuel efficiency, and effective recycling of plastics which would become important components of future automobiles. Photomicrographs. Graphs. (Toguchi, M.; Bulletin of the Japan Institute of Metals, (1990), 29, (8), pp 596-603 [in Japanese] ISSN 0021-4426)

0851 A STUDY OF GAS AND DUST EMISSIONS ASSOCIATED WITH THE THERMAL INSULATION OF KILLED STEEL INGOTS BY VARIOUS FILL MATERIALS. [BIB-199310-51-1585]

Dust and gas emissions from fill materials used for the thermal insulation of killed steel ingots are a major source of air pollution at metallurgical plants. Here, various fill insulations are examined from the environmental standpoint in order to select the most ecologically clean materials. It is shown that particularly low levels of emissions of dust and gases are observed for fill insulation consisting of aluminum cuttings. (Tsybal, V.P.; Ibraev, I.K.; Varenik, V.I.; Zhakypbekova, G.R.; Zavodskaya Laboratoriya, (1992), 58, (7), pp 67-68 [in Russian] ISSN 0321-4265)

0852 ENVIRONMENT-FRIENDLY COMPRESSED AIR GRINDER—NO OIL AND LESS DUST. (UMWELTFREUNDLICHE DRUCKLUFTSCHLEIFER—KEIN ÖL UND WENIGER STAUB.) [BIB-199310-53-0731]

Grinding tools driven by oil-free compressed air have been available for several years. The absence of oil does not interfere with grinding efficiency and makes for a healthier work place. The "Dryline" grinders are equipped with dust aspiration, will not singe wood of fiberglass-filled plastics or melt coatings. Other uses include deburring and polishing of machined metal, i.e. aluminum parts. (Wolf, J.; Industrie-Anzeiger, (10 Aug. 1990), 112, 63-64; pp 25-26 [in German] ISSN 0019-9036)

0853 DECREASED GAS CONSUMPTION OF A FLUIDIZED BED FURNACE. [BIB-199310-56-1389]

The feasibility of utilizing a closed circulatory system to generate gases for a fluidized bed furnace was investigated with the primary concentrations of both economizing on the raw materials used for producing furnace atmospheres and decreasing the air pollution caused by exhaust gases. Air humidified with water vapor was first introduced into a charcoal furnace for causing a reaction with hot charcoal to form a carburizing atmosphere. This atmosphere was then introduced into a fluidized bed furnace to carburize steels. The exhaust gases from the fluidized bed furnace were recycled by repassing them through the hot charcoal layer in the charcoal furnace with a gas pump. The charcoal furnace and the fluidized bed furnace formed a closed circulatory system during the carburization of steels. Experiments were performed with various parameters of this system, including content of water vapor in the humid air, temperature of the charcoal, rate of recirculation of the atmosphere, etc. The effect of each parameter on the carburizing behavior in the fluidized bed furnace was investigated on the basis of the rate of carburization and the carbon potential of the atmosphere. The feasibility of applying this system to a fluidized bed furnace was assessed from the aspects of the fluidization of Al_2O_3 powder, the result of carburizing steel or pure iron, and the rate of consumption of charcoal. The closed system employed in generating atmosphere was demonstrated by the experimental results of have enabled the fluidized bed furnace to operate normally and to have significantly decreased both the consumption rate of charcoal and the environmental pollution. Graphs, 6 ref. (Chen, Y.-C.; Metallurgical Transactions B, (Oct 1993), 24B, (5), pp 889-897 [in English] ISSN 0360-2141)

0854 ATMOSPHERIC RELEASES OF HEXAVALENT CHROMIUM FROM HARD CHROMIUM PLATING OPERATIONS. [BIB-199310-58-1163]

Help is given to the surface finishing industry in identifying and solving specific problems with completion of Form R. A "problem" would generally be defined as a combination of a process (e.g. hard chromium plating) and a release (e.g. fugitive air releases of hexavalent Cr). It was concluded that the majority of

environmental releases (water and sludges) are subject to some form of monitoring, in conjunction with an operating permit. Monitoring data are usually available to support completion of Form R. The principal exception to this generalization concerns air emissions, particularly fugitive emissions. Facilities selected for emission testing were representative of hard Cr electroplating operations, based on the size of the plating tanks, the types of solutions plated and the plating solution operation parameters. Graphs, 5 ref. (Hall, M.S.; Dietz, J.D.; Cooper, C.D.; Wayson, R.L.; Bauman, D.; Plat Surf. Finish., (Nov. 1992), 79, (11), pp 18-22 [in English] ISSN 0360-3164)

0855 ASPECTS OF METAL FINISHING DEVELOPMENT IN THE CONTEXT OF ECONOMIC REQUIREMENTS. (ENTWICKLUNGSASPEKTE DER GALVANOTECHNIK IM HINBLICK AUF VOLKSWIRTSCHAFTLICHE ERFORDERNISSE.) [BIB-199310-58-1240]

A review of basic experiments conducted at the Technische Hochschule Ilmenau, key concern modeling of an intensively steady material transport system, the assurance of an even distribution of current density, the production of an object-directed combination of electrolytes, the performance of stable electrolysis, and the maintenance of specified functional properties. Other projects include the development of microplating techniques, computer assisted plating processes for automation and quality assurance, and the elimination of ecologically damaging waste products. Spectra, Graphs, Photomicrographs. (Schmidt, C.; Galvanotechnik, (Feb. 1991), 82, (2), pp 484-491 [in German] ISSN: 0016-4232)

0856 MATERIALS FOR CARS OF THE 1990S. [BIB-199310-61-1389]

A survey of a number of materials used in modern automobiles is presented. Some of these include: a wood-fiber called Fibrit which is lightweight, dimensionally stable, resistant to temperature and humidity variations, and recyclable; a modified polyamide alloy with exceptionally low moisture absorption, increased impact strength, and improved heat resistance; and Arpro expanded polypropylene bead and Dylite expanded polystyrene resin, said to provide excellent energy absorptive properties. Ashland Chemical has developed a new resin system, Arotran Q-6530, useful for automotive parts requiring high paint bake oven temperatures, and high gloss, weather-resistant bezels are being made from acrylonitrile styrene acrylate resin (grade S778T), with impact strength that remains high even at sub-freezing temperatures. Other products include a line of flexible vinyl composites which readily adhere to other vinyls using in-mold film transfer or overmolding; an advanced filter material providing superior performance in trap oxidizer systems to reduce particulate emissions from diesel trucks and buses. Steels and aluminum are also discussed. (Automotive Engineering, (May 1992), 100, (5), pp 53-59 [in English] ISSN 0098-2571)

0857 SLOPOPOSIT—EXPERIENCES AT FIRMA KUBATRONIK-LEITERPLATTEN. (SLOPOSIT—ERFAHRUNGEN BEI FIRMA KUBATRONIK-LEITERPLATTEN.) [BIB-199310-63-0754]

Slotoposit is a metal-resist process for performing the following steps in printed circuit fabrication: drilling holes, cleaning the holes, conditioning, placement of negative masks, metallizing, removal of masks, and etching. Claimed advantages are more rapid manufacture, less environmental problems, time reduction of the chemical—galvanic processes, and less etchant consumption. Photomicrographs. (Kubat, A.; Roubal, J.; Galvanotechnik, (Feb. 1991), 82, (2), pp 644-647 [in German] ISSN 0016-4232)

0858 MATERIALS AND RECYCLING, EXAMPLES FROM THE AUTOMOTIVE INDUSTRY. (WERKSTOFFE UND WIEDERVERWERTUNG AM BEISPIEL DER AUTOMOBIL-INDUSTRIE.) [BIB-199312-43-0428]

The recycling of used automobiles concentrates on metals. The remainder, which includes plastics, lacquers, textiles, and rubber, constitutes approx 25% of the weight and mainly ends up in landfills. In Germany this amounts to 400 000 tons/year, but this is only a fraction of the total landfill receipts. Work continues to find a more environment-friendly method for recycling all the components of automobiles. Graphs. (Razim, C.; Berg- und Huttenmännische Monatshette, (1991), 136, (9), pp 366-368 [in German] ISSN 0005-8912)

0859 WASTEWATER RECYCLING IN A EUROPEAN MANUFACTURING COMPANY. [BIB-199312-43-0429]

The wastewater regulations in Switzerland are moving toward the elimination, reduction, and recycling of waste compounds. For example, maximum levels of some contaminants are: zinc: 2 ppm, cyanide: 1 ppm, nitrite: 1 ppm, and COD: 75 ppm. The approach of one plating company is shown to illustrate that these requirements can be met by recycling the waste water. New reclamation methods are available to actually make such operation profitable by reclaiming valuable metals from the drag out of the plating baths. Two examples of cost savings are \$67 000 in a salt hardening line and \$5350 in a plating line as a result of the reclamation of materials and reduced energy costs. The system has successfully addressed seven main concerns: meeting sewer limits for nitrite and cyanide discharge; zero salt discharge; 98% of hardening salts are recycled; more careful handling of valuable resources; elimination of hazardous chemicals, and total upgrade of an old plant previously scheduled for replacement. (Fabro, M.; *Plat. Surf. Finish.*, (Dec. 1992), 79, (12), pp. 16-18 [in English] ISSN 0360-3164)

0860 WHERE EVER MORE WASTE DUMPS ARE MOUNTING UP. (WO (ABFALL-)BERGE SICH ERHEBEN.) [BIB-199312-43-0437]

In Switzerland alone, there will be forty thousand tons of scrap computer material in the year 2000. The real problem is stated to be the lack of measures towards avoiding this massive contamination of the countryside, not so much the volume. The study is mostly concerned with the recovery of valuable elements and compounds (including gold, platinum, silver, palladium, copper, nickel, and thermoplastic resins) and recycling them. A three-step program is proposed in which a scientific commission is expected to play an important part. (Heinzelmann, E.; *Technische Rundschau*, (Apr. 1991), 83, (14), pp. 20-27 [in German] ISSN 00-40-148X)

0861 HOT BRIQUETTING OF LD DUST IN THE STEEL PLANT OF VA LINZ. [BIB-199312-45-1295]

Thanks to the conversion from wet de-dusting with complete combustion of the LD process gases on the one hand, to dry de-dusting with converter-gas recovery on the other hand, and as a result of the erection of the hot briquetting plant, LD steelworks 3 at V.A-Stahl Linz has progressed from dumping 100% of its LD dust in the form of sludge, to 100% recycling of all the primary and secondary dusts generated in the LD steelworks. In view of the environmental legislation prohibiting the dumping of this type of dust in the dumping grounds used hitherto, and of the acute shortage of suitable dumping sites and the exorbitantly high—and rising—costs of dumping, this has developed into a factor of great economic significance. At the same time, one should not lose sight of the fact that this plant configuration and mode of plant operation was basically the only ecologically and economically viable way in which to comply with the ever more stringent environmental regulations. Graphs. (Heiss, J.; Apfollerer, R.; Pofel, G.; Binder, H.; 1ST EUROPEAN OXYGEN STEELMAKING CONGRESS, Dusseldorf/Neuss, Germany, 21-23 June 1993. Publisher: VEREIN DEUTSCHER EISENHUTTENLEUTE (VDEH), P.O. Box 10 51 45, D-40042 Dusseldorf, Germany, (1993), (Met. A., 9312-72-0550), pp. 194-197 [in English])

0862 LD-PROCESS METALLURGY UNDER THE ASPECTS OF LD DUST RECYCLING. [BIB-199312-45-1296]

The recycling of dust briquettes back into the LD converter, as performed at the Linz steelworks for environmental reasons, has a number of metallurgical effects which are examined with particular reference to the slag metallurgy. In connection with this, ionic-theory-related inferences are described for slag formation and for the incorporation of individual elements into the slag. When briquettes are charged, there are very considerable effects on the oxidation behaviour and slag formation. The elements silicon, manganese, phosphorus, titanium, vanadium and chrome oxidize faster than is the case when no briquettes have been charged. This leads to low Mn and P contents in the second half of the blowing time. As retro-reduction is also less, low P and Mn values are achieved by the end of blowing. The converter slags, basically consisting of dicalcium silicate, wuestite and dicalcium ferrite incorporate the P in the dicalcium silicate. This is impaired by other anion complexes present in the slag. Sulphur is located in the lattice of dicalcium ferrite. Graphs, Photomicrographs. 17 ref. (Presslinger, H.; Antlinger, K.; Pofel, G.; Maxl, E.; 1ST EUROPEAN OXYGEN STEELMAKING CONGRESS, Dusseldorf/Neuss, Germany, 21-23 June 1993. Publisher:

VEREIN DEUTSCHER EISENHUTTENLEUTE (VDEH), P.O. Box 10 51 45, D-40042 Dusseldorf, Germany, (1993), (Met. A., 9312-72-0550), pp. 198-204 [in English])

0863 ENVIRONMENTAL ASPECTS IN THE APPLICATION OF REFRACTORIES FOR CONVERTER LININGS IN GERMANY. [BIB-199312-45-1305]

A short overview of relevant legislation is followed by a characterization of the various binder systems used for shaped and unshaped basic converter lining materials, coal-tar pitch, bitumen, a new MCA binder and phenolic resins. Pitch is technically the best and also the least expensive binder in this respect. Resin, by comparison, reduces the durability by between 10-17%. This is the reason why nowadays, with a few exceptions, pitch-bonded linings are used in converters in Europe. The low porosity and high strength properties in the coked, i.e. service, condition, which in the case of resin are achievable only by means of antioxidants, explain this durability advantage. However all the binders mentioned also contain harmful substances which can be released on being taken into service. The pitch binder contains the highest concentration of polycyclic aromatics, some of which are carcinogenic, for example benzo(a)pyrene (BaP). The concentration of BaP, as well as of other polycyclic aromatics (PAHs) is—and this must be emphasized—largely reduced, however, as a result of thermal treatment and curing additives. Because of this it becomes possible to keep the workplace concentrations far below the technical guideline concentration (TRK). At present a new binder, which is practically BaP-free and comparable to pitch in quality, is also undergoing tests. Another important advantage of basic converter linings is their almost complete recyclability as a secondary raw material. This advantage is achievable, however, only in the case of linings that are free of dolomite and contain no antioxidants. Graphs. 7 ref. (Klages, G.; Solmecke, R.; Thiemann, E.; 1ST EUROPEAN OXYGEN STEELMAKING CONGRESS, Dusseldorf/Neuss, Germany, 21-23 June 1993. Publisher: VEREIN DEUTSCHER EISENHUTTENLEUTE (VDEH), P.O. Box 10 51 45, D-40042 Dusseldorf, Germany, (1993), (Met. A., 9312-72-0550), pp. 254-259 [in English].)

0864 AN ECOLOGICAL CONCEPT IS MATERIALIZING. (EIN ÖKOLOGISCHES KONZEPT WIRD VERWIRKLICHT.) [BIB-199312-45-1316]

Linz is the major steel production center of Austria. The industry has agreed to effect a major improvement in environmental conditions by reducing dust and SO₂ emissions through the elimination of heating oil, reduction of H₂S in coke oven emissions, and SO₂ in acid sintering operations. Dust from sintering and blast furnace operations will be recaptured. Waste water will be purified. Graphs, Phase diagrams. (Kreulitsch, H.; Schroer, U.; *Berg- und Huttenmännische Monatshefte*, (1991), 136, (9), pp. 324-329 [in German] ISSN 0005-8912)

0865 MODERNIZATION OF COKING PLANT AT LINZ WITH CONSIDERATION OF HIGH REQUIREMENTS ON ENVIRONMENTAL PROTECTION. (MODERNISIERUNG DER KOKEREI LINZ UNTER BERÜCKSICHTUNG DER HOHEN ANFORDERUNGEN AN DEN UMWELTSCHUTZ.) [BIB-199312-45-1317]

The Linz coking plant consists of two furnace groups with a total of seven coking ovens. The product feeds the Linz steel works and other steel plants, as well as the chemical industry, and home heating requirements. The coking plant is being restructured to adapt to decreasing demand, introduce automation, improve working conditions, and protect the environment. This program has been ongoing for 10 years and aims in particular at reducing emissions of dust, SO₂, NO_x, and polycyclic aromatic chemicals. Significant progress has been achieved. Graphs. (Kandler, W.; *Berg- und Huttenmännische Monatshefte*, (1991), 136, (9), pp. 329-335 [in German] ISSN 0005-8912)

0866 SOLUTION OF ENVIRONMENTAL PROBLEMS IN REFRACTORIES MANUFACTURING. (DIE LOSUNG UMWELTECHNISCHER PROBLEME IM FEUERFESTBEREICH.) [BIB-199312-45-1320]

The manufacture of refractories requires a certain amount of sulfur, which oil heating supplied in quantity, but is less available since natural gas was substituted. The sulfur is converted by absorption of SO₂, followed by neutralization of sulfuric oxide with magnesium hydroxide and final oxidation of the of the

sulfite salts. Dust removal for environmental protection is performed by equipment capable of filtering out particles in the 0.3 μm range. Graphs. 9 ref. (Siebenhofer, M. *Berg- und Huttenmännische Monatshefte*, (1991), 136, (9), pp. 347-349 [in German]. ISSN 0005-8912)

0867 HIGHLY VOLATILE CHLORINATED ORGANIC COMPOUNDS. (LEICHTFLUCHTIGE CHLORIERTE KOHLENWASSERSTOFFE (LHKW).) [BIB-199312-57-1511]

Chlorinated organic compounds are subject to laws and regulations to protect personnel working with them, the population at large, and the environment. The laws cover use of the compounds, their disposal, waste treatment, transportation, and storage. Industry is looking for substitutes, which include aqueous solutions, sprays, and halogen-free organic compounds. However most replacements slow down the cleaning process. 16 ref. (*Galvanotechnik*, (May 1991), 82, (5), pp. 1612-1617 [in German]. ISSN 0016-4232)

0868 ENVIRONMENT-FRIENDLY SURFACE CLEANER USED IN THE MANUFACTURE OF CONDUCTOR PLATES. (UMWELTSCHONENDE OBERFLÄCHEN-REINIGER BEI DER LEITERPLATTENHERSTELLUNG.) [BIB-199312-57-1527]

Materials of construction, as supplied, often contain a protective coating which would be harmful in further processing and is removed. This is independent whether processing includes galvanic operations or not. Operating procedures which were developed for this kind of surface cleaning are described. (Philipp, G. *Oberfläche Surface*, (Dec. 1992), 33, (12), pp. 12-14 [in German]. ISSN 0048-1270)

0869 ACTUAL ENVIRONMENTAL PROTECTION SITUATION IN ELECTROPLATING AND SURFACE TREATMENT INDUSTRIES IN GERMANY. (AKTUELLE UMWELTSCHUTZ-SITUATION IN DER GALVANO- UND OBERFLÄCHENTECHNIK IN DER BUNDESREPUBLIK DEUTSCHLAND.) [BIB-199312-58-1348]

Three main constraints binding on surface treatment activities in Germany are defined as customer demand for quality, environmental laws, and business economics. An encapsulated history of development of environmental protection measures in the industry starting from 1935 is given, for example, the 4-stage washing cascade with minimum water consumption is explained. In 1970 the electrostatic powder-coating method evolved as solvent-emission- and waste-free method. An example of the latest minimum-waste integrated galvanizing line is given. Spectra. Graphs. (Winkel, P. *Galvanotechnik*, (Sept. 1991), 82, (9), pp. 3147-3152 [in German]. ISSN 0016-4232)

0870 TREATMENT OF CHROMIUM-CONTAINING WASTE WATER AND COURSE OF CHROMIUM REDUCTION. (ZUR BEHANDLUNG CHROMHALTIGER ABWASSER UND ZUM VERLAUF DER CHROMREDUKTION.) [BIB-199312-58-1357]

A study of the reaction of pH value on the course of chromium reduction in waste water is reported. Colour changes of test solution of Cr-trioxide with SO_2 in water with passage of days are recorded, after turning greenish in 10 days the color remained stable. Other results of the test are discussed. 3 ref. (Bahensky, V.; Nedvedova, J. *Galvanotechnik*, (Mar. 1991), 82, (3), pp. 944-946 [in German]. ISSN 0016-4232)

0871 FUNCTIONAL SURFACES BY GALVANIC ZINC-ING: ENVIRONMENTAL PROTECTION. (FUNKTIONELLE OBERFLÄCHEN DURCH GALVANISCHES VERZINKEN: DER UMWELTSCHUTZ.) [BIB-199312-58-1358]

After discussing the current legal requirements of cleanliness of waste water from galvanizing works, schematic representation of a drum zinc-ing equipment with combined water-saving wash technique and integrated recycling device is given. It has a washing cascade. (Hasler, J. *Galvanotechnik*, (Mar. 1991), 82, (3), pp. 947-948 [in German]. ISSN 0016-4232)

0872 WASTE DISPOSAL PROBLEM SPAN. (PROBLEMKREIS ABFALLENTSORGUNG.) [BIB-199312-58-1359]

A critical review is made of the progressively more stringent and comprehensive environmental regulations in Germany. Some regulations are not economically

friendly, e.g. dirty old oil in Berlin is reprocessed in a refinery while fresh new oil is burnt in heating furnace. Voluntary agreements on disposal of batteries and cooling fluids are discussed. Problems of paper mountain including computer paper are touched upon. (Winkel, P. *Galvanotechnik*, (Mar. 1991), 82, (3), pp. 962-967 [in German]. ISSN 0016-4232)

0873 ENVIRONMENTAL PROTECTION INTERNATIONAL. (UMWELTSCHUTZ INTERNATIONALE.) [BIB-199312-58-1374]

A comparison of the environmental protection procedures of Germany with those of the U.S., Thailand, and Singapore. Air pollution, recycling, treatment of plating wastes, and traffic problems are some of the subjects discussed. Each country has different standards based on its culture, and must differentiate between ideals and reality. (Winkel, P. *Galvanotechnik*, (May 1991), 82, (5), pp. 1703-1706 [in German]. ISSN 0016-4232)

0874 NEW MATERIALS IN THE AUTOMOTIVE INDUSTRY. (LOS NUEVOS MATERIALES EN LA INDUSTRIA DEL AUTOMOVIL.) [BIB-199312-61-1569]

An objective of the search for new materials is the production of lighter, safer vehicles. Environmental concerns are playing a growing role in the development of materials. Graphs. (Garcia-Zayas, J. *Metalurgia y Electricidad*, (Dec. 1992), 56, (650), pp. 42-53 [in Spanish]. ISSN 0026-0991)

0875 DIRECT METALLIZATION OF PRINTED CIRCUIT BOARDS BY THE EE-1 PROCESS. (DIREKTMETALLISIERUNG VON LEITERPLATTEN NACH DEM EE-1-VERFAHREN.) [BIB-199312-63-0823]

Eleven steps of the EE (Eliminate Electroless) process for metallizing printed circuit boards are given. It eliminates chemical copper and is both user- and environment-friendly. Its application to a multilayer circuit board is described: a 10-layer board is under test in Trace Laboratories in U.S.A. Its performance is compared with those of other metallizing processes. Photomicrographs. (Caliaro, S. *Galvanotechnik*, (Sept. 1991), 82, (9), pp. 3204-3212 [in German]. ISSN 0016-4232)

0876 INNOVATIVE METHODS FOR PRECIOUS METALS RECOVERY IN NORTH AMERICA. [BIB-199311-42-1146]

Cyanide leaching and CIP will remain as the preferred route for the treatment of free-milling ores in the near future. The development of ion exchange resins with suitable physical and chemical properties for in-pulp gold extraction is likely to occur over the next decade. These may eventually replace carbon. Heap leaching will be applied increasingly on a large scale as a low cost treatment for low grade ores. Also, methods for heap leaching of ores with more complex mineralogy and in more difficult climates will be developed. Pressure oxidation has become the preferred, if not standard, treatment for noncarbonaceous refractory ores. Biological oxidation is likely to become an important alternative of some ores with potential cost advantages over pressure oxidation and environmental benefits over roasting. Roasting is likely to remain as the preferred option for carbonaceous-sulfidic ores, but environmental pressures will continue to increase the costs of this process. Zinc is discussed. (Marsden, J.O.; Mansanti, J.G.; Sass, S.A. *Mining Engineering (Colorado)*, (Sept. 1993), 45, (9), pp. 1144-1151 [in English]. ISSN 0026-5187)

0877 AN EXEMPLARY ACCOMPLISHMENT IN TERMS OF ENVIRONMENTAL IMPACT. (UNE REALISATION EXEMPLAIRE EN TERMES D'IMPACTS SUR L'ENVIRONNEMENT.) [BIB-199311-43-0379]

CRMA is a French company which specializes in the repair and reconditioning of aircraft parts such as engines, both jet and piston, as well as heating equipment and other mechanical parts. Their principal operations are cleaning, nondestructive testing, machining, painting, welding, and coating. Most of these processes generate environmental pollutants. The company has established two main lines in its plant. One line is for cleaning and conditioning and the other is for coating. Everything possible was done to provide safe conditions for the operators. All the concentrates produced during the procedures are collected and reduced to a stable compact form, and in the process the company has saved considerable expense by recycling the water and other products. Their approach has put them in the front ranks of European companies as a producer and as an environmental

protector. (Galvano-Organ-Traillements de Surface. (Dec. 1992), (631), pp. 1075-1078 [in French]. ISSN 0302-6477)

0878 REPLACEMENT OF CHLORINATED SOLVENTS FOR IN-LINE PREPLATE METAL CLEANING WITH ENVIRONMENTALLY SOUND ALTERNATIVES. [BIB-199311-43-0380]

Work by AT&T to eliminate the trichlorotrifluoroethane (CFC-113) from its Kansas City circuit board plant is described. Twenty-three commercial cleaners were evaluated, and a mixture of aliphatic esters is an excellent cleaner for machining oils encountered on their strip raw materials. Production trials support the experimental work. Photoemission spectroscopy has been shown to be a versatile technique for measuring surface cleanliness in cases where standard techniques cannot be used. 1 ref. (Gillum, W.O.; Jackson, A.M.; Metal Finishing. (Aug. 1992), 90, (8), pp. 13-16 [in English]. ISSN 0026-0576)

0879 THE EFFICIENT USE OF AQUEOUS CLEANING FOR PRECISION COMPONENTS. [BIB-199311-43-0381]

A cleaning system to replace CFCs and provide a higher level of cleanliness is described. Consideration of environmental concerns is covered as well as ease of maintenance and operation. An ultrasonic system is described which includes three steps: a wash, rinse, and dry. Recycling of hot air and water is included as well as a vacuum drying step. Tabular comparisons of various cleanliness parameters indicate the system described is superior to the replaced CFC system in all aspects evaluated. Graphs. (Maltby, P.; Metal Finishing. (Aug. 1992), 90, (8), pp. 17-20 [in English]. ISSN 0026-0576)

0880 PICKLING WITH SULFURIC ACID WITHOUT WASTE WATER AND SLUDGE. (BEIZEN MIT SCHWEFELSAURE OHNE ABWASSER UND SCHLAMM.) [BIB-199311-43-0393]

The author discusses at length the technical and economic aspects of control or complete elimination, respectively, of wastewater and sludge residues that have accumulated in sulfuric acid pickling operations. In a historic review, a process scheme is presented in text and flow chart that was conventional as far back as 1965, whereby copper wire is pickled, the metal is precipitated, the wastewater is neutralized and the Cu is recovered electrolytically from the pickling solution, dating back to the same year, a system then considered progressive dealt with a sludge-free wastewater processing scheme, as indicated in another flow diagram, the wastewater treatment is coupled with Cu recovery from the rinsewater through a combination of ion exchange and electrolysis. Finally, a recirculation scheme is discussed and diagrammatically projected that was perfected in 1967 for the purpose of largely eliminating all wastewater and sludge residue. The system provides a return of rinsewater, pickled metal, pickling acid and heat through use of a rinse cascade, a vaporizer and electrolysis. The author elaborates at length on the problems of unforeseeable effects and presents insights into the practical experience gained with so-called "freedom from wastewater". He concludes with three observations: It is impossible to calculate exactly the cost of an introductory phase of such a system. An economically and technically safe operation is only possible under very specific conditions. No truly wastewater-free but merely wastewater-lean operating conditions can be attained whereby the fluid is shifted into a region of special residue accumulation. (Winkel, P.; Galvanotechnik. (Apr. 1992), 83, (4), pp. 1319-1324 [in German]. ISSN 0016-4232)

0881 CU/ZN REMOVAL FROM BRASS PLATING EFFLUENT. (CU/ZN-ABREICHERUNG AUS ABWASSERN DER MESSINGBESCHICHTUNG.) [BIB-199311-43-0394]

In order to remove copper and zinc dragged out in rinse waters from a continuous brass plating operation of steel wire, an electrolytic recovery cell was installed. In this unit, varying amounts of Zn and Cu are deposited, depending on the electrolyte composition and the operating conditions of the electrodeposition. At the same time, cyanides are decomposed at the anode. Graphs. 1 ref. (Mayr, M.; Blatt, W.; Stroder, U.; Heinke, H.; Galvanotechnik. (Apr. 1992), 83, (4), pp. 1325-1326 [in German]. ISSN 0016-4232)

0882 OPTIONS IN THE ELECTROLYTIC TREATMENT OF CHROMIUM-CONTAINING SOLUTIONS. (MÖGLICHKEITEN DER ELEKTROLYTISCHEN BEHANDLUNG VON CHROMHALTIGEN LÖSUNGEN.) [BIB-199311-43-0395]

Purification of aqueous solutions containing Cr(VI) as well as the regeneration of spent chromic acid etch baths oxidation of Cr(III) can both be advantageously carried out in the enviro cell electrolysis plant. The relevant redox reactions are discussed. The cost-effectiveness of electrolytic Cr(VI) removal from solution is emphasised by contrast with the use of chemical reductants to carry out the same process. Graphs. (Langefeld, W.; Galvanotechnik. (Apr. 1992), 83, (4), pp. 1327-1330 [in German]. ISSN 0016-4232)

0883 ION-EXCHANGE AGENT AND USE THEREOF IN EXTRACTING HEAVY METALS FROM AQUEOUS SOLUTIONS. [BIB-199311-43-0408]

A novel ion-exchange agent, an aluminum-enriched analogue to the zeolite chabazite, hereinafter "Al-Chab" is disclosed. The Al-Chab is used in processes for recovering precious metals from aqueous solutions or for removing toxic heavy metals from contaminated aqueous streams. (Kuznicki, S.M.; Whyte, J.R.; (29 June 1993). [in English]. Patent no.: US5223022 (USA) Convention date: 1 July 1991)

0884 THE SX-EW SOLUTION TO PROCESSING LOW GRADE COPPER ORES. [BIB-199311-43-0413]

The solvent-extraction-electrowinning (SX-EW) process extracts copper from low grade (e.g. 0.4%) oxide ore formerly left as waste from sulphide ore extraction, at about half the operating cost of conventional processes. After light crushing, the oxide ore is sprayed with weak sulphuric acid on leach pads and converted to sulphate. The leachate is mixed with extractant bearing kerosene which extracts the Cu from and re-acidifies the aqueous phase—the barren raffinate. The raffinate separates in settling tanks and is pumped back to the heap-leach pads while the Cu-rich kerosene is mixed with a highly acidic Cu-rich solution where the Cu is extracted by electrolysis. The reasons given for low operating cost include no milling, fewer workers, no smelting, and less capital and maintenance. Analysis of the two US companies coming into production concludes that they are good long-term investments. (Rossier, M.; International Mining Review. (May 1992), (29), pp. 4-5 [in English].)

0885 AN ENGINEERED CALCIUM CARBIDE DESULPHURIZER FOR LOWERING SLAG REACTIVITY. [BIB-199311-51-1605]

Environmental concerns have recently been growing over the disposal of reactive desulphurizing slag. Consequently, increased pressure has been placed on the foundry industry to reduce the reactivity of this slag. To address this problem, Cyanamid has developed a new product which significantly reduces the calcium carbide content of the desulphurizing slag. Testing equipment and procedures have also been developed to evaluate both the existing levels of carbide in the slag and the decreased levels which are achieved with this new material. The development and use of this engineered carbide desulphurizer has made possible significant environmental and efficiency improvements in the field of calcium carbide desulphurizing. Consequently, the lifespan of calcium carbide in ductile iron desulphurization has been increased, as have the benefits of its use in the foundry industry. Graphs. 10 ref. (Barker, B.J.; Canadian Mining and Metallurgical Bulletin. (June 1992), 85, (961), pp. 119-121 [in English]. ISSN 0317-0926)

0886 ENVIRONMENTAL MATTERS SURROUNDING DROSS AND ITS RECOVERY. [BIB-199311-51-1623]

This paper gives a broad outline of the environmental matters related to dross and its recovery. This serves as an introduction to other papers in these proceedings which will supply more detail on dross minimisation and dross processing. The paper concludes that technologies are either available or are being developed to address the environmental concerns associated with dross and its recovery. 2

ref. (Ross, I.B.: ALUMINUM CAST HOUSE TECHNOLOGY: THEORY & PRACTICE, Melbourne, Victoria, Australia, 1-8 July 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1993), (Met. A., 9311-72-0502), pp. 235-238 [in English].)

0887 DEVELOPMENT DOCUMENT FOR EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR THE ALUMINUM FORMING POINT SOURCE CATEGORY. [BIB-199311-52-1787]

The purpose is to provide the supporting technical data regarding water use, pollutants and treatment technologies for any (BPT) best practical technology, (BAT) best available technology, (BCT) best conventional technology, (NSPS) new source performance standards or pretreatment standards for existing sources (PSES), and pretreatment standards for new sources (PSNS) which EPA may choose to issue for the Aluminum Forming Category, under Sections 301, 304, 306, 307 and 501 of the Clean Water Act. (Gov. Res. Announc. Index, 1980), PB93-208213 X.AB. Pp 617 [in English], ISSN 0097-9007)

0888 EVALUATION AND IMPLEMENTATION OF NO-CLEAN PASTES. [BIB-199311-55-2281]

Environmental issues have forced the electronics industry to find substitutes for assembly techniques which involve washing with chlorofluorocarbonate solvents. Tests were conducted on 7 water soluble solder pastes and 12 no-clean pastes. The study concluded that many water soluble and no-clean paste formulations lack the tack time that RMA pastes possess, no-clean pastes can perform satisfactorily in a surface mount production process, and some are capable of enduring extreme environmental conditions. Solder balling with no-clean pastes can be minimized. Photomicrographs. Graphs. 8 ref. (Freitag, B.: Circuits Assembly, (Apr. 1992), 3, (4), pp. 30-32, 37-38, 41 [in English], ISSN 1054-0407)

0889 DEVELOPMENT OF NO-CLEAN WAVE SOLDERING. [BIB-199311-55-2282]

Hewlett-Packard's Puerto Rico manufacturing operations investigated inert atmosphere wave soldering with nitrogen and conducted tests to determine acceptable levels of oxygen. Soldering results using 1000 ppm O were comparable in solder defect level and quality to results using only 10 ppm O and superior to boards processed in air. Three wave soldering machines will be converted to N with wave-only inerting hoods. Economic comparison determined that membrane N containing 1000 ppm O can be cost effective. Graphs. 3 ref. (Lechok, C.A.; McDonald, M.G.; Rodriguez-Sallaberry, S.: Circuits Assembly, (Apr. 1992), 3, (4), pp. 42-45, 47 [in English], ISSN 1054-0407)

0890 CHARACTERIZATION OF SURFACE CONTAMINATIONS ON METAL SURFACES. (CHARAKTERISIERUNG VON OBERFLACHENVERUNREINIGUNGEN AUF METALLOBERFLACHEN.) [BIB-199311-57-1373]

The results are reported of a surface examination of four cold-rolled steel strip samples conducted according to the German standard DIN 55 928, Part 4. Carbonaceous substances, such as oils, greases, waxes and graphitic carbon, as well as salt, chloride and sulfate contents were analyzed. It was found that all samples were only minimally contaminated on their surfaces by water-soluble salts. Relative to carbonaceous contaminants, single stage surface cleaning resulted in an 90% removal efficiency, which could be increased to 98% by mechanical means such as rushing or blasting. In this connection, it is recommended that on the original steel strip carbonaceous protective coatings against corrosion are kept to the absolute minimum. Finally, the removal of ferrous residues from metallurgical processing required further mechanical treatment. It is concluded that the determination of the type of contaminants on the surface of the workpiece and a high degree of decontamination effectiveness assure a superior quality of the end product, as well as an optimizing of the process technology. Moreover, an automated rinse bath control leads to a lowering of waste water pollution. 9 ref. (Sommer, J.; Gressmann, K.: Neue Hütte, (Oct 1991), 36, (1), pp. 385-387 [in German], ISSN 0028-3207)

0891 PAINTS: EVOLUTION AND TENDENCY. (LES PEINTURES: EVOLUTION ET TENDANCE.) [BIB-199311-57-1386]

In 1990 Western Europe used 5.3 million tons of paint for metal protection and decoration. Unfortunately, this was a principal source of pollution, since 70% of the painting was done by spraying, a method whose efficiency is only 40-60%. In order to reduce pollution, changes have been made in both the paint and the methods of application. The use of "high solid" paints cuts the solvent percentage for approx 50% in conventional paints to approx 25%. This has created another problem in that these paints have a high viscosity and are more difficult to apply. Standard water soluble paints offer an acceptable solvent, but have an automatic limit on final thickness. Polymers forming an emulsion in water are now being used in the automobile industry. Resins used as paint without a solvent and applied by electro-deposition are finding new uses and are now 5% of the market. Polyvinyl chlorides do not have a solvent and are applied with UV and EB deposition. All of these newer methods will result in much less pollution than their predecessors. Graphs. (Bianconi, M.: Galvano-Organico-Trattamenti de Surface, (Dec. 1992), (631), pp. 1045-1046, 1051-1053 [in French], ISSN 0302-6477)

0892 REMOVING AIRCRAFT SURFACE COATINGS. [BIB-199311-57-1392]

In the past, coatings have been removed from airframe surfaces by the use of chemical strippers, burn-off systems, sanding or sandblasting. Due to increasing environmental concerns, researchers began to investigate other means of removing surface finishes. Plastic media blasting (PMB) was regarded as a potential process to replace the conventional methods. PMB is described as being superior to conventional removal systems in many respects. There is no disposal of chemical solvents involved. The process uses recyclable plastic particles which are harder than the coatings but softer than the underlying substrates. This means that topcoats and primers can be removed without damaging the substrates. The process is more economical and is expected to become accepted as a standard process for the removal of coatings from aircraft surfaces. (Pauli, R.; Abbott, K.E.; Owens, C.E.: Aerospace Engineering, (Apr. 1992), 12, (4), pp. 9-11 [in English], ISSN 0736-2536)

0893 HELP FOR HEAVY METAL REMOVAL. [BIB-199311-57-1397]

Because of tighter environmental regulations, the metal finishing industry is under increasing pressure to improve its methods of operation. The Nalmet program developed by Nalco Unisolv Group overcomes problems in treating metal effluent by using a multiple component system consisting of a heavy metal precipitant, a coagulant and or flocculant. Strict control of pH is unnecessary. (Bonell, W.: Finishing, (Sept. 1991), 15, (9), pp. 50-51 [in English], ISSN 0309-3109)

0894 COIL COATINGS IN THE NINETIES: ECONOMIC AND ENVIRONMENTAL DIVIDENDS. [BIB-199311-57-1411]

This paper deals with the historical development of coil coatings, the technology of the process, and the economic, environmental, and performance advantages of prepainted metal. 6 ref. (Cocuzzi, D.A.; Pileher, G.R.: ADVANCED COATINGS TECHNOLOGY, Dearborn, Michigan, U.S.A., 10-12 June 1991, Publisher: ESD—THE ENGINEERING SOCIETY, Detroit, Michigan 48202, U.S.A. (1991), (Met. A., 9311-72-0523), pp. 67-71 [in English].)

0895 EXPERIENCE WITH A RECIRCULATED AIR PAINT BOOTH WITH VOC CONTROLS. [BIB-199311-57-1414]

In 1985, the Ohio EPA issued a Permit to Install (PTI) to Navistar International Transportation Corporation for the construction of a new paint facility adjacent to the existing assembly plant near Springfield, Ohio. The major provision of the PTI was the requirement to capture and destroy at least 85.5% of the VOC emitted from the two recirculating air prep coating lines. It was determined during an exhaustive emissions testing program that the capture efficiency component was the limiting factor for compliance. The difficulties in quantifying capture efficiency have already been discussed by McDaniel et al (1990). It was determined that numerous variables have a great impact upon maintaining the

capture efficiency of a recirculated air system. Some of the most important variables to Navistar's system were paint chemistry, booth cleanliness, and employee relations. (M.: Daniel, T. W., ADVANCED COATINGS TECHNOLOGY, Dearborn, Michigan, U.S.A., 10-12 June 1991, Publisher: ESD—THE ENGINEERING SOCIETY, Detroit, Michigan 48202, U.S.A. (1991), (Met. A., 9311-72-0523), pp. 105-107 [in English].)

0896 ACTIVATED CARBON FIBER ADSORPTION SYSTEMS FOR PAINT SPRAYBOOTH SOLVENT EMISSION CONTROL. [BIB-199311-57-1459]

The control of solvent emissions from paint spray booths has been a challenging environmental management problem. Technical and cost problems have inhibited the installation of add on controls. Limitations of new paints and painting technologies, however, have resulted in the need for add on controls to meet more stringent environmental regulations. More cost-effective methods for control of these large air volume low solvent concentration emissions have been developed. Combination of activated carbon fiber adsorption hot air desorption systems with catalytic or thermal incineration systems reduces significantly the operating costs of add on controls for paint spraybooths by concentrating the emissions before incineration. Since operating costs are more significant over a 5-15 year time period than installed equipment costs, the use of activated C fiber adsorption and hot air desorption makes incineration a more cost-effective solvent emission control for paint spraybooths than direct incineration. Examples of actual installation performance and economics show the technical and economic effectiveness of activated C fiber adsorption systems. (Kenson, R.E., ADVANCED COATINGS TECHNOLOGY, Dearborn, Michigan, U.S.A., 10-12 June 1991, Publisher: ESD—THE ENGINEERING SOCIETY, Detroit, Michigan 48202, U.S.A. (1991), (Met. A., 9311-72-0523), pp. 115-125 [in English].)

0897 ESTIMATE OF MAXIMUM AMBIENT ISOCYANATE LEVELS FROM AN ISOCYANATE-BASED CLEARCOAT APPLICATION. [BIB-199311-57-1460]

In the Fall of 1989, a major automotive assembly plant in Michigan became one of the first US plants to spray a two-component, polyisocyanate-based clearcoat paint. The paint is primarily composed of relatively high molecular weight diisocyanate polymers (primarily the isocyanurate), with only a trace of the more volatile hexamethylene diisocyanate monomer. Although isocyanates are generally toxic, 1% of the total sprayed is thought to be emitted from the stacks. While other studies have investigated aspects of worker safety, none have considered the ambient concentrations that result from stack emissions of these compounds. To determine the potential environmental impact of the isocyanate emissions, the maximum 8 h ambient concentrations of isocyanates downwind of the plant were estimated under full production and worst-case meteorology, and these values were compared to acceptable ambient levels determined under Michigan's proposed air toxics rule. Measurements of isocyanate monomer and polymer concentrations made in December 1989, at a single spray booth module in the plant, were scaled to the full production rate to estimate maximum stack emission rates. Maximum ambient concentrations were calculated using the relationships between stack emissions and ambient levels of volatile organic compounds that had been generated for the plant's original air permit application. The results of these calculations indicated that the maximum ambient concentrations that could be expected were $0.026 \mu\text{g m}^{-3}$ for the monomer and $0.280 \mu\text{g m}^{-3}$ for the polymer—levels more than an order of magnitude below the Michigan guideline limits. Graphs. 12 ref. (Ferman, M.A., Ross, R.L., ADVANCED COATINGS TECHNOLOGY, Dearborn, Michigan, U.S.A., 10-12 June 1991, Publisher: ESD—THE ENGINEERING SOCIETY, Detroit, Michigan 48202, U.S.A. (1991), (Met. A., 9311-72-0523), pp. 127-136 [in English].)

0898 PRODUCTION EXPERIENCE WITH AUTOMOTIVE WATERBORNE COATINGS. [BIB-199311-57-1462]

The need to reduce volatile organic emissions and thereby create more environmentally friendly coatings is completely altering the nature of coating process used by the automotive industry. Waterborne basecoats allow application at low volume solids, thus producing optimum metallic effect while maintaining compliance with emission regulations. In order to control rheology and thereby sag resistance and metal flake orientation, a novel aqueous microgel polymer has been developed. Processing of these basecoats is similar to present solvent-borne finishes with the exception that stainless steel equipment must be used and water must be removed before application of clearcoat. The production feasibility of

waterborne basecoats was first established in a Canadian truck assembly plant and in the next two years several other production facilities are expected to convert to this new technology. Graphs. (Fox, C., ADVANCED COATINGS TECHNOLOGY, Dearborn, Michigan, U.S.A., 10-12 June 1991, Publisher: ESD—THE ENGINEERING SOCIETY, Detroit, Michigan 48202, U.S.A. (1991), (Met. A., 9311-72-0523), pp. 161-166 [in English].)

0899 EVOLUTION OF COATINGS. (EVOLUTION DES REVETEMENTS.) [BIB-199311-58-1259]

Improvement of performance and reduction of cost have always been the two principal factors in the evolution of procedures. Quality (required by customers) and concern for the environment (required by legislation) have been added to them more recently. The regulated materials in the coating industry are chromic acid, cyanide, complex materials, fluorides and heavy metals such as cadmium. Substitute procedures including the use of trivalent chrome, passivation for chromic acid, degreasing using materials other than cyanide, and elimination of complex materials are all being tried as replacements. Where the pollutants cannot be replaced immediately, much lower concentrations are used. The search goes on. (Lopez, A., Galvano-Organo-Traitements de Surface, (Dec 1992), (631), pp. 1054-1055 [in French], ISSN: 0302-6477)

0900 THE DEVELOPMENT OF ENVIRONMENTAL CONTROL TECHNOLOGIES IN JAPANESE NONFERROUS SMELTERS. [BIB-199401-42-0003]

This paper describes the endeavor of the Japanese nonferrous smelters for the development of environmental control technologies after the Second World War. In the 1950s, the smelters started to recover sulfuric acid from not only the roasting gas but the off-gas of smelting furnace. In the 1960s and 1970s, meeting the regulatory standards for pollution control, they developed suitable processes for the desulfurization process of fugitive gas, mercury removal from SO_2 gas and hydrometallurgical dust treatment process for the recovery of heavy metals. This paper finally shows how the smelters reduced CO_2 gas emission in four decades. Graphs. 22 ref. (Ueda, K., FIRST INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES, Honolulu, Hawaii, U.S.A., 7-10 Nov. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY (TMS), 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1993), (Met. A., 9401-72-0028), pp. 7-82 [in English].)

0901 UTILIZATION OF WASTE TYRE AT ONAHAMA SMELTER. [BIB-199401-42-0007]

After the second oil crisis in 1979, expensive bunker C-oil for reverberatory furnaces at Onahama was changed for low priced alternative fuels like coal, which is now a main fuel and is consumed approx 9000 MT month. At that time utilization of waste tyres started, illegal dumping of which became a social problem in many places in Japan year by year. At first chipped tyres were used for reverberatory furnaces. Thereafter a pyrolysis and distillation technique of waste tyre was developed in order to realize higher ratio of the alternative fuel for reverberatory furnaces. Consequently oil, gas, carbon powder and char could be recovered as the secondary fuel from waste tyre. Now chipped tyre and whole tyre are utilized at approx 700 and 3000 MT month, respectively, and it also contributes to environmental protection. Graphs. (Oshima, E., Igarashi, T., Abe, K., FIRST INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES, Honolulu, Hawaii, U.S.A., 7-10 Nov. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY (TMS), 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1993), (Met. A., 9401-72-0028), pp. 133-136 [in English].)

0902 CONDITIONS AND LIMITATIONS OF MATERIAL RECYCLING. (VORAUSSETZUNGEN UND GRENZEN DES STOFFLICHEN RECYCLINGS.) [BIB-199401-42-0011]

Closing the circle with regard to recycling materials is quite often seen as a positive aspect. Therefore a great deal of faith is being put into saving resources, reducing the environmental burden and consideration toward new deposit areas. Recycling is only one of the possibilities for getting rid of waste, a process which also requires the use of resources and creates waste and emissions. The condition required, to take recycling as the most ecologically efficient method to get rid of waste in an ecologically sensible manner, is that the difference of the necessary primary resources for recycling and manufacture of secondary raw materials must be lower than the primary resources required for alternative waste

disposal methods. Bearing this in mind, the sensible limitations for recycling are automatically set. Not in every case is the recycling of materials ecologically orientated. Conditions and limitations stipulate each other. The ecological limits are given a lot of consideration where recycling is concerned. Graphs. 7 ref. (Fleischer, G.; Radex Rundschau, (1993), (1-2), pp. 274-278 [in German]. ISSN 0370-3657)

0903 THE POSSIBILITIES AND LIMITS OF THE SHREDDING TECHNOLOGY WHEN RECYCLING CONSUMER MATERIALS. (MOGLICHKEITEN UND GRENZEN DER SHREDDER-TECHNOLOGIE BEIM STOFFLICHEN RECYCLEN VON KONSUMGÜTERN.) [BIB-199401-42-0012]

Shredding means reducing goods in size so that all scrap pieces comprised of one material can be fed to a separate recycling process. The shredding technology today is of a high standard and well developed. Efficient scrap preparation for the steel industry is necessary due to the increasing number of old cars and used consumer items. Various handling methods in the shredder enable almost 100% separation efficiency. Man-made fibres, rubber items, and glass can only be recycled to a certain extent. In this case they are sorted manually. In this way many metals, fibres polyester materials, and glass can be recycled many times and will not be a burden to nature. Our resources will be spared, energy saved, and the environment relieved. Graphs. (Schmiege, F.; Radex Rundschau, (1993), (1-2), pp. 279-288 [in German]. ISSN 0370-3657)

0904 VARIOUS METHODS OF METALLURGICAL RECYCLING. (VERSCHIEDENE VERFAHREN DES METALLURGISCHEN RECYCLINGS DIE THERMISCHE SCHROTTBEHANDLUNG.) [BIB-199401-42-0014]

Ever increasing criticism is being made toward the practiced recycling methods for scrap. This is why the metallurgical recycling systems are losing out on acceptance and attractiveness. Scrap recycling of consumer items is becoming very critical in Germany. Taking the automobile as an example, changes in the scrap recycle system have been gathered and analysed. These analyses make up the basis for alternatives in recycling. These alternatives eliminate the rightfully criticised points occurring in practiced recycle methods. The presented methods of metallurgical recycling are more acceptable and attractive. These methods are the "thermal cleaning in a fluidised bed". It enables scrap pretreatment of smaller parts. This method is applicable for recycling and cleaning of removable parts. It is also possible to supply casting shops with high quality and environmentally friendly scrap. Oily and zinc-plated scrap can be processed in an environmentally friendly way in Kupol furnace. In this way, casting shops can recycle their own scrap in metal working groups. Total recycling in the automobile industry requires coordination with the raw material industry. The material cycle can only be closed at the suppliers, not at the manufacturers. Graphs. 11 ref. (Paul, E.; Radex Rundschau, (1993), (1-2), pp. 296-307 [in German]. ISSN 0370-3657)

0905 "TOTAL RECYCLING OF SCRAP CARS". CONCEPT OF THE STUDY COMMITTEE FOR THE DISPOSAL OF SCRAP CARS (EVA). (DAS "TOTALRECYCLING VON ALTFahrZEUGEN". DAS KONZEPT DER STUDIENGESellschaft ZUR ENTSORGUNG VON ALTFahrZEUGEN MBH (EVA).) [BIB-199401-42-0015]

The combination of development measures, dismantling concepts, utilization of components and downstream metallurgical recycling allows for an applicable continuous future-oriented concept for the disposal of scrap cars. In this overall process an optimum combination of metallurgical values with lowest possible energy consumption is achieved by an ecologically and economically oriented sequence of procedures. The utilization of the chemically bound energy content of the organic substances in the scrap bale will reduce the amount of required primary energy. The use of natural gas as melting energy (i.e. secondary energy source) instead of electrical energy also contributes considerably to minimize CO₂ emissions. This process sequence ensures an environment-friendly disposal of scrap cars with saleable by-products and lowest emissions. Graphs. 4 ref. (Nieder, W.; Radex Rundschau, (1993), (1-2), pp. 308-314 [in German]. ISSN 0370-3657)

0906 IRON CONTROL IN NITRATE HYDROMETALLURGY BY (AUTO) DECOMPOSITION OF IRON (II) NITRATE. [BIB-199401-42-0069]

Iron removal from hydrometallurgical sulphate or chloride systems has not, to date, provided a low-cost route to a saleable Fe product. Regeneration of the Fe³⁺ ion as an oxidant still relies on slow gas liquid transfer. These present work evaluates the possibilities in the nitrate system. Iron (III) nitrate leaching of metallic Fe or reactive iron sulphides would yield iron (II) nitrate, which in this work was found to decompose spontaneously into iron (III) nitrate and iron (III) oxides in the temperature range 63-103 °C, depending on the excess of nitric acid (HNO₃) present. An increase in nitric acid lowers the decomposition temperature. Stirring may have the opposite effect. (Auto) decomposition of Fe(NO₃)₂ involves reduction of nitrate and the gaseous end product was found to contain at least 95% nobelium in the absence of nitric acid. The iron (III) nitric oxide formed 120 °C gave good filterable iron oxides. Hydrolysis at 160 or 180 °C gave a remarkable increase in particle size. In the more concentrated solutions, hematite spheroids of approx 25 µm were produced. When sufficient nitric acid is present, only iron (III) nitrate is formed in the (auto) decomposition. A process possibility is proposed where iron (II) nitrate is first (auto) decomposed to iron (III) nitrate, from which a bleed stream is hydrolyzed to Fe₂O₃ and HNO₃. The bulk of the iron (III) nitrate is directly returned to the leaching operation. Air is used for oxidation of the NO evolved during (auto) decomposition of iron (II) nitrate. Graphs. Photomicrographs. 17 ref. (Weert, G.; Shang, Y.; Hydrometallurgy, (July 1993), 33, (3), pp. 255-271 [in English]. ISSN 0304-386X)

0907 MULTI-DISCIPLINARY APPROACHES FOR ENVIRONMENTALLY SAFE PROCESSING OF MATERIALS FOR PROPERTIES. [BIB-199401-42-0091]

In the last decade, the application of biotechnological principles in the processing of low-grade mineral materials, which are economically not amenable for metal production by the conventional technology, is gaining considerable industrial importance. This tendency is especially motivated by the fact that biotechnological processes are simple to operate, less capital and energy intensive than the conventional technologies. Furthermore, these processes are environment friendly since they do not result in any air, soil or aquifer pollution. As a rule of thumb, for example, a pound of copper can be produced from mining wastes for about one-third to one-half of the costs of Cu production by the conventional smelting process from high-grade sulfide concentrate. Currently, approx 25% of the total Cu produced in the US is unprofitable to bacterial activity in heap, dump and in situ leaching operations. In Canada, an important segment of the uranium production is achieved by bio-assisted leach technologies. Other industrial application of biotechnological processing is related to gold production from refractory pyrite and arsenopyrite materials. When submicron-size native Au particles are finely disseminated within the above refractory ore materials, then the conventional cyanidation technology becomes economically marginal for the Au production. However, if these materials are subjected to pre-oxidation by the bacteria, pores will be created in the mineral matrices and the follow-up cyanidation can successfully extract Au. This integrated biopreoxidation and cyanidation process is industrially practiced in South Africa, Brazil and Australia. Further establishments of industrial plants are in progress in Ghana. Diverse bioremediation processes are under development for the removal of trace concentrations of heavy metals and radionuclides from very large volumes of industrial effluents and contaminated soils. It is well known that the conventional physical and chemical technologies are economically handicapped for dealing with these situations. The application of biotechnology to complex mineral materials treatment opened up new opportunities for the mineral and metallurgical industries for research and application. There are various possibilities for environmentally safe bio-processing of materials and remediation of contaminated sites. Examples of industrial applications are presented and where appropriate, new opportunities for application are discussed. 29 ref. (Torma, A.E.; FIRST INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES, Honolulu, Hawaii, U.S.A., 7-10 Nov. 1993, Publisher THE MINERALS, METALS & MATERIALS SOCIETY (TMS), 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993), (Met. A., 9401-72-0028), pp. 71-76 [in English].)

0908 ZINC OXIDE-BASED SO₂ SCRUBBLING SYSTEM AT HIKOSHIMA ZINC PLANT. [BIB-199401-42-0093]

This system has been in practice for 40 years at the Hikoshima smelter of Mitsui Mining & Smelting Co., Ltd. Its purpose is to effectively recover SO₂ gas and zinc sulphate from the diluted SO₂ gas emitted from the Zn smelter or the single-contact sulphuric acid plant. The diluted SO₂ gas is absorbed by zinc oxide slurry made from water and zinc oxide (calcine of Zn concentrate). The zinc oxide used for desulphurization is converted into zinc sulphite. The zinc sulphite is decomposed with sulphuric acid, and enriched SO₂ gas and zinc sulphate are recovered effectively. The specific advantages of this system are low running cost, high absorption efficiency, and utilizable products. (Monden, S., Sakata, M., Yamamoto, Y.; FIRST INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES, Honolulu, Hawaii, USA, 7-10 Nov. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY (TMS), 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1993). (Met. A., 9401-72-0028), pp. 129-132 [in English].)

0909 CX-EW PROCESS: A COMPREHENSIVE RECOVERY SYSTEM FOR LEAD-ACID BATTERIES. [BIB-199401-43-0011]

Traditional pyrometallurgical technologies for the recovery of lead and other materials from SLI batteries have required the use of massive and expensive air pollution control systems and wastewater treatment plants in order to attempt to meet environmental regulations. These systems in turn generate solid wastes containing Pb and other heavy metals which must be disposed of in an environmentally sound manner. The options for this disposal are becoming more costly and less viable in today's regulatory climate. Obviously, it is far better to prevent the generation of these wastes to the extent possible than to be faced with the disposal dilemma. Basic assumptions in the development and design of ENGI TEC's CX-EW process are waste minimization and pollution prevention. Even though initial capital investment may be higher than traditional technologies, the life cycle costs of CX-EW are significantly lower based on pollution control costs saved. Waste minimization, pollution prevention and environmentally safe recycling today are public policy of governments throughout the world. Through the ENGI TEC CX-EW process battery manufacturers and recyclers have a means to more fully comply with these ideals in an economically profitable manner. (Grady, O'Leary, M.; RECYCLING LEAD AND ZINC: THE CHALLENGE OF THE 1990'S, Rome, Italy, 11-13 June 1991. Publisher: INTERNATIONAL LEAD AND ZINC STUDY GROUP, 58 St. James St., London SW1A 1LD, UK. (1991). (Met. A., 9401-72-0031), pp. 79-90 [in English].)

0910 SIROSMELT FOR SOLVING ENVIRONMENTAL PROBLEMS OF LEAD-ZINC PRODUCTION. [BIB-199401-43-0013]

The salient features and operation of the Sirosmelt furnace system based on top submerged lance technology are described which provides a pollution-free, economic process for recycling residues and waste minerals from the lead and zinc industry and during steel plant operations. The plant design and economics of the systems for smelting steel plant dust or Pb concentrate are highlighted. Examples of Pb-Zn processing via smelting of waste are presented using Zn leach residues, slag dross, steel plant dusts, and vertical retort residues. 4 ref. (Floyd, J.; Robillard, R.E.; Guergi, G.A.; Wu, S.K.; King, P.J.; Floyd, J.M.; RECYCLING LEAD AND ZINC: THE CHALLENGE OF THE 1990'S, Rome, Italy, 11-13 June 1991. Publisher: INTERNATIONAL LEAD AND ZINC STUDY GROUP, 58 St. James St., London SW1A 1LD, UK. (1991). (Met. A., 9401-72-0031), pp. 233-253 [in English].)

0911 LEAD RECOVERY OPPORTUNITIES IN KSS PLANT OF PORTOVESNE. [BIB-199401-43-0017]

The flowchart, operation, and performance of lead smelter in KSS plant are described using either Pb concentrate only, or mixed with battery pastes or Pb-Ag oxide. The recovery figures are 46-60, 97, and 98% for zinc, sulphur, and Pb, respectively, using 170-180 kWt of electrical energy per ton of the charge. The working environment is claimed to be clean with reduced volume of wastegas. 3ref. (Carlini, G.; Ibbra, R.; Pescetelli, A.; Sivali, F.; RECYCLING LEAD AND ZINC: THE CHALLENGE OF THE 1990'S, Rome, Italy, 11-13 June 1991. Publisher: INTERNATIONAL LEAD AND ZINC STUDY GROUP, 58 St. James St., London SW1A 1LD, UK. (1991). (Met. A., 9401-72-0031), pp. 383-392 [in English].)

0912 ALTERNATIVE TECHNOLOGY TO DECREASE THE ENVIRONMENTAL IMPACT OF GOLD MILLING—A PROGRESS REPORT ON CANMET RESEARCH ACTIVITIES IN THIS FIELD. [BIB-199401-43-0022]

The effluent from gold milling operations contains metalocyanide compounds which should not be discharged into the environment. CANMET, Mineral Sciences Laboratories, Ottawa, Canada, has developed and optimized the acidification—volatilization—neutralization (AVR) process for the recovery and recycling of cyanides from clear solutions. With this process the cyanide is recovered and enables the recuperation of a significant portion of the cyanide value present in the Au mill barren solution. Other processes to remove cyanide utilize a supplementary chemical oxidation treatment which generates ammonia which is highly toxic to fish and other wildlife. The AVR process is more economical and produces no harmful ammonia. 23 ref. (Riveros, P.A.; Molnar, R.; McNamara, V.M.; Canadian Mining and Metallurgical Bulletin, (Mar. 1992), 86, (968), pp. 167-171 [in English] ISSN 0317-0926)

0913 THE TREATMENT OF EXHAUST AIR AND THE RECOVERY OF LUBRICATING OIL BY ABSORPTION. [BIB-199401-52-0054]

The reduction of volatile organic compounds (VOCs) into the atmosphere is a worldwide demand today. The absorption system with closed-circuit scrubbing is an ideal technique in reducing hydrocarbons which evaporate during cold aluminum rolling processes and are extracted by fans into the atmosphere. Successfully operating plants have proven that very low residual hydrocarbon contents are reached and, in addition, the recovered hydrocarbons are pure for reutilisation in rolling processes. Graphs. (Schmalz, K.; Lerch, H.; ALUMINIUM 2000, 2ND INTERNATIONAL CONGRESS ON ALUMINIUM 1993, VOL. II, Florence, Italy, 29 Mar-4 Apr. 1993. Publisher: INTERALL PUBLICATIONS, Via Respighi, 246, Modena, Italy. (1993). (Met. A., 9401-72-0034), pp. 273-289 [in English].)

0914 ENVIRONMENTAL AND SAFETY ATTRIBUTES OF WATERJET CUTTING. [BIB-199401-53-0043]

The inherent characteristics of ultrahigh-pressure waterjet technology resolve many of today's concerns over both environmental and operator safety in the work place. Advances in waterjet cleaning provide an alternative solution to today's environmental processing problems. This paper examines the environmental and safety attributes of waterjet cutting as an alternate to other conventional and non-conventional methods. The conventional methods of cutting materials such as paper or GFRP can create an inordinant amount of airborne dust. Cutoff saws used to de-gate metal castings can create a dense fog of airborne particulate. Cutting these materials as well as an endless list of others with waterjet or abrasive waterjet (AWJ) virtually eliminates this hazard. The waterjet stream traveling at three times the speed of sound pulls the potential airborne kerf material into itself and safely deposits it in a catcher. Plasma arc and lasers burn materials which can create heat-affected zones and emit toxic fumes. The abrasive waterjet can cut heat-sensitive materials such as aluminum, steel, titanium, and nickel alloys without risking heat damage. Fume extractors are not required on waterjet or AWJ systems. Potentially hazardous chemical coolants and lubricants required with conventional cutting tools are not needed with waterjet processing. The latest ultrahigh-pressure waterjet systems utilize closed-loop water recirculation systems minimizing water consumption, noise-abatement techniques keeping sound levels 75 dB, and waste disposal systems that separate the kerf material from the water simplifying the disposal process. (Burnham, C.; Sepe, R.; ADVANCED MATERIALS PERFORMANCE THROUGH TECHNOLOGY INSERTION VOL. 38, II, Anaheim, California, USA, 10-13 May 1993. Publisher: SOCIETY FOR THE ADVANCEMENT OF MATERIAL AND PROCESS ENGINEERING, P.O. Box 2459, Covina, California 91722, USA. (1993). (Met. A., 9401-72-0004), pp. 1692-1699 [in English].)

0915 THE GREEN ANODIZING LINE. [BIB-199401-57-0087]

Slijppol Aluminium in Amsterdam, Holland, has built a brand new, completely automatic anodizing line. During the preparing of the lay-out, they discovered important energy-saving features. The speaker would like to tell in which way an anodizing line in Holland has to be built to reach the heavy requirements of present and especially future environmental regulations. The Dutch Anodizing Association has requested the Environmental Studies Department of Amsterdam

University, to investigate possibilities of preventing of waste and emissions in anodizing companies. A list of approx. 40 prevention measurements has been compiled. Some of them are known and easy to execute in every anodizing plant but some of them, while logical, had not yet been used. Slijppol has used the recommendations for its new plant and on that basis the company has now built the first environmentally friendly "green anodizing line" in Holland and probably also in Europe. (Potter, H.; ALUMINIUM 2000. 2ND INTERNATIONAL CONGRESS ON ALUMINIUM 1993. VOL. II. Florence, Italy, 29 Mar.-4 Apr. 1993. Publisher: INTERALL PUBLICATIONS, Via Respighi, 246, Modena, Italy, (1993). (Met. A., 9401-72-0034), pp. 17-26 [in English].)

0916 A NEW CONCEPT IN SURFACE FINISHING TREATMENT ON ALUMINIUM. [BIB-199401-57-0088]

A tougher legislation on classified wastes of hydroxide sludge has made the aluminium coaters companies assume responsibility for the application of some procedures concerning a technology called "clean". In fact, if the effluents by hydroxide precipitation treatments are still being often used, the difficulties that appear when using this method are several. Therefore, we propose a "clean technology" for the near future, which is mainly devoted to the product, additive and equipment development and grants Al protection by anodising and/or lacquering with the recycling solution, approaching the optimum "zero reject". Pickling, etching, colouring, sealing and lacquering products permits the application with recovery equipment based on ultrafiltration, reverse osmosis, ion exchange, evaporation, etc. making possible Al protection with "clean technologies" and "zero reject". Graphs. 6 ref. (Amigo, J.; ALUMINIUM 2000. 2ND INTERNATIONAL CONGRESS ON ALUMINIUM 1993. VOL. II. Florence, Italy, 29 Mar.-4 Apr. 1993. Publisher: INTERALL PUBLICATIONS, Via Respighi, 246, Modena, Italy, (1993). (Met. A., 9401-72-0034), pp. 27-50 [in English].)

0917 RECYCLING TECHNOLOGY IN THE JAPANESE ELECTROPLATING INDUSTRY. [BIB-199401-58-0016]

Recycling and recovery of plating chemicals and water are indispensable technologies in the Japanese electroplating industry due to pollution problems and conservation of resources. The Environmental Administration of Japan has become increasingly more stringent since 1970. The first oil crisis in 1973 drew attention to the increased need of recycling resources. This paper describes basic concepts of recycling and recovery technologies which include a portable type of ion exchanger used in plating processes. It also reports centralized ion exchange regeneration system (so-called resource center) which has been successfully operating since 1976, and has been contributing for recycling of resources in large recycling loops in the Japanese electroplating industry. (Yagishita, A.; Fukuta, I.; Yagishita, K.; FIRST INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES, Honolulu, Hawaii, USA, 7-10 Nov. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY (TMS), 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993). (Met. A., 9401-72-0028), pp. 113-116 [in English].)

0918 IRON POWDER METHOD FOR WASTE WATER TREATMENT. [BIB-199401-71-0001]

Dowa Mining Co., Ltd. has developed a method for simultaneously removing a large number of heavy metals from waste water by using iron powder. Dowa's study of environmental technology as a leader in the resource industry has enabled such a unique technology to develop. The special characteristics of the Fe powder method are introduced: simultaneous removal of a large number of harmful heavy metals and substances, e.g. high toxicity elements arsenic, Cr⁶⁺, and mercury; removal of heavy metals by forming ammonium complexes; removal of heavy metals by forming chelate complexes; removal of ferrocyanides and ferricyanides; removal of fluorine; and easy condensation, filtration, and separation of the precipitates generated after reaction in the Fe powder method. Graphs. (Saito, T.; Tanaka, A.; Murakami, M.; FIRST INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES, Honolulu, Hawaii, USA, 7-10 Nov. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY (TMS), 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993). (Met. A., 9401-72-0028), pp. 91-94 [in English].)

0919 FUTURE OF IRON AND STEELMAKING. [BIB-199401-71-0041]

This double volumes gives a retrospective and an outlook for the future of steelmaking processes (the future evolution of the steel industry, the trends in steel consumption, the steel production, and its geographical repartition, raw materials). Energy sources are reviewed in view of the necessity to reduce CO₂ emission and to comply with stricter ecological constraints. The literature closing date was the end of 1990. English and German subject indexes are provided. (Nilles, P.; Publisher: SPRINGER-VERLAG, P.O. Box 503, 1970 AM Dordrecht, The Netherlands, (1992). (Met. A., 9401-72-0056), Pp. 532 [in English].)

0920 CURRENT ENVIRONMENTAL ISSUES FACING THE LEAD, ZINC AND CADMIUM INDUSTRIES. [BIB-199401-71-0055]

Challenges to the continued production and use of Pb and Cd have increased during the past several years. These challenges have been on charges that the production and use of these metals result in illness in both occupationally exposed workers and the general population. Prominence has been given to some studies suggesting subtle, but perhaps adverse health effects on workers and the general population. Both Pb and Cd are toxic and both have produced well-documented cases of illness. Lead attacks primarily the nervous system, the hematopoietic or blood forming system, and the kidney. There have been suggestions that low level Pb exposure can result in lowered intelligence in children and may impair a variety of biochemical processes in the body. Based on animal evidence, Pb is regarded as a possible human carcinogen. Cadmium attacks primarily the kidney and, according to some studies, may produce lung cancer. As a result of concerns about toxicity, there have been numerous governmental and intergovernmental initiatives proposing or enacting stringent standards for emissions in the air and water. Concerns have also been expressed about the levels of Pb and Cd in soil and dust from prior uses and industrial activity. Additional concerns have been expressed regarding disposal of Pb and Cd containing products in landfills and municipal waste incinerators. Programs encouraging substitution of Pb and Cd in products with other materials have been suggested and outright bans on certain uses have been either suggested or, in limited cases, enacted. While Zn is not regarded as being a toxicant in the same category as Pb and Cd, there have, nonetheless, been concerns expressed about Zn as a toxicant to fish and other aquatic organisms. Zinc runoff from galvanized structures, which also can contain Pb and Cd, is a subject of ongoing study. 12 ref. (Cole, J.F.; FIRST INTERNATIONAL CONFERENCE ON PROCESSING MATERIALS FOR PROPERTIES, Honolulu, Hawaii, USA, 7-10 Nov. 1993. Publisher: THE MINERALS, METALS & MATERIALS SOCIETY (TMS), 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993). (Met. A., 9401-72-0028), pp. 143-148 [in English].)

0921 THE QSL-REACTOR AT THE BERZELIUS SMELTER IN STOLBERG. [BIB-199402-42-0109]

A QSL-plant at Metallgesellschaft AG's Stolberg facility avoids emission of dust because a closed reactor is used as a single-step unit. Flue dust produced is precipitated in an electrostatic precipitator and returned to the mixture over a short way using a closed dragchain conveyor. Produced SO₂ gas is converted into sulfuric acid at a high efficiency (99.5%) because of the continuous production of this gas. Heat of the chemical reaction can be converted into electrical energy and calcium and arsenic can be separated in a pure form. A flowsheet of the QSL-process is shown and described. (Hohn, R.W.; Deininger, L.E.; EDITED PROCEEDINGS TENTH INTERNATIONAL LEAD CONFERENCE, Nice, France, 29-31 May 1990. Publisher: LEAD DEVELOPMENT ASSOCIATION, 42 Weymouth St., London W1N 3LQ, UK, (1990). (Met. A., 9402-72-0123), pp. 141-146 [in English].)

0922 THE TRADITIONAL SMELTING PROCESS: ADAPTING IT TO THE FUTURE NEEDS OF THE ENVIRONMENT. [BIB-199402-42-0112]

Traditionally, the majority of the primary lead consumed by the world has been produced from galena by roasting the ore followed by reduction in a shaft furnace. In recent years, pyrometallurgical processes (QSL, Kovcet, Ou-

tokumpo, Isasmelt) have emerged. In other research in the hydrometallurgical field, methods using the chloride route have resulted. Production of SO_2 and dust during lead extraction and economics of Pb extraction processes are described briefly. (Ferquel, S.; EDITED PROCEEDINGS TENTH INTERNATIONAL LEAD CONFERENCE, Nice, France, 29-31 May 1990. Publisher: LEAD DEVELOPMENT ASSOCIATION, 42 Weymouth St., London W1N 3LQ, UK. (1993). (Met. A., 9402-72-0123), pp. 165-169 [in English].)

0923 DEEP SEWAGE TREATMENT AT CRYOLITE AND ALUMINIUM SMELTERIES. [BIB-199402-42-0156]

A method for removing fluoride from waste waters is proposed which involves a combined treatment by lime and carbon dioxide. Fluoride ions in the waste waters are adsorbed by the surface of the freshly precipitated calcium carbonate crystals. The method has been tested on weakly mineralized waste waters of cryolite and aluminum plants with initial fluoride concentrations of 3 and 12 $mg\ dm^{-3}$. The fluoride content is reduced to the maximum acceptable concentration ($0.75\ mg\ dm^{-3}$) by adding 1-1.5 g of calcium oxide 1 mg of fluoride, with a carbonation time of 90 min. Graphs. (Morozova, V.A.; Kirillova, G.I.; Tsvetnye Metall., (Oct. 1992). (10), pp. 34-35 [in Russian]. ISSN 0372-2929)

0924 NONFERROUS PRODUCTION—ZINC, LEAD, AND TRACE METALS. (NICHTEISENMETALLERZEUGUNG: ZINK, BLEI, UND NEBENMETALLE.) [BIB-199402-43-0097]

Production consumption of zinc and lead in the world, W-Europe, Asia, Germany, South Korea, and Peru are tabulated for 1980-1989. Conventional production and recycling methods are mentioned. New developments and environmental questions are briefly related. (Maczek, H.; Berg- und Huttenmännische Monatshefte. (1991). 136. (5), pp. 162-165 [in German]. ISSN 0005-8912)

0925 PRESENT STATUS OF LD STEELMAKING AT KWANG-YANG WORKS OF POSCO. [BIB-199402-45-0165]

The total production capacity of the Pohang Iron and Steel Company is reported to have reached 10.4 million tons year by October 1992, as against 1 million tons in 1974. Eight design concepts which were instrumental in achieving this enormous growth, are listed, including anti-pollution control systems. Extensive operational results of their LDS system are given. Other topics are minimizing slag carry-over and prolonging lining life. Graphs. (Balk, D.H.; Berg- und Huttenmännische Monatshefte. (1992). 137. (7), pp. 298-303 [in English]. ISSN 0005-8912)

0926 IRON AND STEEL PRODUCTION. (EISEN- UND STAHLERZEUGUNG.) [BIB-199402-45-0173]

Today's developments in iron and steel industry are mainly ecological, i.e. smelter emission decrease. Problems posed by SO_2 in Eastern Europe, CO_2 and industrial waste worldwide. The low-pollution COREX process developed by Voest-Alpine is described. Graphs. 2 ref. (Bogdandy, L.v.; Berg- und Huttenmännische Monatshefte. (1991). 136. (5), pp. 152-156 [in German]. ISSN 0005-8912)

0927 PROCESS TECHNOLOGY AND PLANT CONSTRUCTION. (VERFAHRENS-TECHNIK UND ANLAGENBAU.) [BIB-199402-45-0174]

The COREX process for blast-furnace-quality iron production is taken as an example for discussing various aspects of metallurgical process equipment. Emission characteristics of different processes are compared. Use of expert systems and automation for integrating process industry is represented on block diagrams. Graphs. (Pühringer, O.; Berg- und Huttenmännische Monatshefte. (1991). 136. (5), pp. 165-169 [in German]. ISSN 0005-8912)

0928 EQUIPMENT FOR THE ADDITIVE TREATMENT OF CAST IRON. [BIB-199402-51-0175]

Previously abstracted from original as item 9210-51-1421. A technology which makes reduction in smoke emission and better modifier use possible was developed. An intermediate cast iron modification in a reactor allowed a higher usage of magnesium, reduction of sulfur content, elimination of smoke emission, and improved mechanical characteristics of parts cast from VCh50 cast iron. The technique can be used in small series, mass, and one piece casting production. Graphs. (Dmitriev, S.P.; Ershkanov, E.A.; Alabin, A.L.; Karpenko, V.I.

Soviet Castings Technology (Now: Russian Castings Technology) (See Also Liteinoe Proizvodstvo). (1991). (2), pp. 49-50 [in English]. ISSN 0891-0316)

0929 IN PLANT AIR POLLUTION CONTROL SYSTEMS FOR DIECASTING MACHINES WITH WATER SOLUBLE DIE LUBE. [BIB-199402-51-0284]

In 1983, Aercology was challenged with the task of developing an efficient air pollution control system for aluminum die casting machines using water-soluble die lubricants. The main design goal was to develop a system that eliminated the problems associated with large, higher-cost, ducted systems and could effectively control the contaminants generated in these operations. This paper outlines the design problems and their solutions, with additional discussion of system maintenance considerations. (Schneider, D.; 17TH INTERNATIONAL DIE CASTING CONGRESS AND EXPOSITION, Cleveland, Ohio, USA, 18-21 Oct. 1993. Publisher: NORTH AMERICAN DIE CASTING ASSOCIATION, Rosemont, Illinois 60018, USA. (1993). (Met. A., 9402-72-0159), pp. 133-136 [in English].)

0930 COOLANTS AND LUBRICANTS: THE TRUTH [BIB-199402-52-0203]

The principal types and functions of metalworking fluids are examined, with attention given to mineral and synthetic oils, water-based fluids, and major additives. The discussion covers the main advantages and disadvantages of various fluid formulations, efficiency ranges of lubricating additives, selecting the right combination of additives and chemical blends, and principal types of laboratory tests. Workers health considerations and environmental concerns are also discussed. Graphs. (Bienkowski, K.; Manufacturing Engineering. (Mar 1993). 110. (3), pp. 90-92, 94, 96 [in English]. ISSN 0361-0853)

0931 HOW TO SOLVE THE SOLVENT REDUCTION/INDUSTRIAL CLEANING PROBLEM. [BIB-199402-52-0209]

The principal questions that have to be addressed by the US stamping industry to successfully change over from the vapor-degreaser solvents that are soon to be banned by the EPA to a less regulated or unregulated cleaning method are examined. Solvents to be phased out by 1995 include CFC-113 (Freon) and 1,1,1-trichloroethane (methyl chloroform), as well as halons and carbon tetrachloride. In particular, attention is given to the following five areas: overall use of vapor degreasers, production information, information on new equipment, environmental information, and economic information. (Murphy, R.; Stamping Quarterly. (Spring 1993). 5. (1), pp. 46-50 [in English]. ISSN 1043-5043)

0932 LATEST DESIGN TECHNOLOGY FOR COAL-FIRED LARGE-CAPACITY ADVANCED STEAM CONDITION SUPERCRITICAL SLIDING PRESSURE BOILERS. [BIB-199402-61-0181]

Nowadays Japanese utilities are pursuing thermally high efficient power generation in order to save fuel and protect the global environment by adopting advanced steam conditions for coal-fired units. Coal-fired units have been designed with the following features in addition in Japan: (1) large capacity, (2) capability for burning various kinds of coal, (3) excellent capability for DSS, (4) fast start-up and shut-down capabilities and (5) minimum air pollution including NO_x . The needs for higher steam conditions have resulted in the development of various unique technologies for coal-fired boilers. These advanced technologies developed by Mitsubishi Heavy Industries, Ltd (MHI) for coal-fired advanced steam condition supercritical sliding pressure boilers are introduced, referring to the design of 1000 MW boiler. The applications of Cr—Mo steels and austenitic stainless steels in boilers are discussed. Graphs. (Hisatome, M.; Maruta, T.; Soda, M.; Hashimoto, T.; Sato, S.; Mitsubishi Heavy Industries Technical Review. (Oct. 1993). 30. (3), pp. 162-168 [in English]. ISSN 0026-6817)

0933 THE NEW SIEMENS/KWU MODEL V64.3 GAS TURBINE. (MITSUBISHI 28044). [BIB-199402-61-0245]

A description is given of three gas turbines, the two larger being developed from the smallest by scaling, which are said to be suitable for base load operation in combined gas and steam plants. Improvements over previous models are noted particularly in the compressor and combustion chamber. Hybrid burners which can run on coal gas are said to give low NO_x and CO emissions. From German

(Becker, B., Ziegner, M., *Motortech. Z.*, (1988), 49, (6), pp. 233-240 [in English].)

0934 COREX PLANT IN POSCO. [BIB-199403-42-0170]

In the early 2000s, a part of ironmaking facilities of POSCO such as blast furnaces, coking ovens and sinter plants operated since 1973 and 1976 are expected to be replaced (30 years life expectancy). Replacement by the conventional blast furnace process with acceptable pollution control requires high investment capital cost, but nevertheless the lack of production flexibility and the restriction of raw material conditions are still remaining problems. Therefore it was decided that the Corex process, the only commercialized smelting reduction process in the world until now, will be introduced to POSCO with the scale-up to 600 000 metric tonnes year production capacity. In parallel, the R & D program to develop a new ironmaking process utilizing fine raw materials is being carried out on the basis of Corex technology. POSCO, which accomplished 21 million tonnes of annual steel production in a quarter of a century's construction work until October 1992, will contribute to the development of iron and steel making technology by the introduction of Corex Plant and the performance of the R & D program. (Shin, Y. M.; Use of Coal for Hot Metal Production, Dusseldorf, Germany, 10 Mar. 1993, Publisher: Verein Deutscher Eisenhüttenleute, Sohnstrass 65, Postfach 105145, D-4000 Dusseldorf 1, Germany, (1993), Paper No. 3, (Met. A., 9-403-72-0203), Pp 13 [in English].)

0935 CFB REDUCTION OF FINE ORES WITH COAL—THE LURGI CONCEPT. [BIB-199403-42-0172]

The crude steel output in 1990 was in the order of 770 million t worldwide. More than 60% of this output was obtained via the blast furnace converter route and the balance principally via the scrap EAF route. In the face of the current stagnation of total consumption, steel producers are increasingly exposed to economic and ecological pressure. The concept proposed by Lurgi, to reduce fine ores with coal in the circulating fluidized bed, meets the demands made on a process of the future. Using low-cost raw materials and primary energy that are available world wide, high-grade direct reduced iron is produced which as highly metallized HBI briquette helps compensate for the contaminants introduced by scrap as feed material in electric arc furnaces, as a mixture of fine-grained DRI and char injected into the blast furnace allows one to enhance the capacity of existing blast furnaces, or together with the char produced constitutes a self-fluxing intermediate in an alternative smelting reduction process. Compared with other direct reduction processes, the operating costs and capital outlay for this process method are low and its ecological impact is minimal thanks to the closed, energy-balanced concept. Graphs. 4 ref. (Hirsch, M.; Bresser, W.; Schlebusch, D.; Use of Coal for Hot Metal Production, Dusseldorf, Germany, 10 Mar. 1993, Publisher: Verein Deutscher Eisenhüttenleute, Sohnstrass 65, Postfach 105145, D-4000 Dusseldorf 1, Germany, (1993), Paper No. 5, (Met. A., 9-403-72-0203), Pp 16 [in English].)

0936 PROCESS EXHAUST GAS PURIFICATION IS PAYING OFF FOR ALUMINUM MANUFACTURERS. (IN DER ALUMINIUMINDUSTRIE AMORTISIERT SICH DIE REINIGUNG DER PROZESSABGASE.) [BIB-199403-42-0202]

Environmental protection was for Al producers an ecological challenge. The problem is, however, solved now. The solution is a dry exhaust gas purification plant with fluoride gas recuperation. A Norwegian company has developed the know-how over a period of 40 years. 1 ref. (Keul, E.; *Werkst. Innov.*, (Feb. 1991), 4, (1), pp. 50-52 [in German], ISSN 0934-732)

0937 REDUCTION OF EMISSION OF NITRIC OXIDES IN THE IRON AND STEEL INDUSTRY. (REDUCTION DES EMISSIONS D'OXYDES D'AZOTE EN SIDERURGIE.) [BIB-199403-45-0208]

Approximately 30 000 t of nitric oxides per annum are discharged into the atmosphere by the French iron and steel industry. EEC member countries aim, as a priority, to reduce these emissions. The main nitric oxide emissions (50%) occur during sintering in the coking plant, in heating furnaces and to a lesser extent, during nitric acid pickling. After a description of the formation of these oxides, the possible means of reducing these emissions are discussed. These are selection of coals with a low nitrogenous compound content, treatment of the coals (the coking process can be considered as a coal treatment) and treatment

of the emitted siderurgical gases. 7 ref. (Griffay, G.; *Docque, B.*; *Rev. Metall., Cah. Inf. Tech.*, (Oct. 1991), 88, (10), pp. 1001-1006 [in French], ISSN 0035-1563)

0938 ENVIRONMENTAL MEASURES IN EUROPEAN SINTER PLANTS AND BLAST FURNACES. (MIT FE 28952). [BIB-199403-45-0249]

Previously abstracted from original as item 9206-45-0702. 102.5 million t hot metal have been produced in the member countries of the European Blast Furnace Committee in 1990. At present, there are still differences in terms of pollution control requirements in the individual member countries, which lead to competitive distortions in terms of the costs incurred for the construction and operation of environmental protection facilities. Standards in this respect have been set by the Technical Directive "Clean Air" adopted in Germany in 1986, which has been followed in part also by several other European countries. This report, which is based on an inquiry, outlines some measures for the protection of the environment in European sinter plants and blast furnaces. Plant data of different production units from Belgium, Germany, Finland, Great Britain, Holland, Italy, Luxembourg, Austria and Sweden have been used for the preparation of the documents for evaluation purposes. These are complemented by examples of plant and process technologies applied for the protection of the environment. Graphs. (Lungen, H.B.; Theobald, W.; *Stahl und Eisen*, (16 Dec. 1991), 111, (12), pp. 97-104, 168 [in English], ISSN 0340-4803)

0939 APPARATUS FOR TREATMENT AND PURIFICATION OF WASTE GASES FROM A SECONDARY ALUMINUM MELTING PLANT. [BIB-199403-46-0056]

A process and apparatus for purifying waste gases from a secondary aluminum melting plant are provided, by which the individual waste gas flows are collected and thermally post-combusted, wherein the generation of the energy necessary for post-combustion is provided by waste substances of high caloric value. (Sommer, H.W.; Schloderer, R.; Neubacher, F.P.; (28 Sept. 1993), [in English], Patent no.: US5248473 (USA) Convention date: 25 Mar. 1992)

0940 ECOLOGICAL ASPECT OF MOLD PRODUCTION FOR TITANIUM ALLOY CASTINGS. [BIB-199403-51-0435]

Previously abstracted from original as item 9302-51-0302. More than 80% of Ti alloy castings are produced using graphite molds. The graphite dust presents a significant health and ecological hazard. The resin binders used in the molds evolve significant amounts of CO₂ and carbon monoxide. Analysis of the options available for making the process more ecologically safe leads to the conclusion that molds must be replaced with ceramic preheated molds which do not react with Ti, e.g. yttria. (Atashov, V.G.; Trunov, A.I.; Chernikov, V.A.; *Soviet Castings Technology (Now: Russian Castings Technology)* (See Also: *Liteinoe Proizvodstvo*), (1992), (3), pp. 33-34 [in English], ISSN 0891-0316)

0941 HEALTH EVALUATION OF THE REFINING OF ALUMINUM ALLOY MELTS. [BIB-199403-51-0436]

Previously abstracted from original as item 9302-51-0301. A new ecologically safe flux was developed. The flux has a reduced amount of toxic substance evolution. The fluxes were evaluated during their use in melting of Al alloys AK12. The flux was recommended as a cleaner alternative in Al alloy refining. A detailed analysis of the evolved substances was carried out. (Ermolenko, A.E.; Grinberg, A.A.; Savichev, S.A.; Rabinovich, A.M.; *Soviet Castings Technology (Now: Russian Castings Technology)* (See Also: *Liteinoe Proizvodstvo*), (1992), (3), pp. 29-32 [in English], ISSN 0891-0316)

0942 ENHANCING THE EFFECTIVENESS OF ALUMINUM ALLOY DEGASSING BY INERT GAS INJECTION. [BIB-199403-51-0442]

Previously abstracted from original as item 9302-51-0293. An ecologically pure technique for Al alloys degassing was developed. The technique reduces the amount of hexachloroethane released into the atmosphere. Optimal conditions for the processing of hypereutectic Al-Si alloy KS740 were established. The effect of various additions on the hexachloroethane produced was established. Graphs. (Palachev, V.A.; Inkin, S.V.; Belov, V.D.; Kurdyumov, A.V.; *Soviet Castings Technology (Now: Russian Castings Technology)* (See Also: *Liteinoe Proizvodstvo*), (1992), (3), pp. 12-14 [in English], ISSN 0891-0316)

0943 ADVANCEMENT IN THE RECLAMATION OF PHENOLIC ESTER BINDERS. [BIB-199403-51-0447]

The development of the Alphaset process by Borden (UK) in 1981 introduced to the UK foundry industry a unique binder system for the manufacture of moulds and cores. The phenolic ester system was developed against a background of increasing problems with the emission of sulfur dioxide from the furane resin systems which were currently being used. Since the mid-1970s, furane resins hardened by sulfonic and sulfonic containing catalysts were increasingly being used for the production of boxless moulds on a jobbing and semi-mechanized basis. Experience with the problems created by the emission of SO₂ fumes at casting led directly to the development and introduction of the phenolic ester system known as Alphaset. An investigation into the possibility of re-using Alphaset reclaim sand was made, in conjunction with Baker Perkins Ltd. Among the factors which were to be examined was an assessment of the level of reclaimed sand which could be satisfactorily used without problem, and also an examination of the environmental features of the system when it was reclaimed. From the very beginning, the benefits of low fume at mixing and casting were established as a major benefit of the phenolic ester system, and it was necessary to assure that these advantages would be retained in a system which used reclaimed sand (in casting aluminum or copper). Graphs. 4 ref. (Higgins, R.; Stevenson, M.; IBF 88th Annual Conference—CASTCON 91, Harrogate, UK, 6-7 June 1991. Publisher: IBF Publications, 3rd Floor, Bridge House, 121 Smallbrook, Queensway, Birmingham B5 4JP, UK, (1991). Paper No. 5. (Met. A., 9403-72-0256). Pp 22 [in English].)

0944 SILICA SAND: THE OTHER SIDE OF THE EQUATION. [BIB-199403-51-0451]

Increased demands are being placed upon the foundry industry, as a result of the current economic and environmental situations. This paper describes the efforts made by one major supplier to address the problem by considering sands and binders together as a complete system rather than in isolation, and thus offer the maximum benefits to the foundryman. An attempt was made to illustrate the factors that should be considered when selecting a suitable base sand. The correct choice, remembering that price is not necessarily the only consideration, can open up other possibilities if a compatible binder system is also selected. Judicious choice, to achieve a higher strength system, may well lead to lower addition rates, lower cost resins, reduced mix sand costs, increased reclamation and improved environment. Graphs. Photomicrographs. 3 ref. (Curtis, M.; IBF 88th Annual Conference—CASTCON 91, Harrogate, UK, 6-7 June 1991. Publisher: IBF Publications, 3rd Floor, Bridge House, 121 Smallbrook, Queensway, Birmingham B5 4JP, UK, (1991). Paper No. 9. (Met. A., 9403-72-0256). Pp 16 [in English].)

0945 THE DISPOSAL CRISIS—CURSE OR BLESSING IN DISGUISE? [BIB-199403-51-0461]

From the discussion presented the following conclusions can be drawn. Waste reduction is an absolute must. Waste minimization by way of improved process control, process change, etc. will have highest priority, specifically since this will nearly always be associated with quality and/or productivity improvements. Unavoidable wastes must be used constructively as much as possible. While external constructive use has many favorable aspects connected with it, the legal risks resulting therefrom may in many cases shift the interest towards internal constructive use, i.e. reclamation. Every effort must be made to use thermal processing only where it is absolutely unavoidable because thermal reclamation will in all cases force one to consider complicated emission legislation. If thermal processing is unavoidable the lowest possible degree of thermal processing must be applied. The latest European research suggests that process temperatures of 300 °C should not be exceeded when reclaiming green sand for re-use with resin binders. 14 ref. (Leidel, D.S.; IBF 88th Annual Conference—CASTCON 91, Harrogate, UK, 6-7 June 1991. Publisher: IBF Publications, 3rd Floor, Bridge House, 121 Smallbrook, Queensway, Birmingham B5 4JP, UK, (1991). Paper No. 26. (Met. A., 9403-72-0256). Pp 38 [in English].)

0946 HORIZONTAL CASTING AT ARDAL FOR FOUNDRY ALLOYS. (COLATA CONTINUA AD ARDAL PER LEGHE DA FONDERIA.) [BIB-199403-51-0538]

New computer-controlled horizontal casting equipment at Hydro Aluminum's smelter in Ardal, Norway, allows for continuous casting and contains a flying shear linked to the casting process. The system consists of two casting furnaces,

an in-line degassing filter, a casting machine, and shear. It is totally computer-controlled and requires highly skilled operators. Continuous casting provides the benefit of an even surface, which is of ingot quality but in the form of rods, and which reduces the risk of condensation. The in-line degassing filter ensures the cleanest metal possible before casting. Foundry alloys are continuously cast and cooled, then automatically fed to the shear where it is cut into pieces weighing 6.5 or 7.5 kg. The largest customer base for aluminum foundry alloys is the automotive industry, particularly for use in wheels. Regarding pollution, the Ardal foundry has cut fluoride emissions by 50%, without large investments in new pollution abatement equipment. (Sunnana, D.; Alluminio e Leghe, (Jan. 1993), 5.(41), pp. 27-29 [in English, Italian].)

0947 A GLANCE ON THE FUTURE: PHYSICAL PROCESSES AS PRETREATMENTS TO PAINTING? [BIB-199403-57-0267]

Environment friendly processes are becoming more and more necessary; physical processes might be the right answer. After having made some investigation about them, some testing was performed (using 3003 Al). After a short survey of the characteristics of PVD processes, the results of the tests are presented along with some practical considerations. (Pozzoli, S.A.; Mura, G.; Aluminium 2000, Vol. 3, Firenze, Italy, 29 Mar.-4 Apr. 1993. Publisher: Interall Publications, Via Respighi 246, Modena, Italy, (1993). (Met. A., 9403-72-0215). pp. 59-68 [in English].)

0948 ADVANCED POWDER COIL COATING: NEW POWDER PRODUCTS AND NEW HIGH-SPEED LINE. [BIB-199403-57-0268]

Hunter Engineering, a member of the Tata group of companies, is a world leader in coil coating lines for steel and aluminum. Hunter is constantly developing its range of products and machinery in order to meet the need for new products and technologies. Presently, the major problems are pollution control and the need for high-performance, thick and flexible coatings. The answer is powder coil coating (PCC). Hunter is now collaborating with an "industrial-pilot" powder coil coating line in Italy (Otefal Sud), which is currently coating approx 4000 t/year of Al coils per shift, and is ready to build an improved line, running at much higher speeds. Experience with the present line has shown that architectural panels are an immediate market, home appliances are an around-the-corner market, and a possible "avalanche market" may be in store for the future, when solvent pollution may cause problems to liquid painting lines. Characteristics of PCC architectural Al sheet are described, and examples are given of practical working and applications. (Bianconi, E.; Rota, R.; Sacchi, F.; Aluminium 2000, Vol. 3, Firenze, Italy, 29 Mar.-4 Apr. 1993. Publisher: Interall Publications, Via Respighi 246, Modena, Italy, (1993). (Met. A., 9403-72-0215). pp. 69-86 [in English].)

0949 COLD SEALING OF ANODIZED ALUMINUM WITH COMPLETE RECOVERY AND RECYCLING SYSTEM. [BIB-199403-57-0272]

Cold sealing (or impregnation) of anodized aluminum has long been part of the industrial anodizing practice, but new regulations in many countries are limiting the use of nickel ions in the waste waters and sludges coming from the water treatment waters. To face this problem, a special system for the recovery of the Ni ion and the fluoride ion from the rinsing waters has been set up. The procedure proposed insures the observance of the strictest law parameters. At the same time a new system for the dosing of chemical products for cold sealing has been developed. (Burbidge, A.; Pieve, A.; Aluminium 2000, Vol. 3, Firenze, Italy, 29 Mar.-4 Apr. 1993. Publisher: Interall Publications, Via Respighi 246, Modena, Italy, (1993). (Met. A., 9403-72-0215). pp. 121-128 [in English].)

0950 WATTS NICKEL AND RINSE WATER RECOVERY VIA AN ADVANCED REVERSE OSMOSIS SYSTEM. [BIB-199403-58-0299]

The report summarizes the results of an eight month test program conducted at the Hewlett Packard Printed Circuit Board Production Plant to assess the effectiveness of an advanced reverse osmosis system (AROS). The AROS unit, manufactured by Water Technologies, incorporates membrane materials and system components designed to treat metal plating rinse water and produce two product streams: a concentrated metal solution suitable for the plating bath and rinse water suitable for reuse as final rinse. Waste water discharge can be virtually eliminated and significant reductions realized in the need for new

plating bath solution and rinse water (Schmidt, C.; White, I.E.; Ludwig, R. Gov. Res. Announc. Index, (1993), PB93-229011 NAB, Pp 78 [in English] ISSN 0097-9007)

0951 AN APPROACH TO IMPROVE THE QUALITY OF HOT DIP LEAD—TIN ALLOY COATING. [BIB-199403-58-0314]

Rare earths and gallium were added to hot dip Pb—Sn alloy coatings. Optimization was carried out of these added elements. The surface appearance and the anticorrosion and antioxidation properties of the coatings were improved by those elements. On the other hand, the pollution induced by Pb was reduced. Photomicrographs. 5 ref. (Kong, X., Materials Protection (China), Aug. 1991), 24, (8), pp. 26-29 [in Chinese]. ISSN 1001-1560)

0952 CREATIVE DESTRUCTION OF EXISTING SOLUTIONS IN FAVOUR OF ECOLOGICALLY BETTER ALTERNATIVES. (RETROACTIVE COVERAGE). [BIB-199403-61-0265]

In the past few months, there has been a change over in the material used for bottle neck labelling from Al to paper on the basis of "ecological requirements." EPH-Tochter haendler und Natermann in Hannover, Germany comments on eco-marketing in the brewing industry with the example of Al bottle neck labelling. It is plainly absurd to talk of a "poisonous" or "noxious" material. Aluminium has on the basis of its attractive qualities, a large share of the packaging market. The questions "How shall we explain to the consumer that we gave up such an ecologically-irreproachable material as Al in favour of paper? Shall we, in another few years, give up paper also?" were posed. (Alfred Verpack.-Berat., (May 1991), (5), pp. 85-88 [in German].)

0953 ECOLOGY—MAXIM FOR THE 1990S—A CHOICE BETWEEN ORDER AND CHAOS IN REFUSE. (RETROACTIVE COVERAGE). [BIB-199403-71-0124]

Ecological and economic aspects of energy and recycling are considered, both in general terms and in the specific case of aluminium. Fundamental to this is a knowledge of thermodynamics. An overall energy balance (manufacturing, usage and recycling) is required from an ecological and economic point of view and Al, like no other material, has an excellent chance of becoming the material of the future. It fulfills outstandingly the requirements of a cyclical system and both manufacturer and user of Al products have long made use of its recyclability. The high value of Al used products enable collection and processing systems to be introduced without the need for subsidies. (Alfred, (Bald, L., Verpack.-Berat., (Oct. 1990), (10), pp. 18-22 [in German].)

0954 GLOBAL CONSIDERATIONS OF ALUMINIUM ELECTROLYSIS ON ENERGY AND THE ENVIRONMENT. [BIB-199404-42-0248]

Aluminium production requires resources in the form of energy and minerals, and the by-products of the process have an impact on the environment. Important tasks for the Al producers are to use the energy and the raw-materials more efficiently, and to reduce the amounts of various harmful gaseous and particulate emissions and their negative effects on the surroundings. The ways that the Al producers can contribute to lower the total energy consumption and reduce the emissions are reviewed and discussed. Graphs. 12 ref. (Hugi, R.; Kvande, H.; Light Metals 1994, San Francisco, California, USA, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1994), (Met. A., 9404-72-0317), pp. 373-380 [in English].)

0955 STRATEGIES FOR DECREASING THE UNIT ENERGY AND ENVIRONMENTAL IMPACT OF HALL HEROULT CELLS. [BIB-199404-42-0251]

The electrolytic production of Al in a molten cryolite bath depends upon, as major raw materials, alumina, electrical energy, coke, pitch, and aluminium fluoride. From both economic and environmental aspects, conservation of these inputs, decreasing the energy in or operating voltage across cells, raising production, controlling and minimizing emissions from reduction plants are extremely important to every primary Al producer. Due to the complex and interactive nature of the parameters, fixed and variable, fundamental to the electrolytic process, there is a hierarchy of choices possible for addressing and improving, for instance, components of cell voltage, heat balance and conserva-

tion, variability among and stability within pots, consistency of high current efficiency, life of the cells, management of anode effects, etc. The impacts that operational procedures and work practices have on key parameters, their relationship to the inventory of basic knowledge about the Hall Heroult process and the expectations for relative improvements are identified and quantified to the extent possible. Additionally, with recent increased concern for global warming and environmental effects of carbon monoxide and CF_4 enlarging the industry's continuing concern and responsibility for the immediate surroundings of a plant, aspects for characterizing and decreasing fluorocarbons are discussed. 4 ref. (Richards, N.E.; Light Metals 1994, San Francisco, California, USA, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1994), (Met. A., 9404-72-0317), pp. 393-402 [in English].)

0956 REVIEW OF THE RETROFIT PROGRAM FOR THE PREBAKE POTLINES OF HYDRO ALUMINIUM A.S. [BIB-199404-42-0253]

Hydro Aluminium a.s. has continuously improved and retrofitted its old prebake potlines. The most common structural changes made in cell retrofitting are introduction of point feeding of alumina, improved cathode design and materials, use of larger anodes, and rearrangement of the current busbar system in order to improve the magnetic conditions in the cell. Technical results are presented together with a discussion on how continuously improved technical results, productivity and finally outcome is possible through increased knowledge about the organizational processes, and how these processes are influenced to take the desired directions for successful operations. Graphs. 1 ref. (Moen, T.; Vee, K.O.; Gjorven, S.; Solbu, A.; Jordal, F.; Light Metals 1994, San Francisco, California, USA, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1994), (Met. A., 9404-72-0317), pp. 413-415 [in English].)

0957 RECENT DEVELOPMENTS IN THE LEAD INDUSTRY: SOME ASPECTS OF SMELTING, REFINING AND ENVIRONMENTAL ISSUES. [BIB-199404-42-0313]

Considerable progress in the development of the new direct smelting processes for Pb has been made although not all the problems have been solved. QSL, Kivcet and Isasmelt, together with increased contribution from the ISF, amount to a shift of 18% away from the sinter blast furnace route in a period of seven to eight years. They offer lower production costs and reduced capital costs and demonstrate the possibility of greater efficiency in controlling emissions of Pb, SO_2 and other toxic dusts. As Pb's image problem is rectified, new applications such as the development of advanced Pb—acid batteries for electric vehicles will proliferate. 9 ref. (Temple, D.A.; Eleventh International Lead Conference, Venice, Italy, 24-27 May 1993, Publisher: Lead Development Association, 42 Weymouth Street, London, W1N 3LQ, UK, (1993), Paper 8.1, (Met. A., 9404-72-0347), Pp 9 [in English].)

0958 THE KIVCET PROCESS: 12 YEARS' EXPERIENCE AT PORTO VESME (1981-1993). [BIB-199404-42-0314]

The KSS Pb plant of Portovesme (KSS Kivcet Samum Snamprogetti), is the largest Pb smelter in the world based on a new technology of direct smelting. It is located at Portovesme, Sardinia (Italy), under the ownership of Nuova Samum S.p.A. The KSS plant started up in February 1987 and two years after the start-up the results obtained from the process, with respect to production cost and ecological factors, were better than expected. Since June 1990 capacity of the KSS plant has been increased to 800 t/day of charge and the KSS furnace has been treating a wide range of Pb concentrates, Zn leaching residues, and secondary Pb bearing materials, with a 96% continuous running. As far as the environmental hygiene and the protection of workers is concerned, the experimental data detected by monitors, either in the working area and on the ground outside the complex, are widely below the stricter new limits recommended by the EEC (European Communities) rules and by Italian law. For the time being the KSS plant of Portovesme is the biggest Pb running plant in the world based on a new technology and it represents a milestone in the Pb and Zn industry. (Ibba, R.; Eleventh International Lead Conference, Venice, Italy, 24-27 May 1993, Publisher: Lead Development Association, 42 Weymouth Street, London, W1N 3LQ, UK, (1993), Paper 8.2, (Met. A., 9404-72-0347), Pp 26 [in English].)

0959 RECENT DEVELOPMENTS IN IRON ORE SINTERING. IV. THE SINTERING PROCESS. [BIB-199404-42-0324]

The major developments around the sinter strand are in four areas: (i) energy consumption, (ii) productivity, (iii) process control, and (iv) environmental control. Significant reductions in energy requirements have already been achieved as a result of installing heat recovery systems, improved ignition, decreasing air leakage, improved raw materials characteristics, and improved fan control. Increased productivity is achieved by maximizing the yield of sinter product. This is influenced by factors such as uniformity of sintering both horizontally and vertically in the bed, sinter bonding strength, crushing of the sinter product, and selection of screen aperture for return fines. Other factors such as bed depth, size distribution of coke breeze, ignition, plant availability, and oxygen enrichment may also have an effect on productivity. The latest plant control systems are based on artificial intelligence and their use is spreading. The main emissions from sinter plants are dust, sulphur oxides, and nitrogen oxides. Many plants have installed electrostatic precipitators to control particulate emissions and can achieve levels 50 mg Nm^{-3} . Desulfurization equipment has been installed at about one-half of the operating plants in Japan but at only one plant in Europe. Graphs 60 ref. (Dawson, P.R., *Ironmaking and Steelmaking*, (1993), 20, (2), pp 150-159 [in English]. ISSN: 0301-9233)

0960 ENVIRONMENTAL PROBLEMS AND SUMITOMO'S NICKEL REFINING TECHNOLOGY. [BIB-199404-42-0327]

In nonferrous industry, a company cannot continue its business activities nor coexist in the regional community if the company has no adequate countermeasure against environmental problems such as air pollution and industrial waste water. Thus, the environmental problem is the most serious theme for Sumitomo since its copper refining was begun 400 years ago. This report describes Sumitomo's fundamental policy, the accumulated technology and the countermeasures for solving the problems together with the process for recovering the original phase in nature from the ruined state. Sumitomo's nickel refining technology developed based on these efforts is also described. 3 ref. (Ueda, M., *Proceedings of the International Conference on Mining and Metallurgy of Complex Nickel Ores*, Jinchang, China, 5-8 Sept. 1993, Publisher: International Academic Publishers, 137 Chaonei Dajie, Beijing, 100010, China, (1993), (Met. A., 9404-72-0356), pp 12-21 [in English].)

0961 SILVER CHLORIDE: REDUCTION TO METALLIC SILVER. [BIB-199404-42-0364]

Several methods of reducing silver chloride to metallic silver are discussed. The classic thermal reaction with sodium carbonate and then some experience with hydrazine are given. Finally, the work to reduce the boiling and smoking of the sodium carbonate procedure is described. A study of the chemical reactions and the temperatures at which they occur is outlined. The simple tests that were made to try to explain the reduction in smoke are given. The procedure using lower temperature (below the melting point of Ag) and some borax in the mix is given. 8 ref. (Loewen, R., *Precious Metals 1993*, Newport, Rhode Island, USA, June 1993, Publisher: International Precious Metals Institute, 4905 Tilghman St., Suite 160, Allentown, Pennsylvania 18104, USA, (1993), (Met. A., 9404-72-0357), pp 181-192 [in English].)

0962 PRECIOUS METAL REFINING; MEETING THE CHALLENGE OF THE 1990'S. [BIB-199404-42-0368]

The 1990s pose many daunting obstacles for refiners in general and precious metal refiners in particular. The stringent environmental laws have required many operations to undergo very expensive process control improvements to greatly limit or totally eliminate emission of certain effluents into the air or water. Tighter requirements are also in the products that each customer may require. For example, in the semiconductor industry, spent sputtering targets are refined and upgraded not only to meet a simple minimum metal content such as 99.999% minimum gold, but also to meet specifications limiting alkali metals on the order of 1-2 ppm. This impacts both the refining techniques employed and the analytical processes to test with absolute confidence in the result. The focus of this paper is to address these topics in detail and provide an outlook as to the direction of the industry. 4 ref. (Castilleja, D., *Precious Metals 1993*, Newport, Rhode Island, USA, June 1993, Publisher: International Precious Metals Institute, 4905 Tilghman St., Suite 160, Allentown, Pennsylvania 18104, USA, (1993), (Met. A., 9404-72-0357), pp 289-294 [in English].)

0963 INJECTION OF SILICA FLUX TO A NICKEL CONVERTER THROUGH A SUBMERGED TUYERE. [BIB-199404-42-0378]

A 3.7 x 7 m Peirce-Smith converter at Kalgoorlie Nickel Smelter is being fluxed by injecting silica sand through a submerged tuyere. Flux injection eliminates fugitive emissions of sand into the working environment which is experienced using the traditional method of fluxing through the mouth. It also decreases the converter's reliance on cranes, and decreases cut of the wind time, thus increasing converter utilisation. This paper discusses the design and operation of the flux injection system and compares it with the current practice of flux addition by boat. Graphs 4 ref. (Cuishaw, C.P., Hunt, A.G., Nilmani, M., *Converting, Fire Refining and Casting*, San Francisco, California, USA, 27 Feb.-3 Mar. 1994, Publisher: The Materials, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993), (Met. A., 9404-72-0361), pp 79-90 [in English].)

0964 THE KENNECOTT—OUTOKUMPU FLASH CONVERTING PROCESS. [BIB-199404-42-0380]

The Kennecott—Outokumpu flash smelting process was developed to commercial stage during the 1980s. The first flash converting process in full industrial scale will be put into operation in Kennecott Corporation's Salt Lake City Plant in June, 1995. However, because the new process still raises many basic questions and there exist some misunderstandings regarding the process concept and its benefits, the most essential facts and most misleading fictions are discussed. The requirements of today for a modern converting operation include economical, metallurgical and environmental issues. The flash converting process fulfills all of these criteria. Graphs 8 ref. (Hannala, P., Kojo, I.V., Kyoto, M., *Converting, Fire Refining and Casting*, San Francisco, California, USA, 27 Feb.-3 Mar. 1994, Publisher: The Materials, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993), (Met. A., 9404-72-0361), pp 107-119 [in English].)

0965 INCREASE OF CONVERTER AISLE PRODUCTIVITY AT RONNSKAR. [BIB-199404-42-0394]

The productivity of the Ronnskar smelter is heavily dependent on a high converter aisle operation. The output has steadily increased and the quality of the anodes has improved substantially. This has been achieved through scheduling converter operation, improved maintenance and quality teamwork. New measurement technologies have helped to understand the metallurgical process and hence allow for better process control and lower unit cost. The improved availability resulted in lower number of hot units needed. This led to lower energy consumption and reduction in manpower. The improvements are also demonstrated by improved environmental performance of the smelter. Graphs (Nyström, L., Lundström, J., *Converting, Fire Refining and Casting*, San Francisco, California, USA, 27 Feb.-3 Mar. 1994, Publisher: The Materials, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993), (Met. A., 9404-72-0361), pp 311-321 [in English].)

0966 EXPERIENCE OBTAINED WITH A NEW SEWAGE WATER TREATMENT PLANT ACCORDING TO APPENDIX 40 IN MIXED WORKS FOR NOBLE METALS. (BETRIEBSERFÄHRUNGEN MIT EINER NEUEN ABWASSERBEHANDLUNGSANLAGE NACH ANHANG 40 IN EINEM EDELMETALL-MISCHBETRIEB.) [BIB-199404-43-0127]

New regulations (Appendix 40) relevant to the operation of electroplating works specify acceptable additions to water entering the works and set standards for the treatment of waste water. A waste water treatment plant, designed for an electroplating works modelled in accordance with Appendix 40 was installed at the Demetron works, Schwabisch Gmünd, concerned with the electrodeposition of noble and base metals. Data are given to illustrate the range of application and effectiveness of the plant in the removal of contaminants. It was concluded that the assumptions based on Appendix 40 regarding the design and operation of a model electroplating works were in practice invalid, and in particular the removal of nickel residues from waste water to the level specified in Appendix 40 was not practicable using current technology. Graphs (Nagel, R., Schenzel, H.-G., Entert, T., *Metalloberfläche*, (Sept. 1993), 47, (9), pp 448-456 [in German]. ISSN 0026-0797)

0967 MEMBRANE ELECTROLYSIS. METAL RECOVERY FROM WATER FROM PROCESSING AND CLEANING SYSTEMS. (MEMBRANELEKTROLYSE. RÜCKGEWINNEN VON METALLEN AUS PROZESS- UND SPÜLWASSERN.) [BIB-199404-43-0128]

Nickel is deposited on a rotating cathode in a catholyte separated from a Ni- and chlorine-free anolyte by an anion-impermeable membrane. The efficiency of deposition was 80-90% and is maintained as the concentration of Ni decreases by the addition of hydrochloric acid to the catholyte and sodium hydroxide to the anolyte. In a particular installation the cell was operated for 60-90 h at a temperature of 40-43 °C, the concentration of the Ni decreasing from 3.5 g/l to 50-150 mg/l. The Ni recovered has a value which, together with a reduction in the cost of waste (sludge) disposal, justifies the cost of installing and maintaining the plant. Graphs. (Reidl, H.; *Metalloberfläche*, (Sept. 1993), 47, (9), pp. 457-460 [in German]. ISSN 0026-0797)

0968 ILSERV PROCESS FOR THE TREATMENT OF EAF AND AOD. [BIB-199404-45-0382]

The largest plasma arc furnace for the treatment of EAF (electric arc furnace) and AOD (argon oxygen decarburization converter) dusts has recently come on stream in the Terni, Italy, area. The plant has a Multiserv Plasminox Furnace with the capacity to treat 20 000 t/year of dusts having a high chromium and nickel content, arising from the steelmaking plants of ILVA, Terni Works. The furnace is tapped at regular intervals, with approx 4 t of liquid ferroalloy and at the same time approx 1.5 t of slag. The ferroalloy (typically 12% Cr, 2.5% Ni) is reintroduced into the production cycle of the EAF, whereas the volatile metals (Zn, palladium and cadmium) are recovered from the furnace as dry dust of their oxides and collected in the dust filtration plant. They are then traded thanks to their very high zinc oxide content. Slag, which mainly contains SiO₂, CaO, MgO and Al₂O₃ and is by now non-toxic, is sent for dumping. (Bruno, F.; Hunt, J.J.; Repetto, E.; *Processes and Materials Innovation Stainless Steel* Vol. 2, Florence, Italy, 11-14 Oct. 1993, Publisher: Associazione Italiana di Metallurgia, Piazzale Rodolfo Morandi 2, I-20121, Milan, Italy, (1993), (Met. A., 9404-72-0324), pp. 2 113-2 118 [in English].)

0969 INVESTIGATION OF DUST AND GAS EMISSIONS IN THE HEATING OF INGOTS OF KILLED STEEL BY DIFFERENT HEAT-INSULATING PACKINGS. [BIB-199404-51-0575]

Previously abstracted from original as item 9310-51-1585. Dust and gas emissions from fill materials used for the thermal insulation of killed steel ingots are a major source of air pollution at metallurgical plants. Here, various fill insulations are examined from the environmental standpoint in order to select the most ecologically clean materials. It is shown that particularly low levels of emissions of dust and gases are observed for fill insulation consisting of aluminum cuttings. (Tsybal, V.P.; Ibraev, I.K.; Varenik, V.I.; Zhakypbekova, G.R.; *Industrial Laboratory* (Russia), (July 1992), 58, (7), pp. 680-681 [in English]. ISSN 0019-8447)

0970 A NEW GENERATION OF FLUXING IN ALUMINUM MELTING AND HOLDING FURNACES. [BIB-199404-51-0589]

The surface of the holder bath shimmers orange with little evidence of dross. Twenty three gently rolling elevations break the surface as the flux cycle nears its end. There are no wands, no hoses, no therming, no smoke and no splashing of molten Al. Observed is an advanced level of hydrogen removal in furnaces. There is unparalleled emissions control at bath level. A new generation of fluxing technology in the aluminum industry is described. 1 ref. (Guttery, J.R.; *Evans, W.*, *Light Metals* 1994, San Francisco, California, USA, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1994), (Met. A., 9404-72-0317), pp. 921-927 [in English].)

0971 AUTOMOTIVE ALUMINUM RECYCLING CHANGES AHEAD. [BIB-199404-51-0612]

The high intrinsic value of Al has been an inhibiting factor for its wide-spread use, and a stimulating factor when its favorable properties can be augmented with its recyclability. The can recycling success story in the US delivers a convincing testimony to that effect. In the car industry, Al has played a modest role until recently. However, the public's growing concerns about resources and the protection of the environment, and the car manufacturers' increased realiza-

tion of the favorable properties and recyclability of Al, are positioning the metal well for a predominant role as the automotive construction material of choice. The use of many alloys to meet the requirements for the different applications poses a challenge to the existing recycling infrastructure. The lessons from the can recycling efforts are discussed in light of applicability to automotive recycling. Graphs. 12 ref. (Linden, J.L.L.; *Light Metals* 1994, San Francisco, California, USA, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1994), (Met. A., 9404-72-0317), pp. 1115-1120 [in English].)

0972 RESPONSIBLE RECYCLING AND DISPOSAL OF HAZARDOUS AND NON HAZARDOUS WASTES IN THE ROLL SHAPE. [BIB-199404-52-0522]

EPA regulations force more sophisticated, technical solutions to waste management problems, differentiate between waste streams, and focus toward specific treatment technology. The Resource Conservation and Recovery Act emphasizes source reduction, recycling, treatment, and disposal. Treatment may involve neutralizing waste products while disposal may be effected through incineration or less desirably, land filling. (Campbell, R.L.; *35th Mechanical Working and Steel Processing Conference* Vol. 31, Pittsburgh, Pennsylvania, USA, 24-27 Oct. 1993, Publisher: Iron and Steel Society, Inc., 410 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1994), (Met. A., 9404-72-0377), pp. 3-6 [in English].)

0973 FRICTION WELDING: A PROVEN JOINTING METHOD. (WRIJVINGSLASSEN: EEN BEPROEFDE VERBIDENSG METHODE.) [BIB-199404-55-0542]

Friction welding is an ecologically precise technique giving reproducible energy-saving rapid automated and mechanized butt jointing of components. It is described and illustrated on bonding of ceramics, hard metal or brass to steel, of duplex steel 1.4462 to steel C35, of GGG40Fe to St37 or St52, of brass to X20Cr13, X20Cr13 or brass, and of 422CrMo4 to 42CrMo4. Graphs, Photomicrographs. 2 ref. (Horn, H.; Grunauer, H.; *Metall & Kunststoff*, (1 Nov. 1993), 31, (21), pp. 28-31 [in Dutch].)

0974 ADHESION: AQUEOUS CLEANERS FOR PRETREATMENT. (HAFTFESTIGKEIT: WASSRIGE REINIGER ZUM VORBEHANDELN.) [BIB-199404-57-0423]

Water based cleaners have been under test as alternative solvents to industrially and environmentally hazardous organic compounds, such as 1,1,1-trichloroethane, used to decontaminate steel plate before the application of an adhesive. Steel plate was used as delivered, cleaned with one of the chosen solvents or cleaners in conjunction with ultrasonic action, and or subjected to abrasion by a jet of carborundum particles. The aqueous cleaners each contained a surface active compound, a sequestering agent, and was neutral or made alkaline or acidic by the addition of a caustic hydroxide or phosphoric acid, respectively. The cleaners tested were NA 09 (organic), 1,1,1-trichloroethane, Cleaner GC (neutral), Ultrasonic Alkaline HD, and Descaler 2 (acidic). The strength of adhesion of appropriately cured 0.2 mm layers of an epoxide or polyurethane based adhesive was measured by a peeling test DIN 53 282. Although the use of aqueous cleaners resulted, in part, in some improvement in resistance to peeling, further investigation was considered necessary before advising their use as replacements for solvents in current use. Graphs. 9 ref. (Dorn, L.; *Salem, N.*, *Metalloberfläche*, (Sept. 1993), 47, (9), pp. 440-443 [in German]. ISSN 0026-0797)

0975 ENVIRONMENT FRIENDLY PROCESS FOR STAINLESS STEEL PICKLING. [BIB-199404-57-0503]

The traditional methods for pickling stainless steels may now be regarded as being surpassed as it is possible to substitute the most toxic compound, HNO₃, with less toxic substrates. An environment friendly process has been developed for pickling ferritic and austenitic grades. Pickling mechanisms are centered on the concept of potentiostatic pickling of stainless steels developed by CSM during the 1970s for sulfuric acid solutions. The potentiostatic elements are substituted by suitable proprietary mixtures named Cleanox 352, consisting mainly of HF together with inhibitors and wetting agents, properly stabilized H₂O₂ and H₂SO₄. The pickling process is operated within the metal solution potential range where the anodic dissolution of the chromium-depleted layer under mill scale is kinetically favoured over that of the base alloy, which remains

passive. Process management limits reagent consumption and relevant operating costs without impairing the productivity of the production line or the surface quality of products due to problems of under or over-pickling. Graphs. 10 ref. (Fortunati, S.; Novaro, E.; Pedrazzini, C.; Pollastrelli, A.; *Processes and Materials Innovation Stainless Steel Vol. 2*, Florence, Italy, 11-14 Oct. 1993. Publisher: Associazione Italiana di Metallurgia, Piazzale Rodolfo Morandi 2, I-20121, Milan, Italy, (1993). (Met. A., 9404-72-0324), pp. 2.119-2.128 [in English].)

0976 RECOVERY VALUES OF NEUTRALISATION SLUDGES IN METALLURGICAL PLANTS. (DIE VERWERTBARKEIT VON NEUTRALISATIONSSCHLAMMEN IN METALLURGISCHEN ANLAGEN.) [BIB-199404-58-0479]

As well as identifying selected metallurgical plants for recovery of sludges from neutralised metal salts derived from electroplating operations. Tables are shown, listing the maximum permissible values of other substances present. Most such plants are based on the pyrometallurgical route. However, certain special cases are treated separately. These include sludges from zinc coating plants, effluents from ferro-alloy processes based on plasma technology, and those from copper-based processes. The ideal situation for producing recoverable sludges can only be reached by separating the various effluent streams. On-site electrolytic metal recovery is an attractive option. Precipitation using sodium hydroxide rather than lime is recommended, since in the latter case there will be greater concentrations of precipitant and the sludge will be less easily treated. (Wallis, E.; *Galvanotechnik*, (Mar. 1994), 85, (3), pp. 889-902 [in German]. ISSN 0016-4232)

0977 PLATINUM-CONTAINING FUEL CELLS UPDATE—A COMMERCIALIZATION PERSPECTIVE. [BIB-199404-61-0427]

Platinum-containing fuel cell development and commercialization prospects, phosphoric acid fuel cell (PAFC) and proton exchange membrane fuel cell (PEMFC), is the subject of this update. PAFC is closest to commercialization but reliability and unit cost hurdles remain. PEMFC is in its early development phase though technology has significant merits for transportation applications. Commercialization of PAFC is anticipated in the mid-1990s and PEMFC not until after year 2000. Acceleration of fuel cell commercialization hinges on manufacturers ability to provide cost effective and reliable products coupled with favorable environmental factors such as enforcement of clean air regulations, and suitable infrastructures to support a nascent industry. (Woo, M.Y.C.; *Precious Metals 1993*, Newport, Rhode Island, USA, June 1993. Publisher: International Precious Metals Institute, 4905 Tighman St., Suite 160, Allentown, Pennsylvania 18104, USA, (1993). (Met. A., 9404-72-0357), pp. 475-480 [in English].)

0978 STAINLESS STEEL AND THE ENVIRONMENT: GLOBAL GROWTH OPPORTUNITIES. [BIB-199404-71-0185]

The environment is defined as the aggregate of external circumstances, conditions, and influences that affect the existence and development of an individual, organism, or group. This discussion considers three of these influencing factors, air, water, and soil. Humans can exert very little control over natural forces affecting the environment. However, control can be exerted over man made threats to the environment that will affect future development and existence. These controls must stand the test of availability, durability, ease of use, longevity, and cost. Perhaps a better and more concise term is life cycle costing. Stainless producers have a strong case to make that stainless steel is an ideal material of choice for environmental equipment, balancing life, longevity and cost. (Rutherford, R.W.; *Processes and Materials Innovation Stainless Steel Vol. 1*, Florence, Italy, 11-14 Oct. 1993. Publisher: Associazione Italiana di Metallurgia, Piazzale Rodolfo Morandi 2, Milan, I-20121, Italy, (1993). (Met. A., 9404-72-0323), pp. 1.35-1.42 [in English].)

0979 ENVIRONMENTAL BENEFITS OF STAINLESS STEEL PROVIDE NEW MARKET OPPORTUNITIES. [BIB-199404-71-0186]

The compatibility of a material with the environment is a key factor of market success. Investors and private consumers increasingly orient their buying deci-

sions toward ecological criteria. Stainless steel perfectly complies with this trend. In fact, it is beneficial to the environment in four ways: clean production processes; ecologically desirable use properties; durability, integrated corrosion resistance, minimum maintenance requirements; perfect recyclability; and key material in environmental technology. Examples are shown of how stainless steel contributes to securing one of mankind's most precious resources, water. It is shown how the unique combination of technical properties, aesthetic appeal and environmental benefits of stainless steel is used in marketing. Actual campaigns run by companies and industry organizations are described. 2 ref. (Pauly, T.; *Processes and Materials Innovation Stainless Steel Vol. 1*, Florence, Italy, 11-14 Oct. 1993. Publisher: Associazione Italiana di Metallurgia, Piazzale Rodolfo Morandi 2, Milan, I-20121, Italy, (1993). (Met. A., 9404-72-0323), pp. 1.79-1.84 [in English].)

0980 AOX DETERMINATION IN PROCESSING SOLUTIONS. (AOX-BESTIMMUNG IN PROZESSLOSUNGEN.) [BIB-199404-71-0191]

German effluent discharge legislation (Appendix 40) lays down administrative procedures for management procedures in the metal-finishing and metal-working industries, describing a straightforward means of AOX determination. Modifications in the procedures for sampling, storage of samples, their concentration and analytical methods are described. Especially in cases of high DOC contents, these measures call for a significant increase in the analytical effort required. 8 ref. (Schatzlein-Maierl, P.; Jungnickel, F.; Held, K.; *Galvanotechnik*, (Feb. 1994), 85, (2), pp. 394-397 [in German]. ISSN 0016-4232)

0981 EVALUATION OF ENVIRONMENTALLY ACCEPTABLE MULTI-LAYER COATING SYSTEMS AS DIRECT SUBSTITUTES FOR CADMIUM PLATING ON THREADED FASTENERS. [BIB-199405-35-1161]

Cadmium has been identified by the US Army's Tank and Automotive Command as a threat to worker health and the environment. Based on already completed Cd substitute testing, an evaluation program was conducted to quantify the performance of environmentally acceptable, multi-layer coatings that could be directly substituted for Cd on threaded fasteners. The performance issues investigated included coating system lubricity and corrosion control performance. Data were generated from both natural marine atmosphere exposure tests and laboratory evaluations. Test specimens were prepared by applying sacrificial plating layers and lubricous topcoat materials to commercially available 1.2-20 UNC Fine, Grade 5 fasteners. Experimental analyses included realistic torque-tension curve development, marine atmosphere exposure testing, and ASTM B 117 salt fog evaluations. Program findings indicate that ASTM B 633 zinc coatings (without the Type II or III chromate passivation treatment) exhibited torque tension behavior that was directly comparable to that of the Cd experimental controls. Corrosion control performance test results indicated that regardless of underlying plating chemistry, systems topcoated with Everlube 6108 performed as well as the Cd experimental controls. Graphs. 7 ref. (Ingle, M.W.; Handsy, J.C.; Schorr, B.S.; 6th Automotive Corrosion & Prevention Conference, Dearborn, Michigan, United States, 4-6 Oct. 1993. Publisher: Society of Automotive Engineers, Inc., 400 Commonwealth Dr., Warrendale, Pennsylvania 15096-0001, United States, (1993), p.268. (Met. A., 9405-72-0382), pp. 233-246 [in English].)

0982 ROUTES TO THE DEVELOPMENTS OF LOW TOXICITY CORROSION INHIBITORS. [BIB-199405-35-1282]

Because of the toxic and carcinogenic nature of chromate containing corrosion inhibitors, considerable efforts are made by researchers to develop environmentally acceptable compounds. A review of such corrosion inhibitors for mild steel in neutral aqueous solution is given. The mechanism of corrosion inhibition is discussed and correlations between the structure and inhibitive efficiency of organic molecules are studied. The concept of a computer design of corrosion inhibitors, i.e. 'tailor-made inhibitors', is given. The role of synergism is presented. Relationships between scaling and corrosion are discussed. Graphs. 65 ref. (Kalman, E.; Publisher: The Institute of Materials, 1 Carlton House Terrace, London SW1Y 5DB, UK, *Corrosion Inhibitors*, (1994). (Met. A., 9405-72-0411), pp. 12-38 [in English].)

0983 A NEW TECHNIQUE FOR COMPREHENSIVE UTILIZATION OF GOLD-, ANTIMONY-, AND ARSENIC-BEARING SULFIDE ORE FROM LONGSHAN HUNAN. [BIB-199405-42-0409]

A new process was developed for treating the title ore, which consists of Sb using antimony pentachloride—atmospheric catalyzing—oxidizing leaching of arsenic—roasting for sulfur removal—dissolution of gold in aqueous chloride solution. This process proved to be highly smooth in operation, easy to scale-up to commercial size, dispensable of autoclaves and high in recovery and utilization of metal values and insignificant to environmental pollution. Graphs. 3 ref (Chen, Q.B.; Lu, Y.Y.; Mining and Metallurgical Engineering, China), (Dec 1993), 13, (4), pp 44-47, 56 [in Chinese]. ISSN 0253-6099)

0984 AMALGAMATION IN SMALL GOLD OPERATIONS: ALTERNATIVES AND TREATMENT OF MERCURY-CONTAMINATED SOILS AND EFFLUENTS. [BIB-199405-42-0422]

There is a large use of Hg in Brazil by the Au miners in the so-called garimpos (non-registered mining operations), where it is usual to recover the Au contained in the gravity concentrates by amalgamation, which is highly deleterious to environment if not conducted properly. Unfortunately, this is a common practice there. After presenting in brief the *modus operandi* generally practiced in the garimpos and the environmental problems, this work reviews some of the research conducted in CETEM according to two approaches: replace amalgamation by other processes and develop technology to treat magnesium-contaminated soils and effluents. Conventional processes like froth flotation, to recover Au from gravity concentrates, and centrifuges were considered. Also as alternatives to amalgamation, innovative process like the recovery of Au by coal-oil agglomerates and a technology that is currently under development in the laboratory, called Au-paraffin process, are described in brief, some results presented and their potential use is assessed. To reclaim sites already polluted, a technology was developed to float Hg selectively from contaminated soils. The potential use of centrifuges to pre-concentrate the Hg is also discussed. The scope for applying the last techniques is to concentrate the pollutants in a small volume of mass which would be suitable for recycling or isolation from the environment. A prospective technology to treat contaminated soils, or Hg concentrates, is the immobilization of Hg by adding inorganics. Concerning the ionic Hg which may be present in effluents, precipitation of the ions and flotation of the precipitates are being studied. Graphs. 49 ref. (Lins, F.F.; Monte, M.M.; Hamelmann, C.R.; Middea, A.; EPD Congress 1994, San Francisco, California, United States, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, United States, (1994), (Met. A., 9405-72-0389), pp. 193-207 [in English].)

0985 OPERATING EXPERIENCE WITH THE QSL-PLANTS IN GERMANY AND KOREA. [BIB-199405-42-0428]

The QSL plant in the existing "Berzelius" Stolberg GmbH lead smelter in Stolberg, Germany, was commissioned in August 1990. Following some modifications to the process and equipment which had become necessary in line with the implementation of this technology, conclusive operating results are now available. These are reported together with a short description of the plant design. In May 1992, raw material feeding to the QSL reactor in the new Pb smelter of Korea Zinc Co. in Onsan, Korea, was started. As all the experience gained up to that point in time in the Stolberg plant had already been incorporated in this plant prior to start-up it reached stable, satisfactory operating conditions in a short period of time. After an introductory description of the plant important operating results are reported. The operating experience gained in the two plants fully confirms the correctness of the inventors' creative ideas in the 1970s. The QSL process meets all demands made on modern, ecologically compatible and energy-saving Pb production technology. The paper ends with suggestions on how the QSL process will be optimized further in the future. Graphs. (Deininger, L.; Choi, K.C.; Siegmund, A.; EPD Congress 1994, San Francisco, California, United States, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, United States, (1994), (Met. A., 9405-72-0389), pp. 477-501 [in English].)

0986 CYPRUS MIAMI MINING CORPORATION SMELTER MODERNIZATION PROJECT SUMMARY AND STATUS. [BIB-199405-42-0430]

Anticipating a major power cost increase in 1990, Cyprus Copper Company decided to modernize the Miami Smelter at a cost of \$92.5 million. The modernization project included the addition of an Isasmelt vessel for use as the primary Cu smelter and the modification of the existing electric furnace to a slag matte separating vessel. The project was completed in June of 1992 and is currently operating at close to its design capacity. This paper provides a summary of the decision making process, a description of the project, a summary of start-up problems and solutions and the current status of the smelter operation. Graphs. 9 ref. (Bhappu, R.R.; Larson, K.H.; Tunus, R.D.; EPD Congress 1994, San Francisco, California, United States, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, United States, (1994), (Met. A., 9405-72-0389), pp. 555-570 [in English].)

0987 IMPROVING COPPER SMELTING PROCESS, CAPACITY AND COSTS—THE ANSWER IS OUTOKUMPU FLASH SMELTING. [BIB-199405-42-0433]

The smelting process of the old reverberatory furnace including its capacity has been improved over the years in different ways, e.g. with oxy-fuel burners, parallel reactors with the reverb or with various modifications of the reverb furnace itself. The future reverb modifications with old concepts are difficult or impossible as the increased copper losses in slag call for separate slag treatment and particularly the process modifications do not solve the environmental issues but instead mean unavoidable high capital and operating costs in gas cleaning and sulphur recovery. This paper discusses the possibilities for future process improvements of the existing flash smelters, taking into account the process concepts, equipment modifications and capital aspects, not forgetting the environmental issues. The revamping of the PASAR smelter in Philippines is introduced as an example of a recent success story. Graphs. (Jortikka, M.; Helle, L.; Hanniala, P.; EPD Congress 1994, San Francisco, California, United States, 27 Feb.-3 Mar. 1994, Publisher: The Minerals, Metals & Materials Society, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, United States, (1994), (Met. A., 9405-72-0389), pp. 669-686 [in English].)

0988 PROCESS FOR RECOVERY AND TREATMENT OF HAZARDOUS AND NON-HAZARDOUS COMPONENTS FROM A WASTE STREAM. [BIB-199405-43-0183]

A process for removing and recovering specific constituents from a waste stream at higher temperatures than the boiling point of the specific constituents. In the process, the waste is moved at a specified retention time, through a heat zone, thus increasing the temperature of the waste stream. There is further provided a means to separate certain components in that waste stream whereby the components are evaporated and are released in a gaseous state, either from a liquid or a solid within the waste stream. The gaseous components are then transferred in the gaseous state through a flow of an inert medium, such as nitrogen gas, to inhibit combustion of the components, or to prevent the combination of oxidation, or oxygen being used as a catalyst to form even more hazardous compounds. The gaseous components then are released in a distilled state, which would then be mixed with the waste, or an emulsion with the waste stream, containing heavy metal such as cadmium, arsenic, lead, or some other type of heavy metal which may be a threat to the environment. (Ormeaux, T.F.; (5 Oct 1993), [in English], Patent no.: US5250175 (USA) Convention date: 29 Nov 1989.)

0989 SURFACE-LUBRICATED STEEL SHEET. [BIB-199405-45-0424]

In a process of producing electric appliances, most zinc coated steel sheets are degreased after press forming to eliminate press lubricant oils and other contaminants, then assembled as end products. Organic solvents such as CFCs (chlorofluoro carbons), 1,1,1-trichloroethane have been widely employed as cleaning solutions. However, these solvents will not be available, since they are

recognized as ozone-depleting materials and are scheduled to be phased out by the end of 1995. Therefore, recent research has focused on alternative techniques of degreasing; development is still under way. A surface-lubricated steel sheet with a special lubrication is one of the solutions. This steel sheet enables both oiling and degreasing out of processing, thus shortening the process and cutting cost. This is one of the steel sheets which are very gentle on the environment. This report introduces some properties and performance of the surface-lubricated steel sheets developed by Sumitomo Metals. Graphs, Photomicrographs. 5 ref. (Hoboh, Y.; Yauchi, A.; Oshima, K.; Kajiyama, E.; Sumitomo Metals. (Sept. 1993). 45. (5). pp. 72-80 [in Japanese]. ISSN 0371-411X)

0990 ENERGY SAVING AND ENVIRONMENTAL PROTECTION BY CONTINUOUS CASTING. [BIB-199405-51-0760]

The introduction of continuous casting has been a major factor in energy saving and environmental protection for steel production. Comparative data with ingot casting are discussed. Innovation in plant and process technology leads to further reductions in energy consumption and environmental pollution. As an example, the features of the modern slab caster concept are illustrated by the new slab caster at Egyptian Iron and Steel Works Hadisoh, which was supplied and installed by VAI. Graphs. 15 ref. (Schwaha, K.L.; Granitz, F.; Ortner, A.; Felbermayr, E.; Advances in Continuous Casting: Research and Technology. Cairo, Egypt. 13-15 Apr. 1992. Publisher: Woodhead Publishing Ltd., Abington Hall, Abington, Cambridge. CBI 6AH. UK. (1992). (Met. A., 9405-72-0396). pp. 247-257 [in English].)

0991 OPERATION START-UP OF CONTINUOUS CASTING. [BIB-199405-51-0774]

This paper explains the experience and techniques of ANSDK for smooth operation since start-up, including the improvement procedures to the optimum operation condition based on good training programs for staff, keeping work and operation standards, and techniques of minimizing operational troubles of continuous casting machines. The goal is to maximize the time utilization of continuous casting machines, increase productivity while keeping cost down, and improve the product quality. Graphs. 5 ref. (Ahmed, M.T.; Avoub, A.M.; Farrag, S.H.; Advances in Continuous Casting: Research and Technology. Cairo, Egypt. 13-15 Apr. 1992. Publisher: Woodhead Publishing Ltd., Abington Hall, Abington, Cambridge. CBI 6AH. UK. (1992). (Met. A., 9405-72-0396). pp. 435-449 [in English].)

0992 NON-CHROMATE TALC CONVERSION COATINGS FOR ALUMINUM. [BIB-199405-57-0597]

A method has been developed for applying an inorganic conversion coating on aluminum that is procedurally similar to chromate conversion coating methods. This new method, however, does not use or produce hazardous or toxic chemicals. The coating forms by a precipitation mechanism involving Al^{3+} , Li^+ , OH^- , CO_3^{2-} , and possibly other anions present in the bath as impurities. This polycrystalline coating is continuous, conformal and persistent in aggressive environments. Coating thicknesses range from several tenths to ten micrometers depending on the substrate alloy composition and the coating process conditions. The outer portions of the coating are porous, but pores do not penetrate to the coating-substrate interface. These coatings, as currently fabricated, do not match the levels of performance offered by commercially available chromate conversion coatings, but are capable of meeting many of the corrosion resistance, electrical resistivity, and paint adhesion requirements established in MIL-C-5541E, Chemical Conversion Coatings on Aluminum and Aluminum Alloys. Methods for producing the talc coating on Al alloys 1100 and 6061-T6 are described and compared to traditional chromate conversion coating methods. The resulting coating structure and composition are described. Additionally, performance data for the talc coatings in MIL-C-5541E required tests are presented along with comparative data from samples prepared using commercial chromate-based coating processes. Graphs, Photomicrographs. 15 ref. (Buchheit, R.G.; Drewien, C.A.; Finch, J.L.; Stoner, G.E.; Publisher: NACE International, P.O. Box 218340, Houston, Texas 77218, USA. (1994). Paper No. 542. Pp 13 [in English].)

0993 AIRCRAFT DEPAINTING: IMPACT OF NEW FEDERAL REGULATIONS. [BIB-199405-57-0606]

Federal-level environmental regulations for the US aerospace industry, resulting from the implementation of the 1990 Clean Air Act Amendments, will force the industry to change the methods used to repaint air vehicles. The regulations are scheduled for promulgation in November 1994, with compliance within 18-36 months. Mechanical repaint methods, which include abrasion, erosion and pyrolysis, comply with the requirements to emit zero hazardous air pollutants for repaint processes. Many of these methods are still in the development stage and their applicability to a wide variety of commercial, military and space vehicles is limited. Many methods require dedicated repaint hangars, are capital intensive, and can cause damage to some air vehicle surfaces. Some result in increased cycle time in the air vehicle maintenance process. The Federal regulations will, however, level the competitive playing field and create similar regulations for aerospace organizations in each state. California, which previously was one of the most stringently regulated states, will no longer be singularly penalized in the market place because of the added cost of environmental compliance. Because most of the compliant repaint processes are custom-designed equipment and facilities, US aerospace companies must act quickly to select and install the new processes. Graphs. 8 ref. (Morris, V.; Moving Forward With 50 Years of Leadership in Advanced Materials. Vol. 39. I. Anaheim, California, USA. 11-14 Apr. 1994. Publisher: Society for the Advancement of Material and Process Engineering, P.O. Box 2459, Covina, California 91722, USA. (1994). (Met. A., 9405-72-0392). pp. 1143-1155 [in English].)

0994 VOC ABATEMENT. [BIB-199405-57-0609]

Over the last decade, one of the leading challenges facing the rail car industry has been the abatement of volatile organic compounds (VOCs). This situation is exacerbated when coatings are applied in such non attainment areas as Harris County, Texas and the strict environmental requirements of the Texas Natural Resources Conservation Commission have to be adhered to. However, it can be shown that these requirements can be attained, within reasonable cost limits, when a proven technology such as Carbon Adsorption is adapted to the large areas utilized in rail car coatings. (Markoe, K.; Publisher: NACE International, P.O. Box 218340, Houston, Texas 77218, USA. (1994). Paper No. 594. Pp 8 [in English].)

0995 WATER-BORNE AND HIGH SOLIDS COATINGS: INNOVATIVE APPLICATIONS. [BIB-199405-57-0615]

Water-borne and high solids coatings are used for compliance to regulations that limit the amount of organic solvents that may be emitted into the atmosphere. While these products are now used generally to replace their higher VOC counterparts, a number of innovative industrial applications are showing promise due to certain unique coating characteristics. An understanding of quality requirements along with application and curing parameters is paramount to the achievement of successful service performance. Examples of coatings for Al and stainless steel shipping containers, transmission towers, and pipelines are given. (Masciale, M.J.; Publisher: NACE International, P.O. Box 318340, Houston, Texas 77218, USA. (1994). Paper No. 435. Pp 7 [in English].)

0996 BEHAVIOR OF ION VAPOR DEPOSITED ALUMINUM IN MARINE ENVIRONMENTS. [BIB-199405-58-0531]

The Clean Air Act Amendments of 1990 and pending changes in the Clean Water Act make it imperative that alternative coating systems be developed and evaluated. With this in mind, the efficacy of ion vapor deposited Al as an environmentally compliant coating for the replacement of cadmium coatings and zinc chromate primers is presented. Previous work also indicates that ion vapor deposited Al coatings provide an effective basecoat for organic topcoats such as epoxies and polyurethanes. The focus of this manuscript is to provide a review of the corrosion behavior of ion vapor deposited Al coatings as applied to steel substrates exposed to chloride containing environments. Some preliminary data on research in progress is presented and discussed. In general, Cd coatings perform better than Al coatings in neutral salt-spray testing, however, they do not perform as well as ion vapor deposited Al coatings when exposed to

SO₂ salt-spray and most outdoor environments, particularly in marine atmospheric exposure. Graphs, Photomicrographs. 35 ref. (McIntyre, J.F.; Scaturro, M.R.; Reilly, J.J.; Publisher: NACE International, P.O. Box 218340, Houston, Texas 77218, U.S.A. (1994). Paper No. 551. Pp 24 [in English].)

0997 STUDY ON A LESS SMOG AND HIGH QUALITY PASTE FOR SODERBERG ANODE. [BIB-199406-42-0507]

A less smog and high quality paste for Soderberg anode used in aluminum electrolysis was studied. The measures were modifying properties of the middle temperature pitch with air blowing and heating and reduction of the amount of the binder pitch added. The various physical and chemical properties of the raw materials and Soderberg paste were measured. The results show that the binder requirement of Soderberg paste is dependent on the paste fluidity and properties of raw materials. However, the green apparent density of the paste is only a function of the raw material properties and independent of the fluidity. 4 ref. (Cao, G.F.; Yang, T.Z.; Journal of Central-South Institute of Mining and Metallurgy (China), (Apr. 1994), 25, (2), pp. 186-190 [in Chinese]. ISSN 0253-4347)

0998 SAIL LAUNCHES ACTION PLAN TO CONTROL POLLUTION. [BIB-199406-42-0509]

The Steel Authority of India Limited has launched a massive environment management programme under an action plan involving an expenditure of Rs 1100 crores to control pollution in its five integrated steel plants. (Minerals and Metals Review, (Jan. 1994), 20, (1), pp. 40 [in English]. ISSN 0378-6366.)

0999 IRONMAKING BY SMELTING REDUCTION: AN ANALYSIS UNDER INDIAN CONTEXT. [BIB-199406-42-0510]

Smelting reduction of Fe ore has started receiving attention as a viable alternate route for ironmaking. The smelting reduction processes can be classified into three categories—single, two and three stage processes. Single stage process is carried out in a single well stirred vessel in which cold Fe ore, coal and oxygen are reacted. The gases evolved from the molten bath is post-combusted to a very high degree (approx 70%) and the post-combustion heat is sent back to the bath. FLPR is an example of this process. Two stage process is characterised by moderate degree of post-combustion of the smelter off gas (approx 50%). The post-combusted gas having lean reduction potential is used to pre-heat and pre-reduce iron oxide up to FeO stage. The pre-heated and pre-reduced iron oxide is fed into the smelter. Hi-smelt, HSC and NKK processes fall in this category. In the three-stage process, the hot smelter off gas is enriched by reacting with coal before being sent to the pre-heating and reduction unit. COREX is an example of this type of process. The efficiency of these processes increase with a rise in complications necessitated by addition of steps. The quality requirement of raw materials also become more stringent with increase in number of stages. Indian coals are characterised by high ash and high VM content. Graphs. (Ray, A.K.; Prasad, K.K.; Chaudhury, P.K.; Aeron, S.M.; Minerals and Metals Review, (Dec. 1993), 19, (12), pp. 11, 13, 15 [in English]. ISSN 0378-6366)

1000 DIRECT IRON ORE SMELTING REDUCTION, NEXT GENERATION MAKING PROCESS. [BIB-199406-42-0511]

A direct iron ore smelting reduction (DIOS) pilot plant under construction by the Japan Iron and Steel Federation (JISF) at NKK's Keihin Works has been completed. Billed as a next-generation ironmaking process, DIOS is expected to replace the current blast furnace process, allowing the use of cheaper non-coking coal with greater operational flexibility and lower production costs. The DIOS project was launched in 1988, by JISF jointly with the Centre for Coal Utilisation Japan (CCUJ), an affiliate of MITI, which partly funded the project. NKK and seven other integrated steelmakers participated in the study of elementary technologies, jointly dividing the work. (Minerals and Metals Review, (Dec. 1993), 19, (12), pp. 31 [in English]. ISSN 0378-6366)

1001 NEW GROSS ENERGY-REQUIREMENT FIGURES FOR MATERIALS PRODUCTION. [BIB-199406-42-0515]

New gross energy requirements (GER) have been calculated for 40 materials for the reference year 1988. The materials comprise metals (steels, aluminum, and copper), plastics, paper, ceramics and non-metallic minerals, wood and fertilizers. GERs are given both for the final (distinguished with respect to energy carriers) and primary energy consumption. Most of the GERs hold for Western Europe but some only apply to the Netherlands. 81 ref. (Heijningen, R.J.J.; Castro,

J.F.M.; Hazewinkel, J.H.O.; Worrell, E.; Beer, J.G.; Faay, A.P.C.; Vringer, K.; Energy, (June 1994), 19, (6), pp. 627-640 [in English]. ISSN 0360-5442)

1002 PRODUCTION OF HIGH QUALITY SINTER FROM ALL REVERT BURDENS AT INLAND STEEL. [BIB-199406-42-0520]

Changes in Inland's No. 3 sintering plant to machine, materials, and practices successfully eliminated Inland's reliance on foreign suppliers for sintering materials and increased the amount of waste oxides and fluxes recycled at the Indiana Harbor Works. Two key process changes were responsible for eliminating most of the purchased materials: a mill scale deoiling facility was constructed to enable the sintering plant to use large quantities of mill scale; high iron content fines from magnetically separated BOF slag were screened out for use in the sinter burden. Raw material costs per mg of sinter were reduced 51% in the fourth quarter of 1991 compared to the second quarter of 1989. Prior to the start of the program, reverts made up approx 46% of the sintered burden. Now, revert materials make up approx 93% of the sinter burden. Though sinter production is currently 24% less than in 1989, revert consumption is up 27% over previous levels. Graphs. 2 ref. (Horst, C.A.; Ironmaking Conference Proceedings, Vol. 51, Toronto, Ontario, Canada, 5-8 Apr. 1992. Publisher: Iron and Steel Society, Inc., 410 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1992). (Met. A., 9406-72-0462), pp. 67-71 [in English].)

1003 EOS—EMISSION OPTIMIZED SINTERING: A NEW PROCESS FOR ENHANCED POLLUTION CONTROL IN IRON-ORE SINTERING. [BIB-199406-42-0521]

Iron ore sintering entails substantial off-gas volumes, the treatment of which causes considerable cost to meet increasingly stringent environmental protection standards. The EOS process is geared to reducing the off-gas volume by 60-80% while conserving or even improving the sinter characteristics. This process opens up completely new opportunities of off-gas cleaning and leads to appreciable savings for environmental control measures. Lurgi has applied for industrial property rights to cover all process features. Graphs. 1 ref. (Cappel, F.; Weisel, H.; Ironmaking Conference Proceedings, Vol. 51, Toronto, Ontario, Canada, 5-8 Apr. 1992. Publisher: Iron and Steel Society, Inc., 410 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1992). (Met. A., 9406-72-0462), pp. 73-78 [in English].)

1004 REDUCTION OF SINTER PLANT EMISSIONS AT HOOGOVENS IJMUIDEN. [BIB-199406-42-0524]

At Hoogovens IJmuiden, Netherlands, three sinter-machines with specific suction areas of 1 x 90 m² and 2 x 132 m² produce 4 million tons of sinter/year. The burden composition of the blast furnaces is 50% sinter and 50% pellets. The pellet plant on site produces approx 4 million tons/year as well. These productions are sufficient for a pig iron production of 4 million tons. Pellets are only MgO-fluxed thus sinter basicity is relatively high (CaO/SiO₂ is approx 2.30). All plant reverts, i.e. mill scales, steel plant dusts, steel plant slags, screen offs, etc. are recirculated through the sinter plant if chemistry permits. A typical composition of the blend for the sinter plant and the chemistry of the sinter are presented. A review is given of present Dutch Government regulations and some government intentions as well as the results and conclusions of studies and tests by or on behalf of Hoogovens as a result of the environmental pressure to reduce emissions. (Keddeman, E.; Oosterhuis, E.; Ironmaking Conference Proceedings, Vol. 51, Toronto, Ontario, Canada, 5-8 Apr. 1992. Publisher: Iron and Steel Society, Inc., 410 Commonwealth Dr., Warrendale, Pennsylvania 15086, U.S.A. (1992). (Met. A., 9406-72-0462), pp. 95-100 [in English].)

1005 ENVIRONMENTAL PROTECTION IN THE SINTERING PLANT OF STEEL WORKS. [BIB-199406-42-0525]

A desulfurization plant (brought into operation in October 1976) and a denitrification plant (June 1979) having a capacity of 1 230 000 Nm³/h were installed in the sintering plant site of the Keihin Works after various fundamental tests and industrialization tests on pilot plants. These large-capacity facilities have been in operation with no serious trouble since the startup. High desulfurization and denitrification rates are constantly kept, and the reduction of quantities of produced SO₂ and NO_x is believed to be making a great contribution to environmental protection. Graphs. (Hattori, M.; Ino, B.; Kimura, K.; Matsunaga, Y.; Ironmaking Conference Proceedings, Vol. 51, Toronto, Ontario, Canada, 5-8 Apr. 1992. Publisher: Iron and Steel Society, Inc., 410 Common-

wealth Dr., Warrendale, Pennsylvania 15086, USA. (1992). (Met. A., 9406-72-0462), pp. 101-106 [in English].)

1006 THE INTRODUCTION OF $Mg(OH)_2$ TYPE DESULFURIZER IN THE SINTER WASTE GAS LINE AND OPERATION RESULTS. [BIB-199406-42-0526]

The $Mg(OH)_2$ type desulfurizer developed by Nippon Steel was introduced in the sinter waste gas line at the Tobata No. 3 Dwight-Lloyd type sintering machine in 1988. This desulfurizer is relatively small and about one-third the cost of the conventional $Ca(OH)_2$ type. At the same time, completely unattended operation of the desulfurizer has been made possible due to the lack of scaling trouble and the fully automatic operation system. Graphs. 1 ref. (Kubo, S.; Iida, T.; Sakuragi, J.; Inokunchi, K.; Kodama, I. Ironmaking Conference Proceedings, Vol. 51, Toronto, Ontario, Canada, 5-8 Apr. 1992. Publisher: Iron and Steel Society, Inc., 410 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA. (1992). (Met. A., 9406-72-0462), pp. 107-110 [in English].)

1007 ENVIRONMENTAL AND OPERATIONAL BENEFITS OF A HCN DESTRUCT UNIT. [BIB-199406-42-0570]

This paper describes the HCN destruct unit installed at the USX Clairton Works and its impact on the environment (overall sulfur emissions). The operational benefits of the installation are also reviewed. As shown in the simplified process block diagram, desulfurization facilities at the Clairton Works consist of a vacuum carbonate unit, an HCN destruct unit, parallel Claus sulfur recovery trains and a Claus tail-gas treating (SCOT) unit. The function of the vacuum carbonate unit is to remove the acid gases from the carbonate (coke oven) feed gas. The HCN destruct unit decomposes the hydrogen cyanide (HCN) in the acid gas from the vacuum carbonate unit. The Claus sulfur units recover S from the acid gas downstream of the HCN destruct unit. The SCOT unit converts S compounds in the Claus tail gas to hydrogen sulfide and recovers hydrogen sulfide as acid gas recycle to the Claus unit. Graphs. 1 ref. (Terza, R.R.; Sardesai, U.V. Ironmaking Conference Proceedings, Vol. 51, Toronto, Ontario, Canada, 5-8 Apr. 1992. Publisher: Iron and Steel Society, Inc., 410 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA. (1992). (Met. A., 9406-72-0462), pp. 493-499 [in English].)

1008 NH_3 - AND H_2S -REMOVAL FROM COKE OVEN GAS AND ITS PROCESSING. [BIB-199406-42-0571]

Numerous papers and notes have already been published on the removal of NH_3 and H_2S from coke oven gas. This paper will highlight that an economical solution to both problems can be found only if both tasks are contemplated jointly. The optimum process for the removal and processing of NH_3 and H_2S in a distinct coke oven gas cleaning facility need not necessarily be the combination of the best processes for each application for the NH_3 and H_2S treatment being contemplated. As a result of a process evaluation it can be safely stated that the A/S circulation scrubbing process is the most economic process combination for the NH_3 - and H_2S -removal in coke oven gas. This is based on the assumption, that the required H_2S concentration in the clean gas is not less than approx 15 g/100 scf. (Schupphaus, K. Ironmaking Conference Proceedings, Vol. 51, Toronto, Ontario, Canada, 5-8 Apr. 1992. Publisher: Iron and Steel Society, Inc., 410 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA. (1992). (Met. A., 9406-72-0462), pp. 501-508 [in English].)

1009 PROSPECTS FOR FUTURE IRON- AND STEELMAKING. [BIB-199406-45-0509]

Three serious issues which the steel industry needs to solve and the prospects for iron- and steelmaking in the future are discussed. The first difficulty has arisen because of the dependence of the steel industry on the use of fossil fuels and their deleterious effect on the environment. There is also a problem because the technical requirements for some steel products are becoming more stringent, with increasing demands for much lower concentrations of carbon, phosphorus and sulfur. A third major problem is that it is not economically feasible to produce high quality steel from steel scrap because of the difficulty of removing tramp metals from the scrap. Predictions are made with regard to future steelmaking technology and pollution abatement. (Graphs. 12 ref. (Fuwa, T. Scandinavian Journal of Metallurgy, June 1993), 22, (3), pp. 192-196 [in English]. ISSN 0371-9459.)

1010 CONSTEEL PROCESS SUCCESSFUL IN USA—A 120 MT/HOUR UNIT STARTED UP IN JAPAN. [BIB-199406-45-0513]

The Consteel process is a technological leap in electric steelmaking which features energy efficiency, increased productivity in the meltshop and rolling mill, improved working conditions in the meltshop, dramatic decrease in dust and gaseous emissions, and steam or energy cogeneration. The patented process consists in continuously feeding-preheating-melting and refining ferrous scrap or direct reduced iron, using the chemical and sensible heat of the furnace off-gas to preheat the scrap. Thermal incineration of the flue gas reduces harmful emissions to the level required by current worldwide regulations on environmental protection. Flue gas dust is approx 60% that in conventional electric steelmaking. The tap to tap time is set to match the cycle of the caster. A Consteel prototype was tested at the Nucor Steel plant in Darlington, South Carolina, USA. A 54 tonne/h commercial plant is in its third year of operation at Florida Steel Corporation, Charlotte, North Carolina, USA, proving the economic viability of the process. A 120 metric tonne/h plant went into operation in early October 1992 at the Nagoya works of Kyoei Steel in Japan. (Vallomy, J.A.; Fuse, T.; Nakamura, S. 4th European Electric Steel Congress, Madrid, Spain, 3-6 Nov. 1992. Publisher: UNESID CENIM SIDERINSA, Madrid, Spain. (1992). (Met. A., 9406-72-0452), pp. 39-48 [in English].)

1011 LME METALESCAUT: DIRECT CURRENT CONTINUOUS CHARGING DC3. [BIB-199406-45-0522]

The tri-electrodes arc furnace of LME Metalescaut was the first big industrial DC furnace in the world. In such system, a convergence of the arc occurs and a possible consequence is a hot spot at the center of the roof. This disadvantage was turned to account by installing a continuous feeding system of half of the scrap charge through a hole at the center of the roof. Besides the reduction of solidifications to the roof, some important production savings were confirmed: energy saving by reduction of thermal losses, time saving in relation with these losses reductions and the cancellation of half of traditional charging operations, saving of dust emissions while charging. Now, this equipment is able to produce charges of 80 tons of goods billets with a tap to tap time of 45 min. Graphs. (Lebrun, C.; Thebault, J.M. 4th European Electric Steel Congress, Madrid, Spain, 3-6 Nov. 1992. Publisher: UNESID CENIM SIDERINSA, Madrid, Spain. (1992). (Met. A., 9406-72-0452), pp. 111-120 [in English].)

1012 THE SHEERNESS SHAFT FURNACE. [BIB-199406-45-0545]

The new and unique solution of an arc furnace with integrated scrap preheating at Sheerness Steel, the so-called Ruchs Shaft-Furnace, is introduced. In a conventional arc furnace 20% of the overall energy requirement is carried away with the off-gases. The shaft-furnace has proven that approx 60% of this energy is returned into the scrap, thus reducing the melting energy requirements, therefore reducing the heat cycle and increasing the productivity by almost 20%. This contributes to an overall efficiency of the steel works and reduces environmental burden. The return of investment could be proven in some cases to be less than three years. Graphs. (Clayton, J.; Ehle, J.; Twisleton, J.; Knapp, H. 4th European Electric Steel Congress, Madrid, Spain, 3-6 Nov. 1992. Publisher: UNESID CENIM SIDERINSA, Madrid, Spain. (1992). (Met. A., 9406-72-0452), pp. 357-370 [in English].)

1013 ADVANCED ENVIRONMENTAL TECHNOLOGIES—THE BSW CONCEPT FOR ENVIRONMENTAL PROTECTION. [BIB-199406-45-0546]

BSWm Badische Stahlwerke AG, Kehl, Germany, is trying new ways to cope with the demands of environmental protection regarding noise, water treatment and exhaust gas cleaning. To reduce the noise of falling scrap at the scrap yard, a special noise protection wall was installed two years ago. The existing steelplant outside wall was coated with a new type of noise absorbing material. Regarding water supply, BSW uses, as far as possible, circuits with progressive filtration technologies, without application of any chemical additions. In January 1991, BSW started, at both ROFAFs, a new type exhaust gas system. The new system is based on an after-combustion and following fast cooling-down of the exhaust gas. Substantial advantages of this system are the extensive avoidance of formation of dioxines in furnaces, reduction of dust settling in the tube system

to a minimum as well as reduction of carbon monoxide content in the off-gas. Measurements of dioxine in the off-gas showed values with only one-tenth of the values measured before with conventional systems. With the installation of the new exhaust gas system, the existing baghouse could be reused without capacity increase of the filter area. Graphs. (Klein, K.-H.; Koster, V.; Paul, G.; Haas, J. 4th European Electric Steel Congress, Madrid, Spain, 3-6 Nov. 1992. Publisher: UNESID CENIM SIDERINSA, Madrid, Spain, (1992). (Met. A., 9406-72-0452), pp. 373-382 [in English].)

1014 A NEW SCRAP VARIETY: SHREDDED SCRAPS FROM INCINERATED DOMESTIC WASTE. [BIB-199406-45-0547]

The action undertaken since the early 1980s, by French tinplate producers, to maintain and strengthen the position of steel as a "green" packaging material, allows for the marketing of a new type of scraps, the quality price ratio of which places them in a favourable competitive position in relation to existing scrap materials. Potential deposit, through incinerated French annual household refuse, is approx 300 kt. The specifications defined, taking account of the performances made possible with a specially developed shredder mill, are as follows: magnetically separated from ashes after waste incineration; Fe % 90; density 0.9; residual content 1%, and scrap dimensions all between 10-200 mm. Today, the conditions to extend the recycling mechanism, nationwide, in compliance with the defined standards, have all been met. French territory has been divided up into six zones, whose selection criteria are based on: the importance of the deposits, the proximity of potential users; and the motivation of local decision makers and contractors. East, North and Paris areas are operating well, with one specific shredding plant each. South-East and West will join the recycling movement in 1993, then South-West in 1995. Nearly 200 kt of good scraps have been collected from incineration plants by magnetic separation to the shredder in 1991, representing 100 kt of good scraps to be consumed in steel furnaces, either EAF or BOF. All French, even all European, steel plants are concerned, but the more experienced at that step are Dunkirk and Florange Sollac's BOF steel plants; Valenciennes, Thionville, Neuvs-Maisons and Montreau Unimetal EAF steel plants; and Schifflange Arbed's EAF steel plant. Graphs. (Gros, B. 4th European Electric Steel Congress, Madrid, Spain, 3-6 Nov. 1992. Publisher: UNESID CENIM SIDERINSA, Madrid, Spain, (1992). (Met. A., 9406-72-0452), pp. 383-393 [in English].)

1015 HYDROCYCLONE TREATMENT OF ELECTRIC ARC FURNACE FLUE DUST (EAF AND EAF/AOD). [BIB-199406-45-0550]

This report presents the preliminary results obtained in the hydrocyclone treatment of electric arc furnace flue dust, designed to give a substance with higher zinc and lead contents which, after hydrometallurgical processing, can then be recovered. The first step was to determine the ideal cyclone geometry by testing internal diameters of 10 25 and 50 mm and different sizes of apex and vortex finders. This geometrical study was initially carried out using dust from carbon-steel furnaces which can be considered as representative of Spanish flue dust with a high Zn content. After establishing the optimum cyclone geometry and operating conditions (pressure and concentration of solids in fed slurry), a number of samples from different Spanish steelmaking facilities were studied (carbon, high-alloy and stainless steel plants). The results show that it is possible to increase Zn and Pb contents in the cyclone's overflow in comparison to the original metal contents of the initial dry flue dust, to give a level of non-ferrous metals of 70-80%. To reach this level, a hydrocyclone with a 50 mm internal diameter is required, with a 3.2 mm vortex finder and an 8 mm apex finder, operating at a pressure of 3.2 kg/cm² and using a fed slurry with a dry solid content equal to 34 g/l. The field of application for this process is preferably in the treatment of steelmaking flue dust with a Zn content of 20 wt.%. Graphs. 7 ref. (Sainz, E.; Lopez, F.A.; Formoso, A. 4th European Electric Steel Congress, Madrid, Spain, 3-6 Nov. 1992. Publisher: UNESID CENIM SIDERINSA, Madrid, Spain, (1992). (Met. A., 9406-72-0452), pp. 419-429 [in English].)

1016 A PYRO-HYDROMETALLURGICAL ALTERNATIVE FOR THE TREATMENT OF THE ELECTRIC ARC FURNACE DUST. [BIB-199406-45-0555]

This paper presents an alternative for the need to convert thousands of tons of electric arc furnace dust (EAFD) into an environmentally safe or economically recyclable product. Since the content of Zn in the EAFD is low and variable, though important, this work also attempts the reclamation of Zn from this waste

material. The EAFD is first subjected to a double kiln process in a rotary reactor. The calcination product shows a high and fairly constant Zn concentration and its main components are zinc oxide (ZnO), iron oxide (Fe₂O₃) and zinc-iron oxide (ZnFe₂O₄). Sulfuric acid leaching experiments were performed to search for and establish the effects of ultrasound, air bubbling rate, temperature, acid concentration and weight of calcine to acid solution volume ratio on the Zn and Fe recovery in solution and on the An-Fe selectivity index. These results led to using sulfuric acid instead of other acids for further leaching testing. Zinc sulfate solutions were cemented with Zn dust and electroized showing a current efficiency as high as 92%. Nonetheless, the presence of halogen elements in the electrolyte induced the Zn deposit to stick to the substrate. Thus, it was proven that it is possible to reclaim Zn from the electric arc furnace dust by means of a pyro-hydrometallurgical process. Graphs. 19 ref. (Godínez, J.A., 4th European Electric Steel Congress, Madrid, Spain, 3-6 Nov. 1992. Publisher: UNESID CENIM SIDERINSA, Madrid, Spain, (1992). (Met. A., 9406-72-0452), pp. 451-455 [in English].)

1017 AN ENVIRONMENTALLY SAFER AND PROFITABLE SOLUTION TO THE ELECTRIC ARC FURNACE DUST (EAFD). [BIB-199406-45-0565]

The modified Zincex process, a Spanish process, is the best solution for the secondary residue treatment regarding technical, economical and ecological areas. It is a hydrometallurgical process with atmospheric leaching, solvent extraction and electrowinning, with low capital and operating costs, and it is able to produce SHG zinc (99.99%), with high overall Zn recovery. Nevertheless, this possibility is a good solution to companies with residues such as hot galvanizing ashes, Wacely oxides, brass and bronzes residues and others. It is also a profitable solution and reliable process to the EAFD treatment. The modified Zincex process has advantages over other pyrometallurgical and conventional methods of treatment in the following aspects: higher Zn recovery, better plant flexibility, better Zn quality, better ratio gains investment costs, no problems regarding fluorine, chlorine and magnesium and environmentally safer. Experimental tests from more than ten EAFD samples of European industrial companies, and more than six weeks of pilot plant running with several EAFD sources show a high global Zn recovery with nil ecological risks. (Díaz, G.; Martín, D.; Lombra, C. 4th European Electric Steel Congress, Madrid, Spain, 3-6 Nov. 1992. Publisher: UNESID CENIM SIDERINSA, Madrid, Spain, (1992). (Met. A., 9406-72-0452), pp. 511-517 [in English].)

1018 CARBON DIOXIDE AND THE STEEL INDUSTRY. [BIB-199406-45-0636]

The main issues related to the use of CO₂ in the steel industry (levels of consumption, measures to reduce CO₂ emissions, alternatives to a carbon tax) are summarized. A quantitative analysis of carbon consumption data provided by a small sample of integrated and EAF producers is included. The data provide an interesting global overview and focus for discussion. 6 ref. (Publisher: International Iron and Steel Institute, rue Colonel Bourg, 120, B-1140 Brussels, Belgium, (1993), Pp 81 [in English].)

1019 THE PRODUCTION OF WATER-BASED SHELLS IN ONE DAY. (RETROACTIVE COVERAGE). [BIB-199406-51-1011]

The paper describes a proven method of rapid drying which enables finished water-based ceramic shell moulds to be produced in one day and reports the results of tests carried out to assess the properties of the moulds produced. Such a system affords obvious benefits in terms of reducing both lead times and production costs. Examples are illustrated of shells produced using standard assemblies supplied by three established UK foundries presently using water-based systems. Standard test-pieces were also produced using the same materials. To obtain compatible results, shells were produced by both the rapid drying method and a normally processed water-based technique. The shells were assessed at NEL's International Shell Technology Centre to determine the hot permeability, resistance to hot deformation and the overall integrity of shells so processed. Moulds were also returned to the foundries concerned for casting trials. The purpose of the trials was not only to prove the credibility of the rapid drying system, but also to study any improvement in the performance of the shells. In view of the tighter restrictions being imposed on the emission of atmospheric pollutants, these results should also be of interest to those foundries using ethyl silicate based slurries. Graphs. 5 ref. (Challinor, R.; Williams, J.V.,

Liang, W., McCallum, R. INCAST Roundup 907, Dallas, Texas, USA, 7-13 Oct. 1990. Publisher: Investment Casting Institute, 8350 N. Central Expressway, Suite M1110, Dallas, TX 75206-602, USA, (1990). Paper No. 9. (Met. A., 9406-72-0428), Pp 32 [in English].

1029 A HIGHLY CONCENTRATED COAL-WATER SLURRY BURNER. [BIB-199406-52-0815]

Based on simple introduction to the mechanical and burning properties of highly concentrated coal-water slurry (CWS) the construction and operation behavior of a newly-developed CWS burner are described in detail. In addition, the practical working performances of this kind of burner, such as combustion stability, start-up, turn down ratio, CWS nozzle durability, effect on reheating process of steels, and pollutant emission are also evaluated. The results of application show that this series CWS burners can be widely used in ordinary industrial furnaces. 7 ref. (Wang, H., Wang, S.J., Zhao, L., Iron and Steel (China), (Jan. 1994), 29, (1), pp. 62-66 [in Chinese]. ISSN 0449-749X.)

1021 ENVIRONMENTALLY COMPLIANT ADHESIVE BONDING PRIMERS. [BIB-199406-55-0832]

Several papers citing the performance of low VOC and more environmentally friendly adhesive bonding primers have been presented over the past years by suppliers to the aerospace aircraft industry. None of these primers to date has been implemented by that industry. Problems reported are they provide less corrosion protection than solvent-borne primers, at primer thickness of 0.005 mm, provide poorer humidity resistance, and greater primer thickness sensitivity in mechanical performance. Other problems reported by the industry include: increased brittleness, poorer atomization and film forming properties, a rough and grainy texture, poor oxide penetration, and they cannot be readily handled prior to curing. This paper reviews the data base and latest technology for Hysol low VOC adhesive bonding primers, addresses the above problems, and shows equivalent or improved performance when compared with industry accepted solvent-borne primers. Adherends used were 2024-T3 clad and unclad aluminum phosphoric acid anodized per ASTM D3933. Photomicrographs. 10 ref. (Browne, J.M., Cullen, R.D., Lehmann, S.L., Teschendorf, A.F., Moving Forward With 50 Years of Leadership in Advanced Materials, Vol. 39, II, Anaheim, California, USA, 11-14 Apr. 1994. Publisher: Society for the Advancement of Material and Process Engineering, P.O. Box 2459, Covina, California 91722, USA, (1994), (Met. A., 9406-72-0460), pp. 3156-3170 [in English].)

1022 ELIMINATION OF CHROMATE CONVERSION COATINGS FROM ARMY TACTICAL VEHICLE MANUFACTURING PROCESSES. [BIB-199406-57-0703]

Many US Army light tactical vehicles are fabricated from armor-grade Al. Aluminum-hulled tactical vehicles are coated with the Army's standard chemical agent resistant coating (CARC) system. The CARC system includes chemical pretreatments, epoxy primers, and polyurethane topcoats. The MIL-C-5541 chromate conversion coating pretreatment process included in the CARC specification contains hazardous chromic acid. Chromic acid is a SARA Title III extremely hazardous substance and air emissions of the material will be regulated by the 1990 Clean Air Act Amendments. In 1989, Red River Army Depot (RRAD) staff investigated replacing the hazardous chromate conversion coating with a more environmentally acceptable production process. The Army Acquisition Pollution Prevention Support Office reviewed the RRAD results and tasked Ocean City Research Corporation (OCRC) to conduct a comprehensive coating performance assessment and develop appropriate non-chromate production process control documents. The evaluation program demonstrated that chromate conversion coatings may be eliminated from Al-hulled tactical vehicle painting operations without degrading overall coating system performance. Graphs. 5 ref. (Higle, M., Moving Forward With 50 Years of Leadership in Advanced Materials, Vol. 39, I, Anaheim, California, USA, 11-14 Apr. 1994. Publisher: Society for the Advancement of Material and Process Engineering, P.O. Box 2459, Covina, California 91722, USA, (1994), (Met. A., 9406-72-0449), pp. 713-724 [in English].)

1023 CHROMATE-FREE SURFACE TREATMENT: MOLYPHOS—A NEW SURFACE CONVERSION COATING FOR ZINC. OPTIMISING THE TREATMENT BY CORROSION TESTING. [BIB-199406-57-0717]

As an alternative to chromating of electroplated Zn a new treatment has been developed. The composition of the treatment solution (molybdate phosphate ratio), the temperature and duration of the treatment were optimised using the Taguchi statistical planning and evaluating the corrosion resistance obtained in the various conditions by simultaneous CMT (corrosion measurements by titration) and EC (electrochemical measurements). Protective layers formed on Zn and also on cathodically polarised electroless nickel were analysed by Auger analysis. The Mo/P ratio is higher in the protective layer than in the treatment solution, and molybdenum is apparently present in a low oxidation state. Graphs. 9 ref. (Bech-Nielsen, G., Chorkendorff, I., Tang, P.T., Modifications of Passive Films, Paris, France, 15-17 Feb. 1993. Publisher: The Institute of Materials, 1 Carlton House Terrace, London, SW1Y 5DB, UK, (1994), Book No. 577, (Met. A., 9406-72-0456), pp. 195-197 [in English].)

1024 THERMAL SPRAYING: A REVIEW OF 1993. [BIB-199406-58-0596]

An attempt is made to give a survey of the current state of the art in the field of thermal spraying, as being reflected at the most important international events in the TS field, TS'93 and NTSC'93. Primarily, applications and new materials are focused on for two reasons. On the one hand, investigations, research work, as well as new development, must focus on new industrial applications and the improvement of existing applications. On the other hand, even thermal spraying is forced to open up new markets and find new applications for this interesting and cost-effective process. Furthermore, keeping mass production and product liability in mind, new methods of quality assurance and possibilities for in-time coating control must be found. Aside from investigations on environmental pollution caused by the spraying process, in the future there will be a large demand for research work on this matter. Graphs, Photomicrographs. 53 ref. (Steffens, H.-D., Nassenstein, K., Powder Metallurgy International, (Dec. 1993), 6, pp. 280-284 [in English]. ISSN 0048-5012.)

1025 THE DRY PURIFICATION OF FUME EMITTED FROM HOT DIP GALVANIZING. (RETROACTIVE COVERAGE). [BIB-199406-58-0619]

The fume emitted from hot dip galvanizing of steels with flux brings about severe environmental pollution. The galvanizing process and fluxes such as ammonium chloride-zinc chloride are responsible for the fume. The white fume is difficult to be dealt with, because the particles in it, have extremely small size, high viscosity, and high humidity absorption. The dry purifying method of galvanizing fume by a fabric collector is more advantageous than others. This method is performed mainly through temperature control and with the help of necessary units. Many studies and experiments on it have been carried out in recent years at Shanghai No. 3 Steel Works, and many encumbered problems have been solved. Now it has been successfully applied in the line of galvanizing sheet production of the Works for more than two years. Graphs. (Zhen, J.H., Journal of Iron and Steel Research, (Mar. 1999), 2, (1), pp. 31-36 [in Chinese]. ISSN 1001-0963.)

1026 DESIGN OF HIGH TEMPERATURE HIGH PRESSURE LARGE CAPACITY BOILER FOR HIGH RELIABILITY. [BIB-199406-61-0573]

Not only economical power generation but also the saving of fuel and for minimization of CO₂ emissions which is considered to be concerned with global warming, the improvement of the thermal efficiency of power plants is increasing in importance. Coal-fired power generation will increase its share in power generation in the future and, at the same time, the unit capacity will be increased because of the limited availability of plant sites. From the view point of operation, the plants will be fired with a wide range of coal imported from various regions of the world, satisfying the very stringent air pollution limitations and

operated in middle load mode. To meet these requirements, Mitsubishi Heavy Industries, Ltd. (MHI) has established design technology for large capacity high temperature supercritical pressure once-through boiler, developing new materials with high strength at high temperature and established technologies for application. SUS 347 HTR, SUS 310 J1TB, STPA 24, STPA 28, HCM 12A, NF 616, SUS 316 HTP, STBA 28 are discussed. Graphs. (Hisatome, M., Hishida, M., Iwanaga, A., Sada, T., Soda, M., Mitsubishi Juko Goho. (1994), 31, (1), pp. 2-5 [in Japanese]. ISSN 0387-2432.)

1027 COMPETITION BETWEEN STEEL AND ALUMINIUM FOR THE PASSENGER CAR. [BiB-199406-61-0621]

A comprehensive comparison of the relative merits of steels (e.g. EDDQ, DDQ, SPC35, SPC 40, BH 300, BH 365, BH400) and Al alloys (e.g. 6009, 6010, 6011, 6016, 2036, 2038, 2008, 5052, 5182, G4B, GZ45, KS5030, GC45, TG19, TG25, KS6183, TM17, TM02, AL2G, CV15) as materials for use in passenger cars is presented. Following an overview of the automobile industry and its markets, an investigation of required metal properties and vehicle performance is presented. Materials properties and fabrication issues addressed include formability, weldability, joinability, paintability, reparability, and recyclability primarily of sheet materials. Economic and safety considerations are also covered along with legislative requirements that influence the final selection of materials for automotive applications (especially weight reduction, emissions and fuel consumption standards). It is concluded that Al is an important competitor for steel in automotive applications, especially in the production of small series passenger cars. Graphs. (Publisher: International Iron and Steel Institute, Rue Colonel Bourg, 120, B-1140 Brussels, Belgium, (1994), (Met. A., 9406-72-6425), Pp 165 [in English].)

1028 WHY MELT CUPOLA. [BiB-199407-42-0618]

The primary driving forces leading to a shift to electric melting were environmental concerns, differential escalation of coke vs. electric energy costs and technological improvements in electric furnaces, equipment and refractories. Concurrent with the shift of some tonnage to electric melting, cupola technology also improved tremendously and this type of furnace still remains the major tonnage melter in iron foundries. Recent studies predict that during 1994 cupola melted Fe will account for 63-64% of all castings produced in US Fe foundries. Today, environmental compliance needs are catching up with electric melting processes and the Clean Air Act amendment of 1990 is substantially affecting the complexity and cost for installing and operating environmental control systems for this substantially batch type melter. Conversely, during the last 30-years, environmental controls for cupolas have been substantially improved. Further, the continuous melting nature of the cupola makes it easier to comply with the Clean Air Act needs. Today, the cupola is the more environmentally responsible type of Fe melter for both input conditions and emissions to atmosphere and its tolerance for so-called less-than-clean scrap substantially increases its competitiveness with electric melting. Cupola energy costs have been, and are now, more than competitive due to efficiency improvements and escalated electric energy costs. (Kaiser, F.T., AFS International Cupola Conference, Rosemont, Illinois, United States, 1-3 Mar. 1994, Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994), (Met. A., 199407-72-0492), pp. 1-8 [in English]. ISBN 0-87433-171-4.)

1029 CUPOLA DESIGN CONSIDERATIONS. [BiB-199407-42-0619]

Continual tightening of the environmental standards has affected the design of the cupola. Charge door openings have been reduced in size, to reduce the degree of infiltrated air, therefore reducing the amount of gases to be handled by the emission system. Stack height has also been increased to burn the gases properly. Tuvare placement and size, to achieve optimum combustion throughout the cupola, has received much attention during this period. The advent of the protruding, water cooled tuyere provided the opportunity to explore and test different approaches. The more efficient long campaign cupolas have resulted in reducing the cupola size required to provide a specific melt rate. The 100 ton/h cupola is now in production. The advent of OSHA, and the current legal atmosphere, has dictated that safety and working conditions be improved in the melting area. (Rubin, R., AFS International Cupola Conference, Rosemont, Illinois, United States, 1-3 Mar. 1994, Publisher: American Foundrymen's

Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994), (Met. A., 199407-72-0492), pp. 9-21 [in English]. ISBN 0-87433-171-4.)

1030 RECENT DEVELOPMENTS IN ELECTROMETALLURGICAL TANKHOUSE ENVIRONMENTAL CONTROL. [BiB-199407-42-0640]

A discussion of the mechanisms by which aerosols of the process electrolyte are entrained into the breathing environment of copper, zinc and nickel electro-winning tankhouses is presented. Literature outlining the health effects associated with worker exposure to the acidic and metallic contaminants found in the airborne aerosols is summarized and compared with existing North American regulations. A brief review of the existing technologies for the source reduction of the aerosols is presented and experience with use of covers, balls, beads, shapes, fixtures and chemical surfactants is outlined. Each of these devices is ranked according to its effectiveness in the process in which it is used, and rated according to its operator acceptance. The various forms of existing in-plant ventilation systems are reviewed with a discussion of their relative merits and effectiveness. Actual field experience is related, detailing the methods of testing for ambient experience is related, detailing the methods of testing for ambient contaminant levels in a variety of tankhouse environments. Guidelines are provided for the site and process specific criteria which govern the selection and ultimate effectiveness of a particular form of ventilation system. Finally, actual project experience is cited in which hydraulic modelling is used as a design tool in tankhouse ventilation design. These projects include the upgrading of existing traditional ventilation designs, and the "grass roots" design of a more efficient aerosol source control system to be used in high altitude, cold weather sites. 11 ref. (Davis, J.A.; Hopkins, W.R.; Can. Min. Metall. Bull., (June 1994), 87, (981), pp. 86-94 [in English].)

1031 A SCANDINAVIAN VIEW OF (COATED) SCRAP AND THE ENVIRONMENT. [BiB-199407-45-0661]

A lot of different actions can be taken to solve the problem of smelting of coated scrap. In the Scandinavian steel industry, scrap sorting and scrap pre-treatment are important before melting. Pre-treatment in shredders can have a great impact on the environment at EAF shops because the organic load in scrap is important. During melting, post-combustion and injection of absorbants are important. A high oxidation degree in the furnace is important but post-combustion in separate channels/chambers seems to be an expensive way of solving these environmental problems. Injection of absorbants before the filter can perhaps solve the problem with the dioxin emission and of metals like mercury. Graphs. 4 ref. (Lindblad, B.; Burstrom, .. Steelmaking Conference Proceedings, Vol. 75, Toronto, Ontario, Canada, 5-8 Apr. 1992, Publisher: Iron and Steel Society, Inc., 410 Commonwealth Dr., Warrendale, Pennsylvania 15086, United States, (1992), (Met. A., 199407-72-0474), pp. 705-712 [in English]. ISBN 0-93289-76-2.)

1032 SIDOR'S ENVIRONMENTAL QUALITY NETWORK (RED DE CALIDAD AMBIENTAL DE SIDOR). [BiB-199407-45-0708]

The pollution potential of the steel industry demands the systematic measurement of the air, water and waste disposal to assist in the development of control strategies, verify their efficiency and provide for the timely responses to any contingencies or new legal requirements. The design of SIDOR's environmental quality monitoring network and the sampling data obtained during the period from July 1990-April 1993 are discussed. The results of the program show an overall improvement of the environmental quality in the areas covered by the network and indicate the need of an improved and tighter control in the areas of raw material handling, dust generating production processes, oil, chrome and acidic waste leakage and spills and sewage treatment. The industrial landfill will also require improved operating, maintenance and operational control procedures. (Castro, E., Sidor Hoy Int., (Aug. 1993), 15, (46), pp. 35-41 [in Spanish].)

1033 EAF-DUST TREATMENT BY DC-ARC FURNACE WITH HOLLOW ELECTRODE AND NEW CONCEPT OF DUST RECYCLING. [BiB-199407-45-0712]

EAF dust generated on the steel production is classified as hazardous waste by environmental protection acts. Several dust treatment processes are being applied to fulfill both the environmental aspect and recovery of valuable metals such as iron, zinc, lead, chromium and nickel. Thus, focus was given on the

comparison of main pyrometallurgical processes which can treat dust without any pretreatment. And new concept of DC technologies and dust recycling for other applications were given and explained. Graphs. (Ban, B.C., Lum, B.M., SEAIISI Quarterly, (Jan. 1994), 23, (1), pp. 54-66, 80 [in English] ISSN 0129-5721)

1034 HEAT CURABLE EPOXY AS AN ALTERNATIVE TO TRADITIONAL SHELL RESIN PROCESSES. [BIB-199407-51-1203]

The Crowing (shell) process is widely used to make complex sand core shapes. The characteristics of the existing process include an intense ammonia-like odor during curing and possible exposure to phenol and formaldehyde emissions. After casting, shell sand may contain significant amounts of residual phenol and is often difficult to reuse without thermal processing. There has been no direct alternative for this technology since its development in Germany, just prior to World War II. The alternative technology is based on a heat curable epoxy resin-bonded sand. The new process should allow foundries to use shell, hot box or warmbox equipment and tooling to produce cores that will perform similarly to these processes. The new process was evaluated in the laboratory to determine the binder addition, sand mixing and core strength parameters. Foundry tests with new sand and waste sand were run to prove casting performance. Analytical instrumentation was used to characterize the products of combustion from the process. Both a liquid resin warmbox version and a dry, pre-coated shell version were evaluated. Waste sand from the new process is expected to be less toxic than sand from traditional shell cores. Waste sands, of several types, have been shown to be usable to make new cores. Foundries may be able to use the new process with sand normally considered as waste to produce a damp, liquid resin warmbox sand or a dry, resin-coated shell sand for making cores. This would eliminate or reduce the waste sand, the need for its disposal and the need to purchase new raw sand and new resin-coated shell sand. Graphs. Spectra. (Cobert, F.A., Transactions of the American Foundrymen's Society, Vol. 101, Chicago, Illinois, United States, 24-27 Apr. 1993, Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994), (Met. A., 199407-72-0475), pp. 275-281 [in English].)

1035 NEW INORGANIC NOBAKE BINDER SYSTEM. [BIB-199407-51-1221]

The introduction of a new phosphate-based binder system affords the foundry industry a viable alternative to conventional inorganic nobake processes for the production of ferrous castings. This two-part binder system offers considerable advantages over organic binder systems in terms of smoke and emissions at pouring and shakeout. Thermal breakdown of molds and cores prepared using this technology is considerably more facile than for conventional systems at typical binder levels. This advantage is most dramatic in comparison to silicate binder technology. Conventional mixing and molding techniques have been used to produce molds and cores of up to approx 5000 lb. Strength development of the phosphate binder technology is somewhat slower than with organic binders, necessitating attention to proper foundry practice. All understanding of this technology's potential applications is obtained through an overview of recent foundry trial applications. Graphs. 6 ref. (Adamovits, M., Barnett, K.W., Transactions of the American Foundrymen's Society, Vol. 101, Chicago, Illinois, United States, 24-27 Apr. 1993, Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994), (Met. A., 199407-72-0475), pp. 485-490 [in English].)

1036 REPLACING OZONE-DEPLETING CHEMICALS IN CORE AND MOLDMAKING OPERATIONS. [BIB-199407-51-1244]

Chlorofluorocarbons (CFCs) commonly used in the core and moldmaking operation as carriers or solvents for release agents, metal cleaners and refractory coatings are being outlawed. These products, such as methylene chloride, 1,1,1-trichloroethane and freon, deplete earth's ozone and have been targeted by all countries for elimination. As set forth by the Montreal Protocol, The U.S. as part of the 1987 Clean Air Act, set the end of 1995 as the deadline for ending the production of these chemicals. Meanwhile, the use of CFCs is becoming extremely expensive due to increases in ozone-depletion taxes and mandatory phase-out of production. The increased cost of CFCs and their ultimate unavailability are causing foundry suppliers and business to

evaluate alternative products. Fortunately, not only do alternatives exist, but in many cases these alternatives can save the foundry money if properly implemented. This paper reviews the challenges posed by eliminating CFCs from foundry operation and discusses the solutions. (Swartzlander, M.W., Martin, R.A., Transactions of the American Foundrymen's Society, Vol. 101, Chicago, Illinois, United States, 24-27 Apr. 1993, Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994), (Met. A., 199407-72-0475), pp. 797-800 [in English].)

1037 NEW INORGANIC CORE AND MOLD SAND BINDER SYSTEM. [BIB-199407-51-1251]

The properties of a new inorganic sand binder are described. This binder is a water solution of a soluble glass that is cured by blowing warm air through cores or molds to remove excess water in the binder. This results in the production of cores or molds having good strengths. This warm air-cured glass binder (WACGB) releases no organic vapors during core making or metalcasting, making it an environmentally friendly system. Core removal can be accomplished by conventional knockout methods or by using water to dissolve the binder (shown for aluminum casting). Graphs. 4 ref. (Armbruster, D.R., Dodd, S.F., Transactions of the American Foundrymen's Society, Vol. 101, Chicago, Illinois, United States, 24-27 Apr. 1993, Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994), (Met. A., 199407-72-0475), pp. 853-856 [in English].)

1038 BENCHMARKING THE NOBAKE BINDER SYSTEMS. [BIB-199407-51-1258]

The coldbox binder systems were benchmarked at the 56th World Congress in Dusseldorf, Germany. The wide variety of nobake processes available and the limited foundry experience with some of the recently introduced systems have left the metalcaster with a very difficult selection process. The objective of this paper is to benchmark the general characteristics of eight nobake processes when selecting a nobake system. The eight nobake binder systems compared in this technical offering have unique production features and environmental considerations (of gray iron and steel). Production needs, quality demands, cost and environmental considerations must be carefully studied to assure that metalcasters remain competitive. The nobake binder systems available to the metalcasting industry offer many opportunities for improvements; the challenge is in the selection process. Graphs. 22 ref. (Archibald, J.J., Transactions of the American Foundrymen's Society, Vol. 101, Chicago, Illinois, United States, 24-27 Apr. 1993, Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994), (Met. A., 199407-72-0475), pp. 967-978 [in English].)

1039 AIR EMISSIONS FROM FOUNDRIES: A CURRENT SURVEY OF LITERATURE, SUPPLIERS AND FOUNDRYMEN. [BIB-199407-51-1259]

Research on emission control and waste disposal is the number one priority within AFS. In an industry survey conducted by AFS, ten top areas of concern were outlined, headed by sand system waste and emissions from molding, pouring, melting and shakeout in iron and steel green sand foundries. The objective of the present program is to define the foundry waste streams and emissions, establish where the streams originate and their make-up. Currently available technology is identified to minimize, treat, dispose, or reuse the waste. Information obtained is summarized into a manual for use by foundry operators. Additional research and development needed to respond to environmental regulations is identified. A primary driving force for this work is the Clean Air Act Amendments of 1990, which will set new regulations for air emissions from foundries for 189 hazardous air pollutants (HAP) by 1997. This report covers the first year's research on the nature of the foundry waste streams in the form of air emissions from processes of coremaking, molding, pouring and shakeout, and establishes where they originate and their makeup. Binder chemicals are a major potential contributor to emissions from coremaking and subsequent processes. Remaining objectives will be accomplished in a further development of the program. Graphs. 26 ref. (McKinley, M.D., Jetcoat, I.A., Herz, W.J., Frederick, C., Transactions of the American Foundrymen's Society, Vol. 101, Chicago, Illinois, United States, 24-27 Apr. 1993, Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994), (Met. A., 199407-72-0475), pp. 979-990 [in English].)

1040 WASTE OR OPPORTUNITY: IT'S YOUR DECISION. [BIB-199407-51-1356]

Waterman Industries, Inc. has been in business for 80 years in Exeter, California, U.S.A. The company employs approx. 350 people in two plants, a foundry division and a water control division. The foundry produces the rough castings for the water controls division which machines, assembles, sells and delivers the finished water control units to customers all over the world. Beginning in 1989, the foundry division was virtually cut off from county and city landfills and, through changes in regulations, found itself generating "designated waste". This paper describes the many unique and profit-generating approaches used by Waterman Industries to solve a very difficult problem. (Ireland, M., AFS International Cupola Conference, Rosemont, Illinois, United States, 1-3 Mar. 1994. Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994). (Met. A., 199407-72-0492), pp. 103-112 [in English]. ISBN 0-87433-171-4)

1041 SCRAP PROCESSING TECHNOLOGIES TODAY AND IN THE FUTURE. [BIB-199407-51-1357]

In many cases, foundries spend more money for iron and steel scrap than any other purchased commodity. Because of this fact, current scrap processing techniques must be reviewed continually between the scrap processor and foundry consumer to determine if there is a way to improve quality and reduce costs to the consumer. Continuous improvements are a way of life at foundries today. This same commitment must be made by scrap processors to insure that they are supplying the best possible charge materials to the foundry industry. (Jensen, A., AFS International Cupola Conference, Rosemont, Illinois, United States, 1-3 Mar. 1994. Publisher: American Foundrymen's Society, Inc., 505 State St., Des Plaines, IL 60016-8399, United States, (1994). (Met. A., 199407-72-0492), pp. 123-131 [in English]. ISBN 0-87433-171-4)

1042 ENVIRONMENT/HEALTH/SAFETY. [BIB-199407-51-1375]

Renewed concerns for workers' health and safety have generated considerable legislation from the US Congress and stricter compliance rules from regulatory agencies. The legislation as it applies to the foundry industry is briefly reviewed. Topics covered in this review include Occupational Safety and Health (OSHA) concerns such as protective equipment and ergonomics and Environmental Protection (EPA) concerns as they relate to discharges to the air, water, and land. Solid waste disposal has become a major problem and costs the foundry industry \$451M/year. 10 ref. (Foundry Manage. Technol., (Jan. 1994), 122, (1), pp. 12-15 [in English].)

1043 ADHESIVE BONDING IN ALUMINIUM VEHICLE CONSTRUCTION. [BIB-199407-55-1106]

The case for regarding the adhesive bonding process as "ecologically sound" is presented. The basic properties of adhesives are analysed and ways in which they are used in practice to make best use of their damping and crevice corrosion prevention properties illustrated. The need for improvements in knowledge of the materials in the workplace and in the colleges and the lack of certain calculation fundamentals are highlighted. Appropriate procedures for the non-destructive testing are given. Illustrations showing the performance of joints in shear, torsion, compression, tension and peel and good and bad joint design, are presented. The long-term performance of adhesive bonds is shown to depend on the use of the appropriate pretreatment for the particular material being bonded. Improvements in shear strength and high temperature performance can be achieved through combining adhesive bonding with mechanical fastening. Graphs: 9 ref. (Diggelmann, K., Joining of Aluminium, 2nd Advanced Training Seminar, Dusseldorf, Germany, 25-26 February 1992. Publisher: Aluminium Zentrale e.v., Königsallee 30, Postfach 101262, Dusseldorf D-4000, Germany, (1992). Paper No. 10. Pp. 21 [in German].)

1044 POLLUTION-PREVENTION ANALYSIS AND THE QUENCHING OF STEELS. [BIB-199407-56-0668]

With the goal of improving process efficiency and reducing risk, a pollution-prevention analysis technique that can be applied to most secondary steel heat-treating operations involving quenching is described. Costs, risk assessments, and pollution-prevention options are discussed, as are the effects of quenching on two subsequent processes—parts cleaning and tempering. In contrast to many process comparisons, the issues of worker exposure, material safety and toxicity,

liability, waste reduction, reclamation, and disposal are emphasized. (Michels, W.H., JOM, (May 1994), 46, (5), pp. 43-45 [in English].)

1045 NEW GENERATION WATER BASED EPOXIES. [BIB-199407-57-0887]

This paper discusses modern water-based epoxies which can outperform solvent-based epoxies. Dulux AMERCOAT 149, 300 and 335 are examples of these new products. The main benefits obtained when using water-based epoxies include ease of handling and clean up. No solvents are used, which makes the products safer to use and without harm to the environment. There is no hazardous waste from washing and the materials are nonflammable. Low odour makes the products ideal for use in sensitive environments such as hospitals and food and beverage plants. These products, developed by AMERON Corporation in the U.S.A. have been used commercially for seven years in that country for food processing plants, abattoirs and nuclear power facilities. Graphs (Berger, S., Corros. Manage., (Feb. 1994), 3, (1), pp. 3-5 [in English].)

1046 POSSIBILITIES FOR THE REDUCTION OF ENVIRONMENT POLLUTION OF SURFACE TREATMENT METHODS. [BIB-199407-58-0729]

The most difficult problems of environment pollution caused by surface treatment processes are the treatment of sewage water and heavy metal containing sludge. Reviewing the possibilities of formation of dangerous materials in the course of electrodeposition, the author has described the dangerous wastages. Specific wastage, use and loss of metal and metal hydroxides formed annually are listed for electroplating shops. Possibilities for the reduction of pollution are outlined in detail. 17 ref. (Utas-Novak, Z., Korroz. Figy., (1993), 33, (1), pp. 5-8 [in Hungarian].)

1047 NEW TECHNOLOGIES TAKING PLACE OF TOXIC CADMIUM PLATING. [BIB-199407-58-0745]

The complex problem of substituting the use of Cd in the electroplating is discussed. A complex view of the ecological and technological aspects of the problem is presented. The toxic effects of Cd are described and all positive properties of Cd coatings which led to their wide use in the field of electroplating are mentioned. Finally, some alternative technologies making possible a substitution of Cd coatings are presented. Graphs, Photomicrographs: 37 ref. (Szelag, P., Kos, J., Sikac, J., Kratka, Z., Skorova, V., Strojrenstvi, (1990), 40, (9-10), pp. 544-550 [in Czech].)

1048 REGENERATION OF WASTE WATER FROM PLATING INDUSTRIES USING SOLAR STILL. [BIB-199407-58-0761]

Even though electroplating industries generate a considerable amount of wastewater which causes pollution and environmental damage it is widely practised for the purpose of producing decorative, protective and functional coatings. Various chemical and electrochemical methods have been proposed and are being used for treating these wastewaters. However, these methods are tedious and expensive and hence are not widely practised in small scale industries. The study deals with the utilization of freely available solar energy for distilling the wastewater by employing the solar stills which could be reused in the regular plating processes. Wastewater from Watt's plating process is taken as an example which is recovered and regenerated using wick type solar stills fabricated out of stainless steel. 3 ref. (John, S., Thangaveju, P., Vidyasagar, E., Veeramani, P., Raghavan, M., Trans. Met. Finish. Assoc. India, (Jan-Mar 1994), 3, (1), pp. 45-47 [in English].)

1049 CONTROL OF SECONDARY EMISSIONS IN PYROMETALLURGICAL SMELTERS. [BIB-199407-71-0277]

Existing environmental, health and safety regulations have forced pyrometallurgical facilities worldwide to drastically change some of their traditional methods of operation. In extreme cases, a number of facilities have been closed due to their inability to conform to these existing regulations. Tougher future legislation and government policy will lead to more stringent regulations and enforcement policies. The efficient control of smelter secondary emissions will, therefore, become critical to successful smelter operation. Much attention has been paid to the smelter primary process off-gas systems, including the development of new process designs. Some of the potential secondary emissions encountered in many of the present process technologies are discussed. A few of the emission sources presented are only periodic in nature, such as those caused by mainte-

nance procedures, but which have the capability of forcing smelter shut-down because of their direct impact on worker health and safety. A variety of topics relating to the efficient control, maintenance and monitoring of secondary emissions in Cu, Ni, Al, Mg, and Pb smelters, as well as in Fe foundries and steel making facilities are dealt with. Examples of the typical problems encountered in each of the above process operations are presented, including fume

control at furnace tapping and slagging locations, metal transfer stations, tapping launders, and ladle transfer operations. The parameters for the most efficient design of fume capture systems, problems encountered with the handling and clean-up of certain collected emissions, and examples of successful solutions in particular operations are discussed. 16 ref. (Davis, J.A., Taylor, J.C.; Can. Min. Metall. Bull., (June 1994), 87, (981), pp. 79-85 [in English].)

1050 THE DEVELOPMENT AND CHARACTERIZATION OF A WATER BASED SEMI-PERMANENT MOLD RELEASE AGENT. [BIB-199303-E1-D-0083]

Semi-permanent mold release agents (SPMRAs) were first developed commercially 25 years ago. A SPMRA, which is traditionally solvent based, offers composite manufacturers numerous advantages over more conventional release agents: advantages such as no contaminating transfer, minimal release agent build up on the mold and the potential of multiple releases release agent application. Recent restrictions on chlorofluoro-carbons (CFCs) and volatile organic compound (VOC) content have forced release agent manufacturers to change the solvent blend of many existing formulations. This has ultimately lead to the development of water-based SPMRAs. These water-based release agents have, by their nature, many safety and environmental advantages over solvent-based systems. However, it will be their ability to provide easy release, with no contaminating transfer, that will ultimately determine the acceptance or failure of these water based SPMRAs for aerospace composite release. This paper details the development and characterization of a water based SPMRA and compares its properties (in terms of cure time, release efficiency and degree of transfer) with two solvent based SPMRAs which are currently in use with many composite manufacturers. The advantages and disadvantages of both types of system are also discussed. Graphs 7 ref (Rigby, M., ENVIRONMENT IN THE 1990'S—A GLOBAL CONCERN, SAN DIEGO, CALIFORNIA, USA, 21-23 MAY 1991, Publisher SOCIETY FOR THE ADVANCEMENT OF MATERIAL AND PROCESS ENGINEERING, P.O. Box 2459, Covina, California 91722, USA, (1991), (Eng. Mat., 9303-G2-Z-0086), pp. 248-262 [in English])

1051 WATERBORNE, MOLD RELEASE COATINGS. [BIB-199303-E2-D-0089]

Mold release coatings are widely used as manufacturing aides in the bonding of Al alloy and E graphite or aramid fiber composite aerospace components. These coatings are applied to metal and composite tool surfaces to insure the detail sub-assemblies do not adhere to the tool surface. The critical requirements for the materials are that they must work as a release media, must tolerate the processing cure temperature range, and that they do not transfer so as to inhibit any subsequent bonding on released substrates. Current common release coatings use solvent carriers which are either toxic, contribute to stratospheric ozone depletion or are photochemical smog precursors. After screen testing several waterborne release coatings, two candidates were found to meet the minimum requirements of our release agent specification for release ease, use temperature and transfer and underwent full qualification tests. This paper discusses the qualification results of release and transfer tests conducted on those candidate materials to current Rohr Riverside requirements for mold release coatings. Upon satisfactory shop trial of each material they will be added as qualified production materials and implemented in production. 3 ref. (Werley, R.T., ENVIRONMENT IN THE 1990'S—A GLOBAL CONCERN, SAN DIEGO, CALIFORNIA, USA, 21-23 MAY 1991, Publisher SOCIETY FOR THE ADVANCEMENT OF MATERIAL AND PROCESS ENGINEERING, P.O. Box 2459, Covina, California 91722, USA, (1991), (Eng. Mat., 9303-G2-Z-0086), pp. 424-490 [in English])

1052 AN EVALUATION OF LOW VOLATILE ORGANIC COMPOUND (VOC) ELECTRIC OR RADIATION EFFECT COATINGS. [BIB-199303-E7-D-0059]

A low VOC (187 g/l) highly conductive electric or radiation effect (ER) coating has been evaluated that meets high performance missile requirements. This coating is a single component, Ag-filled, water-based polyurethane coating. Materials properties testing has shown that the electrical resistance, heat resistance, adhesion, humidity resistance, salt spray resistance, fuel resistance, and engine oil resistance of this new ER coating equals or exceeds the present state-of-the-art VOC (730 g/l) coating. Long-term exterior exposure tests are in progress at the Point Loma Ocean Systems Command beach site located in San Diego, California, USA. ER coating system configurations evaluated included (1) conversion coated Al MIL-P-85582 primer ER coating MIL-P-85582 primer MIL-C-85285 topcoat, (2) conversion coated Al ER coating MIL-P-85582 primer MIL-C-85285 topcoat, and (3) epoxy-fiberlass ER coating MIL-P-85582 primer MIL-C-85285 topcoat. This new ER coating reduces VOC emissions, is less expensive, faster curing, and has a lower electrical resistance at a coating thickness of one-half the standard high VOC coating. In addition, the low VOC ER coating is a one component coating, whereas, the

standard state-of-the-art coating is a two component coating thinned with methyl ethyl ketone. Thus, the new low VOC ER coating reduces mixing errors and coating waste due to exceeding the pot life of catalyzed coating. 5 ref. (Morris, G.R., Skrabski, W., ENVIRONMENT IN THE 1990'S—A GLOBAL CONCERN, SAN DIEGO, CALIFORNIA, USA, 21-23 MAY 1991, Publisher SOCIETY FOR THE ADVANCEMENT OF MATERIAL AND PROCESS ENGINEERING, P.O. Box 2459, Covina, California 91722, USA, (1991), (Eng. Mat., 9303-G2-Z-0086), pp. 226-238 [in English])

1053 EVALUATION OF LOW VOC COATINGS FOR AEROSPACE APPLICATIONS. [BIB-199303-E7-Z-0074]

To reduce total VOC emissions in the aerospace industry, the VOC content of many specialty coatings must be eventually lowered below existing limits. The objective of this project (jointly funded by Hughes Aircraft and South Coast Air Quality Management District) was to identify coatings with VOC content significantly below levels allowed under current SCAQMD regulations. These materials were then evaluated to conformance to aerospace performance requirements. Four coating categories were targeted for testing: (1) spacecraft coatings (general and 650 °C resistant), (2) optical anti-reflection coatings, (3) military topcoats, and (4) conformal coatings. Coatings with significantly lower VOC content than currently allowed were tested. Of these four categories, conformal coatings tested come closest to meeting all military requirements necessary for implementation. Based on physical, processing and handling properties, several of these materials can be implemented on some product lines without further testing. Few viable candidates in the other specialty categories were found in the VOC range targeted. Discussions with other aerospace users as well as resin and coating manufacturers indicate that water-borne and high solids technology is just beginning to be capable of producing coatings with sufficient properties to meet Skydrol immersion, low outgassing, and low infrared reflectance properties needed to replace existing high VOC specialty coating applications. Continued evaluation of recently developed coating technologies should produce promising high performance low VOC candidates in the near future. Graphs (Lum, J.L., ENVIRONMENT IN THE 1990'S—A GLOBAL CONCERN, SAN DIEGO, CALIFORNIA, USA, 21-23 MAY 1991, Publisher SOCIETY FOR THE ADVANCEMENT OF MATERIAL AND PROCESS ENGINEERING, P.O. Box 2459, Covina, California 91722, USA, (1991), (Eng. Mat., 9303-G2-Z-0086), pp. 93-103 [in English])

1054 PILOT PROCESS WASTE ASSESSMENT: POLYURETHANE FOAM MIXING AND CURING. [BIB-199310-C4-P-0413]

This report represents a comprehensive assessment of the process waste streams for a polyurethane foam mixing and curing process in a rigid foam molding facility. The assessment includes profiles of waste streams, mass balances, pollution prevention options, benefit analysis of the options, and recommendations. (Watson, D.R., Gov. Res. Announc. Index, (1992), DE93005484 NAB, Pp. 86 [in English], ISSN 0097-9007)

1055 ECONOMIC IMPACT ANALYSIS OF PROPOSED EFFLUENT LIMITATIONS AND STANDARDS FOR THE PLASTICS MOLDING AND FORMING INDUSTRY. [BIB-199310-E1-P-0340]

The purpose is to analyze the economic impact which could result from the application of effluent limitations guidelines and standards issued under Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act to the plastics molding and forming industry. (Gov. Res. Announc. Index, (1984), PB93-16773 NAB, pp. 81 [in English], ISSN 0097-9007)

1056 POLLUTION REDUCTION STRATEGIES IN THE FIBERGLASS BOATBUILDING AND OPEN MOLD PLASTICS INDUSTRIES. [BIB-199310-E1-Z-0351]

The book provides an overview of the industry, the incentives for pollution reduction including economic, regulatory, liability and psychological factors. Production-based pollution reduction strategies and some case studies are described for air assisted airtless spray guns, resin impregnators, resin roller dispensers, vacuum bag molding, resin transfer molding, and rotational molding. Managing contaminated solvents, facility based pollution reduction management strategies, and materials safety information are discussed. (Davis, D., Ed.,

Y.J. Gov. Res. Announc. Index, (1987), PB93-164127-NAB, Pp. 127 [in English] ISSN 0097-9007.

1057 PRETREATMENT OF POLYMERS: COLD PLASMA INSTEAD OF FLAMING. (OBERFLACHEN-VORBEHANDLUNG VON KUNSTSTOFFEN: KALTPLASMA STATT FLAMMEN.) [BIB-199312-E7-P-0216]

Many low cost industrial plastics such as polypropylene have excellent mechanical properties, but they do not provide a good adhesive base for paints and glues because of their apolar surface. Efforts to overcome this often included a combination of treatments such as flaming chemical primers and UV. These were often harmful to the environment, and the results for complex surfaces were not satisfactory. The new Balzers cold plasma technology is the solution. After two years of experience with a pilot system in France, the first production system with a capacity of 130 bumpers h was installed in August 1992 and has recently gone into production. (Strasser, G.; Steunmann, J.E., *Plastverarbeiter*, (1993), 44, (2), pp. 30-32 [in German]. ISSN 0032-1338)

1058 SURFACE TREATMENT METHODS WITH PLASMA AT LOW PRESSURES AND THEIR APPLICATIONS: ACTIVATION, DEGREASING, UPGRADING (POLYMERIZATION). (METHODES DE TRAITEMENT SUPERFICIEL AU PLASMA A BASSE PRESSION ET LEURS APPLICATIONS: ACTIVATION, DEGRAISSAGE, REVETEMENT (POLYMERISATION).) [BIB-199401-E7-P-0013]

The more people talk about non-polluting processes, the more frequently one hears the words "using plasma at low pressures". Plasma is sometimes referred to as the fourth phase. It is produced by containing a high-frequency, hyper-magnetic field. Its main industrial applications are described and discussed. The resulting grain structure may be called a fine filter medium. Gauge measurements against the various possible forms of coatings are shown in a table. The matter of assessing the degree of deviation from ideal on the finished article, is also dealt with. (Graf, H.; Surfaces, (Feb. 1992), 227, pp. 14-15 [in French]. ISSN 0585-9840)

1059 INJECTION MOLDING: CLEANING SCREW CONVEYORS AND TOOLS — FOR THE SAKE OF THE ENVIRONMENT.. (SPRITZGIESSEN: SCHNECKEN UND WERKZEUGE REINIGEN — DER UMWELT ZULIEBE.) [BIB-199402-E1-P-0070]

Screw conveyors on extrusion machines present a difficult cleaning problem. Because chemicals can cause pollution a mechanical system is preferred. This system uses a water jet carrying shot such as corundum, glass pearls, stainless steel or plastic granules. In special cases alkaline cleaning products are added. The jet operates at 400 kPa pressure. Residues are removed by flocking and filtering. (Graf, D., *Industrie-Anzeiger*, (3 Feb. 1992), 114, (6), pp. 58 [in German] ISSN 0019-9036)

1060 RECYCLING OF ELECTROSTATIC PRECIPITATOR DUST FROM GLASS FURNACES. [BIB-199403-D1-C-0344]

Electrostatic precipitators have found wide acceptance in the glass industry for abating particulate discharge from glass furnaces. In the past, the relatively small amounts involved and the difficulties in handling the very fine, low-bulk-density material have made disposal in a landfill the least expensive method. Various efforts to improve the material handling characteristics, such as pelletization and roll compression, have had only mixed success. The required equipment is expensive and has high operating costs. Increasing disposal costs, legislative penalties, and spiraling raw material costs require reconsideration of the use of electrostatic precipitator (EP) dust as a batch material. In this paper, the choice of equipment, modifications to complement the existing facility, material characteristics of the collected dust, and the process requirements for two systems are described. Both systems successfully return EP dust to the batch house for incorporation into the glassmaking process with the use of dense-phase pneumatic conveying at Niles, Ohio, and dilute-phase, negative-pressure pneumatic conveying at Lexington, Kentucky. Operational experiences since the installation are discussed. The systems are recommended as possible solutions for meeting the environmental concerns of a glass plant. (Boothe, D.T.; Severin, H.; Branc, C., 54th Conference on Glass Problems, Urbana, Illinois, 26-27 Oct

1993, *Ceramic Engineering and Science Proceedings*, (Mar-Apr 1994), 15, (2), pp. 62-72 [in English] ISSN 0196-6219)

1061 CLEAN FIRING OF GLASS FURNACES THROUGH THE USE OF OXYGEN. [BIB-199403-D1-C-0346]

Many companies are presently considering 100% oxygen—fuel firing of glass melting furnaces. The question being asked regularly is whether oxy-fuel is a niche solution to specific environmental issues or a trend that will change the primary glass melter. Several factors will ultimately determine the outcome including air quality regulations, relative costs of electricity and natural gas, advancements in air separation, as well as the technical results achievable in glass melting. 3 ref. (Eleazer, P.B.; Slavejkov, A.G., 54th Conference on Glass Problems, Urbana, Illinois, 26-27 Oct. 1993, *Ceramic Engineering and Science Proceedings*, (Mar-Apr 1994), 15, (2), pp. 159-174 [in English] ISSN 0196-6219)

1062 CLEAN AIR ACT AMENDMENTS NO_x COMPLIANCE REQUIREMENTS—GLASS INDUSTRY. [BIB-199403-G1-C-0026]

This paper simplifies the understanding of the NO_x compliance requirements by summarizing requirements in a four-box matrix. To understand the impact of these regulations on a facility, one must know its location (attainment or nonattainment area) and whether the generating source is an existing or a new modified source. Additionally, one must understand the significant differences between the three levels of control technology required: reasonably available control technology (RACT), best available control technology (BACT), and lowest achievable emission rate (LAER). This paper explains these relevant terms and, through the use of a four-box matrix, explains requirements for existing major sources (due by 31 May 1995) and for new modified sources. (Gallo, A.J., 54th Conference on Glass Problems, Urbana, Illinois, 26-27 Oct. 1993, *Ceramic Engineering and Science Proceedings*, (Mar-Apr 1994), 15, (2), pp. 112-117 [in English] ISSN 0196-6219)

1063 WATER THINNABLE LACQUER SYSTEMS FOR PLASTIC ITEMS. (WASSERVERDUNNBARE LACK-SYSTEME FÜR KUNSTSTOFFTEILE.) [BIB-199405-E7-P-0114]

Lacquering of plastic materials is frequently encountered in the car industry and is attaining increased importance with the spread of recycling. Considerable advances have been achieved in the development of water based lacquering systems. The authors review some of these advances with reference to hydro priming, hydro based lacquers, hydro clear lacquers, and hydro single layer lacquers, citing the actual compositions. The ecologically favourable low contents of organic solvents in these lacquers is somewhat offset by the problems in drying water from the sprayed items. This aspect as well as suitable equipment for coating and cleaning finished items are fully discussed. (Ritter, R.; Hirnann, U., *Oberfläche JOT*, (Dec. 1993), 33, (12), pp. 28-32 [in German] ISSN 0170-4044)

1064 ENVIRONMENTALLY CONSCIOUS MANUFACTURING OF COMPOSITE STRUCTURES. [BIB-199406-E2-D-0278]

Organic matrix composite structures provide enhanced performance capabilities for the most current US Department of Defense (DOD) weapon systems and many commercial applications. Defense and commercial applications are continually calling for lower priced components. One method to reduce cost is to reduce waste. Environmental issues must be addressed to improve the cost, reliability and future existence of composites manufacturing. Environmentally conscious manufacturing takes into account all aspects of the manufacturing process with a focus on waste minimization and acceptable disposal methods. Many composite fabrication processes were assessed from incoming materials to final part inspection. This assessment examined the types of materials used and released during composites processing. Furthermore, a quantitative assessment investigated the quantities of materials and the costs related to acquisition, disposal, recycling, reuse, and waste management. Major cost drivers were identified for future development work. Environmentally conscious manufacturing is a cost issue, which, when more completely addressed will enhance the competitiveness of the composites fabrication industrial base and the cost of products to the US Department of Defense and commercial customers. (Gephart, J.; Lawwiller, P.B., *Moving Forward With 50 Years of Leadership in Advanced Materials*, Vol. 9, L. Anaheim, California, United States, 11-14 Apr

1994, Publisher: Society for the Advancement of Material and Process Engineering, P.O. Box 2459, Covina, California 91722, United States. (1994). (Eng. Mat., 9406-G2-D-0150), pp. 1171-1182 [in English].)

1065 HOW DO POLYMERS FIT INTO THE ENVIRONMENTAL EQUATION? [BIB-199408-D1-P-1349]

The use of polymers has made and is making a very significant, positive contribution to the conservation of resources and the effort to protect the

environment. In general, both re-use and recycling will conserve material resources but are likely to be out-weighted by other environmental losses. When it comes to the question of disposal, there is no single right solution. (Can. ... Materials World, (June 1994), 2, (6), pp. 303-305 [in English], ISSN 0967-8638)

1066 RECOVERING HEAVY METALS. [BIB-199301-G1-0007]

Heavy metals are essential in the manufacture of such products as automotive batteries and fluorescent lights and in many industrial processes. As a result, the presence of these materials in factory waste, scrapped products, or contaminated waste sites poses a major disposal problem for manufacturers. The problem with heavy metals is that they are indestructible. Even in a dilute form, metals such as Pb are toxic to humans. If they are ingested by aquatic life in contaminated water they will continue up the food chain to human beings. Equipment and processes to recover heavy metals from post-consumer trash, factory waste streams, and wastes sites are continually under development by environmental engineers. Heavy metals are recycled, rendered nonhazardous, or concentrated for landfilling, depending on the cost of disposal. (Valenti, M.; MECHANICAL ENGINEERING, (DEC 1992), 114, (12), pp. 54-58 [in English]. ISSN 0025-6501)

1067 "GREEN" LAW STUDY PLANNED. [BIB-199301-G4-0001]

Coopers & Lybrand, the accountancy firm, and the Metals and Minerals Research Services consultancy organisation, have set up a joint venture to monitor all aspects of environmental laws worldwide to assess the impact on Cu, Pb and Zn production. The venture springs from a comprehensive review by MNRS completed in July 1992, which examined 700 pieces of legislation and came to the unsettling conclusion that the three base metals industries would have to find at least US\$6B to comply with existing environmental laws. (Gooding, K.; FINANCIAL TIMES, (27 OCT 1992), pp. 34 [in English].)

1068 CALIFORNIA MOLDER SWITCHES TECHNOLOGY TO MEET STIFF LOCAL AIR REGULATIONS. [BIB-199301-P4-0002]

To comply with the South Coast Air Quality Management District's (SCAQMD) Rule 1175, Western Insulfoam's block molding plant, Chino, California, USA, was faced with the requirement to reduce pentane emissions by up to 95%. SCAQMD 1175 regulates emissions of volatile organic compounds (VOCs). Western Insulfoam is a division of Premier Industries, Tacoma, Washington, and a maker of EPS block molding for construction, packaging and flotation applications. The company purchased a new batch pre-expander, made by AMD, Filago, Italy, which it says gives precise control of the EPS expansion process. Also a pentane recovery system manufactured by Elliot Thermodynamics, Laguna Hills, California, serves as an extension of the pre-expansion and molding process, reportedly destroying pentane emissions at a 99% efficiency rate. Further emission reductions are being achieved by using BASF's Styropor BFL low-pentane resin. (PLAST. ENVIRON., (27 NOV 1992), pp. 2 [in English].)

1069 CLEAN WATER ACT MAY TAKE CENTER STAGE. [BIB-199301-P4-0003]

In the US, overhauling the Clean Water Act may become a congressional priority because of its potential to do double service on President-elect Bill Clinton's agenda. Because drainage and sewer projects probably would be part of a new Clean Water Act, industry and environmental lobbyists alike believe Clinton may want to push such a bill to meet his dual campaign aims of pollution cleanup and economic revival through public spending. While it is not known what provisions a renewed Clean Water Act would include, possible limits on toxic industrial discharges, mandated pollution-prevention plans and ground-water monitoring could spell new responsibilities for processors. But industry representatives say they are heartened by a heightened focus on pollution caused by urban and agricultural runoff, called non-point-source pollution. (Gardner, J.; PLASTICS NEWS (DETROIT), (30 NOV 1992), 4, (40), pp. 3 [in English]. ISSN 1042-802X)

1070 LTV STEEL REDUCES TOXIC EMISSIONS BY 23 PERCENT. [BIB-199301-S4-0004]

LTV Steel Co. reduced toxic chemical releases by its manufacturing plants by 23%, or 2.3 million lb, in 1991-1992 was the third consecutive year for which it reported improvement, under the Superfund Amendments and Re-authorization Act of 1986 (SARA). Since 1989, LTV Steel has reduced air emissions by 36%, water emissions by 48% and releases to land by 20%. (AMERICAN METAL MARKET, (8 DEC 1992), 100, (236), pp. 4 [in English]. ISSN 0002-9998)

1071 COKE PRODUCERS INK HISTORIC ENVIRONMENTAL PACT. [BIB-199301-S4-0005]

American metallurgical coke producers, in late October 1992, agreed to comprehensive regulations called for by the 1990 Clean Air Act that established maximum emission limits for coke oven operations. Under the pact, coke oven emissions will be reduced by an additional 90% from present levels, which already have gone through an earlier 90% reduction. Coke-producing members of the American Iron and Steel Institute (AISI) and the American Coke and Coal Chemicals Institute (ACCCI) signed the agreement with the US Environmental Protection Agency, environmental groups, state and local air pollution control officials, and the United Steelworkers union. (IRON AND STEELMAKER, (DEC 1992), pp. 12 [in English]. ISSN 0097-8388)

1072 PYROMETALLURGICAL TREATMENT OF STEEL-PLANT DUSTS. [BIB-199301-S4-0006]

The Enviroplas process, which is currently under development at Mintek, South Africa, is a plasma-arc process that can treat EAF dust, alloy-steel dust, or a mixture of both. A non-toxic slag is produced, together with a mixture of Pb and Zn oxides and/or an alloy containing Cr and Ni. To date approx 100 t of Pb blast-furnace slags and steel-plant dusts have been processed at various pilot scales up to 1MW, and the process is at present being further developed to recover metallic Zn directly in a Pb splash condenser. It appears that the proposed units could be operated profitably, even without taking the avoided costs of disposal into account. (STEEL TIMES INTERNATIONAL, (NOV 1992), 16, (6), pp. 31 [in English]. ISSN 0143-7798)

1073 SAVING THE ENVIRONMENT CAN SAVE ENERGY. [BIB-199301-S4-0007]

A close symbiosis exists between controlling gaseous pollutants and saving energy. This article examines the relationship between environmental control and energy use, and although the cases studied are in Europe, the same advantages will be found anywhere. The need for internationally agreed objectives on air pollution is also emphasised. (Pronk, K.; STEEL TIMES INTERNATIONAL, (NOV 1992), 16, (6), pp. 37, 40 [in English]. ISSN 0143-7798)

1074 HOW GREEN IS MY STEELWORKS? [BIB-199301-S4-0008]

The complexity of production processes which comprise a modern Fe and steel plant offer many opportunities for optimising by-product use through waste minimisation. But inevitably there remains a certain degree of final waste which must be disposed of. An environmental audit can be used to establish just how efficient a works is at minimising its waste output. (Miles, A.J.; STEEL TIMES INTERNATIONAL, (NOV 1992), 16, (6), pp. 38 [in English]. ISSN 0143-7798)

1075 TWO ROUTES TO MORE ECOLOGICAL STEELMAKING. [BIB-199301-S4-0009]

Although steelmaking is a trend-setter regarding both recycling techniques and energy recovery systems, there is still some potential to further improve economical and ecological harmony in the iron and steel industry. Greater industrialisation and shortages of disposal sites were the reasons that legislators began to draw up stricter laws for industrial companies. This article gives three examples of technologies which can make the further improvements which are still possible. (Strohmeier, G.; STEEL TIMES INTERNATIONAL, (NOV 1992), 16, (6), pp. 30-31 [in English]. ISSN 0143-7798)

1076 DUST CONTROL AGENT. [BIB-199301-S4-0011]

SOIL-SEMENT dust retardant control technology from Midwest Industrial Supply, Inc. is available for management of PM₁₀ fugitive emissions, compliance with new clean air regulations and storage pile leachate control, without causing any adverse effect on soil and water quality. With the several national and state environmental statutes that exist, SOIL-SEMENT permits a comprehensive program of dust control and coal stockpile leachate and runoff control which protects air, water and soil. SOIL-SEMENT does not contribute any pollutant regulated by the NPDES (stormwater runoff) program and will actually reduce pollutants by reducing Total Suspended Solids (TSS) present in runoff. (IRON AND STEEL ENGINEER, (DEC 1992), 69, (12), pp. 54 [in English]. ISSN 0021-1559)

1077 NO_x RULES IN 1990 CLEAN AIR ACT AMENDMENTS—IMPLICATIONS ON COKE INDUSTRY. [BIB-199301-S4-0012]

Promulgation of the 1990 Clean Air Act Amendments has instituted a need by control agencies for the quantification and possible control of NO_x emissions from sources identified in nonattainment areas for ozone. A total of 25 of the 32 operating coke plants are located in areas that are qualified as nonattainment. These facilities will be required to provide emissions inventories to the respective control agencies by 15 November 1993. Plants located in some nonattainment areas will be required to reduce NO_x emissions to a level corresponding to ozone attainment for the air shed. The coke industry is in need of adequate emissions factors for use in calculating the baseline (1990) emissions from which reductions will be enforced. (Jr., J.T., IRON AND STEEL ENGINEER, (DEC 1992), 69, (12), pp. 17-19 [in English]. ISSN 0021-1559)

1078 JAPANESE STEELPLANTS GO GREEN. [BIB-199301-S4-0013]

Environmental compliance is now seen as one of the most important issues for Japanese steelmakers. The industry's fundamental policy is to study environmental concerns before undertaking any new corporate activity, a policy which will obviously require close management and explicit rules. Japan is also contributing internationally through the Environmental Issues Committee of the International Steel Association. Japanese steelmakers have established technology alliances with many overseas firms, the Federation providing developing countries with training programs for environmental protection specialists in their steel industries. (METAL CASTING AND SURFACE FINISHING, (SEPT-OCT. 1992), 38, (9-10), pp. 10-11 [in English]. ISSN 0008-7521)

1079 BIODEGRADABLE PLASTIC ALLOY PROTECTS STEEL. [BIB-199301-S4-0014]

A relatively low-cost biodegradable plastic has been developed by researchers from Sumitomo Metal Industries Ltd., and Tokyo Institute of Technology. The polymer alloy consists of approx 40% bacteria-based and 60% synthetic-based polymers. Its strength and density are said to be similar to those of polyethylene. When buried in soil, however, it decomposes three to four times faster than conventional (and more costly) biodegradable plastics, which are 100% bacteria-based. Sumitomo is developing the material as a green alternative to the plastics used to protect pipes, coated sheets, and other steel products from corrosion during sea voyages and damage during handling. (ADVANCED MATERIALS & PROCESSES, (DEC 1992), 142, (6), pp. 13 [in English]. ISSN 0882-7958)

1080 THEISEN SLUDGES IN THE MANSFELD DISTRICT—RECYCLING OR DISPOSAL? A PROPOSED CONCEPT FOR RECYCLING. (THEISENSCHLAMME IM MANFELDER REVIER, VERWERTUNG ODER DEPONIERUNG? EIN KONZEP-TVORSCHLAG ZUR VERWERTUNG.) [BIB-199302-G1-0043]

In the 1980s, the Mansfeld mining combine—still under GDR control—requested from the metallurgical branch of Lurgi AG in Frankfurt the development of a concept of utilization of Pb, Zn and Ge contents of the Theisen sludges. Initially, the costs were judged to be too high for the expected yield. Owing to the environmental protection laws of the FRG, Lurgi AG and Mansfeld AG have expanded the original concept of exploiting the Theisen Sludge. Emphasis has been placed on waste gas purification, and in particular on dioxide retention. In the conceptualized recycling process described, the principal areas highlighted are: mining, transfer, ore dressing and concentration, roasting, postheating and purification of the roast gas and sulfonic acid recovery. The capacity of the installation, waste disposal costs and time span for planning, installation and start of operation are also covered. (Lorenz, R., Tacke, M., Hartman, F., Wetlandt, E., METALL, (SEPT. 1992), 46, (9), pp. 955-957 [in German]. ISSN 0026-0746)

1081 LEAD-FREE BRASS PASSES TEST. [BIB-199302-G1-0051]

The recyclability of a new Pb-free brass alloy has been demonstrated in trial melts of 800 lb each, according to AT&T Bell Labs, Murray Hill, New Jersey, USA. AT&T said it was recently granted a US patent for a family of Pb-free brass alloys that offer promise in eliminating potential drinking-water problems caused by Pb leaching from brass plumbing fixtures. (Worden, J., AMERICAN

METAL MARKET, (22 DEC 1992), 100, (246), pp. 9 [in English]. ISSN 0002-9998)

1082 "SO GREEN IS THE COUNTRY"—ZINC MINING IN IRELAND AT THE TARA MINES LIMITED. ("SO GRÜN IST DAS LAND"—ZINKBERGBAU IN IRLAND—DIE TANA MINES LIMITED.) [BIB-199302-G1-0061]

In the center of Ireland lies Europe's largest Zn mine operated by Tara Mines Ltd, a subsidiary of the Finnish concern Outokumpu. The ore is mined in open pit and passed through crushers at 300 m depth. The comminuted ore is brought to the surface for processing, i.e. grinding, concentrating and drying. The annual production from 2.5 million tonnes of ore at Tara is approx 340 000 t Zn concentrate with approx 55 wt.% Zn content and approx 10 000 t Pb concentrate with approx 60 wt.% Pb content. All operations in the mine and concentration plant are characterized by the latest technical advances and a high degree of automation. Air, water and soil contaminations as well as noise pollution are subjected to strictest controls. Tara Mines is convinced that early consideration of environmental protection has already resulted in a handsome pay-off. (METALL, (SEPT. 1992), 46, (9), pp. 958-959 [in German]. ISSN 0026-0746)

1083 LUBRICATION SYSTEM FOR NON-FERROUS MACHINING. [BIB-199302-G4-0006]

It is claimed that, following extensive trials in the Netherlands and Germany, Niels Nederland bv has introduced Niels—a new generation environmentally friendly spray lubrication system for non-ferrous metals. The firm claims that with enhanced consideration for the environment, this system will uprate production involving cutting and non-cutting processes—i.e. reduced use of lubricants, no chemical waste and no water or air pollution. The Niels system works on air oil mixture which also provides a cooling effect. It can use environmentally friendly oils and is said to be easy to install on virtually all machines. Tool life is extended, and a dry product and swarf are obtained with improved surface finish, and cleaner machines. (METALS INDUSTRY NEWS, (DEC 1992), 9, (4), pp. 11 [in English]. ISSN 0265-8321)

1084 ENVIRONMENTAL POLICIES PUT THE US NONFERROUS METAL INDUSTRY UNDER PRESSURE—ON CURRENT DEVELOPMENTS IN LEGISLATION. (DIE NE-METALLINDUSTRIE IN DEN USA UMWELTPOLITISCH UNTER DRUCK—ZUR AKTUELLEN ENTWICKLUNG IN DER GESETZGEBUNG.) [BIB-199302-G4-0008]

A debate about environmental problems is presently going on in the US, the outcome of which could have far reaching consequences in the country's nonferrous metal industry. After the recently passed modified version of the Clean Air Act, the debate in Congress focusses on the possible enactment of a modification of the Resource Conservation and Recovery Act (RCRA). The treatment and disposal of solid wastes is its principal objective. The continuing debate over the RCRA and its consequences also delays ratification of the Basel Convention by the US Congress. The impact of the latter on the American transport of potentially hazardous materials that are destined for recycling is one of the issues confronting the US Government. The major part of the article is devoted to the most important problems faced by the individual non-ferrous metal industries, i.e. those producing or dealing in Al, Cu, Pb, Ni, Zn, Hg and precious metals. (Abrahams, A.E., METALL, (SEPT. 1992), 46, (9), pp. 963-965 [in German]. ISSN 0026-0746)

1085 EPA PUBLISHES MACT SCHEDULE. [BIB-199302-D4-0004]

On 24 September 1992, the US Environmental Protection Agency published a list of industry categories, and the dates by which the agency is to establish Maximum Achievable Control Technology (MACT) standards for each category. MACT standards for the Reinforced Plastics Composites Production category are due by 15 November 1997. Assuming that EPA keeps to this deadline, this means that composites manufacturing facilities will have until 15 November 2000 to comply. The MACT standard for composites will be developed by EPA's Office of Air Quality Planning and Standards. Funding for the composites project is expected to be received in late 1993 or 1994. (Schweitzer, J., FIBER COMPOSITES, (DEC 1992-JAN. 1993), pp. 8 [in English].)

1086 EPA TARGETS COMPOSITES [BIB-199302-D4-0005]

The US Environmental Protection Agency's Source Reduction Review Project (SRRP) is targeted at reducing emissions at the source (rather than capturing and/or destroying the emissions) in several industries, including composites manufacturing. The SRRP is an activity of the EPA Pollution Prevention Policy Staff (PPPS), and functions by bringing the resources of two EPA divisions, the Office of Research and Development (ORD) and the Office of Pollution Prevention and Toxicity (OPPT), to bear as the agency develops control technology standards for a given industry. In the case of the US composites industry, these control technology standards, or MACT (Maximum Achievable Control Technology), will be developed by EPA's Office of Air Quality Planning and Standards (OAQPS). As OAQPS develops MACT for composites, the SRRP will involve the ORD and OPPT to insure that the standards takes maximum advantage of source reduction opportunities. (Schweitzer, J.: *CI ON COMPOSITES*, (DEC. 1992-JAN. 1993), pp. 8 [in English].)

1087 US EPA BANNING CFC-CONTAINING FOAMS [BIB-199302-P4-0009]

The US Environmental Protection Agency on 4 January 1993, announced the final rule banning the sale of plastic foams that use chlorofluorocarbons as a foaming agent. The rule, which will be effective one year after it is published in the Federal Register, implements a section of the Clean Air Act of 1990 that bans non-essential products that contain the ozone-depleting chemicals CFCs, halons, carbon tetrachloride and methyl chloroform. Rigid and flexible plastic foams, made for packaging, insulation and other applications, sometimes use CFCs in manufacturing. Because EPA believes viable substitutes for CFCs are available in those applications, however, plastic foams qualify as a non-essential product. (PLASTICS NEWS (DETROIT), (11 JAN. 1993), 4, (45), pp. 3 [in English], ISSN 1042-802X)

1088 OUTLINES OF DEVELOPMENT OF METALS PRODUCTION AND METALLURGICAL PROCESS TO THE NEXT CENTURY. [BIB-199302-S3-0053]

Metallurgical industry is in front of big challenges in the opening of the new century. Threats and challenges at metals production are not so much in eventual shortage of raw materials and energy or competition against other materials, but rather in rapidly increasing demands to solve evergrowing energy and environmental problems. Metals have, in general, good possibilities to maintain their position as central materials in engineering and technology due to their relatively big production volume, efficient production technologies, and reasonable price to properties ratio. Supply of primary raw materials is not threatened in the near future and recycling is able to satisfy a growing share contemporary and future metallmaking. Environmental effects of metals and energy production and usage form a great challenge for metallurgists in the turn of the next century. Process development in Fe and steelmaking as well as in nonferrous metals production aims at energy saving and efficient, direct utilization of energy by developing direct and intensive smelting processes, casting methods and by utilizing in full amount the latent and sensible energy of raw materials, intermediate and final products, off gases and wastes. Environmental protection by safe elimination or recovery and usage of harmful byproducts and wastes will be a very essential task in the development of metallurgical processes and the energy production for it. Through progress in metallurgical processes is still mainly directed toward more efficient utilization of coal as a basic energy source, the usage of natural gas as a less CO₂-emitting energy form and the goal of hydrogen economy shall not be out of the scope. (Holappa, L.E.K.; Jalkanen, H.K.: *MATER. SOC.*, (1991), 15, (4), pp. 423-447 [in English], ISSN 0146-6399)

1089 CANADIAN STEEL STUDY TARGETS WASTE ISSUES. [BIB-199302-S4-0017]

The Canada Centre for Mineral and Energy Technology (Canmet), Ottawa, Canada, has chosen Alternative Industrial Marketing Resources to research the Canadian steel industry specifically related to the generation of by-product wastes by Fe and steel producers. The generation of the by-product wastes is an increasingly critical issue for the industry due to a number of factors, including more-stringent environmental regulations. (AMERICAN METAL MARKET, (5 JAN. 1993), 101, (2), pp. 4 [in English], ISSN 0002-9998)

1090 LOW NO_x REGENERATIVE BURNER. [BIB-199302-S4-0018]

A joint development project between British Gas and Hotwork Development has resulted in maintaining the efficiency of a regenerative burner out without the penalty of the higher NO_x emissions normally associated with combustion air preheat. (STEEL TIMES, (DEC. 1992), 220, (12), pp. 572 [in English], ISSN 0039-095X)

1091 RECOVERY OF ZINC FROM EAF DUST BY ELECTROWINNING. [BIB-199302-S4-0019]

The modified Zincex process offers a hydrometallurgical alternative to existing pyrometallurgical techniques to recover Zn from EAF dust and render the residue safe for disposal. The process is currently being developed by Tecnicas Reunidas, Spain, under an EC sponsored programme. (STEEL TIMES, (DEC. 1992), 200, (12), pp. 567-568 [in English], ISSN 0039-095X)

1092 FIFTH OF FURNACE COST ON POLLUTION CONTROL. [BIB-199302-S4-0021]

The rebuilding of Port Talbot's, UK, No. 4 blast furnace incorporated not only today's environmental standards but those anticipated during its expected campaign life of more than ten years. The initial cost of the project was increased by one-fifth by incorporation of pollution control equipment. The furnace is fitted with the latest process control systems which contribute to an improved fuel efficiency for both the furnace and the hot blast stoves which heat blast air on its way to the furnace. As part of the project, a new blower, of the latest energy efficient design, was installed. (STEEL NEWS (BR. STEEL STRIP PROD. WALES), (DEC. 1992), (14), pp. 7 [in English].)

1093 OXY/FUEL MELTING OF SECONDARY ALUMINIUM. [BIB-199303-G1-0077]

Brock Metals has commissioned an innovative melting furnace for turning scrap Al into ingots with optimum energy efficiency and low pollution. The new plant not only handles organically contaminated material but uses any hydrocarbon based coatings on the scrap as an additional source of fuel. This contamination would be emitted as heavily polluting fumes after partial combustion in a conventional furnace and the cost of cleaning such fumes would inhibit the use of the contaminated scrap. (Fianagan, J.: *ENERGY MANAGEMENT*, (JAN-FEB. 1993), pp. 15 [in English], ISSN 0141-9218)

1094 THE 1990S: THE ENVIRONMENTAL DECADE. [BIB-199303-G4-0014]

Copper, Pb, and Zn producers in what was the non-Socialist world are embarked on mine and plant upgrading programs to comply with environmental legislation which will cost \$6 billion. This is one of the conclusions of Metals & Minerals Research Services' recent multi-client report An Environmental Audit of Base Metals Industries. Some metal producers will simply not be able to financially meet the latest actual or proposed environmental legislation while others will be technically unable to do so. Either way, the result will be profound market instability as the supply sides of the Cu, Pb and Zn industries feel the impact of mine and plant closures. (Hobson, S.: *ENGINEERING AND MINING JOURNAL*, (JAN. 1993), 194, (1), pp. 30-31 [in English], ISSN 0095-8948)

1095 ENVIRONMENTAL PROTECTION IN THE BASE METALS SECTOR—EMISSIONS, RELATIONS, AND AMBITIONS. [BIB-199303-G4-0015]

Environmental protection in the base metals sector has progressed appreciably world wide over the last three decades. Sweden's contribution to ecology in metallurgy can be seen at the Boliden Pb—Zn works in Ljusval and a smelting works in Ronnskar. (Panan, P.G.: *BERGSMANNEN*, (1992), (6), pp. 7-10 [in English], ISSN 0284-0448)

1096 CALIFORNIA TIGHTENS PARTICLE EMISSIONS. [BIB-199303-G4-0017]

California USA, metal processing companies are facing new regulations that will require some facilities to cut their emissions by as much as 95% to reduce the risk of cancer. Often added to nonferrous metals such as Al and brass to

improve appearance or durability, the compounds are released into the air when the materials are reheated during recycling. They also are contained on particles flowing from dust piles in metal processing facilities. (Goodwin, M.E.; AMERICAN METAL MARKET, (26 JAN. 1993), 101, (16), pp. 4 [in English]. ISSN 0002-9998)

1097 VOLUNTARY PROGRAM TO PREVENT POLLUTION. [BIB-199303-P4-0013]

The US Environmental Protection Agency has proposed a voluntary pollution-prevention program that could ease permit review and reporting requirements for participating processors. In one of its last acts during Administrator William Reilly's tenure, the agency on 15 January published its proposal for the Environmental Leadership Program in the Federal Register. The program would recognize companies and manufacturing plants that have shown their top officers are committed to reducing pollution at its source. To qualify, companies would be expected to have a record of compliance, open their pollution-reduction programs to public scrutiny, submit plans to meet goals and to measure progress in reducing the impact of manufacturing processes and involve employees and community members. (Gardner, J.; PLASTICS NEWS (DETROIT), (1 FEB. 1993), 4, (48), pp. 8 [in English]. ISSN 1042-802X)

1098 EPA TO LIST SAFE CFC ALTERNATIVES. [BIB-199303-P4-0014]

Last fall, the US EPA created a preliminary policy aimed at governing the use of CFC alternatives. Labeled the Significant New Alternatives Policy (SNAP), the final version is set to go into effect this fall. Under the ruling, numerous HCFCs, HFCs and water-based blowing agents will be deemed either acceptable or unacceptable based on their ozone-depletion and global-warming potentials, flammability and chemical toxicity. Separate listings will be issued for blowing agents used in rigid and flexible polyurethane foams, PUR integral-skin foams, polystyrene extruded insulation board and sheet, phenolic foam insulation board and polyolefin foams. (Monks, R.; PLASTICS TECHNOLOGY, (FEB. 1993), 39, (2), pp. 95 [in English]. ISSN 0032-1257)

1099 FIRST JOINT ENVIRONMENTAL CONSULTANCY FOR CHINA. [BIB-199303-P4-0016]

China's first joint venture environmental consulting firm, Environomics, formed with \$100 000 from Chinese and US investors, will begin doing business in March. The chemical industry is the foremost source of emissions of toxic substances such as Hg, phenol, and Cr; it also emits one-third of all industrial wastewater in the country, according to a May 1992 Ministry of the Chemical Industry report. Demand for ozone-depleting chlorofluorocarbons, without any change in technology, is set to triple by 2000. Solid waste treatment, isolation, and incineration ventures involving US and Australian firms are under negotiation. US multinational consulting firm Ecology and Environment (E&E), is also considering a joint venture. The part of the mandate of the firm is to train an expert Chinese consulting sector that will be able to spot opportunities to cut waste and improve efficiency. In 1993, the World Bank will start a three-year program involving \$600 million and focusing on waste treatment. (Hendry, S.; CHEMICAL WEEK, (17 FEB. 1993), 152, (6), pp. 26 [in English]. ISSN 0009-272X)

1100 STORM WATER/WASTEWATER ISSUES FOR THE STEEL INDUSTRY. [BIB-199303-S4-0024]

The development of new water quality criteria by the US Environmental Protection Agency (EPA), the Great Lakes Water Quality Initiative (GLWQI) and by individual states will result in more restrictive effluent limitations on industry for all types of discharges, perhaps including storm water. States currently are drawing on waste load allocation models to establish more restrictive limits that would comply with the new water quality standards. (Hacker, D.W.; IRON AND STEELMAKER, (FEB. 1993), 20, (2), pp. 38-40 [in English]. ISSN 0097-8388)

1101 COKE-OVEN CHARGING CARS HELP CLEAR SCUNTHORPE'S AIR. [BIB-199303-S4-0026]

Autumn 1992 saw the installation of two new charging cars at British Steel Scunthorpe's Dawes Lane coke ovens. The cars are designed for fast, smokeless charging of 35 m³ of coal into a 5.3 m oven chamber through four charge holes

using the square charging principle. The car consists of four coal trays, each including hopper with volumetric measuring sleeve, horizontal screw feeder, clam shell gate and sealed telescope, all constructed of stainless steel. Each coal tray is further equipped with automatic magnetic lid lifter oscillator with lid-on indicator and a combined rotary oven lid charge hole frame cleaner. (STEEL TIMES, (JAN. 1993), 221, (1), pp. 28 [in English]. ISSN 0039-095X)

1102 REDUCED PAINT CONSUMPTION AT BRITISH STEEL. [BIB-199303-S5-0010]

A new plant for the spray-painting of shot-blasted steel plate and sections at the Teeside works of British Steel, has reduced paint consumption by 32%, compared with conventional automatic plant, and has cut associated solvent emissions by 85%, saving costs and minimizing environmental pollution. The conveyor-fed automatic system, believed to be the first of its kind, has been designed, manufactured and installed by Air Industrial Developments. (FINISHING, (NOV. 1992), 16, (11), pp. 20 [in English]. ISSN 0309-3109)

1103 HOW INCO CUT ITS SMELTER SULFUR DIOXIDE EMISSIONS. [BIB-199304-G4-0021]

Inco's CS600 million Sulfur Dioxide Abatement Program (SOAP) will cut sulfur emissions from 30% to 10% when implemented at the company's Ontario, Canada, smelters later in 1993. SOAP couples improved recovery methods with radical changes in its Ni- and Cu-extraction processes, which Inco is already marketing to other mining companies worldwide. (American Metal Market, (25 Feb. 1993), 101, (37), pp. 10 [in English]. ISSN 0002-9998)

1104 TASMANIA CURBS OBSTRUCTIVE ENVIRONMENTALISM. [BIB-199304-G4-0022]

The Tasmanian government has adopted a package of legislation affecting the mining industry which can be considered historic. The reforms are designed to encourage and promote mining in this mineral-rich Australian state and to revitalize investor confidence in the industry. They recognize that proper environmental standards must be adhered to but at the same time remove the threat of undue interference from the preservationists. Actions taken include: creation of Strategic Prospectivity Zones in areas of high potential to guarantee access to miners; rezoning of some park areas, and limiting the depth of national parks to 50 m below the surface to promote nonobtrusive exploration; and streamlining of the licensing process. (Engineering and Mining Journal, (Feb. 1993), 194, (2), pp. 9, 11 [in English]. ISSN 0095-8948)

1105 ALUMINUM CASTINGS GAIN COST EDGE OVER IRON. [BIB-199304-G4-0023]

Manufacturers of Al for castings could benefit from rising costs in the Fe castings business, including the cost of meeting federal environmental standards. While both Fe and Al foundries in the US are finding it difficult to pay for the changes that are needed to meet clean water and clean air regulations, manufacturers of Fe castings appear to be having the most difficulty right now. On a product-by-product basis, the environmental costs associated with Fe castings are higher than those associated with Al. (Wrigley, A.; American Metal Market, (2 Mar. 1993), 101, (40), pp. 4 [in English]. ISSN 0002-9998)

1106 MITSUBISHI MARKETS PROCESS WORLDWIDE. [BIB-199304-G4-0024]

Mitsubishi Materials Corp. has set out to market worldwide its pollution-free Cu smelting process, known as the Mitsubishi continuous Cu smelting and converting process, and related equipment. The Mitsubishi process is a patented and virtually pollution-free Cu smelting and converting process developed in the mid-1970s. (Furukawa, T.; American Metal Market, (4 Mar. 1993), 101, (42), pp. 5 [in English]. ISSN 0002-9998)

1107 KENNECOTT TAMING THE WILD BEAST OF EMISSIONS. [BIB-199304-G4-0025]

Kennecott Corp. will employ advanced emission control systems at its new Cu smelter and modernized refinery. The \$880M project at the company's Bingham Canyon Mine near Salt Lake City, Utah, USA, is expected to be able to capture 99.9% of the S from concentrates while reducing overall smelting and refining costs by 60%. (Zavodni, C.; American Metal Market, (2 Mar. 1993), 101, (40), pp. 4 [in English]. ISSN 0002-9998)

1108 EPA'S BROWNER FAVORS PREVENTION OVER COMMAND-AND-SLIDE CONTROL STYLE. [BIB-199304-P4-0020]

The US Environmental Protection Agency will favor pollution prevention over new regulation under Administrator Carol Browner, building on the foundation the agency laid during the Bush administration. Speaking to approx 50 trade publication reporters in a 16 February briefing, Browner outlined the broad philosophy she said she will follow in her tenure at EPA. Browner said regulation has accomplished tremendous things to protect the environment, but she acknowledged that the agency's focus must shift from command-and-control regulations to preventing pollution early in industrial processes before the environment can be improved any further. She has said she will try to end the adversarial relationship between business and regulators, reflecting President Clinton's campaign emphasis on using market forces to encourage environmental protection. (Gardner, J.; *Plastics News* (Detroit), (22 Feb 1993), 4, (51), pp. 5, 18 [in English]. ISSN 1042-802X)

1109 STA TO START ECOMATERIALS PROJECT. [BIB-199304-P7-0134]

Plans to conduct an Ecomaterials project aimed at developing new environment-friendly materials have been announced by the Science and Technology Agency (STA) in Japan. The STA will start the five-year project in April and provide approximately 1.8 billion yen to support the research. Participants in the project will include relevant experts from government research institutes, academia and industry. Specific areas of interest will be: the development of materials that can be recycled without causing environmental hazards, despite the presence of impurities, and the development of alloys with a variety of added functions. (*New Materials Japan*, (Mar. 1993), pp. 15 [in English]. ISSN 0265-3443)

1110 OLD AUTOS PAVE ROAD TO MAKING NEW STEEL. [BIB-199304-S1-0032]

As an industry, US and Canadian steelmakers have invested \$22.5B since 1989 to reduce emissions, improve operations, upgrade facilities and become more compatible with the environment. Automotive recycling has been a key component in the industry's environmental conservation activities. Since the inception of the automobile, automotive steel has been retrieved from the solid-waste stream and used for making new steel. More than 90% of today's scrapped automobiles are recycled—a rate considerably higher than that of most consumer products. (Melbourne, S.; *American Metal Market*, (18 Feb. 1993), 101, (32), (Suppl. Electric Furnace Steel), pp. 13A-14A [in English]. ISSN 0002-9998)

1111 COKE OVENS WILL DWINDLE UNDER EMISSION REGS. [BIB-199304-S4-0029]

Costly new Environmental Protection Agency rules governing coke oven emissions likely will prompt producers to close some coke oven batteries. And this combined with other market-related factors probably will lead to further declines in the use of coke. The new EPA rules, which affect 86 batteries at 30 facilities, are intended to cut toxic emissions at coke ovens by 66-90% over the next three decades. They were mandated by the Clean Air Act Amendments of 1990 and agreed to during fall 1992, by representatives from the steel industry, labor unions, government and environmental groups. (Connaughton, D.; *American Metal Market*, (25 Feb. 1993), 101, (37), pp. 7, 10 [in English]. ISSN 0002-9998)

1112 STEELMAKERS TACKLE ENVIRONMENTAL TASKS. [BIB-199304-S4-0030]

The regulatory sticks at work in the American manufacturing industry are driving a substantial amount of environmental progress, particularly in steelmaking. However, the standards that are imposed are fraught with ambiguity. Terms such as "reasonably available control technology" and "maximum achievable control technology" in the Clean Air Act ensure that steel companies will be chasing a moving target for the foreseeable future. In an industry starved for capital, this potentially expensive uncertainty is at best a considerable challenge, and at worst a threat to survival. (McLaughlin, R.; *American Metal Market*, (25 Feb. 1993), 101, (37), pp. 8 [in English]. ISSN 0002-9998)

1113 MEXICO AWAKENS TO CLEAN UP OR SHUT DOWN. [BIB-199304-S4-0033]

Mexican steelmakers, under the gun to clean up their act, are investing millions of dollars to treat wastewater and prevent emissions of sulfur dioxide and other harmful pollutants. The steel companies, which for years enjoyed extremely lax enforcement of environmental regulations, are closing down their dirtiest and most antiquated equipment and installing wastewater treatment facilities and other pollution-fighting equipment. (Delson, J.; *American Metal Market*, (25 Feb. 1993), 101, (35), pp. 4, 10 [in English]. ISSN 0002-9998)

1114 GREEN WAVE WON'T CAPSIZE STEEL. [BIB-199304-S4-0035]

It may not have reached tidal wave proportions yet but America's environment movement is rapidly gaining momentum. Gathering force in the form of tougher compliance standards and penalties, this groundswell of activity finds metals producers in a precarious situation. With operating profits being hammered down in recent years, the costs of ensuring environmentally correct production processes has resumed an upward spiral. Whether this pattern will lead to the kind of pollution control spending explosion that rocked the industry in the mid-to late 1970s—a time production will be significantly impacted by coming legislation. (Iron Age, (Mar. 1993), 9, (3), pp. 32-33 [in English]. ISSN 0897-4365)

1115 CLEANING UP CONFUSION. [BIB-199306-G4-0037]

The doctrine that the polluter pays is increasingly preached but RTZ believes that the method and the motivation warrant close scrutiny. The highly inefficient legislative system weakens any incentive for owners to use new technology to extract usable products from fellow mine wastes. Pragmatic approaches, working primarily through market mechanisms, are thought to be preferable to bureaucratic or legalistic methods. (Crowson, P.; *RTZ Review*, (Mar. 1993), (25), pp. 3-7 [in English].)

1116 ALUMINUM IS ECOLOGICAL. (ALUMINIUM IST ÖKOLOGISCH.) [BIB-199306-G4-0039]

Aluminum's claim for classification as an ecological material is justified by various criteria, i.e. low mass in decay, no corrosion products, low energy expense during use, little energy demand for recycling, little loading of air, water, or floor, etc. Also its use in automobiles has reduced CO₂ emission significantly. A linear relationship between CO₂ reduction and weight of Al car is shown on a graph. (Schirmer, J.; *Aluminium*, (Jan. 1993), 69, (1), pp. 27-28 [in German]. ISSN 0002-6689)

1117 AMENDMENT OF US RULE 1162 ON VOCS. [BIB-199306-D4-0008]

In the US, the South Coast Air Quality Management District (SCAQMD) has suggested a complete review of Rule 1162 aimed at an amended version which would continue the reduction of Volatile Organic Compounds (VOCs) from the composites industry in southern California. The proposed vehicle to accomplish this objective is a SCAQMD - Industry Task Force led by the Western Composites Institute. SCAQMD further suggested that this proposal could keep the Southern California composites industry on 1162 command and control, as opposed to the RECLAIM program now being offered to other major industry segments to meet the longer term air quality objectives of the SCAQMD. The Western CI Board voted to support an amended 1162 vs. the RECLAIM proposals. ((Apr.-May 1993), pp. 13 [in English].)

1118 SPI MEMBERS ADVISE UNIDO ON CFC ISSUE. [BIB-199306-P4-0031]

In papers presented to the United Nations Industrial Development Organization (UNIDO) at the Polymer Institute of the University of Detroit Mercy in February, scientists from several polyurethane chemical-producing companies reviewed the polyurethane industry's progress toward eliminating chlorofluorocarbons (CFCs) from product formulations. The Polyurethane Division of the Society of the Plastics Industry has supported research to identify viable substitutes for

CFCs since they were first implicated in the depletion of atmospheric ozone in the late 1980s. Overall, the polyurethane industry sector has reduced CFC use by 33% from 209.4 kilotonnes in 1986 to 141.7 kilotonnes in 1990. The greatest reductions have been in the flexible foam and integral skin sectors. The rigid foam sector, which depends on the insulating properties that CFCs have traditionally provided, has reduced CFC consumption by 5% between 1986 and 1990, from 132.4 to 126 kilotonnes. (Plastics Engineering, (Apr. 1993), 49, (1), pp. 3 [in English]. ISSN 0091-9578)

1119 STEELMAKING IN SYDNEY: BHP MINIMILL ON STREAM. [BIB-199306-S2-0163]

Stage I of BHP Steel's Sydney minimill was commissioned towards the end of 1992. 1993 will see the completion of Stage II—the merchant bar and section mill. It is claimed that the mill is a world leader in environmental control. In conjunction with the extensive landscaping, the mill employs advanced environmental protection technology. An air monitoring station installed near the site incorporates a high volume sampler, a dust fallout gauge as well as wind direction and wind velocity metres. Air quality is measured constantly and reported quarterly. The New South Wales Environmental Protection Authority keeps a watchful eye on test results, which BHP Steel also makes available to Blacktown City Council. (Steel Times International, (Mar. 1993), 17, (2), pp. 32 [in English]. ISSN 0143-7798)

1120 CALIFORNIA'S TRUCKERS WILL CRUISE ON CLEANER, MORE COSTLY FUEL. [BIB-199306-S3-0169]

Truckers hauling steel and other metals around California, (U.S.A.) won't have to park their trucks when new clean-air regulations go into effect in October, 1993. State clean-air officials pledged that there would be an adequate supply of diesel fuel this October when new Air Resources Board (ARB) cleanup standards go into effect, a move that will reduce soot-like emissions by 20% and smog-forming nitrogen oxides by 7%. They also said they were encouraged by oil company announcements that a substantial amount of the fuel would meet the ARB's standards by the deadline and that the ARB would act to help refiners comply as quickly as possible with the remaining supplies. (American Metal Market, (11 May 1993), 101, (90), pp. 4 [in English]. ISSN 0002-9998)

1121 DOFASCO, STELCO SEE YIELD FROM YEARS OF POLLUTION SPENDING. [BIB-199306-S4-0052]

Decades of environmental improvements at Canadian steelmakers Dofasco Inc. and Stelco Inc. are yielding impressive results. Long thought of as a big part of the pollution problem, Hamilton's steelmakers are working to prove they're an important part of the solution. At Dofasco, 3.8 million tons of steel are produced annually—up 70% from tonnage levels of the early 1970s. But while tonnage levels have risen substantially in the past two decades, pollution levels have dropped dramatically. (American Metal Market, (27 Apr. 1993), 101, (80), pp. 4 [in English]. ISSN 0002-9998)

1122 THE BASEL CONVENTION AND OTHER INTERNATIONAL ENVIRONMENTAL ISSUES THAT AFFECT CADMIUM TRADE AND MARKETS. [BIB-199307-G4-0052]

The Basel Convention of 1989 held under United Nations (UN) auspices gave guidelines to handle waste disposal and recycling operations as well as trade hazardous waste. Other guidelines affecting waste disposal and recycling such as the scrap market include rules developed by the Organization for Economic Cooperation and Development (OECD) which provides rules for trade in recyclables and classifies them: as green (no problem), amber (tacit consent) or red (hazardous). The UN will also convene a meeting on Environment and Development to discuss diverse issues which could have an effect on cadmium markets. (Larrabee, D.; SEVENTH INTERNATIONAL CADMIUM CONFERENCE, NEW ORLEANS, U.S.A. 6-8 APRIL 1992. Publisher: CADMIUM ASSOCIATION, 42 Weymouth Street, London W1N 3LQ, U.K. (1992), pp. 11-12 [in English].)

1123 THE REGULATORY STATUS OF CADMIUM IN THE EUROPEAN COMMUNITY. [BIB-199307-G4-0058]

The European Community (EC) has cadmium specific regulations as well as general legislation for potentially hazardous materials and these laws are reviewed in light of recent findings on Cd. Political pressure and public opinion are strong factors in any legislative program involving Cd in the EC. Results of

the legislative survey indicate that the EC Cd industry will have to devote substantial efforts to education and implementation of technology to satisfy the demands of the regulations. (Shagorofsky-Tummers, A.; SEVENTH INTERNATIONAL CADMIUM CONFERENCE, NEW ORLEANS, U.S.A. 6-8 APRIL 1992. Publisher: CADMIUM ASSOCIATION, 42 Weymouth Street, London W1N 3LQ, U.K. (1992), pp. 106-109 [in English].)

1124 OECD: CO-OPERATION IN CONTROLLING CADMIUM IN THE ENVIRONMENT. [BIB-199307-G4-0059]

The Organization for Economic Cooperation and Development (OECD) adopted a Decision-Recommendation on the Cooperative Investigation and Risk Reduction of Certain Chemicals. The details of these plans are outlined with the specific steps of the procedure. Preliminary considerations for cadmium indicate an international effort will be needed because of the mobility of airborne Cd. Strategies for the following industries will be identified: pigments, stabilizers and plating; batteries; fertilizers and sewage sludge; landfill sites; and manufacturing heavy point sources. (Morgenroth, V.H.; SEVENTH INTERNATIONAL CADMIUM CONFERENCE, NEW ORLEANS, U.S.A. 6-8 APRIL 1992. Publisher: CADMIUM ASSOCIATION, 42 Weymouth Street, London W1N 3LQ, U.K. (1992), pp. 103-105 [in English].)

1125 SKIL MONITORS HELP REDUCE EMISSIONS AT ALUMINUM RECYCLING PLANT. [BIB-199307-G4-0066]

Skil Controls' visible emission monitors (VEMs) installed on a new furnace at Sandbach Car and Commercial, Cheshire, UK, are ensuring compliance with the Environmental Protection Act. At the recycling plant, aluminum vehicle components with ferrous content are heated to melt, and the aluminum is cleaned and separated. The company is using a sloping hearth furnace specially designed for this purpose, fitted with an afterburner operating at 850 °C to clean the flue gas, which is then monitored by a Skil Model 251 VEM. (Foundryman, (May 1993), 86, (4), pp. 127 [in English]. ISSN 0007-0718)

1126 HIGH-VALUE METALS RECOVERED FROM BATTERY WASTE WATER. [BIB-199307-G5-0056]

A treatment process for the waste water generated during battery production has been developed by KCH Keramchemie. A typical application of the system is at the Varta battery production plant in Hagen Germany, treating up to 100 m³ of waste water h, recovering metals from the waste stream and reducing the amount that goes for disposal. Effluent is collected in a buffer tank and conveyed to the neutralisation vessel. Hydrochloric acid is then added to adjust the pH value and to ensure the precipitation of nickel and cadmium. The effluent then flows through a flocculation tank to a clarifier where water is separated from the slurry. The sludge is pumped under high pressure into a filter press and dehydrated to form a filter cake from which the metals are recovered. Before treatment, the waste water contains approx 100 mg/l of Cd, the same amount of Ni and a pH value of 12. These levels are reduced to 0.1 mg/l for Cd, 0.5 mg/l for Ni and a pH of 6.5-9. (Materials Reclamation Weekly, (22 May 1993), 161, (14), pp. 11 [in English]. ISSN 0025-5386)

1127 FEDERAL METAL UNVEILS PLUMBING BRASS ALLOY THAT CONTAINS NO LEAD. [BIB-199307-G5-0064]

An Ohio brass ingot maker has developed a lead-free plumbing brass alloy that could serve as an effective substitute for existing alloys that have stirred environmental concerns over their Pb content. Federal Metal Co. said it has named the new alloy Federalloy. The research and test results indicate that brass castings produced with Federalloy have qualities that compare favorably with CDA 836 and CDA 844, the two most common alloys used in brass castings and plumbing. Unlike CDA 836 and CDA 844, Federalloy contains bismuth—but 1%, which should not put undue stress on the current supply of Bi or pose recycling hardships in the current environment. (Goodwin, M.E.; American Metal Market, (4 June 1993), 101, (107), pp. 10 [in English]. ISSN 0002-9998)

1128 LEAD IN THE LEGISLATURE. [BIB-199307-G7-0331]

The US lead industry in 1993 has seen itself under attack from several legislative and regulatory proposals. Bills of greatest concern have been HR-1808 and S 729 but the worst is yet to come. Congress is considering several other bills dealing with Pb-use abatement in paints, however. Of deepest concern to the industry, however, is legislation that is expected to be reintroduced into the House later in June 1993 imposing a tax on Pb. The tax would be between

\$0.35 lb and \$0.75 lb and would be imposed on all Pb as soon as it enters the market. Such a tax may put the 25% of US producers not in the car battery segment out of business. (Metals Week Focus, (May 1993), 2, (5), pp. 10, 22 [in English])

1129 PLASTICS INDUSTRY REVEALS ECOLOGICAL IMPACT DATA. [BIB-199307-P4-0036]

The Association of Plastics Manufacturers in Europe (APME, Brussels, has published ecological impact (eco-balance) data for a number of commodity polymers—the latest stage of its program to assess the environmental impact of plastics products. Two main aims of the project are to address public concern about packaging waste and provide data to allow legislators to make better decisions. About 40% of Europe's plastics output is used in packaging. Already Europe's proposed packaging waste directive calls for 60% of recovered waste to be recycled by mechanical or feedstock routes. The control states 90% of the packaging waste stream is to be recovered. The targets are to be achieved ten years after the directive is adopted, which is expected to be in 1994. (Chyroweth, E.; Chemical Week, (2 June 1993), 152, (21), pp. 17 [in English] ISSN 0009-272X)

1130 US EPA TO EXPAND TOXIN-RELEASES INVENTORY. [BIB-199307-P4-0037]

Processors and resin suppliers may be required to increase reporting of chemical releases and disposal under the US Environmental Protection Agency's inventory of toxin releases. The agency by November 1993 intends to add 198 chemicals to a list of 250 specific chemicals and 21 families of compounds for which manufacturing companies now must report their emissions or disposal. Reports of emissions and disposal are what EPA uses in compiling the inventory. EPA Administrator Carol Browner announced the inventory expansion at a 25 May press conference during which EPA released its 1991 emissions report. (Gardner, J.; Plastics News (Detroit), (31 May 1993), 5, (14), pp. 22 [in English]. ISSN 1042-802X)

1131 INCINERATION—THE ANSWER TO PLASTIC WASTE PROBLEM. [BIB-199307-P4-0038]

A national strategy for waste management is one of the main recommendations of the UK's Royal Commission on Environmental Pollution, which has just published its 17th report. Where wastes are unavoidable, the Commission wants to recycle them if possible, but where they cannot be recycled in the form of materials then the energy should be recovered from them. Incineration and the subsequent energy recovery would be part of the decision procedure which leads the Commission to make its first recommendation in this report. A further recommendation is that "as part of preparing the national strategy the DoE should press forward with the studies already in hand to establish the best practicable environmental option for particular waste streams". Plastics waste has to be examined carefully to assess the best options. (Plastics and Rubber Weekly, (29 May 1993), (1487), pp. 1 [in English]. ISSN 0032-1168)

1132 APME LAUNCHES NEW POLYMER ECO-STANDARDS. [BIB-199307-P4-0040]

Polymer producers across Europe now have benchmark sets of data for measuring the environmental impact of their production processes, numbers that could now pave the way for a realistic assessment of plastics products, including packaging, on environmental grounds. The data gathering and analysis represents a three year co-operative between polymer producers, the APME, and its panel of environmental and scientific experts, whose techniques and neutrality held the key to opening many doors marked commercially confidential. The companies that took part in the work account for approx 90% of plastics made in Europe each year. Details of energy and material use, emissions and waste generated in the production of polystyrene, polyethylene polypropylene and olefins have been released, and corresponding information for other polymers, including PVC and PET is to follow later in the year. (Plastics and Rubber Weekly, (5 June 1993), (1488), pp. 1 [in English]. ISSN 0032-1168)

1133 TREATMENT PRODUCTS FOR STAINLESS. [BIB-199307-S3-0211]

Two new formula products from stainless steel surface treatment specialists Anopol Ltd are claimed to cut costs and reduce environmental problems. Cleaner CX is a non-solvent degreasing agent which also removes the oxide discoloura-

tion typically produced by spot welding stainless steel. It is particularly suitable for light gauge fabrications manufactured from pre-polished steel. The heat oxides can be removed, under controlled conditions, without detriment to the polished finish, saving the cost of manual blending. Neutra paste NP neutralises acids on stainless steel surfaces after cleaning, pickling and passivating products have taken effect. A light foam forms which quickly subsides once the neutralising action is complete and is removed by clean water rinsing, assisting the formation of the passive oxide surface layer. Both products can be applied by brush, roller or spray applicator. (Metallurgia, (Apr. 1993), 60, (4), pp. 155 [in English]. ISSN 0141-8602)

1134 CFC SUBSTITUTE METAL CLEANING SOLVENTS. [BIB-199307-S4-0060]

Kyowa Hakko Kogyo Co., Ltd. has developed four types of hydrocarbon solvents as substitutes for CFC-113 and 1,1,1-trichloroethane, use of which will be banned by 1995. These four products, commercialized under the brand name Kyowasol, are highly pure isoparaffins made from butene and propylene and have 6-12 C atoms. Since the number of carbons is fixed, the range of distillation is narrow and the ozone-destruction factor is zero. Two of the solutions with lower boiling points are suitable for aerosol metal cleaners, water-repellent sprays, stain removers, and cleaners for resists. The other two with higher boiling points can substitute for trichloroethane to clean metals. (New Technology Japan, (May 1993), 21, (2), pp. 43 [in English]. ISSN 0385-6542)

1135 KRUPP VDM FIGHTS POLLUTION. [BIB-199307-S4-0061]

In Germany part of the domestic waste is recycled or burned in modern waste-to-energy conversion plants. The generated energy is used to supply electricity and district heat. The scrubbers that remove pollutants are lined with Krupp VDM GmbH's Nicrofer 5923 hMo-alloy 59. (Stainless Steel Europe, (May 1993), 5, (4), pp. 57 [in English]. ISSN 0924-5820)

1136 PROCESSING ALUMINUM DROSS WITH PLASMA. [BIB-199308-G1-0207]

At the heart of this aluminum recovery system is a thermal plasma torch—a tool that converts electricity into high-temperature thermal energy. Without combustion, a plasma heating system generates temperatures of up to 20 000 °F. Because the heat is generated without combustion, there are no combustion emissions and the volume of stack gas is reduced by up to 90%. Unlike conventional processing, the plasma-fired, rotary furnace is sealed to reduce the amount of oxygen allowed into the vessel. (Thirty-Three (33) Metal Producing, (June 1993), 31, (6), pp. 24 [in English]. ISSN 0149-1210)

1137 RECYCLING OF COPPER. [BIB-199308-G1-0216]

The paper examines the Cu cycle, technical processes for recycling, and conventional and special scrap. The latter includes cable and electronic scrap. Future prospects for recycling will be affected by stricter emissions regulations, higher waste disposal costs, and the Basle Convention, part of the United Nations Environment Programme. Graphs. (Gockmann, K.; COPPER 91 (COBRE 91), OTTAWA, ONTARIO, CANADA, 18-21 AUG. 1991, Publisher: PERGAMON PRESS INC., Maxwell House, Fairview Park, Elmsford, New York 10523, USA, (1992), pp. (Vol. 1), 27-43 [in English].)

1138 THE GREENING OF COPPER. [BIB-199308-G4-0072]

The impact of environmental protection legislation in various countries on the Cu industry is discussed. The producers have paid for investment in upgraded plant and sometimes greater operating costs by diverting profits and improving productivity. Meanwhile, environmental laws are becoming everywhere more complex and stringent. (Hobson, S.; COPPER 91 (COBRE 91), OTTAWA, ONTARIO, CANADA, 18-21 AUG. 1991, Publisher: PERGAMON PRESS INC., Maxwell House, Fairview Park, Elmsford, New York 10523, USA, (1992), pp. (Vol. 1), 111-119 [in English].)

1139 US AUTOMAKERS MAY SHARPLY EXPAND USE OF ALUMINUM, COMPOSITE MATERIALS IN VEHICLES BY 1997 MODEL YEAR. [BIB-199308-G6-0149]

US manufacturers of cars and light trucks may sharply step up their substitution of steel and cast iron material by lighter weight aluminum and composites in vehicles starting in the 1997 model year. The need for more widespread use of

Al and composite material in newly built cars and light trucks of 3750 lb GVW is primarily driven by mandatory compliance to low emission vehicle standards recently enacted into law by the State of California, U.S.A. By the 1997 model year, 25% of the fleets of cars and light trucks sold in California are mandated to emit from their tailpipes not 0.075 g/mile of non-methane organic gases, 3.4 g/mile of carbon monoxide and 0.4 g/mile of nitrogen oxides. (Stark's Component Ledger, (June 28), 2, (13), pp. 49 [in English].)

1140 STRUGGLE FOR COMPETITIVENESS: AN INDUSTRY PERSPECTIVE FOR THE NINETIES. [BIB-199308-G8-0812]

This paper focuses on what seem to be the leading indicators of prosperity in the Cu industry during this decade: the geographical distribution of deposits, environmental impact, capital allocation and acid consumption. There is a potential for meeting environmental criteria at a reasonable profit margin, but those with limited acid demand within economic range will face hard times to meet growing environmental concerns, resulting in additional mine closures. At the other end, those with old waste dumps who are thinking about smelting capacity additions will need capital influx at a much larger rate than ever before. There is a growing need to internalize these effects back to the ore blocks before a meaningful estimate of world Cu reserves becomes available. (Bannach, H.: COPPER 91 (COBRE 91), OTTAWA, ONTARIO, CANADA, 18-21 AUG. 1991. Publisher: PERGAMON PRESS INC., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A. (1992), pp. (Vol. 1), 57-66 [in English].)

1141 OVERVIEW OF PLASTICS RECYCLING IN EUROPE. [BIB-199308-P1-0165]

According to an editorial, the Western Europe plastics manufacturing industry is concentrating intensely on the task of managing the total plastics waste arising from its activities and seeking to do so without any additional burden on environmental resources. It may be possible to achieve overall mechanical recycling of plastics of approx 20% with the balance recovered for their value as fuel. EC strategy on waste is briefly stated as the prevention and reduction of waste arisings at source; the increased use of recycling and re-use of materials wherever possible; and the safe disposal of unavoidable waste. (Matthews, V.: Plastics, Rubber and Composites Processing and Applications, (1993), 19, (4), pp. 197-204 [in English] ISSN 0959-8111)

1142 ZINC PHOSPHATE PROTECTS STEEL. [BIB-199308-S5-0043]

The US Department of Energy's Brookhaven National Laboratory has developed a zinc phosphate coating that protects steel surfaces against rust and corrosion. The coating can be used on numerous automotive parts—from motor mounts to clip fasteners—to reduce corrosion and prolong the life of the vehicle. Brookhaven's new zinc phosphate coating process is more efficient and environmentally safer than previous methods. It cuts corrosion prevention from a 25-step chemical process to one-step using only four chemicals and water. (Tooling and Production, (July 1993), 59, (4), pp. 16 [in English] ISSN 0040-9243)

1143 ON THE PROBLEM OF EQUALIZING THE ECOLOGICAL BALANCE. (ZUR PROBLEMATIK VON ÖKOLOGISCHEN VERGLEICHEN.) [BIB-199309-G4-0081]

A qualitative re-analysis of the ecological balance of the automotive intake manifolds made of either polyamide or aluminum alloys is presented. The author questions the hypothesis that the emissions of CO₂ during automobile use are proportional to weight. Re-analysis of the data on production and total lifecycle usage of the 35% glass reinforced polyamide 6.6 manifolds and those made of G-AlSi10Cu2Fe and G-AlSi9Cu3 Al alloys shows that the Al alloys have an ecological advantage, especially in regard to recycling. (Ostermann, F.: Aluminium, (May 1993), 69, (5), pp. 440-441 [in German] ISSN 0002-6689)

1144 BEER WAR'S END NO TAX RELIEF FOR ALUMINUM CANS. [BIB-199309-G4-0082]

The Ontario government hung on to its \$0.10 can environmental duty on aluminum beer cans in a so-called compromise with the US supposedly ending the US-Canada beer war. It looked to some like Al cans may have been inadvertently crumpled on the altar of expediency to further the North American Free Trade Agreement. The US and Canada declared they had resolved the long-running trade war over imported beers. Under the agreement, the US agreed

to remove the 50% tariffs it had imposed in 1992 on beer imported from the Canadian province of Ontario and Canada agreed to scrap similarly high punitive tariffs it had imposed on beer manufactured by two American companies—the G. Heileman Brewing Co. and the Stroh Brewing Co. (American Metal Market, (9 Aug. 1993), 101, (152), pp. 2 [in English] ISSN 0002-9998)

1145 METALLURGY VS. THE ENVIRONMENT: THE CASE OF THE TEXAS COPPER CORPORATION. [BIB-199309-G4-0083]

In March 1992, the Mitsubishi Materials Corporation, the parent of the Texas Copper Corporation, announced the abandonment of a proposed \$200M copper smelter in Texas City, Texas. This article discusses the modern metallurgical plants in terms of zero discharge upon environment. Abandonment of the Texas Copper project is apparently irreversible. This is a significant loss in numerous terms, including the effort to renew the competitive position of an important basic industry; the need to create jobs, many of them high paying; the drive to sway trade balance between the US and other countries; and the struggle to find a balance between environment protection and industrial development. If similar losses are to be prevented in the future, we must develop a more enlightened approach to the conflicting interests of environmental advocates, industry, and regulatory agencies. (Kellogg, H.H.: JOM, (Aug. 1993), 45, (8), pp. 32-34 [in English] ISSN 0148-6608)

1146 NON-CYANIDE BRIGHT ZINC PLATING PROCESS. [BIB-199309-G5-0091]

Zincslot 30, an alkaline, non-cyanide bright Zn plating process, suitable for both rack and barrel plating, is developed. The solution contains a chemically pure zinc oxide, sodium hydroxide, and two addition agents. Developed to overcome some of the problems associated with the use of toxic cyanide zincs, the environmentally-friendly solution is said to provide an even deposit with excellent covering power, plus a high level of brightness over a wide current density range. Cathode current density for rack plating is 1.5-4 A/dm² and for barrel plating 0.5-1.4 A/dm². As there are no complexing agents in the solution, treatment is both simple and economical. The effluent treatment consists of neutralisation to a pH of 8.5-9 which is adequate for reducing the Zn content to below the admissible level. Bath maintenance is also straightforward, as the plating bath uses only two additives, a starter and a brightener. (New Coatings & Surfaces, (Aug. 1993), pp. 2 [in English].)

1147 CADMIUM CYANIDE-FREE PLATING PROCESS. [BIB-199309-G5-0093]

The Novalyte 370 process utilises a slightly-alkaline electrolyte, completely free of any cyanide-bearing constituents. The addition agent was developed to produce a semi-bright to bright deposit for industrial applications. Its use is claimed to markedly improve the low throwing and covering power of the electrolyte, and deposits produced by this process have excellent base-metal adhesion, good lustre and ductility. The process is limited to barrel plating of all types (horizontal, oblique perforated and imperforated). It can be used in both manually-operated and automatic equipment at a wide range of temperatures, i.e. 60-100 °F (15.56-37.78 °C), with cathode current density of 2-15 ASF, anode current density of 5-40 ASF. The bath consists of cadmium oxide (0.5-1.5 oz/gal, metal), ammonium chloride 3-5 oz/gal, ammonium sulphate 10-15 oz/gal, Novaplex (acting as a buffer, anode corrosion agent, and cadmium ions stabiliser at the pH of the electrolyte) 10% by volume, Novalyte 370-A 0.5-1.0% by volume, and Novalyte 370-W wetting agent with a dual property of reducing surface tension of the plating solution as well as being an anti-pitting agent. (New Coatings & Surfaces, (Aug. 1993), pp. 1 [in English].)

1148 NEW DISK SHUTTERS HIT MART. [BIB-199309-G6-0183]

Sumitomo Light Metal Industries Ltd has started shipping samples of 3.5 in micro-floppy disk (MFD) shutters which are made of a newly developed painted aluminum alloy sheet instead of the more-conventional stainless steel sheet. Most 3.5 in MFD shutters are made of stainless steel sheet, which requires the use of press oil during the processing stage and cleansing with solvents such as trichloroethylene. The use of press oil and solvent is considered environmentally damaging. The new product, which is coated with a special resin paint developed for Al alloy, omits the need for press oil and the cleansing process. The coated alloy is expected to be used in mini-disks (MFDs), which are gaining popularity

in the audio market. (Furukawa, T.; American Metal Market, (11 Aug. 1993), 101, (154), pp. 6 [in English]. ISSN 0002-9998)

1149 ECO-BALANCES FOR PLASTICS. [BIB-199309-P4-0044]

The European Centre for Plastics in the Environment (PWE) has published Eco-balance methodology for commodity thermoplastics. This technical paper is the result of a two year project by the European plastic industry to provide a methodology for producing an eco-balance inventory of the major plastic materials manufactured in Europe. A panel of independent experts supervised and developed a methodology that could be used throughout the industry and was compatible with all similar known procedures. The study was designed to provide a standard for all PWE member companies to compare the environmental impact of their own individual processes and to provide a basis for targeted improvement programmes. Copies of the booklet are available from PWE, Avenue E. van Nieuwenhuyse 4, Box 5, B-1160 Brussels, Belgium. (Chemistry in Britain, (July 1993), 29, (7), pp. 566 [in English]. ISSN 0009-3106)

1150 STEEL FOUNDRIES AND THE EPA. [BIB-199309-S4-0071]

Steel foundries that produce stainless steels often receive orders for high-nickel exotic alloys, which in terms of production expertise and melting equipment requirements, are essentially extensions of the stainless-steel range. The Environmental Protection Acts requires Part B authorization for both ferrous and nonferrous alloy production in such shops, and imposes stricter control of EAF emissions, with which many UK steelmakers are struggling to comply. (McBaron, M.; Foundry Trade Journal, (18 June 1993), 167, (3477), pp. 348 [in English]. ISSN 0015-9042)

1151 BIOLOGICAL TREATMENT OF FULL-STRENGTH COKE PLANT WASTEWATER AT GENEVA STEEL. [BIB-199309-S4-0072]

A single-sludge biological treatment process has economic and operational advantages over conventional systems. Coke plant wastewater containing ammonia concentrations 3000 ppm, COD of 8000 ppm, and high cyanide, phenol, and thiocyanate concentrations are reduced in the effluent to ammonia levels 10 ppm, COD levels 600 ppm, and negligible phenol concentrations using a system installed by Geneva Steel at its Utah Lake facility. (Shaw, K.C.; Iron and Steel Engineer, (Aug. 1993), 70, (8), pp. 29-32 [in English]. ISSN 0021-1559)

1152 ZINC REMOVAL FROM STEEL MILL PROCESS WATER AT LUKENS STEEL. [BIB-199309-S4-0073]

Industrial growth world-wide has put an increasing demand on the environment. Legislation requires compliance to more stringent levels than ever before. In 1991, Lukens Steel brought on-line a hydrogen peroxide water treatment plant specifically targeting reduction of zinc in the process water system. The Zn levels have been consistently reduced to 0.03 ppm using the system; levels as low as 30 ppb are reached through a synergistic coprecipitation reaction coexisting Zn and iron ions. (Mair, I.S.; Iron and Steel Engineer, (Aug. 1993), 70, (8), pp. 41-44 [in English]. ISSN 0021-1559)

1153 TOLL RECYCLING: WIN—WIN DEAL FOR OHIO, USA, MINI-MILL. [BIB-199310-G1-0288]

IMCO Recycling recently opened a \$17.8 million facility in Uhrichsville, Ohio, USA, just over the fence from Barmet Aluminum's Newport mill, which produces coilstock for structural and fabricating applications. Barmet and IMCO have signed a 10-year exclusive supply contract that gives the Newport mill priority. IMCO's 265 million lb year operation toll-processes Al scrap purchased by Barmet, and replaces two Barmet recycling plants—a 100 million lb year operation in Uhrichsville and a plant in Rockport, Indiana, USA, that supplied 140 million lbs year to Newport. Emissions from the IMCO plant are estimated at 60% less than Barmet's Uhrichsville facility alone. (Modern Metals, (Aug. 1993), 49, (7), pp. 54-56 [in English]. ISSN 0026-8127)

1154 BIG COIL COATER GETS STATE-OF-THE-ART UPGRADE. [BIB-199310-G2-0163]

Color change in a minute or less is one of many advantages gained by Norandal USA when its coil coating line in Scottsboro, Alabama, USA, was recently

modernized. Color and coating consistency has been vastly upgraded, from coil to coil and even from order to order. Control of process variables is now state-of-the-art. And the line is ready for any stiffening of environmental regulations into the 21st century. The facility is one of the largest coil painting lines in the North American aluminum industry. It applies polyester and acrylic coatings to strip up to 64 in wide and 0.013-0.60 in thick. It can handle coils weighing 16 000 lbs. Principal elements in the \$5 million modernization include a complete new coating section, new ovens, emissions controls, a coil splicing unit, a new paint handling system, and a new roll grinder. (Modern Metals, (Aug. 1993), 49, (7), pp. 68, 70 [in English]. ISSN 0026-8127)

1155 EPA ON MACT AND STATE PROGRAMS. [BIB-199310-D4-0013]

In the US, representatives of the Clean Air Management Partnership (CAMP)—comprised of chlorine, the Composites Fabricators Association, the International Cast Polymer Association, and the National Marine Manufacturers Association, met with staff from the US Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards (OAQPS), in June at EPA's offices in Durham, North Carolina. The purpose of the visit was to determine EPA's plans for developing Maximum Achievable Control Technology (MACT) standards for the composites industry, and to establish a working relationship between industry representatives and OAQPS staff. The agency's position on MACT was detailed. Following the meeting, CAMP launched a two-part program. One part focuses on the EPA survey of the composites industry. The second part will be a major effort to educate the agency on composites manufacturing processes and feasible controls. (Schweitzer, J.; CI on Composites, (Aug.-Sept. 1993), pp. 20-21 [in English].)

1156 SALMON BAY SEATTLE, WASHINGTON, USA ROLLING MILL GOES STATE-OF-THE-ART. [BIB-199310-S2-0261]

Salmon Bay Steel, Seattle, Washington, USA, a subsidiary of Birmingham Steel, has just brought on line a \$50 million, 600 000 tons year rod and bar hot rolling mill. This facility is already delivering huge savings in conversion cost, plus productivity and quality gains. The first bar was rolled on 14 June 1993, 16 days ahead of schedule. Changeover time is now down 75%, crews have decreased in size, quality has improved, transport costs have shrunk, and environmental compliance is assured. (Modern Metals, (Aug. 1993), 49, (7), pp. 47-48, 50-51 [in English]. ISSN 0026-8127)

1157 OCMA BATTLES GREAT LAKES INITIATIVE. [BIB-199310-S4-0077]

In the spring of 1992, the EPA brought forth its proposal for cleaning up the pollution in the Great Lakes. The guidelines, known as the Great Lakes Water Quality Initiative, would standardize chemical control regulations in Ohio, Michigan, Wisconsin, Illinois, Indiana, Minnesota, Pennsylvania, and New York. New restrictions could cost factories, municipal wastewater plants, and other polluters between \$80 and \$505 million. OCMA members are concerned, particularly about their nonferrous foundry members who undoubtedly will be hard-hit, should the initiative pass. The association is upset that the guidelines focus only on point source discharges with little attention to urban runoff, agricultural runoff and deposition, or air deposition. There is also concern that the guidelines will be enforced by the Ohio EPA office statewide, not just along Lake Erie. The public comment period on the initiative ended 13 September 1993. (Foundry Management and Technology, (Aug. 1993), 121, (8), pp. 8 [in English]. ISSN 0360-8999)

1158 REYNOLDS' PLANT HIGHLY REGULATED. [BIB-199311-G4-0098]

The spent potliner reclamation plant at Gum Springs, Arkansas, USA, is one of the most regulated facilities of any type in the state. Reynolds Metals Co. said in literature designed to assure surrounding residents that the facility is environmentally sound. The aluminum producer conceded that the mere mention of a facility to treat a material classified as a hazardous waste can cause concern to the neighbors. Reynolds outlined the steps taken to minimize environmental impairment. (Worden, F.; American Metal Market, (5 Oct. 1993), 101, (192), pp. 8 [in English]. ISSN 0002-9998)

1159 PALLADIUM-ONLY CONVERTER UNVEILED. [BIB-199311-G5-0148]

A three-way catalytic converter for cleaning motor vehicle exhaust emissions which employs only palladium instead of conventionally used platinum and rhodium has been developed by Toyota Motor Corp. The newly developed catalyst, which already has been tested for performance, durability and reliability, is planned to be used on some compact-class vehicles from January 1994, Toyota said. Presently, approx 90% of Rh produced in the world is used for automotive catalysts. The new development should correct this imbalance in supply and demand as well as create greater use of Pd. Toyota said. (Furukawa, T.; American Metal Market, (24 Sept. 1993), 101, (185), pp. 6 [in English]. ISSN 0002-9998)

1160 ENVIRONMENTAL EUROPEAN STRATEGIES. [BIB-199311-P4-0051]

A European Community study of technical innovation in the plastics industry, and its influence on environmental problems associated with plastics waste, is discussed. Part of the study comprises a strategic dossier, compiled by J.C. Bongarts of the Institut Fur Europaische Umweltpolitik and D. Castiglione of Plastic Consult. The dossier points out that reduction of waste must be related to a specific model of production and consumption. Criteria which can lead the plastics sector toward rational waste management are still at an experimental stage. (Casati, B.; Macplas International, (July 1993), (10), pp. 30-31 [in English].)

1161 HCFC FOR RIGID INSULATION FOAMS. [BIB-199311-P4-0052]

The use of HCFC 123 and or HCFC 141 b to replace CFC 11 for blowing rigid polyurethane (PUR) foams is discussed. HCFCs have similar characteristics to CFC 11 but a significantly reduced effect on the ozone layer. Results of studies indicate that CFC 11 can be replaced by HCFC 141b for the majority of rigid PUR foams. The transition from CFC 11 to HCFC 141b can be made without any investment and with an increase in formulation cost of approx 10%. (Mouton, D.; Macplas International, (July 1993), (10), pp. 81-82 [in English].)

1162 REDUCED EMISSIONS AT WEST SIBERIAN WORKS. [BIB-199311-S4-0080]

Reduction of atmospheric emissions are a main aim of the developments currently under way at the West Siberian Iron and Steel Works. A number of measures are envisaged, including Saturn coke-oven doors (Heulter, Germany) that will prevent emissions through non-sealed areas; a joint venture on heat-resistant BF stockyard runners (US Quigley Co.); sintering gas treatment by Mitsui, Japan, providing for complete utilization of sulphurous anhydride and a substantial reduction in emissions of hydrogen sulphides. (Steel Times International, (Sept. 1993), 17, (5), pp. 4 [in English]. ISSN 0143-7798)

1163 HISTORY-MAKING COKE OVEN RULE NOW ONE FOR THE BOOKS. [BIB-199311-S4-0083]

The unprecedented coke oven rule that the steel industry, the United Steelworkers, environmental groups and state and federal environmental protection agencies spent most of 1992 negotiating is now final, the US Environmental Protection Agency said. The negotiated agreement was signed by the groups in late October 1992, but it has taken the agency almost a year to fine tune the agreement into a rule. The negotiations were the first successful efforts of government working with industry to develop amendments to the Clean Air Act. The first method of compliance, called the maximum achievable control technology (MACT) track, calls for cuts in current coke oven emissions by 66% by 31 December 1995. The companies must adhere to residual risk standards by 31 December 2003. (Viani, L.; American Metal Market, (22 Oct. 1993), 101, (205), pp. 1, 9 [in English]. ISSN 0002-9998)

1164 HEAT RESISTIVE STEEL. [BIB-199311-S5-0068]

Hitachi Metal, in collaboration with Professor Ementus T. Fujita, a world authority on heat resistive steel, has developed a low cost ultra-heat resistive steel that resists high temperatures 1000 °C. While it was developed for turbo-charger parts applicable to high power automobile engines, the material is also applicable to thin and light weight exhaust parts to realize high power low fuel consumption engines. Over 10% fuel saving is feasible compared with conventional engines. Also, the other advantage is that the exhaust emissions are

20-30% cleaner. (Japan Technology Highlights, (6 Oct. 1993), 4, (19), pp. 12-13 [in English].)

1165 MOLTEN METAL SOLIDIFIES A HAZARDOUS WASTE SOLUTION. [BIB-199312-G4-0100]

Metal producers are not alone with their dilemmas over hazardous by-products. One EPA statistic places the level of hazardous and toxic waste each year at 200 million tons. Particularly with solid waste, all types of US manufacturers must address the mounting problems of disposal. However, metal producing, in a sense, may offer a solution to many of those problems. A four-year-old company, Molten Metal Technology's in Massachusetts, has applied the dynamics of the melting process to hazardous-waste processing: a molten-metal bath reduces hazardous and toxic materials resulting from an array of manufacturing processes to their elemental parts so they can be extracted as gases, specialty organics, and metals. These can be handled safely as well as conveniently, and perhaps even profitably. Most attractively, the approach offers an effective alternative to landfilling and incineration. (Thirty-Three (33) Metal Producing, (Dec. 1993), 31, (12), pp. 37 [in English]. ISSN 0149-1210)

1166 THE BASLE CONVENTION AND ITS LEGAL IMPLICATIONS IN GERMANY. (DIE BASELER KONVENTION UND IHRE RECHTLICHEN AUSWIRKUNGEN IN DER BUNDESREPUBLIK DEUTSCHLAND.) [BIB-199312-G4-0101]

The Basle Convention ordained by UN within its Environmental Program on 22 March 1989 to prevent the transfer and disposal of hazardous wastes across borders. Germany became a signatory on 23 October 1989. The related OECD Council decision C(92)39 of 30.3.92 on procedure for transfer of poisons across borders for use is explained. The implications of this to the waste-related economy are examined. (Iyimen-Schwarz, Z.; Metall, (Aug. 1993), 47, (8), pp. 757-759 [in German]. ISSN 0026-0746)

1167 PARTNERS WITH THE ENVIRONMENT. [BIB-199312-G4-0102]

General Die Casters, Inc. (GDC), an aluminum and zinc die casting company stands one block from the center of Peninsula, Ohio, USA. In the past, metal casters have been a type of industry which has not easily fit into a clear air and water environment. However, General Die Casters is doing just that by blending into and making die casting work in harmony with the environment. Effectively combining industry and the environment is one of the most challenging areas this industry is facing today. General Die Casters has kept the environment in mind whenever revising the die casting process, and when implementing new secondary processes. Top priority has been given to the safety of employees and environment. The fact that no hazardous materials are used directly or as a product of the die casting process is an indication of the extent to which the company goes to maintain environmental compliance. Specially selected die release agents are used to keep the concentration and overspray to a minimum, and to allow for the highest degree of burn-off. All die casting machines and trim presses operate with synthetic hydraulic fluids. (Gruber, L.; Die Casting Engineer, (Sept., Oct. 1993), 37, (5), pp. 12-14 [in English]. ISSN 0012-253X)

1168 ENVIRONMENTALLY FRIENDLY COPPER EXTRACTION PROCESS. [BIB-199312-G5-0172]

A Sydney-based mineral processing company, Intec Pty, has developed a copper extraction technique which is more environmentally friendly than traditional Cu smelting and refining processes. Intec Pty received \$2.5 million research funding from an international consortium to test the process. This investment will be used to construct a 50 kg of Cu per day pilot extraction plant at the company's site in Chatswood, Sydney, Australia. If the process proves viable, an \$8 million 3500 tonnes year, four-cell demonstration plant will then be constructed at Port Kembla, possibly by 1995. (Waste Management and Environment, (Nov. 1993), 5, (1), pp. 10-11 [in English].)

1169 MATERIAL TRENDS IN COMPOSITE BOATBUILDING. [BIB-199312-D4-0015]

Passage of the 1990 Clean Air Act will soon be causing increased regulatory pressure on US boatbuilders from the Environmental Protection Agency, (EPA) and Occupational Safety & Health Administration (OSHA). According to a discussion of the current situation in boatbuilding, it is doubtful that just one process, equipment or material change will be the magic bullet composite

fabricators are looking for in the next few years; also, it is difficult to establish a research programme when the pace of regulation, and the standards to which the industry will be held, remain unclear. Highlights from a US EPA-sponsored Pollution Prevention Focus Group Meeting on Reinforced Plastic Composite Manufacturing are discussed. (Pfund, B.: Reinforced Plastics, (Dec. 1993), 37, (12), pp. 18-20, 22-23 [in English]. ISSN 0034-3617)

1170 MG INVESTS IN NEW BATTERY RECYCLING PLANT. [BIB-199401-G1-0016]

Metallgesellschaft-owned Rheinische Zinkgesellschaft is investing DM25 million in modernising its recently-acquired secondary lead production plant in Freiberg, Saxony, Germany, to make it one of the most modern Pb-acid battery recycling plants in the industry. The plant has a production capacity of 55 000 t/year and will use new CN technology, the benefits of which include a high level of pollution control, good separation of components, neutralisation of the sulphuric acid and desulphurisation of the Pb paste. (Metal Bulletin, (2 Dec. 1993), (7836), pp. 11 [in English]. ISSN 0026-0533)

1171 NO TOMORROW? [BIB-199401-G2-0012]

While Japan is no slouch in terms of environmental requirements, even the Japanese have troubles gaining necessary environmental approvals in the United States. A detailed study has been completed comparing US and Japanese environmental laws governing major industrial-facilities' emissions. Mitsubishi Materials, the parent of Texas Copper started a feasibility study in 1987 and after two years selected Texas City, Texas, USA, for a new, modern Cu smelter. The plant was publicly announced on 16 January 1989. Prior to that, state and federal officials visited Japan and assured the parent company that all the permits would be issued within 12-18 months. The first detailed permit application was submitted on 23 June 1989. This set in motion over 33 months of conflict between environmental groups, permitting agencies, and management. After Mitsubishi saw the delays in the U.S. it decided to build the identical Cu smelter in Japan. They obtained the permits in 42 days and built the plant in only 17 months by working 16 h/day. The plant now produces 35 mt/h Cu metal. (Mackey, T.S.: Engineering and Mining Journal, (Dec. 1993), 194, (12), pp. 16A-16B, 16D [in English]. ISSN 0095-8948)

1172 EUROPEAN ALUMINUM INDUSTRY TRIES TO MINIMIZE EFFECT OF EC LEGISLATION. [BIB-199401-G4-0001]

The European aluminum industry is lobbying on several fronts to minimize moves underway by the European Commission to introduce regulations on energy, packaging and waste, and on automotive wrecks which would have far-reaching effects on its operations within the European Union. In the case of energy, the EC's momentum towards introducing an Energy CO₂ tax aimed at reducing carbon dioxide emissions into the atmosphere is reaching a critical stage. For the \$2.5 billion European Al industry, whose costs are among the highest in the world and who are increasingly having to choose between: running loss making smelters; or close down capacity, a tax imposed on energy could be expected to raise costs significantly. For most European smelters, the breakeven price for Al is \$200 mt higher than current market prices. (Platt's Metals Week, (Dec. 1993), 2, (12), pp. 8 [in English]. ISSN 0026-0975)

1173 NEW EPA PROPOSAL AIMED AT CHROMIUM. [BIB-199401-G4-0004]

A new proposal from the Environmental Protection Agency would cut chromium emissions sharply at as many as 5000 anodizing and electroplating operations nationwide. The proposed air-emission regulation calls for the use of maximum achievable pollution control technology. The proposal is expected to affect 5000 electroplating and anodizing operations and to reduce US Cr emissions by 99% from current levels. Less than 10% of Cr production goes into electroplating and anodizing, according to a Cr specialist at the US Bureau of Mines. But there are numerous companies—big and small—that perform electroplating and anodizing functions, including metal producers and processors. (Schmitt, B.: American Metal Market, (28 Dec. 1993), 101, (248), pp. 7 [in English]. ISSN 0002-9998)

1174 US EPA MAY ASK PROCESSORS TO DISCLOSE EMISSIONS. [BIB-199401-D4-0001]

In the U.S., processors for the first time would be required to report emissions of some fiber reinforcements and hydrochlorofluorocarbons under a proposed expansion of the federal government's inventory of toxic chemical releases. EPA

argues that glass and refractory ceramic fibers, sometimes used as reinforcements in plastics composites, may cause cancer, and as a result, their emissions should be reported. Meanwhile, EPA says HCFCs, which sometimes are used as foaming agents, damage the earth's ozone layer, which protects the earth from skin-damaging ultraviolet radiation. Eight other chemicals and substances used by the plastics industry also would be added to the list of chemicals for which the Environmental Protection Agency requires emissions data. The list would nearly double in number to 633 if the proposal is approved. The proposal would take effect 1 January 1995. (Gardner, J.: Plastics News (Detroit), (17 Jan. 1994), 5, (46), pp. 6 [in English]. ISSN 1042-802X)

1175 ENHANCED MONITORING REQUIRED OF MAJOR SOURCES. [BIB-199401-D4-0003]

Under a proposed Enhanced Monitoring Program published in October, the US EPA will require all major sources of hazardous air pollutants to employ enhanced monitoring techniques to ensure and demonstrate continuous compliance with applicable emissions limits. Composites facilities emitting more than ten tons/year of styrene are major sources. Enhanced monitoring may be based on such equipment or techniques as continuous emissions monitors, continuous process or control device parameter monitoring systems or procedures, emission calculations based on accepted engineering estimation techniques, periodic verification of emissions, or process parameters or control device parameters using portable or in situ measurement devices. The exact enhanced monitoring protocol to be required for composites manufacturers will be the subject of negotiations with EPA during Maximum Achievable Control Technology development. (CI on Composites, (Dec. 1993-Jan. 1994), pp. 4 [in English].)

1176 EPA WANTS FEWER EMISSIONS OF PVC PRECURSOR. [BIB-199401-P4-0001]

The US Environmental Protection Agency is urging further reductions in emissions of the PVC precursor ethylene dichloride at resin plants because of its possible cancer-causing effects. However, it also says that vinyl makers, which consume nearly all of the EDC in the US, are responsible for only a small part of total emissions. EPA ranks EDC 53rd in emissions to the environment reported under the agency's inventory of toxic chemical releases in 1989. It was tenth among suspected carcinogens. Federal regulations considered EDC a hazardous pollutant if emitted into the air or water or disposed of on land. (Gardner, J.: Plastics News (Detroit), (17 Jan. 1994), 5, (46), pp. 9 [in English]. ISSN 1042-802X)

1177 NEW CLEAN WATER BILL MAY AFFECT US PROCESSORS. [BIB-199401-P4-0002]

A US Senate subcommittee is to begin work 2 February on a Clean Water Act renewal bill that could call upon processors and resin suppliers to reduce the amount of toxic pollutants they emit. A subcommittee of the Senate Environment and Public Works Committee will hear a version of the Water Pollution Prevention and Control Act that subcommittee Chairman Bob Graham, D-Florida, sponsored 24 January. The bill's provisions on toxic pollutants would require some factories to develop pollution prevention plans for the first time. The bill would cover plants that report emissions or off-site transfers of 200 000 lb/year of toxic chemicals. About 37 000 plants would be affected. (Gardner, J.: Plastics News (Detroit), (31 Jan. 1994), 5, (48), pp. 8 [in English]. ISSN 1042-802X)

1178 SOUTH COAST US AIR QUALITY UPDATE. [BIB-199401-P4-0003]

In the U.S., the South Coast Air Quality Management District (SCAQMD) presented its proposed amendments to Rule 1162 for polyester resin operations at a December workshop. The objectives of the proposed amendments are to: remove the current exemptions for use of specialty resins such as gel coats, fire retardant polyester resins, corrosion resistant polyester resins, and high performance boat resins. The proposed amendments will include new monomer content limits for these materials. They would permit monomer contents of up to 50% for the various categories of the specialty resins used in the SCAQMD. The new limits reflect the technology currently achieved by the polyester resin industry, which has been defined by numerous SCAQMD Industry Task Force meetings over the past year. When completed, the draft environmental document will be submitted for a 45-day public review period. The amendments will become effective 1 July 1994. (CI on Composites, (Dec. 1993-Jan. 1994), pp. 12 [in English].)

1179 EPA LISTS TOXIC CHEMICALS TO HELP PROTECT PUBLIC FROM ACCIDENTAL RELEASES. [BIB-199401-P4-0004]

The US Environmental Protection Agency (EPA) has published a new citizen's right-to-know list of toxic substances that is intended to enable communities to protect themselves from catastrophic accidental releases. This list of chemicals was mandated by the 1990 Clean Air Act Amendments. In addition to 25 substances specifically included by Congress, it contains substances EPA believes are the most likely to be accidentally released and cause injury. On a practical front, EPA's accident prevention efforts overlap considerably with very similar requirements issued by the Occupational Safety and Health Administration (OSHA). The chemical industry is already moving to comply with OSHA's process safety standard which also requires planning within the plant to prevent accidents. The Clean Air Act charges both OSHA and EPA with trying to prevent or minimize the consequences of a catastrophic accident. OSHA is expected to focus on effects inside the plant, EPA, on the impacts outside the plant fence. (Hanson, D.; Chemical and Engineering News, (31 Jan. 1994), 72, (5), pp. 16-17 [in English]. ISSN 0009-2347)

1180 US POLLUTION REGS SEEN PROMPTING STEELMAKING TECHNOLOGY SHIFT. [BIB-199401-S4-0002]

Stricter environmental regulations may cause US steelmakers to change production processes to avoid increasing costs and to comply with new environmental regulations, according to a recent report. The report, put together by the International Trade Commission, said the Clean Air Act Amendments of 1990, the Clean Water Act and the Resource Conservation and Recovery Act have led to expenditures of \$635M in 1992 for carbon steelmakers and \$57M for stainless and alloy tool steel producers. Between 1988-1990, capital expenditures on air quality increased by 300%, rising another 95% in 1991 to \$323.2M. (Viani, L.; American Metal Market, (8 Dec. 1993), 101, (236), pp. 16 [in English]. ISSN 0002-9998)

1181 BLAST FURNACE STEELMAKERS PROVIDE ENVIRONMENTAL AID TO ROMANIA. [BIB-199401-S4-0004]

A decision was recently made for both Nippon Steel and Kobe Steel to provide technological assistance for environmental protection to the Galati Steel Plant, Romania, the largest integrated steelmaker in Eastern Europe. This is part of the Japanese government's overseas direct aid (ODA) activities aimed at providing environment and energy technological assistance to the steel industry in China, Central Asia, and Eastern Europe. This will be the first time that ODA concerning the environment has provided technological assistance through blast furnace steelmakers. Both steelmakers have already sent the first technological team to Romania. Japan is already in the process of providing environment and energy related technology to steelplants in Kazakhstan and Bulgaria mainly through the Japan International Cooperation Agency (JICA). It is expected that this type of assistance will continue to expand in the future. (Japan Metal Bulletin, (13 Dec. 1993), 41-48, (5779), pp. 4-5 [in English]. ISSN 0021-4523)

1182 US FERROALLOY MAKERS FIND COSTS TO CLEAN UP EMISSIONS VERY HIGH [BIB-199401-S4-0005]

Chromium, manganese, and nickel are the three metals of highest concern to the US Environmental Protection Agency regarding hazardous air emissions from ferroalloys production facilities. Compared with other industries, ferroalloys producers do not emit enough hazardous air pollutants to be considered alarming. Nevertheless, representatives from the domestic ferroalloys industry and the EPA are working together on national emission standards for hazardous air pollutants (Neshaps). By early 1995, the EPA should propose federal regulations concerning environmental controls on ferroalloys production. (Cohn, L.M.; American Metal Market, (4 Jan. 1994), 102, (2), pp. 7 [in English]. ISSN 0002-9998)

1183 ALUMINIUM INVOLVED IN PACK-EE ENVIRONMENTAL PROJECT. [BIB-199402-G1-0045]

Packagings and the environment are at the centre of the wide-ranging European environmental project PACK-EE, and initiative of the French aluminium producer Pechiney which is sponsored by the European Union. Besides a number of European manufacturers of paper, glass and plastics, other Al producers are also taking part, including Hoogovens Aluminium. This company produces foil, can stock and Alulite (Al with an organic coating for beverage can lids) for

packaging purposes. PACK-EE stands for Packaging and Environment in Europe: the project will run until 1997. (Hoogovens Groep Bulletin, (Jan. 1994), 13, pp. 1 [in English].)

1184 EXAMINING THE OPTIONS TO CLEAN UP FOUNDRY MELTING. [BIB-199402-G4-0008]

The 1990 Environmental Protection Act (EPA) is changing the face of the British foundry industry. Its strict regulations on levels of emissions are forcing all foundries to examine their mode of operation. The costs of introducing the anti-pollution measures required to comply with the EPA can be significant, and this means that in some cases, there can be financial as well as environmental benefits in changing to a different process technology. Foundries still operating on coke-fired cupolas face particular problems. Electric melting is generally able to meet EPA emissions standards without any type of filtration or environmental control. The present rules regarding emissions are therefore a strong incentive to change to electric melting, particularly for replacement cupolas and new installations. (Materials World, (2 Feb. 1994), 2, (2), pp. 77 [in English]. ISSN 0967-8638)

1185 LEAD AND THE ENVIRONMENT. EUROPEAN COMMUNITY LEGISLATION. WHAT DOES THE COMMISSION HAVE IN STORE? [BIB-199402-G4-0011]

In order to comply with EC environmental policy, the non-ferrous lead business will need to develop coherent policies on an international basis. Main aspects should include classification, health and safety at the workplace and industrial pollution. Missing data will need to be generated through a critical review of all substances and their various uses and applications. Manufacturers will have to demonstrate their capability to produce and market their products in a responsible way. (Franckaerts, A.; Eleventh International Lead Conference, Venice, Italy, 24-27 May 1993. Publisher: Lead Development Association, 42 Weymouth Street, London W1N 3LQ, UK, (1993), pp. 2.2 1-9 [in English].)

1186 FINDING SUBSTITUTE PROCESSES THAT WORK. [BIB-199402-G4-0013]

Metal finishers and the industries they serve are involved in an important mission—the mission to find suitable, workable substitute processes that are more environmentally correct than the processes they replace. Finding substitutes is easy. Finding substitutes that don't compromise performance is a different matter. CFC-based compounds such as Freon are a good example of substances whose alternatives fall short as far as performance. Cadmium finishes offer another example of the same thing. But progress is being made. At this juncture, it's useful to know what options are currently available—and any limitations those options entail. Some of the key metal finishing substitutes like zinc alloys for Cd, among others, are discussed. (Finishers' Management, (Jan. 1994), 39, (1), pp. 24-26 [in English]. ISSN 0015-2358)

1187 NUOVA SAMM'S POLICY FOR THE TECHNOLOGICAL AND ENVIRONMENTAL DEVELOPMENT OF THE ITALIAN LEAD INDUSTRY. [BIB-199402-G8-0157]

Nuova Samm, Italy's leading company in lead production and the country's sole producer of primary Pb with a production capacity of 170 000 t/year, has adopted a far-reaching and innovative policy toward incorporating new technologies. Substantial investment in Kivcet has played an important role in pollution control. The company is also the main promoter of the COBAT consortium for collecting and recycling used Pb batteries. (Sandri, S.; Eleventh International Lead Conference, Venice, Italy, 24-27 May 1993. Publisher: Lead Development Association, 42 Weymouth Street, London W1N 3LQ, UK, (1993), pp. 1.1 1-14 [in English].)

1188 EMISSIONS CONTROL OPTIONS FOR AN OXY-FUEL-FIRED FURNACE. [BIB-199402-C4-0001]

Glass manufacturers have to worry about such furnace emissions as sodium sulfates, SO_x, lead oxide, and other particulates or gases depending on the glass composition. Switching to an oxy-fuel system can cause higher emissions and, therefore, solutions must be found. United McGill Corp. has developed a number of ways to reduce these emissions. Dilution cooling at the furnace exhaust is recommended to reduce the temperature and moisture content. This will make flue gas conditioning and particulate collection less risky. Dilution cooling can also be used to eliminate the need for high-temperature duct materials. Air

pollution control devices should be insulated to reduce the chance of SO_x and water vapor condensation which can lead to hopper buildup and or corrosion. Dry lime injection also can be used for SO_x reduction if needed. Hopper heaters should be added to existing electrostatic precipitators to avoid hopper buildup, unless operating at a high temperature. Duct flow velocities should be recalculated and ducts replaced if needed to avoid dust fallout. The fan load should be recalculated as well—a different-sized fan or a variable-frequency drive may then be needed. In addition, the furnace operator must be careful with standard cooling programs, since the furnace exhaust contains mostly CO₂ and water vapor. (American Ceramic Society Bulletin, (Feb. 1994), 73, (2), pp. 62 [in English]. ISSN 0002-7812)

1189 Q&A: TITLE V OPERATING PERMITS. [BIB-199402-D4-0006]

Title V of the Clean Air Act Amendments (CAAA) signed into US law by George Bush in November 1990, requires states to adopt new permit programs. The Title V permits are the means by which the objectives of the CAAA are achieved, including limitations on emissions of air toxics under Title III and VOCs under Title I. Title V permits will regulate the operation and modification of sources of air pollution. An article explains the rules of applying for a Title V permit. (Schweitzer, J., CI on Composites, (Feb.-Mar. 1994), pp. 12-13 [in English].)

1190 RESEARCH CONSORTIUM SEEKS ALTERNATIVE TO LEADED FREE-MACHINING STEELS. [BIB-199402-S4-0008]

The Institute of Advanced Manufacturing Sciences, an Ohio Edison Center, has formed the Steel Machinability Research Consortium (SMRC) with the objective of addressing the issue of Pb use in free-machining steels. Specifically, the center will seek a less toxic additive for production and attempt to develop a process to engineer the new material for commercial use. Lead-containing steels

machine 30% more efficiently than unleaded steels, thereby reducing machining time and costs. However, the US Environmental Protection Agency has directed that Pb be removed as an industrial waste to the environment before the year 2000. As a result, the SMRC is working to find a viable replacement for 12L14, which is the industry's standard leaded steel (approx. 140 tonnes sold in 1992) (JOM, (Feb. 1994), 46, 92), pp. 7 [in English]. ISSN 0148-6608)

1191 ENVIRONMENTAL PROTECTION: A CORE VALUE AT OUTOKUMPU. [BIB-199402-S4-0009]

Examples of Outokumpu's commitment to environmental improvements are described which production of sulfuric acid from sulfur dioxide recovered at 30 kg/tonne of metal produced by flash smelting, reduction in water usage from 40 to 5 million m³ and introduction of waste management. Dust from the steel melting shop at Outokumpu Polarit has been reduced to 0.2 kg/tonne of steel produced, while the melting capacity has been up from 50 000 t/year to today's 375 000 t/year. (Outokumpu News, (1993), 30, (2), pp. 26-28 [in English].)

1192 STRATEGIC RAMIFICATIONS OF CORPORATE ENVIRONMENTAL POLICY. [BIB-199403-G1-0059]

The minerals industry has been confronted by increasingly stringent environmental regulations that are significantly altering the economics of the industry. Heightened media attention, threats of litigation and decreasing support by the general public have exacerbated the industry's difficulties. Regardless of their merit, environmental issues present a serious threat to the continued viability of mining companies. Most of the changes in corporate environmental activities have been reactive. Pending regulations present formidable but uncertain technical requirements for compliance, and future regulatory developments are difficult to predict. (Cavender, B.W., Mining Engineering (Colorado), (Mar. 1994), 46, (3), pp. 204-207 [in English]. ISSN 0026-5187)

1193 ELIMINATE THREE WASTES IN PRODUCTION [BIB-JSTE000160]

To reduce environmental pollution in Shandong Province (China) each industry was set the target of the elimination or reduction of three effluents wastes. At the Yantai Synthetic Leather General Factory 10,000 M.T.A of 4,4' diphenylmethane diisocyanate is produced as a precursor of polyurethane, and gives rise to effluents contaminated with nitrobenzene, aniline, and benzene chloride. The wastes are treated by distillation to reduce the contamination levels to comply with current legislation. The recovered compounds are recycled through the reaction sequence. The system has been shown to have economic as well as environmental advantages over the alternative biochemical clean-up of the effluents which is accompanied by the loss of valuable materials (Wang, Yoo-feng, First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: UNEP, (1990). [in English].)

1194 NETT: A CENTRE FOR THE PROMOTION OF CLEANER TECHNOLOGY. [BIB-JSTE000161]

The European market in environmental matters (1990) was worth 0.3 billion ECU. The solutions to environmental problems are to be provided by science and industry, and to assist in this work NETT (Network for Environmental Technology Transfer) has been developed to become a European information centre. A PC-Modem and a contract with NETT gives access via one telecommunication line to more than 1,300 data bases, and provides specific databases on environmental matters. An explanation of the services available, the conditions and methods of access, and charges is given in the report. (Fairclough, A.J., First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: UNEP, (1990). [in English].)

1195 REPORT ON THE WORKING GROUP ON (HALOGENATED) SOLVENTS. [BIB-JSTE000162]

The remit of the working group associated with UNEP/IE for the promotion of cleaner technologies was to examine the use of halogenated solvents in industry and the home, and to propose ways in which the use of such solvents could be reduced, the waste controlled, and to what extent there could be substitution by solvents less damaging to the environment. Information would be gathered, monitored, and made available through a panel of experts, a network established, research and development promoted, and industry encouraged by examples from case studies of the adoption of cleaner technology to follow concepts of benefit to both industry and the environment. Substitution of halogenated solvents is recommended as the preferred and most important way forward. (Hillersborg, Aage S., First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: UNEP, (1990). [in English].)

1196 ENVIRONMENTALLY SOUND TECHNOLOGICAL INNOVATION [BIB-JSTE000163]

The warning, given in 1972 at the UN Conference on Human Environment, of damaging changes in the atmosphere and geosphere, has been followed by international efforts to reduce pollution due to industry. It is the concern of the UN Centre for Science and Technology that the cleaning of industrial production should be directed to the inherent processes and less reliance placed on end-of-pipe pollution removal with often an associated problem of toxic waste disposal. It is emphasized that cleaner technology must be made available, with the necessary information and financial assistance, to industries in developing countries. The solution of the environmental problem requires international action and cooperation, with facilitated transfer of relevant technology and information. (Trindade, Sergio, First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: UNEP, (1990). [in English].)

1197 THE INTERNATIONAL CONSULTANCY CENTRE FOR ENVIRONMENTAL TECHNOLOGY AND NUTRITIONAL INDUSTRY [BIB-JSTE000164]

The International Consultancy Centre for Environmental Technology and Nutritional Industry (ICCI) was founded in 1979. Consultancy, systems analysis, project management, applied research and development of new technologies are services provided over a wide spectrum of environmental pollution control and clean-up processes, and the recycling of industrial and municipal wastes. An integral part of the company's programme is cooperation with scientific and technical institutions. (Samimi, B., First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: ICCI, (1990). [in English].)

1198 AIPP'S ROLE IN THE COLLECTION AND DISSEMINATION OF INFORMATION ON CLEANER PRODUCTION [BIB-JSTE000165]

American Institute for Pollution Prevention. Support is to be sought from the private and public sectors, and assistance given to other agencies, in the promotion of cleaner production processes, and in particular to lease between the US Environmental Protection Agency and industry. Access to expertise and the information services of the UN-Environmental Programme is to be facilitated. The AIPP organization is based on four councils specializing in economics, education, implementation, and technology. The economic and technological barriers to clean production and pollution control are to be identified and the role of incentives in the overcoming of these barriers examined. Industry is to be made aware of the available technology for the prevention of pollution and of the economic advantages that may attend its application. (Rimer, Alan E., First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: AIPP, (1990). [in English].)

1199 NETWORKED COMMUNICATION: THE KEY TO GLOBAL PROGRESS IN POLLUTION PREVENTION AND CLEANER PRODUCTION [BIB-JSTE000166]

Pollution prevention technologies have not been widely adopted in the USA due to lack of knowledge of the options available, lack of finance, and reluctance to modify methods of production which meet current specifications and consumer demands. To change production patterns and encourage the adoption of options for pollution prevention by local government and industry the US-EPA has undertaken the setting up of an information network to act as a clearing house for experience and technology transfer. Two information hotlines exist together with a PC based Pollution Prevention Information Exchange System (PIES) which is widely used by government and industry. Access is available to data bases compiled by US-EPA, PIES, International Cleaner Production Information Computer System, and is being negotiated with industry cooperative for ozone layer protection and with information networks in Europe. It is intended that the network will accumulate and provide information on an international scale. (Morse, Myles E., First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: US EPA, (1990). [in English].)

1200 OECD PROGRAMME ON TECHNOLOGY AND ENVIRONMENT [BIB-JSTE000167]

A programme was approved in March 1990 by the OECD Council for the examination of incentives and barriers to innovation and diffusion of environmental technologies, and for the seeking out of cost-effective measures to prevent pollution, conserve materials, and reduce emissions in industry and elsewhere. Cooperation will be sought with UNEP/IE and with the OECD Business and Industry Advisory Group. Special support for the programme has been given by the USA, Japan, and the Netherlands. (Hammer, Rebecca, First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: OECD, (1990). [in English].)

1201 PROPOSAL FOR SETTING UP A UNEP/IE CLEANER PRODUCTION WORKING GROUP ON SUSTAINABLE AGRICULTURE AND FOOD PROCESSING [BIB-JSTE000168]

A return to less intensive farming with the adoption of organic mixed farming, with a reduced demand on fossil fuels, is advocated. All processing of foodstuffs involves waste and an output of contaminated water. Cleaning and preparation processes need to be revised and improved, with the cleaning and recycling of water. It is proposed that a working party be appointed to examine these matters, and recommend and cost the actions to be taken. (Jorgenson, Michael Sogaard, First Seminar on Cleaner Production, Canterbury, 1990/917-20. Publisher: Uni. Denmark, (1990). [in English].)

1202 LOW AND NON-WASTE TECHNOLOGY DATA BASE AT CENTRE FOR ENVIRONMENTAL SCIENCE AND ENGINEERING IN INDIA [BIB-JSTE000169]

Clean technologies developed and operated in temperate climates have in some cases been shown by research in Thailand and experiences in India not to be applicable under tropical conditions. A data base specific to Indian industries has been evolved by voluntary effort to provide access to information on low and non-waste technologies. The data-base is designed for access by PC, and information structure follows the ICPIE (UNEP/IE) format. Experts are to be

recruited to undertake validation of the information received. Some 100 case studies have been gathered of which several examples are quoted in this report. The provision of the information centre is intended to promote waste reduction/elimination processes in preference to end-of-pipe solutions. It is hoped that funding for the project can be obtained from industry. A draft policy statement on pollution abatement is under consideration by the government of India. (Modak, Prasad; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1203 THE ECOLOGICAL INFORMATION NEEDS OF THE INDUSTRIAL DESIGNER [BIB-JSTE000170]

The designer is restricted with regard to choice of materials by the fitness for purpose specifications of a particular product. To design for production with minimum effect on the environment the designer needs to be supplied with more information on materials, especially recyclable and recycled materials, and with reliable information on material properties. This has to be made available in a readily assimilable form to meet the specific requirements for compliance with product standards, with demands for waste reduction, with possible reuse of materials, and for overall cleaner production. (Burnette, Charles; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1204 AN ELECTROPLATING CASE STUDY OF STRUCTURING INFORMATION AND MODELLING TO PRODUCE MORE WITH LESS [BIB-JSTE000171]

In 1989 a working group, acting in cooperation with VOM (Netherlands), and consisting of representatives from the electroplating industry in the Netherlands, was formed to study how the heavily contaminated effluents and sludges generated by current processes could be reduced. Information on the efficiency of work already undertaken has been collected and the operation of plant studied using a computer model which is modified as information is received. The working group and its operations, in particular its role as an international coordinator and dissemination of information is being extended. An example with costing of the modification of procedures in a nickel plating plant to reduce the through-put of rinsing water, to avoid iron sludge, and to recover nickel, is annexed to the report. (Ros, J.P.M.; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1205 ICI'S STRATEGY TO PROMOTE RESEARCH AND ADOPTION OF CLEAN TECHNOLOGIES [BIB-JSTE000172]

For advances in the adoption of clean technologies there has to be investment, in scientific and technological research, and of capital in application and training, expenditure which can only be undertaken by profitable enterprises. A fundamental requirement is the making available of information to all who are concerned and this is being undertaken by a number of organizations including the UN. Financial incentives to develop new technologies, already provided by the EEC, need to be provided by governments. Implementation of waste and pollution control on existing plant can be difficult and replacement of plant impracticable. At ICI work is in hand to reduce waste and pollution and to set standards for new plant. The organization includes a Group Environmental Laboratory, a Central Toxicology Laboratory, and a team of environmental advisors to monitor international legislation and promote best practices within ICI. A worldwide database is proposed. Process development is aimed at reduction of waste at source, and where pollution is inevitable the effect on the environment and wild life is monitored. Improvements have been made in the manufacture of a fungicide, insecticide, and of caustic soda and chlorine. (Oatley, G.E.; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1206 ENCOURAGING CLEAN TECHNOLOGIES: THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY POLLUTION PREVENTION PROGRAMME [BIB-JSTE000173]

A primary method of control of pollution is the introduction of a cleaner less wasteful manufacture of products which, when discarded, are to the maximum extent recyclable to yield materials readily acceptable for reuse. Processes should be designed to use materials and energy economically, and where possible to include closed-loop recycling of materials not forming part of the final product. Research is required to provide more reliable measurements of

pollution on both micro and macro scales. Current projects monitored by USEPA are investigations of product design, the evaluation of existing technologies, the substitution of chlorinated hydrocarbon and organic solvents, and the recycling of antifreeze and engine oils. The importance of the dissemination of information and of technology transfer is emphasized. Included in the report is a list of relevant organizations, personnel who may be contacted, and a bibliography. (Lewis, Ivars J.; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1207 THE UNEP CLEANER PRODUCTION PROGRAMME. AN OVERALL VIEW. [BIB-JSTE000174]

A network facilitating the development and transfer of environmental technology will be promoted by UNEP/IE together with governments, industrial research organizations, and relevant institutions. The advice of 23 experts from different countries has been sought by the IE, and it was agreed that priority should be given to the raising of awareness and to information exchange. The aim of the programme was the prevention or reduction to a minimum of short and long-term risks to mankind and the environment. The description 'cleaner production' was introduced to include both new technologies and good operating procedures. Information would be made available through the US Environmental Protection Agency Pollution Prevention Information Clearinghouse, serving as a link to existing data bases. Working groups were created to specialize in the metal plating, textile, and leather industries, and in the use of halogenated solvents. Other working groups have been proposed for the petroleum, pulp and paper, and aquaculture industries. (de Lardereel, Jacqueline Aloisi; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1208 LIMITS AND POSSIBILITIES OF ECODESIGN [BIB-JSTE000175]

Solutions to the environmental problems originating in the current systems of production and consumption require not only the involvement of pure technology but also, through redesign, the creation of a consumer demand for products more favorable to an environmentally protective culture. This 'ecodesign' would be based on a combination of the ecologically necessary and the technically possible, but whether consisting of a modification of the old or production of the totally new, it must be both socially acceptable and culturally attractive. (Manzini, Ezio; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1209 A GOVERNMENT PERSPECTIVE ON CLEANER TECHNOLOGY [BIB-JSTE000176]

There must be international cooperation and research and development directed towards replacement by a cleaner technology of purification, dilution, and dumping, if solutions to the problems of pollution and degradation of the environment are to be sustainable. Legislative control of industry needs to be supported by incentives, motivation, and access to information, to promote the adoption of processes and product designs based on the use of newer natural resources, the economic use of energy, recycling, and reduction of waste to a minimum. Since 1987 a development programme concerned initially with the reduction of pollution caused by heavy metals, solvents, hazardous materials, and the discharge into the sea of organic waste, has been adopted and subsidized by the Danish government, by whom it will be sought within the EEC to make cleaner technology an essential part of the EEC environmental action plan. (Dybkjaer, Hon. Lone; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1210 LABELLING CLEANER PRODUCTS: A CRADLE TO GRAVE APPROACH [BIB-JSTE000177]

In Canada, before a product can be marketed under an official label testifying to its environmentally 'green nature' the production, use, and ultimate disposal of the product is examined. The overall environmental effects of the choice of materials, method of manufacture, use and disposal, are not always clearly discernible, and substitution of a harmful ingredient not always possible. Labelling of products had been undertaken but insufficient time (1990) had passed to allow the effect on the sales, or the economic advantages to the manufacturer to be assessed. (Delbridge, Pat; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1211 THE GERMAN ENVIRONMENTAL LABEL PROGRAMME [BIB-JSTE000178]

A market economy instrument of environmental labelling was introduced in Germany in 1977 with the advantages of consumer awareness of the need for environmental protection, and of the existence of highly developed relevant technology. Both indigenous and foreign companies could be licensed to display the label. Environmental Compatibility of products needs to be an essential component of market competition. (Müller, Edda; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: UNEP, (1990), [in English].)

1212 REPORT ON THE WORKING GROUP ON THE TEXTILE INDUSTRY [BIB-JSTE000179]

Vast quantities of water are used in the sequence of processes characteristic of textile production. The management of waste water has been largely end-of-pipe treatment before discharge, treatment which has become increasingly expensive. The control of manufacture so as to use water, chemicals, and energy more effectively and economically has been proposed, but has had limited application as information and new cleaner technologies are not readily available. The creation of an information network and a panel of experts from the industry for the gathering and dissemination of information was initiated on behalf of the UNEP/IE in 1990. The members of the panel with four exceptions represent Asian and Indonesian industries and increased representation is sought from Europe and America. (Modak, Prasad; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: UNEP, (1990), [in English].)

1213 REPORT ON THE WORKING GROUP ON TANNERIES [BIB-JSTE000180]

A specimen information sheet is given for an aluminum-titanium complex tanning agent to be used for the partial or complete replacement of chromium compounds in tanneries. Chemical manufacturers are advised of the preparation of a Clean Technology database which will initially be made available to European tanneries, and of information to be publicized in relevant technical journals. The gathering of data is illustrated by a questionnaire issued to industry seeking information on processes and the availability of expert personnel. (Alexander, Ken; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: UNEP, (1990), [in English].)

1214 REPORT ON THE WORKING GROUP FOR THE METAL PLATING INDUSTRY [BIB-JSTE000181]

In conjunction with the UN-EPA information dissemination initiative a network of about fifty specialists from the metal plating industries in Western Europe and North America has been formed by the National Institute of Public Health and Environmental Protection (Bilthoven, Netherlands). It is proposed that the network should become an international information centre for the industry, given the interest, funding, and cooperation from industry in the provision of case studies and technological information on clean production. (Ros, J.P.M.; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: UNEP, (1990), [in English].)

1215 THE TRANSFER OF CLEANER TECHNOLOGIES [BIB-JSTE000182]

In 1988 experts from different countries were invited to form an advisory group on Cleaner Production. Sub-groups were arranged to consider particular industries, and action was taken to improve the exchange of information. Financial support was given by the United Kingdom, France, and Italy for specific projects, and by the United States of America for the programme as a whole. To oversee the programme the Netherlands seconded a consultant for six months. In this report the work of the consultant is summarized. Improvements in the process of technology transfer are recommended, in particular the necessity to provide investors and their advisors in industry with appropriate data on cleaner production methods. (Winkel, Peter; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: UNEP, (1990), [in English].)

1216 DESCRIPTION OF GOVERNMENT POLICY IN FINLAND [BIB-JSTE000183]

This paper is part of the documentation of the Canterbury, UK, seminar in 1990, concerning environmental protection matters in Finland. Here, in 1983, a Technological Development Centre (TEKES) was set up to maintain and develop technology and technological knowledge. A Ministry of Environment was set

up in 1983 to cover low and non-waste technology. Details are given of a variety of projects undertaken by these organizations and the goals established for developing the two technologies above. Information is given on the work undertaken by industries such as copper smelting, ferro-chrome production and various sections of wood processing. Some results are given of the outcome of these activities. (Ministry of the Environment; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: UNEP, (1990), [in English].)

1217 PROGRAMMES TO PROMOTE LOW AND NON-WASTE TECHNOLOGY: COUNTRY PROFILE OF THE UNITED STATES OF AMERICA [BIB-JSTE000184]

This report summarizes the policies of the USA in regard to waste reduction. It covers federal, state and industry programmes and lists the main sources of Low and Non Waste Generating Technologies (LNWT). Separate summaries are given of the types of programmes carried out for the federal, state and industry programmes. The inter-relationships which already exist, and which are envisaged, are also given. Some information is given in regard to interesting programmes being carried out by certain sections of industry. Some types of Clearing House exist, and the use of these is described. Some specialized information services available are mentioned. (Baker, D. Rachel; Warren, John L.; US Environmental Protection Agency; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: US EPA, (1990), [in English].)

1218 FINAL REPORT SEMINAR ON THE PROMOTION OF CLEANER PRODUCTION [BIB-JSTE000185]

This report is on the Seminar held in Canterbury, UK, on 7-20 September 1990, arranged by the UK Government and held under the auspices of the United Nations Environment Programme Industry and Environment Office. The Cleaner Production Programme of 1989 was to implement decisions taken by the UNEP Council. All agreed on the need to transfer cleaner production methods, including managerial and research matters. An International Cleaner Production Information Clearing House was set up and now produces a newsletter, distributed to 20,000 readers in 160 countries. It was agreed to develop CPIC further and the newsletter and to support countries developing their own cleaner production programmes. (UNEP/IE; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: UNEP, (1990), [in English].)

1219 POLLUTION PREVENTION: ESTABLISHING AND IMPLEMENTING A PROGRAMME [BIB-JSTE000186]

General Electric (GE) of the USA has established a POWER (Pollution, Waste and Emission Reduction) programme to identify and eliminate waste. The programme encourages GE's employees to think in terms of pollution prevention rather than control, and to integrate this concept into product design, production and packaging. The economic, safety and health, public relations, marketing and competitive benefits of the programme are explained. The establishment and implementation of a pollution prevention programme are described. It is suggested that a POWER task force is set up and waste reduction goals established. An Opportunity Assessment is performed and an inventory (which traces each waste stream from its source to its final disposition) compiled. Options and priorities are identified so that specific pollution prevention projects can be recommended. Methods for tracking and measuring progress of these projects are given. (General Electric Company; First Seminar on Cleaner Production, Canterbury, 19900917-20, Publisher: GE, (1990), [in English].)

1220 LESSONS LEARNED THE HARD WAY [BIB-JSTE000187]

Examples of how General Electric's (GE) non-chemical businesses have been affected by environmental enforcement are given. Violations of environmental regulations and the lessons learned from these violations are described. GE's POWER programme for pollution prevention is outlined. It is usually cheaper and environmentally preferable to avoid generating waste rather than treat and dispose of it. Health effects due to electromagnetic fields are considered. Possible links between such fields and cancer should not cause alarm but point to a need for additional research. The packaging issue, fuelled by growing awareness of solid waste disposal problems, is discussed. GE already uses recycled cardboard for a large percentage of its packaging, and has developed a recyclable plastic bottle for the European market. Environmental groups with whom GE's employees may have to deal are identified. GE's global business strategy, and its environmental implications, are addressed. (General Electric

Company. First Seminar on Cleaner Production. Canterbury, 19900917-20. Publisher: GE. (1990). [in English].)

1221 POLLUTION PREVENTION PRACTICE IN THE NETHERLANDS: POSSIBILITIES OFFERED THROUGH THE APPLICATION OF BIOTECHNOLOGY AND BIODEGRADABLE ADJUNCTS [BIB-JSTE000188]

An investigation into the use of biotechnological processes and biodegradable adjuncts to prevent or reduce pollution across a range of industrial sectors is reported. Enzymatic hydrolysis of vegetable-based material in the food industry has been shown to be feasible; further experiments will be undertaken to optimize the process. There is also a promising future for enzyme processes in the leather industry. Biodegradable degreasing agents, metal working fluids, lubricants and engine oils are discussed. At present these are expensive and/or difficult to obtain. In some cases, practical and technical problems need to be addressed. Biosorption and bio-recovery of metals for on-site re-use in the electroplating industry have been examined. The systems work well but are too expensive for recovering the relatively cheap metals such as zinc, nickel and chromium which the industry uses. Paints and cleansing agents based on biodegradable materials are a possibility. (Kothuis, Bas; Sterrenberg, Lydi; Brezet, Han; Netherlands Organization for Technology Assessment; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: NOTA. (1990). [in English].)

1222 WHAT ROLES CAN UNIVERSITIES PLAY IN HELPING TO EFFECT SOCIETAL TRANSITION TO CLEANER PRODUCTION? [BIB-JSTE000189]

Academic institutions can play a role in changing the approach to environmental protection from one of pollution control to one of pollution prevention. Industrial demonstration projects developed in Sweden, Norway and the Netherlands show that a "Cleaner Production" (CP) philosophy can be applied successfully in European companies. Financial as well as indoor and outdoor environmental benefits resulted when CP technologies were adopted. Environmental benefits include reduced raw material wastage and the elimination of waste streams. A pulp and paper industry company in Norway found that CP approaches increased product quality and productivity, improved worker safety and decreased worker absence. A Netherlands producer of resins reported that process and procedural modifications will pay for themselves within a year and then provide increased profitability. Ten useful steps for a company leader seeking to move towards CP are listed. Universities are beginning to offer courses in CP. The syllabus for one such course is presented. (Huisingsh, Donald; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: UNEP. (1990). [in English].)

1223 THE ENVIRONMENT LABEL INTRODUCES ITSELF [BIB-JSTE000190]

The aims, background and procedural aspects are described. This label is awarded to products which are particularly acceptable in terms of environmental protection, compared with other products serving the same purpose. Award of the label is based on eligibility criteria laid down by an independent Environmental Label Jury, in consultation with experts. The label's philosophy, legal basis and award criteria are explained and the award procedure detailed. Environmental Label product groups are listed and the eligibility criteria for each product group are given. (Umweltbundesamt, RAL Deutsches Institute fuer Guetesicherung und Kennzeichnung; First Seminar on Cleaner Production, Canterbury, 19900917-20. Publisher: Umweltbundesamt, (1990). [in English].)

1224 UNEP INTERNATIONAL SEMINAR ON CLEANER PRODUCTION HELD IN POLAND [BIB-EEIS013055]

The meeting focused on three issues: policy initiatives to promote cleaner production, activities in industry, and funding and financing of Cleaner Production. The participants reported on various national and regional policy initiatives to promote the development of Cleaner Production and learned of many programmes blossoming in various parts of the world that adhered to the Seminar's slogan "Start Small but Think Big." Initiatives made in Poland, China, Egypt, India and other countries illustrated the progress made during the past two years. Participants also discussed several associated challenges such as the fragile structuring of programmes and the lack of proper institutional mechanisms to stabilize them. The seminar found industry is increasing its activity in promoting Cleaner Production as leading large and small companies are developing pro-

grammes. Participants generated many recommendations to promote Cleaner Production. One message from the Session on Funding and Financing was the need to raise awareness and hold training activities for funding institutions so that they can better understand and evaluate projects related to Cleaner Production. It also recommended that macroeconomic adjustments, such as subsidies, pricing of raw materials and energy, be carefully examined for their adverse effects on investments. (UNEP/IE, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: UNEP. (1994)1021). [in English].)

1225 THIRD HIGH-LEVEL ADVISORY SEMINAR ON CLEANER PRODUCTION [BIB-EEIS013091]

M. Rigola and I. Volodin attended this third UNEP Seminar on this topic. Discussions were held with IE concerning the NCPC programme and selection of candidate institutions; EBRD about possible funding of eastern European NCPCs as part of privatization and restructuring exercises; Basel Convention secretariat about waste minimization regional centres under that programme. (United Nations Industrial Development Organization, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: UNIDO. (1994)1020). [in English].)

1226 CLEANER TECHNOLOGY CENTRE - MALTA [BIB-JSTE000100]

The Ministry of the Environment, Malta, published a Waste Management Strategy after a two year study. This advised the Government to set up a Cleaner Technology Centre. This was acted upon at once and the Centre is based at the University of Malta. It is a joint venture - Ministry of the Environment, Department of Industry and Malta University Services Ltd. Formation was in 1994 and, so far, little formal activity has taken place, apart from a single one day seminar "CFCs What Future?" The formal agreement for the formation of the Centre is attached. (Cleaner Technology Centre, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: CPC Malta. (1994). [in English].)

1227 RECENT DEVELOPMENT ON ENVIRONMENTAL POLICY IN JAPAN [BIB-JSTE000101]

This paper consists mainly of a list of fundamental plans on the environment, efforts towards global environmental problems, economic measures, environmental assessment and the establishment of an environmental auditing system. A few very brief details of work being undertaken in Japan are given. From January to March 1994 some 339 companies developed "Voluntary Plans on Environment". There is a resume of the contents in a publication issued in June 1994, called "Providing environment vision for industry". Reference is made to a number of reports on waste management and recycling and some publications issued on the subject. A classification list is given for Eco business. (Hayashi, T.; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: GISPRI. (1994). [in English].)

1228 COUNTRY REPORT: ETHIOPIA [BIB-JSTE000102]

Ethiopia has a low level of industrial development and is beset with many socio-economic priorities. This being so, matters of clean technology take a very low priority. Some interest has, however, arisen in the 1990s. The Ethiopian Government has started to issue some national policies, to help socio-economic conditions and development. Much effort is made to introduce environmental considerations - including Cleaner Production. The following policies and draft policies have been introduced: National Science and Technology, National Environmental, National Science and Technology for Industry and National Development of Engineering Industries (Mebratu, Desta; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: Chem-Tech, (1994). [in English].)

1229 FINANCING CLEANER PRODUCTION IN DEVELOPING COUNTRIES [BIB-JSTE000103]

One argument in support of CP projects is that it gives both environmental and economic benefits. Emphasis is placed on the payback period involved. Funding in developing countries often involves a number of matters - awareness, up to date knowledge of CP practices and technologies, training and demonstration projects. The obstacles and constraints likely to be met in CP funding in developing countries are discussed in detail. Generally, they impede the speed

with which these projects may be undertaken. Outside help is normally required and due consideration has to be given to the donor country, commercial bankers etc as well as to the recipient of the funds. (Hafez, Salah: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: NA. (1994). [in English].)

1230 CLEANER PRODUCTION IN THE CZECH REPUBLIC [BIB-JSTE000104]

Sustainable development in the Czech Republic is covered by a Czech law, which includes the duty to prevent the generation of pollution by source. It is supported by The Ministry of Environment and Ministry of Industry and Trade and the Czech Environmental Management Center. The first case study in the country was one of waste minimisation and eight new projects are being started in factories at present. Cooperation exists with Norway (since 1992), using a model used earlier in Poland. The final aim is to found a Cleaner Production Centre (CPC) (with Norwegian help) with Czech lectures and consultants and some fifteen participating companies. (Czech Cleaner Production Center, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: CPC Czech. (1994). [in English].)

1231 US AID'S ENVIRONMENTAL POLLUTION PREVENTION PROJECT (EP3): EXPERIENCES IN CHILE [BIB-JSTE000105]

This project has just entered its second year. It involves a sustained pollution prevention programme and has two main avenues - the development of supply of and demand for pollution prevention knowledge. The structure of EP3 is outlined. It hires local staff and places great importance on the local entity. Contact is constantly maintained with the American-Chilean Chamber of Commerce. Sections of the paper cover the development of supply and demand through information system access and details of the EP3 Chile staffing. Some direct technical assistance is given and the main aims always include that of sustainability. (USAID, Environmental Pollution Prevention Project, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: USAID. (1994). [in English].)

1232 THE WORLD FEDERATION OF ENGINEERING ORGANIZATIONS AND CLEANER PRODUCTION [BIB-JSTE000106]

WFEO is a non-government international organization formed in 1968 under UNESCO sponsorship. Its aims were to train scientists and technical people for the benefit of humanity, to foster technical development for social and economic purposes and to study major problems generally. All members are scientific or technical institutions and the major ones involved are listed. Considerable time is spent on matters of cleaner production and minimizing waste generally and a number of examples of these is given. Literature is prepared in several languages, for distribution to member bodies and regional and national level conferences are arranged regularly, world wide. (Thom, David: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: WFEO. (1994). [in English].)

1233 APCTT'S ACTIVITIES IN TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGIES AMONG SMES IN ASIA AND THE PACIFIC [BIB-JSTE000107]

The UN-ESCAP Asian and Pacific Centre for Transfer of Technology (APCTT) was established in India in 1977. The aim is a better environment for technology transfer in Asia and the Pacific. At present, the Centre is handling over 250 business to business introductions monthly. It is vital that small and medium sized enterprises (SMEs) succeed and, to do so, they must keep abreast of new technology and cleaner production developments. Much of this, as is explained, is done by forming partnerships and networks - another APTCC activity, of which a few details are given. Cooperation exists with the Mechanism for Exchange of Technology Information (METI) funded by UNDP. (Kotelnikov, Vadim: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: APCTT. (1994). [in English].)

1234 ENERGY AUDITS AND CLEANER PRODUCTION IN TANZANIA [BIB-JSTE000108]

The paper relates some of the work done by the Tanzania Industrial Research and Development Organization (TIRDO), which commenced operations in

1979. One of these spheres was that of energy audits. These are of particular interest to Tanzania and, with the help of the Government, TIRDO carried out audits in over 50 industries in the country. One of the snags experienced was the fact that several industries do not have the funds to implement the recommendations made. They also lack the necessary trained personnel. This is unfortunate, as the audits showed that it was possible to effect savings of up to 50%. Mention is also made of TIRDO's role in the Cleaner Production programme. (Tanzania Industrial Research and Development Organization: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: TIRDO. (1994). [in English].)

1235 PROMOTION OF MINIMISATION OF WASTE UNDER THE BASEL CONVENTION ON THE CONTROL OF TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND THEIR DISPOSAL, 1989 [BIB-JSTE000109]

Transboundary movements of hazardous wastes and their disposal are covered by the Basel Convention. This became effective in May 1992 and has been ratified by 73 countries and the European Union. There are three main aims: (1) these movements should be a minimum; (2) such wastes should be disposed of near their source; (3) waste generation should be reduced to a minimum. Some of the more important points of the Convention are highlighted. These include the necessity for continual cooperation between the parties and continual training of staff employed in handling these wastes. Several feasibility studies are available - in Latin America region, Asia Pacific region and Eastern Europe. (UNEP, Basel Convention: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: UNEP. (1994). [in English].)

1236 CLEANER PRODUCTION POLICIES AND ACTIVITIES OF THE INTERNATIONAL LABOR ORGANIZATION [BIB-JSTE000110]

The ILO, as with other organizations, is involved with environmental matters and this paper describes some of its activities. The priorities are working environments, employment and development, training and tripartism. Considerable attention is given to the working environment, including health priorities. Matters such as safety in the use of chemicals at work are studied closely as is cleaner production, in all its phases: employment, development, training, tripartism. A number of environmental projects have been implemented with a total value of \$ 25 million. Other activities include appropriate publications, safety matters, courses for employers and business types of training. (UN ILO: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: ILO. (1994). [in English].)

1237 BACKGROUND INSTITUTES PAPER [BIB-JSTE000111]

This paper summarizes the activities of the International Institute for Interstructural, Hydraulic and Environmental Engineering, Delft, Netherlands. At present, 250 students from over 70 countries, attend one year post graduate courses. A further 60 students attend short courses annually. A more detailed description is given of the one year Environmental Sanitation and Management Course. The syllabus is outlined and includes the occurrence and properties of micropollutants and their forms of distribution. Other subjects include the effects of micropollutants on living organisms and their detection, analysis and sampling. Other subjects include legislation and the more important parts of process technology and its benefits. (Siebel, Maarten: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: IHE. (1994). [in English].)

1238 IEA - DESCRIPTION OF RELEVANT ACTIVITIES FOR THE UNEP SEMINAR ON CLEANER PRODUCTION [BIB-JSTE000112]

The IEA has over twenty years of experience in examining matters involved in developing and deploying energy in OECD countries. This paper describes some of its activities. Information systems clearing houses have been established by the IEA which list available technologies. A study group has been set up to consider future technology needs and the framework of future policy. These may include additional specialist type centres. Some of the financial issues which arise are considered. (OECD International Energy Agency: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: OECD. (1994). [in English].)

1239 WHAT GETS MEASURED GETS DONE—SETTING ENVIRONMENTAL GOALS [BIB-JSTE000113]

This paper describes some activities of the USA based S.C. Johnson company in the field of environmental impact, using the adage "What gets measured gets done". The range of possible objectives is enormous and work was focussed on manufacturing waste, packaging, product formulation and public education. Targets posed problems, as did the establishment of a measuring unit. The overall goal was to produce more, with less waste. Getting data set, more problems and a few details are given on the methods adopted. Feedback methods adopted are described, hampered by the sheer volume of new data and its variations in presentation form. (Montgomery, Diana, Salzman, Jim. Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: SCJ, (1994). [in English].)

1240 UNIDO ACTIVITIES IN THE FIELD OF CLEANER PRODUCTION [BIB-JSTE000114]

Cleaner production has been a sub-programme of the UNIDO environment programme since 1990. It is similar to process optimization, aiming at waste reduction. Cleaner production builds on process optimization. The main requirements are suitable government policies, support for institutions able to implement cleaner production and demonstration projects to show the advantages. An example is described of such help given to the Brazilian textile industry and the leather sector and also for the chemical industry in Poland. Further examples given are applications in the cement industry in Egypt and several assorted ones in India - all showing appreciable results. (UNIDO HQ: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: UNIDO, (1994). [in English].)

1241 THE DELPHI GROUP—BACKGROUND REPORT ON CLEANER PRODUCTION [BIB-JSTE000115]

The Delphi Group is involved in investment and consulting services for sustainable development in the Asia Pacific Region, Africa Region and Eastern Europe. It was founded in 1988 and has offices in Europe and North America and contacts elsewhere. Some details are given of typical activities in India and South Africa. These include eco-efficient municipal services and such an industrial park in Bangalore. A publication entitled "Financing Cleaner Production" was prepared for UNEP, which studies examples of successful financial solutions and also recommendations for a number of bodies, governments and companies. The Globe 94 conference was organized by Delphi. (Delphi Group: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: Delphi, (1994). [in English].)

1242 CZECH CLEANER PRODUCTION CENTER [BIB-JSTE000116]

This paper describes the final goal of the Czech-Norway Cleaner Production Project, funded by the latter Government in 1992-94. Since inception, two interactive training programmes have been initiated and about 10 projects completed. The Centre is continuing activities and also widening them and international support is being sought. The main activities are listed and cover encouragement of cleaner production, training, methodology, policies funding and international cooperation. Various Czech educational establishments are responsible for the training programmes and are situated in Zlín and Prague. Members of two Ministries are members of the CPC Steering Committee and discussions are being held elsewhere. (Czech Cleaner Production Center: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: CPC, (1994). [in English].)

1243 COOPERATION ON INDUSTRY, ENVIRONMENT [BIB-JSTE000117]

This paper describes an idea put forward by Carl Duisberg, Germany, for an international training project to increase common effort for new production technologies and economic patterns of development which can be maintained. Modern economy is felt to cause shortcomings, including the handling of natural resources. All types of countries could participate and all manner of organizations within them. The subjects to study could include eco-efficient measurement of large enterprises, clean production, cooperation in technology transfer, energy and production. Carl Duisberg already handles a number of programs for others and training with over 100 countries and is thus well qualified to offer the idea

(Carl Duisberg GesmbH: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: CDG, (1994). [in English].)

1244 WASTE PREVENTION THEORY AND PRACTICE SUMMARY [BIB-JSTE000118]

This paper seeks to establish the design effects of design-waste by basic systems and theoretical elements. This leads to an overall transformation module and a number of modules can be linked to form a model chain. The overall transformation process leads to materials and information as input and waste as output. A materials life cycle model is also presented and applied to analyze aspects of waste management. The general employment of the system is described, together with its present capabilities and some likely future developments. Government policies and social factors and their overall effect on waste are considered. (van Weenen, J.C.: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: NA, (1994). [in English].)

1245 NORWEGIAN INDUSTRIAL TRANSFER OF KNOWHOW PROGRAMMES ON WASTE MINIMISATION AND CLEANER PRODUCTION TO CENTRAL AND EASTERN EUROPEAN COUNTRIES [BIB-JSTE000119]

The Norwegian Government finances know-how programme transfer to Poland, the Czech Republic and Slovak Republic and is starting a programme for the Russian Federation. The programmes aim at profitability, environmentally favorable conditions and restructuring of 200 350 companies in each country in the first 2-4 years. The detailed goals are listed, with emphasis on environmental and economic ones. A few details are given of typical progress made to date. The bases of typical programme instruction schemes are sketched, and also matters concerning marketing, libraries and the like. The Norwegian Society of Chartered Engineers is cooperating with the Society of Engineers in Poland. (Nedenes, Olav S.: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: NIF, (1994). [in English].)

1246 COUNTRY PAPER REPORTING POLICIES AND ACTIVITIES ON CLEANER PRODUCTION IN THE NETHERLANDS [BIB-JSTE000120]

The government policies and activities to promote cleaner production are described under four headings: the target group management approach; managing priority waste streams; product policy; and stimulating environmental technology. The national environmental policy plan of the Netherlands in 1989 set out a strategy for achieving sustainable development in one generation. The mechanism for doing this is by devolving responsibility onto other groups, with the use of voluntary agreements or covenants. Dates between 1990-1995 for the covenants in some 15 sectors are listed. An energy conservation plan is included. The section on priority waste streams is concerned with effect-oriented and source-oriented policies, the former for limiting negative effects on humans and animals, plantlife etc., and the latter with preventing or reducing pollution at source. Details are given on products and the environment policy, environmental product development and an environmental labelling system. The last section deals with financing these policies. (Suurland, Jan A.: Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: Ministry of Housing, Netherlands, (1994). [in English].)

1247 MAURITIUS COUNTRY PAPER ON CLEANER PRODUCTION [BIB-JSTE000121]

The Government of Mauritius has been fully committed to the conservation and protection of the environment for over two decades. Mauritius had formulated its National Environment Action Plan in 1989 covering 32 projects and including issues such as: institutional strengthening, land management and tourism, sewerage, creation of environmental laboratories, agricultural practice, marine conservation and terrestrial conservation. This work is costed at US \$ 69 million with the first phase to be completed by October 1995. The Government has two main concerns, firstly, the island is small, hence the ecosystem is fragile and, secondly, it wishes to improve the quality of life of its citizens. The University of Mauritius provides training in environmental sciences. With regard to industry on the island it is considered that 60% of the reasons why cleaner production is not used are human attitudes, 30% are financial and only 10% lack of technology. It is recommended that a seminar or workshop should be organized to work on real case studies for existing industries in Mauritius. (Prayag, R.H.: Third

High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: Ministry of Environment, Mauritius. (1994). [in English.]

1248 AN UPDATE ON THE UNEP CLEANER PRODUCTION PROGRAMME [BIB-JSTE000122]

The "Cleaner Production" term was launched and adopted in Canterbury 1990 at the first Cleaner Production Seminar hosted by the UK. This programme supports a new preventive approach to achieve both environmental and economic benefits. It is facilitated at the international level by UNEP, at the request of its governing council, endorsed by UNCED in 1992 and in CSD decisions in May 1994. It is advised by a large core of international experts. The main aim is to increase world awareness of the cleaner production concept as well as improving information exchange, training, demonstration projects and cooperation with governments, etc. Its achievements include expanded information exchange on technologies, policies, etc. Publications on cleaner production are prepared and circulated. Information is also available by electronic mail and seminars and workshops are organized. Details are given on China's Cleaner Production Project and demonstration projects in the Africa Region. The lessons learned from these efforts are briefly described and emphasized the importance of information dissemination, seminars, working groups and demonstration projects. Of crucial importance is the question of cooperation at every stage. (de Lardereel, Jacqueline Aloisi; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: UNEP. (1994). [in English].)

1249 EUROPEAN BANK FOR RECONSTRUCTION AND DEVELOPMENT—FUNDING AND FINANCING CLEANER PRODUCTION [BIB-JSTE000123]

The European Bank was founded in 1990 by the leading OECD nations together with the countries of Central and Eastern Europe and the former Soviet Union. It began operations in April 1991 with a mandate to promote the transition in these countries toward free market economy democracy. Projects which attract investment include industrial waste management, municipal effluent, atmospheric emissions control, water supply, nature conservation, etc. Improvement of energy efficiency is also a major contender for investment. Particular environmental programmes are outlined e.g. for the Baltic sea and the Danube basin. The bank is also supervising the Nuclear Safety Account to improve the safety of the more dangerous nuclear plants in Central and Eastern Europe. Environmental self-help is encouraged. Ways in which the bank promotes cleaner production outlined. (Prasek, Dariusz; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: EBRD. (1994). [in English].)

1250 WASTE MANAGEMENT: CLEAN TECHNOLOGIES - UP-DATE ON SITUATION IN MEMBER STATES [BIB-JSTE000124]

A study on cleaner technology in the EU member states was initiated by the Commission of the European Union in 1993. The report gives an historical view of the concept of cleaner technology and describes the policies, strategies and concepts of each member state. Particular attention is given to the Netherlands, Denmark and Spain. The Cleaner Technology activities in the EU member states are tabulated and briefly discussed. In addition an overview of cleaner technologies and achievements is given for selected industries e.g. metal products, the dairy products industry and wood and furniture industries. The cleaner technology activities of international organizations and networks are described. Environmental management systems are presented and the future role of the European Commission is discussed. Recommendations for future work are given. (Nielsen, Brigitte B.; Doelman, Peter; Schelleman, Fard; Christiansen, Kim; CEC DG for Environment, Nuclear Safety and Civil Protection; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: CEC. (1994). [in English].)

1251 DEMONSTRATING CLEANER PRODUCTION IN SMES IN INDIA. UNIDO-NPC EXPERIENCE OF PROJECT DESIRE [BIB-JSTE000125]

The DESIRE project 'Demonstration in Small Industries for Reducing Waste' was sponsored by UNIDO and conducted by the National Productivity Council India during 1993-1994. Three industrial sectors were involved, namely pulp and paper industry from agricultural wastes, dyeing and printing of textiles, and pesticides. In each sector four units participated. Details on the method of

selection are given and the results achieved during the test period are tabulated. Some 450 waste minimization options were identified of which over 200 were implemented at a cost of US\$ 0.38 million compared with annual savings of US\$ 1.2 million. In the pulp and paper sector there was a 31% reduction in pollution, for textiles 16% reduction and in pesticides some 75%. Numerous barriers to the implementation of the projects were encountered, including organizational, systemic, attitudinal, economics, technical and governmental barriers and measures were developed to overcome them. The overall conclusion is that there is considerable scope for reducing waste in small industries provided the barriers can be overcome. (Chandak, Surya Prakash; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: NPC. (1994). [in English].)

1252 CLEANER PRODUCTION IN OECD COUNTRIES [BIB-JSTE000126]

This is a report on how the OECD countries are coping with environmental problems after some three decades of sizeable investment in capital, technological and human resources. In the manufacturing sector one conclusion is that they are not doing too badly at the moment but that the real challenges are in dispersed pollution, particularly in transport and agriculture. It is difficult to assess the overall level of investment in cleaner technology as some modifications may occur for non-environmental reasons, however it is evident that investment in clean processes makes good economic sense. The emergence of an environmental industry has earned some US\$ 300 billion worldwide in 1993. An important factor is the emergence of the sustainable development world model, replacing the anti-growth, anti-technology models of the 1960's and 70's. This has resulted in a shift from waste management to pollution prevention i.e. to move away from "end-of-pipe" methods. Pressure can be exerted by market-based policy tools i.e. taxation, charges, etc. A hybrid approach is emerging based on a mix of government regulations and market-based forces. Other matters considered include substitutes for some raw materials, providing more information to a wider audience outside OECD countries, eco-labelling, general support for cleaner technology, etc. (Long, Bill L.; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: OECD. (1994). [in English].)

1253 LATIN AMERICA AND THE CARIBBEAN—POLICY INITIATIVES TO PROMOTE CLEANER PRODUCTION [BIB-JSTE000127]

The concept of Cleaner Technologies is quite new in this region and there is little activity there to date. UNEP promotes seminars in Trinidad and Tobago and Uruguay; it also distributes information to governments and some industries. UNIDO/UNEP has established two National Cleaner Production Centres and the Environmental Pollution Project (EP3) of the US government has units in Chile and Ecuador. Other activities include the Responsible Care Programme of industry. Voluntary environmental auditing is encouraged, as in Mexico, and yearly audits are now required in Brazil. The major obstacles are lack of information on economic and pollution control benefits as well as specific technical information. In addition, there is no credible demonstration that cleaner production works and is economically beneficial. There is a lack of financing and also the idea that if there is no legislation then industry does not have to do anything. (Heileman, Leo; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: UNEP. (1994). [in English].)

1254 POLAND AND CENTRAL-EASTERN EUROPE (CEE)—POLICY INITIATIVES TO PROMOTE CLEANER PRODUCTION [BIB-JSTE000128]

Government and industries still have a largely traditional approach to waste minimization and cleaner production. Coordination is needed between industrial policy and environmental policy in most CEE countries. There is, however, an increasing appreciation of restructuring of industry and reduction of industrial pollution leading to large economic savings. The CEE countries do not have the financing to use traditional end-of-pipe waste treatment. Poland and the Russian Federation have applied high pollution charges since 1990. In some cases the savings produced by minimizing waste and energy utilization have more than offset the pollution charge. All CEE countries subsidize raw materials and energy. This has a very negative effect. The largest obstacle to implementing cleaner production waste minimization is a lack of leadership understanding of possible large economic savings. A number of near zero investment options can

usually be applied with savings of 15-25%. With additional finance this can be increased to some 50%. A number of recommendations are made: in particular, use of pollution charges, financial aid and free assessment advice, training and grants for pilot tests. Costs should be less than US\$ 5,000 per company. (Nedenes, Olav S.; Nowak, Zygfryd; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: UNEP, (1994). [in English].)

1255 ACTIVITIES ON ECOLABELLING [BIB-JSTE000129]

For many countries, developed and developing, the spread of ecolabelling schemes raises concerns. It is possible for these to be used as a non-tariff barrier. Some developing countries, as yet, have not been able to participate in ecolabel development. UNEP is working on such problems from several perspectives. There are over twenty "third party certification" ecolabelling programmes in the world. The first dates from 1978 and most are based on limited life cycle analysis. UNEP is working to ensure that an ecolabel takes all environmental criteria involved into consideration and also mutual cross-recognition. (Campbell, Laura B.; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: UNEP, (1994). [in English].)

1256 UNITED KINGDOM CLEANER PRODUCTION PROGRAMME [BIB-JSTE000130]

An outline is given of some of the more important legislation which affects cleaner production and, in particular, the Environmental Protection Act of 1990. The Government has also supported a voluntary British Standard BS 7750 related to waste minimisation. It supports the objects of Integrated Production Control. A programme, which led to the Environmental Technology Best Practice Programme (ETBPP), includes a free environmental helpline, performance guides, good practice guides, practice case studies and future research and development practice support. A Technology Partnership Initiative run by the Department of Trade and Industry encourages transfer of environmental goods and services to 43 developing countries. (Department of Environment; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: DOE, (1994). [in English].)

1257 CLEANER PRODUCTION COMES OF AGE IN AUSTRALIA [BIB-JSTE000131]

Industry in Australia did not know about cleaner production before 1990 although there was some legislation in 1986 on waste minimization. Interest free-loans of up to \$100,000 for ten years are offered to small scale industry medium scale industry which introduce new non-waste or waste reducing technologies. Although Australia did not qualify for World Bank assistance many states and Federal government departments were participating in education programmes and demonstration projects, particularly in the state of Victoria. The Australian Centre for Cleaner Production was set up in February 1993 under the aegis of the Environment Protection Agency (Vic). Details of the charter and objectives are given. The centre needs strong industrial support, it has 3 levels of membership, it is independent, and non-profit making. It has three basic products: training, consultancies and technology transfer. A business plan and legal aspects are outlined. The centre will relocate at Bundoora, Victoria. Some suggestions relating to a global programme include a centre's club for sharing successful ideas and the question of accreditation with the advent British Standard 7750 and a possible 1501401. (Reeve, Darrell J.; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: Australian CPC, (1994). [in English].)

1258 AUSTRALIA'S APPROACHES TO FINANCING CLEANER PRODUCTION—FUNDING AND FINANCING CLEANER PRODUCTION [BIB-JSTE000132]

The Australian programme is based on the principle of ecologically sustainable development. The Australian Prime Minister's 1992 Environmental Statement has led to the setting up of a national cleaner production programme and signalled the Government's intention to provide services and finance to companies and organizations to promote and implement cleaner production. In particular, information dissemination and the increase in awareness are important, hence, the Federal government has produced a free information kit. Environmental Management handbooks at \$25 have also been produced which show how to analyze costs of producing wastes, how to improve processes, etc. Cooperation with industrial associations and unions is also encouraged. Dem-

onstration projects are described. Grants and loans are offered to companies to assess operations and implement cleaner production. Incentives are also provided for companies to adopt cleaner production practices. Australian funding to developing countries is also outlined. (Gayler, Dianne; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: EPA Australia, (1994). [in English].)

1259 ASIA AND THE PACIFIC—POLICY INITIATIVES TO PROMOTE CLEANER PRODUCTION [BIB-JSTE000133]

Cleaner Technology means a more efficient technology to achieve waste prevention and minimization by reduced consumption of raw materials. It also means upgrading of the process with the adoption of a preventive rather than a corrective approach to pollution control reduction. The policy initiative provides for assistance to small scale industry units, minimization of waste, phasing out subsidies and the introduction of environmental auditing. Other actions are the setting up of common effluent treatment for clusters of small industrial units and modernization of old industrial units. Some details of the impact of this policy initiative are outlined. The main points here relate to the reduction of greenhouse gases and the upgrading or phasing out of old power plants. Boilers' combustion systems are also earmarked for upgrading. Energy conservation in the steel industry has also been improved. Comments are made on financial support. The recommendations are mainly on the preparation of a priority list for action. (Maudgal, S.; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: Ministry of Environment, India, (1994). [in English].)

1260 INVENTORY OF CLEANER PRODUCTION EDUCATIONAL ACTIVITIES [BIB-JSTE000134]

Education and training is one of the tools in the dissemination of cleaner production throughout the world. An international inventory made in 1994 by sending a questionnaire to several thousand universities, educators and trainers produced a response from some 100 and the number of courses and curricula with some cleaner production content was around 140. These results were analyzed and this paper gives an overview of conclusions obtained up to October 1994. The questionnaire can be seen as a follow-up to a similar inventory made in 1991. The contents of the 1994 questionnaire asked for details of the faculty, courses with some emphasis on cleaner production, relevant curricula and educational material. The 1994 overview indicates a very unequal response from different parts of the world, 70% of the respondents are from the Europe region, 14% North American, zero % South American, 6% Asian, 4% Pacific and 2% African. Preliminary findings are detailed. The general indication is that the number of courses are growing although there is some lack of understanding of the concepts. A detailed analysis will be available in early 1995. (Huisingh, Donald; Jorgenson, Michael Sogaard; Borup, Mads; Leskinen, Arto; Pöyry, Sirkka; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: N.A., (1994). [in English].)

1261 ONGOING GREENING OF POLAROID CHEMICAL AND POLYMER SYNTHESIS PLANTS [BIB-JSTE000135]

The continuous improvement effort at Polaroid is aimed at making the chemical synthesis activities cleaner, safer, more competitive and ever less wasteful. Examples of cleaner chemistry are described. A process for producing solid esters has now been developed which does not release SO₂ and HCl in addition no solvent is used. An alternative approach is to run the reaction in the molten phase. Another example involves the synthesis and coatings of a polymer—this new process will use a water-based dispersion of mixed acyclic acids instead of MEK as used in the current system. Further improvements relate to the use of more modern equipment which can reduce the number of process steps and avoids some transfer losses. Detailed information is given on equipment for future developments. A final item is the so-called "Chemometrics". This a statistically-based computational technique which can be used to predict the chemical and or physicochemical behavior of reacting systems. (Kaufman, Neil; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14. Publisher: Polaroid, (1994). [in English].)

1262 EXPERIENCE IN THE TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGY [BIB-JSTE000136]

This paper provides a summary of the experience of UNEP Industry and Environment related to the transfer of environmentally sound technology, tech-

nology, cooperation and capacity building. Three programmes are covered: the Ozon-Action Programme, the Cleaner Production Programme and the Environmental Technology Assessment Programme. The Ozon-Action Programme deals with the phasing out of ozone depleting substances (CFCs) and involves information exchange, training courses and workshops etc., supported by a multilateral fund. The strategy includes the strengthening of local capacity and a regular assessment of user needs. The main elements of the Cleaner Production Programme are: information and publications, demonstration projects, and the strengthening of environmental protection programmes in industry and government. The Environmental Technology Assessment Programme includes case studies, a newsletter, the development of an Environmental Technology Assessment Primer and a feasibility study of environmental guidelines for technology transfer. Some general conclusions are drawn and the need for financing is emphasized. (UNEP/IE, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: UNEP, (1994), [in English].)

1263 POLISH CLEANER PRODUCTION PROGRAM—BACKGROUND COUNTRY PAPER [BIB-JSTE000137]

The Polish Cleaner Production Program is now completing its 3rd year of activities. It has achieved a well developed multistage approach. Cleaner production is developing from simple "at site" housekeeping and waste minimization into a sophisticated strategy reaching back along the product line up to the source as near as possible. While awareness has been increasing, the practical and financial means of implementing legislation has been reduced. It is noted that the Polish Environment Policy Act with a charge for "Use of the Environment" had the negative effect of producing "Cleaning Up" and "End-of-Pipe" solutions. These are key issues taken up by a Norway-Polish Task Group for starting a "Technology Transfer Program". This aims at training engineers, moving toward sustainable development and the formation of a permanent structure for activity in cleaner production. Operational details are described and illustrative results from the program are presented. These include the restructuring of a coke oven waste gas cooling system, rebuilding a sludge waste treatment system and housekeeping at a meat processing plant. Follow-up policies are noted. (Polish Cleaner Production Programme, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: Polish CPC, (1994), [in English].)

1264 PHILIPPINES CLEANER PRODUCTION—BACKGROUND COUNTRY PAPER [BIB-JSTE000138]

With the aid of a 5-year grant from USAID, the Philippine Government has started to promote cleaner production with a programme called Industrial Environmental Management Project (IEMP), 1992. After 2 years there has been a marked increase in awareness by industry, not only reducing pollution but improving profitability. For the last 14 years every company has had to appoint a Pollution Control Officer. These officers have now formed an Association and undertake initiatives to improve pollution management. The Environmental Management Bureau have also had a Waste Exchange Programme from 1988-91. The Pasig River Rehabilitation Programme has also been launched with partial funding from Denmark DANIDA. A number of other projects are also described. The IEMP appears to have been very successful and it is important that its experience and expertise should not be lost. (Favila, Grace, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: PBE, (1994), [in English].)

1265 CLEANER PRODUCTION ACTIVITIES IN NEW ZEALAND [BIB-JSTE000139]

In the central government activities legislation is made to provide and implement policies. The Resource Management Act 1991 provides the framework for implementing cleaner production and, in particular, to promote the sustainable management of physical and natural resources. Duties and restrictions are also formulated as well as penalties and remedial costs. A number of demonstration projects have been set up including glass, timber, electroplating, plastics, paints and varnishes etc. Information has been distributed by means of "Going Green" kits which provide practical information. Some 67,000 were issued. A programme on energy efficiency and conservation was initiated. The problems associated with financing schemes is discussed. A number of local government activities have been implemented successfully, particularly that of Wellington

City and Hamilton City Councils followed by a number of other councils. Various other activities are described. In all, New Zealand has successfully introduced the concept of cleaner production but additional finance is required. (Bailey, Margaret, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: Ministry of Environment, NZ, (1994), [in English].)

1266 CLEANER PRODUCTION INITIATIVES IN THAILAND [BIB-JSTE000140]

Thailand is situated centrally in Southeast Asia. Approximately 50% of its land is cultivated. It has a population of some 58 million with an annual growth of 1.4%. Although Thailand is traditionally an agricultural country and a major food exporter it experienced rapid industrialization in the 1980's and is well on its way to becoming a newly industrialized country. There are now some 27,000 industries of which 20,000 are classified as creating water pollution. Degradation of the environment is becoming increasingly apparent and is threatening sustainable growth and public health. The Royal Thai Government has attempted to regulate industries but it appears that the rapid increase in industrialization calls for stronger measures. These measures by the government and the private sector are outlined including Thailand's Development and Environmental Objectives including the 1992-1996 5 year plan and the relevant environmental laws and environmental institutions. A section is included on cleaner production programmes followed by comments on the constraints and recommendations on cleaner production programmes. (Bueangsung, Sermphol, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: FTI, (1994), [in English].)

1267 CLEANER PRODUCTION ACTIVITIES IN KOREA [BIB-JSTE000141]

Korea is undergoing rapid industrialization and urbanization. After the Earth Summit in 1992 environmental policies were adjusted to minimize environmental pollution. Government policies are being implemented where necessary by notification or Acts of Parliament. This legislation is aimed at the more effective use of resources and the recycling of by-products and waste. Environmental labelling is being undertaken to promote cleaner technology development. An Environmental Technology Development and Assistance Act will be launched in 1995 to promote cleaner production and clean technology development. A Highly Advanced National Project (1992-2001) has been set up covering eleven research topics all related to cleaner production. From 1998 the environmental technology development project will be switched over from "end-of-pipe" technology to pollution prevention. Financing schemes are detailed—they include government grants and loans, loans from Korea Merchant banking corp., the Industrial Bank of Korea and the Korea Development Bank as well as the Industrial Development Fund and the Citizens Bank. Information services are listed. (Korea Environmental Technology Research Institute, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: KETRI, (1994), [in English].)

1268 INDONESIA: BACKGROUND ORGANIZATION REPORT [BIB-JSTE000142]

The Government's cleaner production policies are described. These are aimed at controlling environmental degradation and focus on priority areas which include the Clean River Programme, the Clean City Campaign, Hazardous Waste waste management, Air Pollution Control, etc. This programme is to be executed by a BAPEDAL office. Other Cleaner Production efforts are described. In 1994 a workshop on Objectives Oriented Project Planning (OOPP) was set up at the instigation of UNIDO. A positive result was achieved for setting up a National Cleaner Production Centre (NCPC) in Indonesia. IEMIC founded a National Coordinating Board consisting of governments, business associations and industries. Cleaner Production contacts have been established and international conferences in the Netherlands, Germany and Poland have been attended. IEMIC now have their own building with technological support systems. They are also translating a number of relevant books. IEMIC is the only body dealing with the business community on information relating to environmental management. A seminar is being organized for November 1995 on Bali Island. (Elias, Ilhamy, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: IEMIC, (1994), [in English].)

1269 INDONESIA—BACKGROUND COUNTRY PAPER [BIB-JSTE000143]

Indonesia consists of some 17,000 islands of which some 6,000 are inhabited. Total population is some 185 million of which 80 million live on the island of Java. About 79% of the nation's industry is also located on Java. Industrial production has increased eight-fold since 1970 and is expected to expand a further thirteen-fold by the year 2000. Some legislation was introduced as early as 1973 aimed at sustainable development. The government has encouraged the private sector to apply sustainable development concepts. Law 4 of the 1982 regulation on the basic principles of environmental management covers all environmental regulation in Indonesia. There are two main agencies responsible for the environment, the Ministry for the Environment and the Environmental Impact Management Agency (BAPEDAL). The latter was created in 1990. Details of the organizational structure are illustrated. BAPEDAL now recognizes the need to progress from "end-of-pipe" waste treatment to the cleaner production type of programme and now provides technical assistance, conducts environmental auditing, launches demonstration projects, etc. Training needs are recognized and considerable effort is put into information services dissemination. Details are given on the current status of plans including the 5 year plan for 1994-95 to 1998-99. (Bratasida, Liana; Lowry, Jean; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: BAPEDAL, (1994). [in English].)

1270 LACK OF CLEANER PRODUCTION IN COSTA RICA [BIB-JSTE000144]

This is a preliminary report on what can be done in Costa Rica, because it is considered that very little is being effectively done. In May 1994 the new government of Costa Rica declared that sustainable development was going to be one of the main aims of its policies. Costa Rica is a very centralized country. The population, industrial production and a considerable portion of its commercial agriculture is concentrated in the Central Valley. Important goals in education and health have been reached, largely due to the elimination of army and military expenses. Agri-product processing and agricultural products are central to the economy—e.g. bananas and coffee are important. The main pollution problems include the fact that most of the sewage and industrial wastes residual effluent is thrown into the rivers without treatment, there is a very heavy usage of pesticides and safety conditions for agricultural workers are poor. Energy and fuel are cheap and this has a negative effect on the cleaner production programme. There is, in fact, a general apathy toward improving the situation. Some efforts have been made by the universities and the government is laying down policies which should greatly improve the situation if implemented. (Pujol, Rosendo; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: University Costa Rica, (1994). [in English].)

1271 PRELIMINARY EXPERIENCES WITH THE INTRODUCTION OF CLEANER PRODUCTION IN CHINA AND INDIA [BIB-JSTE000145]

International efforts are undertaken to support developing countries in implementing cleaner production. This provides industries in these countries, for the first time, with an opportunity to "leap frog" over older, more established industries. There are number of demonstration projects in China and India. The Chinese Research Academy for Environmental Sciences is responsible for technical implementation of the project which involves 30 company projects. The Indian project is funded by UNIDO and implemented by the National Productivity Council. The results and experiences with these projects are compared with that of the Netherlands PRISMA project. These results are very preliminary and thus only have an illustrative nature. It is noted that the question of different terminology and scope needs attention as the precise interpretation depends on the locality. Comments are made on funding and project partners and emphasize the need for a high level of involvement by the funding body. Other comments indicate the differences in approach in the three countries. (van Berkel, Rene; Kryger, John; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: UNEP, (1994). [in English].)

1272 CHINA—POLICY INITIATIVES TO PROMOTE CLEANER PRODUCTION [BIB-JSTE000146]

China is a very large, rapidly developing country. Its gross national production in 1991 was nearly 3 times its 1978 value. This has put an increasingly large pressure on the environment. Industry in China has a relatively low level of

technical competence. There is also a low level of equipment renewal—many outdated facilities are still in operation and industrial wastes generated per unit of product is high. Energy efficiency is also lower than in other industrialized countries. A 1980 analysis indicated that more than 50% of pollution was caused by poor housekeeping. The required actions are listed, putting pollution prevention policy first. They include incorporating environmental protection in plans for economic and social development, promoting cleaner production, etc. Secondly, policies for strengthening management and retrofitting of old pollution sources, etc. Thirdly, strengthening legislation. The World Bank offered to provide funds for implementing the Environmental Technical Assistance Project in China in 1992. Other items include labelling and future actions. (Ruqiu, Ye; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: NEPA, (1994). [in English].)

1273 STUDY OF CLEANER PRODUCTION TECHNOLOGY IN INDUSTRY [BIB-JSTE000147]

This paper covers a very wide field of technology associated with cleaner production. It tries to identify and characterize cleaner production equipment in industry, barriers and openings in the development of this industry and find recommendations for governments to assist such development. Most of the research has been in the United States of America. Some typical technologies of this type are listed, covering a variety of industries. An analysis is made of the equipment industry involved, some 45% of the value being in solid waste waste management. A comprehensive review is made of a number of industries where the new technologies can best be employed, and some of the difficulties ahead. (Geiser, Ken; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: University of Massachusetts, (1994). [in English].)

1274 IMPLEMENTATION OF CLEANER PRODUCTION STRATEGY IN THE POLISH CAR MANUFACTURERS [BIB-JSTE000148]

Poland is one of the most polluted countries in Europe. Much of this is due to propaganda over the past 45 years, when this subject was "hidden" to a great extent. This paper covers changes since 1990, in the Polish FSO firm, makers of the Polonez car. This car uses a Rover engine, which reduces a lot of the emissions due to its catalyzer. The paper also covers pollution from the factory itself, particularly water utilization and water treatment and recovery of oil. Attention is also being paid to future problems such as car breaking for recycling and also ease of subsequent material sorting. (Tyszkiewicz, Andrzej; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: NA, (1994). [in English].)

1275 DEVELOPMENT OF ECO-EFFICIENCY IN INDUSTRY [BIB-JSTE000149]

Much product development is short term. In the long run, however, attention is needed to fundamental shifts in society and human needs. Birth rates are stabilizing in China, India and the Latin America Region, but in the Africa Region and the Middle East region they are increasing. In 30 years' time there will be another 3 billion people to feed. Eco-efficiency is needed to ensure that the earth can support healthy life systems, via Eco-security. In 1993 the Business Council for Sustainable Development (BCSD) made preliminary recommendations with a view to setting targets for Eco-efficiency. This paper gives some of the recommendations, likely pitfalls and the best ways forward. (Fussler, Claude; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: NA, (1994). [in English].)

1276 CLEANER PRODUCTION IN SMALL AND MEDIUM SIZED INDUSTRIES [BIB-JSTE000150]

This paper covers problems in Hong Kong - a rather special case of a small area (100km²), large population (6 million) and over 40,000 factories. 95% of these employ less than 50 people and are a problem to monitor. Two types of cleaner production exist. Type 1 is highly beneficial, completely eliminating pollution control costs. Type 2 is marginally beneficial although increasing manufacturing cost and slightly increasing total production cost. Cleaner production is a new concept to most Hong Kong factories. A few examples are given of applications to typical kinds of factory and some views are expressed as to likely future developments. (Lin, C M; Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: HKPC, (1994). [in English].)

1277 THE EPS SYSTEM—A JOINT SCIENTIFIC AND INDUSTRIAL EFFORT TO DEVELOP A SUSTAINABILITY-BASED MANAGERIAL TOOL FOR LIFE-CYCLE DESIGN OF PRODUCTS [BIB-JSTE000151]

The Federation of Swedish Industries, and others, set up a project (the Product Ecology Project) with 15 companies, and others. This was to obtain a system for calculating the environmental impact (EIA) of a process or product. This is called Environmental Priority Strategies (EPS) and is aimed at producing daily decision needs. The EPS system is described and is based on a number of key components. A diagram is given of the framework involved. Another diagram shows the calculation steps and assessment elements of the system. A description is given of the development of a sustainable recycling concept - something not normally given by Life Cycle Assessment methods. (Ryding, Sveng-Olof, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: FSL (1994). [in English].)

1278 BIOTECHNOLOGY FOR CLEANER PRODUCTION [BIB-JSTE000152]

Biotechnology is defined as the systematic use of living organisms or biologically active substances. These can be enzymes or microorganisms. Applications of these processes can prevent or reduce waste and polluting emissions. This paper describes some of the work of the UNEP working group dealing with this topic. The various objectives are listed and an international network has been established, of which details are given. Some of the available case studies are outlined, including oil extraction from seeds, pulp bleaching and desizing of textiles and some of the resulting advantages are mentioned. A few details are given of planned activities. (Schelleman, Ferd, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: IAAE, (1994). [in English].)

1279 CLEANER PRODUCTION IN THE WEST ASIA REGION [BIB-JSTE000153]

Arab countries fall into three categories - those which are oil rich, those with relatively old manufacturing industry and the less developed ones manufacturing mainly small agricultural products. Much of the industry is state owned, and much of it causing serious pollution. More attention has been paid to expansion than to dealing with pollution, but this is starting to change and cooperation is taking place with the international organizations. A description is given of a national environmental policy on pollution, being formulated in Egypt and the activities being undertaken in the preliminary phases. The work is limited by top management interest, availability of suitable staff and the willingness to succeed. (El-Kholy, Ossama, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: UNEP, (1994). [in English].)

1280 WESTERN ASIA—POLICY INITIATIVES TO PROMOTE CLEANER PRODUCTION [BIB-JSTE000154]

Western Asian (Iraq, Syrian Arab Republic, Lebanon, Jordan, the Gulf States, Republic of Yemen and Egypt) industrial development has been largely in urban areas - those of highest growth and demand. Old technological obsolescence was normal and imposing laws on state owned industries difficult. Severe pollution problems have resulted. Improvements started in the early 1970s. Policies in most of the countries do little to encourage sufficient attention to pollution matters. The result is industry-intensive communities which do not support, or get supported by, local environment. Service industries are growing rapidly in the area and can extend the life of capital goods, but involve some recycling. Some information is given on some projects. (Hamza, Ahmed, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: UNEP, (1994). [in English].)

1281 A RISING TIDE: GROWING INTEREST IN CLEANER PRODUCTION IN ZIMBABWE [BIB-JSTE000155]

For some time, Zimbabwe has had legislation and regulations governing emissions by industries and other sectors. The government is taking a continuous interest, with the population, in these matters and a few details are given of some existing laws in this sphere. Details are given of a few organizations set up in Zimbabwe to coordinate work on pollution generally, and not only for industry. These include both local government authorities and regulations and also coordination with international organizations. Some results have been the introduction of environmental labelling (in 1991) and an Environmental Impact

Assessment (EIA) Policy (in 1994). (Maviya, Johnson, Boyle, John, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: DNR, (1994). [in English].)

1282 URUGUAY-BACKGROUND COUNTRY REPORT [BIB-JSTE000156]

Uruguay is making its first steps in cleaner production strategies—previously such work was mainly towards industrial pollution control at the end of processes and not where pollution is generated. Recently, attention has been paid to two main national production areas - tanning and slaughtering. The Laboratory of Technology, Chamber of Industries and University of Engineering collaborated on new processes for sheep and cow hides and skins and methods to reduce pollution and increase efficiency. Some particular activities are described very briefly, these are, at present, rather limited by lack of sufficient funding. To deal with this, an application is being made to the Interamerican Development Bank. (Ministry of the Environment, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: Ministry of Environment, Uruguay, (1994). [in English].)

1283 THE ENVIRONMENTAL POLLUTION PREVENTION PROJECT (EP3)—TUNISIA BACKGROUND PAPER [BIB-JSTE000157]

Pollution prevention is recognized in Tunisia as essential, although no clear strategy exists. All new industrial projects have, however, to submit Environmental Impact Assessments (EIAs) before going ahead, which requires official approval. A fund has been started to encourage such projects. A two year EP3 program, funded by USAID, started in 1993. Brief details are given of this program and also of nine pollution prevention audits which started in a variety of industries. The companies are relatively small having between 17 and 220 employees. A Training program for developing and carrying out pollution prevention is available. Details are given of financial aspects of the nine companies involved in pollution prevention. (Nafti, Rachid, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: EP3, (1994). [in English].)

1284 SOME PERSPECTIVES ON CLEANER PRODUCTION - FRAMEWORK IN PORTUGAL [BIB-JSTE000158]

In the 1980s the Portuguese industrial sector was weak, in comparison with other EU countries. A 5-year programme was then set up and gave a framework for caring for the infrastructure which was necessary for industrial development. The Ministry of Industry and Energy is involved and is now giving support and a great number of companies are involved with it. The shift to cleaner production will not be easy - as for many other countries. An Institute of Environmental Technologies has been set up and organized a seminar on Cleaner Production (in 1993). Full details are given of a programme of work which will be undertaken by the Institute. (Penada, M.C., Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: NIET, (1994). [in English].)

1285 CLEANER PRODUCTION ACTIVITIES IN TRINIDAD AND TOBAGO [BIB-JSTE000159]

Prior to the 1990s, the main concern in Trinidad and Tobago was to achieve growth. Matters of the environment tended to be left to factory owners. After rapid growth, the Government has now started to set up an Environmental Management Authority. Some of the "clean up" activities in hand are electrostatic precipitators in a cement factory, the use of bagasse as a fuel for boilers and the addition of bagasse and other materials for animal feed. Affiliation has been effected with a number of organizations in Trinidad and Tobago, other parts of the West Indies and other countries, such as Japan (Caribbean Industrial Research Institute, Third High-Level Advisory Seminar on Cleaner Production, Warsaw, 941012-14, Publisher: CARIRI, (1994). [in English].)

1286 CLEANER PRODUCTION IN THE ASIA PACIFIC ECONOMIC COOPERATION REGION (PRELIMINARY VERSION) [BIB-JSTE000207]

A number of case studies of cleaner production initiatives in the Asia Pacific Economic Cooperation (APEC) region are presented. The studies show how the application of cleaner production methods can lead to environmental benefits and reduced production costs for industry and for consumers. Countries contrib-

uting studies include: Australia, China, Mexico, the Philippines, United States of America, Canada, Malaysia and Thailand. The industries described include agriculture, engineering, food processing, photography, rubber, textiles chemicals and wood. (UNEP IE, Publisher: UNEP, (1994). [in English].)

1287 REDUCING WATER USE AND HAZARDOUS WASTE IN THE WOOD FINISHING INDUSTRY [BIB-JSTE000208]

A company manufacturing wood and wood-finish cabinets has introduced a total quality management scheme and one team has investigated hazardous waste reduction. 54,000 kg year of water-based hazardous wastes was being generated and disposed of in drums at high cost. A chemical separation of solid and liquid waste was introduced giving clean water for recycling and a non-hazardous solid waste for disposal. The recycling of waste materials including metals, papers and boards was also introduced. Water usage and waste disposal costs have been reduced substantially. (UNEP IE, Thomson Crown Wood Products, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1288 SAVING ENERGY AND RAW MATERIALS IN THE CHEMICAL INDUSTRY [BIB-JSTE000209]

A chemical factory specializing in the production of additives for the processing of high polymer materials has participated in the preparation phase of the cleaner production project in China. The penta-erythritol plant was found to be responsible for more than 40% of the chemical oxygen demand (COD) of the entire factory effluent. 20 cleaner production options were identified and 9 have been implemented. 4 require substantial investment including the installation of a microcomputer and vacuum pumps and the upgrading of refrigeration and centrifuge equipment. The improvements will allow a reduced treatment plant size and give increased production and savings in raw materials and energy. (UNEP IE, Beijing Chemical Factory No. 3, Chinese Research Academy of Environmental Sciences, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1289 RECOVERING WATER AND CHEMICALS IN TEXTILE DYEING [BIB-JSTE000210]

A medium-sized dyeing plant processing cotton-polyester blend fabrics has installed a vacuum suction system to recover and re-use textile finishing chemicals. The equipment sucks excess chemical solution from the fabric at the end of the dyeing process for recovery and recycling. A computerized spectrophotometer has been installed for accurate colour matching. The system improves finish quality by facilitating the even distribution of chemicals on the fabric and gives increased productivity, savings in chemicals, water and fuel, reduction in pollution load and waste water treatment costs. (UNEP IE, Chiung Sang Industry Co. Ltd., Royal Thai Linen Ind. Co. Ltd., Carl Duisberg Gesellschaft-South East Asia Programme Office, Asian Institute of Technology, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1290 TREATING WASTE WATER IN THE RUBBER INDUSTRY [BIB-JSTE000211]

Waste water from the treatment of latex concentrate in rubber production is traditionally treated in biological oxidation ponds, but the final run-off fails to meet modern effluent standards. A Malaysian company has introduced a secondary treatment for pond discharges which involves an upward flow clarification system with integrated filtration and aeration to reduce chemical and biological oxygen (COD & BOD) demands and the solids content of the effluent. The treated water is recycled, resulting in zero discharge to the waterways. (UNEP IE, Golden Hope Agrotech Consultancy Sdn., Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1291 RECYCLING WATER AND WASTE IN THE PHOTOGRAPHIC INDUSTRY [BIB-JSTE000212]

Photographic processing uses large volumes of water which can result in wastage of processing chemicals and waste water pollution problems. A large photographic finisher has installed a proprietary closed-loop system which cleans and recycles water and regenerates and re-uses some photographic wastes. The system involves three processes: (1) water sterilization and mem-

brane filtration; (2) chemical analysis, regeneration and re-use of chemicals; and (3) vacuum distillation to recover water from residual concentrate. The final discharge was previously 265,000 l day of waste water and is now only 750 l day of waste concentrate. (UNEP IE, Black Photo Corporation: Altech Technology Systems Inc., Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1292 RECOVERING WASTE MATERIALS IN PINEAPPLE PROCESSING [BIB-JSTE000213]

A pollution management appraisal was conducted at a pineapple canning factory to minimize waste, conserve resources, reduce environmental risks and improve process efficiency. A major step was to install collection pans at all the fruit preparation and trimming tables, together with improved monitoring and supervision. Juice savings from the pans amount to greater than 55 l hour and employees are protected from splashes. Monitoring and supervision is recovering more than 60 kg hour of lost pineapples. (UNEP IE, Del Monte Philippines Inc., Industrial Environmental Management Project, USAID, Philippines, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1293 SAVING WATER AND WASTE IN FOOD PROCESSING [BIB-JSTE000214]

A major soup company has introduced a corporate-wide cleaner production programme emphasizing water conservation, waste minimization and solid waste recycling. Vegetable wastes are recycled as pig feed, cardboard, wood and metals are salvaged and measures introduced to reduce enamel wastage in cans' manufacture. Water conservation involved dry cleaning of floors and equipment, flow metering and usage control. Solids recycling has led to waste reduction of 70%, enamel waste has been reduced by 80% and water usage by greater than 75% leading to annual savings in excess of \$ 1,000,000. (UNEP IE, Campbell Soup Company, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1294 TURNING COCONUT WATER FROM A WASTE INTO A JUICE [BIB-JSTE000215]

A desiccated coconut plant was producing 80,000 l day of waste coconut water, creating major pollution problems. A pollution management appraisal was carried out which recommended segregation, recycling and recovery. A joint venture led to the establishment of an adjacent plant which receives the collected coconut water, concentrates, freezes and finally processes it into a commercial fruit juice drink. This has resulted in a reduction of the pollution load by 50% together with major savings in production and effluent treatment costs. (UNEP IE, Industrial Environmental Management Project, USAID, Philippines, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1295 RECYCLING COOLANT AND TREATING OILY WASTE WATER FROM MACHINING [BIB-JSTE000216]

A water-soluble coolant used in machining engine manifolds was becoming frequently contaminated with tramp oil leading to coolant failure and large volumes of waste. A site assistance team identified several pollution streams and created the basis for a permanent pollution prevention programme. A high phosphate floor cleaning agent was found to cause emulsification of tramp oil and high conductivity problems in the coolant. A surfactant floor cleaner is now used and the oily waste water sent to an ultrafiltration unit for removal of the tramp oil. A maintenance and repair programme for oil leaks was also introduced. The new procedure results in a major saving in coolant costs, reduced ground water contamination and improved cleanliness of the AI swarf sent for remelting. (UNEP IE, CMI-Texas, TNRCC OPFR, Delta-Omega Technologies Ltd, Industrias Fronterizas CMI SA de CV, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1296 AUTOMATING A BICYCLE WHEEL PLATING OPERATION [BIB-JSTE000217]

A cycle wheel plating plant has expensive waste water treatment facilities but failed to meet national environmental standards. A cleaner production audit was

carried out which revealed 38 cleaner production options, 24 of which were no-cost options which have been implemented resulting in major savings in raw materials and improvements in environmental protection. An analysis of the remaining options led to a decision to automate the plating line which will involve (a) rearranging plating baths and (b) automating temperature, additive and process control systems. This double output and productive efficiency will reduce the amount of waste water and effluent produced thus reducing the cost of waste treatment and environmental standards to be met. (UNEP IE, Snaovng General Bicycle Plant, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1297 CONVERSION OF PIG EFFLUENT INTO ENERGY AND FERTILIZER [BIB-JSTE000218]

A 1,200-head pig farm producing 210,000 l day of slurry formerly treated this effluent by land waste disposal. An anaerobic digestion system has now been installed involving: (a) automatic flushing of effluent from sheds; (b) grit removal; (c) dissolved air flotation for solids concentration; (d) a cogeneration plant for electric power and hot water; and (e) a fertilizer production plant. The two stage digester plant produces 1700 m³ of bio gas day which is converted to 3840 kWh of power and 28,800 MJ of energy as hot water together with 4 tones of humus solids which can be converted to 12 tones of fertilizer. (UNEP IE, Charles I.F.E. Pty Ltd, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1298 SAVING WATER, ENERGY AND RAW MATERIALS IN FERMENTATION [BIB-JSTE000219]

In a distillery grain is used to produce alcohol, methane and hypha albumen. A cleaner production audit was carried out which produced 102 options for improving production and management, most of which have now been implemented. This involved: (a) special training; (b) avoiding leakages; (c) periodic maintenance and repair; (d) controls to reduce waste water volumes; (e) recycling cooling water; (f) guarantees of raw material quality; and (g) improved storage of raw materials. Concentrated ingredient fermentation is now being introduced. Advantages found include a major reduction in waste, water and energy production and the avoidance of raw material spoilage. (UNEP IE, Fuyang General Distillery, Publisher: UNEP, (1994). Appears in: *Cleaner Production in the Asia Pacific Economic Cooperation Region (Preliminary Version)*, [in English].)

1299 CLEANER PRODUCTION WORLDWIDE [BIB-JSTE000221]

A variety of approaches to the application of cleaner production methods, which result in environmental benefits and reduced costs, are presented. The examples are drawn from a number of countries including Singapore, Greece, Denmark, Indonesia, the Netherlands, France, India, Poland, United Kingdom, Austria, Sweden and United States of America. The improvements relate to a variety of industries including metals, leather, textiles, food processing, printing, paints and varnishes and electronics. (UNEP IE, Publisher: UNEP, (1993), 92-807-1369-8)

1300 RECOVERY OF COPPER FROM PRINTED CIRCUIT BOARD ETCHANT. [BIB-JSTE000222]

In printed circuit board (PCB) manufacture unwanted Cu is etched away and builds up in the solution. Regeneration involves the precipitation of Cu as CuO which is usually landfilled. An alternative process has now been introduced using electrolysis in a divided cell. This permits regeneration of the etching solution and recovery of the surplus Cu as metal flakes. The process gives improved PCB quality with the etching solution maintained at optimum composition. Waste disposal costs are virtually eliminated. Cu is recovered in high value form and there is no handling of hazardous materials chemicals. (UNEP IE, Finishing Services Limited, Praeger Industries Inc., Publisher: UNEP, (1993). Appears in: *Cleaner Production Worldwide*, [in English].)

1301 MINIMISATION OF ORGANIC SOLVENTS IN DEGREASING AND PAINTING [BIB-JSTE000223]

A factory producing light fittings from Al or steel sheet carried out a pollution prevention audit (environmental auditing) of its degreasing and painting opera-

tions. It was found that trichloroethylene degreasing could be replaced by an alkali wash if the cutting fluid used in previous machining operations on Al was changed to a biodegradable type. Degreasing now takes place in a 30 m tunnel incorporating degrease, rinse, phosphates, rinse and drying stages. Electrostatic powder painting has been introduced using solvent-free polymer paints. The new system has produced cost savings as well as reduced air pollution and hazardous waste disposal problems are avoided. (UNEP IE, Thorn Järnkörst AB, Publisher: UNEP, (1993). Appears in: *Cleaner Production Worldwide*, [in English].)

1302 CLEANER PRODUCTION IN A CITY-BASED PROJECT [BIB-JSTE000224]

A clean technology initiative in the city of Graz was supported by 11 companies and their suppliers who carried out 26 projects. Examples include a printing shop which: (a) changed to bulk purchase of ink to reduce the empty container (packaging) problem and prevent solvent evaporation; (b) purchased mixing inks for gravure printing in large containers to enable surplus inks to be returned for re-use; and (c) reduced the production of paper and cardboard wastes. A car repair workshop (automobile industry): (i) introduced an accurate mixing system two-part paints, eliminating wa. i.e. (ii) installed extraction units for CFC when repairing air conditioning systems and replaced CFC-12 by HFC-134a and (iii) proposed a computerized paint-mixing system for color matching of repairs which would reduce waste. (Department of Environmental Protection—Eco-profit, UNEP IE, Publisher: UNEP, (1993). Appears in: *Cleaner Production Worldwide*, [in English].)

1303 NEW PRODUCT: WATER-BASED ADHESIVES [BIB-JSTE000225]

A range of water-based adhesives has been developed which can improve upon and replace solvent-based adhesives. Evaporation of the volatile organic compounds (VOCs) used in many solvent-based systems contribute to atmospheric pollution. Other solvent-based systems may require heat energy input to dry or melt the adhesives. The new water-based adhesives are non-toxic and non-polluting and require a much lower drying energy input. They are particularly suitable for food packaging applications. (Bluminsten Ltd, UNEP IE, Publisher: UNEP, (1993). Appears in: *Cleaner Production Worldwide*, [in English].)

1304 WASTE REDUCTION IN STEELWORK PAINTING. [BIB-JSTE000226]

The finishing operations in a steel factory involved shot blasting and painting. Paint was applied manually by air-atomized spraying. A pollution prevention audit was carried out and the existing painting method compared with (a) airless spray and (b) pressure atomized electrostatic spray techniques. Results show that both alternatives reduce consumption of paint and solvents and reduces waste compared with the original system but that (b) is considerably more efficient than (a). (UNEP IE, Steelworks Ostrowiec, Publisher: UNEP, (1993). Appears in: *Cleaner Production Worldwide*, [in English].)

1305 WASTE REDUCTION IN ELECTROPLATING [BIB-JSTE000227]

A car component manufacturer uses Cu-Ni-Cr and Zn plating lines producing waste streams containing CN, Cr-6, Cu, Zn and Ni. A pollution prevention audit was carried out resulting in a number of improvements. Low concentration plating and passivation processes are being introduced and some circulating overflow rinses changed to static rinses. Modified rinsing cycles have been introduced for Cr, Ni and CN with Fe final rinse tanks equipped with ion exchange columns to permit water recycling and material recovery. Benefits include a decrease in water and raw material usage and in waste stream quantities produced. (UNEP IE, FSM Sosnowiec, Publisher: UNEP, (1993). Appears in: *Cleaner Production Worldwide*, [in English].)

1306 REDUCTION OF SULPHIDE IN EFFLUENT FROM SULPHUR BLACK DYEING [BIB-JSTE000228]

In the dyeing process for cotton fabrics using S dyes, the dissolved dye is reduced to the affinity form before application and oxidized to the insoluble form after application. Traditionally the reduction is carried out using Na₂S which creates severe effluent problems. A major cotton textiles company has investigated alternative reducing agents. Alkaline glucose was found to work but was too expensive. A by-product of the maize starch industry (Hydro) containing about

50% of reducing sugars has now been identified and found to be a satisfactory and economic alternative to H_2S . The modified process has now been introduced resulting in a reduction in S^{2-} concentration in the effluent from 30 ppm to less than 2 ppm. (UNEP IE: Century Textiles and Industries Ltd. Publisher: UNEP. (1993). Appears in: *Cleaner Production Worldwide*. [in English].)

1307 DE-INKING PROCESS FOR WASTE PAPER [BIB-JSTE000229]

A de-inking process enables printed waste paper to be processed into a feedstock suitable for making new paper. The waste paper is pulped into a process which ensures that the ink has been detached from the paper fibers. First stage de-inking takes place in a flotation cell using air and a foaming agent to separate the ink-loaded sludge. The pulp is dewatered and kneaded to complete the breakdown of the ink-fibre bonding before a second stage flotation cell treatment to complete separation. The process allows recycling of a wider range of printed waste papers and avoids the use of bleaching. Waters are recirculated and effluent volume is minimal. (UNEP IE: St Regis Paper Co Ltd. Publisher: UNEP. (1993). Appears in: *Cleaner Production Worldwide*. [in English].)

1308 NEW TECHNOLOGY: GALVANIZING OF STEEL [BIB-JSTE000230]

A continuous galvanizing process for tubes and wire has been developed. The stock is uncoiled, shot blasted and preheated by induction before entering the galvanizing chamber where electrically melted Zn is held in suspension in an inert atmosphere by an electromagnetic field. Coating thickness is measured electronically and fed back to control the speed of the line. The use of the process would result in total elimination of conventional plating liquid waste plus a reduced Zn requirement and more consistent product quality. (UNEP IE: Deiot Processes S.A. Publisher: UNEP. (1993). Appears in: *Cleaner Production Worldwide*. [in English].)

1309 RECOVERY OF PROTEIN FROM POTATO STARCH EFFLUENT [BIB-JSTE000231]

A large factory producing starch from potatoes produces 2.2 m³ year effluent, which was formerly discharged without treatment. Following research, a cleaner production method has been introduced which permits internal recycling of the water. The protein content is concentrated by reverse osmosis (RO) followed by coagulation. Open channel tubular membranes are utilized for RO which are non-clogging and easy to clean. Steam coagulation produces a high grade protein concentrate for animal feed. The process saves 17m³ year of feed water intake and recycles a further 1.1 m³ year within the factory. (UNEP IE: Avebe Foxhol; PCI Membrane Systems Ltd. Publisher: UNEP. (1993). Appears in: *Cleaner Production Worldwide*. [in English].)

1310 POLLUTION AND WASTE REDUCTION BY IMPROVED PROCESS CONTROL [BIB-JSTE000232]

A cement manufacturing company has introduced an automated system of process control of the firing kilns to mimic best operating practice and maintain optimum process conditions. This expert system monitors NO_x , CO and O_2 levels, temperatures and power requirements for kiln rotation, and adjusts feed rate, rotational speed, fuel supply and fan suction to maintain steady kiln conditions. The system results in some reductions in NO_x and S_x emissions as well as savings in fuel, prolongation of lining life and production of a higher quality clinker. (UNEP IE: PT Semen Cibinong; ABB LNKman Systems Ltd. Publisher: UNEP. (1993). Appears in: *Cleaner Production Worldwide*. [in English].)

1311 MINIMIZED ENVIRONMENTAL EFFECTS IN COTTON PRODUCTION. [BIB-JSTE000233]

A textiles company is applying cleaner production principles to all stages of cotton production. This includes: (a) organic cotton growing without artificial fertilizers, chemical pesticides or defoliant sprays; (b) hand picking; (c) computer-controlled spinning and knitting machines with dust extraction facilities; (d) use of only water-soluble dyes; (e) the use of H_2O_2 for bleaching in place of Cl; (f) dyeing in enclosed high pressure jet machines with reduced water consumption; and (g) mechanical finishing, eliminating the use of chemicals such as formaldehyde. Dyes and chemicals are removed from wash waters by chemical precipitation prior to activated sludge waste treatment and filtration

(UNEP IE; Novotex AS. Publisher: UNEP. (1993). Appears in: *Cleaner Production Worldwide*. [in English].)

1312 CHROME RECOVERY AND RECYCLING IN THE LEATHER INDUSTRY [BIB-JSTE000234]

Clean technology developed in Denmark has been applied to a tannery in Greece with the assistance of the EEC. Chromium Cr^{VI} is the major tanning agent but permitted discharge limits for Cr^{VI} are very low. The new technology involves the recovery and recycling of Cr^{VI} from spent tannery liquors. The liquor is neutralized with MgO and the Cr precipitates as $Cr(OH)_3$ which is reacidified to dissolve and recycled for reuse. Loss of Cr^{VI} has been reduced from 20-40% to 2-5% and Fe pollution load and treatment costs greatly reduced. (Hellenic Leather Center S.A.; Ministry of Housing, Spatial Planning and the Environment; British Leather Confederation; Publisher: UNEP. (1993). Appears in: *Cleaner Production Worldwide*. [in English].)

1313 GAS PHASE HEAT TREATMENT OF METALS [BIB-JSTE000235]

A tool-making company which formerly used salt baths for carburizing, carbonitriding and hardening steel tools has replaced the salt baths by a gas phase treatment system using a fluidised bed of Al_2O_3 particles. A mixture of air, NH_3 , natural gas and liquid petroleum gas (LPG) is used according to treatment and quenching is also carried out in a fluidised bed. This change has resulted in the elimination of hazardous wastes (liquid effluents and solid) together with savings of process chemicals, in maintenance costs as well as energy savings. (UNEP IE: Chartered Metal Industries Pte Ltd; Quality Heat Treatment Pty Ltd. Publisher: UNEP. (1993). Appears in: *Cleaner Production Worldwide*. [in English].)

1314 THE TEXTILE INDUSTRY AND THE ENVIRONMENT [BIB-JSTE000191]

The textile industry is a significant contributor to many national economies, and all textile industries have many features, good and bad, in common. This report examines the impacts of textile production on the environment, both in terms of discharge of pollutants and also the usage of water and energy. An overview is taken of the wet operations in the textile industry which highlights the problems created, and discusses solutions by end-of-pipe treatments. Clean technology production techniques and processes are examined, suggestions made, and typical solutions to improved technology quoted and discussed. Finally, legislation and the environment are featured as a means of creating a clear policy on environmental protection. The annexes contain data on safety in handling textile chemical materials, tolerable limits for effluents environmental audits etc. and a number of case studies. (UNEP IE: Publisher: UNEP. (1993). [in English].)

1315 US EPA, BAT, AND BPT EFFLUENT LIMITS FOR THE TEXTILE INDUSTRY [BIB-JSTE000192]

The chapter consists of tables of effluent limits issued by the US EPA for the textile industry as being BPT (best practical technology available) and BAT (best available technology economically achievable). The sub-categories itemized are hereby listed, and the figures refer to kg/1000 kg of fibre for the finishing of wool, woven fabrics, knit fabrics, carpets, and stock and yarn. In the tables, monthly averages are quoted and also a daily maximum for BOD, COD, TSS, sulphide, phenols, total chromium, and pH. (UNEP IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1316 WASTE AND EMISSION AND ENERGY AUDITS [BIB-JSTE000193]

The chapter describes cleaner production as is achieved by auditing the wastes, emissions and energy consumed in a textile manufacturing process. A good waste audit: defines sources, quantities, and types of waste being generated, collates information on unit operations, raw materials, products and water usage and wastes, highlights process inefficiencies and areas of poor management, helps to set targets for waste reduction; permits the development of cost-effective waste management strategies, raises awareness in the work force regarding benefits of waste reduction; increases knowledge of the process, and helps improve process efficiency. Energy audits on the other hand can indicate where consumption can be reduced by adopting more efficient procedures and equipment. A standard procedure for energy audits is illustrated by a flow diagram. Typical waste and energy audits are presented having an audit team made up of

the Environmental Officer, the Chief Chemist, the Plant Manager, and two Junior Engineers. The full sequence of the audit is shown, areas of improvement indicated, and presented as a table. Following an audit, recommendations for change are made. (UNEP/IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1317 SAFE HANDLING OF TEXTILE CHEMICALS [BIB-JSTE000194]

The chapter sets out guidelines and general recommendations for precautions to reduce the exposure of textile workers to harmful materials. It does not claim to be all embracing, nor to discourage other precautionary measures. Some of the principal features are: typical data sheets on the properties and precautions for individual materials e.g. hydrogen peroxide, trichloroethylene etc; list of dyes classified by the International Agency as either probably or possibly human carcinogens; and list of colorants classified as toxic. Detailed procedures for the safe handling of dyestuffs in color storerooms are provided including good housekeeping, dyestuff storage, weighing stage ventilation, respiratory protection, personal protective clothing, washing and showering, eating, drinking, and smoking, first aid, information, training, and supervision, and the construction of color storerooms. Also, a similar set of guidelines are given for the safe handling of chemicals other than dyestuffs. (UNEP/IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1318 CLEANER PRODUCTION AT A UNITED KINGDOM WOOLEN TEXTILE MILL [BIB-JSTE000195]

The plant processes 100 tones of Australian wool per week and about the same volume of synthetic fibers. Its water utilization is as follows: dyeing and scouring - 1600 m³; raw wool scouring - 180 m³; and loss as steam - 220 m³. After treatment the effluent is discharged to the sewer at 800 ppm grease and 1000 ppm dissolved solids at an allowable rate of 2000 m³/day. This means a discharge of 1500 kg of grease per day. Discharge consent charges are rising steeply as environmental legislation is tightened. The company invested 1 million pounds sterling on new scouring systems using one bowl in place of three and succeeded in reducing the effluent by 30%. A 30k pound heat exchanger was installed to reduce the temperature of the dyehouse effluent, and grease is now recovered profitably by an in-house centrifuge to give pure lanolin. Some 90% of the residual grease is recovered by acid cracking and this is one control measure which is unprofitable. By spending 4% of the value added from pollution control measures, the company now meets its discharge consent conditions by treating its own effluent whilst recovering valuable products. The investment is considered worthwhile in view of tightening of environmental legislation. (UNEP/IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1319 RECYCLING SPENT NYLON HOSIERY DYE BATHS TO REDUCE RAW MATERIAL AND DISPOSAL COSTS, DOMINION TEXTILES INC, VALLEYFIELD, QUEBEC [BIB-JSTE000196]

A pilot operation was established to recycle spent nylon hosiery dye baths containing disperse dyes and chemical auxiliaries such as scouring, levelling, and wetting agents. The dye baths are pumped from the rotary drum drying machine to a holding tank for analysis and reconstitution with dyestuff. An average of 30 batches can be dyed before discharge. Capital costs for the conversion and analytical equipment required in 1980 amounted to US\$28,441. Operating costs for wet processing fell by US\$0,044/kg, resulting in a disposal and feedstock saving of US\$12,240/year along with 19% reduction in dye consumption, 35% in auxiliaries use and 57% energy savings. Volumes entering the waste stream fell because spent and contaminated dyes were being recycled. The process reduces the need for raw materials and the costs associated with waste disposal. (UNEP/IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1320 POTENTIAL WATER AND ENERGY SAVINGS IN TEXTILE BLEACHING AT DU PONT, CHEMICAL PIGMENTS DEPARTMENT, DELAWARE, USA. [BIB-JSTE000197]

The factory operates a bleach process consisting of 3 stages: desize; caustic; and perox. Each washing train has major water utilization of between 50-70 gal/min which is counterflowed through all the washers in that stage. Water temperatures vary but are seldom less than 180 °F. Consequently, saving water

inevitably leads to conserving heat as well. Water and energy utilization at all stages is expressed in the form of a table. In this connection, a series of experiments was carried out including: reduced water temperature; reduced water flow rate; reduced number of water feeds; and prewashing. The trials were successful and gave a number of options for optimizing water energy conservation. These options are shown on a table which itemizes the likely savings of water and energy for each particular variant. (UNEP/IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1321 RECOVERY AND RE-USE OF WATER IN WET TEXTILE PROCESSING AT A BTRA TEXTILE MILL, BOMBAY, INDIA. [BIB-JSTE000198]

A range of measures was suggested in the interests of water conservation reuse in the textile mill. These included: reduced rate of water flow and throttling on water supply to washing machines; counter-current flow of washing water on soapers, mercerizing machines, J-box etc; effective reuse of wash water earlier in the sequence via a common pump and sump; collection of steam condensate for reuse via boiler feed water; application of static washes on jiggers in place of overflow washers; use of NaHCO₃ in place of acetic acid for the oxidation of vat-dyed goods for easy removal of the NaOH; recycling the water for washing of blankets on printing machines; reducing the number of washing steps in the processing sequence by giving appropriate treatment to fabrics. Bulk trials were then carried out and the results presented in the form of a table. It was shown that total freshwater consumed before the optimization exercise was 183,350 l/day and after it 110,950 l/day. Over the period of a year the saving amounted to 21.7M litres of water, and thus 60 Rupees per 10K litres of water. (UNEP/IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1322 HEAT RECOVERY IN TEXTILE MANUFACTURING, ELLEN KNITTING MILLS, SPRUCE PINES, USA. [BIB-JSTE000199]

Dye bath effluent discharge to the sewer had a temperature of 132 °F and caused breakages in the sewer pipes. In 1991, a \$100K heat exchange system was installed which was intended to finance itself within 2 years. In this system, the dye water was fed into a holding vat and from thence into a heat exchanger made from stainless steel. Heat taken from the effluent is then used to preheat feed water from the dye tubes, causing a temperature increase from 55 to 105 °F. This operation was thought to save the company the cost of about 200K litres of fuel oil per annum. (UNEP/IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1323 ELIMINATION OF SULPHIDE PROBLEMS BY CHEMICAL SUBSTITUTION AT CENTURY TEXTILES AND INDUSTRIES LTD, BOMBAY, INDIA. [BIB-JSTE000200]

In a black dyeing process, a reduction stage had traditionally used Na sulphide. The tolerance for sulphide concentration in the treated effluent as prescribed by the State was not more than 2 ppm. Experiments were carried out to find a substitute reducing agent, and efforts concentrated on an alkali glucose alternative. A cheap source of glucose concentrate was located and it was found that 100 parts of Na sulphide (50%) could be replaced by 61 parts of glucose (80% solids) and 26 parts NaOH. Despite problems, a method was developed and gradually introduced from April 1990. Dyeing quality was unaltered, the effluent plant worked better, and the foul sulphury smell was eliminated. Presently, 3500 kg of cotton is dyed black in this way daily and the process can be extended to dye other colors. No capital expenditure was involved in this substitution. (UNEP/IE: Publisher: UNEP. (1993). Appears in: *The Textile Industry and the Environment*. [in English].)

1324 WATER CONSERVATION AT BINNY TEXTILE MILLS, MADRAS, INDIA [BIB-JSTE000201]

In the title plant, pollution is generated by the following departments: process and treatment; captive power generation unit (coal fired thermal power station); sizing; and yarn dyeing and printing. In order to preserve precious water, the following re-use and waste water measures were taken: 1. Re-use of pressure filter backwash water. By installing a settling pond with a 12 hour retention time, the stream's suspended solids precipitated and could be periodically removed. Thus, 20 m³ of fresh water was saved and is now used for gardening purposes. 2. Re-use of waste water from the dyeing and finishing department. The 'hard

to treat waste water was successfully substituted for the 1,200 m³ day fresh water formerly used for quenching boiler ash. This was therefore saved, and a reduction of 520 kg day biological oxygen demand (BOD) also achieved. 3. Re-use of waste water from sizing activities. The fresh water used to dampen coal in the yard was substituted by the waste water from the sizing operations. This 27 m³ day was saved as well as a reduction of 25% of the BOD on the effluent treatment facility. (UNEP IE; Publisher: UNEP, (1993). Appears in: *The Textile Industry and the Environment*, [in English].)

1325 POLICY, MANAGEMENT AND LEGAL FRAMEWORK [BIB-JSTE000202]

In the textile industry, many changes in policy and regulations have occurred. For example, many dyestuffs and chemicals have been banned as a result of their toxicity or carcinogenicity—a table of these materials is presented. Most countries have adopted laws or come to voluntary agreements with industry councils on codes of practice, one such example is quoted between the government of Thailand and the Thai Textile Federation. Several industry councils have developed standards norms for manufacture which dictate desirable usage of materials etc. for manufacture. Whilst they are not enforced, it is in everyone's clear interest that they are targeted. An example is quoted and tabulated for water and steam usage for different processes. Regarding environmental regulations, disposal of effluents (solid waste, liquid waste, and gas) legislation varies from country to country, though laws are becoming ever more specific. Examples are tabulated for allowable textile effluent disposal into rivers for Germany, Indonesia, Japan, Venezuela, and India. Also air emission requirements for textile dyeing and finishing plants in the State of Victoria, Australia. (UNEP IE; Publisher: UNEP, (1995). Appears in: *The Textile Industry and the Environment*, [in English].)

1326 END-OF-PIPE-TREATMENT [BIB-JSTE000203]

Methods used for liquid end-of-pipe-treatment in the textile industry are considered in this section. These can be classified into mechanical, biological, and advanced physico-chemical. An overview of the end-of-pipe treatments is presented in a table, identifying types of effluent created by the 7 basic processes, treatments used for these effluents, and strategies adopted. First, the effluents need to be screened to remove fibers from the liquid. Equalisation and neutralisation then follow into a holding reservoir to give a 24 hour residence time and create a standard effluent for subsequent treatment. Oil and grease separation is described, along with a grease recovery system. Chromium removal is effected as a sludge in alkaline conditions with lime, this is indicated in a flow diagram. Biological treatment is very important, and this is considered along with an activated sludge treatment and disposal plan, again illustrated by a line diagram. Decolorization of effluent is done by methods which include active charcoal, ozonization, and hyperfiltration. Finally, air pollution emission control methods are outlined with reference to bag filters, cyclone separators, scrubbers etc. (UNEP IE; Publisher: UNEP, (1993). Appears in: *The Textile Industry and the Environment*, [in English].)

1327 CLEANER PRODUCTION TECHNIQUES AND PROCESSES [BIB-JSTE000204]

The implementation of cleaner production technology at any manufacturing plant can help reduce the effluent burden considerably. The benefits of this are threefold: economics of production, need for less costly end-of-pipe pollution control and improved health of the workers. The cleaner techniques can be

categorized into: water management and energy conservation; optimization of chemicals' usage; and process equipment modifications. Water usage for all the basic 7 processes under typical conditions is shown in tabular form. Four different washing schemes designed to save water are considered including countercurrent and water re-use processes etc., all illustrated by line diagrams. Energy savings are also mentioned with reference to the case of a mill in Ireland which used a heat exchanger. Optimization of chemical use is discussed including such initiatives as: reuse of dyes' solutions from the dye bath; recovery of caustic in mercerizing; recovery of size in cotton processing; and recovery of grease in wool processing. Finally, process equipment modification features: washing operations; sizing-desizing systems; pad-batch dyeing; solvent processing; transfer printing; and foam processing technology. All of the latter are fully described and illustrated with line diagrams. (UNEP IE; Publisher: UNEP, (1993). Appears in: *The Textile Industry and the Environment*, [in English].)

1328 ENVIRONMENTAL IMPACT OF THE TEXTILE INDUSTRY [BIB-JSTE000205]

The sources of pollutants in the textile industry are discussed in detail. Individual chemicals occurring in effluent streams vary considerably, and many agents bearing a trade name only serve to confuse the situation further. Substantial tabulated data are presented on typical chemicals used in textile mills. Liquid textile effluents are generally grey in color, have a high biological oxygen demand (BOD), high dissolved solids content and are high in temperature. Typical analyses and characteristics of liquid wastes from all 7 basic processes are presented by a source report from Canada which highlights the pollutants in textile effluents. Air pollution sources and occupational safety of the workforce are also detailed. These emissions are generally categorized into: acid mists, oil mists, solvent vapors, odours, dusts and lints. A table is presented which lists these irritants. (UNEP IE; Publisher: UNEP, (1993). Appears in: *The Textile Industry and the Environment*, [in English].)

1329 OVERVIEW OF TEXTILE WET PROCESSING OPERATIONS [BIB-JSTE000206]

This section reviews wet operations in the textile industry and indicates likely sources of environmental vitiation resulting therefrom. Although a wide variety of fibers are used in the textile industry, the following categorization (1-7) suggested by the US Environmental Protection Agency (1978) forms a useful basis on which to judge these operations: 1) Wool scouring—this leaches out natural products from the wool (blood, faeces, grease etc), producing 1.5 kg waste per kg of scoured wool and thus a considerable liquid waste effluent stream; 2) Wool finishing—this generates a high effluent loading containing such toxic wastes as chromium Cr and phenols; 3) Dry processing—gives only light effluent arisings containing knitting oil; 4) Woven fabric finishing—high liquid effluent production from chemicals used for desizing, scouring, bleaching, mercerizing, printing, dyeing and resin treatment. The effluent quantity and nature depends much on the fibre being finished; 5) Knit fabric finishing—much the same effluent arisings as for 4); 6) Carpet manufacture—a separate case and effluent production is similar to 4) and 5); 7) Stock and yarn dyeing and finishing—has an effluent stream containing agents for cleaning, scouring, bleaching, mercerizing, dyeing, and special finishing. Each of the operations 1-7 is illustrated by a line diagram which indicates all sources of liquid waste, air pollution emission vapour and particulates. (UNEP IE; Publisher: UNEP, (1993). Appears in: *The Textile Industry and the Environment*, [in English].)

1330 GUIA TECNICA PARA LA MINIMIZACION DE RESIDUOS DE CURTIEMBRES [BIB-CEPI000001]

Explica el principio de minimización, su importancia y aplicación a la industria del cuero. Muestra aspectos generales del proceso productivo e identifica los puntos que generan residuos. Analiza el impacto de las curtiembres sobre el ambiente y la salud y describe experiencias realizadas a fin de minimizar este impacto. Explica de manera detallada un estudio de caso, los cambios obtenidos y las ventajas económicas. Presenta conclusiones y recomendaciones (Zarate, Max A.; Rojas, Clara Ines; Forst, Jürgen; CEPIS (Lima, PE); (1993). Appears in: *Guia tecnica para la minimizacion de residuos de curtiembres*, pp. 108 [in Spanish].)

1331 ANALISIS ECONOMICO DE ALTERNATIVAS NO CONTAMINANTES PARA CURTIEMBRES EN CHILE [BIB-CEPI000002]

Presenta un análisis de la situación actual del sector industrial del cuero y del problema de los efluentes. Contiene una descripción de las tecnologías disponibles que se pueden implementar para minimizar las emisiones y una evaluación económica de la adopción de algunas de estas tecnologías (Ibabaca Arenas, Patricia; CEP-AL (Santiago, CL); (1993). Appears in: *Analisis economico de alternativas no contaminantes para curtiembres en Chile*, pp. 107 [in Spanish].)

1332 UEBER DEN UMGANG MIT SCHADSTOFFBE- LASTETEN GRUNDSTUECKEN IN DEN KOMMUNEN AM BEISPIEL DER LANDESHAUPTSTADT HANNOVER (ABOUT TOXIC WASTE TREATMENT IN A MUNICIPIUM. EXAMPLE: HANNOVER) [BIB-CEPI000003]

(Moeninghoff, Hans; Poepelbaum, Martina. Müll und Abfall, (November 1992), pp. 806-809 [in German]. 0027-2957)

1333 ENTSORGUNG VON ELEKTRONIKSCHROTT (EVACUATION OF ELECTRONIC WASTES) [BIB-CEPI000004]

(Herrmann, Ernst; Entsorgungs Praxis, (September 1992), pp. 554-556 [in German]. 0724-6870)

1334 ABFALLWIRTSCHAFTSZENTRUM IN DER AUTOMOBILINDUSTRIE (CENTER FOR WASTE ADMINISTRATION IN THE AUTOMOBILE INDUSTRY) [BIB-CEPI000005]

(Berger, Hans-Werner; Tschackert, Albrecht; Entsorgungs Praxis, (May 1992), pp. 294-297 [in German]. 0724-6870)

1335 DIE VERWERTUNG VON LACKSCHLAMM (RECYCLING LACQUER SLUDGES) [BIB-CEPI000006]

(Holper, Josef; Voigt, Bodo; Müll und Abfall, (July 1993), pp. 497-501 [in German]. 0027-2957)

1336 KOMMUNALE ABFALLBERATUNG ALS TEIL INTEGRIERTER ABFALLWIRTSCHAFTSKONZEPTE; ERFAHRUNGSBERICHT AUS DEM RHEIN-SIEG-KREIS (COMMUNAL ADVICE FOR WASTE REDUCTION AND MINIMIZATION AS PART OF AN INTEGRATED WASTE ADMINISTRATION CONCEPT) [BIB-CEPI000007]

(Cichonski, Paul; Spielberg, Johannes; Müll und Abfall, (January 1993), pp. 1-6, 8-9 [in German]. 0027-2957)

1337 EMISSIONSMINDERUNGSTECHNIK IN DER EISEN- UND STAHLINDUSTRIE (EMISSION REDUCTION TECHNIQUES IN IRON AND STEEL INDUSTRIES) [BIB-CEPI000008]

Examina las técnicas utilizadas para reducir la formación de sustancias nocivas durante el proceso de producción del acero y del hierro, con la finalidad de disminuir las cargas ambientales (Angrick, Michael; Entsorgungs Praxis, (June 1993), pp. 466-469 [in German]. 0724-6870)

1338 TREATMENT AND DISPOSAL OPTIONS FOR HAZARDOUS WASTE [BIB-CEPI000009]

(Ogawa, Hisashi; OMS (Ginebra, CH); WHO Intensive Course on Environmental Health for Public Health Engineers, Kuala Lumpur, 18-22 Oct. 1993, (1993). Appears in: *Treatment and disposal options for hazardous waste*, pp. 13 [in English].)

1339 GUIA TECNICA PARA LA MINIMIZACION DE RESIDUOS EN CURTIEMBRES; RESUMEN EJECUTIVO [BIB-CEPI000010]

Estudio de caso de aplicación del principio de minimización de residuos en la industria del cuero. El estudio se realizó entre mayo de 1990 y abril de 1993 en una curtiembre de Lima, Perú, que procesa pieles de ganado ovino y caprino. En el estudio de caso, se obtuvo un ahorro promedio de 30 por ciento de sulfuro durante el proceso de pelambre y 25 por ciento de insumos químicos en el curtido. La rentabilidad de las propuestas de reuso en conjunto tuvo un valor actual neto de US\$34,381.00 con una tasa interna de retorno de 30 por ciento y el tiempo de recuperación de la inversión de 3 años, 7 meses (García, María Mercedes; CEPIS (Lima, PE); (1993). Appears in: *Guia tecnica para la minimizacion de residuos en curtiembres; resumen ejecutivo*, pp. 11 [in Spanish].)

1340 ELEKTRONIKSCHROTT-VERWERTUNG; ANFORDERUNGEN UND VORAUSSETZUNGEN (USE OF ELECTRONIC WASTES; REQUIREMENTS AND PRECEDENTS) [BIB-CEPI000011]

(Affüpper, Marc; Entsorgungs Praxis, (November 1993), pp. 786-790, 792 [in German]. 0724-6870)

1341 SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION PROGRAM; TECHNOLOGY PROFILES [BIB-CEPI000012]

Compendia 170 perfiles de proyectos tecnológicos aplicables al manejo de los residuos peligrosos. Cada perfil describe la tecnología, discute su aplicabilidad a varios residuos, la situación de su desarrollo o demostración, resultados y disponibilidad. Incluye directorio (Environmental Protection Agency (Cincinnati, US). Office of Research and Development, Risk Reduction Engineering Laboratory; (1993). Appears in: *Superfund innovative technology evaluation program; technology profiles*, pp. 424 [in English].)

1342 MINIMIZATION OF HAZARDOUS WASTE IN INDUSTRIES [BIB-CEPI000013]

(Ogawa, Hisashi; OMS (Ginebra, CH); WHO Intensive Course on Environmental Health for Public Health Engineers, Kuala Lumpur, 18-22 Oct. 1993, (1993). Appears in: *Minimization of hazardous waste in industries*, pp. 13 [in English].)

1343 IMMOBILIZATION MECHANISMS IN SOLIDIFICATION/STABILIZATION OF CD AND PD SALTS USING PORTLAND CEMENT FIXING AGENTS [BIB-CEPI000014]

Investiga el comportamiento de las sales de cadmio y plomo en el proceso de solidificación/estabilización usando cemento como agente fijador. Se realizaron pruebas de percolación, de conducción calorimétrica, y del estado sólido en función del tiempo. Los resultados muestran que el cemento puede inmovilizar el cadmio, mas no las sales de plomo (Cartledge, Frank K.; Butler, Leslie G.; Chalasani, Devi; Eaton, Harvill C.; Frey, Frank P.; Herrera, Esteban; Tittlebaum, Marty E.; Yang, Shou-Lan; Environmental science & technology, (June 1990), pp. 867-873 [in English]. 0013-936X)

1344 DEVELOPMENT OF A THERMAL STABILITY RANKING OF HAZARDOUS ORGANIC COMPOUND INCINERABILITY [BIB-CEPI000015]

Desarrolla una lista de compuestos orgánicos peligrosos en base a su estabilidad térmica. Evalúa la temperatura requerida para descomponer en un 99 por ciento una serie de compuestos orgánicos constantes de composición elemental de mezcla, relación combustible oxígeno y tiempo de residencia de la fase gaseosa

Los análisis de la cinética de las reacciones termoquímicas indican que las variaciones (Taylor, Philip H.; Dellinger, Barry; Lee, C.C.; *Environmental science & technology*, (March 1990), pp. 316-328 [in English]. 0013-936X)

1345 RESEARCH NEEDS FOR THE THERMAL TREATMENT OF HAZARDOUS WASTE [BIB-CEPI000016]

Resume las principales investigaciones publicadas en relación a la incineración de residuos peligrosos y cómo es vista por la División de Sistemas Químicos y Termales de la Fundación Nacional de Ciencia. Discute cómo la Fundación esta enfocando multidisciplinariamente los problemas del medio ambiente y menciona cómo estos enfoques se relacionan con los esfuerzos de otras agencias federales (Grosshandler, William L. *Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute*, (1990), pp. 1-6 [in English]. 0882-5696)

1346 PREDICTION OF TRANSIENT BEHAVIOR DURING BATCH INCINERATION OF LIQUID WASTES IN ROTARY KILNS [BIB-CEPI000017]

Desarrolla un modelo matemático para definir los mecanismos que gobiernan la generación momentánea de bocanadas de humo y predecir cómo es controlada por las propiedades de los desechos durante la incineración de desechos líquidos en hornos rotatorios. Describe los resultados conseguidos y sus aplicaciones prácticas para controlar la formación de vapores por un exceso de aire en la flama primaria (Wendt, J.O.L.; Linak, W.P.; Lemieux, P.M.; *Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute*, (1990), pp. 41-54 [in English]. 0882-5696)

1347 POLYCHLORINATED DIOXIN/FURAN FORMATION IN INCINERATORS [BIB-CEPI000018]

Revisa las evidencias de la formación de dioxinas furanos policlorinados durante la incineración de desechos peligrosos. Propone un modelo global para definir la cinética de formación de los compuestos policlorinados. Sostiene que las reacciones catalizadas superficiales a bajas temperaturas (250-400C) generan la formación de compuestos tóxicos (Altwickler, E.R.; Schonberg, J.S.; Kondari, R.K.N.V.; Milligan, M.S.; *Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute*, (1990), pp. 73-87 [in English]. 0882-5696)

1348 SOLID PYROLYSIS AND VOLATILE SECONDARY REACTIONS IN HAZARDOUS WASTE INCINERATION; IMPLICATIONS FOR TOXICANTS DESTRUCTION AND PIC'S GENERATION [BIB-CEPI000019]

Estudia los procesos de pirólisis de sólidos y la reacción secundaria de los compuestos volátiles formados por oxidación parcial, que afectan la eficiencia de la incineración de residuos sólidos peligrosos. Muestra cómo un apropiado diseño, operación y monitoreo beneficia a un mejor entendimiento cuantitativo del fenómeno de devolatilización. Describe los métodos de investigación que se aplican para estudiar la pirólisis de sólidos y las reacciones secundarias de compuestos volátiles (Peters, William A.; Darivakis, George S.; Howard, Jack B.; *Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute*, (1990), pp. 89-102 [in English]. 0882-5696)

1349 CHLOROBENZENE AND DICHLOROBENZENE REACTIONS IN HYDROGEN AND IN HYDROGEN/OXYGEN MIXTURES [BIB-CEPI000020]

Estudia las reacciones térmicas del clorobenceno y el diclorobenceno en hidrógeno y mezclas de hidrógeno-oxígeno a diferentes temperaturas y presión constante de atmósfera. Las investigaciones experimentales demostraron que la descomposición en presencia de hidrógeno ocurre más rápidamente que la pirólisis en un gas inerte. Asimismo la presencia de hidrógeno acelera la destrucción de los compuestos aromáticos clorinados vía el proceso catalítico de fase gaseosa (Ritter, E.; Bozzelli, Joseph W.; *Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute*, (1990), pp. 103-115 [in English]. 0882-5696)

1350 MINIMIZACION Y RECICLAJE; UNA ESTRATEGIA PARA EL DESARROLLO [BIB-CEPI000001]

Comenta sobre las perspectivas del desarrollo de las estrategias de minimización y reciclaje de desechos industriales en América Latina. Define el concepto de minimización de los residuos industriales, detalla las técnicas de minimización comúnmente empleadas y los beneficios que representan para las industrias y el medio ambiente, al hacer un mejor uso de los recursos (Rincones C., María E. CEPIS (Lima, PE); Congreso de la Industria Metalmeccánica, I. Arequipa, 4-5 mayo 1990, (1990). Appears in: *Minimización y reciclaje: una estrategia para el desarrollo*, pp. 6 [in Spanish].)

1351 TREATMENT OF HAZARDOUS LANDFILL LEACHATES AND CONTAMINATED GROUNDWATER; PROJECT SUMMARY [BIB-CEPI000022]

Describe un estudio a escala piloto y de campo que evalúa la aplicación dominada e individual de técnicas de tratamiento biológico y físico-químico del líquido percolado de rellenos sanitarios y el vertido de sustancias peligrosas sobre el terreno. Las técnicas evaluadas durante los experimentos a escala de laboratorio son: sistemas microbianos dispersos y de membrana fija aerobios y anaerobios, floculación-precipitación, ultrafiltración y ósmosis inversa (Ahler, Robert C.; Kosson, David S.; Environmental Protection Agency (Cincinnati, U.S.), Risk Reduction Engineering Laboratory, (February 1990). Appears in: *Treatment of hazardous landfill leachates and contaminated groundwater, project summary*, pp. 9 [in English].)

1352 SITE DEMONSTRATION OF THE CHEMFIX SOLIDIFICATION/STABILIZATION PROCESS AT THE PORTABLE EQUIPMENT SALVAGE COMPANY SITE [BIB-CEPI000023]

Describe el proceso patentado de solidificación-estabilización CHEMFIX utilizado para el tratamiento de líquidos, lodos, aceites y cenizas conteniendo aceites pesados y compuestos orgánicos. La demostración de este proceso fue realizada en marzo de 1989 con residuos conteniendo plomo, cobre y PCBs provenientes de la Compañía de Equipo Portátil de Salvataje ubicada en Chackama, Oregon. Los resultados de las pruebas realizadas por la EPA demuestran una reducción sustancial de la lixivabilidad del plomo y cobre en los residuos al utilizar esta técnica de tratamiento. La efectividad de este proceso para inmovilizar los bifenilos policlorados (PCBs) no fue determinada. Los resultados de pruebas físicas indican la durabilidad del material tratado frente a las condiciones del medio ambiente (Barth, Edwin F.; *Journal of Air and Waste Management Association*, (February 1990), pp. 166-170 [in English].)

1353 GUIDES TO POLLUTION PREVENTION; THE PESTICIDE FORMULATING INDUSTRY [BIB-CEPI000024]

(Environmental Protection Agency (Cincinnati, U.S.) Risk Reduction Engineering Laboratory, (February 1990). Appears in: *Guides to pollution prevention: the pesticide formulating industry*, pp. 54 [in English].)

1354 GUIDES TO POLLUTION PREVENTION; THE PAINT MANUFACTURING INDUSTRY [BIB-CEPI000025]

Contiene una visión de los procesos y operaciones que generan desechos en la industria de la pintura. Presenta opciones para minimizar la producción de desechos por medio de reducción de fuentes y reciclaje. Describe el procedimiento de evaluación de la minimización de residuos peligrosos y el uso de formularios para el caso. Ilustra la aplicación de la evaluación en dos casos de fábricas de pinturas sobre la generación de residuos peligrosos y prácticas de minimización (Environmental Protection Agency (Cincinnati, U.S.) Risk Reduction Engineering Laboratory, (June 1990). Appears in: *Guides to pollution prevention: the paint manufacturing industry*, pp. 65 [in English].)

1355 GUIDES TO POLLUTION PREVENTION; THE FABRICATED METAL PRODUCTS INDUSTRY [BIB-CEPI000026]

Contiene los lineamientos y opciones para implementar programas de minimización de residuos peligrosos y no peligrosos producidos por la industria metalmeccánica. Examina los residuos generados en los cuatro tipos de procesos usados por esta industria como: la operación de máquinas, limpieza de partes,

tratamiento de las superficies metálicas, platinado y aplicación de pintura. Orienta sobre el uso de formularios de evaluación de la minimización de residuos peligrosos (Environmental Protection Agency (Cincinnati, US) Risk Reduction Engineering Laboratory; (July 1990). Appears in: *Guides to pollution prevention: the fabricated metal products industry*, pp. 76 [in English].)

1356 GUIDES TO POLLUTION PREVENTION; THE PRINTED CIRCUIT BOARD MANUFACTURING INDUSTRY [BIB-CEPI000027]

Identifica y analiza las metodologías apropiadas de minimización de residuos peligrosos para la industria de tarjetas impresas de circuitos. Describe los procesos que generan estos residuos que por lo general son partículas llevadas por el aire, restos de baños de platinado, residuos de enjuague, y otros. Muestra el uso de los formularios de evaluación de minimización, y presenta casos estudiados sobre el desempeño de la evaluación (Environmental Protection Agency (Cincinnati, US) Risk Reduction Engineering Laboratory; (June 1990). Appears in: *Guides to pollution prevention: the printed circuit board manufacturing industry*, pp. 77 [in English].)

1357 GUIDES TO POLLUTION PREVENTION; RESEARCH AND EDUCATIONAL INSTITUTIONS [BIB-CEPI000028]

Contiene una visión de los procesos y operaciones que generan desechos en las instituciones educacionales y centros de investigación. Presenta opciones para minimizar la producción de residuos peligrosos por medio de la reducción de fuentes y reciclaje. Proporciona enfoques para el uso de formularios para la evaluación de la minimización de residuos peligrosos en los centros de educación e investigación (Environmental Protection Agency (Cincinnati, US) Risk Reduction Engineering Laboratory; (June 1990). Appears in: *Guides to pollution prevention: research and educational institutions*, pp. 48 [in English].)

1358 GUIDES TO POLLUTION PREVENTION; THE COMMERCIAL PRINTING INDUSTRY [BIB-CEPI000029]

Identifica y analiza las metodologías apropiadas de minimización de residuos peligrosos y no peligrosos generados en los centros de impresión comercial. Describe el uso de formularios en el desarrollo de opciones de minimización de desechos para instalaciones individuales. Ilustra la aplicación de la evaluación en dos plantas de impresión comercial sobre la generación de residuos peligrosos y alternativas de minimización (Environmental Protection Agency (Cincinnati, US) Risk Reduction Engineering Laboratory; (August 1990). Appears in: *Guides to pollution prevention: the commercial printing industry*, pp. 45 [in English].)

1359 WASTE MINIMIZATION INCENTIVES [BIB-CEPI000030]

(Environmental Protection Agency (Cincinnati, US); Federal register, (October 1990), pp. 40881-40887 [in English].)

1360 STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE INCINERATORS AND BURNING OF HAZARDOUS WASTES IN BOILERS AND INDUSTRIAL FURNACES [BIB-CEPI000031]

Regulaciones de control de emisiones de metales tóxicos, cloruro de hidrógeno y residuos orgánicos. Rectifica especificaciones de los incineradores (Environmental Protection Agency (Cincinnati, US); Federal register, (27 May 1990), pp. 17862-17921 [in English].)

1361 GUIDELINES FOR LABORATORY PERSONNEL WORKING WITH CARCINOGENIC OR HIGHLY TOXIC CHEMICALS [BIB-CEPI000032]

(National Health and Medical Research Council (Canberra, AU); (1990). Appears in: *Guidelines for laboratory personnel working with carcinogenic or highly toxic chemicals*, pp. 19 [in English].)

1362 MECHANISMS AND APPLICATIONS OF SOLIDIFICATION/STABILIZATION [BIB-CEPI000033]

Contiene estudios sobre los mecanismos y aplicaciones de la técnica de solidificación/estabilización (s.s) como tecnologías para el tratamiento y disposición

de residuos peligrosos orgánicos, inorgánicos y residuos radiactivos. Presenta información que puede usarse para seleccionar el método(s) para el tratamiento de un residuo dado. Se incluye definiciones (Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification/stabilization*, pp. 138 [in English].)

1363 OVERVIEW OF THE HISTORY, PRESENT STATUS, AND FUTURE DIRECTION OF SOLIDIFICATION/STABILIZATION TECHNOLOGIES FOR HAZARDOUS WASTE TREATMENT [BIB-CEPI000034]

Revisa el desarrollo de las tecnologías de solidificación/estabilización en el futuro, fuertemente influenciada por las necesidades de la industria y las normas gubernamentales. Identifica áreas claves donde el conocimiento de esta tecnología es limitada y factores que impactarán su utilización (Barth, Edwin F.; Environmental Protection Agency (Cincinnati, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and application of solidification/stabilization*, pp. 1-6 [in English].)

1364 STABILIZATION OF HAZARDOUS WASTE LAND-FILL LEACHATE TREATMENT RESIDUE [BIB-CEPI000035]

Discute resultados del proceso de estabilización de residuos peligrosos, como consecuencia de un programa de investigación diseñado para determinar la tratabilidad de lixiviados peligrosos de rellenos de seguridad por procesos químicos y biológicos. Concluye que el proceso de estabilización de residuos acuosos, con un bajo nivel de compuestos orgánicos, es factible. De los compuestos orgánicos analizados en el estudio de tratabilidad de lixiviados, solamente el metanol no fue estabilizado según normas establecidas (Conner, Jesse R.; Li, Alan; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanism and applications of solidification/stabilization*, pp. 6-14 [in English].)

1365 TEST RESULTS FROM A PILOT BURN OF OVERAGE PESTICIDES D.G. KHAN, PUNJAB, PAKISTAN [BIB-CEPI000036]

Reporta la conducción de una prueba del quemado de pesticidas caducos en un horno de cemento como una técnica efectiva para su destrucción. Dos tipos de pesticidas fueron utilizados para la prueba piloto: compuestos de fosfatos (CP) y compuestos clorados (OC). Se determinó que el 99.99 por ciento de los compuestos orgánicos seleccionados son destruidos o removidos por el método de incineración. La concentración promedio en la exhalación del pesticida gaseoso debido al quemado es de 0.053 mg/nm³ para el OP y 0.011 mg/nm³ para el OC. Esto demuestra (Chahaske, John; Yoest, Helen; AID (Washington, D.C., US); (November 1990). Appears in: *Test results from a pilot burn of overage pesticides D.G. Khan, Punjab, Pakistan*, pp. 164 [in English].)

1366 PESTICIDE DISPOSAL IN A CEMENT KILN IN PAKISTAN; REPORT OF A PILOT PROJECT [BIB-CEPI000037]

(Huden, Gudrun Hartig; AID (Washington, D.C., US); (November 1990). Appears in: *Pesticide disposal in a cement kiln in Pakistan: report of a pilot project*, pp. 164 [in English].)

1367 COMPARISON OF CONTAMINANT LEACHABILITY TO QUANTITY OF BINDER MATERIAL [BIB-CEPI000038]

Discute los resultados de las pruebas de fugas de contaminantes aplicados a residuos peligrosos y los cambios en la movilidad del contaminante relacionado a la cantidad de aglomerante agregado durante la aplicación de la solidificación/estabilización (s.s). Los residuos evaluados provienen de la industria del acero y contienen metales pesados. Concluye que un incremento de la concentración de aglomerantes, incrementa significativamente la inmovilización del contaminante (Holmes, Teresa T.; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification/stabilization*, pp. 112-119 [in English].)

1368 LEACHING MODELS: THEORY AND APPLICATION [BIB-CEPI000039]

Presenta el desarrollo de modelos de lixiviación a aplicarse en la predicción de los efectos de las variables del proceso en la performance de residuos solidificados. Ellos pueden usarse para predecir el comportamiento del lixiviado a largo plazo en el medio ambiente, para correlacionar datos experimentales y para mejorar el entendimiento de la solidificación-estabilización (Batchelor, Bill; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 103-111 [in English].)

1369 BINDING CHEMISTRY AND LEACHING MECHANISMS OF HAZARDOUS SUBSTANCES IN CEMENTITIOUS SOLIDIFICATION/STABILIZATION SYSTEMS [BIB-CEPI000040]

Los mecanismos de aglomeración química y lixiviación de sustancias peligrosas, particularmente los metales contaminantes, en sistemas de estabilización solidificación a base de cemento son discutidos en términos de sus volúmenes y estados superficiales. Provee información para lograr un mejor entendimiento en los nuevos diseños o mejoramiento de sistemas de estabilización y solidificación, además información necesaria para modelar matemáticamente la lixiviación (Cocke, David L.; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 81-102 [in English].)

1370 SOLIDIFICATION/STABILIZATION OF HAZARDOUS WASTE SUBSTANCES IN LATEX MODIFIED PORTLAND CEMENT MATRICES [BIB-CEPI000041]

La inmovilización de residuos peligrosos en un molde de cemento Portland es considerada el mejor método de solidificación debido a la simplicidad del proceso y a su bajo costo. Sin embargo, la porosidad relativamente alta de este molde podría permitir una lixiviación considerable. Esto ha creado la necesidad de mejorar los aglomerantes del cemento Portland. Estudios preliminares indican resultados alentadores en la estabilización solidificación de residuos inorgánicos (Pb y Cr) usando un cemento modificado con latex (Danially, Saeed; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 77-80 [in English].)

1371 DEVELOPING A KINETIC LEACHING MODEL FOR SOLIDIFIED/STABILIZED HAZARDOUS WASTES [BIB-CEPI000042]

Desarrolla el modelo de la cinética de lixiviación en los residuos peligrosos solidificados estabilizados. El modelo se basa en la relación de ion hidrógeno en el lixiviado, la distancia de lixiviación y la alcalinidad (Cheng, Kuang Ye; Bishop, Paul L.; University of Cincinnati (Cincinnati, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 66-77 [in English].)

1372 OVERVIEW OF PRESENT DAY IMMOBILIZATION TECHNOLOGIES [BIB-CEPI000043]

Presenta las evidencias físico-químicas que distinguen a un aglomerante que químicamente se une con el residuo a uno que simplemente se adsorbe en la superficie. Estas evidencias provienen de técnicas de análisis ampliamente reconocidas (ej. análisis termogravimétricos, cromatografía de gas y otros). Discute la practicabilidad de la vitrificación como técnica de inmovilización y la solidificación con cal viva (Soundararajan, R.; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 55-66 [in English].)

1373 SOLIDIFICATION/STABILIZATION OF TECHNETIUM IN CEMENT-BASED GROUTS [BIB-CEPI000044]

Presenta los resultados de la aplicación de la técnica de solidificación-estabilización como tecnología para el tratamiento y disposición final de residuos químicamente peligrosos y radioactivos. Los sedimentos del cemento Portland convencional y el de cenizas finas han demostrado ser efectivos para la retención de metales hidrolizables (plomo, cadmio, uranio y níquel) pero son marginalmente aceptables para la retención del ⁹⁹Tc radioactivo. La adición de tierra de altos hornos a los sedimentos ha demostrado reducir la lixiviableidad del tecnecio (Tc) por varios órdenes de magnitud. El efecto selectivo de la escoria se cree que es debido a su capacidad de reducir el TC (VII) a la especie Tc (IV) menos soluble (Gilliam, T. Michael; Spencer, Roger D.; Bostick, William D.; Shoemaker, J.L.; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 49-55 [in English].)

1374 FACTORS FOR SELECTING APPROPRIATE SOLIDIFICATION/STABILIZATION METHODS [BIB-CEPI000045]

Presenta información para seleccionar el método de solidificación-estabilización (S/S) en el tratamiento de un residuo inorgánico. Estos métodos se presentan en 6 categorías: aglomerantes a base de cemento, aglomerantes a base de cal, absorbentes, materiales termoplásticos, polímeros termofraguables y vitrificación. El documento discute solamente las dos primeras categorías de S/S y hace una breve mención de las otras. Estas técnicas no son adecuadas para la estabilización de residuos orgánicos, aunque pueden ser usadas en combinación con otros esquemas de tratamiento que remueven el material orgánico de los desechos (Weitzman, Leo; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 40-49 [in English].)

1375 SPECTROSCOPIC AND LEACHING STUDIES OF SOLIDIFIED TOXIC METALS [BIB-CEPI000046]

Muestras de cemento Portland conteniendo los nitratos solubles de los metales contaminantes: cromo, plomo, bario, mercurio, cadmio y zinc, fueron investigados usando la técnica termogravimétrica y la técnica infrarroja de Fourier. Discute y tabula la mayor banda vibracional de especies de carbonato, sulfato, silicato, agua y nitrato, comparándola con el cemento no contaminado. Además reporta resultados de estudios de lixiviado de las muestras mencionadas conteniendo sulfuro y fosfato como aditivos (Ortega, J. Dale; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 26-32 [in English].)

1376 SOLIDIFICATION/STABILIZATION OF PHENOLIC WASTE WITH CEMENTITIOUS AND POLYMERIC MATERIALS [BIB-CEPI000047]

Presenta la investigación sobre el potencial del polímero polyester en la estabilización solidificación del fenol. Los resultados fueron alentadores. La efectividad del polímero polyester fue comparado con la del cemento con una proporción agua cemento de 0.5. El fenol inhibe el fraguado del cemento y el polímero polyester. Bajo la mayoría de las condiciones de prueba los sistemas polímero polyester mostraron no presentar fugas. La recuperación de fenol de los sistemas de cemento dependían del tiempo de curado y de la concentración inicial del fenol. El fenol también produce grandes vacíos en la microestructura del cemento. El residuo de fenol solidificado por el polímero polyester tuvo mayor asistencia a la compresión y tensión que el residuo solidificado en cemento (Vipulanandan, C.; Krishnan, S.; Gulf Coast Hazardous Substance Research Center (Texas, US); Annual Symposium Gulf Coast Hazardous Substance Research Center, 2, Beaumont, 15-16 feb. 1990, (1990). Appears in: *Mechanisms and applications of solidification stabilization*, pp. 14-26 [in English].)

1377 THERMAL PROCESSES [BIB-CEPI000048]

Se refiere a los procesos térmicos como medio de tratamiento de residuos peligrosos. Los sistemas han sido diseñados para destruir los residuos peligrosos a través de la combustión o pirólisis por exposición de los materiales a altas temperaturas en ambientes controlados. Contiene 20 capítulos que tratan sobre muchas de las nuevas tecnologías que están generando interés en el campo del tratamiento de residuos peligrosos (Freeman, Harry M; Innovative hazardous waste treatment technology series. (1990). Appears in: *Thermal processes*, 684 p., 3, v.1, pp. 241 [in English].)

1378 PHYSICAL/CHEMICAL PROCESSES [BIB-CEPI000049]

Contiene información referida a los procesos físico-químicos como medio de tratamiento de residuos peligrosos. En 24 capítulos estudia nuevos procesos que están generando interés en el campo del tratamiento de residuos usando principios físico-químicos (Freeman, Harry M; Innovative hazardous waste treatment technology series. (1990). Appears in: *Physical chemical processes*, 684 p., 3, v.2, pp. 242 [in English].)

1379 TRAFICO DE DESECHOS PELIGROSOS EN AMERICA LATINA [BIB-CEPI000050]

Define el origen y características de los residuos de carácter peligroso. Informa que existen diversas técnicas de tratamiento, pero ninguna brinda seguridad en la eliminación total del riesgo en la disposición final. Analiza las formas de tráfico de residuos peligrosos entre países industrializados y países del tercer mundo. Hace referencia a las condiciones económicas de endeudamiento y dependencia. Presenta un análisis de los conceptos de ecología, seguridad nacional, seguridad regional y global (Sánchez, Vicente; Sepúlveda, Claudia; Cerda, Rodrigo; Comisión Sudamericana de Paz (Santiago, CL); Documento de estudio. (1990). Appears in: *Tráfico de desechos peligrosos en América Latina*, pp. 61 [in Spanish].)

1380 PREVENTING POLLUTION THROUGH TECHNICAL ASSISTANCE; ONE STATE'S EXPERIENCE [BIB-CEPI000051]

(Dorfman, Mark H.; Riggio, John G.; (1990). Appears in: *Preventing pollution through technical assistance: one state's experience*, pp. 63 [in English].)

1381 MEMORIA DE LA I REUNION DEL NUCLEO TECNICO EN MANEJO DE RESIDUOS PELIGROSOS [BIB-CEPI000052]

Contiene memoria de la primera reunión del núcleo técnico en manejo de residuos peligrosos realizada en Lima del 5-9 de noviembre de 1990, con la participación de representantes de Argentina, Brasil, Colombia, Estados Unidos, Francia, México, Perú, Puerto Rico y Venezuela. Se resume las ponencias de los participantes en las áreas temáticas de: análisis de la situación actual; minimización y reciclaje; transporte, tratamiento y disposición; y legislación sobre residuos peligrosos. Proporciona conclusiones y recomendaciones, además de un plan de trabajo futuro (Benavides, Livia; Rincones C., María E; CEPIS (Lima, PE); GTZ (Eschborn, DE); Reunión Núcleo Técnico en Manejo de Residuos Peligrosos. 1. Lima, 5-9 nov. 1990. (June 1991). Appears in: *Memoria de la I Reunión del Núcleo Técnico en Manejo de Residuos Peligrosos*, pp. 32 [in Spanish].)

1382 LAND DISPOSAL RESTRICTIONS FOR THIRD THIRD SCHEDULED WASTES; RULE [BIB-CEPI000053]

Texto definitivo de norma que establece estándares de tratamiento específico y fechas para prohibir la disposición en el terreno de ciertos residuos peligrosos no tratados, comprendidos dentro del grupo de residuos del "tercer tercio". Incluye a los radiactivos y a los de la industria de refinera del petróleo (Environmental Protection Agency (Washington, D.C., US); Federal Register. (June 1990), pp. 22520-22720 [in English].)

1383 ADDENDUM FOR ACRYLONITRILE WASTES (K011, K013, AND K014) [BIB-CEPI000054]

Presenta el fundamento técnico de la Environmental Protection Agency (EPA) para el desarrollo de estándares de tratamiento para los efluentes codificados como K011, K013 y K014, generados en la producción del acrilonitrilo. El documento constituye un addendum al documento previo publicado en 1989

Informa sobre el tratamiento de efluentes y las tecnologías que fueron evaluadas para seleccionar la mejor. Señala estándares de tratamientos para estos residuos (Rosengrant, Larry; Chatmon McEaddy, Mónica; Environmental Protection Agency (Washington, D.C., US); Office of Solid Waste; Best Demonstrated Available Technology (BDAT) Background Document. (May 1990). Appears in: *Addendum for acrylonitrile wastes (K011, K013, and K014)*, pp. 50 [in English].)

1384 P AND U THALLIUM WASTES; BACKGROUND DOCUMENT [BIB-CEPI000055]

Presenta las razones técnicas en las que se basa la Agencia de Protección Ambiental de los Estados Unidos (EPA) para el desarrollo de normas de tratamiento de los residuos de talium identificados en la norma 40 CFR261.33. Proporciona el número y ubicación de plantas industriales en los Estados Unidos afectadas por las restricciones de disposición de estos residuos en el terreno. Identifica los procesos que generan residuos y presenta datos de su caracterización. Señala las tecnologías usadas para tratar estos residuos o similares incluyendo resultados. Explica cómo la EPA determina la mejor tecnología de tratamiento. Selecciona los elementos que deben ser regulados y determina los estándares de tratamiento para estos residuos (Rosengrant, Larry; Craig, Rhonda M; Environmental Protection Agency (Washington, D.C., US); Office of Solid Waste; Best Demonstrated Available Technology (BDAT). (May 1990). Appears in: *P and U thallium wastes: background document*, pp. 28 [in English].)

1385 VANADIUM-CONTAINING WASTES (P119 AND P120); BACKGROUND DOCUMENT [BIB-CEPI000056]

Señala el fundamento técnico de la Environmental Protection Agency (EPA) para el desarrollo de estándares de tratamiento de los residuos identificados en la norma 40 CFR261.33 por los códigos P119 y P120. Residuos generados en la industria de productos químicos inorgánicos que utilizan compuestos de vanadio. Indica el número y ubicación de plantas industriales en los Estados Unidos afectadas a las restricciones de disposición en el terreno de estos residuos. Identifica los procesos que generan los residuos P119 y P120 e incluye datos de su caracterización. Presenta resultados de tecnologías y criterios considerados para la elección del mejor tratamiento y establecer la norma (Rosengrant, Larry; Craig, Rhonda M; Environmental Protection Agency (Washington, D.C., US); Best Demonstrated Available Technology (BDAT). (May 1990). Appears in: *Vanadium-containing wastes (P119 and P120): background document*, pp. 30 [in English].)

1386 K073; BACKGROUND DOCUMENT [BIB-CEPI000057]

Proporciona el soporte técnico de la Agencia de Protección Ambiental de los Estados Unidos (EPA) para la selección y el desarrollo de estándares de tratamiento para los elementos que deben ser regulados en los residuos codificados como K073 (residuos de hidrocarburos clorinados de la industria de producción de cloro). Señala el número y ubicación de plantas en los Estados Unidos afectadas por las restricciones de disposición de estos residuos en el terreno e identifica procesos que los generan y su caracterización. Presenta resultados de las tecnologías usadas y la determinación de la EPA en la elección de la mejor. Discute la selección de elementos para ser regulados y la determinación de los estándares (Rosengrant, Larry; Eby, Elaine; Environmental Protection Agency (Washington, D.C., US); Office of Solid Waste; Best Demonstrated Available Technology (BDAT). (May 1990). Appears in: *K073: background document*, pp. 50 [in English].)

1387 SILVER-CONTAINING WASTES; BACKGROUND DOCUMENT [BIB-CEPI000058]

Información sobre el número y ubicación de las instalaciones en los Estados Unidos afectadas por las restricciones de disposición en el terreno de los residuos que contienen plata codificados como D011, P099 y P104. Discute los procesos que generan estos residuos y presenta datos sobre su caracterización. Señala las tecnologías usadas para tratar estos residuos y presenta resultados que sirven de base para las normas de tratamiento (Rosengrant, Larry; Chatmon McEaddy, Mónica; Environmental Protection Agency (Washington, D.C., US); Office of Solid Waste; Best Demonstrated Available Technology (BDAT). (May 1990). Appears in: *Silver-containing wastes: background document*, pp. 36 [in English].)

1388 INORGANIC PIGMENT WASTES; BACKGROUND DOCUMENT [BIB-CEPI000059]

Presenta el apoyo técnico de la Environmental Protection Agency (EPA) y las razones para el desarrollo de normas de control de residuos generados por la producción de pigmentos inorgánicos. Contiene información específica de los residuos codificados como K002, K003, K004, K005, K006, K007 y K008. Detalla el número, ubicación e instalaciones afectadas por las restricciones de disposición en el terreno, los procesos que generan residuos y datos de caracterización de residuos. Discute las tecnologías usadas para el tratamiento. Presenta datos de los resultados de las tecnologías e identifica la mejor. Señala los elementos regulados y explica el proceso utilizado para calcular las normas (Rosengrant, Larry; Chatmon McEaddy, Mónica; Environmental Protection Agency (Washington, D.C., US), Office of Solid Waste, Best Demonstrated Available Technology (BDAT), (May 1990). Appears in: *Inorganic pigment wastes; background document*, pp. 76 [in English].)

1389 CYANIDE WASTES; BACKGROUND DOCUMENT [BIB-CEPI000060]

Señala la generación y caracterización del residuo codificado como F019 (residuos de cianuro). Trata sobre las tecnologías aplicables y demostradas para cianuros y metales. Presenta resultados de estas tecnologías e identifica la mejor. Discute los elementos regulados y el cálculo de las normas de tratamiento exigido por la mejor tecnología (Rosengrant, Larry; Chatmon McEaddy, Mónica; Environmental Protection Agency (Washington, D.C., US), Office of Solid Waste, Best Demonstrated Available Technology (BDAT), (May 1990). Appears in: *Cyanide wastes; background document*, pp. 99 [in English].)

1390 K086 (INK FORMULATION EQUIPMENT CLEANING WASTES); BACKGROUND DOCUMENT [BIB-CEPI000061]

Señala datos de caracterización del residuo K086 generado en la industria de la tinta. Describe las tecnologías de tratamiento aplicables a este residuo. Incluye resultados e identifica la mejor tecnología. Especifica los elementos a ser controlados que garantizan la calidad de la información que sirve de base para la norma. Explica el cálculo de las normas de tratamiento de los constituyentes seleccionados (Rosengrant, Larry; Labiosa, José; Environmental Protection Agency (Washington, D.C., US), Best Demonstrated Available Technology (BDAT), (May 1990). Appears in: *K086 (ink formulation equipment cleaning wastes); background document*, pp. 77 [in English].)

1391 WASTEWATER TREATMENT SLUDGES GENERATED IN THE PRODUCTION OF CREOSOTE K035; BACKGROUND DOCUMENT [BIB-CEPI000062]

Informa sobre el número y ubicación de las industrias afectadas por las restricciones de disposición en el terreno del residuo codificado por la norma estadounidense K035 (lodos de tratamiento de aguas residuales generados en la producción de creosota). Presenta los procesos que generan este residuo, datos de caracterización, tecnologías usadas para su tratamiento y los resultados en que se basan las normas. Explica los procedimientos de la Environmental Protection Agency (EPA) para determinar la mejor tecnología disponible para tratar este tipo de residuo, seleccionar los elementos a ser regulados y calcular las normas de tratamiento (Kinch, Richard; Labiosa, José; Environmental Protection Agency (Washington, D.C., US), Office of Solid Waste, Best Demonstrated Available Technology (BDAT), (1990). Appears in: *Wastewater treatment sludges generated in the production of creosote K035; background document*, pp. 76 [in English].)

1392 DISTILLATION BOTTOMS FROM THE PRODUCTION OF ANILINE K083; BACKGROUND DOCUMENT [BIB-CEPI000063]

Informa sobre el número y ubicación de instalaciones que pueden estar afectadas por las restricciones de disposición en el terreno para el residuo codificado como K083, generado en la producción de anilina. Describe los procesos que generan este residuo, datos de caracterización del residuo, tecnologías utilizadas para su tratamiento y resultados en que se basan las normas. Explica como la Environmental Protection Agency (EPA) determina la mejor tecnología de tratamiento de estos residuos, selecciona los elementos contaminantes para ser regulados y calcula las normas de tratamiento (Kinch, Richard; Labiosa, José; Environmental Protection Agency (Washington, D.C., US), Office of Solid Waste, Best Demonstrated Available Technology (BDAT), (1990). Appears in: *Distillation*

bottoms from the production of aniline K083; background document, pp. 86 [in English].)

1393 STRIPPING STILL TAILS FROM THE PRODUCTION OF METHYL ETHYL PYRIDINES K026; BACKGROUND DOCUMENT [BIB-CEPI000064]

Señala el proceso de generación del residuo K026 y la caracterización del mismo. Describe las tecnologías aplicables al tratamiento del residuo y presenta resultados. Identifica la mejor tecnología y las normas recomendadas (Kinch, Richard; Labiosa, José; Environmental Protection Agency (Washington, D.C., US), Office of Solid Waste, Best Demonstrated Available Technology (BDAT), (May 1990). Appears in: *Stripping still tails from the production of methyl ethyl pyridines K026; background document*, pp. 23 [in English].)

1394 DISTILLATION BOTTOMS FROM THE PRODUCTION OF NITROBENZENE BY THE NITRATION OF BENZENE K025; BACKGROUND DOCUMENT [BIB-CEPI000065]

Señala las características del residuo K025 generado en la producción del nitrobenzeno por nitración del benceno. Describe las tecnologías de tratamiento aplicables a este residuo e identifica la mejor. Indica normas de tratamiento exigidos para los elementos de control (Kinch, Richard; Labiosa, José; Environmental Protection Agency (Washington, D.C., US), Office of Solid Waste, Best Demonstrated Available Technology (BDAT), (May 1990). Appears in: *Distillation bottoms from the production of nitrobenzene by the nitration of benzene K025; background document*, pp. 28 [in English].)

1395 F002 (1,1,2-TRICHLOROETHANE) AND F005 (BENZENE, 2-ETHOXYETHANOL, AND 2-NITROPROPANE) [BIB-CEPI000066]

Presenta datos y fundamentos para el desarrollo de estándares de tratamiento para el 1,1,2 tricloroetano (F002), benceno (F005), 2-etoxietanol (F005) y el 2-nitropropano (F005). Analiza las tecnologías para el tratamiento de estos residuos e identifica la más apropiada para cada solvente. Incluye los cálculos de los estándares de tratamiento (Rosengrant, Larry; Labiosa, José; Environmental Protection Agency (Washington, D.C., US), Office of Solid Waste, Best Demonstrated Available Technology (BDAT) Background Document, (May 1990). Appears in: *F002 (1,1,2-trichloroethane) and F005 (benzene, 2-ethoxyethanol, and 2-nitropropane)*, pp. 57 [in English].)

1396 D006 CADMIUM WASTES [BIB-CEPI000067]

Presenta las razones y soporte técnico de la Environmental Protection Agency (EPA) para el desarrollo de normas de tratamiento aplicables a los residuos identificados en la norma 40 CFR261.24 bajo el código D006 (residuos que contienen cadmio). Identifica el número y ubicación de plantas en los Estados Unidos que estarían afectadas por restricciones de disposición de estos residuos en el terreno, y los procesos que los generan y caracterizan. Presenta resultados de tecnologías usadas y la elección de la mejor (Rosengrant, Larry; Labiosa, José; Environmental Protection Agency (Washington, D.C., US), Office of Solid Waste, Best Demonstrated Available Technology (BDAT) Background Document, (May 1990). Appears in: *D006 cadmium wastes*, pp. 44 [in English].)

1397 REMOCION DE METALES PESADOS MEDIANTE ZEOLITAS CUBANAS [BIB-CEPI000068]

Los talleres de acabado de metales constituyen uno de los focos de contaminación por metales pesados más comunes en nuestro país, tratándose en la mayoría de los casos de instalaciones pequeñas en las que es muy costoso el tratamiento de los residuales según los métodos tradicionales, por lo que resultan muy atractivos los estudios para la utilización de esquemas tecnológicos en los que la remoción de los cationes metálicos presentes, se realiza mediante rocas zeolitas. Discute las características del intercambio de níquel, cobre y cromo en zeolitas cubanas, en condiciones estáticas y dinámicas, y se obtienen los principales parámetros que caracterizan estos procesos. Basado en los resultados obtenidos, propone un esquema de tratamiento para los residuales del taller galvanico de la Empresa No Ferrosa Sergio González, actualmente en fase de pruebas en dicha industria (Díaz, Guillermo, Chabalina, Liuba; Quimindustria '90 Seminario del Centro de Investigaciones Químicas, 6. Ciudad de La Habana, 9-12 mayo 1990, (1990). Appears in: *Memorias del 17 Seminario del Centro de Investigaciones Químicas*, pp. 2-6 [in Spanish].)

1398 PREVENIR ES MEJOR QUE CURAR; MINIMIZACION DE RESIDUOS EN LA INDUSTRIA DE CURTIEMBRE [BIB-CEPI000069]

Resume la situación de la industria de curtiembre en América Latina, destacando la urgente necesidad de minimizar la generación y/o el impacto de los residuos de esta industria. Identifica las operaciones y procesos en esta industria, además de los residuos que en estos se generan. Presenta un estudio de caso para la implantación de una filosofía de minimización en una curtiembre de Lima, Perú. Concluye que la implantación de una estrategia de minimización en una curtiembre de Lima, Perú. Concluye que la implantación de una estrategia de minimización de residuos en el sector industrial de los países de América Latina, es una alternativa interesante para la atención del grave problema de contaminación ambiental que representa la descarga cruda de residuos provenientes de una actividad industrial (Zarate, Max A.; Universidad Mayor de San Simón (Cochabamba, BO). Facultad de Ciencias y Tecnología; Congreso Bolivariano de Ingeniería Sanitaria, 5. La Paz, 15-19 set. 1991. (September 1991). Appears in: *Prevenir es mejor que curar; minimización de residuos en la industria de curtiembre*, pp. 20 [in Spanish].)

1399 DISTILLATION BOTTOM TARS FROM THE PRODUCTION OF PHENOL/ACETONE FROM CUMENE K022 [BIB-CEPI000070]

Contiene enmiendas al documento sobre la mejor tecnología para el tratamiento del residuo K022 generado de la producción de fenol/acetona. Describe las tecnologías aplicables al tratamiento de este residuo. Presenta información de los procesos, selecciona los elementos a ser controlados en el tratamiento de este residuo y establece normas (Kinch, Richard; Labiosa, José; Environmental Protection Agency (Washington, D.C., US). Office of Solid Waste; Best Demonstrated Available Technology (BDAT) Background Document, (May 1990). Appears in: *Distillation bottom tars from the production of phenol/acetone from cumene K022*, pp. 53 [in English].)

1400 MINIMIZACION DE RESIDUOS PELIGROSOS GENERADOS EN LA INDUSTRIA TEXTIL DE ALGODON Y FIBRAS ARTIFICIALES [BIB-CEPI000071]

Revisa las operaciones que se realizan durante el procesamiento textil. Considera algunos de los aspectos ambientales potenciales de los productos químicos usados en el procesamiento textil de fibra de algodón y sintéticos. Analiza las alternativas para conseguir la minimización de los residuos peligrosos de estas industrias (Rondinel Pineda, Petra Eline; Universidad Nacional de Ingeniería (Lima, PE). Facultad de Ingeniería Ambiental, (December 1990). Appears in: *Minimización de residuos peligrosos generados en la industria textil de algodón y fibras artificiales*, pp. 80 [in Spanish].)

1401 INCINERATION FOR SITE CLEANUP AND DESTRUCTION OF HAZARDOUS WASTES [BIB-CEPI000072]

Presenta al sistema de tratamiento térmico (incineración) como una de las formas más comunes y costo-efectivas para la disposición de residuos peligrosos. Describe el método de tratamiento y los diferentes sistemas y sus aplicaciones en el tratamiento de suelos contaminados y lodos. Describe la legislación ambiental en la cual este sistema debe operar. Incluye análisis de costos y comparaciones entre incineradores convencionales y modernos (Hesketh, H.E.; Cross, F.L.; Tessitore, J.L. (1990). Appears in: *Incineration for site cleanup and destruction of hazardous wastes*, pp. 148 [in English].)

1402 PROCEEDINGS OF THE TWENTY-SECOND MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE; HAZARDOUS AND INDUSTRIAL WASTES [BIB-CEPI000073]

Compila los trabajos presentados por los participantes a la 22 Conferencia de Residuos Industriales del Atlántico Medio, realizada del 24-27 de julio de 1990 en Philadelphia, Estados Unidos. Trata temas relacionados a los residuos industriales y peligrosos, refiriéndose a aspectos legales, nuevas técnicas de tratamiento, minimización y recuperación de recursos, evaluación de riesgos, reuso de residuos, tratamiento de lodos, disposición de residuos en el terreno, procedimientos analíticos y tratamiento térmico (Martin, Joseph P.; Cheng, Shi-Chieh; Susavidge, Mary Ann; Mid-Atlantic Industrial Waste Conference, Philadelphia, 24-27 jul. 1990. (1990). Appears in: *Proceedings of the Twenty-*

Second Mid-Atlantic Industrial Waste Conference: hazardous and industrial wastes, pp. 793 [in English].)

1403 CITIZEN'S GUIDE TO PROMOTING TOXIC WASTE REDUCTION [BIB-CEPI000074]

Proporciona una guía al ciudadano para estudiar y evaluar los esfuerzos de reducción de residuos realizados por las industrias en su comunidad. Ofrece las herramientas necesarias para promover la reducción de fuentes en plantas locales. Revisa los alcances legales que apoyarán este esfuerzo (Kenworthy, Lauren; Schaeffer, Eric; (1990). Appears in: *Citizen's guide to promoting toxic waste reduction*, pp. 122 [in English].)

1404 BIOLOGICAL PROCESSES [BIB-CEPI000075]

Presenta una amplia variedad de técnicas de biodegradación para el tratamiento de residuos peligrosos. Algunos de los métodos son completamente nuevos y otros son modificaciones sofisticadas de técnicas ya conocidas. Presenta tecnologías relacionadas al compostaje, bioreactores, biotampas, inmovilización, bioabsorción, contacto líquido-sólido (Sferra, P.R.; Freeman, Harry M.; Innovative hazardous waste treatment technology series, (1991). Appears in: *Biological processes*, 684 p., 3, v.3, pp. 201 [in English].)

1405 EVALUACION TECNICO ECONOMICA DEL TRATAMIENTO DE RESIDUALES GALVANICOS CON ZEOLITAS NATURALES [BIB-CEPI000076]

Los estudios de laboratorio de intercambio iónico de metales pesados (cobre, níquel y cromo) en zeolitas naturales cubanas permitieron elaborar esquemas tecnológicos para el tratamiento de las aguas residuales del Talber Galvanico de la Empresa no Ferrosa "Sergio González". Propone las variantes de este esquema que contiene un bloque de adsorción en el que a su vez pueden ser utilizados diferentes tipos de reactores. Se calcularon las dimensiones de estos reactores y se valoró el costo de tratamiento del residual para cada tipo de reactor en las dos variantes del esquema tecnológico (Chabalina, Liuba; Klushin, V.N.; Diaz Diaz, J.; Instituto de Investigaciones del Transporte (Ciudad de La Habana, CU); Instituto Superior Tecnológico Mendiliev (Moscú, SU); Seminario del Centro de Investigaciones Químicas, 6Quimindustria 90, Ciudad de La Habana, 9-12 mayo 1990. (May 1990). Appears in: *Memorias del 17 Seminario del Centro de Investigaciones Químicas*, pp. 7-10 [in Spanish].)

1406 TREATMENT AND DISPOSAL METHODS FOR WASTE CHEMICALS; IRPTC FILE [BIB-CEPI000077]

Expone brevemente sobre los métodos recomendables para el tratamiento y disposición final de residuos químicos. Destaca que el archivo de métodos de tratamiento y disposición presentado es una herramienta útil para aquellas personas responsables de la protección de la salud humana y el medio ambiente de los efectos tóxicos de las sustancias químicas (PNUMA (Ginebra, CH) International Register of Potentially Toxic Chemicals; IRPTC data profile series, (1991). Appears in: *Treatment and disposal methods for waste chemicals; IRPTC file*, pp. 302 [in English].)

1407 TRADITIONAL TECHNOLOGIES IN INDUSTRIAL SOLID WASTE MANAGEMENT [BIB-CEPI000078]

Revisa brevemente tecnologías tradicionales del manejo de residuos industriales dentro del contexto de la región latinoamericana. Concluye que existen tecnologías para el tratamiento y disposición que proporcionan un manejo limpio de residuos peligrosos. Explica que las limitaciones para su implementación son los costos y la falta de sistemas de control. Resalta la necesidad de adquirir la filosofía de minimización de residuos para su manejo. Describe brevemente el Programa de Manejo de Residuos Peligrosos del CEPIS (Benavides, Livia; International Seminar on Waste Processing Management and Technologies, 1, Sao Paulo, 10-14 nov. 1991. (1991). Appears in: *Traditional technologies in industrial solid waste management*, pp. 12 [in English].)

1408 WASTE MINIMIZATION [BIB-CEPI000079]

Revisa aspectos relacionados con el manejo de los residuos domésticos e industriales en Alemania Federal. Analiza la experiencia sobre minimización de residuos y el reciclado de residuos, y revisa los aspectos técnicos y legales de esta tecnología (Nels, Christian; International Seminar on Waste Processing

Management and Technologies. 1. Sao Paulo, 10-14 nov. 1991. (1991). Appears in: *Waste minimization*, pp. 23 [in English].)

1409 NEW TECHNOLOGIES FOR WASTE MINIMIZATION PROCESSING AND ADEQUATE DISPOSAL [BIB-CEPI000080]

Revisa el nivel de desarrollo del proceso y disposición de residuos peligrosos generados por procesos industriales. Presenta el nivel técnico real en Europa Occidental y especialmente en la República Federal Alemana. Enfatiza en los rellenos sanitarios como una solución a largo plazo y en las tecnologías de tratamiento térmico, como la incineración (Amsoncit, Norbert; International Seminar on Waste Processing Management and Technologies. 1. Sao Paulo, 10-14 nov. 1991. (1991). Appears in: *New technologies for waste minimization processing and adequate disposal*, pp. 23 [in English].)

1410 SOLIDIFYING TRAPS HAZARDOUS WASTES [BIB-CEPI000081]

Indica que la solidificación está convirtiéndose en una herramienta principal para el tratamiento de residuos peligrosos. Señala que para seleccionar, diseñar u operar un sistema de solidificación eficiente, se deben conocer las numerosas alternativas disponibles. La técnica consiste en entrapar los residuos en una matriz sólida que tiene una integridad estructural alta, el cual minimiza el riesgo de escape por fuga. Diferencia los tipos de residuos industriales. Expone los detalles del proceso de solidificación, así como, sus ventajas y desventajas. Resalta que los cementos Portland y puzolámico son los agentes para la solidificación más empleados. Comenta sobre los sorbentes, que son empleados para reducir o eliminar los líquidos libres, pero que no son químicamente ligados al residuo y no son agentes solidificantes. Describe los métodos empleados para la aplicación de los agentes. Presenta los factores a tomar en cuenta para la selección de un proceso de solidificación. Incluye los costos asociados con un proyecto típico de solidificación. Trata sobre la importancia de evaluar la eficiencia de una instalación o proceso dado. Estima que esta evaluación debe tener la mayor prioridad (Arniella, Elic F; Bythe, Leslie J; Chemical engineering in field. (February 1990), pp. 92-102 [in English]. 0009-2460)

1411 CONCEPTS FOR THE REDUCTION OF INDUSTRIAL WASTES [BIB-CEPI000082]

Analiza algunos conceptos sobre la reducción de residuos industriales. Se refiere a las tecnologías que tienden a reducir la cantidad de residuos que requieren disposición y al reciclado de los mismos. Presenta casos de la aplicación de estas tecnologías en la industria alemana (industria química, metalmeccánica, galvanoplástica, de la pintura) (Goosmann, Georg; Sutter, Hans; CEPAL (Santiago, CL); Regional Seminar on Policies for the Management of Urban and Industrial Wastes. Santiago, 1-3 jul. 1991. (1991). Appears in: *Concepts for the reduction of industrial wastes*, pp. 19 [in English].)

1412 USER'S GUIDE FOR SWAMI; STRATEGIC WASTE MINIMIZATION INITIATIVE, VERSION 2.0 [BIB-CEPI000083]

Manual de usuario para el software SWAMI (Iniciativa estratégica de Minimización de Residuos) versión 2.0. Este programa de computadoras sirve en el análisis de procesos para identificar oportunidades de minimización de residuos dentro de un establecimiento industrial. Detalla la capacidad del software y proporciona ejemplos de uso paso por paso para un problema artificial (PEER Consultants (Dayton, US); University of Dayton (Dayton, US); Research Institute. (September 1991). Appears in: *User's guide for SWAMI: strategic waste minimization initiative, version 2.0*, pp. 45 [in English].)

1413 ACHIEVEMENTS IN SOURCE REDUCTION AND RECYCLING FOR TEN INDUSTRIES IN THE UNITED STATES [BIB-CEPI000084]

Proporciona 20 ejemplos de recientes iniciativas que han alcanzado el éxito en el sector industrial para minimizar los residuos a través de esfuerzos de reducción de fuentes y reciclado. Los ejemplos descritos proporcionan ideas a otros sectores sobre como incorporar los procesos de reducción de fuentes y el reciclado en sus operaciones. Los 10 tipos de industrias tratados en este documento incluyen: metalmeccánica, manufactura de maquinaria no eléctrica, productos de madera, industria electrónica, industria textil, industria del petróleo, productos alimenticios, productos químicos, imprenta y publicación e industrias

relacionadas con el transporte (Environmental Protection Agency (Cincinnati, US); Risk Reduction Engineering Laboratory. (September 1991). Appears in: *Achievements in source reduction and recycling for ten industries in the United States*, pp. 60 [in English].)

1414 REMEDIAL ACTION, TREATMENT, AND DISPOSAL OF HAZARDOUS WASTE; PROCEEDINGS OF THE SEVENTEENTH ANNUAL HAZARDOUS WASTE RESEARCH SYMPOSIUM [BIB-CEPI000085]

Contiene actas del simposio en el que se presentan los últimos resultados de los proyectos en ejecución y recientemente concluidos, financiados por el Laboratorio de Ingeniería de Reducción de Riesgos de la Oficina de Investigación y Desarrollo de la EPA. Los temas tratados incluyen tecnologías de control y tratamiento para la disposición de residuos, sistemas de cobertores de rellenos sanitarios, tanques de almacenamiento subterráneos y demostración y desarrollo de tecnologías innovadoras alternativas para el tratamiento de residuos peligrosos. Incluye temas de destrucción térmica de residuos peligrosos, evaluaciones de campo, opciones de tratamiento existentes, desarrollo y minimización de residuos y biosistemas para la destrucción de residuos peligrosos (Environmental Protection Agency (Cincinnati, US); Risk Reduction Engineering Laboratory; Annual Hazardous Waste Research Symposium. 17, Cincinnati, 9-11 abr. 1991. (1991). Appears in: *Remedial action, treatment, and disposal of hazardous waste: proceedings of the Seventeenth Annual Hazardous Waste Research Symposium*, pp. 695 [in English].)

1415 DETOXIFICATION OF AND METAL VALUE RECOVERY FROM METAL FINISHING SLUDGE MATERIAL [BIB-CEPI000086]

Presenta metodología para el tratamiento de lodos que contienen metales utilizando técnicas hidrometalúrgicas. Destaca los beneficios económicos y ambientales de la recuperación de metales de estos lodos. Describe operaciones unitarias para la recuperación de Cobre, Hierro, Cromo, Cadmio, Zinc, Niquel, Aluminio (Twidwell, L.G; Dahnke, D.R; McGrath, S.F; Innovative hazardous waste treatment technology series. (1990). Appears in: *Physical chemical processes*, 684 p., 3, V.2, pp. 55-61 [in English].)

1416 EPP PROCESS FOR STABILIZATION/SOLIDIFICATION OF CONTAMINANTS [BIB-CEPI000087]

Informa sobre una tecnología para la estabilización/solidificación de contaminantes. El proceso EPP (Polímeros de protección ambiental) cita ventajas de su alto rendimiento y costo-efectividad en la estabilización/solidificación de residuos tóxicos (Unger, S.L; Lubowitz, H.R; Innovative hazardous waste treatment technology series. (1990). Appears in: *Physical chemical processes*, 684 p., 3, V.2, pp. 77-86 [in English].)

1417 MINIMIZATION OF ARSENIC WASTES IN THE SEMICONDUCTOR INDUSTRY [BIB-CEPI000088]

Describe las fases de un programa de minimización de residuos de arsénico en la industria de los semiconductores. En la primera fase se revisaron varios procesos para reducir, reciclar y/o tratar in situ los residuos de arsénico. Los métodos evaluados incluyeron técnicas de separación sólido-líquido, precipitación/fijación, intercambio iónico, seleccionándose al sistema de filtración como proceso prometedor para recuperar el material particulado de arsénico del agua residual. En la segunda etapa se evaluó la filtración a escala piloto que permite un adecuado diseño de la instalación a escala real. Destaca los beneficios económicos, ambientales y de salud de este programa (Hertz, Darryl W.; Environmental Protection Agency (Cincinnati, US); Innovative hazardous waste treatment technology series. (1990). Appears in: *Physical chemical processes*, 684 p., 3, V.2, pp. 131-142 [in English].)

1418 INNOVATIVE PRACTICES FOR TREATING WASTE STREAMS CONTAINING HEAVY METALS: A WASTE MINIMIZATION APPROACH [BIB-CEPI000089]

Revisa las técnicas para la minimización de residuos conteniendo metales pesados, técnicas que incluyen: reducción en las fuentes de generación, recuperación y tratamiento centralizado. Se refiere a la caracterización de aguas residuales, descripción de procesos o tecnología para reducir la generación de residuos. Resume los resultados de proyectos de demostración en este campo (Grosse, Douglas W.; Innovative hazardous waste treatment technology series. (1990).

Appears in *Physical chemical processes*, 684 p., 3. V.2, pp. 221-235 [in English].)

1419 UPDATE OF INNOVATIVE THERMAL DESTRUCTION TECHNOLOGIES [BIB-CEPI000090]

Describe cinco nuevas tecnologías para la destrucción térmica de residuos peligrosos. Ellas son: incineración por oxígeno enriquecido, cámara de combustión Westinghouse O'Connor, cámara de combustión de lecho circulante, sistema infrarrojo y arco plasma. Incluye un estudio de casos, estado actual de la tecnología, y ventajas y desventajas de cada tecnología (Lee, C.C.; Huffman, George L. *Innovative hazardous waste treatment technology series*, (1990). Appears in *Thermal processes*, 684 p., 3. V.1, pp. 1-18 [in English].)

1420 HYDROGENATION AND REUSE OF HAZARDOUS ORGANIC WASTE [BIB-CEPI000091]

Proporciona información sobre la tecnología de hidrogenación como unidad de proceso para la conversión de residuos orgánicos en materia prima reciclable. Entre otros, se considera aplicable a residuos conteniendo solventes clorados, PCBs, hidrocarburos oxigenados y organometálicos. Presenta la descripción del proceso e indica sus ventajas ambientales, de flexibilidad y económicas sobre los sistemas de tratamiento convencional. Resume datos de estudios en plantas pilotos que demuestran la aplicabilidad de esta tecnología a residuos que contienen materia orgánica halogenada (Kalnes, T.N.; James, R.B. *Innovative hazardous waste treatment technology series*, (1990). Appears in *Thermal processes*, 684 p., 3. V.1, pp. 65-76 [in English].)

1421 LOW-TEMPERATURE THERMAL TREATMENT FOR REMOVAL OF ORGANIC CONTAMINANTS FROM SOIL [BIB-CEPI000092]

Describe uno de los nuevos procesos térmicos que en la actualidad está en operación a escala real. El proceso denominado Tratamiento Térmico de baja Temperatura, usa el principio de la transferencia indirecta de calor para remover por evaporación, los contaminantes presentes en el suelo. El rango de temperatura está entre 121C-232C. En la forma de vapor, estos contaminantes pueden recuperarse en un condensador o ser destruidos en un incinerador. Indica ventajas, requerimientos operacionales y costos de tratamiento. Destaca la versatilidad del sistema y la capacidad para procesar una gran variedad de contaminantes volátiles, semivolátiles, carcinogénicos, aromáticos (Velazquez, Luis A.; Nielson, Roger. *Innovative hazardous waste treatment technology series*, (1990). Appears in *Thermal processes*, 684 p., 3. V.1, pp. 157-166 [in English].)

1422 USE OF OXYGEN FOR HAZARDOUS WASTE INCINERATION [BIB-CEPI000093]

Revisa el uso del oxígeno para la incineración de residuos peligrosos. Analiza los efectos en la combustión por el uso de oxígeno o aire enriquecido con oxígeno. Cita las ventajas de efectividad, económicas y de control de la contaminación de esta técnica (Ding, Maynard G. *Innovative hazardous waste treatment technology series*, (1990). Appears in *Thermal processes*, 684 p., 3. V.1, pp. 181-190 [in English].)

1423 AUDIT AND REDUCTION MANUAL FOR INDUSTRIAL EMISSIONS AND WASTES [BIB-CEPI000094]

Informa sobre procedimientos de auditoría de emisiones y fuentes de residuos industriales, lo que permite adoptar métodos de producción que generen menos residuos y emisiones que los procesos industriales tradicionales. Incluye 3 estudios de casos de aplicación de esta auditoría de residuos (PNUMA (Paris, FR); ONU Di (Viena, AT); (1991). Appears in *Audit and reduction manual for industrial emissions and wastes*, pp. 127 [in English].)

1424 GUIDELINES FOR TREATING AND DISPOSING OF SMALL QUANTITIES OF PESTICIDE WASTES; DRAFT [BIB-CEPI000095]

Guía sobre tratamiento y disposición de residuos de pesticidas para prevenir daños a la salud y al medio ambiente. Presenta una revisión de varias opciones simples de tratamiento que pueden ser usadas cuando no se dispone de recursos necesarios. Señala la disposición de pequeñas cantidades de residuos de pesticidas hasta 25 Kg o 1 de pesticidas (o 2 a 3 10 Kg de pesticidas altamente tóxicos)

y sus contenedores (PNUMA (Paris, FR) Industry and Environment Office, (March 1991). Appears in *Guidelines for treating and disposing of small quantities of pesticide wastes; draft*, pp. 75 [in English].)

1425 MINIMIZE WASTE DURING DESIGN [BIB-CEPI000096]

Destaca las ventajas de la minimización de residuos en los nuevos procesos industriales. Resume los programas adoptados como resultado de la revisión de oportunidades de minimización de residuos en los nuevos proyectos (Berghand, R.L.; Snyder, G.E. *Hydrocarbon processing*, (April 1990), pp. 39-42 [in English].)

1426 TREATING LAND BAN WASTE [BIB-CEPI000097]

Describe las mejores tecnologías existentes desarrolladas por la Environmental Protection Agency (EPA) para el tratamiento de residuos peligrosos. Explica sobre: la precipitación química, la inmovilización, incineración, oxidación de aire húmedo, extracción por solvente, adsorción con carbón activado, vitrificación in situ, biorremediación y oxidación ultravioleta (Min, Maung, Barbour, Richard, Hwang, Jou. *Pollution engineering*, (August 1991), pp. 64-70 [in English].)

1427 CHROME RECOVERY AND REUSE IN INDIA [BIB-CEPI000098]

Describe la problemática de la contaminación ambiental causada por las descargas de efluentes de curtientes no tratados, efluentes con altos contenidos de cromo y otros contaminantes, en la India. Discute el desarrollo de un sistema de reuso y recuperación indirecta de cromo usando álcalis, sistema que es técnico y económicamente factible de aplicarse en las curtientes de la India. Evalúa resultados experimentales de este sistema ensayado en una planta piloto y analiza los costos y beneficios de esta tecnología (Rajamani, S.; Gupta, S.N.; Mitra, R.B.; Schaapman, J.E.; Pelckmans, H.H.A., *Water environment & technology*, (January 1992), pp. 60-63 [in English].) 1044-9493)

1428 GUIDES TO POLLUTION PREVENTION; THE PHARMACEUTICAL INDUSTRY [BIB-CEPI000099]

Revisa varias operaciones y procesos de la industria farmacéutica que generan residuos y presenta opciones para su minimización a través de la reducción de fuentes generadoras y el reciclado en los casos donde existan oportunidades adecuadas. Incluye formatos para llevar a cabo dichos procesos y tres estudios de casos de generación de residuos y prácticas de minimización ejecutados en California, Estados Unidos (Environmental Protection Agency (Cincinnati, US), Risk Reduction Engineering Laboratory; (October 1991). Appears in *Guides to pollution prevention; the pharmaceutical industry*, pp. 74 [in English].)

1429 GUIDES TO POLLUTION PREVENTION; THE PHOTO-PROCESSING INDUSTRY [BIB-CEPI000100]

Revisa los procesos y operaciones de la industria del fotoproceso que generan residuos, y presenta opciones para su minimización por medio de la reducción de fuentes y reuso. Incluye formatos para asistir al personal de estas industrias en la realización de una autoevaluación de los procesos que generan residuos y en la identificación de oportunidades de minimización de residuos. Anexa resultados de evaluación de tres laboratorios en los Estados Unidos, donde se identifica la potencialidad de las opciones de minimización de residuos (Environmental Protection Agency (Cincinnati, US), Risk Reduction Engineering Laboratory; (1991). Appears in *Guides to pollution prevention; the photoprocessing industry*, pp. 61 [in English].)

1430 GUIDES TO POLLUTION PREVENTION; THE AUTOMOTIVE REPAIR INDUSTRY [BIB-CEPI000101]

Proporciona opciones de minimización de residuos generados por la industria de reparación automotor. Señala que cantidades significativas de residuos pueden ser eliminadas o evitadas a través del establecimiento de prácticas adecuadas de manejo de residuos de fluido automotor, adecuada operación de equipos, evitando derrames y usando detergentes en lugar de solventes. Incluye formatos para la realización de una evaluación de los procesos que generan residuos, identificación de oportunidades de minimización de residuos y estudios de casos realizados en los Estados Unidos (Environmental Protection Agency (Cincinnati, US), (1991). Appears in *Guides to pollution prevention; the automotive repair industry*, pp. 46 [in English].)

1431 INDUSTRIAL WASTE REDUCTION AT SOURCE; BETTER ENVIRONMENTAL PROTECTION, INCREASES ECONOMIC COMPETITIVENESS [BIB-CEPI000102]

Señala la amenaza que representan los residuos químicos peligrosos en la salud humana y el medio ambiente. Considera que el manejo de los desechos industriales (tratamiento y disposición final) para controlar la contaminación ha probado ser una estrategia insuficiente. Destaca la necesidad de reorientar la estrategia hacia la reducción de fuentes generadoras de residuos, los mismos que tendrían lugar a un mejoramiento en la eficiencia de la producción industrial (Dorffman, Mark. Industrial Waste Conference UNDP Project on "Technology Transfer and Management with Particular Reference to Clean Technologies", Jakarta, nov. 1991. (1991). Appears in *Industrial waste reduction at source: better environmental protection, increases economic competitiveness*, pp. 9 [in English].)

1432 REDUCCION, ELIMINACION Y RECICLAJE DE DESECHOS INDUSTRIALES; LA EXPERIENCIA CUBANA [BIB-CEPI000103]

Informa que la estrategia para la eliminación o reducción de residuos industriales pasa por tres fases: racionalización del proceso de producción, reciclaje de desechos económicamente aprovechables y aplicación de la biotecnología en el sector agrícola, asociado este cada vez más a la agroindustria. Enfatiza que la utilización de determinado tipo de tecnología para eliminar, reducir y/o reciclar residuos agroindustriales se ha vuelto imprescindible en los últimos años, especialmente en los países en vías de desarrollo. Describe la experiencia cubana en la reducción, eliminación y reciclaje de desechos industriales. Señala que las aguas residuales de alrededor de 90 plantas azucareras están siendo empleadas actualmente para la "Terti-irrigación" de las plantas de caña, sin detrimento alguno en cuanto a la salubridad del producto final. Incluye una discusión de la aplicación de la biotecnología en la agroindustria (Costa Moreno, R. Ingeniería ambiental, revista de la Sociedad Mexicana de Ingeniería Sanitaria y Ambiental. (1991), pp. 23-24, 26 [in Spanish].)

1433 EVALUATION OF AN ADVANCED REVERSE OSMOSIS SYSTEM AT THE SUNNYVALE, CALIFORNIA HEWLETT-PACKARD FACILITY [BIB-CEPI000104]

Evalúa la efectividad técnica y económica de un sistema de osmosis inversa avanzada para la recuperación de soluciones de baño de níquelado y agua de lavado en las instalaciones de la compañía Hewlett-Packard, en Sunnyvale, California. La compañía determinó que el material recuperado a través del sistema de osmosis inversa puede ser reciclado; sin embargo, el ahorro anual de \$17,000 fue insuficiente para justificar el gasto de un capital de aproximadamente \$75,000 en la compra de la unidad (Brown, Lisa M.; Ludwig, Robert; Erbas-White, Ilhanur. Environmental Protection Agency (Cincinnati, US). Risk Reduction Engineering Laboratory. Annual Hazardous Waste Research Symposium, 17. Cincinnati, 9-11 abr. 1991. (1991). Appears in *Remedial action, treatment, and disposal of hazardous waste: proceedings of the Seventeenth Annual Hazardous Waste Research Symposium*, pp. 162-171 [in English].)

1434 BEHAVIOR OF TRACE METAL IN ROTARY KILN INCINERATION: RESULTS OF INCINERATION RESEARCH FACILITY STUDIES [BIB-CEPI000105]

Presenta los resultados de programa de estudio para determinar el destino de cinco constituyentes peligrosos y cuatro constituyentes no peligrosos presentes como trazas de metales en una matriz sintética de residuo sólido tratada térmicamente en un incinerador rotatorio. Estudia la distribución de descarga de los metales como función de la temperatura de operación del incinerador y del contenido de cloro presente en el residuo. Las 5 trazas de metales no peligrosos fueron: bismuto, cobre, magnesio y estroncio. Las pruebas se realizaron utilizando dos dispositivos de control de contaminación del aire: un sistema de ventury columna empacada, y otro de estado ionizado húmedo simple. El porcentaje de eficiencia de recolección del primer sistema fue de 57 por ciento, mientras que para el segundo fue de 43 por ciento (Fournier, D.J.; Waterland, I. R.; Lee, J.W.; Carroll, Gregory J. Environmental Protection Agency (Cincinnati, US). Risk Reduction Engineering Laboratory. Annual Hazardous Waste Research Symposium, 17. Cincinnati, 9-11 abr. 1991. (1991). Appears in *Remedial action, treatment, and disposal of hazardous waste: proceedings of the Seventeenth Annual Hazardous Waste Research Symposium*, pp. 172-189 [in English].)

1435 HIGH ENERGY ELECTRON BEAM IRRADIATION: AN EMERGING TECHNOLOGY FOR THE REMOVAL OF HAZARDOUS ORGANIC CHEMICALS FROM WATER AND SLUDGE; AN INTRODUCTION [BIB-CEPI000106]

Cuando los electrones de alta energía impactan en una solución acuosa se forman especies transitorias. Las especies transitorias de mayor interés son el electron acuoso, e-(aq), el radical hidrogeno, H, y el radical hidroxilo, OH. Describe investigaciones preliminares para determinar la eficiencia de remoción de cuatro compuestos orgánicos (cloroformo, tricloroetileno, tetracloroetileno, benceno y tolueno) usando este proceso de tratamiento. El acelerador es un transformador del tipo núcleo aislado de 1.5 MeV, 50 mA. Examina el efecto de la destrucción de los compuestos orgánicos en agua potable, agua residual secundaria y lodo secundario digiriendo anaeróbicamente (2-5 por ciento sólidos). Los resultados indican que este proceso de tratamiento es adecuado para la remoción de compuestos orgánicos tóxicos y peligrosos de soluciones acuosas (Cooper, William J.; Waste, Thomas D.; Karacz, Charles N.; Nickelsen, Michael G. Environmental Protection Agency (Cincinnati, US). Risk Reduction Engineering Laboratory. Annual Hazardous Waste Research Symposium, 17. Cincinnati, 9-11 abr. 1991. (1991). Appears in *Remedial action, treatment, and disposal of hazardous waste: proceedings of the Seventeenth Annual Hazardous Waste Research Symposium*, pp. 416-435 [in English].)

1436 THERMAL DESORPTION ATTAINABLE REMEDIATION LEVELS [BIB-CEPI000107]

Describe la tecnología de desorción térmica y presenta datos sobre la eficiencia del tratamiento y su efectividad en caso de compuestos orgánicos considerados difíciles de tratar. La desorción térmica es un proceso de separación física que utiliza un calentador indirecto para vaporizar contaminantes orgánicos, los cuales pueden ser removidos y recuperados. Esta tecnología tiene amplia aplicación en el tratamiento de suelos, lodos y sedimentos contaminados con hidrocarburos, PCBs y dioxinas (Percin, Paul R. de. Environmental Protection Agency (Cincinnati, US). Risk Reduction Engineering Laboratory. Annual Hazardous Waste Research Symposium, 17. Cincinnati, 9-11 abr. 1991. (1991). Appears in *Remedial action, treatment, and disposal of hazardous waste: proceedings of the Seventeenth Annual Hazardous Waste Research Symposium*, pp. 511-520 [in English].)

1437 FIELD ASSESSMENT OF AIR EMISSIONS FROM HAZARDOUS WASTE STABILIZATION OPERATIONS [BIB-CEPI000108]

Presenta los resultados de un estudio realizado por la EPA para cuantificar las emisiones atmosféricas de compuestos orgánicos volátiles y semivolátiles, así como de partículas generadas en las operaciones de estabilización de residuos peligrosos. Este método de tratamiento de residuos peligrosos consiste en crear una mezcla de residuo y cemento que pueda ser dispuesta en un relleno sanitario. El estudio incluye los resultados de pruebas de campo de un proceso de estabilización en el cual un balance de masa fue usado para calcular las emisiones al aire (Ponder, Thomas C.; Schmitt, Diane. Environmental Protection Agency (Cincinnati, US). Risk Reduction Engineering Laboratory. Annual Hazardous Waste Research Symposium, 17. Cincinnati, 9-11 abr. 1991. (1991). Appears in *Remedial action, treatment, and disposal of hazardous waste: proceedings of the Seventeenth Annual Hazardous Waste Research Symposium*, pp. 532-542 [in English].)

1438 OZONE-ULTRAVIOLET LIGHT TREATMENT OF IRON CYANIDE COMPLEXES [BIB-CEPI000109]

Evalúa el efecto combinado de ozonización e irradiación con luz ultravioleta en la destrucción del complejo de ferrocianuro, un complejo estable que no es destruido por tecnologías de tratamiento convencional. Estudia los efectos de la temperatura, intensidad de luz UV y configuración del reactor en las tasas de destrucción. Los resultados confirman que una concentración inicial de ferrocianuro de 150 mg/l puede ser reducida a menos de 1 mg/l en 4 horas usando una intensidad de luz UV de 3 W/l, temperatura de 63°C y una dosis de ozono de 56.5 mg min/l en un reactor donde las burbujas de ozono se dispersan debajo de las lámparas de luz UV sumergidas en la solución. No se confirma la hipótesis de que la activación del ozono por irradiación con luz UV en la fase gaseosa pueda proporcionar resultados similares como la activación del ozono en la solución (Hassan, Sardas O.; Briggs, Mark J.; Forest, Mary Beth; Timberlake, Dennis L. Environmental Protection Agency (Cincinnati, US). Risk Reduction

Engineering Laboratory. Annual Hazardous Waste Research Symposium. 17. Cincinnati. 9-11 abr. 1991. (1991). Appears in: *Remedial action, treatment, and disposal of hazardous waste: proceedings of the Seventeenth Annual Hazardous Waste Research Symposium*, pp. 560-573 [in English].)

1439 WASTE MINIMIZATION FOR HAZARDOUS MATERIALS INSPECTORS; MODULE 1, INTRODUCTORY TEXT WITH SELF-TESTING EXERCISES [BIB-CEPI000110]

Revisa información básica sobre contaminación ambiental, definiciones, tipos y fuentes de residuos peligrosos. Señala la necesidad de prevenir la contaminación. Explica sobre la minimización de residuos peligrosos y las barreras e incentivos para la participación industrial en programas. Incluye técnicas y estrategias básicas de minimización de residuos peligrosos que han sido utilizadas con éxito en varios tipos de industrias (Merritt, Sheridan V.; Carpenter, Molly W. University of California (Riverside, US). University Extension. (1991). Appears in: *Waste minimization for hazardous materials inspectors: module 1, introductory text with self-testing exercises*, pp. 114 [in unknown language].)

1440 EXPERIENCES WITH A NETWORK FOR METAL PLATING [BIB-CEPI000111]

Describe la experiencia de un grupo de trabajo del PNUMA, destinado a la creación de una red mundial para la transferencia de información sobre tecnologías limpias en la industria galvanoplastica. Describe las actividades realizadas y el potencial de esta red que se inició en mayo de 1989 (Ros, Jan P.M.; National Institute of Public Health and Environmental Protection (Bilthoven, NL). (1990). Appears in: *Experiences with a network for metal plating*, pp. 22 [in English].)

1441 PROCESS-BASED METHOD FOR THE SUBSTITUTION OF HAZARDOUS CHEMICALS AND ITS APPLICATION TO METAL DEGREASING [BIB-CEPI000112]

Desarrolla una metodología basada en las consideraciones de proceso para reducir el riesgo debido a compuestos químicos peligrosos. Indica que este método incluye: listar los productos químicos, obtener información sobre su composición, desarrollar hojas de datos, describir el proceso, fijar el riesgo y probar posibilidades para su sustitución. Enfatiza que en la sustitución, los compuestos químicos en la situación final deben ser potencialmente menos peligrosos que en la situación inicial. Señala que esta sustitución podría consistir en la introducción de nuevos compuestos, nuevos diseños de procesos o aun en un nuevo proceso. Describe la aplicación de este método en el desengrasado de metales. Discute una estrategia para mejorar el ambiente de trabajo en conexión con el desengrasado. La principal estrategia es la sustitución del uso de solventes orgánicos por soluciones acuosas alcalinas. Estima que es especialmente importante evitar el uso de compuestos con efectos a largo plazo (Sorensen, Frode, Petersen, H.J. Stryhr. Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute. (1990), pp. 69-84 [in English] 0882-5696)

1442 SOLIDIFICATION/STABILIZATION OF A HEAVY METAL SLUDGE BY A PORTLAND CEMENT/FLY ASH BINDING MIXTURE [BIB-CEPI000113]

Informa que la solidificación/estabilización es un método atractivo para el tratamiento de residuos peligrosos. Examina los resultados de ensayos de solidificación de lodos con metales pesados conteniendo Cr, Ni, Cd y Hg, utilizando una mezcla de unión de cemento Portland Cenizas. El propósito es lograr un mejor entendimiento de los mecanismos microquímicos de la solidificación/estabilización. Utiliza la microscopia electrónica, espectrometría de dispersión de energía de rayos X, microscopia óptica y difracción de rayos X para analizar las muestras. Los resultados sugieren que los lodos conteniendo metales pesados podían ser químicamente complejos, lo que indica que podría haber una amplia variabilidad en la composición de los lodos parcialmente deshidratados. Estima que tal variabilidad puede conducir a diferencias localizadas en la composición química del material solidificado (Roy, A., Eaton, H.C., Cartledge, F.K.; Tittlebaum, M.E. Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute. (1991), pp. 7-41 [in English] 0882-5696)

1443 HAZARDOUS WASTE INCINERATION IS GOING MOBILE [BIB-CEPI000114]

Informa que la incineración es una alternativa popular creciente para suelos contaminados por residuos peligrosos. Una de las formas de reducir los costos de tratamiento por incineración es a través del uso de incineradores móviles. Señala algunas consideraciones sobre tratamiento de suelos, que equipo utilizar y estimación de costos. Presenta un ejemplo de diseño para dos tipos de incineradores de residuos peligrosos. Incluye algunos problemas de operación de incineradores móviles en la descontaminación de suelos (McGowan, Thomas; Ross, Richard; Chemical engineering: in field. (October 1991), pp. 114-118, 121-123 [in English]. 0009-2460)

1444 INVESTIGATION OF SOLIDIFICATION FOR THE IMMOBILIZATION OF TRACE ORGANIC CONTAMINANTS [BIB-CEPI000115]

Determina el grado de inmovilización de contaminantes orgánicos obtenibles usando diversos procesos genéricos de solidificación (cemento, cemento ceniza, cemento carbon activado, cemento bentonita y cemento silicatos solubles). Señala que esta investigación a escala laboratorio fue diseñada para simular una situación en la cual un residuo orgánico conteniendo cantidades de trazas de contaminantes orgánicos es solidificado. Indica que fueron seleccionados veinte contaminantes orgánicos, representando ocho categorías de contaminantes prioritariamente orgánicos, basados en un índice de peligrosidad que considera la toxicidad crónica, solubilidad y persistencia en las aguas subterráneas. Los lotes son inyectados con una mezcla de los contaminantes orgánicos a tres niveles de concentración de los contaminantes (10, 100 y 1000 ug/g de residuo solidificado). Estima la movilidad de los contaminantes orgánicos calculando los coeficientes de partición entre las fases sólida y líquida de los resultados de una extracción de agua destilada. Analiza los resultados basados en la solubilidad en agua y volatilidad de los contaminantes, así como la capacidad de fijación de los procesos de solidificación (Caldwell, Robert J.; Cote, Pierre L.; Chao, Chih C. Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute. (1990), pp. 273-282 [in English]. 0882-5696)

1445 WASTE MINIMIZATION FOR PRINTED CIRCUIT BOARD MANUFACTURE [BIB-CEPI000116]

Estudio de minimización de residuos en la industria de tarjetas impresas de circuitos. El propósito es examinar diversos procesos de separación y reciclaje de residuos para fijar la posibilidad de lograr una minimización significativa en el uso del agua y en la generación de aguas residuales y residuos peligrosos. Expone y discute medidas cuantitativas de eficiencia obtenidas por la aplicación de ingeniería de análisis químico. Evalúa diferentes alternativas y tácticas para reducir la generación de residuos. Incluye un análisis económico de cuatro procesos diferentes (Chang, Li-Yang; Mc Coy, Benjamin J. Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute. (1990), pp. 293-318 [in English]. 0882-5696)

1446 WASTE MINIMIZATION STUDY FOR A PRINTED CIRCUIT BOARD MANUFACTURING FACILITY IN TAIWAN [BIB-CEPI000117]

Presenta una demostración de minimización de desechos industriales patrocinada por la Administración de Protección Ambiental, Taiwan. Identifica y evalúa las oportunidades de reducción de residuos para una industria de tarjetas impresas de circuitos en Taiwan. Realiza inspecciones sobre diferentes procesos que se efectúan en esta industria. Las áreas específicas en las cuales podrían minimizarse los residuos son identificadas, fijadas e implementadas. Efectúa ensayos de jarras sobre las aguas residuales y utiliza los resultados para mejorar la eficiencia de la planta de tratamiento de los efluentes residuales de esta industria para la remoción de metales pesados y reducción de generación de lodo. Adicionalmente recomienda controles administrativos de residuos peligrosos diseñados para reducir los peligros asociados a la salud y el ambiente (Chiu, Shen-Yann; Huang, Hann S.; Peters, Robert W.; Tsai, Steve Y.; Tsai, Wen-Tien; Shieh, Shih-Shien; Hsieh, Te-Yuan; Hwang, Li-Shyong; Liu, Solo; Peng, Chien-Tang; Wu, Min H. Hazardous waste & hazardous materials: official journal of the Hazardous Materials Control Research Institute. (1991), pp. 99-114 [in English] 0882-5696)

1447 GESTION ECOLOGICAMENTE RACIONAL DE LOS DESECHOS PELIGROSOS INCLUIDA LA PREVENCIÓN DEL TRAFICO INTERNACIONAL ILICITO DE DESECHOS PELIGROSOS [BIB-CEPI000118]

Referente a la gestión ecológica racional de los desechos peligrosos incluida la prevención del tráfico internacional ilícito de desechos peligrosos. Detalla objetivos, actividades y medios de ejecución para: la promoción de la prevención y la reducción al mínimo de los desechos peligrosos; promoción y fortalecimiento de las capacidades institucionales en materia de gestión; promoción y fortalecimiento de la cooperación internacional en materia de gestión de los movimientos transfronterizos de desechos peligrosos; y prevención del tráfico internacional ilícito de los mismos (ONU (New York, US): Conferencia de las Naciones Unidas sobre el Medio Ambiente y el Desarrollo, Río de Janeiro, 3-14 jun. 1992, (1992). Appears in: *Gestión ecológicamente racional de los desechos peligrosos incluida la prevención del tráfico internacional ilícito de desechos peligrosos*, pp. 18 [in Spanish].)

1448 UTILIZING HIGH ENERGY ELECTRONS FOR TREATMENT OF INDUSTRIAL WASTES CONTAINING NON-BIO-DEGRADABLE ORGANIC COMPOUNDS [BIB-CEPI000119]

Describe resultados de irradiación con rayos de electrones a efluentes industriales conteniendo residuos peligrosos no biodegradables (cloroformo, benceno, tetracloruro de carbono, tetracloroetileno y tricloroetileno). Muestra que este proceso de irradiación parece ser efectivo en la destrucción de estos compuestos. Presenta el mecanismo que detalla la razón de la eficiencia de la destrucción de este rayo de electrones (Waite, T.D.; Kurucz, C.N.; Cooper, W.J.; Mid-Atlantic Industrial Waste Conference, 22, Philadelphia, 24-27 jul. 1990, (1990). Appears in: *Proceedings of the Twenty-Second Mid-Atlantic Industrial Waste Conference: hazardous and industrial wastes*, pp. 95-99 [in English].)

1449 STABILIZATION OF CLASS F ASH WITH LIME AND CEMENT [BIB-CEPI000120]

Presenta el estudio de laboratorio realizado para evaluar el uso potencial de mezclas estabilizadas de cenizas (de la combustión del carbón) con cal y cemento como material grueso de base o sub-base en la construcción de carreteras. Basado en los datos obtenidos se concluye que las cenizas pueden ser estabilizadas exitosamente con cal, cemento o combinaciones de cal y cemento para producir mezclas con adecuada resistencia y características de durabilidad (Usman, M.A.; Chou, C.P.; Mid-Atlantic Industrial Waste Conference, 22, Philadelphia, 24-27 jul. 1990, (1990). Appears in: *Proceedings of the Twenty-Second Mid-Atlantic Industrial Waste Conference: hazardous and industrial wastes*, pp. 171-192 [in English].)

1450 TOXICITY REDUCTION THROUGH AN AERATED SUBMERGED BIOLOGICAL FILTER TREATING WASTEWATER FROM AN OIL REFINERY SOUR WATER STRIPPING UNIT [BIB-CEPI000121]

Presenta información relacionada a la composición de las aguas residuales ácidas de las refinerías de petróleo, su toxicidad y datos preliminares de tratabilidad. Específicamente este proyecto de investigación se centra en la evaluación de la eficiencia de un filtro biológico aerado sumergido (FBAS) como un medio para reducir la toxicidad en estas aguas ácidas. El FBAS incorpora características de unidades de película biológica fija y unidades de lodos activados completamente mezclados. Describe las características de la unidad piloto de tratamiento, parámetros operacionales y resultados obtenidos (Carroll, C.G.; Veenstra, J.N.; Burris, S.L.; Mid-Atlantic Industrial Waste Conference, 22, Philadelphia, 24-27 jul. 1990, (1990). Appears in: *Proceedings of the Twenty-Second Mid-Atlantic Industrial Waste Conference: hazardous and industrial wastes*, pp. 355-376 [in English].)

1451 BIOLOGICAL LAND TREATMENT OF DIESEL FUEL CONTAMINATED SOIL; A CASE STUDY [BIB-CEPI000122]

Discute técnicas de tratamiento biológico en el terreno, las cuales vienen siendo empleadas para la limpieza de aproximadamente 8400 galones de petróleo diesel derramados de un tanque de almacenamiento en New Jersey. El tratamiento biológico del petróleo diesel en el terreno está dirigido al rompimiento de las fracciones de hidrocarburos por microorganismos aerobios en el estrato superior del suelo donde el oxígeno está disponible. Este sistema de tratamiento demuestra ser una opción viable para la recuperación de suelos contaminados

con petróleo diesel. Los suelos contaminados demuestran ser de fácil tratamiento biológico si son suplementados con nutrientes y manejados para mantener condiciones apropiadas de humedad y pH (Troy, M.A.; Greenwald, B.P.; Berry, S.W.; Price, T.; Woodhall, P.M.; Jerger, D.E.; Mid-Atlantic Industrial Waste Conference, 22, Philadelphia, 24-27 jul. 1990, (1990). Appears in: *Proceedings of the Twenty-Second Mid-Atlantic Industrial Waste Conference: hazardous and industrial wastes*, pp. 425-437 [in English].)

1452 BIODEGRADATION OF AQUEOUS HAZARDOUS WASTE LEACHATES IN A PILOT-SCALE ROTATING BIOLOGICAL CONTACTOR [BIB-CEPI000123]

Describe trabajos experimentales que investigan el uso de un contactor biológico rotatorio (CBR) para el tratamiento de lixiviados de residuos peligrosos, correspondientes a rellenos sanitarios y al de instalaciones de disposición de residuos peligrosos provenientes de la industria metalmeccánica, electroquímica y producción de DDT. Concluye que el proceso CBR puede ser efectivo en reducir compuestos orgánicos en lixiviados de residuos peligrosos. El grado de efectividad depende principalmente de la composición de los lixiviados, cuidadosamente analizados (Howard, Hinton K.; Innovative hazardous waste treatment technology series, (1991). Appears in: *Biological processes*, 684, 3, v.3, pp. 1-6 [in English].)

1453 COMPOSTING POTENTIALS FOR HAZARDOUS WASTE MANAGEMENT [BIB-CEPI000124]

Analiza el potencial y las limitaciones del compostaje aplicado al tratamiento de los residuos peligrosos. Concluye que el compostaje tiene limitaciones para la biodescomposición de residuos peligrosos, principalmente porque muchos de estos residuos no son buenos alimentos para los microorganismos. Otra de las limitaciones es que en muchos casos, el material a ser degradado (peligroso o no) no es reducido a cero a pesar del tiempo, lo que significa tener generalmente un residual en el compost (y en el ambiente) (Hart, Samuel A.; Innovative hazardous waste treatment technology series, (1991). Appears in: *Biological processes*, 684 p., 3, v.3, pp. 7-17 [in English].)

1454 BIOLOGICAL TREATMENT OF CYANIDE WASTE-WATERS [BIB-CEPI000125]

Investigación relacionada al tratamiento biológico de aguas residuales que contienen cianuro. Presenta los estudios a escala de laboratorio y plantas piloto utilizando aguas residuales sintéticas y naturales. Explica la biodegradación del cianuro y la influencia del pH, fenol y metales pesados en este proceso. Analiza la biodegradación del cianuro con y sin suplemento de nutrientes orgánicos (Shivaraman, N.; Parhad, N.M.; Innovative hazardous waste treatment technology series, (1991). Appears in: *Biological processes*, 684 p., 3, v.3, pp. 39-46 [in English].)

1455 DETOXIFICATION OF CONTAMINATED SLUDGES USING COMBINED MICROBIOLOGICAL AND PHOTOLYTIC DEGRADATIVE APPROACHES [BIB-CEPI000126]

Evalúa la contribución de la descomposición fotolítica y microbiológica de las dioxinas en reactores de contacto líquido sólido como una consecuencia de irradiación UV e inoculación de una biomasa. Las dioxinas han sido reconocidas como las mayores sustancias cancerígenas asociadas con el creosota y pentaclorofenol, contaminantes presentes en lodos y suelos y que presentan significativa amenaza de contaminación de las aguas subterráneas. Los datos indican que existe un cambio en la cantidad de todos los constituyentes involucrados en los residuos de creosota y pentaclorofenol estudiados (Portier, Ralph J.; Fujisaki, Kuniko; Henry, Charles B.; Innovative hazardous waste treatment technology series, (1991). Appears in: *Biological processes*, 684 p., 3, v.3, pp. 55-64 [in English].)

1456 REMOVAL AND RECOVERY OF HEAVY METAL IONS FROM WASTEWATERS USING A NEW BIOSORBENT; ALGA SORB [BIB-CEPI000127]

Presenta una tecnología de bioadsorción conocida con el nombre de ALGA SORB, sistema que ha demostrado ser de utilidad para el tratamiento de varios tipos de aguas residuales. Las aguas pueden ser tratadas y los metales pesados pueden ser recuperados y reciclados. Expone las ventajas que el material de intercambio iónico biológico alga SORB tiene sobre las resinas de intercambio iónico convencional (Darnall, Dennis W.; Innovative hazardous waste treatment tech-

nology series. (1991). Appears in: *Biological processes*, 684 p., 3, v.3, pp. 65-72 [in English.]

1457 IMMOBILIZATION OF MERCURY AND OTHER HEAVY METALS IN SOIL, SEDIMENT, SLUDGE, AND WATER BY SULFATE-REDUCING BACTERIA [BIB-CEPI000128]

Describe los experimentos de laboratorio y campo realizados para la inmovilización del mercurio y otros metales pesados en suelos, sedimentos, lodos y agua. La tecnología se basa en estimular la actividad de las bacterias sulfato reductoras para lograr la reducción de sulfatos a sulfuros metálicos, los mismos que son insolubles en agua, previniendo de esta manera su movilización. La estimulación se basa en la aplicación de sulfato de calcio seco (yeso) sobre los suelos o lodos contaminados para promover la formación de sulfuro de hidrógeno que en combinación con los iones metálicos formarán los sulfuros metálicos (insolubles). Analiza los problemas ambientales y de salud asociados con la utilización de esta tecnología (Revis. N.W. Elmore, J. Edenborn, H. Osborne, T. Holdsworth, G. Hadden, C. King, A. Innovative hazardous waste treatment technology series. (1991). Appears in: *Biological processes*, 684 p., 3, v.3, pp. 97-105 [in English].)

1458 STIMULATING CLEANER TECHNOLOGIES THROUGH ECONOMIC INSTRUMENTS: POSSIBILITIES AND CONSTRAINTS [BIB-CEPI000129]

Presenta experiencias prácticas adquiridas en diferentes países y las cargas para estimular tecnologías más limpias. El análisis demuestra que estos instrumentos económicos pueden, en determinadas condiciones, ejercer un efecto positivo sobre el desarrollo y la puesta en marcha de tecnologías más limpias. Sin embargo, en la práctica, el uso de instrumentos económicos ha provocado principalmente tecnologías de "fin de proceso" en lugar de preventivas. Para poder solventar las presentes dificultades existentes para estimular tecnologías más limpias, se propone ampliar las presentes perspectivas de reglamentación de manera a hacerla surgir como una mayor perspectiva tecnológica. Tomando por base algunos ejemplos, examina cuáles puedan ser los puntos de impacto que esta amplia perspectiva tecnológica pueda ofrecer a los gobiernos para aumentar su influencia directiva (Cramer, J.; Schot, J.; Akker, F. van der, Maas Geesteranus, G.; *Industry and environment*, (April 1990), pp. 46-53 [in English]. 0378-9993)

1459 GESTION DE RESIDUOS PELIGROSOS Y EL PROGRAMA REGIONAL DEL CEPIS [BIB-CEPI000130]

(Benavides, Livia; Risso, Wanda; CEPIS (Lima, PE); Hojas de divulgación técnica, (June 1991), pp. 1-8 [in Spanish].)

1460 INFORME SOBRE PROPUESTAS DE TRATAMIENTO O CRITERIOS PARA REDUCIR LA CARGA ORGANICA DE LAS AGUAS RESIDUALES DE LA INDUSTRIA DEL AZUCAR, DE DESTILERIAS Y DE LA LEVADURA [BIB-CEPI000131]

Recomienda sobre la definición del sistema de tratamiento u otros criterios para reducir la carga orgánica de las aguas residuales de los ingenios de azúcar, de los "trapiches" (industria de azúcar integral no centrifugado), de las destilerías y de la industria de producción de levadura en Colombia. Incluye costo del tratamiento de los sistemas propuestos en cada una de estas industrias (Monteiro, Celso Eufasio; Corporación Autónoma Regional del Cauca (Cali, CO); OPS (Bogotá, CO); (1992). Appears in: *Informe sobre propuestas de tratamiento o criterios para reducir la carga organica de las aguas residuales de la industria del azúcar, de destilerías y de la levadura*, pp. 24 [in Spanish].)

1461 CONTROL AND TREATMENT OF HAZARDOUS (CHEMICAL) WASTES IN HONG KONG [BIB-CEPI000132]

Aborda sobre el control institucional y los métodos de tratamiento que están siendo adoptados en Hong Kong para el control de los residuos peligrosos. Indica que por razones lingüísticas, se llama residuos peligrosos a los residuos químicos, término que es apropiado al traducirlo al cantonés. Presenta las dificultades de introducir procedimientos de manejo y control de residuos peligrosos en una

sociedad industrializada. Discute las iniciativas del gobierno para el desarrollo de una legislación y provisión de instalaciones para el problema de los residuos peligrosos en Hong Kong. Describe el plan de acción formulado en base a éxitos y fracasos en diversos lugares (Nash, J.M.; Cheung, B.; Fung, C.H.; Lei, P.C.K.; Mak, P.W.; Rootham, R.C.; Stokoe, M.J.; Tong, R.; *Waste management & research: journal of the International Solid Wastes and Public Cleansing Association*, (June 1991), pp. 161-169 [in English]. 0734-242X)

1462 TREATMENT OF ORGANIC-CONTAMINATED INDUSTRIAL WASTES USING CEMENT-BASED STABILIZATION/SOLIDIFICATION; MICROSTRUCTURAL ANALYSIS OF CEMENT-ORGANIC [BIB-CEPI000133]

Enfatiza que una de las principales deficiencias de los procesos de estabilización/solidificación basados en cemento es la incapacidad para tratar residuos inorgánicos contaminados con material orgánico o residuos orgánicos. Indica que los compuestos orgánicos son pobremente retenidos en una matriz de cemento y frecuentemente tienen un efecto perjudicial, escasamente comprendido, sobre la hidratación del cemento y el desarrollo de resistencia. Investiga algunos aspectos fundamentales de las interacciones de dos compuestos orgánicos, 3-clorofenol y cloronaftaleno, con una matriz de cemento. Examina los efectos de estos dos compuestos sobre las propiedades microestructurales del cemento y fija los resultados para la aplicación práctica de la estabilización/solidificación (Montgomery, D.M.; Sollars, C.J.; Perry, R.; Tarling, S.E.; Barnes, P.; Henderson, E.; *Waste management & research: journal of the International Solid Wastes and Public Cleansing Association*, (April 1991), pp. 103-111 [in English]. 0734-242X)

1463 TREATMENT OF ORGANIC-CONTAMINATED INDUSTRIAL WASTES USING CEMENT-BASED STABILIZATION/SOLIDIFICATION; MICROSTRUCTURAL ANALYSIS OF THE ORGANOPHILIC CLAY AS A PRE-SOLIDIFICATION ADSORBENT [BIB-CEPI000134]

Señala que las arcillas organofílicas atraen crecientemente la atención como adsorbentes potenciales pre-solidificación para reducir las interacciones adversas compuestos orgánicos-cemento en sistemas de solidificación/estabilización. Presenta estudios microestructurales extensivos de interacciones entre arcilla organofílica, conteniendo residuos orgánicos adsorbidos, y una matriz de cemento. Examina como la presencia de arcilla organofílica en una mezcla de cemento actúa como una interfase entre compuestos orgánicos y la pasta de cemento y modifica las reacciones de hidratación del cemento. Prepara una variedad de mezclas para caracterizar la interacción de la arcilla organofílica con compuestos fenólicos y cemento usando métodos microestructurales. Los resultados muestran que la presencia de arcilla organofílica en una mezcla cemento arcilla retarda parcialmente el proceso de hidratación del cemento y estabiliza la etringita, un producto intermedio en la hidratación normal del cemento. El estudio indica que el uso cuidadoso de arcillas organofílicas puede reducir los efectos adversos de compuestos orgánicos en el fraguado del cemento. Concluye que este último efecto podría ser útil en el diseño de mezclas de solidificación basada en el cemento conteniendo arcillas organofílicas para el tratamiento exitoso de residuos industriales con contaminación orgánica (Montgomery, D.M.; Sollars, C.J.; Perry, R.; Tarling, S.E.; Barnes, P.; Henderson, E.; *Waste management & research: journal of the International Solid Wastes and Public Cleansing Association*, (April 1991), pp. 113-125 [in English]. 0734-232X)

1464 ELIMINACION DE DESECHOS DE INSTITUCIONES PUBLICAS Y PRIVADAS DEL SECTOR SALUD, DEL CIRCULO DE TRABAJO LAGA DE LA REPUBLICA FEDERAL DE ALEMANIA [BIB-CEPI000135]

Proporciona indicaciones para la minimización y eliminación de desechos de los centros públicos y privados del sector salud. Toma en cuenta los principios del sector de desechos sobre la minimización y la utilización, y responde en igual medida a los requerimientos higienicos (CAPRE (San Jose, CR); (1992). Appears in: *Eliminación de desechos de instituciones públicas y privadas del sector salud, del círculo de trabajo LAGA de la Republica Federal de Alemania*, pp. 28 [in Spanish].)

1465 TA ABFALL; ABFALL- UND RESTSTOFF ÜBERWACHUNGS- VERORDNUNG, RECHTS- UND VERWALTUNGSVORSCHRIFTEN, MIT VORDRUCKMUSTERN UND EINER ERLÄUTERNDEN EINFÜHRUNG [BIB-CEPI000136]

En la primera parte informa sobre los pasos técnicos para el establecimiento de un tratamiento físico, químico y biológico, así como la incineración y disposición de residuos especiales. En la segunda parte, enfoca los fundamentos jurídicos de la Abfallgesetz (Ley referente a los desperdicios), del Abfallbestimmungsverordnung (Reglamento de determinación de desperdicios), entre otros. En la tercera y última parte, explica los requisitos jurídicos complementarios, tales como la Bundesimmissionsschutzgesetz (Ley Federal de Emisiones) (Schmecken, Werner, (1991). Appears in: *Ta Abfall; Abfall- und Reststoff überwachungs- Verordnung, Rechts- und Verwaltungsvorschriften, mit Vordruckmustern und einer Erläuternden einföhrung*, pp. 286 [in German].)

1466 FOURTH FORUM ON INNOVATIVE HAZARDOUS WASTE TREATMENT TECHNOLOGIES; DOMESTIC AND INTERNATIONAL [BIB-CEPI000137]

(Environmental Protection Agency (Washington, D.C., US). Office of Solid Waste and Emergency Response: Forum on Innovative Hazardous Waste Treatment Technologies. San Francisco, 17-19 nov. 1992. (1992). Appears in: *Fourth forum on innovative hazardous waste treatment technologies; domestic and international*, pp. 6 [in English].)

1467 MANEJO Y DISPOSICION DE RESIDUALES PELIGROSOS EN CUBA [BIB-CEPI000138]

Expone la situación actual y manejo de las principales industrias cubanas, que generan desechos peligrosos y su caracterización cualitativa, su reciclaje y o disposición final y su aprovechamiento económico. Comenta sobre las normas y legislación en este campo (Hernández Freyre, Clara Olga; Valle Rios, Hilde-lisa; Asociación Interamericana de Ingeniería Sanitaria y Ambiental (Ciudad de La Habana, CU); Congreso de la Asociación Interamericana de Ingeniería Sanitaria y Ambiental, 23. Ciudad de La Habana, 22-28 nov. 1992. Memorias del XXIII Congreso de la Asociación Interamericana de Ingeniería Sanitaria y Ambiental, (1992). Appears in: *Abastecimiento de agua (carteles), tratamiento de residuales: parte 1 y 2*, v. pp. 743-750 [in Spanish].)

1468 GUIAS PARA EL TRATAMIENTO Y LA DISPOSICION DE PEQUEÑAS CANTIDADES DE DESECHOS DE PLAGUICIDAS [BIB-CEPI000139]

Proporciona pautas para el tratamiento y disposición segura de los desechos de plaguicidas con el fin de evitar un daño a las personas y el medio ambiente. Revisa las diversas opciones simples de tratamiento y disposición que pueden ser utilizadas cuando se dispone de recursos limitados. Enfatiza en la disposición de pequeñas cantidades de desechos de plaguicidas -hasta aproximadamente 25 kg ó 25 l de plaguicidas (o bien 2 a 3 l ó 2 a 3 kg de plaguicidas sumamente tóxicos)- y sus envases. Incluye fuentes de información adicional sobre la disposición de mayores cantidades de desechos de plaguicidas (Smith, James E.; Helmick, Jennifer. OPS (Washington, D.C., US); (1993). Appears in: *Guías para el tratamiento y la disposición de pequeñas cantidades de desechos de plaguicidas*, pp. 93 [in Spanish].)

1469 NEXT GENERATION; REDUCING TOXIC POLLUTANTS [BIB-CEPI000140]

Analiza los ajustes regulatorios establecidos para las normas de efluentes basados en la calidad del agua y los cambios inherentes requeridos por los sistemas de tratamiento de propiedad pública. Reporta las estrategias para el tratamiento de las aguas residuales en Sacramento, California para cumplir con los nuevos requerimientos. Enfatiza la necesidad de una reducción de tóxicos a través del control de las fuentes y programas de minimización de residuos para disminuir la necesidad de tratamientos costosos antes de su disposición final (McDonald, H. Stephen; Demir, Jamel; Creson, Cheryl F.; James, Mari Sanna; Kido, Wendell H.; Water environment & technology, (June 1992). [in English] 1044-9493)

1470 HAZARDOUS WASTE TREATMENT TRENDS IN THE U.S [BIB-CEPI000141]

Explica que el desarrollo del tratamiento de residuos peligrosos y las técnicas de minimización de desperdicios en los Estados Unidos han sido largamente amparados por dos estatutos principales en cuanto a la protección del medio ambiente: el "Resource Conservation and Recovery Act" (RCRA) y el "Comprehensive Environmental Response, Compensation and Liability Act", conocido como el "SUPERFUND". Señala que el programa de RCRA para administración de la tierra y las enormes cantidades de desperdicios peligrosos que requieren una solución bajo el Superfund necesitan una rápida expansión de la capacidad de tratamiento de residuos peligrosos e innovación tecnológica. Indica que para satisfacer estas necesidades, los administradores y generadores de desperdicios han incrementado la capacidad de tratamiento térmico. Informa que estas técnicas jugarán un rol importante en los esfuerzos futuros para manejar con mayor seguridad los residuos peligrosos (Skinner, John H.; Waste management & research: journal of the International Solid Wastes and Public Cleansing Association, (February 1991), pp. 55-63 [in English]. 0734-242X)

1471 IMPROVING BIODEGRADABILITY OF INDUSTRIAL WASTEWATER CONTAINING REFRACTORY POLLUTANT BY OZONATION [BIB-CEPI000142]

Estudia el mejoramiento de la biodegradabilidad de los efluentes industriales: a través de la oxidación con ozono. Evalúa el efecto de la concentración inicial del contaminante, pH, dosis de ozono y la biodegradabilidad de una mezcla de compuestos para determinar las condiciones óptimas de biodegradabilidad. Los compuestos estudiados incluyen: ácido sulfónico de naphthaleno (ASN), fenol, benceno y piridina. Estudia también la eficiencia de tratamiento de un efluente industrial conteniendo ASN en un sistema de lodos activados. Demuestra la ventaja de la ozonización en el tratamiento de los efluentes conteniendo los compuestos antes citados, excepto para el caso del fenol en que la ozonización tiene efectos adversos en la biodegradabilidad (Shin, Hang-Sik; Lim, Jae-Lim; Ahn, Duk-Won; Pacific Basin Consortium for Hazardous Waste Research (Honolulu, US); Pacific Basin Conference on Hazardous Waste, Bangkok, 6-10 abr. 1992. (1992). Appears in: *Proceedings of Pacific Basin Conference on Hazardous Waste*, pp. 1-12 [in English].)

1472 TREATMENT AND DISPOSAL OF HEAVY METAL WASTE USING CEMENTITIOUS SOLIDIFICATION [BIB-CEPI000143]

Describe el empleo de la técnica de tratamiento solidificación-estabilización para reducir la movilidad de los metales pesados de tal manera que no presente peligro ambiental. Los metales pesados: arsénico, plata, cadmio, cromo, mercurio y plomo, corresponden a los presentes en el lodo generado en el estanque de una torre de enfriamiento de una planta industrial. Estudia dos fuentes de sílice: cemento portland ordinario y la mezcla de cemento portland ordinario y ceniza de cáscara de arroz en cantidades iguales. Investiga el comportamiento del lodo tratado en el lugar de la disposición final. Los resultados muestran que para lograr la inmovilización exitosa de todos los metales pesados mencionados, los requerimientos de la mezcla aglomerante es por lo menos tres veces la cantidad del lodo. Se encontró que ambos tipos de aglomerante son buenos agentes inmovilizantes (Peralta, G.L.; Ballesteros, F.C.; Cepeda, M.L.; Pacific Basin Consortium for Hazardous Waste Research (Honolulu, US); Pacific Basin Conference on Hazardous Waste, Bangkok, 6-10 abr. 1992. (1992). Appears in: *Proceedings of Pacific Basin Conference on Hazardous Waste*, pp. 1-15 [in English].)

1473 HYDRATION REACTIONS DURING THE SOLIDIFICATION/STABILISATION OF TOXIC WASTES [BIB-CEPI000144]

Explica que el uso de cemento y materiales puzolánicos para la solidificación y estabilización de residuos industriales tóxicos es practicado en muchos países. Muchos residuos industriales tóxicos, sin embargo, contienen componentes que interactúan con los materiales aglomerantes de tal manera que el desarrollo del fraguado y resistencia de la mezcla solidificante se ve afectada. Revisa las reacciones que ocurren, particularmente durante las primeras etapas de solidifi-

cación (Koe, Lawrence C. C. Hills, Colin D. Sollars, C. Perry, Roger J. Pacific Basin Consortium for Hazardous Waste Research (Honolulu, US); Pacific Basin Conference on Hazardous Waste, Bangkok, 6-10 abr. 1992, (1992). Appears in: *Proceedings of Pacific Basin Conference on Hazardous Waste*, pp. 1-10 [in English].)

1474 SOLVENT EXTRACTION TECHNOLOGY IN HAZARDOUS WASTE MINIMIZATION AND TREATMENT [BIB-CEPI000145]

Reporta resultados de estudios de laboratorio y a escala piloto para la separación y remoción de iones de metales pesados de soluciones residuales de hierro usando la tecnología de extracción por solvente. Las soluciones residuales de hierro pueden ser generadas en la producción de pigmentos, concentración y purificación de mineral, manufactura de componentes electrónicos, y procesamiento de metal. La tecnología de extracción por solvente ha sido aplicada por muchos años en la hidro metalurgia, usada en el procesamiento de los minerales de uranio y en la purificación y/o concentración de varios iones metálicos en la industria de la refinación de metales (Martin Lai, Zhugen; Terry, Alfred; Molnar, Ronald; Pacific Basin Consortium for Hazardous Waste Research (Honolulu, US); Pacific Basin Conference on Hazardous Waste, Bangkok, 6-10 abr. 1992, (1992). Appears in: *Proceedings of Pacific Basin Conference on Hazardous Waste*, pp. 1-20 [in English].)

1475 WASTE MINIMIZATION STUDY FOR A PAPER MANUFACTURING COMPANY IN TAIWAN [BIB-CEPI000146]

Presenta proyecto de demostración de minimización de residuos en la industria del papel en Taiwán. Evalúa e identifica las opciones de reducción de residuos, indicando los procesos donde esta técnica puede aplicarse. Incluye costos y beneficios de este proyecto (Lung Kuo, Sheng; Yuan Hsieh, Te; Shynan Hwang, Li; Chen, David; Wu, Min; Pacific Basin Consortium for Hazardous Waste Research (Honolulu, US); Pacific Basin Conference on Hazardous Waste, Bangkok, 6-10 abr. 1992, (1992). Appears in: *Proceedings of Pacific Basin Conference on Hazardous Waste*, pp. 1-12 [in English].)

1476 DISPOSAL METHODS FOR SMALL QUANTITIES OF SOME HAZARDOUS CHEMICAL WASTES [BIB-CEPI000147]

Informa sobre métodos de tratamiento y disposición de algunas sales de metales pesados (Pb, Cd, Sb, Fe, Hg, Al, Cu, Mg, Co), tintes, solventes orgánicos (Dioxan, Tetra hidrofuran), aminas y pesticidas (Diquet, Avadex, picloram y 2,4-D. Reporta el uso de una mezcla a base de carbonato de sodio, bentonita de sodio y arena, la cual se ha demostrado ser de utilidad para el tratamiento de derrames de una amplia variedad de líquidos (Armour, Margaret Ann; Renecker, Donna M; Crerar, John A; Chang, Mui; Spytkowaki, Girard; Pacific Basin Consortium for Hazardous Waste Research (Honolulu, US); Pacific Basin Conference on Hazardous Waste, Bangkok, 6-10 abr. 1992, (1992). Appears in: *Proceedings of Pacific Basin Conference on Hazardous Waste*, pp. 1-10 [in English].)

1477 TECHNICAL ISSUES ON LONG-TERM PERFORMANCE OF SOLIDIFIED/STABILIZED WASTE FORMS [BIB-CEPI000148]

Sostiene que el éxito del tratamiento de residuos peligrosos por solidificación y estabilización depende de la capacidad del residuo tratado para soportar condiciones físicas y químicas del clima sin liberar los contaminantes atrapados. La durabilidad esperada de residuos tratados ha sido estimada en base a resultados de pruebas de laboratorio, pero nunca se ha confirmado en pruebas de campo y monitoreos. Describe el estado de la estimación de la durabilidad de estos residuos tratados y un programa de investigación propuesto para mejorar la predicción del éxito del tratamiento por solidificación/estabilización (Erickson, Patricia M.; Kirk, Diana R.; Wiles, Carlton C.; Pacific Basin Consortium for Hazardous Waste Research (Honolulu, US); Pacific Basin Conference on Hazardous Waste, Bangkok, 6-10 abr. 1992, (1992). Appears in: *Proceedings of Pacific Basin Conference on Hazardous Waste*, pp. 1-13 [in English].)

1478 ZERO-DISCHARGE: A GOAL WHOSE TIME HAS COME? [BIB-CEPI000149]

Señala que en 1972 fue la primera y única vez que un estatuto ambiental moderno de los Estados Unidos incluyó el concepto de "descargas cero". Define la "descarga cero" no propiamente como un tratamiento, sino más bien como una

eliminación total o virtual de material peligroso proveniente de actividades productivas, de uso y residuos. Explica que la filosofía de la nulidad de descargas está orientada a reemplazar sustancias persistentes, tales como PCB, que pueden ser nocivas permanentemente a largo plazo al medio ambiente, por otras sustancias que sean asimiladas y degradadas sin causar ningún daño. Indica que algunos seguidores de este pensamiento alegan la eliminación de productos químicos no deseables, lo cual significaría contar con una legislación adecuada que prescriba fecha de término de uso de dichos productos. Afirma que otros prefieren un concepto basado en la prueba absoluta de que una sustancia es segura en términos de salud y protección ambiental antes de permitir su fabricación y uso (Elake, David; Ford, Libby; Freedman, Paul; Marti, Jose; Melton, Lyndel; Water, environment & technology, (October 1992), pp. 58-61 [in English], 1044-9493)

1479 ESTUDIO DE FACTIBILIDAD RESIDUOS PELIGROSOS, PROVINCIA DE BUENOS AIRES [BIB-CEPI000150]

Evalúa las condiciones existentes de producción de residuos peligrosos y la factibilidad del control y tratamiento de estos residuos. Identifica el marco de reglamentación existente y analiza las legislaciones vigentes en el orden provincial, nacional y además la ley norteamericana del Acta de Conservación y recuperación de recursos (Dames & Moore (Buenos Aires, AR); Argentina, Ministerio de Salud y Acción Social (Buenos Aires, AR); (1992). Appears in: *Estudio de factibilidad residuos peligrosos, provincia de Buenos Aires*, pp. 181 [in Spanish].)

1480 MOLTEN SALT OXIDATION OF HAZARDOUS AND MIXED WASTE [BIB-CEPI000151]

Presenta técnica de oxidación por medio de sal fundida para residuos peligrosos y mezcla de residuos (radioactivos y peligrosos) como un nuevo proceso para destruir los componentes peligrosos de los residuos combustibles a la vez minimizar las emisiones de metales pesados y radionúclidos. Explica que especies radioactivas, tales como los productos de fusión de tierras raras o elementos actínidos son retenidos en el baño de las sales fundidas, las que están conformadas por carbonato de sodio y cloruro de sodio. Señala haberse medido 99

de retención para el Cs, Sr, Ru, Eu, I, Cr, Mn, Fe, Hg, Co y Pb. Presenta resultados al aplicar esta técnica en el tratamiento de residuos con solventes halogenados, PCBs, agentes químicos de guerra, solventes contaminados con uranio y sólidos contaminados con plutonio. Indica las ventajas y desventajas de esta técnica (Gay, Richard L.; Pacific Basin Consortium for Hazardous Waste Research (Honolulu, US); Pacific Basin Conference on Hazardous Waste, Bangkok, 6-10 abr. 1992, (1992). Appears in: *Proceedings of Pacific Basin Conference on Hazardous Waste*, pp. 1-13 [in English].)

1481 WASTE MINIMIZATION: A MAJOR CONCERN OF THE CHEMICAL INDUSTRY [BIB-CEPI000152]

Señala que abastecer la creciente demanda de la sociedad por bienes y servicios está conduciendo a un agotamiento de los recursos y a un aumento de la cantidad de residuos generados. La unicidad de la industria química requiere de soluciones especiales. Afirma que el manejo y minimización de desperdicios, incluso el reciclaje, la reutilización y la valorización deben convertirse en partes integrales de todo proceso productivo. Presenta ejemplos, a nivel grupal de productos y a nivel de medios de transporte, de programas de éxito que eliminaron o redujeron significativamente los desperdicios generados. Informa sobre la generación de residuos, cantidad, tratamiento, minimización y reciclaje de los mismos (Gujer, U.; International Seminar on Industrial Residuals Management, Salvador, 7-9 Nov. 1990, Water science and technology, (1991), pp. 43-56 [in English], 0273-1223)

1482 PROCESS DEVELOPMENT IN PHENOLIC WASTEWATER TREATMENT [BIB-CEPI000153]

Indica que la limitación en el nivel de componentes fenólicos de los efluentes industriales requiere del Nitroclor, un tratamiento de los licores de origen que proceden de su unidad de producción de nitrofenoles, antes de enviarlos al tratamiento biológico. Señala que la literatura y experiencia acumuladas durante los últimos años muestran que la remoción de compuestos nitrofenólicos a elevadas temperaturas es potencialmente peligrosa, debido a la inestabilidad térmica que caracteriza a estos productos. Desarrolla un nuevo proceso minimizando los riesgos térmicos y recuperando los nitrofenoles con un alto grado de

pureza (Teixeira, A.C.; Balassiano, G.L.; International Seminar on Industrial Residuals Management, Salvador, 7-9 Nov. 1990. Water science and technology, (1991), pp. 77-81 [in English]. 0273-1223)

1483 HANDLING AND PROCESSING OF HAZARDOUS SOLID WASTES FROM PETROCHEMICAL INDUSTRIES; CETREL'S EXPERIENCE [BIB-CEPI000154]

Explica que la creciente generación de residuos sólidos peligrosos, que resultan de la rápida expansión de varias actividades industriales dentro de la región, requiere una definición muy consciente y cuidadosa para establecer las alternativas más adecuadas a la disposición final de estos residuos, a fin de evitar efectos nocivos en el medio ambiente y en la población. Informa que el Centro de Tratamiento de Efluentes Líquidos y Residuos Industriales Especiales (CETREL), localizado en Camaçari, Bahía, es responsable del funcionamiento de uno de los sistemas más completos y complejos de manejo de residuos sólidos peligrosos generados aproximadamente por 50 industrias químicas y petroquímicas. Presenta una visión general del funcionamiento del sistema para el tratamiento y disposición de residuos sólidos, desde el condicionamiento inicial y sus fuentes generadoras hasta el manejo, procesamiento y disposición final, así como operaciones de control y minimización (Passos, J.A.L.; Neves, N.M.S.; Ferreira, M.Q.; International Seminar on Industrial Residuals Management, Salvador, 7-9 Nov. 1990. Water science and technology, (1991), pp. 93-101 [in English]. 0273-1223)

1484 SANITATION OF POLLUTED SOIL AREAS AND HAZARDOUS WASTE MANAGEMENT AT DSM [BIB-CEPI000155]

Explica que la administración de residuos en DSM, una gran compañía química en Holanda, se relaciona con dos tipos de actividad: saneamiento de áreas contaminadas por residuos o por operaciones pasadas; manejo y control de residuos, incluyendo los residuos peligrosos de operaciones existentes. Informa que los rellenos sanitarios, así como las operaciones no controladas, llevadas a cabo entre 1925 y 1980 en la DSM condujeron a la creación de varias áreas de suelos contaminados. En el periodo de 1987 a 1990, se constituyó un gran relleno para sanear algunos de estos lugares. Indica que se estableció, asimismo, un departamento central de tratamiento de desperdicios, a fin de manejar adecuadamente todo residuo sólido y líquido (excepto aguas residuales). Afirma que, de acuerdo con la política del gobierno holandés, la DSM empezó un programa de minimización de residuos de producción. Concluye señalando que el saneamiento de áreas contaminadas por rellenos sanitarios no controlados o por operaciones del pasado, es técnicamente dificultoso y extremadamente costoso (Dijkstra, F.; International Seminar on Industrial Residuals Management, Salvador, 7-9 Nov. 1990. Water science and technology, (1991), pp. 113-122 [in English]. 0273-1223)

1485 OILY WASTES APPLICATION IN CERAMIC MATERIALS MANUFACTURING [BIB-CEPI000156]

Señala que la aplicación de residuos de aceite producidos por Petróleo Brasileiro S.A. -Petrobras- en la fabricación de ladrillos cerámicos parece ser una alternativa prometedora para su reutilización, en comparación con el método tradicional de almacenamiento en lagunas o diques y con el proceso de biodegradación por agricultura. Indica que la aplicación de tales residuos empezó experimentalmente en 1988, en una fábrica de ladrillos localizada en el Valle de Paraíba de Sul, Estado de Sao Paulo, y ubicada muy cerca a la Refinería Henrique Lage. Expone que a mediados de 1989, otras refinerías comenzaron a enviar sus residuos de aceite a fábricas que forman parte de la Asociación de Cerámicas Red de Itu. Informa que como ventaja adicional, casi todos los costos de este proceso con disposición de esos residuos serán eliminados por Petrobras y, además, la reducción de los costos de mantenimiento, el menor consumo de energía y un aumento considerable en la producción son ventajas para las fábricas de cerámicas (Amaral, S.P.; Domingues, G.H.; International Seminar on Industrial Residuals Management, Salvador, 7-9 Nov. 1990. Water science and technology, (1991), pp. 165-176 [in English]. 0273-1223)

1486 RECYCLING OF RESIDUES ON CARAIBAS COPPER SMELTER [BIB-CEPI000157]

Resume los pasos del proceso que produce cobre primario a partir de concentrados de sulfuros, relacionándolos con la producción y destino de los residuos industriales. Presenta sugerencias para estudios posteriores de investigación

(Conceição, L.N. da, Lima, P.A.; International Seminar on Industrial Residuals Management, Salvador, 7-9 Nov. 1990. Water science and technology, (1991), pp. 211-215 [in English]. 0273-1223)

1487 HAZARDOUS WASTES MANAGEMENT IN BRAZIL; THE NEED FOR A REGIONAL SYNOPTIC APPROACH [BIB-CEPI000158]

Informa que en el Brasil el manejo de residuos peligrosos es una tarea difícil de cumplir. Señala que el área enorme del país, la falta de tradición en cuanto a este tema, la escasez de personal especializado, los altos costos de inversión y la tecnología sofisticada hacen que el tratamiento regional de estos residuos sea un intento por reducir costos y maximizar beneficios. Presenta un diagnóstico de situación de los residuos peligrosos en este país incluyendo: la generación de los mismos, los diversos tipos de tratamiento utilizados y aspectos socio-políticos y legales al respecto. Propone un acercamiento sinóptico de toda una región geográfica considerando todos los aspectos relacionados con el manejo de residuos peligrosos (Sampaio, J.A.B.; International Seminar on Industrial Residuals Management, Salvador, 7-9 Nov. 1990. Water science and technology, (1991), pp. 11-18 [in English]. 0273-1223)

1488 WASTE DISCHARGE REDUCTION PROGRAM OVERVIEW; MONSANTO AGRICULTURAL COMPANY [BIB-CEPI000159]

Informa que Monsanto es una compañía líder en cuanto a la reducción de descargas de residuos en el medio ambiente. Señala que esta anunció en junio de 1988 que se preparó una comisión para reducir las emisiones en el aire de materiales peligrosos en un 90 por ciento hacia fines del 92. Indica que estableció otra meta para reducir la descarga de materias orgánicas e inorgánicas peligrosas en todos los medios ambientales. Afirma que se han identificado proyectos para que se logre la meta de reducir en 90 por ciento la emisión en el aire y para que se minimicen las descargas residuales proyectadas para 1995 de 150 millones de libras a 50 millones de libras (Keffer, C.W.; International Seminar on Industrial Residuals Management, Salvador, 7-9 Nov. 1990. Water science and technology, (1991), pp. 29-32 [in English]. 0273-1223)

1489 ALTERNATIVAS DE DISPOSICION Y FUNCION DE COSTOS DE LOS RESIDUOS SOLIDOS Y SOLIDOS PELIGROSOS PARA LOS DIFERENTES SECTORES INDUSTRIALES [BIB-CEPI000160]

Describe los procesos y señala los costos de: remoción de grasa y aceites, precipitación, floculación, sedimentación, procesamiento de lodos, neutralización, estabilización, solidificación para el tratamiento de residuos peligrosos (Vargas B., Carlos; Casas, Wilson; Prieto, Alvaro, Colombia, Departamento Nacional de Planeación (Bogotá, CO); (1992). Appears in: *Alternativas de disposición y función de costos de los residuos sólidos y sólidos peligrosos para los diferentes sectores industriales*, pp. 24 [in Spanish].)

1490 OPTIMIZACION DE PROCESOS INDUSTRIALES EN EL SECTOR DE CURTIEMBRES [BIB-CEPI000161]

Presenta las características de la industria de la curtiembre y describe el proceso y materias primas utilizadas. Identifica los materiales descartados o residuos tanto a nivel industrial como artesanal. Señala la contaminación ambiental producida por dicha industria y enfatiza en la optimización del proceso mediante uso de materias primas de alto agotamiento, y el cambio y correcta formulación de las mismas. Indica los beneficios económicos y ambientales obtenidos con la variación de los procesos. Incluye recomendaciones a nivel nacional (Castillo, Evilario; Casas, Wilson; Herrera, Carlos, Colombia, Departamento Nacional de Planeación (Bogotá, CO); (1992). Appears in: *Optimización de procesos industriales en el sector de curtiembres*, pp. 48 [in Spanish].)

1491 WASTE MANAGEMENT SOLUTIONS AT AN INTEGRATED OIL REFINERY BASED ON RECYCLING OF WATER, OIL AND SLUDGE [BIB-CEPI000162]

Proyecto de investigación y desarrollo realizado en una refinería de petróleo en Israel. Describe soluciones desarrolladas, las cuales se basan en la mínima disposición de aguas residuales y lodos fuera de la zona industrial y el máximo reciclaje de agua, aceite y lodos por la refinería e industrias adyacentes. Las instalaciones de tratamiento de acuerdo a los resultados de las investigaciones incluyen el tratamiento separado de efluentes concentrados, almacenamiento y

regulación de los principales efluentes de la refinería: separadores aceite-agua tipo API; floculación química-flotación con aire disuelto; tratamiento biológico con lagunas aeradas; colección, tratamiento y disposición de lodos (Calil, N.; Rebbun, M.; International Conference on Waste Management in the Chemical and Petrochemical Industries - Toxics Management, 2, New Orleans, 17-20 jun. 1991. Water science and technology, (1992), pp. 101-106 [in English]. 0273-1223)

1492 DEVELOPMENT OF A WASTE MINIMIZATION PROGRAM AT AMOCO OIL COMPANY [BIB-CEPI000163]

Discute el desarrollo desde su concepción, evolución y estado actual del programa de minimización de residuos para las refinerías de la Compañía de Petróleo Amoco. Expone el rol del departamento de Investigación y Desarrollo de esta Compañía, incluyendo el soporte lógico (software) para rastrear la generación de residuos, procesamiento, disposición y costos. Presenta estudios de caso de proyectos de control de fuente y recuperación de recursos exitosamente implementados en las refinerías de esta compañía (Spearman, M. K.; Zagula, S.J.; International Conference on Waste Management in the Chemical and Petrochemical Industries - Toxics Management, 2, New Orleans, 17-20 jun. 1991. Water science and technology, (1992), pp. 107-116 [in English]. 0273-1223)

1493 ADVANCED IN RESIDUALS PROCESSING, TREATMENT AND DISPOSAL FOR CHEMICAL AND PETROCHEMICAL INDUSTRIES; A BRAZILIAN CASE STUDY [BIB-CEPI000164]

Indica que los desarrollos tecnológicos y sus aplicaciones deben seguir un curso que sea paralelo con la legislación y las inquietudes del público respecto a la gestión de los residuos peligrosos. Describe y comenta las prácticas que han sido conducidas en el Complejo Petroquímico Camaçan en Brasil durante 10 años. Analiza los avances logrados en el procesamiento, tratamiento y disposición de los residuos para las industrias química y petroquímica presentando este estudio de caso (Fontes Lima, F.; Alves Pereira, F.; International Conference on Waste Management in the Chemical and Petrochemical Industries - Toxics Management, 2, New Orleans, 17-20 jun. 1991. Water science and technology, (1992), pp. 173-181 [in English]. 0273-1223)

1494 RCRA CORRECTIVE ACTION STABILIZATION TECHNOLOGIES [BIB-CEPI000165]

(Environmental Protection Agency (Washington, D.C., US); (1992). Appears in: *RCRA corrective action stabilization technologies*, pp. 77 [in English].)

1495 DRAFT TECHNICAL GUIDELINES ON USED OIL REFINING OR OTHER REUSES OF PREVIOUSLY USED OIL [BIB-CEPI000166]

(PNUMA (Nairobi, KE); Technical Working Group to prepare Draft Technical Guidelines for the Environmentally Sound Management of Hazardous Wastes Subject to the Basel Convention, 5, Geneva, 1-3 Sep. 1993. (1993). Appears in: *Draft technical guidelines on used oil re-refining or other reuses of previously used oil*, pp. 94 [in English].)

1496 DRAFT TECHNICAL GUIDELINES ON INCINERATION ON LAND [BIB-CEPI000167]

(PNUMA (Nairobi, KE); Technical Working Group to prepare Draft Technical Guidelines for the Environmentally Sound Management of Hazardous Wastes Subject to the Basel Convention, 5, Geneva, 1-3 Sep. 1993. (1993). Appears in: *Draft technical guidelines on incineration on land*, pp. 66 [in English].)

1497 SITE SELECTION FOR NEW HAZARDOUS WASTE MANAGEMENT FACILITIES [BIB-CEPI000168]

Señala los procesos involucrados en la selección apropiada del sitio donde nuevas instalaciones puedan establecerse para el manejo de residuos peligrosos. Analiza consideraciones técnicas, de salud, medio ambiente, sociales y económicas para la selección de estos lugares (Sloan, William M.; EURO (Copenhagen, DK); WHO regional publications european series, (1992). Appears in: *Site selection for new hazardous waste management facilities*, pp. 118 [in English]. 0378-2255)

1498 DECISION I/16, TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES DESTINED FOR RECOVERY OPERATIONS; REVISED DRAFT DISCUSSION PAPER [BIB-CEPI000169]

Discute los problemas asociados con la recuperación de residuos peligrosos, los beneficios y consideraciones económicas y ecológicas de esta práctica. Analiza las implicancias del movimiento transfronterero de residuos peligrosos de ritados para operaciones de reciclaje y señala los criterios para determinar los residuos adecuados para estas operaciones. Propone guías y procedimientos para el movimiento transfronterero de residuos, dentro del marco de la Convención de Basilea sobre el control de movimientos transfrontereros de residuos peligrosos y su disposición (PNUMA (Ginebra, CH); (1993). Appears in: *Decision I/16, transboundary movements of hazardous wastes destined for recovery operations; revised draft discussion paper*, pp. 15 [in English].)

1499 TEXTILE WASTE [BIB-CEPI000170]

Revisión bibliográfica sobre las aguas residuales generadas en la industria textil. Aborda los estudios relacionados al tratamiento físico-químico, tratamiento biológico y la minimización de estos efluentes industriales (Groff, Kimberly A.; Water environment research, (June 1992), pp. 425-429 [in English]. 1061-4303)

1500 METAL FINISHING AND PROCESSING [BIB-CEPI000171]

Revisión bibliográfica sobre los efluentes del acabado y procesamiento de metales. Analiza el tratamiento de metales pesados incluyendo: precipitación, intercambio iónico, adsorción y otros. Señala investigaciones referidas al tratamiento de cianuro. Incluye la minimización de estos efluentes industriales, indicando estudios de caso. Resume trabajos respecto al manejo de lodos (Enzinger, Jeffrey D.; Water environment research, (June 1992), pp. 465-468 [in English]. 1061-4303)

1501 CURSO DE ACTUALIZACION AVANCES EN EL TRATAMIENTO DE LOS RESIDUOS PELIGROSOS [BIB-CEPI000172]

(Rosales A., Efraim; AIDIS (Caracas, VE); División de Capacitación, Educación y Adiestramiento; Curso de Actualización Avances en el Tratamiento de los Residuos Peligrosos, Puerto La Cruz, 4-5 oct. 1993. (1993). Appears in: *Curso de actualización avances en el tratamiento de los residuos peligrosos*, pp. 134 [in Spanish].)

1502 VERMEIDUNG UND VERWERTUNG THERMISCH ZU ENTSORGENDER SONDERABFAELLE IN DER STADT NURNBERG UND IN DER REGION MITTELFRANKEN (ELIMINATION AND UTILIZATION OF SPECIAL WASTES IN NURNBERG AND IN MITTELFRANKEN) [BIB-CEPI000173]

(Schagerl, Peter; Rückel, Hans Georg; Müll und Abfall, (April 1992), pp. 198-200, 202-204, 206-207 [in German]. 0027-2957)

1503 NEUES C/P-KREISLAUFVERFAHREN ZUR BODENDEKONTAMINATION (NEW C/P PROCESS FOR SOIL FURIFICATION) [BIB-CEPI000174]

Describe el proceso físico-químico "Ciclo Sólido", el cual permite recuperar las sustancias nocivas y convertirlas en sustancias útiles (Pockl, Erich E.; Entsorgung Praxis, (March 1993), pp. 118-119 [in German]. 0724-6870)

1504 BEHANDLUNG VON RÜCKSTANDEN AUS DER ABFALLVERBRENNUNG (TREATMENT OF RUBBISH FROM WASTE INCINERATION) [BIB-CEPI000175]

(Faulstich, Martin; Kley, Gerd; Entsorgung Praxis, (April 1993), pp. 211-214, 216-217 [in German]. 0724-6870)

1505 SITUATION AND THE PROBLEMS OF HAZARDOUS WASTE TREATMENT IN GERMANY [BIB-CEPI000176]

Analiza la situación actual y los problemas del manejo de los residuos peligrosos en Alemania. Presenta datos de generación de estos residuos en Alemania y otros países europeos, así como de cantidad de estos residuos importados o exportados.

tados. Describe los métodos de tratamiento y disposición: relleno sanitario, disposición en el mar, incineración y disposición subterránea. Destaca la necesidad de encontrar una apropiada tecnología de tratamiento y disposición (Shm. I.K.C.: Water science and technology, (1992), pp. 31-40 [in unknown language]. 0273-1223)

1506 TOXICS MANAGEMENT IN THE CHEMICAL AND PETROCHEMICAL INDUSTRIES [BIB-CEPI000177]

Señala la identificación, evaluación y control de tóxicos con énfasis en: consideraciones legales, evaluación de toxicidad, minimización de residuos y nuevas técnicas de tratamiento para residuos tóxicos y peligrosos. Destaca el consenso entre los entes reguladores, industria e investigadores para la prevención de residuos por reducción en la fuente como la más deseable opción de manejo de residuos (Englande, A.J.; Guarino, C.F.: Waste Management in the Chemical and Petrochemical Industries - Toxics Management, Louisiana, 17-20 Jun. 1991. Water science and technology, (1992), pp. 263-274 [in English]. 0273-1223)

1507 APPLICATION OF PRODUCT LIFE-CYCLE ASSESSMENT TO PRODUCT STEWARDSHIP AND POLLUTION PREVENTION PROGRAMS [BIB-CEPI000178]

Describe la evaluación del ciclo de vida de un producto y su aplicación a la prevención de la contaminación y programa de responsabilidad de productos. La evaluación del ciclo de un producto es una estrategia para la prevención de la contaminación. Define este concepto y muestra un esquema con sus componentes (Fava, J.A.: Page, A.: Water science and technology, (1992), pp. 275-287 [in English]. 0273-1223)

1508 EFFLUENT GUIDELINES COMPLIANCE THROUGH WASTE MINIMIZATION [BIB-CEPI000179]

Presenta la experiencia de la compañía Du Pont, una industria de productos químicos, en su afán por implementar un programa de reducción de residuos y eliminación de la fuente de los residuos. Muestra los logros alcanzados y beneficios económicos de este programa (Wood, K.N.; Bishop, A.L.: Water science and technology, (1992), pp. 301-307 [in English]. 0273-1223)

1509 WASTE REDUCTION BY PROCESS IMPROVEMENT IN THE BRIGHTENER INTERMEDIATES PRODUCTION [BIB-CEPI000180]

Presenta los resultados del mejoramiento de procesos en la producción de pulidores ópticos, con el objeto de minimizar la generación de residuos. Describe la química del proceso y muestra diagrama de los procesos antiguos y nuevos. Cuantifica los efluentes descargados con ambos procesos y destaca los logros alcanzados (Sadek, S.E.; Lee, J.G.; Lund, R.B.; McCormell, W.W.: Water science and technology, (1992), pp. 309-317 [in English]. 0273-1223)

1510 POLLUTION PREVENTION: PART OF YOUR WASTE MANAGEMENT PROGRAM [BIB-CEPI000181]

Presenta información sobre las prácticas de prevención de contaminación y la economía que ésta representa en las industrias. Describe los conceptos reducción de residuos, minimización de residuos y prevención de contaminación. Señala experiencias de prevención de contaminación en tres industrias: industria de productos electrónicos, industria de la madera e industria fotográfica (Brosky, D.L.: Water science and technology, (1992), pp. 389-299 [in English]. 0273-1223)

1511 INCINERACAO DE RESIDUOS SOLIDOS PERIGOSOS; PADROES DE DESEMPENHO [BIB-CEPI000182]

(Associação Brasileira de Normas Técnicas (Rio de Janeiro, BR), (1990). Appears in: *Incineracao de residuos solidos perigosos: padroes de desempenho*, pp. 5 [in unknown language].)

1512 COMENTARIOS AL CAPITULO 21 DE LA AGENDA 21 "ASUNTOS RELATIVOS AL MANEJO AMBIENTALMENTE ADECUADO DE LOS RESIDUOS SOLIDOS Y DE LAS AGUAS SERVIDAS" [BIB-CEPI000183]

El trabajo consiste en una traducción libre del original en inglés del capítulo 21 de la Agenda 21 sobre residuos, al que se agregan comentarios pertinentes a las

actividades del Proyecto CEP-AL GTZ "Políticas para la gestión ambientalmente adecuada de los residuos Fase II". Dichas apreciaciones están presentes cuando hay identidad entre los objetivos y actividades planteadas por el documento de la Conferencia de las Naciones Unidas sobre Medio Ambiente y Desarrollo (CNUMAD) con los del proyecto, o cuando existe alguna carencia en las actividades desarrolladas por el proyecto en relación a las propuestas de la CNUMAD (Arteaga, José Miguel, CEPAL (Santiago, CL), (1993). Appears in: *Comentarios al Capítulo 21 de la Agenda 21 "Asuntos relativos al manejo ambientalmente adecuado de los residuos sólidos y de las aguas servidas"*, pp. 30 [in Spanish].)

1513 KOMMUNALE ABFALLBERATUNG FUR GEWERBEBETRIEBE (COMMON WASTE ADVISORY FOR INDUSTRIES) [BIB-CEPI000184]

Define los requisitos que debe cumplir un informe sobre reducción de desperdicios para el sector industrial y cuál puede ser su aporte en la administración de residuos. Se refiere a la importancia de un catastro de residuos industriales. Explica un posible proceso de preparación, en el que se discute la necesidad de personal y la calificación de los propietarios (Hellmich, Andreas; Anderheide, Jochen; Müll und Abfall, (December 1993), pp. 869-873, 876-883 [in German]. 0027-2957)

1514 MOEGELICHKEITEN DER REDUZIERUNG VON SONDERABFAELLEN DURCH BERATUNG IN GEWERBE UND INDUSTRIE (POSSIBILITIES TO REDUCE SPECIAL WASTES BY MEANS OF THE WASTE CONSULTING) [BIB-CEPI000185]

(Hoffmann, Helmut; Senff, Anja; Müll und Abfall, (January 1992), pp. 12-17 [in German]. 0027-2957)

1515 GEWERBEABFALLBERATUNG DURCH DIE UNTEREN ABFALLBEHÖRDEN: KONZEPT ZUR VERMEIDUNG UND VERWERTUNG NACHWEISPFICHTIGER ABFAELLE (INDUSTRIAL WASTE REPORT BY MEANS OF CONTROL SUBAUTHORITIES; A CONCEPT FOR WASTE DIMINUTION AND UTILIZATION) [BIB-CEPI000186]

(Miná, Erika; Schébek, Lilo; Müll und Abfall, (October 1991), pp. 674-680 [in German]. 0027-2957)

1516 TA SIEDLUNGSABFALL - ZIELE UND INHALT (WASTE TECHNICAL MANAGEMENT; AIMS AND CONTENTS) [BIB-CEPI000187]

(Uhlmann, Bettina; Wunke, Joachim; Entsorgungs Praxis, (September 1991), pp. 444, 446-448, 451 [in German]. 0724-6870)

1517 AUFBEREITUNG UND VERWERTUNG VON RESTSTOFFEN AUS BRAUNKOHELEKRAFTWERKEN (PREPARATION AND UTILIZATION OF RESIDUAL SUBSTANCES FROM LIGNITE ELECTRICITY FACTORIES) [BIB-CEPI000188]

(Lehmkaemper, Otto; Bünte, Hermann P.; Duda, Antje; Rüdebusch-Thiemann, Burkhard; Entsorgungs Praxis, (September 1991), pp. 500, 502, 508, 510, 512, 514 [in German]. 0724-6870)

1518 BEHANDLUNG VON SONDERABFAELLEN (SPECIAL WASTE TREATMENT) [BIB-CEPI000189]

(Kneip, Michael; Entsorgungs Praxis, (February 1991), pp. 8, 9-13 [in German]. 0724-6870)

1519 EINSATZ BIOLOGISCHER VERFAHREN BEI DER BEHANDLUNG FLUSSIGER SONDERABFAELLE (BIOLOGICAL PROCEDURES IN SPECIAL LIQUID WASTE TREATMENT) [BIB-CEPI000190]

(Amoneit, Norbert; Entsorgungs Praxis, (April 1991), pp. 182-184, 186-187 [in German]. 0724-6870)

1520 ENTSORGUNG VON SONDERABFALL NEBEN DEM ANSCHLUSS- UND BENUTZUNGSZWANG AM BEISPIEL SAARLAND (SPECIAL WASTE CONTROL; JUNCTION AND EXPLOITATION: SAARLAND) [BIB-CEPI000191]

(Klett, Wolfgang; Bader, Wolfgang; Entsorgungs Praxis. (August 1991). pp. 392-395 [in German]. 0724-6870)

1521 VERFAHREN H₂O₂ + UV BEWAERT SICH FUR ABWAESSER EINES KOSMETIKA HERSTELLENDE BETRIEBES IN DER PRAXIS (H₂O₂ + UV METHOD, A PROVEN METHOD FOR TREATING THE EFFLUENTS OF A COSMETICS MANUFACTURER) [BIB-CEPI000192]

(Lange, H.-J.; Pfeiffer, W.; Korrespondenz Abwasser. (January 1994). pp. 62-67 [in German]. 0341-1540)

1522 ERARBEITUNG EINES KONZEPTS ZUR SANIERUNG DER ABWASSERVERHAELTNISSE DER LEUNA-WERKE AG (DEVISING A CONCEPT FOR THE REHABILITATION OF SEWAGE DISCHARGES BY LEUNA-WERKE AG) [BIB-CEPI000193]

(Stenger, O.; Lüdtke, T.; Lange, J.; Bauer, I.; Korrespondenz Abwasser. (January 1994). pp. 82-84, 87-88, 90, 92-93 [in German]. 0341-1540)

1523 AGUAS RESIDUALES DE LA INDUSTRIA DE LA IMPRENTA; REGLAS TECNICAS CON RESPECTO A LA GESTION DE AGUAS RESIDUALES Y DESECHOS, INSTRUCTIVO H 703 [BIB-CEPI000194]

Describe los procesos productivos en la industria de la imprenta, los fundamentos del proceso tecnologico industrial, asi como la generacion de desechos liquidos, sus componentes, reciclaje y el tratamiento requerido. Dentro de los procesos productivos incluye: impresion y reproduccion, impresion en alto relieve, impresion en bajo relieve, impresion superficial e impresion por penetracion (Asociacion Alemana de Saneamiento (DE); CAPRE (San José, CR); GTZ (Eschborn, DE); Asociacion Andina de Empresas e Instituciones de Servicio de Agua Potable y Alcantarillado (La Paz, BO). (1994). Appears in: *Aguas residuales de la industria de la imprenta: reglas tecnicas con respecto a la gestion de aguas residuales y desechos. instructivo H 703*. pp. 31 [in Spanish].)

1524 STABILIZATION/SOLIDIFICATION [BIB-CEPI000195]

(Anderson, William C.; Colombo, Peter; Barth, Edwin; Buelt, Jim; Bishop, Paul L.; Conner, Jesse R.; American Academy of Environmental Engineers (Annapolis, US); Innovative site remediation technology. (1994). Appears in: *Stabilization solidification*, 8 v., v.4, pp. 166 [in English].)

1525 ONSITE ENGINEERING REPORT FOR SOLIDIFICATION/STABILIZATION TREATMENT TESTING OF CONTAMINATED SOILS [BIB-CEPI000196]

(IT Environmental Programs, Inc. (Cincinnati, US); Environmental Protection Agency (Cincinnati, US); Office of Research and Development, Risk Reduction Engineering Laboratory; (1991). Appears in: *Onsite engineering report for solidification stabilization treatment testing of contaminated soils*, pp. 2 v., 433 [in English].)

1526 PROCESS PROFILE II [BIB-CEPI000197]

Describe una tecnologia que permite transformar residuos inorganicos en minerales de grado comercial, como: fibra de lana mineral, oxidos metalicos y aleaciones. El proceso permite producir siempre los productos antes indicados, los que pueden variar en cantidad dependiendo de la composicion de los residuos. Los residuos utilizados como materia prima incluyen el lodo de la industria galvanoplastica, cenizas de horno de arco electrico y desechos de aluminio (Titus, David; Chemical Engineering Environmental Engineering, (February 1994). pp. 29 [in English]. 0009-2460)

1527 TECHNOLOGIES FOR SOIL REMEDIATION [BIB-CEPI000198]

Describe nuevas tecnologias para la recuperacion de suelos contaminados por residuos peligrosos. Entre estas tecnicas, discute sobre la biorecuperacion, vitrificacion, fijacion quimica y el lavado de suelos, para el tratamiento de

residuos como los hidrocarburos polinucleares, bifenilos policlorados y otros contaminantes organicos complejos (McAdams, Cheryl L.; Waste age. (May 1993). pp. 37-44 [in English]. 0043-1001)

1528 COMPUTER APPLICATIONS IN THE HANDLING AND DISPOSAL OF HAZARDOUS MATERIALS [BIB-CEPI000199]

Explica como el uso de la tecnologia del computador en el manejo de los residuos peligrosos promete incrementar seguridad y eficiencia. Esta tecnologia incluye a la robótica. El uso de estos equipos permite apoyar en la minimizacion, identificacion y clasificacion de residuos peligrosos o toxicos (McAdams, Walter A.; McAdams, Cheryl L.; Waste age. (May 1993). pp. 47-48, 50, 52 [in English]. 0043-1001)

1529 HAZARDOUS WASTE SITE REMEDIATION SOURCE CONTROL [BIB-CEPI000200]

(Grasso, Domenic. (1993). Appears in: *Hazardous waste site remediation source control*, pp. 594 [in English].)

1530 LECHO FLUIDO Y SU APLICACION A LA INCINERACION DE RESIDUOS PELIGROSOS: 2A. PARTE [BIB-CEPI000201]

Explica la tecnologia del lecho fluido y revisa sus costos de mantenimiento. Describe las caracteristicas de algunas instalaciones en operacion en distintos estados (Mullen, J.F.; Agua Potable: Revista de Saneamiento Ambiental en México. (15 August 1994). pp. 31-35 [in Spanish].)

1531 CONCURSO PUBLICO DE LA SRNYAH PARA EL PROYECTO, CONSTRUCCION Y OPERACION DE PLANTAS DE TRATAMIENTO, DISPOSICION Y ELIMINACION DE RESIDUOS PELIGROSOS [BIB-CEPI000202]

Comenta los puntos sobresalientes de la documentacion del Concurso Publico Nacional e Internacional para la seleccion de empresas y proyectos de inversion para cuatro plantas de tratamiento y que fue dejado en suspenso por decision judicial, apelada por la SRNYAH. Describe los aspectos tecnicos del relleno de seguridad y explica los procedimientos de seleccion de los adjudicatarios (Argentina. Secretaria Nacional de Recursos Naturales y Ambiente Humano: Ingenieria Sanitaria y Ambiental (Buenos Aires). (September 1994). pp. 20-26 [in Spanish].)

1532 HAZARDOUS AND INDUSTRIAL WASTES; PROCEEDINGS OF THE TWENTY-FIFTH MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE [BIB-CEPI000203]

(Davis, Allen P.; Mid-Atlantic Industrial Waste Conference. 25, Maryland. 7-9 jul. 1993. (1993). Appears in: *Hazardous and industrial wastes: proceedings of the Twenty-Fifth Mid-Atlantic Industrial Waste Conference*, pp. 590 [in English].)

1533 PART 264 - STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES [BIB-CEPI000204]

(Environmental Protection Agency (Washington, D.C., US); (1993). Appears in: *Code of federal regulations, parts 260 to 299, revised as of July 1, 1993*, pp. 152-332 [in English].)

1534 PART 265 - INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES [BIB-CEPI000205]

(Environmental Protection Agency (Washington, D.C., US); (1993). Appears in: *Code of federal regulations, parts 260 to 299, revised as of July 1, 1993*, pp. 332-455 [in English].)

1535 SOLIDIFICATION/STABILIZATION PROCESS FOR STEEL FOUNDRY DUST USING CEMENT BASED BINDERS: INFLUENCE OF PROCESSING VARIABLES [BIB-CEPI000206]

(Andres, Ana; Ibrahim, J. Angel; Waste Management & Research Journal of International Solid Wastes and Public Cleansing Association. (October 1994). pp. 405-415 [in English]. 0734-242X)

1536 GUIDANCE MANUAL ON SAMPLING, ANALYSIS, AND DATA MANAGEMENT FOR CONTAMINATED SITES [BIB-CEPI000207]

(Canadian Council of Ministers of the Environment (Winnipeg, CA). (1993). Appears in: *Guidance manual on sampling, analysis, and data management for contaminated sites*, pp. 2 v., 250 [in English].)

1537 TREATMENT OF SPENT PICKLING ACIDS FROM HOT DIP GALVANIZING [BIB-CEPI000208]

(Kerney, Ulrich G.: Resources, conservation and recycling. (April 1994). pp. 145-151 [in English]. 0921-3449)

1538 HAZARDOUS WASTE TREATMENT AND DISPOSAL TECHNOLOGY; SUMMARY [BIB-CEPI000209]

(Cantanhede, Alvaro; Monge, Gladys: CEPIS (Lima, PE). Course on Environmental Risk Control, Lima, 6-10 jun. 1994, (1994). Appears in: *Hazardous waste treatment and disposal technology: summary*, pp. 25 [in English].)

1539 EVALUATION OF COMMERCIAL HAZARDOUS WASTE THERMAL DESTRUCTION CAPACITY [BIB-CEPI000210]

(Jensen, Andrea G.; Batterman, Stuart A.: Air & waste. (August 1994). pp. 995-1003 [in English]. 1047-3289)

1540 PROGRAMA DE MINIMIZACION DE RESIDUOS INDUSTRIALES; ESTUDIO EN LA INDUSTRIA DE GALVANOPLASTIA; ESTUDIO DE CASO DE UNA EMPRESA DE GALVANOPLASTIA EN LIMA - PERU [BIB-CEPI000211]

(Bedregal Morello, Carmela: CEPIS (Lima, PE). (1993). Appears in: *Programa de minimizacion de residuos industriales, estudio en la industria de galvanoplastia; estudio de caso de una empresa de galvanoplastia en Lima - Peru*, pp. 20 [in Spanish].)

1541 INCINERATION AT BAYOU BONFOUCA REMEDIATION PROJECT [BIB-CEPI000212]

(Acharya, Prakash; Ives, Peter. Air & waste. (October 1994). pp. 1195-1203 [in English]. 1047-3289)

1542 POLLUTION BALANCE: A NEW METHODOLOGY FOR MINIMIZING WASTE PRODUCTION IN MANUFACTURING PROCESSES [BIB-CEPI000213]

(Hilaly, Ahmad K.; Sikdar, Subhas K.: Air & waste. (November 1994). pp. 1303-1308 [in English]. 1047-3289)

1543 EXPECTED VALUE ESTIMATES OF THE LONG-TERM LIABILITY FROM LANDFILLING HAZARDOUS WASTE [BIB-CEPI000214]

(Aldrich, James R.: Air & waste. (June 1994). pp. 800-803 [in English]. 1047-3289)

1544 RECYCLING DECISIONS AND GREEN DESIGN [BIB-CEPI000215]

Revisa algunos factores y percepciones a partir del incremento de los residuos en los Estados Unidos y la decisión de adoptar el reciclaje como solución. Resalta la importancia y ventajas del reciclaje, la evolución de su legislación y los costos y beneficios que se pueden obtener. Comenta los impuestos sobre los residuos (Lave, Lester B.; Hendrickson, Chris; McMichael, Francis C.: Environmental Science & Technology. (January 1994). pp. 19A-24A [in English]. 0013-936X)

1545 RECOVERING METALS FROM WASTES [BIB-CEPI000216]

(Parkinson, Gerald; Moore, Stephen; Fouhy, Ken: Chemical engineering. (April 1994). pp. 30-31, 33 [in English]. 0009-2460)

1546 INCINERATORS AND CEMENT KILNS FACE OFF [BIB-CEPI000217]

(Kim, Irene: Chemical engineering. (April 1994). pp. 41, 43, 45 [in English]. 0009-2460)

1547 INCINERATION; TURNING UP THE HEAT ON HAZARDOUS WASTE [BIB-CEPI000218]

Revisa nuevos procesos térmicos que pueden manejar flujos más concentrados teniendo valores menores de calor, que son difíciles de tratar con las técnicas térmicas tradicionales. Además, esta nueva tecnología puede procesar una amplia variedad de residuos industriales (Fouhy, Ken; Ondrey, Gerald: Chemical engineering. (May 1994). pp. 39, 41, 43 [in English]. 0009-2460)

1548 SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION PROGRAM; TECHNOLOGY PROFILES [BIB-CEPI000219]

(Environmental Protection Agency (Washington, D.C., US). Office of Research and Development. (1994). Appears in: *Superfund innovative technology evaluation program: technology profiles*, pp. 499 [in English].)

1549 LOW WASTE TECHNOLOGIES IN SELECTED INDUSTRIES [BIB-JSTE000236]

The use of low and non-waste technology (LNWT) in industrial processes to control environmental pollution is considered. LNWT can yield economic benefits to the industries concerned, including raw material savings, greater self-sufficiency in water resources, lower waste handling and disposal costs, a reduction in waste treatment facilities, increased process efficiency and access to government support, in addition to the more obvious environmental benefits. LNWT measures are outlined and a detailed review given of the introduction of LNWT into a number of industries. Research, development and training activities related to LNWT are also described. The individual sections have been abstracted separately. (Vignesvaran, S.; Muttanara, Samorn; Sriandakumar, K.; Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). [in English]. 0:25-5088)

1550 DISTILLERY INDUSTRY WASTES [BIB-JSTE000237]

The origin and characteristics of distillery wastes are noted. Treatment processes for waste waters are: (a) anaerobic followed by aerated lagoon treatments, (b) anaerobic lagoon, then dilution and agricultural use, (c) methane recovery by anaerobic digestion, then activated sludge treatment (d) potash recovery, (e) concentration to 60% solids and disposal, (g) anaerobic contact filter or activated sludge, then aerobic treatment. Water re-use is not generally practical due to coloration which cannot be economically removed. The recovery of nutrient-rich animal feed products from distillery sludges is both practical and economical. (Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1551 ELECTROPLATING INDUSTRY [BIB-JSTE000238]

In electroplating different streams of waste arise from: (a) cleaning solutions, (b) spent alkaline and rinse waters, (c) acid pickling and rinse waters, (d) CN-containing waste waters, (e) chromate waste and (f) floor washing. Details are given of a low waste process for Zn and Cd investigated in Germany. The quantities of rinse water required are minimized by a triggered compressed air cascade dip-spray-rinse system so that they balance the electrolyte loss through evaporation and recycling and no rinse effluent is produced. Chromate solution is regenerated by ion exchange. FeSO₄ is precipitated continuously from pickling operations and other chemicals are regenerated and maintained automatically. (Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1552 TEXTILE INDUSTRY [BIB-JSTE000239]

The reduction of the waste load on water effluents at various stages of textile processing may be achieved by: (a) replacement of starch by substances with lower biological oxygen demand such as carboxy methyl cellulose for sizing, (b) removal of impurities and sizing compounds using enzymes, NaOH or acids and (c) recovery of NaOH used in mercerizing with a membrane process such as electrodialysis. A waste recycling and effluent production scheme introduced in a French factory has reduced variable operating costs by 22% and recovered initial investment costs within 3 years. A clean technology process for textile printing which is suitable for polyester materials is described. (Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1553 SELECTED FOOD INDUSTRIES [BIB-JSTE000240]

The application of LNWT to a number of food industries is described. In Thailand, pineapple processing residues are successfully converted into animal food protein by solid fermentation using filamentous fungi. In France, the recycling of liquid waste from the manufacture of yeast from molasses has improved yield and effluent quality. The use of cross flow ultrafiltration in the dairy industry to retain lactoserum from cheesemaking and in the subsequent conversion of lactose to lactic acid is described, together with cross flow microfiltration to remove contaminating microorganisms. Grease recovery in meat packing and the replacement of chemical by mechanical potatoes peeling procedures are also noted. (Asian Institute of Technology, Library and Regional

Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1554 PALM OIL REFINERY WASTE WATER TREATMENT [BIB-JSTE000241]

The extraction and purification of oil from palm fruit bunches is described. The main solid wastes - nuts, fibers and shells - are sold as kernels or used as boiler fuel. For waste waters, the commonly used anaerobic pond and tank digester systems usually fail to meet required effluent standards and secondary processes are required to reduce biochemical and chemical oxygen demands to acceptable levels. A pollution abatement study in Malaysia recommended water conservation, process modification and resource recovery and re-use measures to reduce pollution loads. (Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1555 TAPIOCA STARCH INDUSTRY [BIB-JSTE000242]

LNWT operations in the tapioca starch industry include the re-use of waste water from the initial washing process following sedimentation. By-product recovery processes include: (a) the production of yeast from tapioca starch waste water by inoculation and fermentation, (b) biogas production by anaerobic treatment of waste water in filter reactors and (c) ethanol production by hydrolysis, fermentation and distillation of waste water. The methods discussed are not yet widely adopted in the industry. (Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1556 PULP AND PAPER MILL INDUSTRY [BIB-JSTE000243]

The sources and characteristics of waste in the pulp and paper industry are considered and details given of the introduction of water re-use and recycling schemes to mills in Germany, Thailand and France. The recovery of by-products is discussed including the use of filtration to recover fibers, ultrafiltration for high molecular weight lignosulphonates, evaporation to recover organic chemicals and incineration to utilize the heating value of residual wood substances. Pollution reduction by process chemical substitution, using H₂O₂, O₃ or NO₂ for bleaching in place of Cl and Cl compounds is described. (Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1557 SELECTED UNIT OPERATION IN LOW AND NON-WASTE TECHNOLOGY [BIB-JSTE000244]

A number of operations used in LNWT are described and basic design and operating parameters given. These include suspended solids removal from water by: (a) sedimentation, (b) flocculation, (c) filtration and (d) flotation. The removal of dissolved materials by (a) adsorption, (b) ion exchange and (c) membrane processes including reverse osmosis, electrodialysis and ultrafiltration are also considered. Information given includes through flow rates, efficiency and suitability for different industrial processes. (Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1558 METHODS TO ACHIEVE LOW WASTE TECHNOLOGY [BIB-JSTE000245]

The adoption of LNWT in a number of industries has helped to reduce hazardous waste problems, recover useful by-products and reduce the overall waste load. Methods adopted include: (a) by-product recovery, (b) process chemical and raw material recycling, (c) changing production processes to reduce waste and (d) equipment modification. Waste management techniques introduced include: (a) waste classification, (b) water conservation, (c) waste segregation and (d) prevention of spillages and good housekeeping practice. In some cases raw and process materials have been replaced and water management regimes introduced. (Asian Institute of Technology, Library and Regional Documentation Centre; Publisher: AIT, (1989). Appears in: *Low Waste Technologies in Selected Industries*. [in English].)

1559 JEWELLERY PLATER--ISIC CODE: 3911 [CST-UNEP000164]

SUMMARY: The company replaced its chlorofluorocarbon degreaser with ISC-108, an alkali cleaning compound, and eliminated the use of 360 gpy of CFC's. The company improved its recovery of gold through the use of dragout tanks, conductivity meters, timed rinsewater flows and countercurrent rinsing. These process changes have reduced the quantity of waste produced and improved cleaning operations.

MATERIALS BALANCE:

waste type—Electroplating rinsewaters, plating baths, plating rinsewaters, precious metals

medium—Water

waste reduction by—Metals recovery

ECONOMICS:

direct cost—\$1,936 year

feedstock reduction—\$15,000 year

impact—Eliminated the use of chlorofluorocarbon degreasers, 56% reduction in wastewater production.

(CONTACT: Massachusetts Department of Environmental Management, Office of Safe Waste Management, 100 Cambridge Street, Boston, MA, USA)

1560 JEWELLERY PLATER--ISIC CODE: 3911 [CST-UNEP000165]

SUMMARY: The Robbins Company is a jewellery plating and manufacturing company. When upgrading its wastewater treatment system Robbins designed it as a closed loop system. The wastewater recovery system depends on filters, ion exchange resins and electrolytic recovery to purify its wastewater. All filters, resins and cathodes from the electrolytic recovery are sent to a refiner for reclamation of both base and precious metals. There are no wastes lost from the process.

MATERIALS BALANCE:

waste type—Electroplating wastewater

medium—Water

waste reduction by—Substitute less toxic raw material

waste production—36 tons year metal hydroxide sludge eliminated (\$23,000 year)

ECONOMICS:

capital cost—\$220,000

feedstock reduction—\$45,000 year

impact—Reduced sludge disposal volume, reduced wastewater production and recovered reusable metals.

(CONTACT: Robbins Company, Attleboro, MA, U.S.A. c/o Paul Clark)

1561 SEMICONDUCTOR WAFER MANUFACTURE--ISIC CODE: 3674 [CST-UNEP000166]

SUMMARY: The company utilizes automated photoresist dispense systems in its operation. The automated dispense system is designed and sold by Tritac Industries in Mountain View, California. It is reported that the system provides maximum usage of photoresist from the supply bottles, continuous uninterrupted operation with minimal operator assistance, and point of use filtration resulting in higher wafer yields. The dispense system does not require any modification or adjustments to the existing dispense systems on spinner tracks.

MATERIALS BALANCE:

waste type—Residual photoresist

medium—Supply bottles

waste reduction by—Surface finishing, cleaning, and coating

waste production—50% reduction in photoresist waste

feedstock reduction—Based on an 18% annual reduction in photoresist waste, \$6,750 year per unit.

ECONOMICS:

capital cost—\$3,750 unit (1985 dollars)

months to recover—7

impact—Reduces need for virgin photoresist by utilizing higher percentage of photoresist in supply bottles. Reduces waste photoresist incineration/landfilling requirements

(CONTACT: Semiconductor Industry Association (SIA), Steven Pedersen, Director, Environmental and OSHA Affairs, SIA, 10201 Torre Avenue, Suite 275, Cupertino, CA 95014, United States)

1562 METAL RADIATOR MANUFACTURE--ISIC CODE: 3714 [CST-UNEP000167]

SUMMARY: The company utilizes ion exchange and electrolysis for recovery of copper. In the bright dipping process, considerable copper and zinc are etched from the parts being processed and as a result copper sulfate crystals accumulate in the tanks. To eliminate the formation of the crystals, Modine installed an ion exchange column and a plating cell to the system. The hydrogen peroxide sulfuric acid bright dip solution is continuously recirculated through the ion exchange column. The column selectively removes the copper and returns the purified dip solution to the bath. Once the ion exchange column becomes saturated with copper, it is regenerated and the copper ions are fed into an electroplating cell where copper is plated out and recovered as number 1 copper scrap.

MATERIALS BALANCE:

waste type—Copper sulfate from bright dipping

medium—Hydrogen peroxide sulfuric acid bright dip

waste reduction by—Metals recovery

ECONOMICS:

capital cost—\$27,000

feedstock reduction—\$22,000 year

months to recover—14

impact—Eliminated the generation of hazardous bright dip residues and recover copper for reuse.

(CONTACT: Modine Manufacturing, Trenton, MO, James Egide, Tel: 1-414-636-1200)

1563 JEWELLERY PLATER--ISIC CODE: 3911 [CST-UNEP000168]

SUMMARY: The company installed a closed loop plating system. In addition, the company now filters its plating waters, removes the metals, and then recovers them for refining via ion exchange and electrolytic recovery. This system has resulted in a 50% decrease in the amount of trichloroethane used and disposed. In addition, the company reduced its wastewater production by 95%.

MATERIALS BALANCE:

waste type—Electroplating rinsewaters, plating baths, rinsewaters

medium—Water

waste reduction by—Metals recovery

waste production—50% reduction in TCE use waste

feedstock reduction—95% reduction in process water use (\$20,000 year)

impact—Reduces virgin solvent requirements and reduces volume of disposed waste.

(CONTACT: Massachusetts Department of Environmental Management, Office of Safe Waste Management, 100 Cambridge Street, Boston, MA, United States)

1564 MANUFACTURE OF SOLVENTS AND CHEMICAL ADDITIVES--ISIC CODE: 2869 [CST-UNEP000169]

SUMMARY: The company installed floating roof over its tanks of volatile solvents which reduced evaporative loss of solvent. In addition, they added conservation vents on the plants large solvent tank which reduced organic air emissions from the tanks by between 30% and 75%.

MATERIALS BALANCE:

waste type—Volatile solvents

medium—Solvents

waste reduction by—Improved housekeeping

waste production—1.5 million lb year loss prevented

ECONOMICS:

capital cost—\$5,000-\$13,000 tank (1983 dollars)

feedstock reduction—\$150,000 (based on 16 tanks)

months to recover—Less than 12

impact—Conserves solvents, reduces air pollution by solvents

(CONTACT: Exxon Chemical America, Linden, NJ, United States, Tel: 1 (201) 474-0100)

1565 NYLON YARN PRODUCTION AND RESEARCH FACILITY--ISIC CODE: 2824 [CST-UNEP000170]

SUMMARY: American Enka purchased a used distillation unit and modified it to redistill its isopropyl alcohol. The in-house distillation unit recovered 90%

of the isopropyl alcohol. Enka also reuses the still bottoms as an asphalt emulsifier in another product line.

MATERIALS BALANCE:

waste type—Spent isopropyl alcohol, distillation residue

medium—Isopropyl alcohol

waste reduction by—Improved housekeeping

waste production—10,000 gal year reduction

ECONOMICS:

capital cost—\$7,500

feedstock reduction—\$90,000 year

operation/maintenance—\$5,600 year

months to recover—1

impact—Reduces virgin solvent requirements and reduces off-site liabilities.

(CONTACT: American Enka Company, Enka, NC, c/o John Ray, United States, Tel: 1 (704) 667-7351)

1566 MANUFACTURE OF PHENOL, ANILINE, AND RELATED PRODUCTS—ISIC CODE: 2869 [CST-UNEP000171]

SUMMARY: USS Chemicals manufactures phenol from cumene and then uses the phenol to manufacture other organic chemicals. USS has installed resin adsorption systems to control cumene emissions from the phenol manufacturing reducing cumene emissions by 80% and saving 715,000 lbs cumene year. In addition, they have also installed a surplus condenser on the open cumene vents to recover the cumene vapor and return the condensed cumene directly back to the process. They also added floating roofs to the tanks containing volatile chemicals to reduce air emissions.

MATERIALS BALANCE:

waste type—Organic chemical emissions—cumene

medium—Organic chemicals

waste reduction by—Extended use of raw material

waste production—1,115,000 lb year cumene

ECONOMICS:

feedstock reduction—\$275,000 year

months to recover—2

impact—Reduce virgin cumene requirements and reduces cumene emissions.

(CONTACT: USS Chemicals, Haverhill, OH, Tel: (614)532-3420)

1567 DEFLUORINATED PHOSPHATE MANUFACTURE—ISIC CODE: 2879 [CST-UNEP000172]

SUMMARY: This facility uses a closed loop process water recycling system to reduce its waste. Texasgulf produces phosphate animal feed supplement by combining phosphate ore, soda ash, and phosphoric acid in a kiln mixer. The process produces a kiln scrubber sump water with a flow rate of 1725 gpm at 108 F. Lime is added at a rate of two tons per hour to precipitate the fluorides as calcium fluoride. These filtered dewatered wastes are disposed in a landfill as a solid. The clean process water is recycled back to the venturi scrubbers for reuse.

MATERIALS BALANCE:

waste type—Calcium fluoride, wastewater—inorganic fluorides

medium—Water

waste reduction by—Improved operating practices

waste production—Reduced 280,000 gallons per day (\$930,000 year reduction)

ECONOMICS:

months to recover—12

impact—Reduces water usage, wastewater not discharged to the environment.

(CONTACT: Texasgulf, Saltville, VA, United States)

1568 FABRICATION OF PIPE FITTINGS—ISIC CODE: 3471 [CST-UNEP000173]

SUMMARY: Elkhart Products, Inc. fabricates pipe fittings. Elkhart replaced its cyanide dip and chromic acid bright dip passivation with a process that utilizes sulfuric acid and stabilized hydrogen peroxide. The company also installed counter-current rinses. The final rinsewater is regenerated and reused after precipitating the copper as cuprous oxide or copper hydroxide. The bright pickle dip is also regenerated by transferring the saturated fluid to a reservoir where the copper sulfate is precipitated and removed by a cyclonic separator. The copper sulfate crystals, cuprous oxide, and copper hydroxide wastes are introduced into an electrolytic cell, redissolved, and plated out as number 1 copper scrap at a rate of 1000-1500 pounds per month. Total annual cost savings of

\$120,000 are realized by the facility. For more information see "Company Approaches Zero Pollution Discharge," by B. Motzweiler and P. Viet, Plating and Surface Finishing, December 1979.

MATERIALS BALANCE:

waste type—Pickle liquor wastewater

medium—Pickle liquor

waste reduction by—Substitute less toxic raw material; improved operating practices

waste production—182,000 gal. year reduction (\$18,200 year)

ECONOMICS:

feedstock reduction—\$1,770 year

capital cost—\$60,000

months to recover—6

impact—Reduces waste disposal volume and recycles elemental metal.

(CONTACT: Elkhart Products Division, Inc., Elkhart, IN, c/o Lancy International, William McLay, United States, Tel: 1 (412) 452-9360)

1569 MICROELECTRONICS—ISIC CODE: 3670 [CST-UNEP000174]

SUMMARY: Copper sheet metal in the manufacture of flexible electronic circuits must be clean. The sheets were formerly sprayed with ammonium persulfate, phosphoric acid, and sulfuric acid. 3M replaced this cleaning process with a specially designed mechanical device that uses rotating brushes and pumice as an abrasive to clean the copper sheet metal.

MATERIALS BALANCE:

waste reduction by—Substitute less toxic raw material, new technology

waste production—40,000 lb year

ECONOMICS:

capital cost—\$59,000

months to recover—36

direct cost—\$15,000 year

impact—Reduced volume of disposed waste and eliminate hazardous waste management costs.

(CONTACT: Minnesota Mining and Manufacturing (3M), Columbia, MO, United States, c/o Mike Koenigsberger, Tel: 1 (612) 778-4523)

1570 ELECTRONIC TELEPHONE SWITCHING EQUIPMENT—ISIC CODE: 3661 [CST-UNEP000175]

SUMMARY: GTE recovers copper through the use of an electrolytic recovery cell. The cell is part of a closed loop system that follows the etching operation on an electroless copper plating line. The copperless rinsewater is recirculated to the rinse tank. The recovered copper is periodically removed from the cells cathode and is sold as number 1 scrap. For more information see "Case History: Wastewater Treatment", PC FAB, May, 1984.

MATERIALS BALANCE:

waste type—Electroplating wastewater, copper etching rinse stream

medium—Water

waste reduction by—Metals recovery

feedstock reduction—3,900 lb-yr copper (\$2,000)

waste production—CuOH sludge reduced by 2,860 lb/year (\$4,000)

ECONOMICS:

impact—Reduce waste disposal volume, reduce water usage, and recover copper for reuse.

(CONTACT: GTE Sylvania, Chicago, IL, United States, Lancy International, c/o William McLay, Tel: 1 (412) 452-9360)

1571 METAL RADIATOR MANUFACTURE—ISIC CODE: 3714 [CST-UNEP000176]

SUMMARY: The company utilizes ion exchange and electrolysis for recovery of copper. In the bright dipping process, considerable copper and zinc are etched from the parts being processed and as a result copper sulfate crystals accumulate in the tanks. To eliminate the formation of the crystals, Modine installed an ion exchange column and a plating cell to the system. The hydrogen peroxide sulfuric acid bright dip solution is continuously recirculated through the ion exchange column. The column selectively removes the copper and returns the purified dip solution to the bath. Once the ion exchange column becomes saturated with copper, it is regenerated and the copper ions are fed into an electroplating cell where copper is plated out and recovered as number 1 copper scrap

MATERIALS BALANCE:

waste type—Copper sulfate from bright dipping
medium—Hydrogen peroxide sulfuric acid bright dip
waste reduction by—Metals recovery
waste production—Eliminated hazardous waste generation

ECONOMICS:

capital cost—\$27,000
feedstock reduction—\$22,000 year
months to recover—14
impact—Eliminated the generation of the hazardous bright dip residues and recover copper for reuse.
 (CONTACT: Modine Manufacturing, Trenton, MO, United States, c/o James Egide, Tel: 1 (414)-636-1200)

1572 MANUFACTURE OF LOGIC, MEMORY AND SEMI-CONDUCTOR DEVICES--ISIC CODE: 3674 [CST-UNEP000177]

SUMMARY: This plant uses solvent distillation fractionation to recover resist developers. The plant runs two flash evaporators each with a capacity to recover 600 gallons of 1,1,1-trichloroethane per hour. The flash chambers operate at a vacuum of 20 in. Hg and 100-110 F. A packed distillation column is used to recover pure freon from a waste stream containing 90% freon and 10% methyl chloroform. The waste is fed into the column and the freon is condensed and recovered at a rate of 33 gal/hour. 1,1,1-trichloroethane condenses on the column packing and falls to the reboiler. Two box stills are used at the facility which recover 475 gph each of methylene chloride. The units consist of an 800 gal still pot with hot water heating coils. The contaminated methylene chloride is heated to 103-108 °F and clean solvent is condensed overhead.

MATERIALS BALANCE:

waste type—Still bottoms—1,1,1-Trichloroethane resist developer, freon resist developer, methylene chloride
medium—Halogenated solvents
waste reduction by—Solvent recovery
waste production—6,152,000 gal/year decrease
feedstock reduction—3,490,000 gal year methyl chloroform, 152,400 gal year freon (greater than 95% total reduction)

ECONOMICS:

capital cost—\$709,400
operation/maintenance—\$177,600
direct cost—\$16,000,000 year
impact—Reduces amount of disposed spent solvents and reduces virgin solvent requirements.
 (CONTACT: U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio 45268, United States, c/o Dr Harry Freeman)

1573 MOBILE COMMUNICATIONS EQUIPMENT COMPONENTS--ISIC CODE: 3661 [CST-UNEP000178]

SUMMARY: This facility uses two-stage distillation to recover solvents. Printed circuit boards are produced using the subtractive technique and solvent-based photoresists. Methylene chloride resist stripper and TCE developer are continuously recycled in closed-loop stills. The TCE developer wastes are recovered in a Dupont Riston SRS-120 solvent recovery still which operates at atmospheric pressure and 165 F with product returned to the developer line. The facility uses a Recyclene RX-35 solvent recovery system to further recover the TCE from the SRS-120 unit still bottoms. The RX-35 is a batch distillation system with a 30 gallon capacity with a cycle time of approximately 90 minutes. Purity of recovered solvent was 99.99%. The still bottoms contained 7.5 weight% TCE.

MATERIALS BALANCE:

waste type—Resist developer still bottoms—1,1,1-trichloroethane (TCE) resist developer still bottoms
medium—1,1,1-trichloroethylene
waste reduction by—Solvent recovery
waste production—97.5% volume reduction
feedstock reduction—99.8% solvent recovery

ECONOMICS:

capital cost—\$26,150
months to recover—7.3
direct cost—\$43,105
impact—Reduces disposal volume of solvents and reduces virgin solvent requirements.
 (CONTACT: U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio 45268, United States, c/o Harry Freeman)

1574 MANUFACTURE OF PRINTED CIRCUIT BOARDS--ISIC CODE: 3674 [CST-UNEP000179]

SUMMARY: The company electrolytically recovers metals from its rinsewaters. The company converted the primary rinse tank into a static dragout tank and installed the electrolytic recovery units. The units are simple and compact and consist of a wastewater sump, a pump, and the anode and cathode, contained in a rectangular box with dimensions of 22 in. x 10 in. x 22 in. The units are operated at constant voltage and the amperage will vary according to the conductivity of the solution. The cathode material was stainless steel and the anode columbium or titanium. The unit has a maximum flowrate of 16.3 gpm. Currently the facility uses four such units on the copper line and three units on the solder (tin/lead) line. Recovery has averaged approximately 10 pounds of copper per week and five pounds of lead per week.

MATERIALS BALANCE:

waste type—Wastewaters from electroplating and etching processes
medium—Water
waste reduction by—Metals recovery
waste production—32 tons/year reduction

ECONOMICS:

capital cost—\$30,350
operation/maintenance—\$12,333 year
direct cost—At current disposal costs it is more expensive but may become feasible in the future.
impact—Reduces volume of metal sludge and recovers metals for reuse.
 (CONTACT: U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio 45268, United States, c/o Harry Freeman)

1575 PAINT STRIPPING FACILITY--ISIC CODE: 3700 [CST-UNEP000180]

SUMMARY: A tank part paint stripping facility using methylene chloride solvent formulations to enhance solvent action generates approximately 20,000 gallons per year of spent methylene chloride and 3,300 gallons per year of paint sludge. The audit suggests that using continuous centrifugation of paint stripping solvent to remove paint sludge as it is generated will prevent buildup of this sludge in the stripping tanks and significantly extend the life of the solvent. Solvent life could be extended up to one year. Each stripping tank would be equipped with a pump and a solid bowl type centrifuge. The units operate at approximately 5 gpm.

MATERIALS BALANCE:

waste type—Methylene chloride-based paint stripping solvent, paint sludges, wastewaters from rinsed stripped parts:
 F002 - Spent halogenated solvents including methylene chloride
 F004 - Spent halogenated solvents including cresols and cresylic acid
medium—Solvents, water
waste reduction by—Extended use of raw material
waste production—50% reduction
feedstock reduction—Solvent replaced only once per year

ECONOMICS:

capital cost—\$50,000 for six units
operation/maintenance—\$5,000 year
months to recover—6
impact—Reduces waste disposal volume by 50%, reduces virgin solvent requirements.
 (CONTACT: U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio 45268, United States, c/o Harry Freeman)

1576 PAINT STRIPPING FACILITY—ISIC CODE: 3700 [CST-UNEP000181] (see previous record)**1577 AVIATION, INDUSTRIAL, AND SEAPORT SUPPORT COMPLEX—ISIC CODE: 4582 [CST-UNEP000182]**

SUMMARY: The waste audit investigated the feasible options for reducing the volume of solvent used and disposed. There are over 100 solvent end use points on the base. Four of ten stations were audited in detail since these stations represented a fair cross section of the activities that occur. For the four stations, a total of 36 source reduction options were considered. Several options were investigated in further detail these included: use of closed tanks and increasing the cleaning efficiency by increasing the degree of agitation; increasing cleaning efficiency by employing a two-step counter-current cleaning sequence; reclaiming solvent from spent 1,1,1-TCE by using the degreaser as a still; and continuous filtering of stripper solutions.

MATERIALS BALANCE:

waste type— Spent solvents from degreasing parts and paint stripping.

medium— Solvents

waste reduction by— Improved operating practices

waste production—50-75% reduction

feedstock reduction—33-64%

ECONOMICS:

capital cost— \$600-\$6,820

months to recover—7-97

direct cost—\$220-\$2,770 year

impact—The option presented will reduce the virgin solvent requirements and reduce the volume of disposed spent solvents.

(CONTACT: U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory, Cincinnati, Ohio 45268, United States, c/o Harry Freeman)

1578 SEMICONDUCTOR WAFER MANUFACTURE—ISIC CODE: 3674 [CST-UNEP000183]

SUMMARY: The facility reclaims its waste oil through on site distillation filtration. The on site vacuum pump oil reclamation system is designed and sold by the Hilco Division of Hilliard Corporation and can reclaim 90% of the waste oil for reuse. The system draws oil by vacuum from a waste oil tank through a prefilter, an adjustable flow control valve, and an electric heater into a vaporizer. The vaporizer is a packed column in which the oil under vacuum is spread into a thin film and the moisture and dissolved gases are drawn off in the form of vapor. The vapor is condensed and collected for disposal. The purified oil is pumped through a polishing filter and collected for reuse.

MATERIALS BALANCE:

waste type— Spent vacuum pump oil contaminants

medium— Vacuum pump oil

waste reduction by— Recover product from waste

waste production—90% waste oil recovery for reuse

ECONOMICS:

capital cost— \$20,500

months to recover—13

impact—Reduces virgin oil requirements and reduces waste oil disposal volume.

(CONTACT: Semiconductor Industry Association (SIA), Steven Pedersen, Director, Environmental and OSHA Affairs, SIA, 10201 Torre Avenue, Suite 275, Cupertino, CA 95014, United States)

1579 PHARMACEUTICALS—ISIC CODE: 2834 [CST-UNEP000184]

SUMMARY: Riker Laboratories coated medicine tablets using several organic solvents as carriers. A water-based solvent was developed to replace the organic solvent and different spray application equipment was installed to handle the new solvents. These changes eliminated organic solvent losses to the atmosphere.

MATERIALS BALANCE:

waste type— Spent organic solvents

medium— Solvents

waste reduction by— Substitute less toxic raw material

waste production— 24 tons/year reduction in air pollution

ECONOMICS:

feedstock reduction— \$15,000 in solvent costs

months to recover— Less than 12

impact—Eliminates solvent evaporation to the atmosphere.

(CONTACT: Riker Laboratories, Minnesota Mining and Manufacturing (3M), Northridge, CA, United States, c/o Mike Koenigsberger, Tel: 1 (612) 778-4523)

1580 FARM AND CONSTRUCTION EQUIPMENT MANUFACTURE—ISIC CODE: 35203530 [CST-UNEP000185]

SUMMARY: The Company first developed a Hazardous Waste Task Force. Deere also constructed a liquid waste treatment facility, which treats concentrated heavy metal wastes, reclaims oil from 15-60% oil water mixtures, and produces a sludge that is not toxic by the RCRA extraction procedure. The facility can treat over 2 million gallons/year of the following types of hazardous wastes: electroplating sludges, spent electroplating baths, painting wastes, caustic paint stripping wastes, kerosene sludge from casting cleaning, and miscellaneous acid and alkaline wastes. Also, 1,380,000 gallons/year of waste oils and oil water mixtures can be treated such that oil is reclaimed for sale to an oil recycling firm or reused for machining processes. Deere and Company currently has a patent pending on the process and is willing to license its use to other industries.

MATERIALS BALANCE:

waste type— Oil, heavy metals, paint stripper, acids, and bases

medium— Oil water mixture

waste reduction by— Recover product from waste

waste production—Due to reduction of 330,000 gal/year hazardous waste (\$230,000/year savings)

feedstock reduction—Savings due to reuse of oil

ECONOMICS:

capital cost— \$1,900,000

months to recover—30

direct cost—\$155,750

impact—Reduced hazardous waste—process reduces threat to air and groundwater quality, conserves metal, energy and water resources, improves health and safety conditions for plant personnel, and minimizes waste management costs.

(CONTACT: Deere and Company, c/o Mike McGure, Moline, Illinois, United States, Tel: 1 309 752-5435)

1581 PHOTOGRAPHIC PROCESSING—ISIC CODE: 7384 [CST-UNEP000186]

SUMMARY: The process utilizes an electrolytic recovery system (rotating electrode system) that recovers silver from color negative film fixer. An ion exchange system consisting of a sand filter, resin column and two ion exchange columns is used to remove bromide from color developer solution. Reblending is used to correct concentration of bleach solutions. PCA has undertaken a number of projects to recover or recycle their process waste. Projects including silver recovery and process solution regeneration are discussed below.

An electrolytic recovery unit recovers silver from color negative film fixer solutions and paper fixer solutions. A rotating electrode system recovers 2200 troy ounces per week of 96% pure silver. The de-silvered solutions are aerated, returned to full strength, and pumped back to the processing tanks, resulting in a 96% reuse of the fixer solution.

Color developer is regenerated using an ion exchange system. This system removes bromide contamination from the solution and consists of a sand filter, resin column, and two ion exchange columns. Once treated the developer is readjusted to the required concentration and returned to the process tanks, resulting in an 84% recovery of the color developer solution.

Spent bleach solutions are recovered by readjusting the spent baths to the proper chemical concentrations. Once attained, 90% of the bleach solution can be reused.

PCA saves over \$1.1 million each year by recovering and reusing their developer, fixer and bleach solutions. Silver recovery adds another \$800,000 to these savings, depending on the current price of silver.

MATERIALS BALANCE:

waste type— Silver, color developer, spent bleach solutions, color negative film fixer (silver containing)

medium— Liquid

waste reduction by— Metal recovery

waste production—Recovered 115,000 troy ounces silver, eliminated 1,700 gpd color developing waste, 19 gpd spent fixer waste, 1,200 gpd spent bleach waste (savings \$800,000 year).

ECONOMICS:

capital cost—\$120,000

feedstock reduction—\$1.1 million year

months to recover—1.2

impact—By recovering and reusing developer, fixer, bleach, and silver solutions, feedstock costs are reduced and disposal costs are limited.

(CONTACT: North Carolina Department of Natural Resources, P.O. Box 27687, Raleigh, North Carolina 27611-7687, United States)

1582 CHEMICAL COMPANY—ISIC CODE: CST-UNEP000187]

SUMMARY: ICI Americas Inc.'s research and development laboratory used a management approach to reduce the quantity of waste generated. An Environmental Compliance Committee was formed to develop and implement procedures to minimize the production of waste materials. New waste handling practices have been developed to increase the quantity of waste that can be recovered. Some of these practices include: segregating spent chlorinated and non-chlorinated solvents to allow for off-site recovery; segregating hazardous from non-hazardous waste; and returning unused agricultural research chemicals for reuse or reformulation. Since the program was implemented, the quantity of hazardous waste generated has been reduced by 70% even though the research activities have doubled. This reduction saves the company \$37,000 per year in waste management costs.

MATERIALS BALANCE:

waste type—Various spent chlorinated and non-chlorinated solvents and research chemicals.

medium—Solvent

waste reduction by—Improved operating practices

waste production—70% reduction in waste volume

feedstock reduction—Slight

ECONOMICS:

direct cost—\$37,000 yr

(CONTACT: North Carolina Department of Natural Resources, P.O. Box 27687, Raleigh, North Carolina 27611-7687, United States)

1583 ELECTRONIC COMPONENTS—ISIC CODE: 3674 [CST-UNEP000188]

SUMMARY: Faced with the rising costs of virgin chemicals and waste disposal, IBM implemented a program to recycle their wastes. Two major waste solvent streams were determined suitable for recycling. These were the spent Alpha Reliasolve used to deflux electronic boards, and Freon isopropyl circuit cleaner used in the vapor degreasing of circuit boards. By recycling these two solvents, IBM reduced the amount of wastes requiring disposal by 95%. Since 1980 over 1.5 million pounds have been recycled.

Recycling Alpha Reliasolve and Freon isopropyl circuit cleaner saved IBM over \$1.6 million in virgin chemical costs over the last 4 years. In 1984 the cost savings were about \$500,000. Additional savings are the result of the reduction in waste management costs.

MATERIALS BALANCE:

waste type—Alpha Reliasolve, Freon isopropyl circuit cleaner

medium—Liquid and air

waste reduction by—Solvent recovery

feedstock reduction—\$1.6 million/4 years (solvents)

ECONOMICS:

direct cost—(1984) \$500,000 year

impact—By recycling two waste streams, the amount of wastes requiring disposal was reduced by 95%. From 1980 through 1985 over 1.5 million pounds were recycled. Raw materials and waste management costs are reduced.

(CONTACT: North Carolina Department of Natural Resources and Community Development, P.O. Box 27687, Raleigh, North Carolina 27611-7687, United States, Tel: 1 (919) 733-7015)

1584 HOME APPLIANCES—ISIC CODE: 3634 [CST-UNEP000189]

SUMMARY: Scovill reduced the quantity of waste generated and the amount of raw materials it purchases. The quantity of 1,1,1 trichloroethane used for degreasing was reduced by substituting a water soluble synthetic cleaner for the

solvent in many of the degreasing operations. The 1,1,1 trichloroethane that is recovered off-site is reused at the facility. To further reduce operating costs and waste generation, Scovill has instituted an employee-incentive cost-saving program. Teams of employees are formed to make recommendations and the team responsible for the greatest annual cost savings receives a bonus check.

The use of water-soluble synthetic cleaner resulted in an annual cost savings of \$12,000 in reduced raw material costs. Recycling and reusing 1,1,1 trichloroethane degreasing solvent reduced raw material costs by 34% and provided an annual savings of over \$5,000. Additionally, waste disposal costs have been reduced by over \$3,000 per year.

MATERIALS BALANCE:

waste type—Spent water soluble cleaner solvent, 1,1,1 trichloroethylene

medium—Liquid

waste reduction by—Substitute less toxic raw material

waste production—38,000 lb year reduction in waste (\$3,040 year saved)

ECONOMICS:

capital cost—\$3,250

feedstock reduction—\$17,320 year

operation/maintenance—\$100 year (1986 dollars)

impact—After substituting a water-based synthetic cleaner for a solvent-based one, introducing solvent recycling, and initiating an employee incentive cost saving program, the volume of hazardous waste generated was reduced as were raw materials costs and waste disposal costs.

(CONTACT: North Carolina Department of Natural Resources and Community Development, P.O. Box 27687, Raleigh, North Carolina 27611-7687, United States, Tel: 1 (919) 733-7015)

1585 MEAT PROCESSING—ISIC CODE: 2011 [CST-UNEP000190]

SUMMARY: Several efficiency and process modifications were recommended. Modifications for water use include better control of water usage, product losses, and waste load by supervisors; utilizing an education program for management and employees; installing and using valves on all hoses; recording water use and waste characteristics; and recommending waste load mass limitations to the city. Process changes to reduce waste load include using a dry clean-up of the animal holding pens prior to washdown; improving the paunch handling operation; and installing a blood drain system with piping and a heavy duty pump connected to a collection tank.

MATERIALS BALANCE:

waste type—Beef cattle—blood, flesh particles, soluble protein losses and waste materials; wastes are high in 5-day BOD₅, TSS, and floatable oil and grease.

waste reduction by—Improved operating practices; improved good housekeeping

waste production—reduced 80% (60,000 lbs of BOD₅ year) water use reduction of 25% (1,000,000 gallons year)

ECONOMICS:

capital cost—less than \$10,000

direct cost—\$1,500 year

impact—Water use and wastes are reduced.

(CONTACT: Pollution Prevention Program, North Carolina Department of Natural Resources and Community Development, P.O. Box 27687, Raleigh, North Carolina 27611-7687, United States)

1586 SOLVENT RECOVERY FROM SURFACE FINISHING, CLEANING, AND COATING—ISIC CODE: CST-UNEP000191]

SUMMARY: Elementary distillation using a single column recycling still. A single column recycling still is used to recover xylene that is contaminated with paraffin and human tissues. The still recycles approximately 1,500 gallons of xylene per year. The still bottoms are considered a hazardous waste and must be disposed accordingly. Bottoms production, however, is only at a rate of 10 lbs per year.

MATERIALS BALANCE:

waste type—Contaminated xylene—still bottoms (10 pounds/year)

waste reduction by—Solvent recovery

waste production—Still recycles approximately 1,500 gallons of xylene per year

ECONOMICS:

capital cost—\$3,000

months to recover—18

impact—Xylene disposal was eliminated at the William Beaumont Army Medical Center.

(CONTACT: United States Army Environmental Management Office, Directorate of Engineering and Housing, Fort Bliss, Texas, United States)

1587 COMPUTER MANUFACTURING—ISIC CODE: 3674 [CST-UNEP000192]

SUMMARY: NCR Corporation implemented a waste minimization program employing source reduction and recycling. Company efforts have enabled wastewater to be discharged into sewer system by installing a silver recovery system. Furthermore, the company is using a modernized In-Line Circuit Board Defluxer, a modern vapor degreaser with filter system, and a modern automatic wave solder machine. Waste has been reduced by 200 gallons/month, and monthly savings run to \$900.

MATERIALS BALANCE:

waste type—Photographic laboratory waste containing silver, circuit board defluxer waste containing freon, solvent vapor degreaser waste containing freon, automatic wave solder machine waste containing flux and thinner

medium—Sludge

waste reduction by—New technology

waste production—Reduced waste generated by 200 gal. month

ECONOMICS:

direct cost—\$900/month

impact—Source reduction and recycling allow wastewater to be discharged into sewer system.

(CONTACT: James R. Daniell, NCR Corporation)

1588 OIL-FIRED FURNACES—ISIC CODE: 3433 [CST-UNEP000193]

SUMMARY: Retrofitting oil-fired heating systems with special air mixing tube, positive damper control, fuel shut-off valve to improve energy efficiency and to reduce emissions. The changes to a conventional oil-burning furnace are:

1. Replace air mixing tube
2. Install smaller nozzle
3. Solenoid shut-off valve in fuel line
4. Positive damper in stack
5. Interlocking wiring

Benefits range from 15-20% fuel cost reduction.

MATERIALS BALANCE:

waste type—Emissions of CO, particulates, and hydrocarbons.

waste reduction by—New technology

waste production—9% reduction in SO₂ and NO₂

feedstock reduction—20%

ECONOMICS:

capital cost—\$400 (1979 Canadian Dollars)

months to recover—36 to 84

impact—Reduces fuel consumption and waste emissions

(CONTACT: Canadian Combustion Research Laboratory, Energy Research Laboratory, (CANMET), Department of Energy, Mines, and Resources, Ottawa, Ontario, Canada, c/o Mr. R. Breaton)

1589 BLEACHED KRAFT PROCESS—ISIC CODE: 2611 [CST-UNEP000194]

SUMMARY: The company runs a 725 ton/day ERCO Envirotech (Rapson-Reeve) closed-cycle technology for bleached kraft pulp mills. Chlorine dioxide replaced 70% of the chlorine normally used in the first-stage chlorination. This stage is followed by conventional caustic extraction, chlorine dioxide regeneration. Countercurrent washing is employed by the bleach plant, and bleach plant effluent is re-used in pulp mill in countercurrent brown-stock washers. Sodium chloride recovered from white liquor by evaporation and filtration, and is used in chlorine dioxide generator. Saltcake (sodium sulphate) in chlorine dioxide generator (can be dried and sold). Salt (sodium chloride) from salt removal process can be re-used in the generation of bleaching chemicals such as (ClO₂), (NaOH-Cl₂) and (NaClO₂).

MATERIALS BALANCE:

waste type—Aqueous Na₂SO₄ and solid sodium sulfate, wood, NaClO₂, Cl₂, H₂, SO₂, NaOH, Lime

medium—Low-level contaminated water

waste reduction by—Substitute less toxic raw material

waste production—Total flow of 117 m³/ton

feedstock reduction—Fresh process water requirement reduced from 104 m³/ton to about 15 m³/ton.

ECONOMICS:

capital cost—4.5 million (1975 Dollars)

operation/maintenance—1.0 million

direct cost—2.2 million/yr

impact—Reduced wastewater and wastewater contamination in bleached Kraft process.

(CONTACT: U.S. Environmental Protection Agency)

1590 MANUFACTURING OF METAL PRODUCTS, MACHINES AND MATERIAL—ISIC CODE: 3819 [CST-UNEP000195]

SUMMARY: The facility is involved with priming and lacquering aluminum foil. In the low pollution technique the solvent vapors emitted during the hot air drying of the lacquer are recovered with activated carbon. The activated carbon, in a second operation, is steam cleaned. The solvent vapor and water vapor mix is sent into a distilling column after condensation. After condensation, the solvents obtained are recycled to the workroom where the lacquer is prepared. In the standard process, the solvent vapors from the drying of the lacquer are discharged directly into the atmosphere without treatment.

This is the first industrial application of the recovery of ketonic solvent vapors, generally considered as a difficult procedure. As the technical results were positive as far as the reduction of pollution is concerned and the economic results should be satisfactory given the expected increase in the prices of petroleum based solvents, the use of this process should be extended to activities employing the same types of products.

MATERIALS BALANCE:

waste type—Ketonic and ethylic solvent vapors.

waste reduction by—Solvent recovery

waste production—With the low pollution technique, 30 kg of solvent vapors are released into the atmosphere per ton of solvent used. With the standard technique, the quantity of the waste released is 700 kg.

feedstock reduction—Virgin solvent requirements reduced by a factor of three

ECONOMICS:

capital cost—F 3.85 million (1978 Francs)

impact—The amount of new solvents required is reduced by three due to recycling. Energy needs are increased by 13.5 GJ per ton of solvent used in order to produce the vapor necessary for cleaning the activated carbon and the distillation of the recovered solution.

(CONTACT: Ministère de l'Environnement et du Cadre de Vie, Direction de la Prévention des Pollutions, 14, Boulevard du Général Leclerc, 92521 Neuilly-sur-Seine Cedex, France)

1591 MECHANICAL DESCALING OF WIRE-ROD COILS—ISIC CODE: 3700 [CST-UNEP000196]

SUMMARY: Mechanical descaling of wire-rod coils eliminates hot acid bath discharges and provides a more reliable and safer descaling process. The standard technology dips wire-rod coils in a hot acid bath, rinsed and then treated with lime in order to neutralize any trace of acid. In the new process wire-rod is descaled by roller-binding. It then goes through a sanding chamber where it is sand blasted. The surface quality thus achieved permits wire-drawing. The low-waste dry and wet processes require 0.5 GJ per ton of descaled wire-rod versus 2.35 GJ in the standard technology.

MATERIALS BALANCE:

waste type—Water and scale from the metal descaling operation

medium—Solid

waste reduction by—New technology

waste production—5 Kg of scale

feedstock reduction—3.99 m³ of water per ton of descaled wire-rod

ECONOMICS:

capital cost—FF 500,000 (1979 figures)

operation/maintenance—FF 22.9 per ton (1979 figures)

disposal & feedstock—FF 26.6 per ton descaled

impact—Greater safety and reliability due to the absence of hot acid

1592 AUTOMATION OF BATTERY PLATE MANUFACTURING PROCESS—ISIC CODE: 3800 [CST-UNEP000197]

SUMMARY: Automation of battery plate manufacturing process reduces lead oxide dust by 85% and wastewater by 98%. This audit of a manufacturer of battery plates suggests that the automation of the mold filling stage, reduces waste generation. Battery plates are placed manually in a fixed mold which is located in a sound-proof cabinet. When the cabinet is closed, the mold is automatically filled with lead powder. This process is quite different from the standard technology where the battery plates are placed in mobile molds which are manually handled and filled with lead oxide powder. These operations are conducted under water spraying in order to reduce dust. Polluted air is extracted.

MATERIALS BALANCE:

waste type—Lead oxide dust, powder, water containing lead dust

medium—Aqueous, air

waste reduction by—New technology

waste production—Manufacture of 1,000 battery plates generates 110g of lead oxide dust (including 16 g of lead) and 2 m³ of water containing lead dust (versus 836 g of lead dust, 380 g of lead and 80 m³ of water in the standard technology)

feedstock reduction—Material consumption is 2.4 tons of lead oxide and 2 m³ of water per 1,000 battery plates (versus 2.6 tons of lead oxide and 80 m³ of water per 1,000 battery plates with the standard technology).

ECONOMICS:

capital cost—FF 1,500,000 (1979 figures)

operation/maintenance—FF 7,730,000 (1979 figures)

disposal & feedstock—FF 565,000 (1979 figures for 230,000 battery plates produced per year)

impact—The quantity of water used is substantially reduced, improving reliability and efficiency. Substantial improvement of working conditions: elimination of one night shift; reduction of operator fatigue, and the noise level goes down from 95 dB (standard technology) to 85 dB (low-waste technology).

1593 SPINNING RINGS—ISIC CODE: 38 [CST-UNEP000198]

SUMMARY: Spinning rings hardened on a fluidized bed dry process eliminates waste production. This audit of manufacturer of spinning rings used in the textile industry suggests that by replacing the conventional cyanurated salts bath followed by rapid oil cooling hardening process with a dry process on a fluidized bed there is almost no waste generated. Baskets containing parts to be hardened are dipped into a fluidized bath of nitrogen and corundum particles at temperature between 840 and 860 °C. Baskets are then dipped into another fluidized bath at 50 °C. Corundum left on processed parts is recovered and recycled.

MATERIALS BALANCE:

WASTE TYPE—Negligible amount of dust

medium—Fluidized bath of nitrogen and corundum particles

waste reduction by—New technology

waste production—The polluting wastes generated by the standard technology: used cyanurated salts, oil fumes, and rinse water at a pH of 12.5 (3.5 m³ per 1,000 rings, containing 75 Equitox) are completely eliminated

feedstocks—0.4 Kg of corundum, 25 m³ of nitrogen and 0.63 GJ of electricity per 1000 spinning rings.

feedstock reduction—Corundum left on processed parts is recovered and recycled

ECONOMICS:

capital cost—FF 185,000 (1979 figures)

operation/maintenance—60% of the O&M costs for the standard technology (excluding treatment plant operating costs).

disposal & feedstock—FF 125,000 (1979 figures, including the capital cost for the treatment plant. Annual production of 300,000 spinning rings)

impact—This technology is more flexible in its application than the standard technology.

1594 ULTRAFILTRATION OF SPENT CUTTING FLUIDS—ISIC CODE: 38 [CST-UNEP000199]

SUMMARY: Ultrafiltration of spent cutting fluids allows reuse of oil and reduces disposal volume of spent oils. Ultrafiltration may be used to reduce the volume of spent cutting fluids generated from cold machining. The spent cutting fluids are first processed through a magnetic filter and a paper filter before ultrafiltration. The latter process ensures filtration at the molecular level because molecules of pollutants are generally larger than those of active products. The filtrate is then submitted to a quality test. If highly contaminated, the filtrate is

incinerated. If not, it is recycled. The standard process does not include ultrafiltration.

MATERIALS BALANCE:

waste type—Spent cutting fluids, filtration solids, filtrate (if highly contaminated)

medium—Spent fluids

waste reduction by—Extended use of raw material

waste production—Eliminates disposal of 24 m³ of cutting fluid

feedstock reduction—476 m³ of cutting fluids with the low-waste technology (versus 993 m³)

ECONOMICS:

capital cost—FF 200,000 (1976 figures)

disposal & feedstock—FF 142,700 per year (1980 figures)

impact—The volume of filtrate to be incinerated is reduced.

1595 MANUFACTURE OF FOOD, BEVERAGES AND TOBACCO, PAPER AND PAPER PRODUCTS, PRINTING AND PUBLISHING—ISIC CODE: 3134 [CST-UNEP000200]

SUMMARY: The CSM-Biothane U.A.S.B. process for anaerobic wastewater treatment treats organic wastewater generated during processing of food and paper related materials. This new technology consists of a digester where settling occurs under anaerobic conditions. Methane gas is produced as a by-product and can be used as energy for input to the production process.

MATERIALS BALANCE:

waste type—Organic wastewater sludge anaerobic wastewater sludge consisting of 2% to 20% carbon compounds, all nitrogen as ammonia

medium—Organic wastewater sludge

waste reduction by—Recover product from waste

waste production—Reduces production of surplus sludge by 80% to 90%.

feedstock reduction—25% to 50% reduction in need for additional nutrients (P and N)

ECONOMICS:

capital cost—125,000 to 250,000 Dutch guilders

operation/maintenance—0 to 500 Dutch guilders (20% of investment costs)

disposal & feedstock—375,000 to 1250,000 Dutch guilders

impact—The CSM-Biothane process for anaerobic wastewater treatment reduces the quantity of sludge generated by 80% to 90% and also produces methane gas which can be used as a substitute for energy in a production process.

1596 COMPUTER PROCESS CONTROL—ISIC CODE: 3211 [CST-UNEP000201]

SUMMARY: Computer process control reduces tank bottom losses and improves pigment analysis and reduces feedstock requirements as well as waste generation rate in textiles industry. This audit presents the advantages of introducing process control in the pigmentary printing of cloth. First the paste is prepared, then the cloth is printed, dried, and the printing is polymerized. Differences between the conventional and low-waste technologies are in the dressing of the paste. Computer control which is used in the low-pollution process reduces tank bottom losses, and improves the paste's analysis. The paste produced by the low-pollution process contains less white spirit and more water.

MATERIALS BALANCE:

waste type—Rejected washing water containing white spirit, white spirit fumes generated during the drying stage, and reusable tank sediments

medium—Aqueous, air, solids

waste reduction by—Improved process control

waste production—Low-pollution technique generates the following quantities of wastes per 1,000 m² of cloth: 7.5 Kg of rejected washing water containing white spirit (against 57 kg), 50 Kg of white spirit fumes discharged at drying stage (against 175 kg), and 28 Kg of reusable tank sediments (against 57 Kg).

feedstocks—For 1,000 m² of cloth 55 Kg of white spirit 10 Kg miscellaneous products 185 m³ of water

feedstock reduction—165 Kg of white spirit per 1,000 m² of cloth

ECONOMICS:

capital cost—FF 3,730,000 (1980 figures) for an annual production of 2,300,000 m² of cloth

operation/maintenance—FF 5.93 per 1,000 m² of cloth (1980 figures)

disposal & feedstock—FF 1.53 per 1,000 m² of cloth

impact—The additional consumption of energy results from the analysis of the

paste which contains more water and therefore takes longer to dry: 5.85 GJ for the low-pollution process against 4.60 GJ for the conventional process.

1597 CLOSED WATER LOOP IN KRAFT PULPING PROCESS—ISIC CODE: 3411 [CST-UNEP000202]

SUMMARY: Closed water loop in Kraft Pulping Process reduces quantity of reagents and water used and discharged by the bleaching process. This case study presents a modification to the bleaching stage of pulp manufacturing. Bleached kraft pulp is manufactured by cooking, washing, and bleaching wood chips. Modification of the standard bleaching process by preceding the chlorine, caustic soda, and chlorine dioxide bleaching with oxygen bleaching will reduce the quantities of reagents and water used in the conventional bleaching process. Washing water resulting from oxygen bleaching may be used for washing the pulp after cooking. This process reduces the coloration of wastes.

MATERIALS BALANCE:

waste type—Polluting wastes consist of bleaching effluents.

medium—Aqueous

waste reduction by—New technology

waste production—Polluting wastes by the bleaching process consist of the bleaching effluents. Switching from the standard to the low-pollution technique permits reducing by half the rate of coloration of wastes.

feedstocks—Materials requirements for low-pollution manufacturing one ton of pulp: 4 tons of wood, 50 m³ of water, 25 kg of caustic soda, 45 kg of chlorine, 10 kg of chlorine dioxide, 30 kg of oxygen, 8.78 GJ of primary energy.

feedstock reduction—The following reductions in feedstocks have been reported per ton of pulp manufactured: 50 m³ of water, 10 Kg of caustic soda, 55 Kg of chlorine, 5 Kg of chlorine dioxide.

ECONOMICS:

capital cost—FF 24,000,000 (1973 figures) for an annual production of 170,000 tons of pulp

operation/maintenance—FF 13.3 per ton of pulp (1973 figures)

disposal & feedstock—FF 9.1 per ton of pulp in raw: chemicals cost and water consumption

impact—Additional variable expenses of energy and manpower (F 13.3 per ton) are partly offset by savings in chemicals and water (F 9.1).

1598 RECYCLING OF DESALINATION WATER IN HYDRAZINE PRODUCTION PROCESS—ISIC CODE: 3511 [CST-UNEP000203]

SUMMARY: Recycling of desalination water in hydrazine production process reduces wastewater generation by over 90%. Production of hydrazine hydrate through oxidizing ammonia with hydrogen peroxide, in the presence of other chemicals. After several processes, these chemicals are recovered and recycled upstream. In addition to hydrazine hydrate, other mineral residues are recovered which are used in cement works, and heavy tars are burned away.

MATERIALS BALANCE:

waste type—Mineral residues (6.7 kg ton), tar (13.3 kg ton), waste discharge to the environment is negligible.

waste reduction by—Extended use of raw material

waste production—27 m³ ton of desalination water are rejected in standard techniques containing 2.4 tons of chloride ions for one ton of product compared to negligible waste production in low waste technology.

feedstocks—Ammonia, hydrogen peroxide, water, energy

feedstock reduction—14 m³ water required for standard techniques compared to 1.6 m³ for low-waste technique, energy requirements are reduced from 570 MJ to 220 MJ.

ECONOMICS:

capital cost—52,000,000 Francs (15 tons of hydrazine hydrate produced per day)

operation/maintenance—40% lower than standard technique

disposal & feedstock—7,000,000 Francs savings in original investment, 40% lower operating costs

impact—The oxidation of ammonia with hydrogen peroxide instead of ammonia reduces wastewater generation in addition to investment and operating costs. Mineral residues and other chemicals are also recovered.

1599 RECOVERY AND REGENERATION OF PICKLING BATHS—ISIC CODE: 3710 [CST-UNEP000204]

SUMMARY: Recovery and regeneration of pickling baths reduces wastewater generation by 33% and increases recovery rate of chlorides and ferric oxide. Chlorhydric acid pickling baths are regenerated and recycled for pickling of steel plates. The pickling baths go through a roasting oven where the chlorhydric acid is recovered, along with ferric oxide powder which is sold. Residual acid losses are neutralized and settled.

MATERIALS BALANCE:

waste type—Residual used pickling baths and washing water

medium—Water

waste reduction by—Extended use of raw material; recover product from waste
waste production—Low waste techniques generates 0.2 m³ of wastewater containing 0.25 chloride ions, compared to 0.3 m³ water with 1.3 kg chloride ions with conventional technology. Ferric oxide mud is reduced from 7 to 0.6 kg.

feedstocks—HCl - 2 kg ton steel, lime - 1 kg, wash water - 0.2 m³, energy (gas) - 0.125 GJ.

feedstock reduction—HCl requirement reduced by 18 kg ton steel, lime is reduced by 8.5 kg, water by 0.2 m³.

ECONOMICS:

capital cost—25,000,000 Francs (1979 Franc)

operation/maintenance—4.90 Francs ton of steel

disposal & feedstock—Capital investment is increased by 21,200,000 francs, but operating costs are decreased by 5.06 Francs ton of steel. Recovered ferric oxide is sold for 1.10 Franc.

impact—Wastewater generation is reduced by 33%, with a high recovery rate of chlorides and ferric oxide. The technique could be extended to other applications where chlorides are decomposed and recovery of metals is profitable.

1600 COPPER-PLATING RINSE WATER RECYCLING—ISIC CODE: 38 [CST-UNEP000205]

SUMMARY: Copper-plating rinse water is recycled via electro dialysis allowing for recovery of copper ions for reuse while significantly reducing volume of wastes produced. Rinse water from the copper-plating of parts is recycled via electro dialysis. This allows for recovery of the copper ions for reuse in the copper plating process, and recycling of purified rinse water. Conventional technology involves recycling of rinse water by removal of the ions with ion-exchange resins, resulting in the production of toxic effluents from the resin regeneration.

MATERIALS BALANCE:

waste type—Metal hydroxide mud resulting from detoxication of rinse waters containing copper and sodium cyanide

medium—sludge

waste reduction by—Metals recovery

waste production—Volume of metal hydroxide mud is reduced by 90%. Waste waters contained 340 kg of copper compared to 3400 kg in standard technique, and 375 kg of sodium cyanide compared to 3750 kg.

feedstocks—Electrical energy, copper

feedstock reduction—Reduction in copper and energy requirements

ECONOMICS:

capital cost—463,000 Francs (1980 Franc)

operation/maintenance—110,000 Franc reduction in detoxication cost

disposal & feedstock—110,000 Franc reduction in detoxication cost

impact—This low waste technology significantly reduces the volume of wastes produced from copper-plating while reducing the raw material and energy requirements for the process. The technique may be applied to the electroplating of other metals.

1601 RECYCLING OF PRINTING INK—ISIC CODE: 3420 [CST-UNEP000206]

SUMMARY: Recycling of printing ink to be reused by newspapers as black printing ink reduces waste disposal to treatment plant by seven tons. Discarded printing ink is collected, purified, and reused as black printing ink. Waste ink produced from the printing process and from color changes is collected in an accumulation vessel and is passed through four filters, the last of which removes

particles down to 25 μm . The purified ink is then mixed with new printing ink for reuse in newspaper production.

MATERIALS BALANCE:

waste type—Waste ink with moisture content below 5% and other impurities such as oil and organic solvents below 2%. Low volume of synthetic fillers and objects from coarse filter

medium—Solid

waste reduction by—Extended use of raw material

waste production—7 tons of discarded ink requiring disposal in national treatment plant

feedstocks—0.05 kWh energy consumption per ton paper

feedstock reduction—7 tons of discarded printing ink is treated per year

ECONOMICS:

capital cost—37,000 Danish kroner (1980)

operation/maintenance—1.23 Danish kroner per ton of paper

disposal & feedstock—3.0 Dk ton of paper for destruction of discarded ink 21.5 Dk ton savings for reusing the ink

impact—Seven tons of waste no longer require waste disposal in a treatment plant. With a net savings of 24.5 Danish kroner per ton of paper, and about 185,000 tons of paper used per year in Denmark, the possible savings are 4 - 5 million Danish kroner. Annual costs of printing ink are 50 to 60 million Dk (1980).

1602 QSL PROCESS—ISIC CODE: 3720 [CST-UNEP000207]

SUMMARY: QSL Process, developed to smelt lead sulphide concentrates and sulphate secondaries, reduces fuel requirements by 60% and waste gases by 80%. The QSL Process has been developed to smelt lead sulphide concentrates as well as sulphate and mixed oxide-sulphate secondaries such as flue dusts, battery paste or lead-silver residues. As in conventional lead smelting, the gangue minerals contained in the raw materials are separated from the molten metal in the form of a fluid siliceous slag. Instead of two separate steps of sintering and blasting in a furnace, the QSL Process is a one-step process of continuous smelting of the charge, with the resulting pellets directly fed to the oxidation and reduction zones of the reactor. Sulphur dioxide gas emissions of about 15 to 25% by volume are utilized in the manufacture of sulfuric acid. Any sulphur contained in reduction coal or fuel is recovered, and the precipitated flue dust is directly recycled to the mixing section.

MATERIALS BALANCE:

waste type—Air exhaust, dust, discarded slag

medium—Gaseous, solid

waste reduction by—New technology

waste production—Waste gases are reduced from 20,000 to 25,000 m^3/t of lead (20 mg dust/ m^3), to 4,000 to 5,000 m^3/t of lead (10 to 20 mg dust/ m^3). Sulphur dioxide gas can be used in sulfuric acid production, instead of emitting to the air.

feedstocks—Lead concentrate, fuel (coal), oxygen, nitrogen, fluxes, electrical energy

feedstock reduction—60% reduction in fuel consumption, recycling of precipitated flue dust

ECONOMICS:

capital cost—DM 90-110 million

operation/maintenance—235 DM/t lead bullion

disposal & feedstock—30 million DM in capital cost, 149 DM/t lead bullion in operating costs

impact—The QSL Process is a continuous one-step process with low investment and operating costs compared to the conventional technology. Energy recovery reduces the fuel requirements by 60%, and sulphur contained in the raw materials is recovered. The volume of waste gases emitted to the environment is reduced by 80%, and the SO_2 emissions are eliminated.

1603 OUTOKUMPU FLASH SMELTING PROCESS FOR COPPER—ISIC CODE: 3720 [CST-UNEP000208]

SUMMARY: Outokumpu flash smelting process for copper allows high sulphur recovery, efficient energy utilization, and flexibility in varied feed material. The Outokumpu flash smelting process combines the conventional operations of roasting, smelting and partial converting into one process. Preheated oxygen-enriched air is used to provide heat such that additional fuel is not required for the reactions to proceed. Copper concentrate is recovered from the slag and recycled through the smelter. The clean slag is sent for disposal. Heat and dust

are recovered from the smelter gases producing dust for recycle to the smelter, and SO_2 gases for production of sulfuric acid. The matte is further treated in conventional converters to obtain blister copper.

MATERIALS BALANCE:

waste type—Gaseous stream of 10-30% SO_2 for use in sulfuric acid plant, particulates in gas stream (6-7% of the feed), slag from electric furnace

medium—Gaseous, solid

waste reduction by—New technology

waste production—50-80% recovery of sulfur from the concentrate for use in sulfuric acid production, eliminating SO_2 emissions to the environment. Slag cleaning reduces copper content from 24% to less than 0.6% prior to disposal, eliminating liquid run-off from granulation pond

feedstocks—Ore concentrate, fuel, electrical energy, oxygen-enriched air, silica flux

feedstock reduction—Energy consumption is about 20 to 30% of that required by a conventional furnace

ECONOMICS:

operation/maintenance—61.0 cents/kg (27.7 cents/lb)

disposal & feedstock—Operating costs reduced to 61.0 cents/kg from 97.8 cents with conventional process

impact—The main advantages of the Outokumpu process are the high sulphur recovery, the efficient energy utilization, and the flexible process in terms of accepting a varied feed material.

1604 RECYCLING AND SORPTION OF CCl_3F AND TDI GENERATED DURING THE PRODUCTION OF POLYURETHANE (PUR) BLOCK SOFT FOAM—ISIC CODE: 3513 [CST-UNEP000209]

SUMMARY: Recycling and sorption of CCl_3F and TDI generated during the production of polyurethane (PUR) block soft foam involves the sorption and recycling of harmful materials in process gases generated during the production of polyurethane (PUR) block soft foam. Activated charcoal is used for removing CCl_3F and TDI which are emitted with the exhaust air during the conventional production process. Adsorption of TDI is an irreversible process, which eliminates the option of recovering the TDI. The CCl_3F , however, is recovered through regeneration of the charcoal bed with hot steam.

MATERIALS BALANCE:

waste type— CCl_3F in purified exhaust air (less than 20 mg/m^3), CCl_3F in condensed aqueous phase (less than 0.01% by weight), TDI converted to innocuous polyurea on activated charcoal (no longer detectable)

medium—Gaseous, water, solid

waste reduction by—Solvent recovery

waste production— CCl_3F emitted is less than 20 mg/m^3 compared to 0-50 g/m^3 without the recovery process (regulatory level is 300 mg/m^3), TDI is now captured in the charcoal bed compared to emissions of 0-20 mg/m^3 without recovery (regulatory level is 20 mg/m^3)

feedstocks—Steam, electric power, cooling water, activated charcoal

ECONOMICS:

capital cost—700,000 DM (1983 for plant capacity of 30,000 m^3 exhaust air per hour)

feedstock reduction—1443 DM/t of recovered CCl_3F

operation/maintenance—557 DM/t of recovered CCl_3F

months to recover—30

disposal & feedstock—The recovery process is an addition to the process

impact—This sorption and recovery process achieves extremely low CCl_3F emissions from the polyurethane foam manufacturing process and TDI emissions below the detection limit. Additionally, CCl_3F resources are recovered with this process.

1605 ROTALYT-ALUTOP PROCESS FOR ALUMINUM PLATING—ISIC CODE: 3844 [CST-UNEP000210]

SUMMARY: Rotalyt-Alutop process for aluminum plating reduces emission of cadmium into the environment while also reducing costs. It is based on the chemo-mechanical plating of pieces in a medium containing an impact body, and metal particles and catalysts, using relative movement. The pieces are loaded into a perforated drum, and lowered into a plating bath where glass balls are added as the impact body and the aluminum flakes are added. The drum passes through a separation tank where the glass balls are separated for reuse, to a centrifuge unit, and to an unloading station for drying. The cathodic corrosion

protection properties are considerably improved by the use of zinc containing aluminum alloys, or preplating to add a zinc tin layer.

MATERIALS BALANCE:

waste type—Wastewaters, chemical baths

medium—Aqueous

waste reduction by—New technology

waste production—Wastewaters produced from conventional process contains cadmium, cyanide, and chromium compounds. The waters are neutralized, precipitated, and dumped. The low waste technology reduces the toxicity of the waste.

feedstocks—Electric energy - 140 kWh/t, Al metal - 14 kg/t, rinse water - 200 lt, catalyst - 5 kg/t, pre- and post-treatment - 20 kg/t

feedstock reduction—Electrical requirements reduced by 780 kWh/t, rinsewater by 800 lt, 14 kg/t Al required compared to 15 kg/t Cadmium, treatment chemicals by 100 kg/t

ECONOMICS:

capital cost—500,000 DM (1983)

operation/maintenance—294 DM/t treated goods

disposal & feedstock—100,000 DM reduction in capital cost, 94 DM/t of treated goods reduction on process costs

impact—Reduction of environmental pollution from the proven toxicity of cadmium while reducing costs.

1606 ELECTROPLATING—USE OF ALUMINUM INSTEAD OF CADMIUM—ISIC CODE: 3813 [CST-UNEP000211]

SUMMARY: Aluminum is used instead of cadmium in the conventional electroplating technology for the elimination of Cd and CN containing waters and hydroxide sludge, while reducing operating costs. Conventional electroplating technology using aluminum instead of cadmium as the plating metal. A thin layer of nickel is initially deposited on ferrous and aluminum die casting materials. The pieces are dried using fluorohydrocarbons, and passed to the aluminum plating cell. Using an electrolyte solution, an aluminum layer is applied to the nickel coating. A post-treatment process may be applied to improve corrosion protection or for decorative appearance.

MATERIALS BALANCE:

waste type—No wastewaters (electrolyte is recycled), evaporation of toluene from the bath (1-2 kg/hr)

medium—Vapor

waste reduction by—Substitute less toxic raw material

waste production—Cd and CN containing wastewaters are eliminated, 1-2 kg/h toluene vapor is produced.

feedstocks—Nickel - 18 g/m², Al - 27 g/m², electrolytic bath (recycled), electrical energy

feedstock reduction—18 g of Ni, and 27 g Al is require compared to 180 g Cd, and 5 g CN in conventional technology

ECONOMICS:

capital cost—6 million Dfl - 40m²/h plant

operation/maintenance—50 - 75 Dfl/m²

disposal & feedstock—10 - 15 Dfl/m² reduction in operating costs, elimination of wastewater treatment and disposal costs

impact—Elimination of Cd and CN containing waters and hydroxide sludge, with reduced operating costs. Discharge of the bath contents occurs after two years, and the materials are recycled.

1607 BLUE PASSIVATION PROCESS IN THE GALVANIC INDUSTRY—ISIC CODE: 3813 [CST-UNEP000212]

SUMMARY: Blue Passivation process in the Galvanic Industry uses trivalent chromium (instead of hexavalent chromium) to allow for reuse of chemical bath, less aggressive rinsewaters and lower operating costs. The use of trivalent chromium for the Blue Passivation process in the Galvanic Industry instead of hexavalent chromium leads to a no-dump bath. The conventional technology for the chromating of zinc coatings utilizes hexavalent chromium and mineral acid, which reacts with the metal. In addition to the chemicals present in the bath, the wastewater also contains zinc that was dissolved from the metal surface. The low-waste technology utilizes Cr(III) and H₂O₂ which dissolves little zinc and the bath can be replenished with concentrate and reused.

MATERIALS BALANCE:

waste type—Wastewater containing Cr(III) - 200 g, H₂O₂ - 8 ml, citric acid -

600 g, zinc - 750 g (treated by reduction and precipitation of hydroxide) per 1000 m² chromated.

medium—Aqueous

waste reduction by—Extended use of raw material

waste production—Chemical baths are reused, rinsewaters contain less aggressive H₂O₂ and citric acid, compared to conventional method, resulting in savings of 171.50 Dutch guilders in discharge costs.

feedstocks—Cr(III), H₂O₂ (30%), citric acid

feedstock reduction—0.75 kg zinc dissolved in bath compared to 7.5 kg of lost zinc using conventional technique, allowing for reuse of the bath

ECONOMICS:

capital cost—Only material and discharge costs involved

operation/maintenance—40 Dutch guilders/1,000 m² of passivated metal surface

disposal & feedstock—Operating costs are reduced by 190 Dutch guilders/1,000 m² of passivated metal

impact—The use of trivalent chromium over hexavalent chromium in passivating zinc metals allows for reuse of the chemical bath, less aggressive rinsewaters and lower operating costs.

1608 TOBACCO PRODUCTS--ISIC CODE: 2111 [CST-UNEP000213]

SUMMARY: A batch-distillation unit is used to recover 90% of the solvent used to clean engraved printing cylinders, cylinder pans, splatter guards and other machinery used for printing cartons and labels for cigarette packages. The contaminated solvents, after solids settling, had previously been discharged to a 5,000-gallon underground storage tank. The solvents were shipped to a recycler for solvent reclamation, or incineration. Sludge was accumulated in 55-gallon drums before shipment to an incineration facility.

MATERIALS BALANCE:

waste type—Contaminated solvent, sludge

medium—Liquid, solids

waste reduction by—Solvent recovery

waste production—Reduced 95% from 8,820 lbs mo to 440 lbs mo

feedstock reduction—Recovery of 90% of cleaning solvents

ECONOMICS:

capital cost—\$23,400

operation/maintenance—\$3,500 was reported as hazardous waste disposal costs remaining after installation of this unit

disposal & feedstock—\$33,500 in purchase of 55-gal drums, \$5,500 in disposal costs

impact—95% reduction in waste production has allowed Liggett to become a small quantity generator. They have significantly reduced their waste disposal costs, while recovering 90% of their cleaning solvents.

1609 WOODEN FURNITURE--ISIC CODE: 2511 [CST-UNEP000214]

SUMMARY: Conventional air spray guns have been replaced with air-assisted airless spray guns for spraying sealer on the printed finish of bedroom suites in eighteen spray booths. The new spray guns provide a better quality finish and reduce raw material lost through overspray. The reduction in overspray also allows the booths to be cleaned once every three weeks rather than once per week, reducing solvent waste from the cleanup.

MATERIALS BALANCE:

waste type—Finishing sealer, solvents

medium—Liquid

waste reduction by—New technology

waste production—15% yr of the sealer, 50% less solvent waste from spray booth cleanup

feedstocks—Finishing sealer.

feedstock reduction—1% per year

ECONOMICS:

months to recover—12

disposal & feedstock—\$55,000 yr from raw material consumption

impact—The improved spray guns allow for an improved quality product, while reducing the amount of finishing sealer waste from overspray. The solvent needed to clean up the overspray, requiring hazardous waste disposal, is reduced by 50%.

1610 WOODEN FURNITURE—ISIC CODE: 2511 [CST-UNEP000215]

SUMMARY: Solvent-based inks have been replaced by water-based inks for printing woodgrain on fiberboard and plywood pieces prior to furniture assembly. The water-based inks are non-toxic and may be discharged into the city's sewer collection system, reducing off-site solvent recycling costs, as well as raw material costs. The solvent-based finishes still required are being used in a counter-current manner such that the virgin solvents flush the equipment and are later used as a thinner for finishing material.

MATERIALS BALANCE:

waste type—Solvents—inks, coatings

medium—Liquid

waste reduction by—Substitute less toxic raw materials

waste production—30-40% reduction in waste solvents (\$37,000 yr savings in disposal costs)

ECONOMICS:

disposal & feedstock—\$112,000 yr in reduced raw materials and disposal costs

feedstock reduction—The water-based inks cost 50% less than the solvent-based inks (\$75,000 yr savings)

impact—Conversion to water-based inks from solvent-based inks has allowed for a reduction in raw material costs by 50%, and a 30-40% reduction in solvents generated that require off-site recovery. Product quality has remained the same.

1611 RECLINER CHAIR MECHANISMS—ISIC CODE: 2514 [CST-UNEP000216]

SUMMARY: A custom-blended paint, used on a metal part, was replaced with a paint that utilizes the light oil residue on the part as a "plasticizer" to impart flexibility to the coating. The light oil residue was previously removed by dipping into a 1,000 gallon tank containing lacquer thinner. The change eliminated the generation of 1,000 gallons of lacquer every 3 months and improved the quality of the product by reducing trapped moisture, caused by flash, under the paint layer. The trapped moisture had led to rust problems.

MATERIALS BALANCE:

waste type—Paint coating, lacquer thinner

medium—Liquid

waste reduction by—Improved operating practices

waste production—1,000 gallons lacquer thinner every 3 months (\$22,000 yr)

feedstock reduction—1,000 gallons lacquer thinner every 3 months

ECONOMICS:

disposal & feedstock—\$22,000 yr in 1987 and 1988 in lacquer thinner transportation and disposal costs

impact—Substitution of a custom-blended paint eliminated the need for a pre-dip tank used for removing an oil layer. Material and disposal costs associated with the lacquer were eliminated. Rejection and rework of parts decreased due to reduction of trapped moisture under the paint layer, caused by flash.

1612 NUCLEAR FUEL AIRCRAFT ENGINE—ISIC CODE: 281933563499 3728 [CST-UNEP000217]

SUMMARY: General Electric Co. has implemented seven waste minimization strategies to reduce, recycle, and recover multiple wastes. They include:

- Joint venture with Federal Paper Board to utilize ammonium nitrate waste as nutrient feed to the waste treatment plant.
- Design and construction of an ammonia recovery process.
- Collection and sale of sodium hydroxide waste to consumers.
- Installation of a coolant recovery system.
- Implementation of a centralized trash collection, sorting, and recovery operation.
- Installation of a computer-controlled, exhaust-gas-cleaning, dual-chamber incineration system to reduce combustible, low-level radioactive waste and recover usable uranium.
- Installation of a waste oil separation unit.

MATERIALS BALANCE:

waste type—Ammonium nitrate, ammonia, sodium hydroxide, coolant, trash, oil, radioactive waste—process wastes ranging from conventional trash to hazardous and low-level radioactive waste

medium—Liquids, solids

waste reduction by—Extended use of raw material, improved process control

waste production—

Joint venture	4.5 mill. gallons
Sodium hydroxide sales	—
Coolant recovery system reduction in spent coolant	90%
Centralized trash collection recoverers and	20,000 cu. ft. of reusable materials 50,000 cu. ft. of recyclable materials
Incineration system reduces combustible, low-level radioactive waste by (from 40,000 tons of waste to 2000 cu. ft. of ash)	95%
Waste oil separation unit reduced oil disposal by a factor of	6

feedstock reduction—

Joint venture	—
Ammonia recovery process	800 tons
Sodium hydroxide sales	87 tons
sulfuric acid for neutralization	—
Coolant recovery system	—
Centralized trash collection	—
Incineration system	—
Waste oil separation unit	—
Reduced oil usage by a factor of	6

ECONOMICS:**capital cost—(US\$)**

Joint venture	0
Ammonia recovery process	1.2 million
Sodium hydroxide sales	0
Coolant recovery system	220,000
Centralized trash collection (not reported)	—
Incineration system	2.3 million
Waste oil separation unit	25,000

months to recover—

Joint venture	—
Ammonia recovery process	60
Sodium hydroxide sales	—
Coolant recovery system	12
Centralized trash collection	12
Incineration system	36
Waste oil separation unit	12

disposal & feedstock—\$3.73 million

impact—By recovering, reusing, recycling, or selling excess materials, G.E. has reduced the volume of waste shipped off-site by 70%, and has achieved a 3.73 million dollar savings.

1613 MOLDED FIBERGLASS TANKS—ISIC CODE: 3079 [CST-UNEP000218]

SUMMARY: A small in-house batch distillation system was installed in a compact cabinet to distill the acetone used for cleaning molds that manufacture fiberglass tanks for industrial rug and carpet cleaning equipment.

MATERIALS BALANCE:

waste type—Still bottoms—spent acetone

medium—Liquid

waste reduction by—Solvent recovery

waste production—Waste sent off-site was reduced from four drums per month to two per year.

feedstock reduction—Purchased acetone was reduced by 75%

ECONOMICS:**months to recover—6**

disposal & feedstock—\$12,000 to \$16,000 per year

impact—Installation of the in-house recovery system has resulted in savings from reduced solvent consumption, and reduced disposal costs, and has reduced storage requirements for both acetone and spent acetone.

1614 COATER AND LAMINATOR OF INDUSTRIAL FILM MATERIALS—ISIC CODE: 3079 [CST-UNEP000219]

SUMMARY: Waste coating and cleanup solutions from coating operations, which are relatively high in solvents and low in solids, are being recovered for

use as wash solvents in cleanup operations. A 50 gallon per hour on-site distillation unit for recovery was installed. An on-site boiler was also modified to use solvent recovered from the regeneration of a carbon absorption recovery unit as a fuel substitute for natural gas recovery unit as a fuel substitute for natural gas and No. 2 fuel oil for steam production. The boiler was retrofitted by replacing the burners and installing piping. Flexibility in the manufacturing operations was maintained by retaining the capability of firing natural gas or No. 2 fuel oil.

MATERIALS BALANCE:

waste type— Still bottoms—spent solvents

medium— Liquid

waste reduction by— Solvent recovery

feedstock reduction— 37,590 gallons of wash solvent, and 37 billion BTU's of energy, replacing the purchase of 36 million cu.ft. of natural gas or 275,000 gallons of No. 2 fuel oil

ECONOMICS:

capital cost—\$75,000 for the still, \$45,000 in boiler modifications

months to recover—13 for the still, less than four for boiler modifications

disposal & feedstock— \$65,000 yr by recycling ketone \$150,000 in reduced fuel costs

impact—Within 13 months, \$140,000 net annual savings is being realized with the elimination of 437,590 gallons of solvent requiring hazardous waste disposal.

1615 PLUMBING FIXTURES—ISIC CODE: 3400 [CST-UNEP000220]

SUMMARY: Coolant filtration and oil recovery systems have been installed to recover and reuse hydraulic oil and coolant previously sent off-site for disposal. Also, an in-process chrome recovery system has reduced the company's chrome usage by 50% and has reduced chrome disposal costs.

MATERIALS BALANCE:

waste type— Used oil, coolant, chrome waste, pretreatment sludge

medium— Liquids, solids

waste reduction by— Extended use of raw material

waste production— 8000 gallons of hydraulic oil and 6000 gallons of coolant had previously been sent off-site for disposal.

feedstock reduction— Reused 8000 gallons of hydraulic oil and 6000 gallons of coolant, and reduced chrome usage by 50%.

ECONOMICS:

capital cost—\$75,000 for the coolant filtration and oil recovery system

months to recover—17 for the coolant filtration and oil recovery system

disposal & feedstock— \$77,000 during 1986

impact—Recovering the used oil, coolant, and chrome has significantly reduced material costs while minimizing the required disposal of these wastes.

1616 SECURITY PRODUCTS—ISIC CODE: 3429 [CST-UNEP000221]

SUMMARY: An atmospheric evaporation system was installed in a nickel plating process for plating keyblanks. The system evaporates waster from the electroplating bath allowing all rinse waters to be returned to the bath as make-up. The rinse waters had previously been treated by pH neutralization, flocculation and clarification, settling, filtration and compaction of filter sludge, and disposal in a hazardous waste landfill. The evaporators average a removal of 45 gallons per hour each from the process at a bath temperature of 145-150°F.

MATERIALS BALANCE:

waste type— Electroplating bath waste waters containing nickel chloride, nickel sulfate and boric acid

medium— Liquid

waste reduction by— Extended use of raw material

waste production— Reduced 50%, from 56,000 lbs yr to 28,000 lbs yr

feedstock reduction— Recovers all plating bath chemicals (37,200 lbs per year of nickel chloride, nickel sulfate, and boric acid)

ECONOMICS:

capital cost—\$12,500 for two evaporators

operation/maintenance—\$24,741 yr

months to recover—7

disposal & feedstock— \$24,000 net savings in first year, \$36,000 in second year

impact—Installation of the evaporation system has allowed for the elimination of waste water discharge from the plating process, which has reduced waste

generation requiring landfill by 50%. Additionally, all plating bath chemicals are being recovered.

1617 GENERAL MACHINE—JOB SHOP—METAL FABRICATION—ISIC CODE: 3499 [CST-UNEP000222]

SUMMARY: A six tank metal surface preparation (phosphating) and cleaning process, a filtration system and a residuals concentration process replaces a manual process, using acetone, for removing surface oils from metal parts. The wiped parts had been subsequently cleaned in three rinse tanks. The new process uses counterflow to efficiently utilize the rinse waters. The residuals are concentrated by liquid evaporation and sludge concentration, using steam heat from the boiler in the winter and a new gas boiler in the summer. A distillation unit permits additional savings through acetone and other solvent recovery and reuse.

MATERIALS BALANCE:

waste type— Wastewaters, acetone

medium— Liquid

waste reduction by— Solvent recovery, extended use of raw material

waste production— Reduced to less than 500 lbs yr

feedstocks— Water, acetone, chemicals

feedstock reduction— 45% reduction in acetone, 96% in water, and 50% in chemicals

ECONOMICS:

capital cost—\$38,967.68

operation/maintenance—\$500 yr gas per boiler

disposal & feedstock— \$14,418 yr

impact—The new metal fabrication system addresses previous operational problems, reduces material costs, oil accumulation, labor requirements, and residual waste disposal costs. Hazardous sludge generation is reduced to less than one 55 gallon drum

1618 ACTUATORS, ROTARY JOINTS AND MECHANICAL JACKS—ISIC CODE: 3500 [CST-UNEP000223]

SUMMARY: Substitution of a water-based parts cleaning fluid for an oil-based (1,1,1 Trichloroethane Varsol) product has proved to be more efficient in degreasing operations and has eliminated a second rinse that had previously been necessary. A centrifuge is being used to reclaim the water-based solvent.

MATERIALS BALANCE:

waste type— Cleaning solvents

medium— Liquid

waste reduction by— Substitute less toxic raw materials

feedstock reduction— Only 3 gallons of make-up solvent were required during the year, for a 200 gallon degreasing machine

ECONOMICS:

disposal & feedstock— \$3300 yr

waste production— Saved \$900 yr in disposal costs

impact—Changing to a water-based parts cleaning fluid has allowed for recycling of the fluid, which reduces oily wastes and other wastes requiring disposal. A second rinse was eliminated due to increased efficiency, also reducing wastes generated. Employee morale has improved with the "vapor free" environment.

1619 MOBILE STREET SWEEPERS—ISIC CODE: 3711 [CST-UNEP000224]

SUMMARY: A formulation change to eliminate photoreactive solvents in a primer used in painting operations reduces VOC emissions by 50%. A substitute machine coolant, with a longer shelf life, reduces material usage and the volume of spent coolants sent off-site for recovery. Effort to increase employee awareness has reduced the amount of waste xylene requiring off-site incineration.

MATERIALS BALANCE:

waste type— VOC emissions, coolant waste, spent xylene

medium— Gaseous, liquids

waste reduction by— Substitute less toxic raw material

waste production— VOC emissions reduced by 50%, spent xylene sent off-site reduced by 1300 gallons yr

feedstocks—Coolants, chemicals, paints, solvents (xylene)

feedstock reduction— 75% reduction in machine coolant, and reduced xylene requirements

ECONOMICS:

disposal & feedstock— VOC emissions - \$100,000 saved in construction of facility to reduce the emissions. Machine coolant - \$14,400 yr in material and

disposal costs. Nylene - \$3,800 yr in material and disposal costs
impact—Significant reduction in VOC emissions and in hazardous waste generation has been achieved through material substitutions, chemical reformulations, and improved employee awareness.

1620 FIBERGLASS BOAT MANUFACTURING—ISIC CODE: 3731 [CST-UNEP000225]

SUMMARY: In-house batch distillation is utilized to recover spent acetone used in cleaning fiberglass boats. Two thirty-five gallon capacity stills each operate twelve hours a day with automatic control systems for materials handling, cycle control, and safety. Liner bags are used to collect still bottoms which are shipped off-site for disposal. Operator time for each cycle is twelve minutes.

MATERIALS BALANCE: Spent acetone

waste type— Still bottoms

medium— Liquid

waste reduction by— Solvent recovery

waste production— 75% reduction in hazardous waste shipments

feedstock reduction— 75% reduction in virgin solvent purchases (at \$117 drum)

ECONOMICS:

capital cost— \$20,000 per still

months to recover— <12

disposal & feedstock— \$1,000 mo in acetone and disposal costs

impact—Installation of a solvent recovery distillation column has allowed for 75% reduction in hazardous waste generation and in raw material purchasing. Significant savings in material and disposal costs result in a payback period of less than 1 year.

1621 PAPER, FILM AND FOIL PRODUCTS—ISIC CODE: 3861 [CST-UNEP000226]

SUMMARY: On-site distillation is being used for reclamation of spent solvent used in cleaning up the manufacturing area and in product development. The reclaimed solvent is being used as wash solvent for cleanup operations which reduces the cleanup solvent inventory.

MATERIALS BALANCE:

waste type— Spent solvents

medium— Liquid

waste reduction by— Solvent recovery

waste production— Reduced from 80 drums mo in 1985 to 60 drums every other month in 1986.

feedstock reduction— Cleanup solvent inventory has been reduced from 3000 gallons to 2000 gallons

ECONOMICS:

months to recover— 14

disposal & feedstock— \$45,000 (?) in nine months

impact—Waste generation has been reduced significantly by recovering spent solvent for use as wash solvent. Production has also increased by 20%, while costs for raw materials and waste disposal have been reduced.

1622 EMPLOYEE TRAINING, MATERIALS INVENTORY SYSTEM, AND WASTE COLLECTION SYSTEM—ISIC CODE: 37 [CST-UNEP000227]

SUMMARY: A waste collection system was introduced at an Ashland Chemicals resins manufacturing plant to prevent reusable resins from being wasted and reduces feedstock requirements and disposal costs. The system consisted of a clean container, lid and identification tags supplied at the site of waste generation, and staff training. The system was pilot-tested in the quality control area and was later extended to the manufacturing operation and the laboratory. A return system was also installed at the blending tanks to pump excess sampling material back into the tanks. The system consisted of a funnel and valve placed directly below the tank sampler and connected to the inlet side of the pump used for that system.

MATERIALS BALANCE:

waste type— Resin wastes

medium— Solid

waste reduction by— Extended use of raw material

waste production— From 1980 to 1983, waste produced was reduced from 31,000 lbs to 7,000 lbs

feedstock reduction— All waste collected is reworked

ECONOMICS:

months to recover— 1 week

disposal & feedstock— \$600,000 in reduced treatment costs and improved plant efficiency in 1985.

impact—Collection and reworking of waste resins has significantly reduced the amount of plastic resin requiring disposal and is saving the disposal costs, as well as reducing the amount of feedstock required.

1623 ULTRASONIC REACTOR CLEANER REDUCES WASTE GENERATION AND CUTS ENERGY COSTS ARE REDUCED—ISIC CODE: 37 [CST-UNEP000228]

SUMMARY: A Chemdet Sonic Cleaning system is now used at 3-M to clean batch reactors, replacing the old process of filling the reactor with caustic or solvent and boiling the solution for one or two days. Cleaning chemicals are pumped under pressure through a twin-nozzled rotating spray head to break down the waste. Then, caustic or solvent is sprayed under 600 lb pressure to complete the dissolution and flush the vessel clean.

MATERIALS BALANCE:

waste type— Spent solvent, caustic, containing adhesives, resins, polymers

medium— Liquid

waste reduction by— Improved operating class

waste production— 1,000 tons yr of water pollutants were eliminated

ECONOMICS:

capital cost— \$36,000

operation/maintenance—Reduction in labor costs not reported

months to recover—Savings realized in first year

disposal & feedstock— \$575,000 in first year, from labor, materials and machine costs

impact— Installation of the Chemdet system for cleaning the reactors has eliminated the need to fill the 4,000-8,000 gallon reactors with solvent and caustic, which greatly reduces the amount of spent solvent generated. Significant savings were realized in the first year.

1624 RECOVERY OF CHROMIUM FROM PLATING BATH AT INDUSTRIAL ELECTROPLATERS ELIMINATES NEED FOR CHEMICAL TREATMENT—ISIC CODE: 30 [CST-UNEP000229]

SUMMARY: The Model C12-X Chromic Acid Recovery Unit operates as a closed-loop system to recover chromic acid from plating baths. The rinsewater is filtered to remove solids and then pumped through three reciprocating-flow ion-exchange columns. An anion-exchange resin removes the chromate and polychromate ions, and the water is then reused for rinsing. The effluent passes through a second cation-exchange bed, where a concentrated chromic acid solution is collected. The cation and anion resins are regenerated with sulfuric acid and sodium hydroxide, respectively.

MATERIALS BALANCE:

waste type— Spent electroplating bath—contaminated rinsewater

medium— Water

waste reduction by— Metals recovery

waste production— 2300 kg yr chromic acid not disposed as waste, large volumes of wastewater eliminated

feedstock reduction— 2300 kg yr chromic acid recovered, water consumption reduced by 2.4 million gals yr

ECONOMICS:

operation/maintenance— \$8,055 yr for materials

disposal & feedstock— \$11,000 yr in recovered chromic acid \$5400 yr in chemical treatment eliminated, \$400 yr in sludge disposal, \$6,980 yr in water consumption.

impact— The rinsewater used to be diluted at a rate of 10 gallons per minute to reduce the chromium content to 5 ppm to meet local effluent regulations. Chromium in the plant effluent is now less than need for chemical treatment. Rinsing of the plated parts is also more efficient.

1625 SOMMER METALCRAFT USES CLOSED-LOOP EVAPORATOR TO RECOVER CHROMIUM AND SAVE ON WASTE TREATMENT AND DISPOSAL COSTS—ISIC CODE: 30 [CST-UNEP000230]

SUMMARY: A closed-loop evaporator is being used to recover chromium from electroplating rinse tanks and return it to the plating baths. The system also

enables 100 gallons of water to be recycled to the fourth and last counterflow rinse tank every hour. Water is continually drawn from the plating bath to maintain a constant level, and the heat from the water is returned to the evaporator. Some contaminants, such as copper, are removed by ion-exchange, but a gradual build-up of contaminants in the bath makes it necessary to decant every four years and dispose of the sludge and contaminated fluid.

MATERIALS BALANCE:

waste type—Electroplating rinsewater—sludge, chrome, contaminated fluid
medium—Solid, liquid

waste reduction by—Metals recovery

waste production—172,000 lbs mo sludge generated from waste treatment has been eliminated.

feedstock reduction—180 kg day chromium reduction, 100 gals hr water

ECONOMICS:

operation/maintenance—Maintenance reported to be low.

months to recover—12

disposal & feedstock—\$100,000 yr in chromium raw material, 100 gals hr of water is recycled

impacts—The closed-loop evaporator has saved the company in waste treatment costs, sludge disposal costs, and raw material costs. Significant amounts of chromium, and contaminated rinsewaters are no longer being generated for disposal.

1626 ELECTROLYTIC RECOVERY UNIT—ISIC CODE: 30 [CST-UNEP000231]

SUMMARY: A nickel plating line for lighting fixtures addressed loss of nickel through dragout in the first standing rinse with an electrolytic recovery unit. The unit, at Sun Polishing and Plating, reduces loss of nickel through dragout in the first standing rinse, allowing rinsewater to meet regulatory limits and reuse of nickel. The electrolytic chamber contains expanded steel mesh electrodes in a bed of inert glass beads. The rinsewaters are pumped through the bed in successive rinses until a nickel concentration of 3 ppm is achieved. The scouring action of the beads on the surface of the electrodes ensures that the ion concentration is maintained. The electrodes are periodically removed when the deposits reach sufficient thickness, and the nickel is returned to the plating tanks.

MATERIALS BALANCE:

waste type—Rinsewaters from nickel plating

medium—Water, solid

waste reduction by—Metals recovery

waste production—Eliminates discharge of nickel containing rinsewaters

feedstock reduction—18 kg week nickel

ECONOMICS:

operation/maintenance—Requires less than 1/2 hour day to maintain

months to recover—60

disposal & feedstock—18 kg week nickel recovered at about \$7 kg, waste treatment costs eliminated

impacts—The electrolytic recovery unit reduces the concentration of nickel in rinsewater from 300 ppm to 3 ppm, which meets the regulatory limit of 5 ppm for nickel. Thus, waste treatment costs are greatly reduced, and 18 kg week of nickel can be reused.

1627 RECOVERY OF WHITewater AT A NEWSPRINT MILL—ISIC CODE: 27 [CST-UNEP000232]

SUMMARY: Kruger Inc recovers whitewater at their newsprint mill and reduces wastewater discharge and energy costs. A series of modest modifications to a newsprint mill have achieved recovery of significant amounts of lean and clear wastewaters that had been discharging to the sewer. Lean whitewater from the company's three paper machine presses are collected by gravity flow in a reservoir beneath the machines. It is then pumped through a Sweco filter, where 90% is used for dilution of stock and 10% is sent to the clarifier. Clear whitewater is now used instead of heated freshwater on the paper machine showers.

MATERIALS BALANCE:

waste type—Wastewater—whitewater from newsprint mill

medium—Water

waste reduction by—New technology

waste production—Discharges to sewer significantly reduced

feedstock reduction—1.8 tons day fiber recovered, which represents \$80,000 yr. Recovered lean whitewater led to \$500,000 yr savings

ECONOMICS:

disposal & feedstock—\$580,000 yr

impacts—Efforts to recycle wastewaters, previously discharged to the sewer, have greatly reduced the volume of waste generated, and allow for recycling of fiber feed material.

1628 RECOVERY AND REUSE OF FOUNDRY SAND—ISIC CODE: 29 [CST-UNEP000233]

SUMMARY: KHD Humboldt Wedag recovers and reuses foundry sand and reduces disposed sand by 75% and reduces stack emissions. A new multi-stage process is in use for regenerating used foundry sand. After iron removal by a magnetic separator, the sand is delivered to a fluidized-bed furnace consisting of a vertical, cylindrical brick-lined reaction chamber. Preheated air and natural gas burn the carbon, followed by a second reaction chamber to ensure the gases are completely burned. Heat is recovered to the foundry by counter-current water flow through the regenerated sand. The sand is further cleaned of impurities in a counter-current impact mill consisting of two gas jets, which clean the particles with application of friction.

MATERIALS BALANCE:

waste type—Foundry sand, Gas, scrubber water, sludge, scrap metal

medium—Air, water, solid

waste reduction by—Recover product from waste

waste production—Sand requiring disposal is reduced by 75-80% of that after conventional treatment

feedstock reduction—Operating costs are reduced to 282,110 DM yr if heat is recovered

ECONOMICS:

capital cost—5,480,000 DM

operation/maintenance—532,333 DM yr (regenerating 5 tons of sand hr)

disposal & feedstock—47.67 DM ton in disposal of sand

impacts—Pollution regulations governing waste gas emissions and the disposal of the sand have become more stringent, making conventional treatments less attractive. This process is effective, lower costs, and produces regenerated sand of similar quality to fresh sand.

1629 CLIMBING-FILM VACUUM EVAPORATOR AND OXIDATION SYSTEM FOR CHROMIUM RECOVERY—ISIC CODE: 32 [CST-UNEP000234]

SUMMARY: General Motors uses climbing-film vacuum evaporator and oxidation system for chromium recovery and recovers capital cost in less than two months. A climbing-film vacuum evaporator, consisting of an etch tank followed by four rinse tanks, was purchased by GM to recover chromium from electroplating baths. Three evaporators were installed on the plastic-preplate line, and a substantial reduction was noted in the amount of waste chromium being treated. Two electrolytic oxidation systems were used to recover chromium that remained in solution.

MATERIALS BALANCE:

waste type—Chromium electroplating baths—spent bath chemicals, chromium

medium—Liquid

waste reduction by—Metals recovery

waste production—The amount of waste chromium being treated after evaporation was substantially reduced

feedstock reduction—1.05 million lbs of chromic acid were recovered in the first year, with an additional 230,000 lbs recovered by oxidation.

ECONOMICS:

capital cost—\$170,000 for three evaporators and two oxidation systems

months to recover—< 2

disposal & feedstock—\$1.44 million in the first year

impacts—Spent chromium electroplating baths requiring disposal are being evaporated with chromium recovered as chromic acid for reuse. A reduction in waste volume is realized along with overall savings.

1630 REPLACING CHROMIC ACID SOLUTION IN PLATING BATH SOLUTION—ISIC CODE: 32 [CST-UNEP000235]

SUMMARY: Replacing Chromic Acid Solution in Plating Bath Solution with trivalent chromium reduces volume of sludge generated

This plant carries out decorative chrome plating. Chromic acid solution was originally used in the plating bath. 150 lb of chromic acid solution were replaced every week due to dragout losses. The dragout was treated by conventional

precipitation of chromium as Cr(III). The sludge generated was disposed off-site. This facility has 48 employees, with annual revenues of greater than \$1 million.

stage of development—Fully implemented

technology principle—In order to reduce the quantity of sludge generated by the treatment of the plating bath dragout, the plant replaced the plating bath solution. The original plating bath solution contained Cr(VI). The new plating bath solution (Envirochrome) contains Cr(III) at lower concentrations. One gallon of dragout of the old solution containing 32 oz of Cr(VI), generated 7.11 pounds of sludge when treated. One gallon of dragout of the new solution generates 0.3 lb when treated.

cross-industry application—Chromium plating bath solution

MATERIALS BALANCE:

waste type—Cr(III), spent anodizing solution

medium—Liquid

waste reduction by—Substitute less toxic raw material

waste production—7.1 lb sludge per gal dragout (before), 0.3 lb sludge per gal dragout (after)

feedstock reduction—150 lb wk chromic acid replaced

ECONOMICS:

capital cost—\$46,000 (1987)

impact—More than 90% reduction in the quantity of sludge generated. Two months evaluation on product quality produced acceptable results

benefits—Economic savings in waste treatment costs \$16,000 savings in equipment cost, 19,000 \$/yr savings in treatment costs (including materials and labor for treatment chemicals, sludge treatment, etc.); Reduced liabilities by reducing the quantity of hazardous waste generated. Regulatory compliance is easier with a reduction in the quantity of F006 F007 wastewater treatment sludge resulting from electroplating operations.

(CONTACT: Richard J. Gimello, Susan B. Boyle, New Jersey Hazardous Waste Facilities Siting Commission, 28 West State Street, Trenton, N.J. 08608)

1631 SOLVENT WASTE RECYCLING AND REUSE ON SITE—ISIC CODE: 2833 [CST-UNEP000236]

SUMMARY: Manufacturing of antibiotics by organic synthesis generated hazardous waste, including wastewater containing 10% acetone. The wastewater was discharged for treatment to POTW. It was estimated that 200,000 lb yr of acetone were discharged with the wastewater. This facility has more than 100 employees, and manifested more 1000 tons of waste between 1981-1985.

stage of development—Fully implemented. Solvent recovery systems are commercially available for a wide range of applications.

technology principle—Conventional separation processes were used to recover and reuse 70% of acetone by weight, from the wastewater. The recycling operation generates still bottoms which are disposed off-site. Existing process equipment was used to implement acetone recovery.

cross-industry application—Recovery and reuse of acetone

MATERIALS BALANCE:

waste type—Acetone, water waste solvent stream

medium—Liquid

waste reduction by—Solvent recovery

waste production—100 tons yr (before), 30 tons yr (after)

ECONOMICS:

impact—70% of acetone by weight is recovered

benefits—\$70,000 annual savings in treatment costs. Reduced liabilities by reducing the quantity of hazardous waste generated. Progress toward zero discharge

(CONTACT: Richard J. Gimello, Susan B. Boyle, New Jersey Hazardous Waste Facilities Siting Commission, 28 West State Street, Trenton, N.J. 08608)

1632 MODIFICATIONS TO THE MANUFACTURING PROCESSES RESULT IN REDUCED QUANTITY OF WASTE GENERATED—ISIC CODE: 2865 [CST-UNEP000237]

SUMMARY: The manufacture of plasticizers, such as phthalic anhydride or phthalic esters, generate the following listed wastes: K015 (still bottoms from the distillation of benzyl chloride), K023 (distillation light ends from the production of phthalic anhydride from naphthalene), and K024 (distillation bottoms from the production of phthalic anhydride from naphthalene). Approximately 5 million lb yr of these wastes were generated at this plant. Some wastes were incinerated, and some were landfilled both on site and off-site. This facility has more than 100 employees, and more than 1000 tons of waste manifested between

1981-1985.

stage of development—Fully implemented

technology principle—Manufacturing processes were modified to reduce the quantity of hazardous waste generated by 13%. Process modifications include: additional recycling of distillation overhead waste, installation of on-line analyzers to reduce the production of by-products, better control of chemical reactions to improve yield.

cross-industry application—Organic manufacturing

MATERIALS BALANCE:

waste type—Mixed organic chemicals K015, K023, K024

medium—Liquid, solid

waste reduction by—Solvent recovery; Process equipment modification

waste production—2500 tons yr (before), 2175 tons yr (after)

ECONOMICS:

capital cost—\$500,000 (1987)

impact—13% reduction in the quantity of hazardous waste generated

benefits—\$78,000 annual savings in treatment disposal costs; Reduced liabilities by reducing the quantity of hazardous waste generated. Regulatory compliance is easier with a 13% reduction in the quantity of listed hazardous waste generated at this plant.

(CONTACT: Richard J. Gimello, Susan B. Boyle, New Jersey Hazardous Waste Facilities Siting Commission, 28 West State Street, Trenton, N.J. 08608)

1633 ON-SITE RECYCLING AND REUSE OF ALCOHOL WASH SOLUTION—ISIC CODE: 2821 [CST-UNEP000238]

SUMMARY: Phenol formaldehyde is manufactured in batch reactors. The reactors are cleaned with alcohol every time a change is made in product specifications. This facility has 50 employees, and annual revenues of \$5-10 million.

stage of development—Fully implemented. Alcohol recovery systems are readily available.

technology principle—This plant generated 6,000 gal yr of reactor wash solution containing approximately 50% alcohol, phenol formaldehyde resin, and water. Economic considerations prompted the plant to recycle on site by distilling and reusing the alcohol. The distillation kettle was already available on site. Steam was available at negligible costs. The resin removed from the reactor can also be reused. Laboratory analysis of synthetic resins also generates waste which is disposed off-site. Segregation of these wastes was attempted, but it was impractical due to the small quantities generated, i.e. 2-3 drums month. Proper disposal is the only option available for managing these wastes.

cross-industry application—Wash alcohol recovery

MATERIALS BALANCE:

waste type—Alcohol, resin, water from reactor wash solution

medium—Slurry

waste reduction by—Solvent recovery

waste production—6,000 gal yr (before), < 2,000 gal yr (after)

ECONOMICS:

disposal & feedstock—\$40 drum of waste to treat off site. Alcohol costs \$1.60 gal.

impact—Better than 67% reduction of waste generated and disposed off-site.

benefits—\$15,000 annual savings in material and treatment costs; Reduced liabilities by reducing the quantity of hazardous waste generated. Regulatory compliance is easier with reduced volumes of F003 wastes disposed off-site.

(CONTACT: Richard J. Gimello, Susan B. Boyle, New Jersey Hazardous Waste Facilities Siting Commission, 28 West State Street, Trenton, N.J. 08608)

1634 SUBSTITUTION OF METALWORKING FLUID AND SUBSTITUTION OF SOLVENT-BASED PAINT—ISIC CODE: CST-UNEP000239]

SUMMARY: Substitution of metalworking fluid promotes less need for organic solvent degreasing and substitution of solvent-based paint with powdered paints further minimizes organic solvent emissions. Fixture manufacturing facility utilized a mineral oil-based cutting oil for metalworking. Manufactured components were then degreased using trichloroethylene solvent. Solvent-based paints were utilized in the final finishing of parts. The new program relies upon the use of vegetable oil-based cutting oil for metalworking operations. Substitution with this material allows parts degreasing with an alkaline detergent solution. Use of powdered paints results in reduced organic solvent vapor emissions and reduced operating costs. Produces 400,000 pieces yr.

stage of development—Clean technology is fully implemented and commercialized.

technology principle—This clean technology scheme involves the substitution of mineral oil-based metalworking fluids with a vegetable-oil replacement switch from trichloroethylene degreasing to alkaline water-based detergent system and utilization of powdered paints instead of solvent-based liquid paints. Program reduced trichloroethylene and mineral solvent emissions.

MATERIALS BALANCE:

waste type—Metalworking fluid solvent-based paint

medium—Liquid

waste reduction by—Material substitution, powder process, substitute less toxic raw material

waste production—Trichloroethylene vapor: 5 tons yr less than before

Mineral Solvent vapor: 30 tons yr less than before

ECONOMICS:

capital cost—Investment for system for powdered painting was \$383,000

operation/maintenance—Vegetable-based oil use saves \$5,000 yr over mineral oil.

Trichloroethylene use would have required investment of \$50,000 for recycling unit plus additional \$9,000 yr operating expenses. Previous cost was \$10,000 yr with \$500,000 yr operating costs.

Operating costs for powder painting is \$415,800 yr less than for solvent-based painting. Initial investment for painting system was \$383,000.

months to recover—Payback for painting system changeover investment was less than 1 year.

impact—New processes do away with the need for trichloroethylene degreasing; organic solvent emissions are minimized and costs associated with solvent purchase and waste disposal greatly reduced. Cutting oil costs are also reduced. Further, workplace exposure to solvents is prevented. In addition, new system facilitates continuing compliance with air pollution standards.

assumptions—Payback period calculation for new powder painting system based upon provided annual cost savings estimate only.

(CONTACT: Garnkonst AB, P.O. Box 305, S-261 23 Landskrona, Sweden)

1635 REPLACEMENT OF HEXAVALENT CHROMIUM WITH TRIVALENT CHROMIUM IN DECORATIVE CHROME PLATING—ISIC CODE: 3471 [CST-UNEP000240]

SUMMARY: Replacement of hexavalent chromium with trivalent chromium in decorative chrome plating reduces sludge generation. Although the composition of the plating line was not clear from the source document, it is assumed that the sequence consists of bright nickel plating with drag-out recovery, two clean running rinses, chrome plate, two additional rinses, and a final hot rinse. In the traditional process, hexavalent concentrations are sometimes as high as 120 g/l. Trivalent chromium replaces hexavalent chromium in the new process and organic compounds are added. This results in a decrease in sludge generation of over 95%, energy consumption reduced by over 50%, lower current densities, no chloride in the electrolyte, and a 98% reduction in waste treatment costs. No reduction chemicals are needed with the new process. Product quality was greatly improved due to better coverage and more uniform plating.

stage of development—The technology has been fully implemented and in operation since about 1985. It appears the company has developed the procedure and sells it under the name "Envirochrome-90". The membranes were developed for mercury-free electrolysis of sodium chloride. Canning is a supplier of machineries to the electroplating industry.

technology principle—The cleaner production is achieved by plating with trivalent rather than hexavalent chromium. The tendency of trivalent chromium to be oxidized to hexavalent chromium was overcome by using a special membrane surrounding the anodes. This also allows use of anodes made of lead. The low deposition rates associated with trivalent chrome plating were grossly increased by using specially developed in-house organic additives to modify the reactions and give performances superior to the traditional process. This results in production which is 20-40% higher.

MATERIALS BALANCE:

waste reduction by—Process modification, material substitution, substitute less toxic raw material

waste production—

Before*	After*
100%	95%

Sludge production decreased by 95%, waste treatment costs decreased by 98%.

feedstock reduction—

	Before*	After*
Energy consumption	100%	50%
Current densities	10-15 Amp dm ²	3.2-8 Amp dm ² (8-12V)

*Exact quantities were not supplied.

Power consumption decreased by over 50%. Electrical current densities are lower and the electrolyte is less corrosive since no chloride is present.

ECONOMICS: (in pounds sterling?)

capital cost—Actual figures on investments are not given, and these estimates may be low. A comparison is made on the investment costs for a traditional plating line and the new plating process for a plant producing 3 million nickel and chrome plated water fittings per year.

	Traditional	New
Plating plant	175,000	135,000
Effluent plant	70,000	52,000

operation/maintenance—Only costs for water treatment were given for the traditional and new technologies as follows:

	Traditional	New
Chrome reduction	6,459	0
Hydrovide precip.	1,605	120
Sludge disposal	2,905	130
Labor and materials	2,050	50
Total	13,064	300

No costs were given for labor, maintenance of membranes, or energy consumption for other operations. Membrane life is assumed to be indefinite since no signs of wear occurred after five years of operation.

months to recover—It is not possible to calculate a payback time due to lack of data but appears the technology is relatively cheap compared to the traditional technology.

impact—The technology appears to be cheaper than the traditional process and results in improved product quality. Brownish color of trivalent chrome may be a problem for some people.

assumptions—

1. Some assumptions were made regarding the manufacturing process description.
 2. Although detailed cost data were not provided, it can be assumed that the technology is relatively inexpensive compared to the traditional process.
- (CONTACT: W. Canning Materials Ltd., P.O. Box 288, Great Hampton Street, Birmingham B18 6AS, U.K. TEL 4421-236-8621, FAX 4421-236-0444)

1636 REMOVAL OF CATIONS FROM CHROMIC ACID EVAPORATION—ISIC CODE: 3471 [CST-UNEP000241]

SUMMARY: Removal of cations from chromic acid and evaporation result in decreased sludge production and energy consumption. The plant operates a three step cascade rinse behind the plating baths and the water is used to replenish the water evaporating from the process baths. This is supplemented with demi water. In the original process, a final rinse with tap water occurred after the cascade.

Because of a build-up of undesired cations such as iron, copper, and nickel in the process baths, drag-out baths are now treated over a cation resin. The water of the final rinse has been substituted with demi water and is also treated over the resin. The process liquor is too aggressive to be treated. By using the waste heat of the cooling system and controlling the process bath temperature, an extra amount of water is evaporated. The resulting wastewater is still treated in a DND installation. Lifetime of the untreated baths was about five years with the original process.

In the original process, the starting power was 10 V and 15,000 Amp. The voltage increased at a rate of 1 V/A. Due to limitations in the transformers, this meant that after about five years the process baths had to be thrown away. In the current situation, the voltage increased two volts in five years of operation, and then remained stable.

Sludge production decreased from 10 tons to 0.4 tons in five years and 60 regenerations of the cation exchanger were performed using 1500 liters of hydrochloric acid. Tap water consumption decreased from 1330 to 15 m³ yr and demi water consumption went up 1320 m³ yr. Energy consumption decreased from 99 MWH yr to 59 MWH yr or more than 40%. The consumption of chromic acid decreased by 2,000 liters yr and chemicals for the DND installation decreased from 2,000 to 20 liters yr.

No effects on product quality were reported in the source document although quality should have improved since foreign elements have been removed.

stage of development—The technology is fully implemented. All necessary parts are widely available.

technology principle—This technique involves use of a cation exchanger for continuous cleaning of drag-out baths and evaporation followed by water reuse.

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

waste production—

	Before	After
Sludge (tons)	10	0.4

feedstock reduction—

	Before	After
New chromic acid (tons)	10	N.A.
HCl (liters in 5 yrs.)	0	1500
Chemicals for DND (tons)	10	0.1
Tap water (m ³ /yr)	1330	15
Demi water (m ³ /yr)	N.A.	1320 m ³ /yr increase
Energy (MWH/yr)	99	59

The new technology resulted in decreases in power consumption, undesired metals in the deposited layer, sludge production, chromic acid, and chemicals needed for wastewater treatment.

ECONOMICS:

operation/maintenance—

	Old (Dfl)	New (Dfl)
New chromic acid	15,000	—
Waste disposal	3,500	140
Chemicals for DND	40,000	400
Power loss	74,250	44,550
Tap water	8,600	100
Extra demi water	—	33,000
Sewage costs	9,550	100

The following are savings realized using the new process:

Less chromic acid	3000 Dfl/yr
DND treatment chemicals	8000
Waste disposal	700
Power consumption	5340
Tap water	1900

months to recover—Costs over five years have decreased by Dfl 71,710. Since no investment costs were given, a payback period cannot be calculated. However, based on the cost information given and the cost of an ion exchanger, it can be estimated that the payback period would be less than one year.

(CONTACT: H. van Zessen, Koni BV, Langeweg 1, Oud-Beyerland, Netherlands. Phone (01860)12500)

1637 USE OF ACID PURIFICATION UNIT ON CONCENTRATED HIGH TEMPERATURE PICKLING LIQUOR—ISIC CODE: 2105 [CST-UNEP000242]

SUMMARY: Use of acid purification unit on concentrated high temperature pickling liquor reduces iron concentration.

In the original pickling process, no purification of the acidic liquor was undertaken. The liquid was discarded in a continuous "bleeding" process after the "bleed" was neutralized with lime.

The new process involves use of equipment consisting of three basic pieces and one optional piece: an Eco-Tec Acid Purification Unit AP30-24 HT cartridge filter and ion exchanger, a feed pump, an Eco-Tec sand filter and an optional 400 gallon (1100 liter) water supply tank. The pickle acid is pumped from the reservoir tank through a media filter to remove dirt and oil particles. The acid then passes through a second filter (0.5 m) to remove very fine particulate and filter media from reaching the resin bed in an ion exchange unit. The following stage contains three steps per cycle: the water displacement stage, the byproduct (iron) removal stage, and the produce (acid) return stage.

The water displacement phase allows the pickle acid into the resin bed, displacing the water from the previous cycle. This water can be reused by sending it to the water supply tank, or sent to drain; this stage lasts approximately one minute. The byproduct stage allows the pickle acid to continue its flow through the resin bed trapping the sulfate ions and allowing the iron to pass through and sent to

drain. This phase also takes about one minute.

The product return phase stops the flow of acid from the reservoir and starts a counterflow of water from a pressurized source (main water line or water supply tank pump). The water picks up the sulfate ions and returns them to the tank of sulfuric acid. This stage takes about two minutes.

This three phase cycle continues automatically until the dirt build-up in the media filter causes the process to automatically shut down. A back flush procedure is necessary to clean the filter before restarting the system again. Backflushing time is approximately one hour.

Using the new process results in the reduction of the iron content of the acid solution from an initial 7.7% to a steady 2.3% during the latter half of the test period. An 89% decrease in use of sulfuric acid and lime also resulted. No new materials are introduced in the process. Since pickling uniformity is a product quality improvement, product quality is at least as good as before using the APU, but this was not quantified.

stage of development—The installation is fully implemented. Data are derived from the last month of testing. The installation is fully commercially available. The vendor seems well equipped and experienced in construction and maintenance of the equipment.

technology principle—This technology involves the use of an acid purification unit (APU) consisting of filters and an ion exchanger to reduce iron content of the pickle acid.

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

feedstocks—

	Before	After
Sulfuric acid (lbs/yr)	629,089	67,558
Lime (computed tons/yr)	252	28

feedstock reduction—Annual savings on chemicals were \$25,942 for sulfuric acid and \$17,995 for lime, or a total of \$43,937. An estimated \$8,000 were saved on sludge hauling.

ECONOMICS:

capital cost—(US\$)

Design and supply of equipment	84,000.00
Equipment installation	10,000.00
Start-up, supplies, etc.	2,500.00
Total	94,000.00

These costs do not include the test program nor the management personnel costs for the project.

operation/maintenance—These costs are estimated at \$2500/yr.

months to recover—Payback time was calculated as 2.33 years. Annual savings on chemicals were calculated as \$43,937. Not included in the calculations are an estimated \$8,000 saved annually on sludge hauling.

impact—The project demonstrated that sulfuric acid used in preparing steel strip for electrogalvanizing could be reclaimed for continuous use.

obstacles—Except for some start-up problems, no other problems seem to have been encountered.

(CONTACT: Metal Koting, Continuous Colour Coat Ltd., 1430 Martin Grove Road, Rexdale ont. M9W 4Y1, Canada, phone (416) 743-7980)

1638 MEETING CLEAN WATER STANDARDS BY IN-LINE MEASURES IN AN ELECTROPLATING SHOP—ISIC CODE: 3471 [CST-UNEP000243]

SUMMARY: Meeting clean water standards by in-line measures in an electroplating shop. The plant operates four plating lines: an automated chrome-nickel line with one chrome and three nickel plating baths, a silver line with a cyanide containing pre-silver plating bath and a cyanidic silver plating bath, a bath for bright nickel plating, and a hard chrome plating bath. Before 1978, none of the lines contained static or spray rinse baths. These have now been installed and a chemec cell was installed in 1980. The chrome rinse is followed by a static rinse and a reduction tank for chrome (VI). Water from the static rinse is returned to the nickel bath at a rate of 200 liters/day and to the chrome bath at a rate of 50 liters/day. All rinse water comes together in a final stream for neutralization and is then sewer. In the original process, wastewater was sewer without treatment.

The small quantities of cyanides are not detoxified, but the Cr (VI) is detoxified with caustic soda and bisulfite. No new waste products are generated. Due to spray rinsing, water consumption has decreased about 5,000 m³/yr. The chemec-

lec cell recovers about 80 kg yr of nickel and spray rinsing results in 80 kg yr less of nickel and chromium being released to the sewer system.

The production capacity is 9,000 m² yr and employs 12 people, 9 of them in the electroplating shop. The shop operates 12 hours day, 360 days yr.

stage of development—The technology is fully implemented. All components needed are widely available. No data was provided for the process before 1978. In 1986, 16-20 kg yr of heavy metals are lost in the wastewater.

technology principle—This technology involves use of in-process measures such as static and spray rinsing and neutralization of wastewater from plating baths.

MATERIALS BALANCE:

waste reduction by—Improved operating practices

feedstock reduction—(Dfl/yr)

Water	3,000
Process chemicals	1,200
Pollution taxes	12,000
Total	16,200

ECONOMICS:

capital cost—Investment costs were Dfl 22,000 for rinse tanks and Dfl 75,000 for the chemec cell. Capital costs were reported as Dfl 19,400 per year.

operation/maintenance—Chemicals for the measures cost Dfl 5,000 per year.

months to recover—Payback time could not be calculated.

impact—The measures were probably implemented in an attempt to meet water regulatory limits. The shop meets the present and proposed future demands. The relationship with water regulation authorities is good. A Roska filter has been ordered to reduce water consumption from some 20,000 m³ yr to 10,000 m³ yr by reusing the water from the filter. The water authorities would like the water consumption to be reduced further to 5,000 m³ yr.

(CONTACT: H.W. du Mortier, VOM, Jan van Eycklaan 2, Postbus 120, 3720 AC Bilthoven, Netherlands. Phone 030-287111. Fax 030-287674)

1639 WATER REDUCTION AND WASTEWATER TREATMENT IN AN ELECTROPLATING PLANT OF PRINTED CIRCUIT BOARDS—ISIC CODE: 2113 [CST-UNEP000244]

SUMMARY: The process consists of four lines, two of which contain an acidic copper bath, a lead tin bath, and spray or cascade rinse baths. The third line is a stain bath with NH₄OH and the rinse water is returned to the bath. The fourth line is a mechanical brush line, releasing heavy metal particles. Before 1980, wastewater was sewered without treatment. It contained 5-8 mg/l of heavy metals, totally 160 kg yr. Concentrates were disposed as chemical waste by specialized companies.

In the new process, water reduction is achieved by changing the rinse baths to cascade rinse baths, using water from the cascade rinses for spray rinsing. The spray water is transported to a wastewater treatment installation.

The treatment begins by electrolytically recovering copper. Copper particles from a mechanical brush line are first dissolved by acids. Concentrations are decreased from 300-400 ppm to approximately 10 ppm. A further decrease in copper concentration is achieved by an ion exchanger, reducing the copper content to less than 1 ppm. Water containing heavy metals (only copper) in low concentrations undergoes neutralization and ultrafiltration. The sludge and concentrates are chemical waste and disposed of by specialized companies. Water not containing heavy metals is released without treatment.

Water use decreased by 15,000 m³ yr and 100-200 kg yr of sludge is produced. No new feedstocks were introduced and no effects on product quality were reported.

The facility produces 100 m² day of printed circuitry and employees 5 people in the electroplating department.

stage of development—The technology is fully implemented. All equipment is widely available.

technology principle—This technology involves using electrolysis and ion exchange to remove copper spray rinsing to reduce water usage and treatment of wastewater by neutralization and ultrafiltration.

MATERIALS BALANCE:

waste reduction by—Improved operating practices, extended use of raw material

waste production—(kg/yr)

	Before	After
Copper	160	1
Heavy metals	N.A.	negligible
Sludge	0	100-200
feedstocks—		
Water (m ³ yr)	25,000	10,000
Energy	N.A.	negligible

feedstock reduction—Water usage has decreased by 15,000 m³ yr and copper levels in the wastewater have decreased from 160 kg yr to 1 kg yr. Savings on copper were Dfl 6,000.

ECONOMICS:

capital cost—Investment costs were Dfl 350,000 for 1980. Capital costs were 35,000 Dfl yr.

operation/maintenance—Costs were 9,000 Dfl yr for chemicals and 3,000 Dfl yr for manpower.

months to recover—The investment will not be paid back since annual costs (Dfl 47,000) outweigh savings (Dfl 6,000 on copper).

impact—Demands by water regulation authorities prompted use of the measures. The facility now meets the regulatory standards.

obstacles—It took 7-8 months (1.5 man-years) to properly regulate the ultrafiltration system. No other problems were encountered.

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1640 REDUCTION OF LOSS OF PROCESS BATH LIQUOR BY MECHANICAL AND OTHER MEANS IN A SEMICONDUCTOR PLANT—ISIC CODE: [CST-UNEP000245]

SUMMARY: The plant operates one line in which copper products are stained and tin plated. After the stain bath (with sulfuric acid and peroxide) the workpieces are spray rinsed and the wastewater goes to the water purification plant. After the plating in a bath with lead and tin salts, the workpieces are spray rinsed in two steps. The water of the first step goes to the water treatment plant and the water of the second spray is neutralized and sewered.

In-line improvements include shortening the staining time and adapting positions and holders. Process liquids are removed from the workpieces by mechanical and physical means. A wastewater treatment plant has been constructed to treat plant water in a DND installation. Sludge is concentrated in a filter press and retreated to remove cadmium containing particles. The sludge is removed and the water is sewered. The composition of the streams leaving the plant are as follows:

	Clean (mg l)	Contaminated (mg l)
Lead	0.28	103
Tin	< 1	287
Copper	1.2	305

In the original operation, only one spray rinse after the tin bath was used. Wastewater was sewered without treatment and spent baths were taken to another plant of the same company. The in-line measures were undertaken in the early 1980's.

Sludge is a new waste product. No new materials were introduced. The company claims that the measures have decreased heavy metals in the wastewater by 30%. However, it is difficult to compare the old and new situations since production has grossly increased.

The capacity of the plant is 300,000 m² yr. The plant operates 6000 hours yr with 20 people working in the department.

stage of development—All improvements are fully implemented. All parts are widely available. The plant produces two water streams, a fairly clean stream which is sewered directly and a strongly contaminated stream which is combined with another dirty water stream from the factory before entering the DND installation.

technology principle—The technology uses spray rinsing in-process measures and wastewater neutralization and treatment to decrease heavy metals and lower water consumption.

MATERIALS BALANCE:

waste reduction by—Improved operating practices

waste production—(kg/yr)

	Clean		Contaminated	
	Before	After	Before	After
Lead	650	5.6	725	7.2
Tin	1350	< 20	2010	<12
Copper	900	16.4		4.8
Sludge		0		150

feedstocks—

Water from electroplating plant	45.000	20.000		7.000
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ECONOMICS:

capital cost—

Investment (Dfl)	900.000
Capital (Dfl.yr.)	180.000

operation/maintenance—(Dfl/yr)

Labor	90.000
Chemicals	50.000
Sludge Removal	45.000
Energy	13.000

months to recover—Annual savings were estimated at 378.000 Dfl yr. Savings were not quantified so payback could not be calculated.

impact—The improvements were made to reduce risks of accidents, reduce loss of copper and lower water consumption. According to company estimates the heavy metal content of the wastestream has been lowered by 30%.

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1641 IN-PROCESS MEASURES TO CYANIDE-FREE ZINC BATHS IN A STEEL FURNITURE FACTORY—ISIC CODE: 2000 [CST-UNEP0002-46]

SUMMARY: In-process measures to cyanide-free zinc baths in a steel furniture factory reduce metals in effluent. The company operates two lines which both contained cyanides originally. The first line is for cyanide-free nickel and zinc plating and blue passivation with chrome (VI), following a preparation line. It is an automated drum line but is not used much since it is very old. The second line contains an electrolytical zinc sulfate bath free of cyanides and a bath for blue or black passivation with chrome (VI). The other baths in the line are for degreasing, staining, rinsing (static and cascade), and acidic dipping. The zinc sulfate bath has a concentration of 6-7 g/l.

The in-line process measures included

- 1) changing to cyanide-free process baths;
- 2) partial return of water from the static bath to the process bath;
- 3) continuous filtration and monitoring of the zinc bath liquor;
- 4) longer dripping times;
- 5) spray rinsing over the process bath;
- 6) closed cooling system; and
- 7) installation of a water treatment system.

In the original process, wastewater was not treated but was directly sewerred. In the new process, the treatment system involves use of separate storage tanks for alkaline, acid and chrome-containing rinsewater streams and concentrates, final purification in a DND installation, and sludge dehydration in a filter press. Overflow from a sedimentation tank is sewerred. The new technology results in a decrease in the amount of metals released in the effluent. New feedstocks include sodium bisulfite for detoxification of Cr(VI), neutralization with lime, pH adjustment with hydrochloride or lye, and polyelectrolytes for flocculation. The resulting sludge is 25% dry matter containing iron, lime, and about 10% zinc.

Plant capacity is 12 million workpieces per year, equivalent to 700.000 m² of area or 500 tons of deposited metal per year. The plant employs 8 workers in the electroplating department.

stage of development—The technology is fully operational. All necessary components are widely available

technology principle—The technology involves in-line process measures such as cyanide-free process baths water reuse filtration and monitoring longer drip times spray rinsing closed cooling and wastewater treatment.

MATERIALS BALANCE:

waste reduction by— Substitute less toxic raw material, improved operating practices.

waste production —(kg/yr)

	Before	After
Metals in effluent	945	37
Sludge, 25% dry matter	0	80.000

feedstocks—

	Before	After
Lime(ton yr)	0	14
HCl (m ³ /yr)	0	7
NaOH (m ³ /yr)	0	7
Sodium bisulfite (ton yr)	0	14
Flocculation chemicals	0	N.A
Water Use (m ³ /yr)	330.000	20.000

* *Includes 3.500 m³/yr of non-contaminated cooling water used to prevent foaming in the end control pit.

ECONOMICS:

It is difficult to make cost estimates of the in-line measures since the rinse baths and other equipment were installed at the time the lines were constructed. Therefore, costs presented are for the water treatment system.

capital cost—Costs for the DND system were Dfl 545.000 for 1980 - 1982. Capital costs were 95.400 Dfl/yr.

operation/maintenance—(Dfl/yr)

Labor	53.000
Chemicals	35.000
Energy	17.000
Sludge removal	29.000

months to recover—Savings were estimated as 78.475 Dfl/yr from pollution taxes with costs estimated at 229.400 Dfl/yr. Net costs would be 150.925 Dfl/yr.

impact—The change to cyanide-free sulfate baths was inspired by safety considerations. The other measures were taken to meet public standards. The economic benefit is decreased taxes on heavy metal pollution, at a rate of 53.64 Dfl/kg or 78.475 Dfl/yr.

obstacles—It is more difficult to maintain the low zinc concentration at a constant level than in a cyanide bath.

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1642 MINIMIZATION OF WATER CONSUMPTION AND WASTE PRODUCTION IN ELECTROPLATING PLANTS—ISIC CODE: 3471 [CST-UNEP0002-47]

SUMMARY: The original process was not described but it appears it included one stat. bath and one flow rinse bath. The new technology uses dip-spray multiple counter-current rinsing, followed by a final continuous flow rinsing bath. Two tanks are used for the spray rinsing. Evaporation losses are supplemented with water from the first rinsing tank. Regeneration is achieved by ultrafiltration and the freezing out of soda. Metals are recovered by electrolysis. The new process results in greater than 98% reduction in water consumption, 95% reduction in sewage sludge produced, 98% reduction in nickel in the effluent, 98% reduction in copper in the effluent, and over 99% reduction in degreasing chemicals.

No new materials or additional wastes were mentioned. The stabilization of the process parameters has a positive effect on product quality.

At full capacity the plant consume 32 kg/day of copper, 41 kg/day of nickel, and 5 kg/day of tin. This corresponds to 1100 m² of nickel plating and 120 m² of acid tin plating per day.

stage of development—It appears that the changes have been implemented but this is not clear.

technology principle—This technology involves use of rinsing techniques ultrafiltration and electrolysis to conserve water and minimize waste generation from plating baths.

MATERIALS BALANCE:

waste reduction by— Improved operating practices; extended use of raw material

waste production—

	Before	After
Sewage sludge, 65% water (tons/yr)	23 6	1.2
Nickel in wastewater (kg/yr)	4.1	0.5
Copper in wastewater (kg/yr)	27.3	0.027
Degreasing chemicals	8000	800

feedstocks—

	Before	After
Water Use (m ³ /yr)	13670	236

Energy use increased. The recovery rate for free acid in pickling liquor was 80%.

ECONOMICS:

operation/maintenance— A preliminary estimation of the costs indicated an increase of 6.3% (0.009 DM d m⁻²) over the costs of the conventional operation.

impact— The project was originally undertaken as a test or demonstration facility in electroplating within the framework of the investment program for the impact on the environment, sponsored by the minister of the environment of the FRG. Benefits include decreases in water consumption, sludge production, and nickel, copper, and degreasing wastes.

obstacles—Space requirement for the Removal of plant components plant (rinsing tanks) and workshops. Maximum rate of utilization Storage for the workpieces and of the plant computer controlled electroplating process Long conveying distances Cross belt Complicated shapes of workpieces Final flow rinsing bath Reduction of wastewater nickel Process bath free of content of only 98.5% complexing agents (EDTA)

(CONTACT: Schempp & Decker GmbH & Co., Industriegalvanu AG, Am Stuehkanal 6-8, D-1000 Berlin 37)

1643 LOW COST REDUCTION IN WATER CONSUMPTION AND WASTE PRODUCTION IN AN ELECTRO-ZINC PLATING DEPARTMENT IN A SMALL IRONWARE FACTORY—ISIC CODE: 2000 [CST-UNEP000248]

SUMMARY: In the original process, there were two drum lines and the process baths were detoxified in situ with no purification. The plant now operates four plating lines including a large automatic cyanic zinc drum line, a large automatic acid zinc line, a manually operated zinc line, a manually operated nickel drum line with separate baths for brass and iron pieces. All lines contain passivation baths, preparative treatment, and rinsing and drying steps after plating. The in-line measures instituted for the large cyanic zinc line include longer dripping times, cascade rinsing, and a static bath with electrolytical zinc deposition. The static bath reduces the zinc content from an initial 6 g/l to 2 g/l and maintains it at that level. This results in 300 kg yr of deposition, with low energy consumption.

The rinse baths in the large acid zinc line have been converted into cascade rinses. The baths are checked frequently and continuously regulated and, therefore, spent baths are rare. Rinsewater is reused and water from the previous lines are used in subsequent lines. All rinsewater is collected in a dirty water pit, where pH is regulated, and NaClO is used for detoxification. The water is then sent to a Roska filter where coagulation and flocculation chemicals are added. The water is neutralized to a pH of 9 and the sludge is sent to a filter press. The spent passivation baths are detoxified in situ and filtered separately. Water leaving the water treatment system contains 3-6 mg/l of zinc with occasional peak loads of 12 mg/l.

No new wastes are produced other than the sludge. The coagulation and flocculation chemicals are new in the plant. The techniques resulted in a water reduction from 80,000 to 8,000 m³/yr and a strongly reduced metal content from 1352 kg yr in 1977 to 36 kg yr in 1986.

Plant capacity is 700 tons of door locks, screws, etc. annually, employing ten workers in the electroplating department.

stage of development—The technology is fully operational. The necessary equipment is widely available commercially.

technology principle—In-line measures to reduce water consumption include longer dripping times cascade rinsing continuous regulation of baths rinsewater reuse water purification and filtering.

MATERIALS BALANCE:

waste reduction by— Improved operating practices; extended use of raw material

waste production—(kg/yr)

	Before	After
Metals in rinsewater	1351	36

feedstocks—(m³/yr)

	Before	After
NaClO, 30%		16
NaOH, 33%		3
HCl, 33%		7
Water	80,000	8,000
Energy	N.A.	negligible

ECONOMICS:

capital cost—(Dfl)

Roska filter	150,000
Filter press	37,000
Building	18,000
Receivi g pits	25,000
Pumps, regulation system, etc.	50,000
Total	280,000

Capital costs were reported as 51,700 Dfl/yr.

operation/maintenance—(Dfl/yr)

Labor	25,000
Maintenance	4,000
Chemicals	10,000
Sludge removal	3,400

months to recover—Total annual costs were 94,100 Dfl/yr. Savings from reduced water consumption and decreased metal purchases were not reported. Therefore, a payback time could not be calculated.

impact—The measures were undertaken to reduce water consumption and satisfy water regulation limits. Decreases in metal levels in the rinsewater, water consumption, and metal purchases appear to be the benefits, although cost savings were not reported. The plant does not full meet regulatory standards, probably due to sludge flakes in the overflow water of the settlement tank.

obstacles—No problems seem to have been encountered.

assumptions—Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors

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1644 REDUCTION OF LOSS OF PRECIOUS METALS THROUGH ION EXCHANGE, ELECTROLYSIS, AND OTHER IN-PROCESS MEASURES IN AN ELECTROTECHNICAL COMPANY—ISIC CODE: CST-UNEP000249]

SUMMARY: The company operates copper, nickel, and silver plating lines. Processes within the lines include degreasing baths without cyanides, acid staining baths, and pre-silver plating baths, baths for plating and unplating silver and copper, and nickel baths.

The in-process measures undertaken include blowing off process liquors, electrolytical recovery of silver and wastewater treatment. Rinsewater from the silver line is first treated in a cartridge ion exchanger. Nickel containing rinsewater is first treated in a cation exchanger at a rate of 15 m³/hr. Cyanide-containing rinsewaters, degreasing waters, and acid stain bath waters are treated in a DND installation. Cyanide-containing concentrates are conveyed to third parties, except for the silver bath which is reclaimed electrolytically.

The wastestream of 30,000 m³/yr (1977) of untreated, heavily contaminated water has been changed to a stream of 70,000 m³/yr (1986) of slightly contaminated water. New wastes produced are about 10,000 kg yr of sludge.

The plant capacity is about 300,000 m²/yr, employing 25 people in the galvanizing department.

stage of development—The changes have been fully implemented. All equipment is commercially widely available

technology principle—This technology involves electrolytic recovery ion exchange and wastewater treatment to reduce metal loss from nickel, copper and silver plating processes.

MATERIALS BALANCE:

waste reduction by— Metals recovery

waste production—(kg/yr)

	Before	After
Sludge	N.A.	10,000
Metals lost in wastewater		
Copper	1000	20-30
Nickel	1000	30-50
Silver	350	15-20

feedstocks—(metric tons/yr)

	Before	After
HCl	0	15
NaOH	0	150
NaClO	0	150
Water (m ³ /yr)	30,000	70,000
Energy (Dfl/yr):		
For blowing off	0	135,000
For water treatment	0	35,000

ECONOMICS:

capital cost—Capital costs are estimated at 100,000 Dfl/yr. No costs are associated with sludge removal since the sludge is treated for metal recovery by a third party in the U.S.

1977 Dfl	210,000
1981	276,000
1984	350,000
	15,000 (includes measurements, etc.)
Total	986,000

operation/maintenance—(Dfl)

Labor	190,000
Energy	35,000
Chemicals	200,000
Removal of strikes	90,000
Removal of silver baths	90,000

months to recover—As annual costs are estimated at Dfl 705,000 and savings on wastewater release and purchase from copper and nickel salts are 64,500 Dfl/yr and 15,000 Dfl/yr, respectively, the equipment will not pay for itself.

impact—The measures were undertaken to meet water regulation demands. The bylaw limits have been met. The limits are 0.5 mg/l of nickel in a substream, 0.25 mg/l of nickel in the mainstream, 1 mg/l of copper, and 1 mg/l of silver. The proposed freight demands of 2 kg/yr per metal are not met.

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1645 USE OF CHEMELEC CELL RECOVERS ZINC IN LOW CONCENTRATION IRON-CONTAINING RINSEWATERS—ISIC CODE: 2105 [CST-UNEP000250]

SUMMARY: The original effluent system was based on conventional methods of pH adjustment, precipitation of metals as hydroxides, filtration and dewatering of sludge, and disposal in a landfill. In the new process, rinsewaters following pickling and plating operations are pumped from a drag-out tank to a reservoir tank and are then transferred to the electrolysis chamber of the Chemelec unit. This chamber is fitted with a number of mesh electrodes providing the large surface area required for the electrolysis of dilute electrolytes. The electrodes are situated in a bed of inert glass beads fluidized¹, the action of the pumped liquids. To reduce the effects of the boundary or diffusion layer at the cathodes, the solution must be agitated. Sufficient agitation is obtained from the pumping action and the activity of the glass beads to permit relatively high rates of deposition, as confirmed by the rather high calculated cathode efficiencies, varying from 23% at an initial 1 g/l to 94% at an initial 4.3 g/l. When operating with four Chemelec modules, the system was capable of maintaining a zinc concentration of under 1 g/l. The zinc deposits were smooth, adherent, and dissolved satisfactorily when used as anodes in the zinc cyanide plating baths, regardless of iron content (4.2% on the average).

The company processes about 2500 tons/month and employed 70 people in 1987 at one site, engaged in the bulk processing of small product in electroplating zinc and cadmium, zinc phosphate and dip galvanizing.

stage of development—The technology is fully implemented. The equipment appears to be of the company's own design and construction.

technology principle—This technology uses a Chemelec system to recover zinc from pickling and plating rinsewaters. The rinsewaters are iron-containing with low metal concentrations.

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

waste production—The achieved zinc concentration of 1 g/l corresponds to a total drag-out of 140 g/hr. At a rinse flow of 3375 liters/hr, this corresponds to an effluent concentration of 41 ppm which does not meet the effluent quality standards of 5 ppm.

Total zinc drag-out was reduced from 980 g/hr to 140 g/hr, a reduction of 86%, with an extra energy requirement of 6.4 kW (36.9kW have been installed).

ECONOMICS:

capital cost—Investment costs were \$180,000 for equipment and installation with an expected life of 10 years.

operation/maintenance—Labor costs are estimated at \$1.67/hr and energy costs at \$1.53/hr (based on the full installed capacity of 36.9 kW). With 7200 hours of operation per year this is a total of \$23,040/yr (1987).

months to recover—Annual costs were estimated to be \$41,040 and savings from recovered zinc and avoidance of landfilling were estimated at \$2,70/hr or \$19,440/yr. Therefore, there will be no payback.

impact—Company growth, tightening limits for effluent discharges, the high costs of sludge disposal and possible future difficulty in finding disposal sites all contributed to the company's interest in alternative technologies for controlling metal concentrations in effluents.

obstacles—The primary problem with this technology was pH control, resulting in operation at pH values both higher and lower than specified. For a successful operation of the system the pH must remain below 6, as otherwise iron will be precipitated as hydroxide, impairing the good functioning of the beads and thus cluttering the flow. The bead retention basket proved incapable of holding the glass beads. The escaped beads penetrated the pumping mechanism, creating problems. Low pH values led to generation of chlorine gas at the anodes, necessitating the addition of a fume extraction system. Suggested remedies include installing a reliable pH control unit before the effluent enters the reservoir, installing an automatic shut-off to prevent the reservoirs from overflowing, and filtering precipitated iron out before the reservoir stage.

(CONTACT: Torcad Ltd., 275 Norseman Street, Toronto, Ontario M8Z 2R5, Canada)

1646 CHROME IS ELIMINATED FROM SLUDGE BY ION EXCHANGE IN A TIN PLATING LINE—ISIC CODE: 2017 [CST-UNEP000251]

SUMMARY: The plating line contains degreasing, staining, electro tin plating, rinses chromatic passivation, and a final rinse. The passivation bath containing hexavalent chrome is purified or replenished in a continuous process by water from the running rinse following it. The existing anion exchanger has been modified so the resin volume is greater, capable of containing 80 kg instead of 50 kg of hexavalent chrome. The effluents of the anion exchanger are recovered and separated from those of the cation exchanger in order to concentrate the hexachrome into a small volume of water. Storage of the concentrated solutions is followed by a second pass over an ion exchanger. Chrome-free water contained in filters and cation exchangers is displaced. Two streams result from this process. One contains sodium bichromate (Na₂Cr₂O₇) and one contains acidic chrome (H₂Cr₂O₇). These streams are mixed and the pH is kept at a constant value of 5 by automatically varying the proportions of the two streams. This solution of 10 g/l is returned to the plating line.

No new materials are introduced. The production of sludge has been reduced by over 85%. The sludge is almost completely chrome free. There were no effects on the final products.

stage of development—The changes have been fully implemented.

technology principle—This technology involves modification of ion exchanger to remove chrome from the plating baths of a tin plating line.

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

waste production—(kg/yr)

	Before	After
Sludge (dry material)	300,000	55,000
Chrome	5,300	70

feedstocks—(kg/yr)

	Before	After
Chromic Acid	4,000	3,750
Sodium Bichromate	23,000	4,930
Soda	68,500	27,300
Acidic sulfur	129,10	34,500
Sodium bisulfite	115,480	1,500
Lime	150,000	20,000
Water (liters/hr)	N/A	10-15
Energy:		
Electricity (KWh)	40,000	120,000
Pressurized air (m ³ /yr)	80,000	150,000

ECONOMICS:

capital cost—Investment costs for 1984 were 3 million French Francs (FF)
operation/maintenance—These costs were 258,600 FF yr.
months to recover—Material savings are 225,500 FF yr. There will be no payback.
impact—The new process allows the almost complete elimination of chrome in the sludges, producing about one-sixth of the original sludge quantity. The quantity of feedstocks needed are also reduced.
 (CONTACT: Usinoir, Mardyck, France)

1647 RESOURCE RECOVERY AND ENVIRONMENTAL CONTROL IN A NICKEL-CHROME PLATING INDUSTRY—ISIC CODE: 3471 [CST-UNEP000252]

SUMMARY: The manufacturing process consists of two nickel-chrome plating lines. Four rinsing tanks and a drag-out tank are followed by the chrome bath, a drag-in tank, and five rinsing tanks in countercurrent. Prior to the clean technology, effluents from the running rinses on both plating lines were discharged to a conventional chemical destruct treatment system consisting of bisulfite reduction of chromate, pH adjustment, and the settling of chromium (III) hydroxide and sludge disposal.

In the new process, the final rinsewater is circulated through electrolytic cells containing a 1.2 cm thick ion permeable membrane separating two compartments. The membrane surrounds an inner compartment, approximately 3.4 liters in volume, in which chrome is concentrated. A direct electric current applied across the cell electrodes results in the chrome concentration in the anolyte solution. Low chromium concentrations are thereby maintained in the rinsewater and the anolyte solution is returned to the chrome bath after reaching a predetermined concentration. An Aqua Napper was also installed to reclaim chrome from the drag-in drag-out process water to make countercurrent rinsing possible. At full operation, the energy requirement is about 300,000 KWH yr.

The technology reduced the chromium concentration in the final rinse bath from 32 mg/l to an average of 9.8 mg/l. Further reduction to 7 mg/l may be possible since some spills could be prevented. Chrome savings results from use of the Aqua Napper and it was estimated that 95% of the total chrome recovery of 210 kg/month occurs in this system. Water consumption decreased from 173 liters/min. to 97 liters/min. Sludge production was negligible. The only waste produced is water from the final rinse tank.

Information was not provided on the scale of operation although it was indicated that 320 kg of chromium oxide flakes were used from April - September 1987.

stage of development—The equipment has been in operation since 1982 and fully available commercially. The supplier, Imcva in Clearwater, Florida has experience in delivering the installation.

technology principle—The technology is a Chrome-Napper™ system which circulates rinsewater through electrolytic cells containing an ion transfer membrane. Low concentrations of chromium are maintained in the rinsewater. An Aqua Napper is also used to reclaim chrome from the drag-in drag-out process water and allow for countercurrent rinsing.

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

waste production—(kg/month)

	Before	After
Chrome loss	210	N A

feedstocks—

	Before	After
Water l/min	173	97
Energy KWH/yr	N A	300,000

A chrome loss of 0.94 kg \$1000 sales was reported before the new system was in place compared with 0.14 kg \$1000 loss with the new system.

feedstock reduction—Purchases of chrome oxide (CrO₃) flakes are decreased, resulting in savings of \$13,300. The new process results in savings of \$23,500 in operating costs over conventional treatment.

ECONOMICS:

capital cost—Investment and IFC Demonstration Programme costs totaled \$156,790 in 1982.

operation/maintenance—(US\$)

Operation	1350
Maintenance	1300
Plant Overhead	1325

disposal & feedstock—(US\$)

Materials Membranes:	3000
Dememineralizer	3900
Electricity:	8540
TOTAL	19,415

Annual costs of the Chrome-Napper system were reported as \$30,043. An estimated \$13,300 yr of chrome is recovered from the system.

months to recover—Conventional treatment at full operation would cost \$53,571 yr. Payback time will be approximately 5 years.

impact—Chromium losses exceeded the municipal sewer bylaw limit of 10 mg/l as a result of poor performance of the conventional system. Rather than upgrade the chemical destruct system, Dovercourt looked for alternative technologies to allow chrome recovery and substantially reduce or completely eliminate sludge disposal. In a two year period prior to installation of the system, the sewer bylaw limit was exceeded in 14 of 16 samples. After installation, this occurred in 5 of 15 samples, all related to specific activities in the plant and all preventable.

obstacles—The Chrome-Napper must be operated using cool rinsewater. As this gave problems with product quality, the fifth and final rinse tank was converted into a hot running rinse and the Chrome Napper was connected to the fourth tank.

After ten months of operation, Dovercourt was forced to shut down one of its lines, due to build-up of unwanted cations, preventing plating of chrome. At the time the report was written, the cause of this phenomenon was still unknown. The problem had not occurred in the other plating lines to which the Chrome-Napper had been installed, neither at Dovercourt, nor elsewhere.

(CONTACT: Dovercourt Electroplating Co., Ltd., Toronto, Canada)

1648 MEMBRANE ELECTROLYSIS RESULTS IN ALMOST COMPLETE RECOVERY OF NICKEL FROM ELECTROPLATING WASTEWATERS—ISIC CODE: 3471 [CST-UNEP000253]

SUMMARY: Water purification was previously accomplished in a DND installation. For the new process, membrane electrolysis was selected because the high iron concentration in the solution can impair electrolysis operation. The wastewater is sent to ion exchangers where the stream of 4m³/hr with 0.5 g/l of nickel is concentrated to 10m³ week with a concentration of about 12 g/l. The wastestream is then passed to a membrane electrolysis cell where 99.8% or 5000 kg yr of nickel is reclaimed through batch treatment. The nickel content in the stream is reduced to less than 6 mg/l. The membrane in the cell is composed of perfluorinated PTFE. The cell operates at 7 V and with 900 A 4 days week.

The new technology reduces the rinse water flow, eliminates chlorine and sludge production, and recovers nickel for sale or reuse. There is no effect on the final product.

stage of development—The technology is fully implemented. From the case study, it was not clear whether the equipment was purchased or developed in the plant itself. On further inquiry, it became apparent that the equipment comes from Esmil, Diemen in the Netherlands.

technology principle—This technology involves in-process modifications using membrane electrolysis to recover nickel and reduce rinse water flow from electroplating processes.

MATERIALS BALANCE:

waste reduction by—Improved operating practices, extended use of raw material

ECONOMICS:

capital cost—Investment costs for the electrolysis system were reported as Dfl 715,000. Capital costs were reported as Dfl 100,000. No further breakdown was provided.

operation/maintenance—Operating and maintenance costs were reported to be Dfl 5,000 for energy, Dfl 15,000 for labor, and Dfl 14,000 for maintenance.

months to recover—Nickel savings can be estimated to be about Dfl 100,000 since 5000 kg yr of nickel are recovered at a rate of Dfl 20/kg. Savings on sludge hauling were not specified, however, the amount of sludge not produced was indicated as "tens of tons" and hauling rates are estimated at Dfl 300 to 500.

impact—This process recovers nickel for sale or reuse, reduces the quantity of wastewater requiring further treatment, and eliminates chlorine and sludge production. 5000 kg yr of nickel are reclaimed from the rinsewater.

obstacles—One problem which arose during implementation of the technology was the plugging of anode compartments with iron sludge from steel anodes. This was solved by using activated titanium anodes with a layer of indium oxide.

which also increased efficiency.

At the end of the process, a basic mist was produced above the anode compartments. This problem was eliminated by placing mist filters above the anode compartments. It was found that removal of nickel from the electrodes took about 5 to 6 hours. Using cathode cylinders treated with a contact oil before starting the process decreased the time to about 2 hours.

The problem of the control of the voltage rectifier being destroyed frequently was corrected by using oil cooling instead of air cooling.

(CONTACT: Egidius Jansen, Witveldweg 14, 5951 AV Belfeld, The Netherlands. Phone 04705-1444)

1649 ELECTROLYSIS AND ULTRAFILTRATION IN A LEAD-PLATING PLANT VIRTUALLY ELIMINATES HEAVY METALS FROM WASTEWATERS--ISIC CODE: 2085 [CST-UNEP000254]

SUMMARY: The facility has one lead plating line where workpieces are treated with sulfuric acid and copper is dissolved. A recirculating system is used for spray rinsing followed by staining in a zinc chloride bath. Thermal lead plating in a bath containing 6% tin is then followed by immersion in a cooling bath. A spray bath and a final immersion bath complete the process. Changes to the process included the addition of the cooling bath after the actual plating bath and the regeneration cell parallel to the acid bath.

The wastewater has been separated from the sanitary wastewater at the plant. The remaining wastewater is first sent to a collection pit and a storage tank. It is then treated in a mixing tank with lye and after flocculation goes to an ultrafiltration system. The permeate is sewerage and the concentrate thickened in a filter press.

The new measures involved constructing a regeneration cell parallel to the sulfuric acid bath to recover the dissolved copper. This has resulted in a considerable increase in the lifetime of this bath. The immersion bath cools the workpieces and removes copper oxides.

Water consumption at the facility is greatly reduced with the process modification. Wastewater flows of 18,000 m³ yr. containing 4,000 - 5,000 kg of heavy metals, has been reduced to 10,000 m³ yr. containing 700 kg of heavy metals. The new process requires small amounts of chemicals for neutralization and flocculation. Sludge is a new waste product resulting from the new process. No effects on product quality were experienced.

The facility employs one worker for 1800 hours year and has a production capacity of 30 tons of lead per year, deposited in a layer less than 100m thick.

stage of development—The measures are fully implemented. All equipment needed is widely available.

technology principle—This process involves removing heavy metals from plating wastewaters by electrolysis and ultrafiltration.

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

waste production—(kg/yr)

	Before	After
Heavy metals	4,000-5,000	<2
Sludge, 23% dry matter	0	10,000
Copper	N/A	<1
Zinc	N/A	<1
Nickel, chrome, lead	N/A	immeasurable

feedstocks—

	Before	After
Water (m ³ yr): (including 2,000 m ³ yr sanitary)	20,000	12,000

ECONOMICS:

capital cost— (Dfl)

Regeneration cell at acid bath	36,000
Separation of wastewater streams	33,000
Wastewater treatment system	235,000

operation/maintenance—(Dfl)

The following costs are required to operate the system:

Cooling bath	1,500
Regeneration cell maintenance	2,000
Regeneration cell operation	2,000
Wastewater treatment system—Chemicals (e.g. NaOH)	800
Sludge removal	4,000
Operation (6 manhours week)	10,000
Energy	2,000
Analyses	1,000

impact—Installation of the equipment was promoted by water regulation demands. Water consumption, wastewater quantities, and the quantity of heavy metal contained in wastewaters are decreased.

obstacles—Some minor start-up difficulties were experienced but not specified.

assumptions—Capital costs reported separately in the source document were included here with investment costs.

(CONTACT: H.W. du Mortier, VOM, Postbus 120, 3720 AC Bilthoven, Netherlands. Phone 030-287111)

1650 AN EXPERIMENTAL PROJECT USING AN ELECTROWINNING CELL AND ION EXCHANGE UNIT MINIMIZES WATER USAGE AND HAZARDOUS WASTE--ISIC CODE: 34712067 [CST-UNEP000256]

SUMMARY: The line on which the experiment was undertaken is composed of a bath for bright acid copper plating, followed by a "dead" rinse and two rinses in counterflow. Nothing about pretreatment is mentioned in the source document. The dead rinse consists of a tank of 1500 gallons used to replenish the volume lost from the plating bath. The first running rinse, also 1500 gallons, overflowed to the waste treatment facility. The second running of 3000 gallons, was fed with 4 gallons of city water per minute.

In the first stage of the project, an electrowinning system was introduced in a circulating loop with the dead rinse resulting in reduction in the copper content and in drag-out of copper into the running tanks. The electrowinning cell design consisted of a tank using up to 50 square feet of cathode material and 48 square feet of insoluble anode. A 300 Amp, six volt rectifier powered the cell. Current densities could be varied throughout the study. An air sparger was used to agitate the bath liquid, although no heating was used. After successful reduction of copper in the dead rinse, and thus in the running tanks, an ion exchange unit was installed to remove copper from the drag-out tank. The deionized water was returned to the last rinse bath. The ion exchange system consisted of a pump which supplied four gallons of water per minute to the system. Two ion exchange tanks containing 1.4 cubic feet of a strong acid resin were used. The dual system allowed one tank to be in service while the second tank automatically regenerated or was in standby position. The technology resulted in reduction of the copper concentration from 15 to 6 g/l in the static rinse tank. In seven months of operation, 360 pounds of salvageable copper have been recovered by the electrowinner. As a consequence, the concentration in the first counterflow rinse dropped from over 200 to below 50 mg/l.

The water coming from the ion exchange, has copper levels well below 0.01 mg/l and is reintroduced into the second counterflow tank. It was necessary to change from city water to softened water at the inlet. Regeneration is necessary every second day and takes about 20 minutes.

The run-off water from the first counterflow rinse contains 6 mg/l of copper. It is transformed into sludge in the waste treatment system.

stage of development—Implemented, but tests are continuing.

technology principle—This experimental technology uses an electrowinning cell and ion exchange system to recover copper and reduce water usage.

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

waste production— (lbs/day)

	Before	After
Sludge, 60% dry.	18.5	2.5

feedstocks—

	Before	After
Water (gpm)	4	2

Current density 8 ASF, surface area of 20 sq. ft., 6V, 950 W. See "Assumptions" for a discussion of sludge production calculations.

impact—Use of this technology was prompted by tightening control on dis-

charge limits and waste production in the U.S. Sludge production and water usage are reduced and salvageable copper are recovered.

obstacles—Copper at low concentrations in the electrowinner burned while plating. Lowering current densities also lowers plating to a rate at which the cell cannot keep pace with the drag-out rate. The running rinses had to be fed with demi water.

assumptions—No absolute figures on sludge production are given. It is assumed all wastes of the company are sent to the same facility.

As copper concentrations in the runoff water decreased by over 75% (from over 200 to below 50 mg/l) and the runoff was reduced from 4 to 2 gpm, it is assumed that the amount of copper entering the waste treatment facility from the experimental line decreased 87.5%. In the source document, a 75% reduction was claimed. The sludge production decreased by 16 lbs/day. From these figures, the before and after sludge production were computed.

(CONTACT: Kinetico Engineering Systems, Inc., Newbury, Ohio)

1651 CLEAN TECHNOLOGY MEASURES RESULT IN MINIMAL WASTE PRODUCTION IN ELECTROPLATING SHOP OF A LARGE COMPANY—ISIC CODE: 3471 [CST-UNEP000257]

SUMMARY: The plant operates twelve lines for all kinds of electrolytical surface treatment. Not all lines contain static rinses and one line contains cascade rinsing. In order to minimize waste generation, the lines are operated manually and drip plates are used between baths. Long drip-off times are achieved with slow movements in the process and workpieces are hung carefully. Static rinses are used where possible and a complete return of static rinse water into the process baths is achieved. Continuous treatment of process bath liquid maintains a constant bath quality. This includes electrolytic recovery of silver, activated carbon treatment, and filtration. Intense monitoring of baths maintains a constant composition and the lowest concentration of process chemicals possible is used.

The rinsewater streams of all lines are collected into one stream and sent to a water treatment system. Wastewater and concentrates of outside dischargers are also treated in the system. The contaminated water (200,000 m³/yr) is treated in an ion exchanger then is returned to the plant. A small part of the processed water is first sent to an extra mixed bed ion exchange device for more purification, and then returned to the plant. The regenerate of the ion exchanger is treated in a DND device, the neutralized water is filtered by a filter press and, if necessary, led over a selective ion exchanger to remove cadmium. The pH is corrected and the water is sewerred. The sludge is removed as chemical waste and transported to Western Germany. The rinsewater leaving the electroplating plant (200,000 m³/yr) has an estimated concentration of 5–30 mg/l of heavy metals. The final water released to the local sewer system has heavy metal concentrations far below the regulatory limits. Due to treatment of water and concentrates from outside dischargers, 600 m³/yr–1500 m³/yr are released to the sewer system. The process was installed, as described above, at the outset of operation. These measures are not changes to the process.

Five people work in the electroplating shop. The plant capacity was not provided. Three people are employed in the water treatment unit which has a capacity exceeding 200,000 m³/yr.

stage of development—The plant has been operative since 1968 and has undergone only slight modifications for process improvements since then. All necessary components are widely available. The measures were installed when the plant became operational so there is no "before" situation. The electroplating shop produces 200,000 m³/yr of contaminated liquids but this amount is completely reused after purification. The sludge production is 150 tons/yr of about 30% dry materials.

technology principle—Processes were designed to minimize heavy metal concentrations in rinsewaters and continuous treatment of process bath liquid in order to result in minimal water usage and waste generation.

MATERIALS BALANCE:

waste reduction by—Improved operating practices, extended use of raw material

ECONOMICS:

capital cost—Investment costs include Dfl 1,700,000, of which 1,000,000 were from construction of buildings. Capital costs were Dfl 1,600,000. The costs of the in-process measures cannot be estimated since they were part of the original investment. These costs are from 1970. According to the company, these costs would have tripled by 1986.

operation/maintenance—(Dfl)

Annual costs for the water purification system are as follows.

Maintenance and operation	200,000
Energy	30,000
Chemicals (100 tons/yr)	100,000
Sludge removal (150 tons/yr)	50,000

months to recover—Payback time could not be calculated.

impact—Reusing the water saves the company about Dfl 200,000/yr. Recovery of metals saves about 150,000/yr based on estimates of interviewees.

(CONTACT: H. W. du Mortier, VOM, Jan van Eycklaan 2, Postbus 120, 3720 AC Biltoven, Netherlands, phone 030-287111, fax 030-287674)

1652 DYEBATH REUSE IN JET DYEING—ISIC CODE: 2299 [CST-UNEP000258]

SUMMARY: Replenishing dyes were added to the used dye liquor at the end of a cycle to prepare the dye-bath for the next cycle.

Higher depletion rates were observed for dye carrier compared with dyes and other components, requiring higher recharge of dye carrier.

Dyebath reuse conserves dye and other specialty chemicals and conserves energy by avoiding the cost of reheating.

stage of development—The clean technology is fully implemented and commercialized.

technology principle—This technology involves dyebath reuse and consists of replenishing dyes in used dye liquor.

MATERIALS BALANCE:

waste reduction by—Improved operating practices, extended use of raw material

feedstocks—

	Before	After
Water gal/yr	500,000	140,000
Energy	7.06x10 ⁵	5.19x10 ⁵

ECONOMICS:

capital cost—Capital costs for modification of a typical jet dyeing machine and for the required analytical equipment was US \$15,000.

operation/maintenance—Savings were estimated to be \$120 to \$140 per cycle, resulting in annual savings of \$100,000. For some specific dyes (Yellow dye \$117.00/cycle; Black dye \$179.63/cycle; Blue dye \$141.89/cycle)

months to recover—Estimated payback period is 2 months.

benefits—savings in water, chemicals and energy.

obstacles—The high initial investment costs can pose a problem for some businesses.

1653 DYE BATHS ARE REUSED IN THE TEXTILE INDUSTRY—ISIC CODE: 2299 [CST-UNEP000259]

SUMMARY: Dyebath reuse consists of replenishing dyes and chemical auxiliaries to the used dye bath liquor at the end of each cycle to prepare the dyebath for the next cycle.

In addition to reducing waste effluent, dyebath reuse conserves dyes and specialty chemicals and conserves energy by avoiding the cost of reheating the dyebath. Dyebath reuse was employed with nylon pantyhose which were dyed in rotary drum machines. The textile plant is constantly dyeing 30 batches of hosiery in reuse sequences. Acid dyes and other chemical auxiliaries were used in the dyeing.

Approximately 612,000 pounds of textile products are produced annually.

technology principle—This technology involves dyebath reuse by replenishing dyes and chemical auxiliaries at the end of each cycle.

MATERIALS BALANCE:

waste reduction by—Improved operating practices, extended use of raw material

feedstocks—

	Before	After
Water gal load	363	216

ECONOMICS:

months to recover—Cost savings were estimated to be 2 cents per pounds of goods produced, or US \$12,240 per year.

impact—Dyebath reuse resulted in a 19% reduction in dyebath usage, a 35% reduction in chemical auxiliaries usage, a 43% decrease in water wastewater tax

and a 57% savings on energy.

obstacles—Capital costs to implement the dyebath reuse technology are high (CONTACT: Adams-Millis Company, High Point and Franklinton, North Carolina)

1654 RECOVERY OF ISOPROPYL IN TEXTILE PROCESSING OPERATIONS—ISIC CODE: 2282 [CST-UNEP000260]

SUMMARY: One of the processes used by this company in its production was the use of isopropyl alcohol as a solvent. The distillation of waste isopropyl was previously done off-site by another company, but this practice had several disadvantages. The average distillation losses ranged from 15 to 40%. Also, due to improper cleaning of the distillation column during the process, the isopropyl alcohol was found to be unusable due to contamination. Thus, each batch of recycled isopropyl had to be analyzed for contamination and if found unsuitable then disposal arrangements, including fees, had to be made.

American Enka purchased a used distillation unit for US \$7500 and modified it to redistill isopropyl alcohol in-house. The in-house distillation was found to be more efficient and recovered 90% of the alcohol, as opposed to 85% before. American Enka also utilized the still bottoms as an asphalt emulsifier in another product line.

technology principle—This company purchased its own isopropyl alcohol distillation unit to distill its isopropyl alcohol on-site

MATERIALS BALANCE:

waste reduction by—Solvent recovery

feedstocks—

	Before	After
Recovered	90%	85%

ECONOMICS:

capital cost—The used distillation unit cost US \$7500.

operation/maintenance—American Enka achieved a net savings of US \$90,000 per year.

months to recover—The payback period for this project was less than one month, \$90,000 per year. These savings resulted from the reuse of still bottoms as asphalt emulsifiers and the avoided costs of waste disposal.

(CONTACT: American Enka Company, North Carolina)

1655 CONVERSION OF WILLOW DUST INTO BIOGAS AT COTTON TEXTILE PROCESSING MILL—ISIC CODE: 2211 [CST-UNEP000261]

SUMMARY: Textile mills generate considerable quantities of solid waste materials during different stages of operation. Willow dust is a waste generated from a willow machine. In India, 30,000 to 33,000 tonnes of this material is generated every year. To convert this willow dust into biogas, a pilot plant was installed at Apollo Textile Mills in Bombay with assistance from the Cotton Textile Research Laboratory (CTRL). This plant has a 12.5 ton month capacity. 350m³ y of biogas was produced per 2 tons of willow dust for a retention period of 90 days.

The mill's average production of willow dust is 12.5 tons month. The consumption of liquid propane gas by the laboratory alone has been reduced by 65 kg since the installation of this converter.

The scientists at the CTRL have further developed a process which needs less water, and double the quantity of material can be accommodated in the same unit. Improvements have been made so that the calorific value of biogas is increased. Also, the organic substance that is a by-product of fermentation can serve as a good fertilizer.

Average monthly production of willow dust is 12.5 tons.

stage of development—The clean technology is fully implemented.

technology principle—The technology involves the conversion of willow dust into biogas and organic fertilizer.

MATERIALS BALANCE:

waste reduction by—Recover product from waste

feedstock reduction—

Biogas	12,000 m ³ year	63,412 rupees
Fertilizer	24 tons year	2,400 rupees

ECONOMICS:

capital cost—The investment cost of the project was 3.4 lakhs (lakh 100,000 rupees)

operation/maintenance—Operating costs, including water and collection of

willow dust and alkali, are about 18,000 rupees.

benefits—reduction in gas expenditures and waste disposal costs (CONTACT: Apollo Textile Mills Bombay, India)

1656 EFFICIENT RECOVERY AND REUSE OF CAUSTIC SODA FROM MERCERIZING WASHWATERS—ISIC CODE: 2299 [CST-UNEP000262]

SUMMARY: A plant floor study examined mercerizing machines and a caustic soda recovery plant in a textile mill. It was observed that only 75% of the caustic soda from washwaters was collected, compared to the normal 85%. Also, the caustic soda recovery plant only recovered 81% of the soda, as opposed to the normal 90%.

The probable causes of the low collection and recovery rates were inefficient washing in the mercerized material, poor squeeze and high quantities of caustic left on the fabric, overflowing leakage of dilute caustic soda solutions from the washing tank, and seepage from the underground storage tanks. The probable causes of poor recovery were the improper filtration of caustic soda solution prior to recovery, poor heat transfer coefficient in the recovery plant due to scaling of the metallic tubes of the heat exchanger, lower vacuum obtained by the barometric condenser, and the inefficient removal of non-condensate gases from the evaporation body. Necessary corrective steps were taken yielding significant cost savings.

stage of development—System was fully implemented.

technology principle—This technology involved the efficient recovery and reuse of caustic soda from mercerizing wastewater.

MATERIALS BALANCE:

waste reduction by—Recover product from waste

feedstocks—(kg/day)

	Before	After
	1,190	775

ECONOMICS:

operation/maintenance—(kg)

	Before	After
Mercerizing production day of fabric	10,000	10,000
Caustic soda input day	3,500	3,500
Collection from washwaters	2,630	2,975
Reuse of dilute solutions in bleaching	310	475
Caustic soda recoverable	2,320	2,500
Recovery of caustic soda	2,000	2,225
Total caustic soda consumed in mercerizing (total input less recovery reuse)	1,190	775

Saving of caustic soda day	415 kg
Savings per day	2,282.50 rupees
Savings per year	684,750 rupees

impact—Savings in caustic produced monetary benefits of 684,750 rupees per year and improved the quality of the fabric

(CONTACT: Bombay Textile Research Association (BTRA) Member Mill, Bombay, India)

1657 RECOVERY AND REUSE OF WATER IN WET PROCESSING IN A TEXTILE MILL—ISIC CODE: 2299 [CST-UNEP000263]

SUMMARY: In a BTRA member mill, a month-long study was carried out to study the opportunities for conservation and reuse of water in its wet processing department. The following measures were suggested:

1. Reduce the rate of flow of water and the throttling of water supply in washing machines
2. Counte the current flow of washing on soapers, mercerizing machines, J-box range, etc.
3. Effectively reuse wash waters at some preceding point in the processing sequence, or by a common sump and pump technique
4. Collect and reuse steam condensate for boiler feed water
5. Reuse steam condensate from caustic soda recovery plant in washing of mercerized goods
6. Apply static washes on jiggers in place of overflow washes
7. Use sodium bicarbonate in place of acetic acid for the oxidation of wet-dyed

goods for easy removal of caustic soda.

8. Recycle water for washing of blankets on printing machines.

9. Reduce the number of washings in a process sequence by giving appropriate treatments to fabric. The bulk trials for such conservation and reuse measures were carried out in the mills during the processing of a number of fabric varieties like bleached longcloth, dyed poplin, bleached mulls, voiles, and dyed mulls and voiles.

stage of development—Process suggestions fully implemented.

technology principle—The technology involves the recovery and reuse of waste water in wet processing.

MATERIALS BALANCE:

waste reduction by—Improved operating practices

feedstocks—Total fresh water consumption before the survey was 183,350 liters day. After the survey, consumption was 11,950 liters day. Net savings in fresh water consumption per year was 21,720,000 liters.

	Before	After
Water (liters day)	183,350	110,950
Water reused (liters day)	85,200	157,550

ECONOMICS:

operation/maintenance—Total fresh water consumption before survey was 183,350 liters day. After survey was 11,950 liters day. Total savings in water consumption per year 21,720,000 liters. Monetary benefits amounted to 130,320 rupees per year.

benefits—Savings from reduced water consumption amounted to 130,320 rupees per year (taking cost of water at 60 rupees per 10,000 liters of water).

(CONTACT: Bombay Textile Research Association (BTRA) Member Mill, Bombay, India)

1658 AN ALL-AQUEOUS METHOD OF PHTHALOGEN BLUE DYEING—ISIC CODE: 2299 [CST-UNEP000264]

SUMMARY: In one of the member mills of the BTRA, pthalogen blue dyeing was carried out by a solvent method using Ahurasol TRAF. It was suggested to the mill that it begin using an all-aqueous method of pthalogen blue dyeing. Large scale trials using this method were carried out. The new method's results were found to be comparable to the conventional process. In fact, the new method produced better coverage by the incorporation of small quantities of reactive dyes in the process.

This mill produced 100,000 meters month of material in the pthalogen blue shade.

technology principle—This technology involved the replacement of solvents from the pad bath formulation with an all-aqueous method of pthalogen blue dyeing.

MATERIALS BALANCE:

waste reduction by—Substitute less toxic raw material

feedstocks—

	Before	After
Chlore Blue 3GX	6.818	6.818
Copper Complex	13.636	13.636
Ahurasol TRAF	15.679	0
Urea	15.679	12.272
Noigen HC 30	0	6.818
Reactofix Red H8B	0.5	0.5
Ahuralan 42	0.1	0.1
Sodium Bicarbonate	1.136	1.136

ECONOMICS:

operation/maintenance—Savings per meter of fabric dyed is 0.156 rupees and total annual savings of 187,200 rupees. Savings per liter of pad bath formulation 2.09 rupees. Savings per month of same 15,600 rupees. Annual savings 187,200 rupees. Apart from direct economic benefits, there was an improved coverage of dye by incorporation of small quantities of reactive dyes.

(CONTACT: Bombay Textile Research Association (BTRA) Member Mill, Bombay, India)

1659 POLY VINYL ALCOHOL RECYCLING IN THE PROCESS OF "SIZING" COTTON FIBERS IN THE TEXTILE INDUSTRY--ISIC CODE: 2211 COTTON BROADWOVEN FABRIC MILLS [CST-UNEP000265]

SUMMARY: Poly vinyl alcohol (PVA), polyacrylates (PAA) and starch are used in the textile industry for "sizing" cotton fibers, a process where applied

chemicals confer strength to the fiber and protect it during the weaving process. The PVA, PAA and starch are removed from the cloth after weaving by washing it in hot water in a "desizing" operation resulting in an aqueous effluent containing these chemicals.

An ultra-filtration process to reduce the amount of PVA and starch in the effluent followed by a closed-loop recycling operation was tested for 16 months in a pilot plant. The ultra-filtration membrane used in this process recovered PVA successfully. Starch is enzymatically solubilized prior to desizing and, therefore, can not be recovered. The film forming characteristics of the PAA during testing were impaired by the formation of a calcium-polyacrylate complex.

stage of development—The process was tested for 16 months in a pilot plant.

technology principle—This technology involves the use of a closed-loop recycling including a ultra-filtration membrane process to capture poly vinyl alcohol (PVA).

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

ECONOMICS:

capital cost—The capital cost for the ultra-filtration plant is \$600,000.

operation/maintenance—Operating costs for ultra-filtration plant was \$61,000. Economic benefits were calculated in terms of raw material savings based on 4DE 6 meters year cloth production:

- a) PVA sizing \$ 420,000 year
- b) Enzymes \$ 100,000 year
- c) Steam \$ 20,000 year

This resulted in a net savings of \$ 485,000 year from reduced waste generation (900 tons year) and raw material purchasing needs.

months to recover—The payback period is 15 months.

1660 REDUCTION IN THE OIL CONSUMPTION IN THE SYNTHETIC FIBER INDUSTRY--ISIC CODE: 2299 [CST-UNEP000266]

SUMMARY: In the finishing steps of manufacture of dissolving grade pulp, at Harihar Polyfiber, the pulp is dewatered, flash dried, baled and packed. The mechanical dewatering was done to about 38% of dry content then the pulp was dried further to 70% of dry content using hot air at 300 Degrees C, generated by burning fuel oil.

In order to reduce the oil consumption and temperature of the hot air, two dewatering booster presses were installed in series after the existing dewatering presses running in parallel. This improved the dryness of pulp to ~50% and the temperature of the hot air could be brought down to 200 °C.

stage of development—The clean technology is fully implemented and commercialized.

technology principle—This technology involves equipment modification to reduce oil consumption and hot air temperature.

MATERIALS BALANCE:

waste reduction by—Improved operating practices

feedstock reduction—Improvement in dryness content of pulp by 50% and temperature of hot air is reduced from 300 °C to 200 °C.

ECONOMICS:

benefits—savings of Rs. 3.5 million year by reducing fuel oil consumption by about 14 kg tonne of pulp.

impact—improvement in pulp quality resulted by avoiding the "burnouts" due to higher temperatures of hot air. Environmental benefits include reduction in fuel oil consumption.

(CONTACT: Harihar Polyfibers, GRASIM, Karnataka, India.)

1661 HEAT RECUPERATION AND DYE BATH REUSE AT RUSSEL CORPORATION U.S.A—ISIC CODE: 2299 [CST-UNEP000267]

SUMMARY: Conversion efficiency of steam from boilers to hot water was improved during bleaching operations. Back-pressure regulating valves were installed to control line condensate, which flashed into steam and returned high temperature condensate the boiler.

Basic dyes are normally exhausted acidic baths for acrylic and certain other co-polymer material. Dye baths were reused up to 15 times successfully.

technology principle—The technologies in use involve heat recovery of water and recycling and reuse of dyes

MATERIALS BALANCE:

waste reduction by—Improved operating practices, recover product from waste

ECONOMICS:

capital cost—Capital costs for installation of equipment necessary to accomplish dye bath reuse was \$15,000.

benefits—For the heat recovery system, each 10 °F use of boiler feed water resulted in a 9% fuel saving. Total saving from use of the heat recovery system was \$1000 per day. For dye bath reuse, savings were estimated to be \$120 to \$140 per dye cycle. The annual savings were estimated at approximately \$100,000, components of dye chemical during the dye process was reported.

(CONTACT: Russel Corporation, USA)

1662 APPLICATION OF COUNTER-CURRENT RINSING AND WASHING IN WOOLLEN INDUSTRY—ISIC CODE: 2299 [CST-UNEP000269]

SUMMARY: Fleece (raw wool) contains about 40% impurities by weight which must be removed with the conventional technology. Fleece is beaten and then washed and rinsed in water. Centrifugation of wash water permits recovery of suint and recycling of part of the wash water to the washing baths. Mud and heavy grease separated by centrifuge are discharged to a holding pond.

A number of modifications and new operations are introduced. These include the reuse of rinse water rather than its discharge to public sewers. Effluent from the first washing bath is centrifuged to recover suint and to recycle partially washing water. Bottom residual water loaded with mud and heavy grease is subjected to further treatments consisting of a multiple effect evaporation to concentrate the grease. Water condensate is reused in rinsing and washing. Grease concentrate is vacuum dried to produce a combustible residue (oil distillate and bitumen) for the evaporation boiler. Liquid wastes are completely eliminated with the low waste technology.

No additional pollution control measures are required with the Low Wastage Technology, except for the treatment of fumes from the boiler with a bag-filter. Annual production capacity is 18,500 tonnes of wool per year (285 days of operation per year)

technology principle—This technology involves recycling reuse and reclamation of wool wash water.

MATERIALS BALANCE:**waste production—**

	Before	After
SO ₂ emissions kg/tonne wool	1.5	N A

feedstocks—

	Before	After
Water m ³ /tonne	7.5	2
Energy GJ/tonne	0.6	5.2

ECONOMICS:

capital cost—15,000,000 French Francs (1981) compared to 32,500,000 FF for conventional technology if a conventional effluent treatment is constructed.

1663 IMPROVED WASHING EQUIPMENT FOR POLLUTION LOAD REDUCTION IN A SYNTHETIC FIBER MILL—ISIC CODE: 2299 [CST-UNEP000270]

SUMMARY: Use a three-stage counter-current brown stock pressure washer at a pulp mill resulted in high alkali loss with the brown pulp stock, carry-over of liquid impurities with the pulp, and high chlorine consumption in the bleach stage. This contributed to the effluent load by way of discharge to chlorinated organic compounds, color, COD, etc. The spent liquor recovered from the washing plant was dilute, requiring more steam for evaporation. The introduction of a fourth-stage pressure wash in series with the previous three resulted in reduction in steam requirements and in chemical requirements, and in alleviation of problems caused by alkali loss, carry-over of lignin compound along with the pulp.

technology principle—Process equipment modifications to reduce energy and chemical consumption.

MATERIALS BALANCE:

waste reduction by—Improved operating practices, extended use of raw material

waste production—

	Before	After
Color	N A	40% reduction
Chlorinated organic compounds	N A	14% reduction
COD	N A	22% reduction

feedstocks—

	Before	After
Chlorine	N A	6.5 Kg T reduction
Alkali	N A	3.0 Kg T reduction
Steam	N A	0.2 T T reduction

ECONOMICS:

benefits—Reduction in steam requirements for evaporators, resulting in savings of Rs. 3.0 million year. Reduction in chemical requirements resulted in savings of Rs. 0.8 million year for chlorine and Rs. 19 million year for make-up alkali. (CONTACT: Harihar Polyfibers, GRASIM, Karnataka, India.)

1664 IMPROVING OPERATING CONDITIONS—ISIC CODE: CST-UNEP000271]

SUMMARY:

technology principle—A steam jet ejector has been used to remove moisture from the reactor tank prior to introducing the raw materials. By removing the moisture from inside the tank, product quality has increased and the amount of waste generated was reduced by 42%. Steam is used because the plant has excess steam capacity. After the steam exits the ejector, it is used to preheat another process stream before it is condensed in a heat exchanger.

cross-industry application—all that preclean the reactors

MATERIALS BALANCE:

waste reduction by—Improved operating practices

waste production—45,240 lb yr (before), 26,240 lb yr (after)

ECONOMICS:

capital cost—\$325 (1988)

months to recover—0.05 years (20 days)

impact—42% reduction in the quantity of waste generated. Improved product quality

benefits—5,940 \$ yr net annual savings; reduced liability resulting from reduced quantity of waste generated; source reduction

1665 CONTROLLING REACTION RATE REDUCES THE QUANTITY OF RAW MATERIALS WASTED—ISIC CODE: CST-UNEP000273]

SUMMARY:

technology principle—A conductivity meter was installed to continuously monitor changes in composition during a chemical reaction. Previously, the composition of the material was measured periodically in a laboratory. Under these conditions, raw materials were being disposed of as waste because of the incomplete reaction. By installing the conductivity meter, the reaction is allowed to go to completion, thus reducing the quantity of raw materials wasted.

cross-industry application—all chemical manufacturing industries

MATERIALS BALANCE:

waste reduction by—Improved process control

ECONOMICS:

capital cost—\$1,900 (1988)

months to recover—0.007 years (3 days)

impact—2,591,000 lb yr waste prevented

benefits—273,250 \$ yr net annual savings. Reduced liability resulting from reduced quantity of waste generated; source reduction

1666 HOSE CONNECTIONS REDUCE WASTE GENERATED—ISIC CODE: CST-UNEP000274]

SUMMARY:

stage of development—fully implemented

technology principle—Three sets of dry disconnect couplings were used to help prevent raw material spillage caused by disconnecting hoses. Previously, the spillage problem was so severe that a dike had to be built to contain the spilled material. Periodically, the dike would be cleaned and the contaminated raw

material would be disposed of as waste. The new hose connections virtually eliminated spillage of raw material.

cross-industry application—all

MATERIALS BALANCE:

waste type—Raw material spills

medium—Liquid

waste reduction by—Improved equipment

ECONOMICS:

capital cost—\$1,800 (1988)

months to recover—0.02 years (9 days)

impact—25,200 lb yr waste prevented

benefits—70,450 \$ yr net annual savings; reduced liability resulting from reduced quantity of waste generated; source reduction

1667 OVERFLOW PREVENTION—ISIC CODE: CST-UNEP000276]

SUMMARY:

stage of development—fully implemented

technology principle—A sight glass was installed to prevent material from overflowing a storage tank. Because the material in the tank was a clear liquid, a special sight glass had to be used. It has metallic balls inside that float at the same level as the material in the tank. These balls then act to flip magnets that are white on one side and brightly colored on the opposite side. No spills have occurred since the sight glass was installed. Also, since the material in the tank is a flammable liquid, plant safety has significantly improved.

cross-industry application—all that store clear liquids

MATERIALS BALANCE:

waste type—Flammable liquid

medium—Liquid

waste reduction by—Improved equipment

ECONOMICS:

capital cost—\$1,100 (1988)

months to recover—0.08 years (30 days)

impact—18,000 lb yr waste prevented

benefits—13,500 \$ yr net annual savings; reduced liability resulting from reduced quantity of flammable liquid overflow; improved plant safety

1668 COMPLETELY EMPTY CONTAINERS—ISIC CODE: CST-UNEP000278]

SUMMARY:

stage of development—fully implemented

technology principle—Two drum pump assemblies were used to more efficiently empty grease from 55-gal drums. Before using the drum pump assemblies, an average of 4 gal of material was left inside the drum to be disposed of as waste. After using the drum pumps, an average of only 0.2 gal was left inside the drum. Another advantage is that by having the drums nearly completely emptied, the drum reconditioners are more willing to accept the drums.

cross-industry application—all that handle drums filled with high viscosity materials

MATERIALS BALANCE:

waste type—Grease

medium—Solid

waste reduction by—Improved operating practices

waste production—29,200 lb yr (before), 1,500 lb yr (after)

ECONOMICS:

capital cost—\$8,200 (1988)

months to recover—0.42 years (153 days)

impact—95% reduction in disposed waste

benefits—19,550 \$ yr net annual savings; reduced liability resulting from reduced quantity of waste generated; source reduction

1669 RETURNABLE CONTAINERS—ISIC CODE: CST-UNEP000280]

SUMMARY:

stage of development—fully implemented

technology principle—The portable returnable container replaced the existing disposable containers. The portable returnable container provides easier material handling and storage. Further, any material left inside the container is no longer

being disposed of as waste.

cross-industry application—all

MATERIALS BALANCE:

waste reduction by—Improved operating practices

ECONOMICS:

capital cost—\$2,700 in container deposits (1988)

months to recover—0.34 years (125 days)

impact—9,100 lb yr waste prevented

benefits—7,900 \$ yr net annual savings; reduced liability resulting from reduced quantity of waste generated; source reduction

1670 STATIC MIXER—ISIC CODE: CST-UNEP000282]

SUMMARY:

stage of development—fully implemented

technology principle—A 2ft. long static mixer was installed to mix a two component blend. Previously, the components were mixed in a 30 ft. long x 2 inch diameter pipe. The line has to be flushed out approximately once every hour to maintain quality standards. Considerable reduction in the volume of waste was achieved because of the reduced cleaning volume, 2 ft. vs. 30 ft. The mixing quality has improved and is more consistent. Also, since the static mixer is flanged, it can be easily removed if the pipe becomes clogged.

cross-industry application—all that use in-pipe mixing

MATERIALS BALANCE:

waste type—Cleaning solution

waste reduction by—Improved operating practices

ECONOMICS:

capital cost—\$825 (1988)

months to recover—0.08 years (32 days)

impact—19,700 lb yr waste prevented. Better product due to improved mixing

benefits—9,300 \$ yr net annual savings; reduced liability resulting from reduced quantity of waste generated; source reduction

1671 MINIMUM VOLUME EQUIPMENT—ISIC CODE: CST-UNEP000284]

SUMMARY:

stage of development—fully implemented

technology principle—Four liquid displacers were installed in four separate filter housings. These devices reduce the internal volume of housings. Each time the filter housings are drained to change products or filter bags, less material is wasted.

cross-industry application—all that use filtration

MATERIALS BALANCE:

waste type—Spent filter bags

medium—solid

waste reduction by—improved operating practices, equipment modification

ECONOMICS:

capital cost—\$1,400 (1988)

months to recover—0.14 years (50 days)

impact—12,300 lb yr waste prevented. Less product wasted

benefits—10,300 \$ yr net annual savings; reduced liability resulting from reduced quantity of waste generated; source reduction

1672 CLEANING IN STAGES—ISIC CODE: CST-UNEP000286]

SUMMARY: This facility used to clean parts in a single 55-gallon drum of solvent. The single drum of spent solvent had to be changed on the average every 4 days, because it could not clean the parts well enough to meet quality standards.

stage of development—fully implemented

technology principle—Washing grease off parts was efficiently achieved in three drums of solvent placed in series. The parts are initially placed in the first cleaning drum labeled "prewash". The parts are then removed and placed into the second drum or the "dirty" drum. The last drum or the "clean" drum will clean the parts to meet quality standards. As the solvent solution in the "clean" drum becomes contaminated, it is transferred to the "dirty" drum. The more spent solution in the "dirty" drum is transferred to the prewash drum. Thus, the solution is not disposed of as waste until it becomes completely spent. This operation produces on the average a drum of spent solvent every 6 1/2 days

cross-industry application—all that clean parts

MATERIALS BALANCE:**waste type**— Spent solvent**medium**— liquid**waste reduction by**— Improved operating practices**waste production**— 55 gal every 4 days (before) 55 gal every 6.5 days (after)**ECONOMICS:****capital cost**—\$1,100 (1988)**months to recover**—0.08 years (30 days)**impact**—39% reduction in the amount of spent solvent generated, 8,706 lb yr waste prevented. The parts are cleaned better**benefits**—13,400 \$/yr net annual savings; reduced liability resulting from reduced quantity of waste generated; source reduction**1673 SILVER REDUCTION PROCESS AND ON-SITE SILVER RECLAMATION—ISIC CODE: 3471 [CST-UNEP000287]**

SUMMARY: Two examples of waste minimization at a metal finishing plant are presented in this case study. In the first example, the rinse-wastewater treatment plant was frequently violating the discharge standard for silver. The major sources of the silver were rinses following silver-cyanide plating in the reel-to-reel lines. The plant evaluated whether or not to modify the treatment system or introduce waste minimization in the production line. A strategy to reduce silver drag-out was initiated, including: efficient air-knives installed at the rinse tanks, more efficient electrolytic recovery cells installed on the dead rinses following the silver plating baths, and flow restrictors installed on all rinses.

In the second example, to replace off-site silver reclamation, on-site silver reclamation was initiated to reclaim silver from the silver dead rinses. This in-line reuse system consisted of 6 reverse osmosis units. The installation would involve conversion of the dead rinse and DI-Water rinse stations to a two-stage counter flow rinse, conductivity control of DI Water supply, and recirculation pumps for rinsing to reduce the flow rate.

stage of development—The clean technologies are fully developed, and commercialized.

technology principle—A metal finishing plant tested silver reduction process to replace the existing treatment plant and also tested on-site silver reclamation to replace off-site reclamation consisted of the modification of air-knives electrolytic recovery cells and flow restrictors to reduce silver drag-out and the installation of reverse osmosis units as in-line reuse systems.

MATERIALS BALANCE:**waste reduction by**— Improved operating practices; extended use of raw material**waste production**—

	Before	After
rinse-wastewater gpd	240,000	155,000
silver concentration in influent mg/l	5	0.5
silver concentrations in effluent	N/A	<0.15

ECONOMICS:

capital cost—In the first example, the capital investment for the silver drag-out reduction was \$12,000. The capital cost to install the reverse osmosis units was estimated at \$525,000.

months to recover—Without expanding the capacity of the plant, the payback period for installing the capacity of the plant, the payback period for installing waste minimization in the production line was projected to be less than one month.

The marginal payback period for the in-line reuse system as compared to the existing off-site reclamation was projected as 5 months.

impact—For the first example, the operating savings of silver drag-out reduction versus treatment is \$470,000 per year. For the first six months after implementation of the reduction process, all discharge standards were being met. In the second example, the net savings of the in-line reuse system versus the off-site reclamation were estimated at \$825,000. According to laboratory tests, more than 90% recovery is feasible with the reverse osmosis units. Limits to implementation of waste minimization for these processes. The silver drag-out reduction program required considerable attention from production. QA personnel. Despite initial improvements from waste discharge standards, by the end of a year, silver violations had returned to their former level. This was due to significant changes in production and inadequate new treatment plant and not continue with the waste minimization efforts.

obstacles—Due to the large capital cost needed for the in-line reuse system, the facility also decided not to adopt the in-line system.

(CONTACT: John Rosenblum, Rosenblum, Environmental Engineering, 3502 Thorn Road, Sebastopol, CA 95472, USA or Mazen J. Naser, Plating and Waste Management Consulting, 96 Lyett Circle, Daly City, CA 94015, USA)

1674 USE OF SIMPLE MATERIAL BALANCES SOLVES PROBLEMS IN A CIRCUIT BOARD MANUFACTURER'S WASTE WATER TREATMENT PLANT—ISIC CODE: 36723471 [CST-UNEP000288]

SUMMARY: This circuit board manufacturing facility used conventional precipitation for waste treatment. After monitoring the compliance data from the waste treatment effluent with respect to copper concentration, it became evident that the system was incapable of providing repeatable results. There were copper spikes in the effluent that were apparently caused by non-settleable particles in the clarification process.

A water material balance was conducted to verify the flow rates from the process area and the flow rates into the waste treatment area. To reduce the hydraulic loading on the waste water treatment system, non-contact cooling water and scrubbing water were eliminated by installing closed loop systems.

Equipment washdowns were also reduced 80% by installing automatic shut offs on the washdown hoses and devising and implementing strict water conservation specifications. In addition, to reduce the water flow rate supplying the process equipment, rinsing specifications were determined and flow restrictors were installed. Electronic controls were also installed to shut down the water flow to production equipment when unattended.

A material balance of hazardous waste was also used to attempt to understand the type and amount of waste material that was being disposed of from the waste treatment process. Strategic plans for waste management were then made, including: recycling, incinerating all organic material, and minimizing or eliminating materials that are landfilled. Therefore, two changes were made in waste handling at the facility: (1) a sludge dehydrator was installed to increase the solids content of the F006 metal hydroxide sludge and reduce the amount of material that is disposed of at hazardous waste landfills and (2) the copper pyrophosphate material was to be treated in-house and not shipped off-site for disposal.

To minimize hazardous waste generation, ion exchange can be coupled with electrolytic recovery. A material balance was used to investigate the feasibility of such a system. Depending on the concentration of the process waste water entering the collection system, either conventional treatment (precipitation), or neutralization should be used. It was discovered that one line entering the collection system, which has a flow rate of 15.5 gpm, would benefit from an ion exchange electrolytic recovery system.

There are 275 employees. Water usage at the facility is 100,000 gpd.

stage of development—The technology is fully developed.

technology principle—After conducting a material balance the company implemented technologies including process modification equipment redesign and water conservation. Recycling, incineration, minimizing, landfilling, equipment modification, on-site treatment, ion exchange, neutralization, electrolytic recovery were also used as clean technologies.

MATERIALS BALANCE:**waste reduction by**— Improved operating practices; ion exchange; electrolytic recovery; process modification; equipment redesign**waste production**—(lbs)

	Before	After
copper pyrophosphate	2,764	2,500
metal hydroxide sludge 25%	410,000	101,675

feedstocks—(gpm)

	Before	After
Process rinsewater	176	106
Mechanical scrubber water	118	0
Non-contact cooling water	42	0
Equipment washdowns	10	0

impact—Process water flow rates were reduced approximately 40%. The results of the flow rate reduction proved effective in increasing the repeatability of the effluent stream and resulted in a treatment confidence level of 99.45%. The installation and operation of the sludge dehydrator increased the solids content of the F006 sludge from 25 to 95% and decreased the volume by 75% which reduced disposal by 308,325 pounds per year. In addition, by drying the sludge,

the leaching capability and thus the toxicity is reduced.

The process to treat the copper pyrophosphate was designed and installed in-house. This reduced the outside waste disposal by approximately 2700 lbs per year. Subsequent to a materials balance of the hazardous waste, for a relatively small capital investment, a significant portion of the metal hydroxide sludge generation could be shifted to the production of non-hazardous metal products. (CONTACT: Teradyne Connection Systems, 4 Pittsburgh Avenue, Nashua, NH 03062)

1675 1,1,1-TRICHLOROETHANE IS ELIMINATED FROM THE PRODUCTION PROCESS BY AQUEOUS-BASED CLEANING AT A FASTENING PARTS MANUFACTURING FACILITY—ISIC CODE: 3400 [CST-UNEP000289]

SUMMARY: This facility manufactures nails, staples, and the tools to drive these fasteners. The fastening tools are made of aluminum, magnesium and carbon steel. To produce these fastening parts, grinding, milling, drilling, lathe working, heat treatment and metal finishing operations are employed. Prior to many of these operations, parts are cleaned in a cold application using 1,1,1-trichloroethane (TCA). TCA was being discharged in the wastewater at levels twice as high as the allowable limit. Absorbents used around the machine tools also showed levels of TCA that prevented disposal in the regular trash. The company decided to attempt to eliminate the use of TCA from the manufacturing of fastening tools.

A task force identified for potential causes for excessive TCA cleaning wastes: too much availability of cleaners, unnecessary dumping of TCA, lack of operator awareness, and unnecessary parts cleaning. Initially, the firm reduced the number of cleaning stations from 37 to 27. Costs associated with dumping of cleaners were made the responsibility of each department. Operators were surveyed to identify TCA use and determine opinions for alternatives.

The selected pollution prevention measure was to use a heated tank with liquid agitation, provided the necessary chip removal and oil removal systems were present. In the machine maintenance areas, two mineral spirit cleaners were installed and the company is in the process of installing aqueous-based cleaning systems. At the time of this case study, they had installed 13 aqueous washing systems and two (2) mineral spirits cleaning systems. They expect to have a total of 15 aqueous systems, which are centralized within departments which will replace 37 former TCA locations.

Other process implementation in addition to the processes for reducing TCA included treating soapy water by oil separation and in-house pH neutralization. Also, a precision grinder was replaced by an older piece of grinding equipment which does not require virgin material. A "procedure" (not further described) was also recommended that would prevent the spoilage of coolants.

Approximately 6500 gallons per year of TCA were used. No other measure of the scale of operations was provided.

stage of development—The clean technology is in the implementation stages. All equipment is not yet fully installed. The technology is fully commercialized.

technology principle—The clean technology involved initially reducing 1,1,1-trichloroethane use and finally eliminating its use by installing aqueous cleaning systems.

MATERIALS BALANCE:

waste reduction by—Improved operating practices; substitute less toxic raw material

waste production—

	Before	After
1,1,1-trichloroethane water discharge	400 ppb in waste	not detectable

feedstocks—

	Before	After
1,1,1-trichloroethane	6500 gallons	0

ECONOMICS:

capital cost—The anticipated capital expenditures during 1990-1991 on this project are \$80,000. This includes costs for aqueous cleaning systems, waste water collection equipment, and equipment installation.

operation/maintenance—\$15,000 in utility costs are required for heating and pumping aqueous fluids.

months to recover—With an approximate annual savings of \$56,500 and \$80,000 in capital costs, the pay back period is approximately 1.4 years.

benefits—A net savings of \$7,000 is expected from reduced disposal costs,

since the disposal costs in 1988 were \$9,000 and they expect that the cost for disposal of separated oils will be \$2,000. In addition, the annual cost saving associated with the disposal of absorbents no longer contaminated with TCA is \$34,000. A net savings from replacing virgin TCA and aqueous cleaners will be \$7,000. This was calculated from the difference in the 1988 cost of virgin TCA (\$27,000) and the 1991 costs for aqueous cleaning solution (\$20,000).

Other processes implemented, in addition to the processes for reducing TCA, included treating soapy water by oil separation and in-house pH neutralization. The annual savings from segregation and in-house treatment are \$20,000. The savings from changing to an older grinder lead to an annual savings of \$1,200 from reuse of the coolant. The annual savings from preventing spoilage of coolants are \$1,300.

Overall, the potential savings from eliminating TCA is approximately \$56,500 per year (including the extra utility costs).

impacts—There are regulatory advantages that cannot be directly quantified. Permit concerns associated with TCA discharge were greatly diminished by successfully negotiating with the regulatory agencies to tie the metal finish discharge into the nearby town sewer system. The company will no longer have to report under SARA for TCA which will save considerable time. Eliminating TCA will also allow the company to present a strong example to the State and local communities that they are doing their part to decrease overall emissions, thus increasing community relations. Finally TCA air discharges will be eliminated. This may be especially important since TCA has come under intense scrutiny and regulation because of its ozone depletion and air toxics potential.

obstacles—There is an extra electrical cost associated with heating and pumping aqueous cleaning fluids equal to \$15,000 per year. TCA cold cleaning had no utility cost.

assumptions—It is assumed that this case study was performed between November 1989 and January 1991 because 1989 is the date when the goals for the project were developed and 1991 is the date of publication of the document.

(CONTACT: Stanley Fastening Systems, Route 2, East Greenwich, RI 02818)

1676 REDUCTION OF WASTE GENERATION IN A CHICKEN PROCESSING PLANT ACHIEVED THROUGH DRY CLEANUPS, PLANT MODIFICATIONS, AND A WASTE AWARENESS PROGRAM—ISIC CODE: 2015 [CST-UNEP000290]

SUMMARY: The facility processes chicken nuggets by grinding and blending chicken meat, forming nuggets, battering and breading the meat and then frying, freezing, and packaging. The facility had high water usage and high BOD loading of its wastewater. Changes in City sewer ordinance forced the company to investigate ways to reduce its biochemical oxygen demand (BOD) loadings to the city sewer. Following a waste reduction audit a combination of employee training and supervision, process equipment modification, better housekeeping, waste segregation and reclamation techniques were employed. A Waste Awareness Program has been crucial to employee involvement. The major waste source was raw chicken, fat, dry batter, and processed nuggets washed down the floor drains. Dry cleanup methods were employed, dry and wet wastes were separated, processing equipment was modified to catch particles prior to hitting the floor. Water clean-up occurs only after all dry ingredients are removed from the floor and machinery. Collected dry waste material is sold off-site as animal feed or to be rendered.

The plant has 275 employees and produces 2.5 million breaded chicken nuggets daily.

stage of development—The technologies are fully implemented. Some processing equipment was specifically modified for this application.

technology principle—Training and supervision, recycling, reused and reclamation process equipment modification, waste segregation and housekeeping were utilized to reduce waste generation.

MATERIALS BALANCE:

waste reduction by—Improved operating practices, improved housekeeping, training

waste production—(lbs/day)

	Before	After
BOD	4,500	2,250

feedstocks—(gal/day)

	Before	After
Water	200,000	Not reported

ECONOMICS:

operation/maintenance—\$10,000 per month savings on sewage surcharge fees

based on 1989 prices

benefits—Include \$10,000 month savings on sewage surcharge costs, income from sending 5 million pounds of protein and carbohydrate dry waste off site for uses as animal feed and an unspecified amount of waste sent to a rendering plant. Reusing this dry waste rather than landfilling it prevents approximately 30 ton week of solid waste being sent to a landfill.

impact—The pollution prevention changes were in response to a new City pretreatment ordinance which set new sewage discharge limits and increased surcharge costs. Equity's BOD loadings were well above the limits and were very costly and BOD loadings were cut by 50%. Water use was reduced but the exact amount reduced was unreported.

obstacles—Keeping employees habits from reverting back to old wasteful ways is a constant challenge. The company established a Waste Awareness Program to keep employees involved

assumptions—It is assumed that water use was reduced as a result of the waste reduction techniques employed. The author infers that water use declined but never explicitly states it. This assumption was used in reporting the clean technology benefits.

(CONTACT: Equity Group, Reidsville, North Carolina)

1677 CAMERA MANUFACTURER RECYCLES FREON BY USING NEW DEGREASERS—ISIC CODE: 3861 [CST-UNEP000291]

SUMMARY: Polaroid's camera division uses freon for cleaning plastic parts and electronic circuit boards that go into cameras. Prior to recycling most of the freon used for degreasing was released to the air. New degreasers were installed that recycle freon by efficiently cooling freon vapors and returning them through closed loop recycling to a reusable liquid state.

stage of development—The technology is fully operational. The new degreasers were available at the time of the case study. The article did not indicate if the equipment was readily available or custom designed for this facility.

Prior to using the new degreasers 84.4% of the freon used ended up as waste. After installing the new degreasers 13.3% of the freon used ended up as waste. The new degreasers reduced air releases of freon by 57,200 pounds per year (from 59,200 pounds to 2,000 pounds). Feedstock use of freon went from 22.3 lbs. of freon used per production unit of cameras produced to 4.5 lbs. of freon used per production unit of cameras.

technology principle—This technology involves closed loop recycling and reuse of freon.

MATERIALS BALANCE:

waste reduction by—Solvent recovery.

ECONOMICS:

operation/maintenance—Polaroid reportedly realizes a net annual savings of \$75,000 per year due to lower disposal costs and reduced purchasing costs for freon.

impact—Closed loop recycling and reuse of freon reduced direct atmospheric releases of freon to air from 59,200 lbs. year

assumptions—The article presents the savings has already being realized, however, the 1989 figures are listed as "projected".

(CONTACT: Polaroid Corporation, Norwood, Colorado)

1678 COPPER RECOVERY FROM PRINTED CIRCUIT BOARD ETCHANT USING ELECTROLYSIS—ISIC CODE: CST-UNEP000292]

SUMMARY: Finishing Services Ltd manufactures printed circuit boards. In making printed circuits unwanted copper foil is etched away by an acid solution of cupric chloride. Dissolved copper reduces the effectiveness of the solution. The solution is typically regenerated by oxidizing the cuprous ion with acidified hydrogen peroxide. The volume of solution, however, increases steadily and the surplus liquor must be stored. The copper in the surplus liquor is precipitated as copper oxide and landfilled. The new technology uses electrolytic recovery with a PVC-based membrane which allows the passage of hydrogen and chloride ions but not the copper. The copper is transferred to the cathode and recovered as pure flakes.

A staff of 55 people are employed in England

stage of development—The technology is fully implemented and is commercially available from Finishing Services Ltd.

technology principle—The technology involves reclamation of copper using electrolytic recovery of a PVC-based membrane

MATERIALS BALANCE:

waste reduction by—Recover product from waste

feedstock reduction—Copper Recovery is 11 te yr.

ECONOMICS:

capital cost—Investment costs are 55,000 pounds sterling

operation/maintenance—(pounds sterling)

Annual cost savings reported as

Cost Savings Materials	22,000
Savings in disposal costs	6,000
Less extra costs	1,000
Total	27,000

months to recover—2 years

impact—The quality of the printed circuit boards is improved. Disposal costs for copper are virtually eliminated. The etching solution is maintained at its optimum composition. Copper is recovered in a high value form, and there are no hazardous chemicals to be handled.

(CONTACT: Finishing Services Ltd, Woburn Road Industrial Estate, Kempston, Bedfordshire MK42-7BU, England)

1679 FUGITIVE DUST RECOVERED AND REUSED IN AN IRON FOUNDRY—ISIC CODE: 3322 [CST-UNEP000293]

SUMMARY: Precision iron founding involves the production of moulds and cores from mixtures of sand and clay. In the traditional process the factory space is ventilated by extractor fans. If scrubbers are used, the dust forms a sludge which is dumped at high cost.

At this foundry, the dust collected as sludge by water scrubbers is recovered by returning it to the mixer to make new moulds. A special sludge pumping system uses a centrifugal pump with a natural rubber impeller to overcome the problems associated with the abrasive properties of the sludge. The composition of the moulding material is controlled by using a highly effective and flexible electronic control and display system.

The facility has 400 employees on a 15 acre site. Over 25,000 tonnes of cast iron are melted per year using two 4MW electrical furnaces.

stage of development—The technology is fully implemented.

technology principle—This technology involves recycling fugitive dust back into the manufacturing process.

MATERIALS BALANCE:

waste reduction by—Recover product from waste

feedstock reduction—The system recovers 1600 te per year of sludge.

ECONOMICS:

capital cost—The capital investment was 19,000 pounds sterling

operation/maintenance—The annual savings are 84,000 pounds sterling. (Material savings of 60,000 pounds sterling. Reduced disposal charges of 24,000 pounds sterling)

months to recover—3

impact—The system recovers 99% of the moulding material and sludge generation is reduced by 1,300 m³ year. Emissions are insignificant. Higher quality products are produced and the working environment is improved.

(CONTACT: Baxi Partnership, Brownedge Road, Bamber Bridge, Preston PR5 6SN, England)

1680 RECOVERY AND USE OF METHANE FROM SUGAR BEET PROCESSING EFFLUENT—ISIC CODE: 2063 [CST-UNEP000294]

SUMMARY: The facility processes sugar beets generating a wastewater effluent with a high chemical oxygen demand. Traditionally, this effluent was dealt with aerobically by a water treatment plant and its organic content wasted. The clean technology was to add an anaerobic stage to the water treatment section to convert the organic content of the effluent to usable methane. The fermentation takes place in the digestion vessel, the off-gas consists largely of methane with some carbon dioxide. Key features of the process are the pre-heating of the incoming stream using low-grade heat, careful control of the pH and the recirculation of sludge. The methane provides process heat to dry the pulp for use as an animal feed.

British Sugar operates 12 beet factories and employs 3,000 people. The Peterborough facility produces 100,000 tons of sugar per year.

stage of development—The technology is fully implemented

technology principle—This technology uses an anaerobic stage to recover methane from sugar beet effluent for use as a process fuel

MATERIALS BALANCE:

waste reduction by—Recover product from waste

ECONOMICS:

capital cost—The capital cost of the technology is 750,000 English Pounds.

operation/maintenance—Annual savings in lower sewage charges are 26,000 pounds sterling and 8,000 pounds sterling in electricity cost savings. The value of recovered gas is 25,000 pounds sterling.

months to recover—Payback time is 12 years

impact—The technology resulted in reduced chemical oxygen demand in the wastewater effluent. Recovery and use of methane from organic matter in the waste water effluent were achieved. Lower operating costs and energy conservation were added benefits of the technology.

assumptions—It is assumed that the economics cited in the source document are on a per plant basis and not the total of all 12 British Sugar plants.

(CONTACT: British Sugar plc, Oundle Road, Peterborough PE2 9QU, England)

1681 MASKANT MATERIAL SUBSTITUTION IN THE AEROSPACE INDUSTRY—ISIC CODE: 3479 [CST-UNEP000295]

SUMMARY: Chemical milling is a weight reduction process utilized on aerospace and missile component parts without affecting their structural integrity. In the chemical milling process, most aircraft component parts are covered with a coating called maskant. The coated parts are scribed resulting in the removal of the maskant in certain selected areas as specified by the customer. The areas where the coating maskant has been removed are etched in the appropriate solutions, resulting in the removal of excess weight.

Heretofore, the maskant utilized in our operation had an adverse affect on our environment and workers. The formulation contained as much as eighty% perchloroethylene and only about twenty per cent solids. Caspian in conjunction with Malek developed a high solids low volatile organic compound (VOC) maskant that replaces the solventbase formulation.

This new technology not only reduces fugitive emissions from spraying and dipping applications it also eliminates any emissions from clean-up operations. The equipment instead of being cleaned with solvents is now cleaned with water. The water from the clean-up operation is flocculated and processed through a filter press and a standard activated charcoal cartridge. The remaining water is then recycled back to the clean-up operation and the dry solid is placed into a regular landfill.

Some companies have chosen to install expensive add on equipment, i.e., solvent recovery units to their operations instead of switching to less polluting waterborne products. Solvent recovery units are energy intensive thereby transferring the pollution source to the energy source. Also the carbon bed in the unit must eventually be disposed of at a hazardous waste landfill.

Caspian utilized approximately 23,000 gallons of the CAX waterborne maskant last year.

stage of development—Utilization of CAX waterborne maskant is proven technology. This material has been successfully applied at Caspian for over three years. It is also listed on the Boeing Process Specification BAC 5772. The CAX waterborne maskant is available today. There are several different formulations which can be modified depending upon each individual organizations needs. The equipment required for successful application of waterborne maskant is readily available. Most of the equipment that is used for applying solventbase maskant can be easily adapted for waterborne maskant usage. The major equipment change would be the dip tank for which a design is readily available.

technology principle—Material substitution

MATERIALS BALANCE:

waste reduction by—Substitute less toxic raw material; material substitution

waste production—

	Before	After
	1987	1990
VOC emissions (tons)	450	8
VOC emissions (g/l)	1200	70

ECONOMICS:

capital cost—the capital investment to switch over to CAX waterborne maskants is the cost of a new dip tank and possibly an oven if one is not already available. Many facilities already have ovens which are often already in use for solvent-based maskants. The cost of the oven and redesign of the dip tank are totally dependent upon the size of the unit

months to recover—payback is instantaneous, due to more stringent environ-

mental regulations. It is inevitable that industry will soon be required to: (a) switch over to waterborne technologies or (b) invest in expensive add-on control equipment. When all of the costs of these two compliance options are systematically compared, the CAX product requires one-tenth of the capital and only 80% of the operating costs versus solvent recovery.

impact—This process reduces VOC emissions by as much as 95%. Even more important than emissions is the fact that our workers are not being exposed to the carcinogen perchloroethylene. We have received positive support from the news media and regulatory agencies due to the drastic emission reductions at our facility. This is further illustrated by the fact that the San Diego Air Pollution Control District awarded Caspian 106.9 tons per year of Class "A" Pollutant Emission Reduction Credits. These credits are in the bank and can be used later for offsets at our facility or can even be sold to other industries who may want to expand waterborne CAX is the method in which it is applied.

obstacles—Since water takes longer to dry and does not flash off like solvents the worker must be trained in the proper application. Even though the same equipment is used the method of application is different. Another obstacle is drying time in the oven. Since water is vehicle that carries the material to the part, it has a slightly longer drying cycle. VOC emissions are reduced but not eliminated by the technology.

assumptions—The VOC contents of solvent-base maskant and CAX may slightly vary.

(CONTACT: Caspian Inc., San Diego CA, USA) Technical contact: Mark Jaffari Malek INC., 4951 Ruffin Road, San Diego, California 92123. (619) 279-0277)

1682 BEARING MANUFACTURER INVESTS IN NEW MEDIA FOR COOLANT FILTRATION—ISIC CODE: 356235003400 [CST-UNEP000296]

SUMMARY: Waste stream constituents of concern are spent cooling oil and filtering materials. In response to escalating operating costs for a coolant filtration system, American NTN Bearing installed a new filtration system that has reduced material usage and lowered operating costs. The former system consisted of magnetic and paper filters to filter out grinding swarf from coolant oil. It wasted 1,673 gallons of oil and 25 rolls of filter paper per month. The new filter recycles coolant oil in a closed loop, zero-discharge system. It uses a permanent polyester endless-belt filter, eliminating oil-soaked paper filters and delivering a very dry swarf. This new approach saves on oil, filter media, storage space, and labor costs. A smaller version of the same system has been installed at a second American NTN facility and is expected to produce comparable savings.

stage of development—the clean technology is fully implemented. Hoffman Filtration Systems of Syracuse, New York prescribed the Vacu-matic filter with endless media.

technology principle—material substitution, process substitution, equipment modification.

MATERIALS BALANCE:

waste reduction by—Extended use of raw material

waste production—

	Before	After
filter paper (rolls month)	25	0
waste oil (gal month)	1673	minimal

ECONOMICS:

operation/maintenance—Since the filter is fully automated, operational and maintenance costs are low (not quantified). Utility requirements are not identified.

impact—With the new filtration system, there is less oil and paper to store and handle. Operational and maintenance costs are also lower.

assumptions—Economic data will vary due to economic climate, varying governmental regulations and other factors.

(CONTACT: American NTN Bearing Manufacturing Corp., Schiller Park IL.)

1683 RECYCLING, MATERIAL AND PROCESS SUBSTITUTION AT PHOTOGRAPHIC EQUIPMENT MANUFACTURER—ISIC CODE: 3861 [CST-UNEP000297]

SUMMARY: Polaroid is a well known producer of photographic equipment and supplies. Information about process unit operations is not provided in the report. The following is a list of pollution prevention measures implemented by the company.

- Freon vapor from degreasing operations is cooled and recycled in a closed-loop system, thus reducing both hazardous emissions and repurchasing costs.
- Sodium chromate traditionally used in photographic processes has been replaced with a new, non-toxic dye process. In addition to eliminating hazardous waste emissions, overall waste releases are also reduced.
- Batteries containing mercury in varying concentrations have been traditionally employed in Polaroid film products. New carbon zinc technology has allowed a reduction of mercury content to less than mercury and making the battery product more recyclable.

stage of development—The clean technologies are fully implemented.

technology principle—Recycle and reuse, material substitution, process substitution

MATERIALS BALANCE:

waste reduction by— Solvent recovery; substitute less toxic raw material

waste production—

	Before	After
Freon reduction (lbs freon reduced unit production)	22.3	44.5
Sodium chromate reduction (lbs sodium chromate used unit production)	18	0
Mercury reduction (lbs mercuric chloride used unit production)	129	0

ECONOMICS:

benefits— Include \$75,000 in annual savings from freon use reductions, and other savings (not quantified) from other hazardous material use disposal reductions.

impact— Environmental benefits include the reduction of hazardous wastes as noted above, which are greatly reduced but not eliminated.

(CONTACT: Polaroid Corporation, Massachusetts, USA)

1684 INVENTORY CONTROL, HOUSEKEEPING PRACTICES AND MATERIAL SUBSTITUTION AT PRECISION SHEET METAL PARTS MANUFACTURER—ISIC CODE: ETCHING, PHOTOCHEMICALS/IC 3479 [CST-UNEP000298]

SUMMARY: The facility is a maker of precision sheet metal parts, including solar cell wafers, submarine silencers and satellite dish components. The facility chemically etches stainless steel and nickel to achieve their finished products. Process unit operations include: metal sheet preparation, application of UV-sensitive photo-resist, exposure to desired etching patterns, and developing.

* Inventory control is used to keep track of hazardous materials throughout the plant. Daily site inspections keep process efficiency high. Shelf obsolescence has also been greatly reduced.

* Baking soda water developer has been substituted for a combination of methylene chloride, 1,1,1 trichloroethane and perchlorethylene solvent, thus reducing the hazardous nature of the waste.

* Alkaline cleaners have been substituted for methanol, thus reducing the flammability of the spent cleaning material.

* A sulfuric acid-hydrogen peroxide mix has replaced a chrome-based brightener. Although the acid mix also has hazardous properties, chromium is eliminated from the waste stream. Also, the acid waste stream can be used to neutralize an alkaline waste stream.

stage of development—The clean technologies are fully implemented.

technology principle—Inventory control, housekeeping, material substitution

MATERIALS BALANCE:

waste reduction by— Substitute less toxic raw material; improved cleaning practices

waste production—(tons)

Before	After
68.7	548

ECONOMICS:

benefits— Include a reduction in costs associated with hazardous solvent acquisition and disposal, along with an accompanying reduction in application labor costs (unquantified).

impact— Environmental benefits include a reduction in waste generation from

683 tons in 1988 to 548 tons in 1989, primarily due to reductions in hazardous solvent use

(CONTACT: Brian Wassell, Environmental Compliance Administrator, American Etching and Manufacturing, 13730 Desmond Street, Pacoima, CA 91331, (818) 896-1187)

1685 PROCESS MODIFICATION, INVENTORY CONTROL, AND PROCESS EFFICIENCY AT PAINT MANUFACTURING PLANT—ISIC CODE: 2851 [CST-UNEP000299]

SUMMARY: The facility makes a variety of architectural coatings, including paint products, aerosol spray paints, and specialty paints. Paint bases may either be water (80% of production) or solvents. Process raw materials include resin solutions, emulsions, solvents, pigments, bactericides, fungicides, and extenders, along with defoamers and surfactants.

Paint production begins with the dispersion of pigments, solvents, resins, and additives in a mill (sand, ball, or high-speed). Mills are dedicated to one type of product when feasible.

Additional diluents, resins and additives (bactericides, fungicides, etc.) are added to the dispersion mill effluent in a process known as let-down. When the mix achieves the desired properties, mixing is stopped, the paint is filtered, and the final product is stored in various size cans for shipment. equipment cleaning wastes, obsolete stock, customer rejects, off-spec product, spills, spent filter bags, and empty raw material bags. Waste generation rates were not established. The following pollution prevention measures have been implemented at the plant. For equipment cleaning wastes: replacement of caustic cleaning solution with proprietary alkaline solution, reducing cleanup residual volume; use of high-pressure spray systems to clean water-based process equipment, reducing waste water volume; product dedication of let-down tanks to minimize intermediate cleanings; and batch sequencing (light to dark) to minimize intermediate cleanup.

For obsolete stock: using strict inventory control to prevent raw material obsolescence; and limiting obsolete finished product in the same manner.

For off-spec products: rework of product into marketable goods; increased quality controls; increased process automation; ensuring good intermediate cleanup practices to prevent contamination of subsequent batches.

For spills: recovery of product by manual scooping and reworking into production line; and minimizing the use of adsorbents, as these create additional waste (the adsorbent material).

For filter bags: cleaning and reuse of bags whenever possible.

For empty bags: use of non hazardous pigments to eliminate the hazardous nature of the empty bag; use of pigment slurries, minimizing bag use; and use of water soluble bags that can be added to the batch along with the raw material, thus eliminating waste altogether.

In addition, the plant employs waste stream segregation to keep solvent wastes away from water base wastes (with both waste streams being reworked into their respective product lines); segregation of alkaline cleanup wastes from rinse water wastes (with both waste streams reused); on-site recycling of water-based equipment wastes; reuse of alkaline cleaning wastes and solvent-containing cleanup wastes; and rework of returned products into new products.

The facility produced approximately 8.5 million gallons of paint in 1985, the latest year for which data was presented.

stage of development—The clean technologies are fully implemented. Certain of the listed technologies are commercially available.

technology principle—Production modification, equipment modification inventory control, recovery and reuse, material substitution

MATERIALS BALANCE:

waste reduction by— Substitute less toxic raw material; improved operating practices; improved housekeeping

waste production—(lb waste/gal product)

Before	After
0.34	0

ECONOMICS:

benefits— Include a savings of \$1.78 million in landfill disposal costs from 1983-85.

impact: Environmental benefits include the elimination of all landfilling of solid wastes in 1985, compared to a 1982 level of 1226 tons landfilled

Ablation

0741 Surface Treatments of Metals Using Excimer Lasers: Possible Applications for the Automotive Industry

Abrasion Resistance

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Abrasive Wear

0963 Injection of Silica Flux to a Nickel Converter Through a Submerged Tuyere

Abrasives

0740 Beneficial Reuses for Spent Bridge Painting Blast Material

Absorbers (Materials)

1031 A Scandinavian View of (Coated) Scrap and the Environment

Absorption (Energy)

0856 Materials for Cars of the 1990s

Absorption (Material)

0805 Dioxin Pollution Problem from Scrap Processing

0846 SO₂ Removal from Concentrated Process Gases Using the Sulfred Process

Acetone

1613 Molded Fiberglass Tanks

Acid Leaching

0727 Hydrometallurgical Process of Copper Converter Dust at the Saganoseki Smelter & Refinery

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Acid Pickling

1645 Use of Chemelec Cell Recovers Zinc in Low Concentration Iron-Containing Rinsewaters

Acid Purification

1637 Use of Acid Purification Unit on Concentrated High Temperature Pickling Liquor

Acid Reclamation

1637 Use of Acid Purification Unit on Concentrated High Temperature Pickling Liquor

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0896 Activated Carbon Fiber Adsorption Systems for Paint Spraybooth Solvent Emission Control

1590 Manufacturing of Metal Products, Machines and Material

Activation Analysis

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Adhesion

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0974 Adhesion: Aqueous Cleaners for Pretreatment

Adhesive Bonding

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Adsorbents

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Adsorption

0749 Adsorbing Flotation of Copper Hydroxide Precipitates by Pyrite Fines

0760 Removal of Metal Cations from Water Using Zeolites

0761 Metal Adsorption by Activated Carbon: Effect of Complexing Ligands, Competing Adsorbates, Ionic Strength, and Background Electrolyte

1456 Removal and Recovery of Heavy Metal Ions from Wastewaters Using a New Biosorbent: Alga Sorb

1566 Manufacture of Phenol, Aniline, and Related Products

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0896 Activated Carbon Fiber Adsorption Systems for Paint Spraybooth Solvent Emission Control

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1680 Recovery and Use of Methane from Sugar Beet Processing Effluent

Agriculture

1201 Proposal for Setting Up a UNEP IE Cleaner Production Working Group on Sustainable Agriculture and Food Processing

Air Cooling

0729 Slag Handling in the Ironmaking Industry

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Air Pollution

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0746 Progress in Davy McKee FGD Installations

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 0775 Atmospheric Evaporation in Waste Recycling
 0810 The New Efficiencies of Anti-Pollutant Furnaces
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 0835 World Copper Smelter Sulfur Balance—1988
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 0842 Environmental Control Between Afterthoughts and Future Markets—Conclusions for Economic Policy and Management
 0853 Decreased Gas Consumption of a Fluidized Bed Furnace
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 0895 Experience with a Recirculated Air Paint Booth with VOC Controls
 0896 Activated Carbon Fiber Adsorption Systems for Paint Spraybooth Solvent Emission Control
 0897 Estimate of Maximum Ambient Isocyanate Levels from an Isocyanate-Based Clearcoat Application
 0898 Production Experience with Automotive Waterborne Coatings
 0901 Utilization of Waste Tyre at Onahama Smelter
 0908 Zinc Oxide-Based SO₂ Scrubbing System at Hikoshima Zinc Plant
 0920 Current Environmental Issues Facing the Lead, Zinc and Cadmium Industries
 0929 In Plant Air Pollution Control System for Diecasting Machines with Water Soluble Die Lube
 0954 Global Considerations of Aluminium Electrolysis on Energy and the Environment
 0960 Environmental Problems and Sumitomo's Nickel Refining Technology
 0995 Water-Borne and High Solids Coatings: Innovative Applications
 1003 EOS—Emission Optimized Sintering, a New Process for Enhanced Pollution Control in Iron-Ore Sintering
 1004 Reduction of Sinter Plant Emissions at Hoogovens Ijmuiden
 1005 Environmental Protection in the Sintering Plant of Steel Works
 1006 The Introduction of Mg(OH)₂ Type Desulfurizer in the Sinter Waste Gas Line and Operation Results
 1007 Environmental and Operational Benefits of a HCN Destruct Unit
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 1051 Waterborne, Mold Release Coatings
 1053 Evaluation of Low VOC Coatings for Aerospace Applications

Airframes

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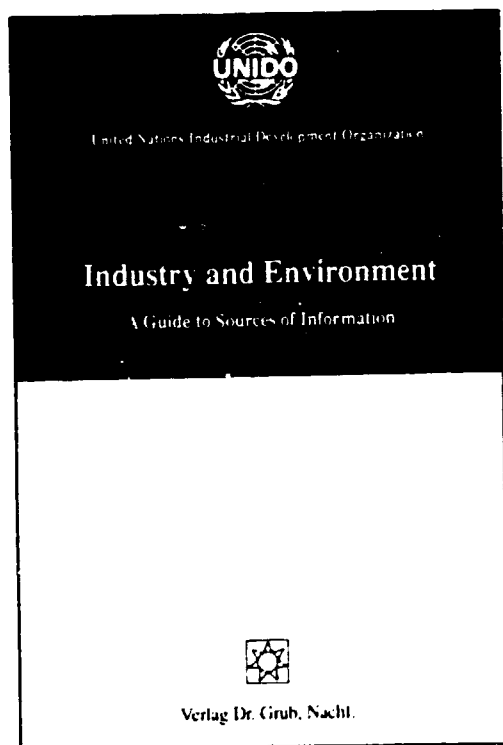
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