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NTIB

ENERGY AND ENVIRONMENT SERIES

Effluent Control in Industry

INTIB

Energy and Environment Series, No. 2

EFFLUENT CONTROL IN INDUSTRY

Compiled by

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Industrial and Technological Information Bank

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NOTE

The *Energy and Environment Series* of the Industrial and Technological Information Bank (INTIB) supersedes the former *INECA Journal* and is produced by UNIDO. INTIB is the information clearing-house of UNIDO, providing industry in developing countries with the necessary background for sound technological and business decisions.

INTIB
Energy and Environment Series, No. 2: Effluent Control in Industry

PREFACE

Effluent Treatment in Industry is the second number in the *Energy and Environment Series* of the Industrial and Technological Information Bank (INTIB). The first number of the *Series* covered energy conservation in industry and was issued in 1992. Earlier in 1992, a volume of abstracts was released under the title *INECA Journal*, the precursor of this *Series*, which dealt with recycling.

As with the two previous volumes of abstracts, this one also presents information from a variety of sources dealing with several industrial sectors. Nearly all of the abstracts listed in this number cover some aspects of either avoiding, treating or disposing of industrial waste-water or heavier effluents. The sectors covered include: metallurgy; plastics, ceramics and other composite materials; pulp and paper and related subsectors; and agro-industry. In addition, business aspects of materials technology and waste avoidance and treatment procedures are highlighted in separate sections.

As with the previous number, abstracts of papers presented in the *Industry and Environment Review*, prepared by the Industry and Environment Programme Activity Centre of the United Nations Environment Programme, have been included.

Information has also been obtained on agro-industry from the International Information System for the Agricultural Sciences and Technology (AGRIS), a system managed by the Food and Agriculture Organization of the United Nations. AGRIS started operation in 1975 and receives around 130,000 additional references per year. Approximately 20 per cent of the citations cover non-conventional or "grey" literature.

PIRA International is a research, consultancy, training and information service for the paper, packaging, printing and publishing industries. Its database and associated information service have been in operation for over 20 years, and approximately 12,000 abstracts are added each year.

Research for Man and the Environment (RIVM), part of the National Institute of Public Health and Environmental Protection of the Netherlands, kindly allowed the preparation of abstracts of their monographs on water, soil, air and waste management techniques, which were printed with the assistance of the Environmental and Energy Research department of the Nederlandse organisatie voor toegepast natuurwetenschappelijk onderzoek (TNO). The monographs were released under the title *Monografieën informatiesysteem technieken* in four volumes.

In addition to the information on the monographs presented in this volume, the main aspects of the technology are summarized in English on single sheets giving a clear technical overview of each monograph. RIVM and UNIDO are planning to jointly publish these technical fact-sheets in 1993. The monographs themselves cover: the type of waste stream; the aim of the process; a general characterization of the contamination; which waste components are to be removed; the principle of the process; equipment and system requirements; applications and technological constraints or preconditions; and related performance criteria (costs, emissions, energy and capacity).

As in previous volumes of abstracts, Materials Information supplied half of the data, which were extracted from their Metals Abstracts, Materials Business File and Engineered Materials Abstracts databases. These abstracts are contained in the first part of this number and cover metals, plastics and composites, as well as business aspects of materials technology.

INDUSTRIAL AND TECHNOLOGICAL INFORMATION BANK

Previously published titles

INECA Journal Vol. 1, Nos. 1 and 2, 1990
Abstracts of industrial energy conservation technologies and technical papers

INECA Journal Vol. 2, No. 1, 1991
Recycling '91 *

Industry and Environment: A Guide to Sources of Information, 1991**

Energy and Environment Series

No. 1: Energy Conservation in Industry, 1992*
No.2: Effluent Control in Industry, 1993*

* Available from Materials Information. Separate order form supplied.
** Available from Verlag Dr. Grüb. Separate order form supplied.

CONTENTS

HOW TO USE THIS PUBLICATION

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

The first section is entitled "Effluent control" and contains almost 400 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 name of the system of databases established by INTIB.

This section is subdivided according to the source of the information as follows: PIRA (PIRA International–a research, consultancy, training and information centre for the paper, packaging, printing and publishing industries, based in England); AGRIS (an international information system/network on agriculture run by the Food and Agriculture Organization of the United Nations); RIVM (a Netherlands national research institute dealing with environmental problems–the monographs were prepared in co-operation with the TNO Environmental and Energy Research group, also of the Netherlands); UNEP/IEPAC (the Industry and Environment Programme Activity Centre of the United Nations Environment Programme).

All the abstracts include:

- A sequential record number;
- The title of the document in upper-case letters;
- An alphanumeric code in brackets;
- An abstract;
- Author(s) and/or corporate author(s);
- Other bibliographic details.

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. The subject index includes the sequential record number of the abstract and the title of the document.

There may be variations in the application of terminology from the three thesaurii: 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: effluent; effluent treatment; liquid wastes; sludge; slurry; waste-water; waste-water treatment; water pollution; water purification; water treatment.

The author and corporate author index entries include the name in alphabetical order followed by the sequential record number.

General points to note:

- The use of the symbol :::: in an abstract indicates that the item has no document number;
- In some cases, the titles of documents have been edited or translated;

In the second section, the technical reports are mainly unedited, unpublished papers.

DOCUMENT DELIVERY / PHOTOCOPYING SERVICE

All items presented in this volume have been prepared from documents available at the source of the abstract. Should you be interested in a full text copy of the articles/reports, please send requests to the following addresses where they are stored:

Effluent control section (pages 29–68)

Materials Information
The Institute of Materials
1 Carlton House Terrace
London SW1 5DB
UK
Tel: (+71) 839 4071
Fax: (+71) 839 2289

For an article of ten pages or less the photocopying rates are £8.00/US$14.00 (US$17.00 overseas) with a mailing charge for outside the respective countries of £1.00/US$2.00 (US$3.00 overseas). Advance payment is recommended to ensure fast processing of orders. When ordering, please quote the title, the subsequent numeric code and the bibliographic details contained in parenthesis at the end of the abstract.

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CLEANTEC DATA – AGRIS

(See Index of AGRIS Information Centres, pages 183-189, for addresses)

AGRIS abstracts are prepared by special national and regional agricultural information centres throughout the world. The documents themselves can be obtained either from the published sources given in each abstract, or from the input centre directly.

The input centre is identified in the abstract code and the address can be obtained by referring to that code in the AGRIS Information Centres index at the back of this volume.

The code is structured as follows:

AGRIS-**PL**9000419

where **PL** is the country code–in this case for Poland.

Details of costs for photocopying should be obtained directly from the AGRIS centres.

CLEANTEC DATA – RIVM

Mr Kees Peek
RIVM
Antonie van Leeuwenhoeklaan 9
P.O. Box 1
3720 BA Bilthoven
The Netherlands

This section contains abstracts of technical monographs, all of which are in Dutch. At the moment, there is no translation facility available for the monographs themselves. A one page technical summary of each monograph has been prepared in English and will be released as a separate publication during 1993.

Copies of individual monographs in Dutch may be requested from the above address. For developing country requests the copies will be free of charge.

CLEANTEC DATA – UNEP/IEPAC

UNEP/IEPAC
Tour Mirabeau
39-43 quai André Citroën
75739 Paris Cedex 15
France
Tel: (+33 1) 4058 88 50
Fax: (+33 1) 40 48 88 74

The full volume of the *Industry and Environment Review* (Volume 15, No. 1-2) is available from the address above at a cost of FFr 50 per issue.

Copies of individual articles from the *Review* are available from

Chief, Industrial and Technological Information Bank
UNIDO
PO Box 300
A-1400 Vienna
Austria
Tel: (222) 211 31 (Ext 3706), Fax: (222) 230 7584

Reproduction charges for articles are: up to 10 pages – US$10; up to 50 pages – US$25; up to 100 pages – US$35.

Please give the order number contained in brackets at the end of the title – e.g. [BIBL-TINF00633] – together with the title when ordering.

CHEMICAL POLLUTION

FROM

INDUSTRY

MANAGEMENT

AND

CONTROL

EXPLANATORY NOTES

BOD	Biological oxygen demand
C/F	Counterflow
COD	Chemical oxygen demand
EM	Environmental management
MLVSS	Mixed liquor volatile suspended solids
PL	Pollution load
RM	Raw materials
SS	Suspended solids
TRS	Total reduced sulphur
UF	Ultrafiltration
VOC	Volatile organic compounds

INTRODUCTION

A. Background

For many years industrial pollution control has been carried out essentially on an end-of-pipe basis, and a wide range of unit processes (physical, chemical and biological) have been developed to service the needs of industry.

Such end-of-pipe systems range from low intensity to high intensity, from low technology to high technology and from low cost to high cost. Most are destructive processes in that they provide no return to the operating company in terms of increased product yield or lower operating cost except in those circumstances where reduced charges would then apply for discharge to municipal sewers.

It should be noted that in all cases the size (and hence the cost) of end-of-pipe treatment bears a direct relationship firstly to the volume of waste-water to be treated and then to the concentration of pollutants contained in the discharge. For example, the size of most physical-chemical reactors (balancing, neutralising, flocculation, sedimentation, flotation, oxidation, reduction etc.) is determined by hydraulic factors such as surface loading rate and retention time.

On the other hand the size of most biological reactors is determined by pollution load; for example, kg COD per kg of mixed liquor volatile suspended solids (MLVSS) per day in the case of suspended growth type systems, and kg COD per m^3 of media or reactor volume in the case of fixed-film type systems.

It is evident therefore that the reduction of emissions by action at the source can have a significant impact on the size and hence the cost of an end-of-pipe treatment system. On this basis it should be established practice in industry that no capital expenditure for end-of-pipe treatment should be made until all waste reduction opportunities have been exhausted. This has not often been the case, and many treatment plants have been built which are both larger and more complicated than necessary.

Increased environmental pressure and awareness now require industry to meet tighter environmental standards on a global basis. In many countries such standards generally cannot be met by conventional end-of-pipe solutions without seriously impacting the economic viability of the individual industries. Accordingly, much more emphasis has to be placed on source management as a necessary first step to reduce to a minimum end-of-pipe treatment to be provided.

Source management can be defined as "the development of a full understanding of the nature of all waste streams, (aqueous, gaseous or solid), and the exact circumstances by which they are generated in order to eliminate or minimize pollution before it arises".

B. Integrated source control

The essential components of source management, referred to in this paper as integrated source control, embrace a number of key technical, management and operational initiatives. Key technical initiatives involve identification of opportunities for the following:

- Application of cleaner processes or processing methods;
- Enhanced housekeeping practices;
- Water conservation, including reuse and recycle;
- Waste avoidance or minimization;
- Materials recovery and/or reuse.

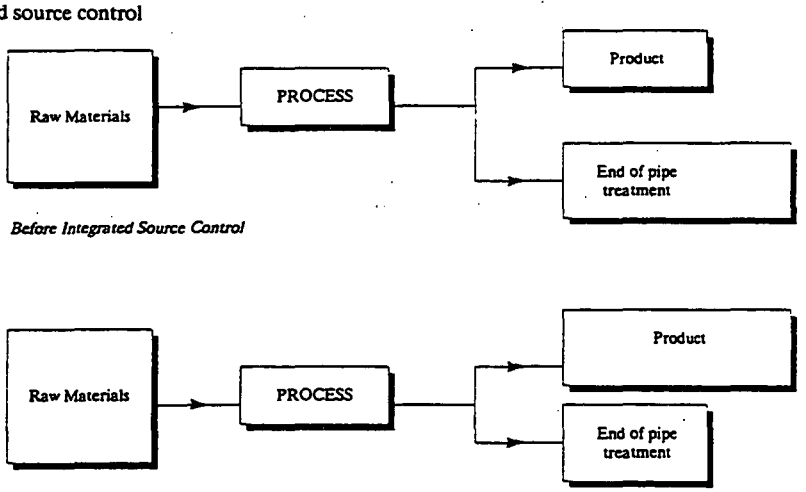
Key management initiatives include:

- Senior management awareness and commitment;
- Better training of technical staff and operatives;
- A management structure that positively links production, pollution control and environmental management;
- Disciplined monitoring of performance.

The potential benefits to be obtained in achieving optimum source management, represented diagrammatically in figure 1 include:

- Enhanced product yield;
- Reduced raw materials inventory;
- Reduced end-of-pipe treatment requirements.

Figure 1. Benefits of integrated source control



"An estimated 30–60 per cent of industrial pollution can be eliminated by reduction of waste and emissions at source.." PREPARE working group (Preventative Environmental Protection Approaches in Europe).

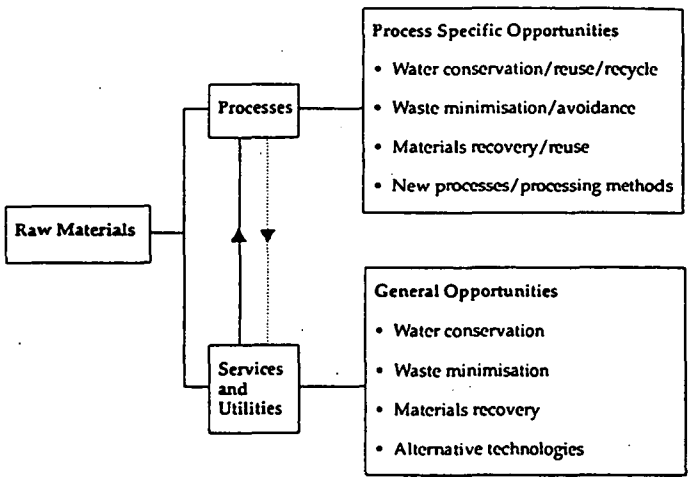
Potential benefits must be identified on an industry by industry basis. They include both direct process benefits (primary benefits) and basic infrastructure benefits (secondary benefits). These are depicted diagrammatically in figure 2.

In support of integrated source control, it is reported that 30–60 per cent of pollution can be eliminated by a reduction of waste and emissions at the source (PREPARE Working Group, Preventive Environmental Protection Approaches in Europe).

Further benefits of integrated source control may be summarized as follows.

- Industry can maximize profits by increasing efficiency while at the same time maintaining environmental concerns;
- Pollution prevention is more environmentally effective, more technically sound and more economical than conventional controls;
- Conventional controls are tools of last resort;
- Often little or no capital expenditure is required; just tightening up procedures can produce major financial and environmental benefits.

Figure 2. Integrated source control: primary and secondary benefits



Definitions

Water conservation/reuse/recycle: a reduction in water usage per unit of production achieved by application of conservation, reuse and recycle technologies.

Waste minimization/avoidance: a reduction in pollutant load per unit of production achieved by application of waste minimization and avoidance techniques.

Materials recovery/reuse: a reduction in pollutant load per unit of production achieved by recovery of material from waste either directly or through renovative technologies.

New processes/processing methods: the application of new processes or processing methods which achieve reductions in water usage and waste generation per unit of production.

Integrated source control in isolation is not sufficient to achieve the overall objective of cost-effective pollution control or cost-effective environmental management. This requires detailed consideration of optimized end-of-pipe control for the irreducible minimum of wastes, in addition to integrated source control.

C. Optimized end-of-pipe control

Optimized end-of-pipe treatment involves technical, management and operational initiatives, the management and operational initiatives being the same as those identified for integrated source control (i.e., a commitment at all levels, with better training to ensure efficient operation and performance monitoring of end-of-pipe systems).

Key technical issues concerning optimized end-of-pipe treatment could include provision of the following:

- Effective segregation of waste-water streams for optimized pre-treatment, energy recovery etc.;
- Effective flow and load pre-balancing;
- Control systems to prevent the overdosing of reagents;
- The upgrading of existing facilities.

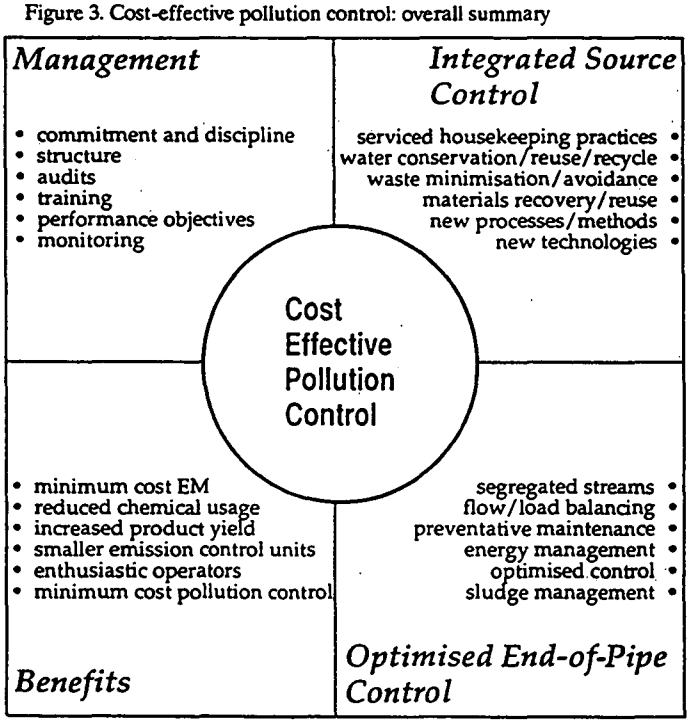
An overall summary of the principal components of cost effective pollution control and benefits is included as figure 3.

D. Scope of paper

The objective of this paper is to identify a procedure by which cost-effective pollution control can be achieved through a combination of integrated source control and optimized end-of-pipe control.

Chapter I identifies the principal implementation steps, including an approach to waste auditing, a management proce-

Figure 3. Cost-effective pollution control: overall summary



EM: Environmental management

dure that is designed to identify areas of poor management, bad housekeeping and inefficient process control. In addition, Chapter I covers the basic procedures to identify opportunities that are economic for the conservation of water, the minimization of waste and recovery of materials and the application of cleaner technologies.

Chapter II provides examples of integrated source control first on a non-process basis and then on a process-specific basis. Chapter II provides examples of optimized end-of-pipe control.

Typical audit review questions are provided in annexes I-V.

I. BASIC PROCEDURES FOR COST EFFECTIVE POLLUTION CONTROL

A. Key issues

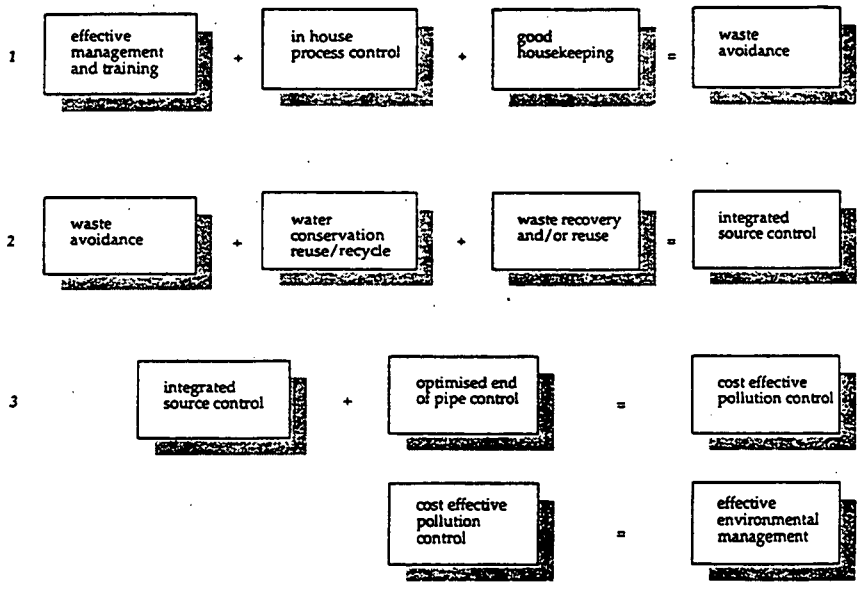
Figure 4 depicts the key elements involved in the identification and the sustained achievement of cost-effective pollution control. In this context cost-effective pollution control equates to good environmental management. The key issues can be defined as follows:

- **Effective management and training:** the introduction and sustainment of a disciplined approach to pollution control and environmental management. This involves senior management commitment to specific objectives including a cradle-to-grave philosophy, the establishment of a management structure that positively links production to environmental management, and training programmes for technical and operating personnel;
- **In-house process control:** the achievement of optimum efficiency in relation to production and processing methods, including the introduction, where feasible, of cleaner processes (alternative technology) or processing methods (substitute materials and/or reformulations, process modifications and equipment redesign);
- **Good housekeeping:** the rethinking of localised habitual practice and the identification and implementation of new practices and procedures;
- **Water conservation/reuse/recycle:** the achievement of optimum efficiency in relation to water use, looking at the possible elimination of use, regulation of use to specific requirement, sequential use or reuse and in-process recycle;
- **Waste recovery and/or reuse:** the identification and implementation of opportunities to recover process chemicals and materials for direct reuse or for reuse elsewhere through renovation or conversion technology.

To achieve cost effective pollution control and environmental management, it is therefore necessary to do the following:

- Promote environmental awareness at three levels within the company hierarchy;
- Ensure full management commitment to environmental performance;
- Establish a review team to carry out an initial audit of present production methods, housekeeping practices, procedures and factory support services and to identify opportunities for integrated source control and optimized end-of-pipe treatment;
- Establish objectives for overall environmental performance; also specific performance targets on a process-by-process basis including utilities;
- Establish a management structure that positively links production pollution control and the environment with clearly defined responsibilities and lines of communication to managing director level;
- Introduce formal training procedures for technical and operational personnel;
- Establish monitoring programmes and procedures designed to continuously assess process efficiency and environmental performance;
- Carry out regular environmental audits to ensure standards are being maintained;

Figure 4. Industrial water and waste-water management



- Establish and maintain a database with relevant information and documentation on performance and on efficient use of resources and reduction of waste production.

A disciplined approach to auditing and implementation is required if the full potential for integrated source management and optimized end-of-pipe control is to be achieved on a sustainable basis.

On an industry-wide basis, there are many examples of failure to realize the potential environmental and cost benefits following the installation of new plant and equipment designed to achieve conservation, reuse, recycle and recovery of water and other useful materials, or after the introduction of new processing methods or technologies.

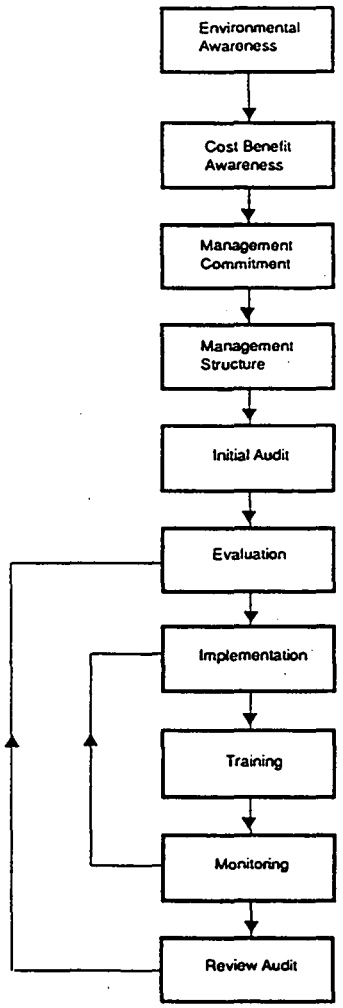
Such failures often can be attributed to an inappropriate choice of technology or to maloperation. Choosing the wrong technology occurs when implementation decisions are made in isolation without due regard to overall environmental objectives and operating constraints. Maloperation often is the principal reason why the potential benefits of low-waste technology are not fully realized. It is prevalent when the attitude of operators, managers and support technical staff is dominated by production objectives only.

Under production-oriented circumstances, equipment installed to conserve water, minimize waste or recover materials tends to be by-passed at times of crisis or in the interest of production output. Such attitudes also reflect badly on the performance of end-of-pipe treatment systems, i.e., the end-of-pipe system is regarded as a "magic box" that is capable of handling anything and everything production departments wish to discharge (strong spent solutions, off-spec batches, spillages, leakages etc.). In reality a waste-water treatment plant or emission control system is designed to operate efficiently within specific limits only.

Accordingly, the attitude of managers, supervisors, technical staff and operators to integrated source control and optimized end-of-pipe treatment is as important as the technology itself.

An overall procedure to achieve cost effective pollution control is depicted in figure 5 and described below.

Figure 5. Procedures to achieve cost-effective pollution control



B. Environmental awareness and management commitment

Pollution control and environmental awareness must be promoted at three levels within the company hierarchy:

(a) Managerial and supervisory staff should be made fully aware of environmental priorities and policies and have a detailed knowledge of regulatory requirements and related operational factors and constraints. Managers and supervisors must be motivated to fully apply such priorities and policies. This involves encouraging managers and supervisors to gather and study information on environmental requirements, environmentally compatible operations and plant management;

(b) Technical staff should be delegated responsibility to incorporate environmental considerations into plant operation and maintenance, and in the treatment and disposal of emissions. This involves motivating technical staff to plan for optimum process scheduling and to monitor plant operators' performance accordingly. Technical staff should ensure that plants for the treatment of emissions operate according to target emission loadings and/or characteristics. In addition, plants should be frequently supervised to ensure that emission loadings or characteristics do not fall outside prescribed standards;

(c) Plant operators should be delegated responsibility for raw material usage and emission control as well as normal process control. Management support should include specific training and motivation to enable operators to detect and tackle any operational problem that could give rise to adverse environmental impact.

Diagrams depicting environmental awareness, cost benefit awareness and managerial commitment are included in figures 6, 7 and 8 respectively.

C. Management structure

As outlined in section A, a key requirement for the successful application of integrated source control and optimized end-of-pipe control is a management structure that positively links production, pollution control and environmental management.

The traditional approach of divorcing production personnel from the true cost implications of utilities supply (water, steam

Figure 6. Procedures to achieve cost-effective pollution control: environmental awareness

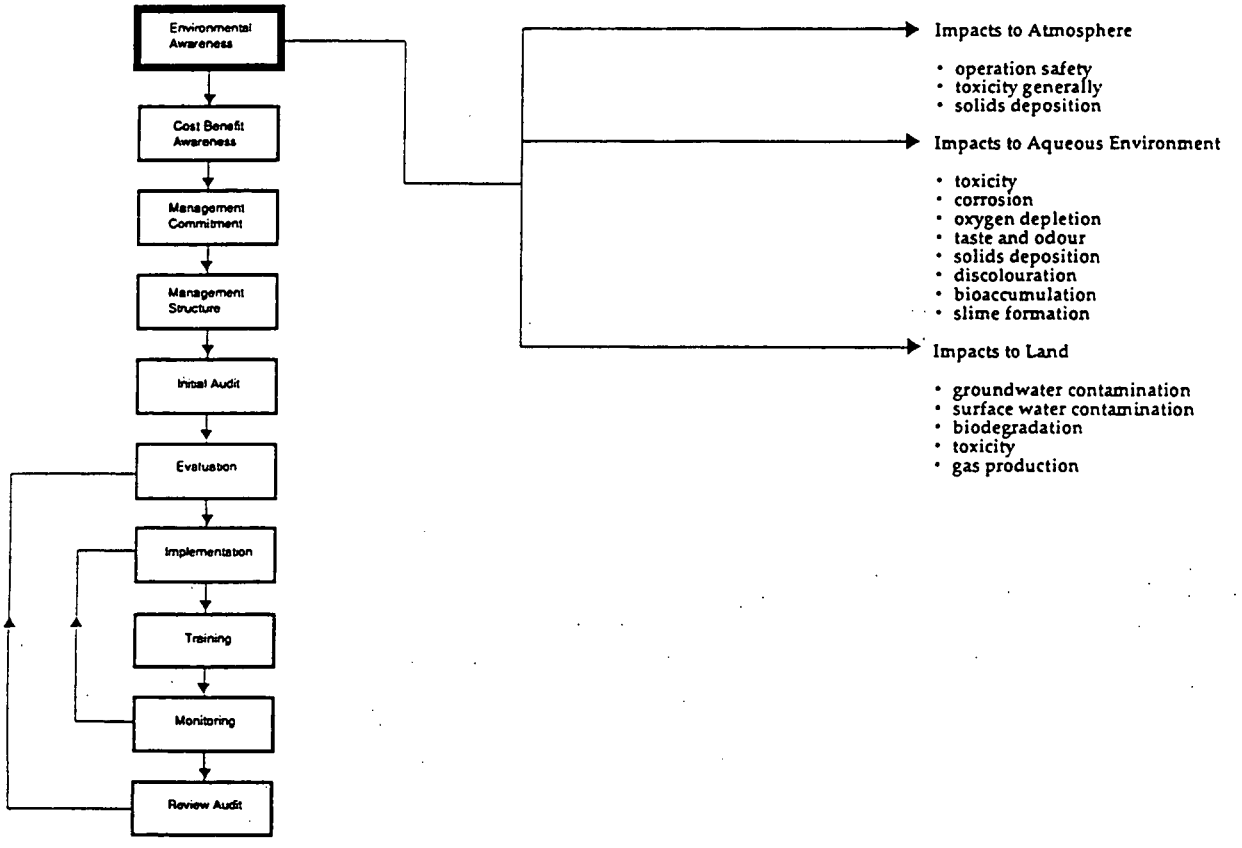


Figure 7. Procedures to achieve cost-effective pollution control: cost-benefit awareness

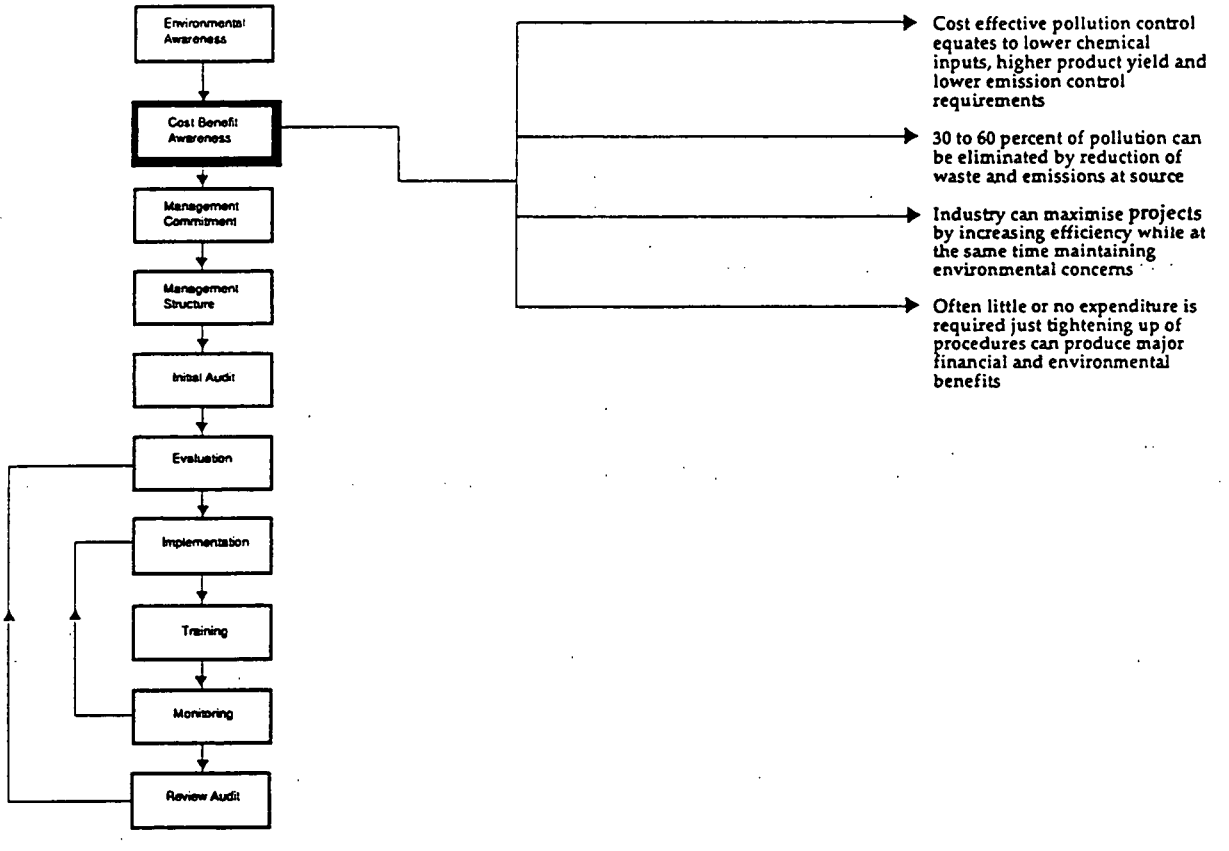
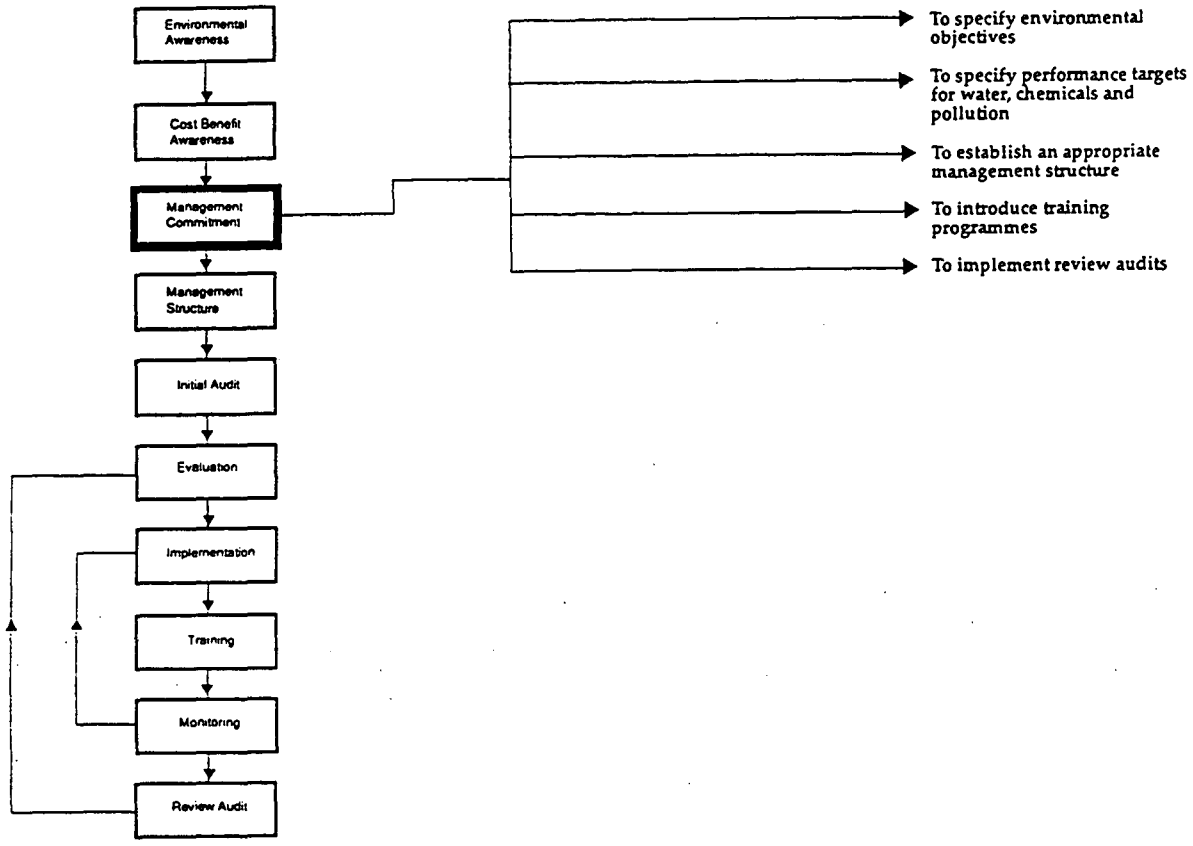


Figure 8. Procedures to achieve cost-effective pollution control: management commitment



etc.) and emissions control (waste-water treatment, wastes treatment and disposal) can be counter-productive.

As a practical illustration, consider the case of a chemicals production unit. The unit utilized batch processing techniques to manufacture a range of inorganic and organic chemicals and produced waste-water with an average volume of 5,000 m^3/d and an average COD load of 21 t/d. A revised management plan to allocate costs for wastewater treatment to individual profit centres on a polluter pays principle reduced the average waste-water volume to 2,700 m^3/d and the COD load to 13 t/d.

A second example involves a metal preparation and finishing establishment. In this case considerable investment was made by management in water conservation devices, including conductivity controllers, and in direct metals recovery using electrolytic techniques. All the equipment fell into disrepair at an early date because no appropriate management structure or support training had been established. Operators continued to function on the basis of production only.

A management and operating structure is required therefore to ensure that production personnel have responsibility for integrated source control procedures and have full awareness of emissions control requirements. An appropriate structure is depicted in figure 9. Also it is necessary to ensure that the true costs of pollution control and the cost benefits of integrated source control and optimized end-of-pipe control are debited/credited as appropriate.

D. Initial audit of practices, procedures and opportunities

An initial audit of practices, procedures and opportunities is required to establish baseline environmental conditions. It involves a critical assessment and review of present production and processing methods and housekeeping practices and procedures. In addition, it identifies opportunities for new processes or processing methods and for the conservation, reuse, recycling and recovery of water and other useful materials.

The principal requirements of the audit are summarised in figures 10 and 11.

The review team delegated with the task of undertaking the initial audit should ideally comprise the following personnel:

- Works director;
- Production manager(s);
- Technical manager;
- Chemist/chemical engineer;
- Accountant;
- Specialist consultant.

The audit should be carried out by one or two people, who consult the review team as appropriate. In addition to the principal objectives of the audit, it is appropriate that the review team take the opportunity to fully assess all environmental risks as potential risk areas. On this basis the principal areas of investigation should include the following:

- Raw materials and utilities;
- Processes and integrated source control;
- End-of-pipe emission control systems;

Figure 9. Procedures to achieve cost-effective pollution control: management structure

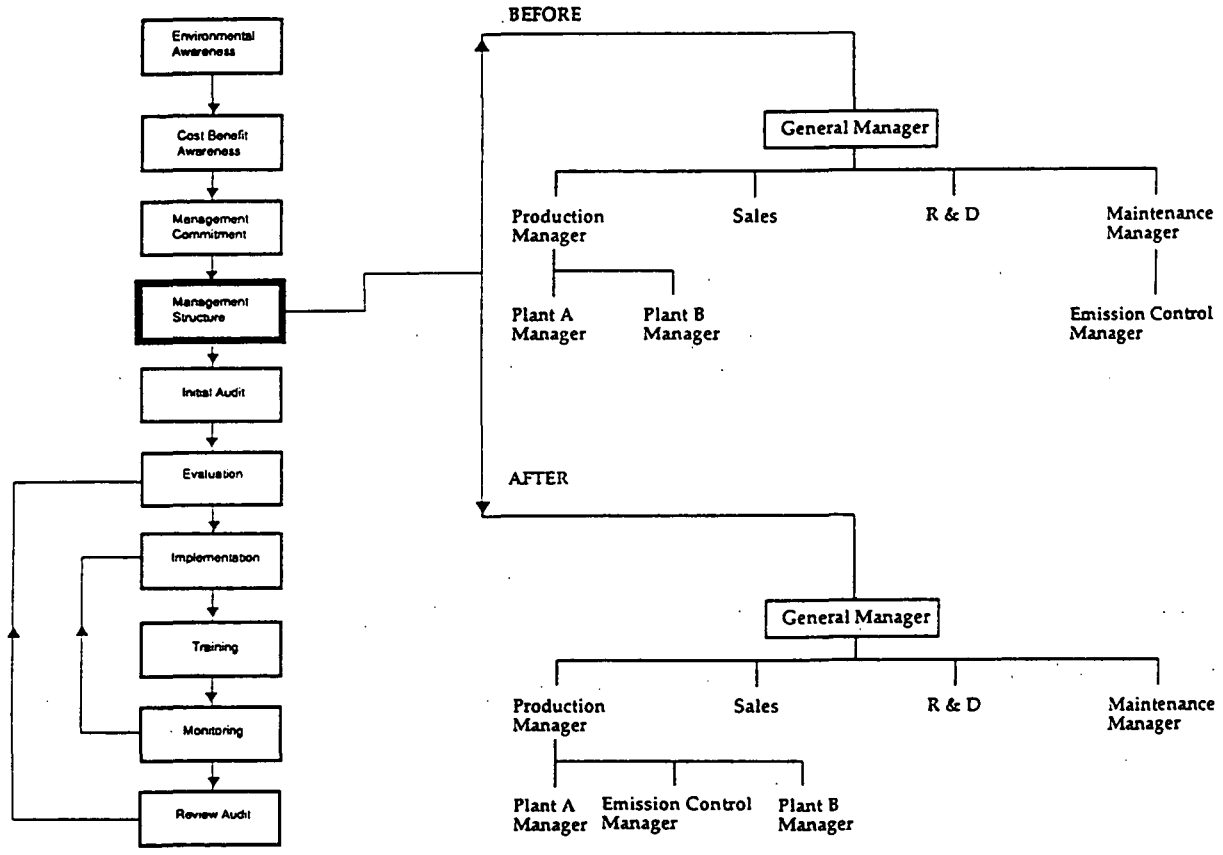


Figure 10. Procedures to achieve cost-effective pollution control: initial audit

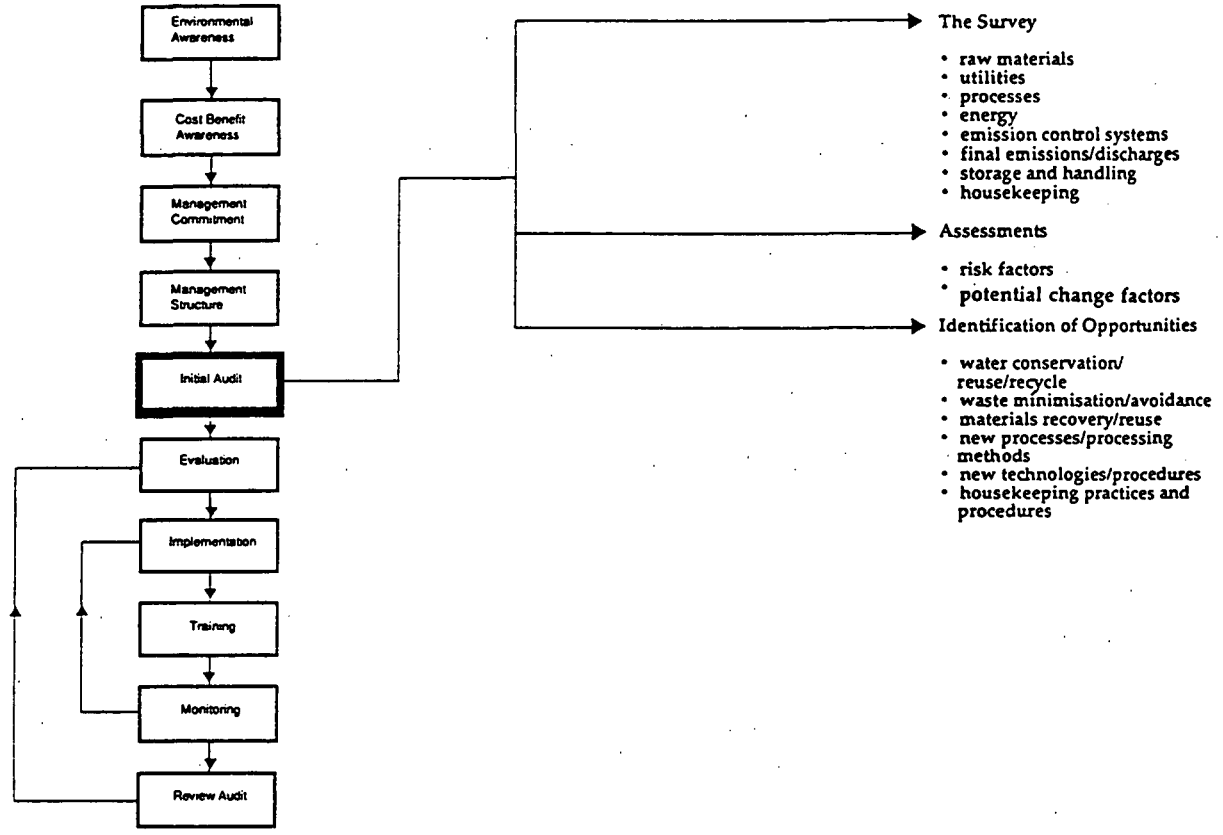
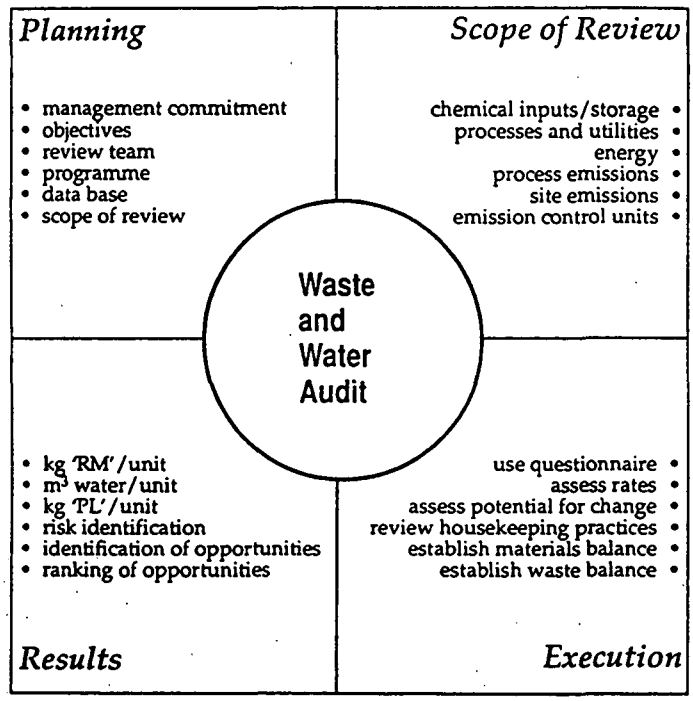


Figure 11. Procedures to achieve cost-effective pollution control: waste and water audit



RM: Raw materials expressed as individual chemicals

PL: Pollution load expressed as COD, BOD, toxic metals etc.

- Final emissions and discharges;
- Storage and handling.

Sample review questions under the above headings are documented in annexes I–V. The questions are designed to obtain a clear understanding of present performance (for comparison with existing performance targets and experience elsewhere) and the potential for change. All questions must be answered honestly, and substantiating documentary evidence must be provided where available.

It would be appropriate to allocate a potential change factor (1, 2 or 3) to relevant current operations and/or procedures to identify specific areas (individual processes or utilities) with the greatest potential for change; i.e., to achieve optimum efficiency in production and processing methods including the introduction of cleaner processes (alternative technology) or processing methods (substitute materials and/or reformulations, process modifications and equipment redesign). The factor 3 would indicate the greatest potential for change.

It would also be appropriate to allocate an environmental risk category (low, medium or high) to each current operation or procedure as an aid to overall environmental management.

Examples of high- and medium-risk categories are summarized below. In doubtful cases, a higher risk category should be allocated to a particular operation at the initial stage. Following subsequent detailed assessment, a lower category (in terms of priority action) may be introduced if appropriate.

The high-risk category (H) covers major environmental threats such as:

- Known adverse environmental impacts;
- Suspect integrity of storage vessels;
- Untrained personnel;
- Lack of control over chemical and waste storage;
- Contamination of ground and ground-water in areas of high permeability.

The medium-risk category (M) would coversthreats such as:

- Heavy reliance on manual control systems, e.g. for switching off water inputs when processes are not in use;
- Insufficient emergency holding capacity, e.g. waste-water treatment plant not provided with side-stream containment or adequate balancing facilities;
- Contamination of ground and ground-water from poor housekeeping in areas of low permeability.

E. Evaluation

Based on the answers to the questions listed in annexes I–V, it will be possible to list specific areas of potential change, with particular reference to opportunities for the following:

- Raw material substitution and/or reformulation, process modifications, or the introduction of cleaner processes or methods based on in-house knowledge;
- Conservation of water by direct reduction, reuse or recycling;
- Waste avoidance or waste minimization;
- Materials recovery for direct reuse or for conversion to a by-product of value.

All potential opportunities should be listed on a process by process basis under the headings noted above, including general housekeeping improvements. Opportunities concerning utilities (e.g. cooling water) should be handled in the same way.

In parallel to the initial audit it is necessary to carry out a review of the relevant literature to identify specific water use and waste generation information for similar industries elsewhere, and to establish relevant opportunities involving cleaner processes or processing methods, water conservation, reuse and recycle, waste avoidance and minimization, and materials recovery.

A schedule of costs and potential returns can then be developed and decisions taken on schemes to implement and new procedures to introduce on a technical and economic basis. Examples of typical opportunities are illustrated in Chapter II. The procedure is depicted in figure 12.

F. Implementation

Based on the results of the audit and the necessary constraints placed on each facility as a result of work in progress and future plans, it will be possible to draw up a list of actions for new plant installation, existing plant upgrading and for new operating practices and procedures. Individual actions are assigned a priority by specifying a target completion date.

In addition, it will be possible to identify specific performances targets by which key operations will be monitored and measured on an ongoing basis. The implementation process is depicted in figure 13.

Figure 12. Procedures to achieve cost-effective pollution control: evaluation

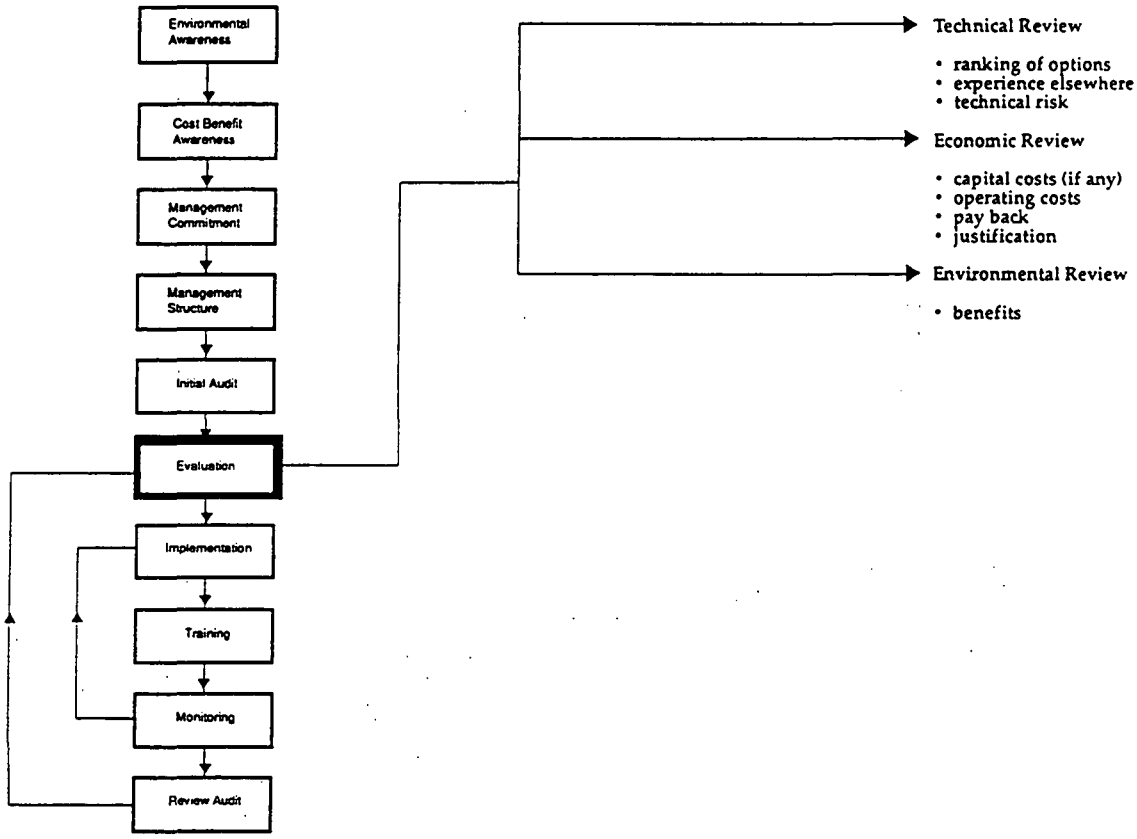
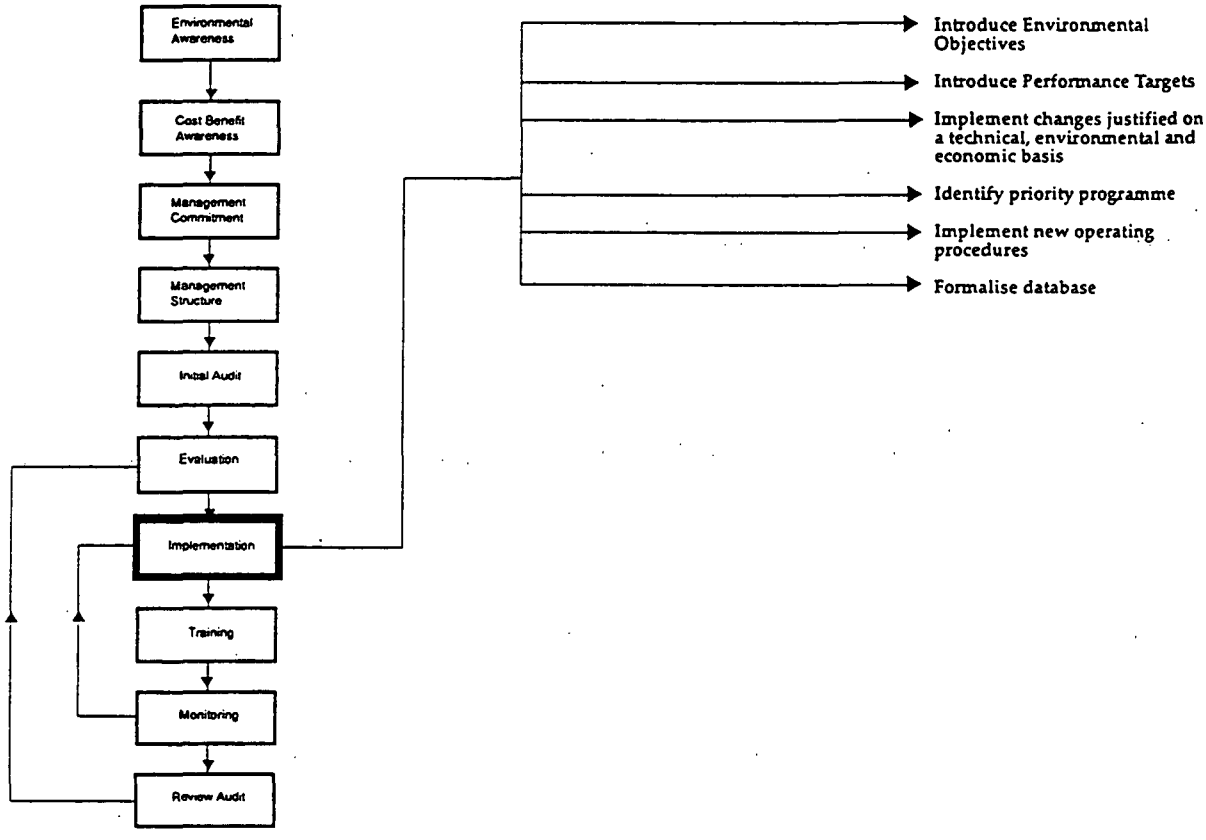


Figure 13. Procedures to achieve cost-effective pollution control: implementation



G. Training

The successful implementation of an enhanced strategy for integrated source control and optimized end-of-pipe treatment is often dependent on the introduction of adequate and appropriate training programmes for managers and supervisors, technical staff and operatives.

The key requirements of such training programmes are summarized in figure 14.

H. Monitoring

Following implementation of enhanced strategies, a key requirement is the introduction of a monitoring programme, particularly the routine checking of raw material usage and emissions per unit of production, with comparison of the data against specific performance criteria. In addition there is a requirement for the routine checking of maintenance procedures and programmes and the introduction of improvements wherever practicable.

Key requirements of a successful monitoring programme are depicted diagrammatically in figure 15. The results of the monitoring programme include implementation of new opportunities whenever appropriate.

I. Review Audit

Requirements of the periodic review audit are summarized in figure 16. Such a review audit includes identification of new opportunities for evaluation and implementation.

Figure 14. Procedures to achieve cost-effective pollution control: training

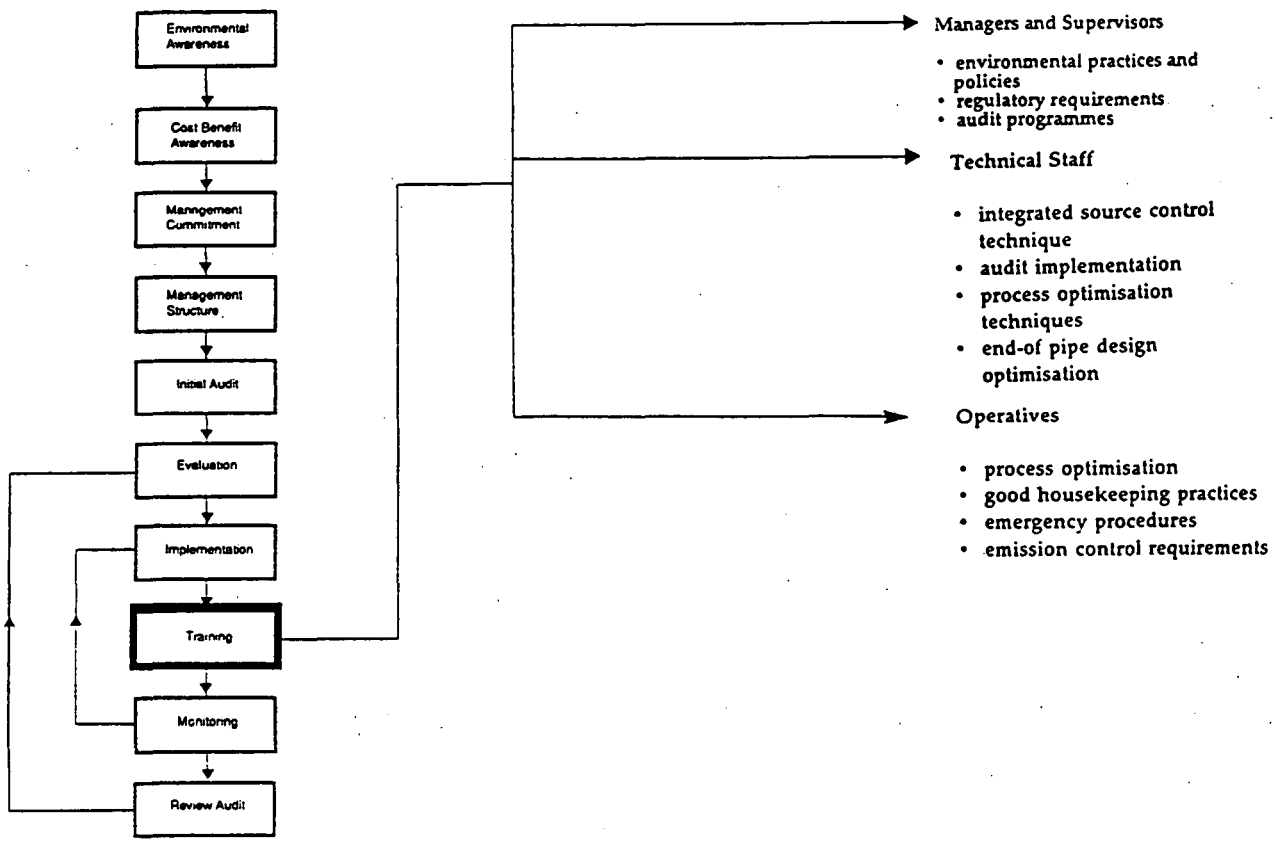


Figure 15. Procedures to achieve cost-effective pollution control: monitoring

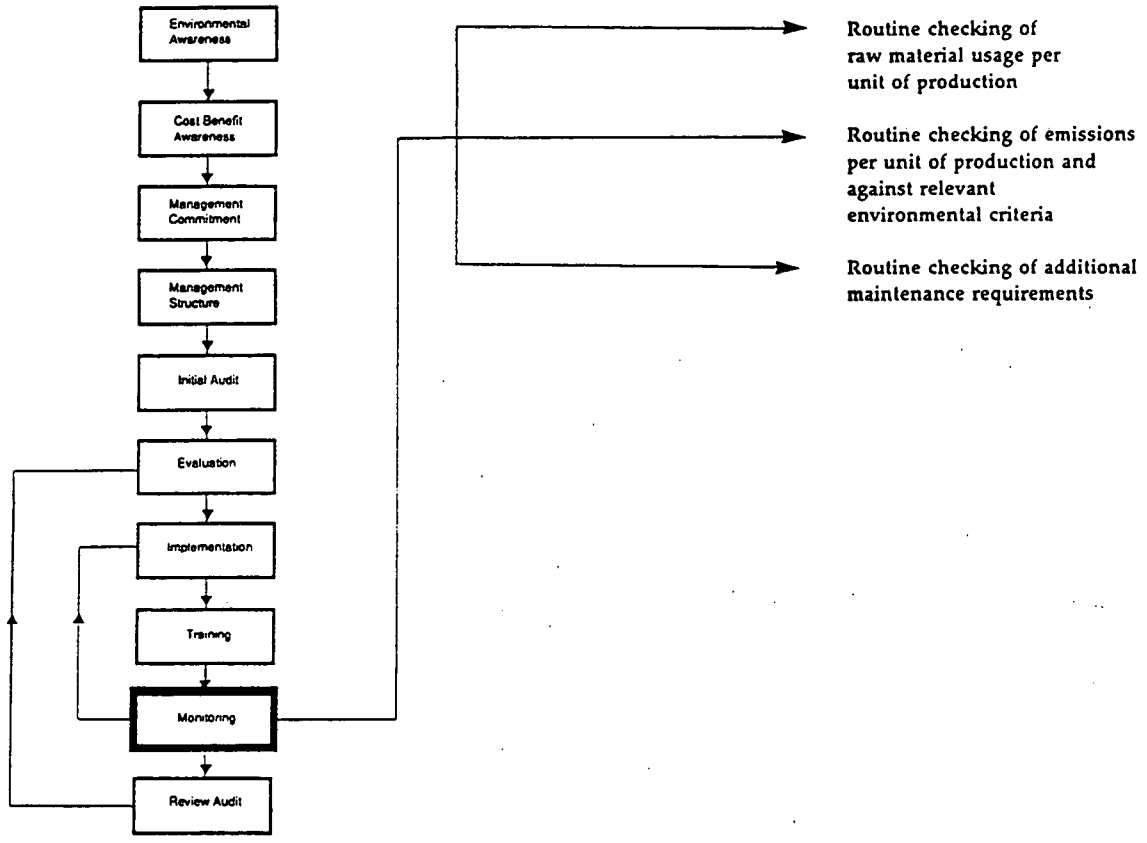
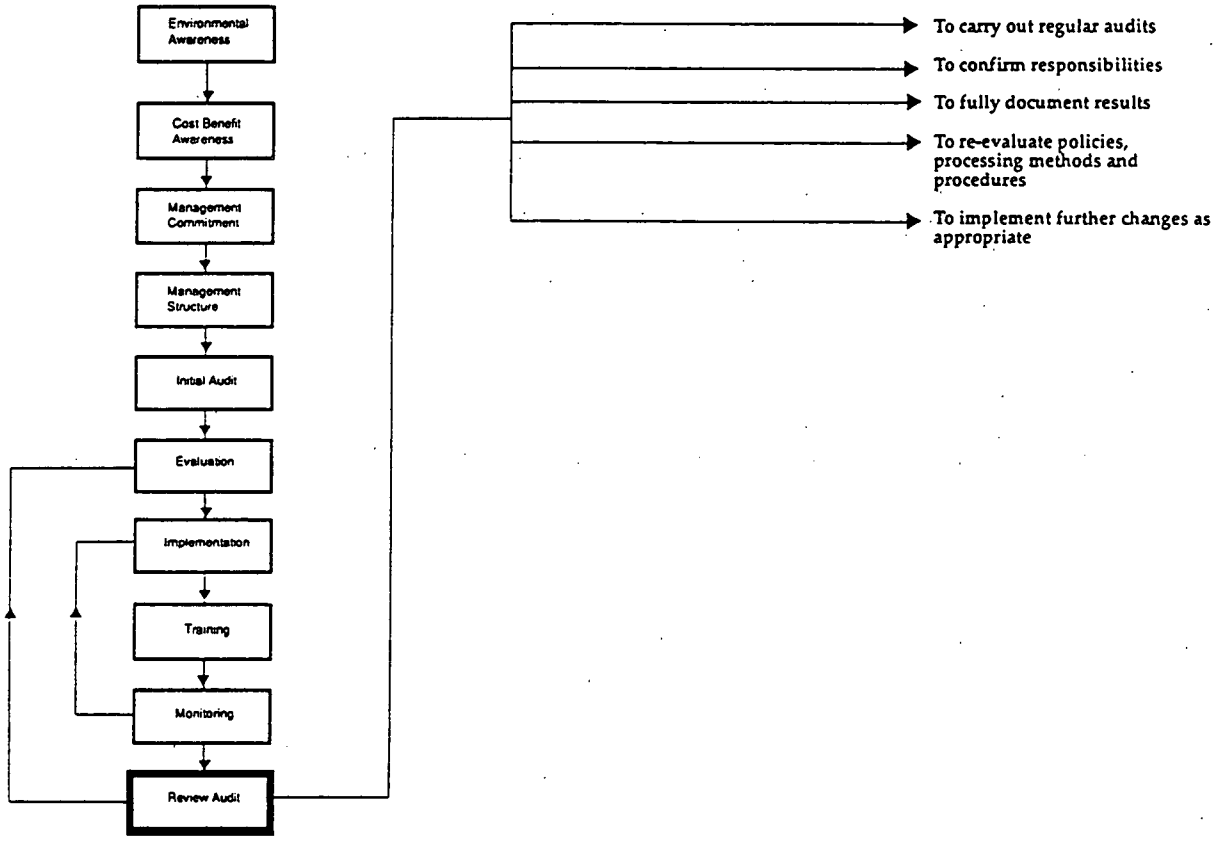


Figure 16. Procedures to achieve cost-effective pollution control: review audit



II. INTEGRATED SOURCE CONTROL: EXAMPLES

The principal components of integrated control and the benefits obtained by implementation are summarized in figure 17. Opportunities include both water conservation (figure 18) and waste minimization (figure 19).

The basic procedures to achieve integrate source control are summarized in figure 20. Typical examples of a general nature are depicted in figure 21. Non-process-specific opportunities are listed in figure 22. Opportunities relating to batch and continuous chemical processing are shown in figures 23 and 24 respectively.

As an example, process-specific opportunities relating to the hides and skins industry are summarized in figure 25 and identified in greater detail in tables 1–4 which deal with the following:

- Cleaner processes or processing methods;
- Water conservation/reuse/recycle;
- Waste minimization/waste avoidance;
- Materials recovery.

Also as an example, process-specific opportunities relating to the pulp and paper industry are summarized in figure 26 and identified in greater detail in tables 5–8.

Figure 17. Procedures to achieve cost-effective pollution control: integrated source control

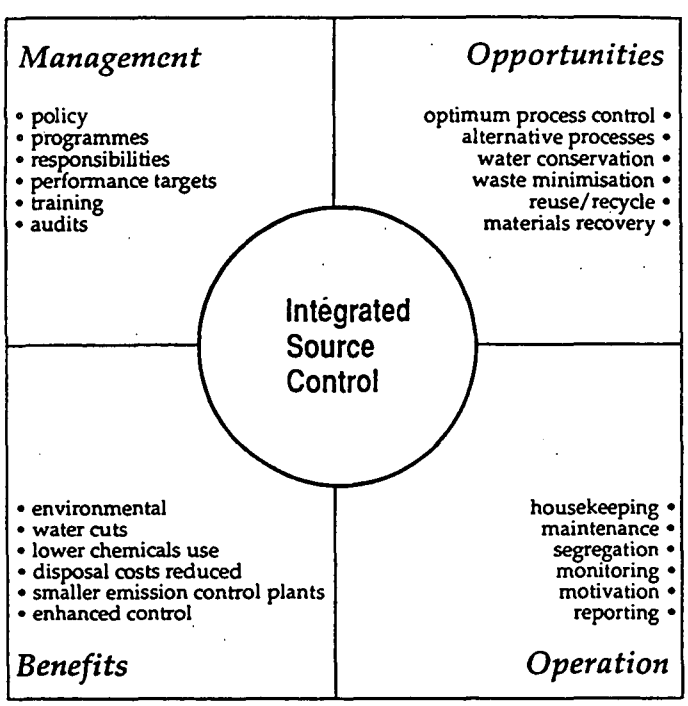


Figure 18. Water conservation

control	*water inputs and outputs*
organise	*water usage "audit"*
nominate	*a water management officer*
specify	*preventative maintenance*
eliminate	*uncontrolled overflows*
regulate	*water pressure*
verify	*water balance*
allocate	*responsibilities*
train	*operators, supervisors, managers*
install	*water meters and controllers*
optimise	*monitoring programmes*
nurture	*water conservation "thinking"*

Figure 19. Waste minimization

maximise	*process efficiency*
initiate	*waste management "audit"*
nominate	*a waste management officer*
investigate	*clean technology opportunities*
minimise	*risks of spillage, leakage*
instigate	*at source recovery opportunites*
segregate	*"Active" solids from water*
automate	*cleaning operations*
train	*operators, supervisors, managers*
improve	*housekeeping practices & procedures*
optimise	*monitoring programmes*
nurture	*water avoidance "thinking"*

Figure 20. Procedures to achieve cost-effective pollution control: integrated source control – procedures

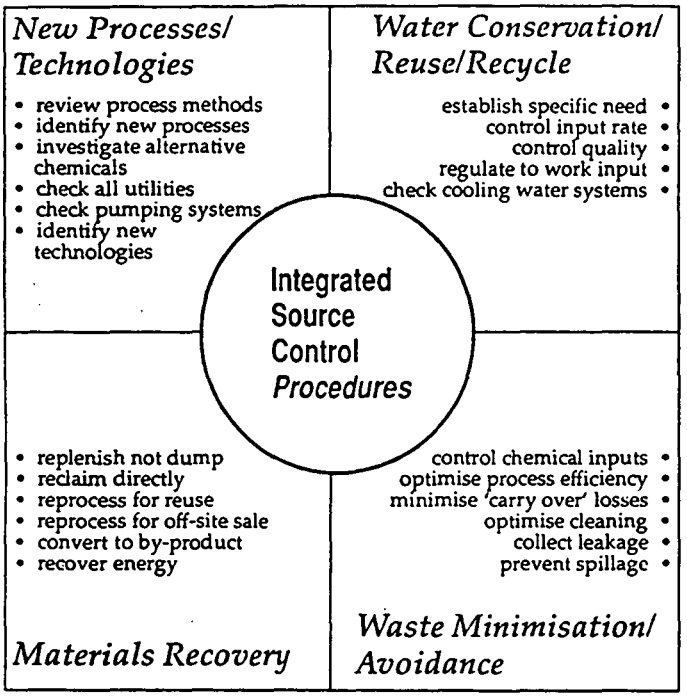
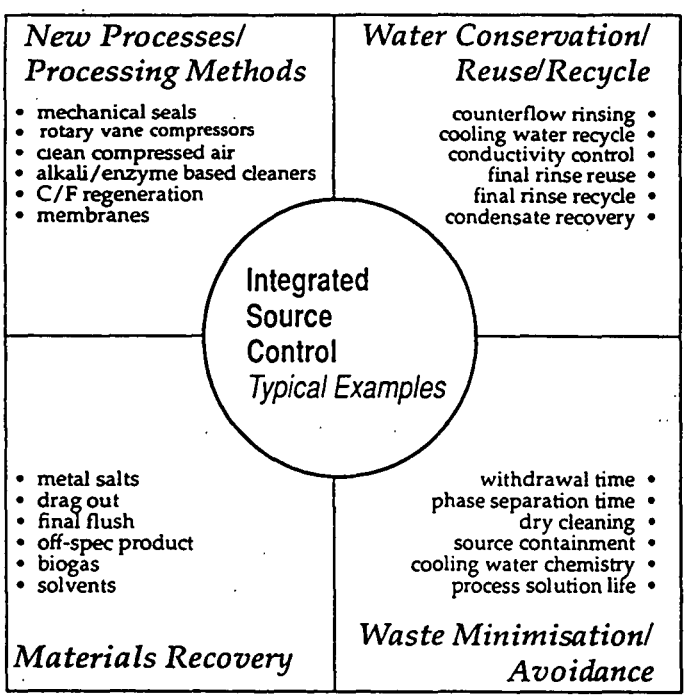


Figure 21. Examples of cost-effective pollution control: integrated source control



C/F Counterflow

Figure 22. Integrated source control:non-process-specific opportunities

- *Water Conservation/Reuse/Recycle*
  - Counterflow rinsing: use 2 or 3 rinse stations
  - Cooling water: recycle rather than once through
  - Quality control: input to meet quality requirement
  - Batch washing: reuse final wash for first wash
  - Wash water: reuse for less critical duties
  - Condensate: recover, also eliminate steam leaks
- *Waste Minimisation/Avoidance*
  - Withdrawal time: allow time for dewatering
  - Phase separations: enhance efficiency
  - Dry cleaning procedures: use wherever possible
  - Cooling water: select appropriate control chemicals
  - Process solutions: prolong usage factor
- *Materials Recovery/Reuse*
  - Metals salts: recover electrolytically
  - Draft out: recover directly
  - Batch cleaning: recover first flush
  - Off-spec product: collect for reprocessing
  - Energy: recovery heat energy, generate biogas
  - Solvents: recover on site for reuse
- *Alternative Technologies/Procedures*
  - Pumps: use mechanical seals rather than packed glands
  - Compressors: use rotary vane units rather than liquid ring units
  - Cleaners: use alkali or enzyme based cleaners, not solvents
  - Membranes: use membranes as an alternative to ion exchange
  - Ion exchange: use counter current regeneration techniques
  - Compressed air: use clean compressed air to prevent corrosion, leakages

Figure 23. Integrated source control: batch chemical processing

- *Process Control*
  - optimise mass balance
  - input raw materials accurately
  - control reactor conditions (temperature, pressure)
  - allow time for efficient phase separation
  - slow down procedures
  - collect off-spec material for reprocessing
  - enhance reaction rates (concentration factor etc)
- *Plant Cleaning*
  - optimise campaign working to minimise cleaning requirements
  - recover first flush
  - reuse final rinse sequentially
  - use clean-in-place procedures
- *Support Utilities*
  - contain spillage for recovery
  - detect leakage
  - optimise cooling water management
  - optimise steam usage
  - consider energy recovery

Figure 24. Integrated source control: continuous chemical processing

- *Process Control*
  - input chemicals accurately and regulate concentrations
  - regulate and control water to specific requirements
  - consider side stream contaminant removal
  - consider side stream process solution enhancement
  - control reactor conditions (temperature etc)
  - minimise 'drag out' of process solutions
  - replenish process solutions to prolong run times
- *Planting Cleaning*
  - question plant clean down frequency
  - use pressure cleaning techniques
  - include automatic shut off on cleaning systems
- *Utilities*
  - recycle cooling water directly
  - reuse cooling water for other duties
  - optimise steam usage
  - consider energy recovery

Figure 25. The hides and skins industry: process-specific opportunities for integrated source control

- *New Processes/Processing Methods*
  - curing - safe insecticides
    curing - green hides
    curing - reduced salt
  - dehairing - enzymes
  - deliming - ammonia free
  - degreasing - enzymes
  - tanning - chrome free
  - finishing aqueous media
- *Water Conservation/Reuse/Recycle*
  - process vessels - low float
  - process vessels - batch washing
  - bating wash - recycle to soak
  - neutralisation wash - recycle to soak
  - second lime wash - reuse as first lime wash
- *Waste Minimisation/Avoidance*
  - dehairing - low sulphide
  - chrome tanning - high chrome exhaustion
  - vegetable tanning - high utilisation
- *Materials Recovery/Reuse*
  - dehairing - hair save by filtration
  - dehairing - separation of unhairing/liming
  - chrome tanning - chrome recovery/recycle

Figure 26. The pulp and paper industry: process-specific opportunities for integrated source control

- *New Processes/Processing Methods*
  - Debarking of wood - dry method
  - Kraft pulping - replace sulphide with anthraquinone
  - Solvent pulping - organic solvents
  - Kraft pulping - extended delignification
  - Straw pulping - use of $Na_2CO_3/NaOH/O_2$
  - Pulp washing - filter belt washers
  - Biopulping - enzymes
  - Biopulping - fungi
  - Biobleaching - enzymes
  - Straw bleaching - oxygen
  - Wood pulp bleaching - chlorine dioxide
  - Wood pulp bleaching - $O_2/H_2O_2/O_3$
  - Paper making - retention and drainage aids
- *Water Conservation/Reuse/Recycle*
  - Bagasse wetting - reuse of wastewater
  - Paper machines - reuse of whitewater
- *Waste Minimisation/Avoidance*
  - Bagasse depithing - solids separation/water recycle
  - Pulp screening - hot screening after washing
  - Evaporator condensates - methanol/TRS removal by stripping
- *Material Recovery/Reuse*
  - Solvent pulping - lignin recovery
  - Soda or kraft liquor - lignin recovery by UF
  - Non-wood pulps - desilication (black liquor recovery)
  - Non-wood pulps - small scale recovery furnaces for black liquor

Figure 27. The metal preparation and finishing industry: process-specific opportunities for integrated source control

- *New Processes/Processing Methods*
  - Chrome plating - trivalent chromium basis
  - Solvent cleaning - alkali/enzyme cleaning
  - Solvent cleaning - on site recovery systems
  - Passivation - chrome free
  - Process solutions - free of complexing agents
- *Water Conservation/Reuse/Recycle*
  - Conductivity control
  - Product movement control
  - Counterflow rinsing
  - Spray rinsing
  - Rate regulation
- *Waste Minimisation/Avoidance*
  - Drag out minimisation
  - Drag out containment and reuse
  - Drag out concentration and reuse
  - Use of low concentration process solutions
  - Design of work operations
- *Materials Recovery/Reuse*
  - Electrolytic recovery of metals
  - Reverse osmosis concentration of metal salts and reuse
  - Electro-dialysis concentration of metal salts and reuse
  - Ion exchange recovery processes
  - Recovery by chemical reactions

Table 1. Integrated source control for the hides and skins industry: cleaner processes or processing methods

Process	Technology	Benefits
• Curing hides and skins	• Use of safe insecticides • Use of green hides • Use of reduced salt (15%)	• Reduced potential toxicity • Reduces effluent salinity by 60% • Reduces effluent salinity by 50%
• Dehairing	• Use of enzymes	• Reduces sulphide usage by 40%
• De-liming	• Ammonia free processing	• Reduced effluent ammonia content
• Degreasing	• Use of enzymes	• Elimination of solvent use • Reduced VOC emissions
• Tanning	• Chrome free (elun) tanning	• Chrome free solid wastes from splitting
• Finishing processes	• Use of aqueous media for finishing processes	• Elimination of solvent use • Reduced VOC emissions

Table 2. Integrated source control for the hides and skins industry: water conservation/reuse/recycling

Process	Technology	Benefits
• Processing vessels – general	• Low float operation • Batch washing	• Reduced water consumption • Reduced chemical costs • Smaller effluent plant
• Bating wash liquors • Neutralisation wash liquors	• Recycle to soaking salted or green hides	• Reduced water consumption
• Second lime wash	• Reuse as first lime wash	• Reduced water consumption

Table 3. Integrated source control for the hides and skins industry:water avoidance/waste minimization

Process	Technology	Benefits
• Dehairing	• Low sulphide	• Reduced sulphide emissions
• Chrome tanning	• High chrome exhaustion	• Reduced chrome content in effluent (by 90%)
• Vegetable tanning	• High utilisation	• Reduced BOD load

Table 4. Integrated source control for the hides and skins industry:materials recovery

Process	Technology	Benefits
• Dehairing	• Hair-saving by filtration	• Reduced sulphide discharge • Reduced BOD discharge • Hair recovery
	• Separation of unhairing/liming	• Materials recovery • Reduced pollution load (60%)
• Fleshings	• Grease recovery by enzyme treatment	• Materials recovery • Eliminates difficult solid waste
• Chrome tanning	• Chrome recovery/recycling	• Reduced materials inventory • Reduced chromium content in effluent

Table 5. Integrated source control for the pulp and paper industry: cleaner processes or processing methods

Process	Technology	Benefits
• Debarking of wood	• Dry debarking	• Reduced water consumption • Reduced BOD discharge
• Kraft pulping	• Replace sulphide with anthraquinone	• Reduced TRS
• Solvent pulping	• Use of organic solvents	• Lignin recovery • Recovery aqueous emissions
• Kraft pulping	• Extended delignification	• Reduced chlorine demand • Reduced emission of organic chlorides
• Straw pulping	• Use of $Na_2CO_3/NaOH/O_2$	• Enhanced chemical recovery
• Pulp washing (incl. straw)	• Use of filter belt washers	• Enhanced black liquor recovery
• Biopulping	• Use of enzymes	• Reduced emissions
• Biopulping	• Use of fungi to pre-soften wood chips	• Improved efficiency
• Biobleaching	• Use of xylanase	• Reduced organochlorines
• Straw bleaching	• Use of oxygen	• Reduced organochlorines
• Wood pulp bleaching	• Use of chlorine dioxide	• Reduced discharge dioxins, furans
• Wood pulp bleaching	• $O_2/H_2O_2/O_3$	• Eliminates use of chlorine
• Paper making	• Retention and drainage aids	• Enhanced whitewater recycling

Table 6. Integrated source control for the pulp and paper industry:water conservation/reuse/recycling

Process	Technology	Benefits
• Bagasse wetting during storage	• Reuse of wastewater	• Reduced water usage
• Paper machines	• Reuse of whitewater	• Lower water costs • Reduced wastewater discharge

Table 7. Integrated source control for the pulp and paper industry:waste avoidance/waste minimization

Process	Technology	Benefits
• Bagasse depithing	• Immediate mechanical separation of solids and water recirculation	• Reduced water consumption • Reduced SS discharge
• Pulp screening	• Hot screening after washing	• Lower BOD discharge • Reduced SS discharge
• Evaporator condensates	• Removal of methanol and TRS by stripping/incineration	• Reduced BOD discharge • Reduced TRS

Table 8. Integrated source control for the pulp and paper industry:materials recovery

Process	Technology	Benefits
• Solvent pulping	• Use of organic solvents	• Lignin recovery • Recovery chlorine demand
• Soda or kraft black liquor	• Use of ultrafiltration membranes	• Lignin recovery
• Non-wood pulps	• Desilication	• Black liquor recovery
• Non-wood pulps	• Small scale recovery furnaces	• Black liquor recovery

III. OPTIMIZED END-OF-PIPE CONTROL

Optimized end-of-pipe control involves technical, management and operational initiatives. Technical initiatives include factors such as the following:

- Source management as defined in chapter II;
- Stream segregation e.g. of incompatible waste streams or of waste streams with potential value;
- Flow and load balancing to maximize self-neutralization and to optimize hydraulic and load-based unit operations;
- By-product generation e.g. methane from anaerobic digestion, sludges with fertilizer value, protein-value materials etc.;
- Choice of control systems to ensure reliability and robustness;
- Choice of batch rather than continuous treatment to provide enhanced control discharge quality and to the increase potential for process intensification.

Key issues involved in optimized end-of-pipe control are summarized in figures 28 and 29.

Figure 28. Procedures for cost-effective pollution control: cost-effective end-of-pipe control

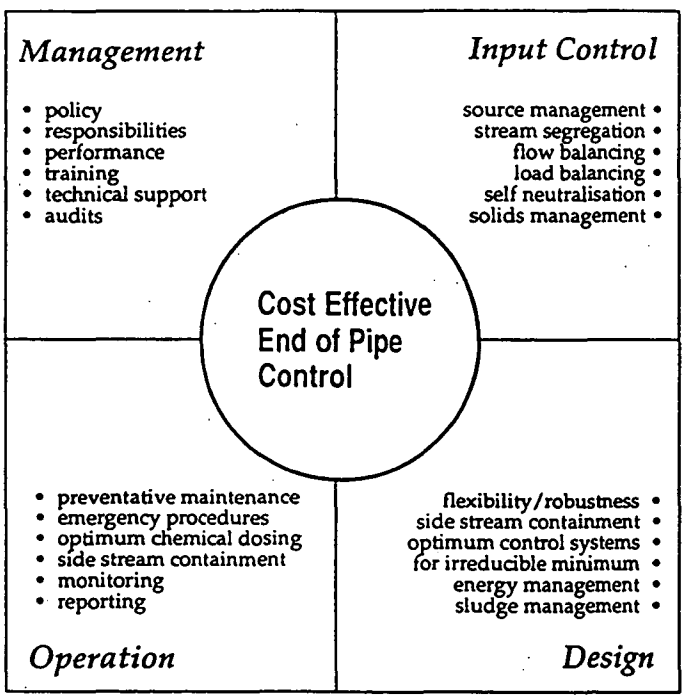


Figure 29. Procedures for cost-effective pollution control: optimized end-of-pipe treatment

- *Segregation*
  - of solvents
  - of incompatible waste streams
  - of waste streams with potential values
- *Flow/Load Balancing*
  - self neutralisation
  - optimisation of hydraulic based unit operations
  - optimisation of load based unit operations
- *By-product Generation*
  - methane from anaerobic digestion
  - water for reuse
  - sludges with fertiliser value
- *Batch (cf continuous) Treatment*
  - exact control of discharge quality
  - potential for intensification
- *Choice of Control Systems*
  - robust and reliable
  - importance of location to avoid fouling
  - accurate reagent dosing
  - controlled oxygenation

Annex I

AUDIT REVIEW QUESTIONS: RAW MATERIALS AND UTILITIES

1. Are all raw materials used on site documented in an inventory?
   . . . . . Provide schedule of raw materials. Identify sources of raw materials. Identify risk category (H, M or L).
2. Has an individual been nominated responsible for the maintenance of the inventory?
   . . . . . Identify nominated individual.
   . . . . . Identify risk category (H, M or L).
3. Are records kept on quantities of raw materials used and unit costs? For example:
   - Basic raw materials;
   - Mains water;
   - Borehole water;
   - Chemicals;
   - Solvents;
   - Energy.

   . . . . . Provide records of consumption for all raw materials for the last 12 months.
   . . . . . Identify risk category (H, M orL).
4. Has an environmental assessment been carried out on all raw materials used?
   . . . . . Provide environmental assessment documentation.
   . . . . . Identify risk category for each raw material used (H, M or L).
5. Has the potential for using alternative, less damaging materials been considered?
   . . . . . Identify changes already introduced. Identify potential for further change.
   . . . . . Identify risk category (H, M or L).
   . . . . . Identify potential change factor (1, 2 or 3).
6. Has the potential for optimum use of raw materials through conservation of resource to minimization of losses been considered?
   . . . . . Identify achievements to date. Identify potential for further achievements.
   . . . . . Identify risk category (H, M or L).
   . . . . . Identify potential change factor (1, 2 or 3).
7. Has the potential for reuse/recycling/recovery been considered for all materials in use or likely to be introduced?
   . . . . . Identify opportunities already introduced.
   . . . . . Identify potential opportunities.
   . . . . . Identify risk category (H, M or L).
   . . . . . Identify potential change factor (1, 2 or 3).
8. Are disposal requirements and implications considered before introducing any materials?
   . . . . . Provide examples.
   . . . . . Identify risk category (H, M or L).

ANNEX II

AUDIT REVIEW QUESTIONS: PROCESSES AND INTEGRATED SOURCE CONTROL

1. Are all processes used on site documented in an inventory?
   . . . . . Provide schedule of processes.
   . . . . . Identify risk category (H, M or L).
2. Has an individual been nominated responsible for the maintenance of this inventory?
   . . . . . Identify nominated individual.
   . . . . . Identify risk category (H, M or L).
3. Has an environmental impact assessment been carried out for all unit processes?
   . . . . . Provide details of assessments.
   . . . . . Identify risk category for each process (H, M or L).
4. Have all hazards associated with use the of process materials been identified?
   . . . . . Identify schedule of risks.
   . . . . . Identify risk category on a hazard by hazard basis (H, M or L).
5. Has the potential for using alternative, less damaging processes been considered?
   . . . . . Identify changes already introduced.
   . . . . . Identify potential for further change.
   . . . . . Identify risk category (H, M or L).
   . . . . . Identify potential change factor (1, 2 or 3).
6. Has consideration been given to the conservation of water through application of integrated source control on a process by process basis? For example:
   - Conservation of water;
   - Reuse of water;
   - Recycling of water.

   . . . . . Identify achievements to date.
   . . . . . Identify potential opportunities.
   . . . . . Identify risk category (H, M or L).
   . . . . . Identify potential change factor (1, 2 or 3).
7. Has consideration been given to the avoidance or minimization of waste through the application of integrated source control on a process by process basis? For example:
   - Minimization of process solution losses through redesign of working procedures;
   - Minimization of process solution losses through application of direct recovery procedures.

   . . . . . Identify achievements to date.
   . . . . . Identify potential opportunities.
   . . . . . Identify risk category (H, M or L).
   . . . . . Identify potential change factor (1, 2 or 3).
8. Has consideration been given to the recovery of materials through application of integrated source control on a process by process basis? For example:
   - Direct or indirect recovery of materials by side-stream treatment;
   - Process solution enhancement through side-stream removal of contaminants;
   - Conversion of waste to by-product of value.

   . . . . . Identify achievements to date.
   . . . . . Identify potential opportunities.
   . . . . . Identify risk category (H, M or L).
   . . . . . Identify potential change factor (1, 2 or 3).
9. Are records kept of specific raw material usage on a process by process basis?
   . . . . . Provide specific material usage schedules on a process by process basis for the past 12 months.
   . . . . . Identify risk category (H, M or L).

ANNEX III

AUDIT REVIEW QUESTIONS: END-OF-PIPE EMISSION CONTROL SYSTEMS

1. Are design details and specifications for end of pipe emission control systems fully documented in an inventory?
   . . . . . Provide details of all end-of-pipe control systems (for aqueous emissions, gaseous emissions
   . . . . . and waste arisings).
   . . . . . Identify risk category (H, M or L).
2. Has an individual been nominated responsible for the maintenance of this inventory?
   . . . . . Identify nominated individual.
   . . . . . Identify risk category (H, M or L).
3. Are end-of-pipe emission control systems monitored on a regular basis to ensure compliance with design requirements (inputs and outputs)?
   . . . . . Provide monitoring information over the last 12 months.
   . . . . . Identify risk category on a system by system basis (H, M or L).
4. Have all end-of-pipe systems been regularly checked for integrity and correctness of operation?
   . . . . . Provide reports for the last 12 months.
   . . . . . Identify risk category in relation to integrity on a system by system basis (H, M or L).
5. Are alternative processes available which would further reduce environmental impact on a technical and economic basis?
   . . . . . Identify potential opportunities.
   . . . . . Identify risk category (H, M or L).
   . . . . . Identify potential change factor (1, 2 or 3).

ANNEX V

AUDIT REVIEW QUESTIONS: FINAL EMISSIONS AND DISCHARGES

1. Are all emissions and discharges documented in an inventory? For example:
   - Process effluent;
   - Domestic waste-water;
   - Cooling water;
   - Stack emissions;
   - Hazardous wastes;
   - Non-hazardous wastes.

   . . . . . Provide schedule of emissions.
   . . . . . Identify risk category (H, M or L).
2. Has an individual been nominated responsible for the maintenance of this inventory?
   . . . . . Identify nominated individual.
   . . . . . Identify risk category (H, M or L).
3. Are emissions and discharges to sewer, surface water or ground-water controlled by regulations?
   . . . . . Provide details of relevant regulations.
   . . . . . Provide details of specific emission standards required.
   . . . . . Identify risk category (H, M or L).
4. Are final emissions and discharges to sewer, surface water or ground-water fully quantified and characterized on an ongoing basis?
   . . . . . Provide monitoring data on relevant emissions and discharges for the last 12 months.
   . . . . . Identify risk category (H, M or L).
5. Do emissions and discharges to sewer, surface water or ground-water fully comply with relevant regulations?
   . . . . . Provide data on extent of compliance.
   . . . . . Identify risk category on an emission by emission basis (H, M or L).
6. Are emissions and discharges to the atmosphere controlled by regulations?
   . . . . . Provide details of relevant regulations.
   . . . . . Provide details of specific emission standards required.
   . . . . . Identify risk category (H, M or L).
7. Are final emissions and discharges to atmosphere fully quantified and characterized on an ongoing basis?
   . . . . . Provide monitoring data on relevant emissions and discharges for the last 12 months.
   . . . . . Identify risk category (H, M or L).
8. Do emissions and discharges to atmosphere fully comply with relevant regulations?
   . . . . . Provide data on extent of compliance.
   . . . . . Identify risk category on an emission by emission basis (H, M or L).
9. Are emissions and discharges of waste to off-site disposal controlled by regulations?
   . . . . . Provide details of relevant regulations.
   . . . . . Provide details of specific controls and requirements.
   . . . . . Identify risk category (H, M or L).
10. Are emissions and discharges to off-site disposal fully quantified and characterized on an ongoing basis?
    . . . . . Provide monitoring data on all disposal arrangements for the last 12 months.
    . . . . . Identify risk category (H, M or L).
11. Do emissions and discharges of waste to off-site disposal fully comply with relevant regulations?
    . . . . . Provide data on extent of compliance.
    . . . . . Identify risk category on a waste type basis (H, M or L).
12. Are the contractors responsible for disposal competent?
    . . . . . Provide evidence.
    . . . . . Identify risk category (H, M or L).

13. Do all waste handling procedures comply with existing legislation?
. . . . . Provide confirmation of compliance.
. . . . . Identify risk category (H, M or L).
14. Are records kept of the fate of wastes produced on-site?
. . . . . Provide documentation for the last 12 months.
. . . . . Identify risk category (H, M or L).
15. Are records kept on the amount of waste generated per unit of production?
. . . . . Provide specific waste generation data for the last 12 months.
. . . . . Identify risk category (H, M or L).
16. Are contingency/emergency plans in place in the event of accidental emission/discharge?
. . . . . Provide documentary evidence.
. . . . . Identify risk category (H, M or L).

ANNEX V

AUDIT REVIEW QUESTIONS: STORAGE AND HANDLING

1. Does an inventory exist for all materials (raw materials, products, by-products, waste materials) stored on site?
   . . . . . Provide schedule of materials stored on site.
   . . . . . Identify risk category (H, M or L).
2. Have all legal requirements associated with storage and handling of materials been identified?
   . . . . . Provide schedules of applicable legal requirements.
   . . . . . Provide details on how the regulations are enforced.
   . . . . . Identify risk category (H, M or L).
3. Are raw process and waste materials stored in a safe and appropriate manner? For example:
   - Bulk acids in tanks – bunded with secondary containment;
   - Flammable materials in a fire-protected, ventilated store;
   - Powders and pellets in areas fitted with dust extraction;
   - Segregation of non-compatible materials.

   . . . . . Provide details of existing storage arrangements, including plans and specifications.
   . . . . . Identify risk areas.
   . . . . . Identify risk category (H, M or L).
4. Has consideration been given to the requirements for segregation of incompatible materials?
   . . . . . Provide details on type of wastes stored in specific areas.
   . . . . . Identify risk areas.
   . . . . . Identify risk category (H, M or L).
5. Are all stored materials labelled clearly and correctly?
   . . . . . Identify schedule of emissions.
   . . . . . Identify risk category (H, M or L).
6. Has consideration been given to the measures required to contain and/or monitor for spills or leaks? For example:
   - Provision of adequate bund capacity;
   - Use of sealants;
   - Provision of blind gully pots;
   - Atmospheric vapour/gas monitoring;
   - Ground-water monitoring;
   - Surface water monitoring.

   . . . . . Provide details on existing arrangements for all storage areas, including drawings and specifications
   . . . . . where available.
   . . . . . Identify risk areas.
   . . . . . Identify risk category (H, M or L).
7. Has the integrity of raw material, process and waste storage areas been checked on a regular basis? For example:
   - Ground quality monitoring;
   - Inspection of tanks, containers, bunds etc.

   . . . . . Provide details and records.
   . . . . . Identify risk category (H, M or L).

INFORMATION CENTRES

Australian Newsprint Mills Limited
Boyer
Tasmania 7140
Australia
Phone: (+6102) 610243, Fax: (+6102) 613471
Manufacturer of newsprint and other types of paper, with research experience relating to: effluent treatment from newsprint mill using eucalyptus timber as raw material; operation of chlorine-caustic plant; manufacture of newsprint from P. Radiata; thermo-mechanical pulping.

Bombay Textile Research Association
L B Shastri Marg
Bombay 400086
Maharashtra
India
Phone: 582651/52; 585117/19/35
Research centre with laboratory and pilot plant undertaking and sponsoring research projects relevant to the textile industry. In the environmental sector, activities include research on textile effluent treatment and reduction and related water management and conservation measures.

Department of Sanitary Engineering
813 68 Bratislava
Radlinskeho 11
Slovak Republic
Phone: (+427) 56842, Fax: (+427) 52027
The Deptartment conducts research and development in all aspects of water supply, water pollution, and water management. The activities are both long term and short term and are characterized by inter-disciplinary research. The department carries out laboratory research, field measures, and design/consulting activities in the field as follows: water treatment and distribution; waste water and sewage treatment; solid wastes; analysis of pollutants in water, soil, and atmospheric pollution. Experimental: laboratory instruments, computer technique, capillary gas chromatography, ultraviolet spectrometry, capillary isotachophoresis and apparatus for electrochemical methods, viscometers, flow and velocity meters, special equipment and apparatus.

Division Documentacion e Informacion de ICAITI (ICAITI)
Oficina 10 1er piso
Ed Registro de la propiedad
9A Avda entre 14 y 1
Zona 1 Ciudad de Guatemala
Guatemala.
Phone: 21 816
Provision of information to the public, training centres and industrial societies involved in environmental matters. Topics include: research; standards and standardization; technical assistance; technology transfer; chemical treatment of waste; drinking water treatment; sewage; industrial effluents; plastic and polymer wastes; sanitary landfill and tipping; waste recovery; eutrophication; inorganic pollutants; long-term effect of pollutants; organic pollutants; pollutant analysis, monitoring, effects; pollutant source identification; pollution control regulations and technology.

Environmental Sanitation Information Centre (AIT/ENSIC)
P.O. Box 2754
Bangkok 10501
Thailand
Phone: NA, Telex: 84276 AIT TH
Topics include: fresh water ecosystems biological resources and monitoring; water pollution; water quality; water treatment and purification; watershed management; conservation of freshwater; water reticulation systems; pipelines; sewage treatment systems; drinking water treatment; flocculation; anaerobic processes; brackish water ecosystems.

Groupement Belge des Techniques et Equipements de Lutte Contre les Nuisances (ANTIPOL)
21 rue des Drapiers
1050 Bruxels
Brabant
Belgium
Phone: (+25) 112370, Telex: 21078
Manages permanent directories of firms and societies specializing in water treatment, gas cleaning, noise reduction and waste treatment. Topics include: water pollution; noise reduction; waste management.

Gujarat State Fertilizers Co. Ltd.
P O Fertilizernagar
Baroda 39150
Gujarat
India
Phone: 72193, Telex: 0175211, Fax: (+265) 72966
Commercial company carrying out research and developing water treatment systems and other methods for control of air pollution and water pollution. Also carries out studies on the environmental effects of air pollutants from the fertilizer industry and of solid and liquid waste utilization.

Hydrobiology Institute Academia Sinica
Wuhan
Hubei
China
Research centre focusing on biological methods and principles of effluent treatment, especially petroleum-degrading algae and production of algae/bacteria symbiosis for use in waste water.

Indian Association for Water Pollution Control
c/o Neeri
Nehru Mag
Nagpur 440020
Maharashtra
India
Phone: 26 071
Provides members of the association with information about technology and policy related to water pollution control. Contributes to the development of water pollution reducing equipment. Topics include: drinking water and its treatment; water pollution; water quality; water treatment and purification; pollution control regulations; pollution control technology; pollution risks.

Industrial Products and Services TNO
Schoemakerstraat 97
P.O. Box 110
NL-2600 AC Delft
Netherlands
Phone: (+15) 696900
Research centre active in the textile and paper sector, with special competence in water management, effluent treatment and in recycling of paper and board.

Institute of Water Pollution Control
Ledson House
53 London Road
Maidstone
Kent ME16 8JH
U.K.
Phone: (+622) 62034
Promotes the development of science and practices related to water pollution control. Topics include: liquid effluents and used water treatment and management; prevention, contamination and control technologies; industrial effluents; water pollution processes; water treatment and purification; water treatment plants and processes.

Instituto de Saneamento Ambiental (ISAM)
Pontificia Universidad Catolica Parana
Rua Imaculada Conceicao
1155-Prado Velao
80000 Curitiba PR
CP670
Brazil

Phone:(+0413) 221515, Telex: (+413) 5085, Fax: (+413) 254373
Research centre, laboratory and information centre, concentrating on: hydrological engineering (particularly sanitation, water supply, water treatment); waste disposal; industrial effluent treatment; energy issues; urban waste treatment.

Lakefield Research (a Division of Falconbridge Ltd.)
185 Concession Street
Postal Bag 4300
Lakefield
Ontario K0L 2H0
Canada
Phone: (+705) 6523341, Fax: (+705) 6526365
Consulting firm which undertakes studies of mine and mill effluent tailings, slurries and waters. Specialized competence in: cyanide destruction; heavy metals precipitation, suspended solids removal; environmental analysis and testing; chemical analysis; industrial waste.

Oil Companies International Study Group for Conservation of Clean Air and Water - Europe (CONCAWE)
Van Hogenhoucklaan 60
2596 te 's-Gravenhage
Netherlands
Phone: (+702) 45035, Telex: 31005 SHELL VOOR CON
Scientific research into environmental aspects of the oil refining industry. Topics include: environmental R & D programmes & policy; health; occupational safety; emissions; air pollution; waste substances; incineration; water pollution; waste gas cleaning; standards; economic aspects.

Pan American Health Organization (PAHO/CEPIS/REPIDISCA)
Casilla 4337
Lima-100
Los Pinos 259
Urbanizacion Camacho
Lima 3
Peru
Phone: 354135, Telex: 21052
Deals with information on sanitary engineering and environmental sciences (especially related to public health and welfare). Topics include: water pollution; water supply; waste management; environmental engineering; waste water treatment and re-use; water purification.

Pierson and Company Ltd. Contracting Engineers
Thrift Street
Wollaston
Northamptonshire NN9 7QJ
United Kingdom
Phone: (+933) 663246, Telex: 311463, Fax: (+933) 664061
Consulting firm offering services related to: sludge filters for process and effluent treatment; liquid/solid separation.

Scandiaconsult International
P.O.Box 35
S-16493 Kista
Sweden
Phone: (+468) 7032000, Telex: 17496 consults, Fax: (+468) 7039250, Telex: 11023 SCCCINTS
Consulting firm offering services over most of the industrial engineering and economy sector. Industry and environment services are offered in industrial and municipal waste water effluent treatment, waste management, hazardous waste and air pollution.

Stiftung Limnologische Arbeitsgruppe Dr. Seidel
Am Waldwinkel 70
D-4150 Krefeld 29
Germany
Phone: (+2151) 730246
Organization carrying out research and analysis and advising on treatment of sewage and waste. Topics include: food industry; iron and steel industry; pulp and paper industry; advice on the location of sewage disposal plants and on waste water treatment; biodegradation.

Water Pollution Department (Department Pollution des Eaux) (CNRS)
BP 1
91710 Vert-le-Petit
France.
Phone: (+1) 64 98 24 75, Telex: 60820 F
Research and study on water pollution and industrial waste water treatment. Topics include: characterisation of pollutant effects (waste waters and sludge) on biological processes; biotic effects of pollutants; construction of mathematical models for reduction of air pollution; water analysis; training courses on water treatment and pollution reduction; treatment plants; liquid wastes; waste gas emissions; gaseous air pollutants; water pollution; industrial waste water; radio-active trace elements; educating public opinion.

1581 MASS BALANCE ANALYSIS USING SIGNAL FLOW CHART AND ITS APPLICATION IN ALUMINA PROCESSING. [MATE-199101-41-0025]

Mass balance analysis is the fundamental work for the design, operation and control of chemical processes. A special program for alumina processes instead of using a ready-made software has been developed. The signal flow chart method can conveniently describe the process studied. Based on the linearity of the problem, transmission matrices are used to express the unit operations. Loop elimination is an important step to simplify the chart. The non-linearity existing in alumina processes has been fully counted. The signal flow chart method is quite flexible; it can solve the mass balance calculation for a variety of alumina processes, such as sintering. Bayer and combination processes, all of which are in popular use in China, meet the requirement to adjust a certain process in detail. It is also a useful tool in analysing and optimizing process parameters. Graphs. 9 ref. – AA (Niu, H.; Guo, S.; Li, H.-L.; Shenyang Aluminum and Magnesium Engineering and Research Institute; Light Metals 1990, Anaheim, California, USA, 18-22 Feb. 1990, Publisher: The Minerals, Metals & Materials Society (1990), (Met. A., 9101-72-0022), 73-78 [in English].)

1582 RECYCLING AS PART OF WASTE WATER IN ZINC PLATING TECHNOLOGY. [MATE-199101-42-0001]

The Zn coating process employs large amounts of chemicals which must be disposed of for environmental protection. Modern procedures described include the recovery of Zn, Pb, Ni, precious metals and electrolytes, the neutralization of cyanides, noxious metals, chromates and peroxides, vacuum evaporation techniques and, finally, filtration. Using computers to select the preferred approach based on bath composition will result in enhanced cost effectiveness. Graphs. – F.H.H. (Danneels, L.; Oberflache Surface, Sept. 1990, 31, (9), 9-12, 14-16 [in German]. ISSN 0048-1270)

1583 ATTENUATION OF CYANIDE IN SEWAGE SLUDGE. [MATE-199101-42-0012]

Cyanidation is one the most common practices used in the extraction of Au and Ag. One method of application is heap or dump leaching, which entails the leaching of the Au or Ag ore by spraying or dripping a cyanide lixiviant over the ore and collecting the effluent. The ore is placed on what is known as a leach pad system. A typical leach pad system consists of a foundation, a leakage detection system, a liner, and a cover layer. It was decided to examine the potential of successfully attenuating cyanide by placing an organic material layer between a liner and the prepared soil base. The first waste to be tested was a product found at any metropolitan area, sewage sludge. Preliminary tests have been performed in the laboratory to determine the efficacy of using sewage sludge as a barrier that will adsorb and consume cyanide. The critical role organic material plays in the attenuation of cyanide in solid material is reinforced. Also, sewage sludge has the ability to provide the environment for the actual chemical decomposition of cyanide. Graphs. 3 ref. – AA (Castillo, D.; Hendrix, J.L.; University of Nevada; Advances in Gold and Silver Processing, Reno, Nevada, USA, 10-12 Sept. 1990, Publisher: Society for Mining, Metallurgy, and Exploration, Inc. (1990), (Met. A., 9101-72-0012), 287-291 [in English].)

1584 A HYDROMETALLURGICAL PROCESS FOR THE TREATMENT OF INDUSTRIAL WASTES. [MATE-199101-42-0073]

A hydrometallurgical process has been developed to treat industrial wastes typically generated by the surface finishing industries. The hazardous wastes to be treated by this process, all inorganics, may contain the following elements in different concentrations: Cu, Ni, Sn, Pb, Fe, Cr, Zn, Cd and precious metals. The process includes a pretreatment followed by electro-recovery of metal. – D.O.N. (Rajcevic, H.P.; Recontek; Plating and Surface Finishing, July 1990, 77, (7), 22-25 [in English]. ISSN 0360-3164)

1585 THE USE OF ZINC-PLATED SHEET AT AUDI. [MATE-199101-58-0048]

Audi is using Zn-plated sheet steel for its automobile bodies. The material has shown good resistance to both corrosion and road hazards, such as dirt and gravel. The steel plates are coated with oil when they are first received to prevent rust, which would interfere with subsequent coating. Before coating the oil is rinsed off, and the plates are given a prephosphate coat followed by the Zn coat. All operations are conducted so as to prevent scratches or other damage. The safety of the workers during galvanizing is assured by the use of aspirators. The by-products of the operation, such as sludge and paint powders, have recently been reduced dramatically. New methods are constantly being studied as possible future improvements. – C.W.M. (Audi; Galvano-Organo-Traitements de Surface, May 1990, (606), 427-431 [in French]. ISSN 0302-6477)

1586 A NEW FLUORIDE RESISTANT CERAMIC ELECTRODE FOR ELECTROCHEMICAL EFFLUENT TREATMENT PROCESSES. [MATE-199101-58-0049]

Free fluorides found in many metal finishing effluents present difficulties for conventional anode materials, restricting the application of electrochemical treatments. The effect of fluoride ion was determined on two conventional inert anode materials, Pt-clad Nb- and iridium-oxide-coated Ti, and a new iridium-oxide-coated titania suboxide ceramic electrode. Results indicate the ceramic material exhibits superior corrosion resistance and hence, longer life, compared to either of these metal anodes. It is expected that the new conductive ceramic will extend the use of electrochemical techniques in fluoride-containing electrolytes. Graphs. 7 ref. – AA (Harnsberger, S.K.; Romoda, I.; Ebonex Technologies; Plating and Surface Finishing, July 1990, 77, (7), 40-42 [in English]. ISSN 0360-3164)

1587 NEW WASTE TREATMENT PROCESS TO MEET STRINGENT DISCHARGE REQUIREMENTS. (RETROACTIVE COVERAGE). [MATE-199101-58-0086]

In this process, workpieces are rinsed in the production line by chemical solutions of sodium borohydrate, hydrogen peroxide or formaldehyde for recovery of metals such as: Au, Pt, Pd, Ir, Rh, Ag, Cu, Zn, Cd, Ni, Pb, Hg, Cr, Sn and others with simultaneous effluent treatment. FKJA/LAFT system installed in Poland, USA, Western and Eastern Europe, technically and theoretically tested in many installations practically guarantee full recovery of metals and almost waste-free operations of all small and large industrial lines. The system has received several valuable international awards and recent investigations done in the USA indicate that the system appears to be one of the best approaches for industrial wastewater treatment. 11 ref. – AA (Tuznik, F.S.; Lis, A.A.; Institute of Precision Mechanics (Poland); Asia Pacific Interfinish '86 – Proceedings. Surface Finishing – Today and Tomorrow, Hobart, Tasmania, Australia, 26-30 Oct. 1986, Publisher: Australasian Institute of Metal Finishing (1986), (Met. A., 9101-72-0030), 53.1-53.15 [in English].)

1588 IMPROVEMENT OF THE PERFORMANCE OF POROUS ELECTRODES USING IONIC CONDUCTING PARTICLES: APPLICATION TO SILVER RECOVERY. [MATE-199101-58-0097]

Experimental measurements are reported for a complex conducting porous electrode system consisting of electronic and ionic conducting particles. A very large value of the ionic conductivity within the electrode is its main characteristic. The complex conducting electrodes and traditional graphitic granular electrodes were used separately to recover Ag from a Ag plating rinse water. The former displayed excellent performance. A packed-bed reactor composed of the complex conducting electrodes has been successfully tested on a plating line. 8 ref. – AA (Yang, B.; Ministry of Electronic Industry (China); Journal of Applied Electrochemistry, Nov. 1990, 20, (6), 974-977 [in English]. ISSN 0021-891X)

1589 WASTE TREATMENT PROCESS FOR ELECTROLESS COPPER. [MATE-199101-58-0112]

The spent electroless Cu bath is deactivated at the overflow by the automatic addition of hydrogen peroxide (H_2O_2) to prevent Cu from plating out in the drain lines, causing the lines to become blocked. Caustic (NaOH) and formaldehyde (HCHO) are then added to the deactivated electroless Cu solution in a batch treatment process. Powdered Al or Al fines are added to precipitate out the Cu as metallic Cu. The Cu concentration (ppm) can be made stable for several days if necessary. The metallic Cu is filtered out and salvaged. The mother liquor is neutralised (pH 6.5-9.0) and discharged. – AA (Holly, J.D.; Tektronix; Circuit World, Oct. 1990, 17, (1), 30-31 [in

English]. ISSN 0305-6120)

1590 THE COPPERSTAT PROCESS: A NEW CONCEPT FOR ELECTROLESS COPPER BATH PURIFICATION AND CONTROL. (RETROACTIVE COVERAGE). [MATE-199101-63-0014]
The Copperstat process is one designed to replenish, control, and eliminate wastes from electroless Cu baths. It combines the principles of electrodialysis and electrosynthesis in a novel way. The electroless Cu utilization efficiency can increase by 14%. Even greater savings result from the virtual elimination of waste treatment with this system. Graphs. 11 ref. – AA (Krulik, G.A.; Lipson, M.A.; Davison, J.B.; Davis, S.C.; Morton Thiokol; Asia Pacific Interfinish '86 – Proceedings. Surface Finishing – Today and Tomorrow, Hobart, Tasmania, Australia, 26-30 Oct. 1986, Publisher: Australasian Institute of Metal Finishing (1986), (Met. A., 9101-72-0030), 41.1-41.6 [in English].)

1591 EFFLUENT TREATMENT IN THE PRINTED WIRE BOARD INDUSTRY. (RETROACTIVE COVERAGE). [MATE-199101-63-0016]
The treatment of effluent from printed wire board manufacture is similar to that for electroplating wastes except that steps must be taken to treat sequestered Cu wastes, particularly ammonia based etchants. Processes and equipment are described which enable reduction of Cu and other metals to 1 mg/l in effluent. Pretreatments for special individual effluent streams which may be necessary to meet other requirements are discussed. 5 ref. – AA (Jackson, W.; Metropolitan Water; Sewage and Drainage Board (Sydney); Asia Pacific Interfinish '86 – Proceedings. Surface Finishing – Today and Tomorrow, Hobart, Tasmania, Australia, 26-30 Oct. 1986, Publisher: Australasian Institute of Metal Finishing (1986), (Met. A., 9101-72-0030), 52.1-52.7 [in English].)

1592 ON-STREAM XRF MEASURING SYSTEM FOR ORE SLURRY ANALYSIS. [MATE-199102-23-0090]
Modern metal ore flotation requires a continuous instrumental measurement of the metal content in main flotation streams. X-ray fluorescence is most often used for on-stream analysis of metal ore slurries. Radioisotope energy-dispersion XRF (REDXRF) was used to determine Pb in tailings and Zn in feed. The accuracy of the on-stream analysis of Zn – Pb ore slurries was within 3-15% relative, depending on metal concentration. Graphs. 3 ref. – D.M.Y. (Holynska, B.; Lankosz, M.; Ostachowicz, J.; Wesolowski, T.; Zalewski, J.; Academy of Mining and Metallurgy (Poland); Advances in X-Ray Analysis. Vol. 32, Steamboat Springs, Colorado, USA, 1-5 Aug. 1988, Publisher: Plenum Press (1989), (Met. A., 9102-72-0079), 45-47 [in English].)

1593 ONE STEP AHEAD. [MATE-199102-58-0165]
Environmental regulations have had a large impact on platers. Flexibility in plating further compounds the problems. The ability to meet EPA and state standards is discussed in relation to a Massachusetts plating shop. This shop uses source-reduction, recycling and recovery programs. Critical to these processes are proper filtration membranes, flow rates, cleaning, sludge control and cross flow filtration. Four electrolytic recovery units were installed to lower the metals content in the first and second dragout tanks on fine plating lines; Cd, Zn, Ag, and two Cu. – R.A.S. (Graves, B.A.; Products Finishing (Cincinnati), Aug. 1990, 54, (11), 42-47 [in English]. ISSN 0032-9940)

1594 HOW TO TREAT SPENT ELECTROLESS NICKEL BATHS. [MATE-199102-58-0166]
Most disposal methods are potentially illegal and may have severe liabilities for the generator. Recycling the baths is a solution that eliminates liability and disposal problems. This can be done by reduction to elemental Ni, precipitation as an insoluble Ni compound, or separation of the bath constituents. Each method is discussed, along with advantages and drawbacks. 5 ref. – R.A.S. (Kunces, D.J.; Fidelity Chemical Products; Products Finishing (Cincinnati), Aug. 1990, 54, (11), 49-52 [in English]. ISSN 0032-9940)

1595 ADVANTAGES AND LIMITATIONS OF MATERIAL CIRCULATIONS WITH INTERNAL AND EXTERNAL RECOVERY WITH SPECIAL REGARD TO ION-EXCHANGE SYSTEMS. [MATE-199102-58-0174]
Against the background of general considerations referring to the recovery of galvanic baths, the system of recovery of raw materials, especially of heavy metals, developed in the GDR, based on the use of "mobile" ion-exchange columns and designed for the regeneration of ionites at the regional stations and for the treatment of concentrated solutions, has been presented. Some technological problems relating to the application of ion-exchange processes, electrolysis on solid bed, reverse osmosis and adsorption for the mentioned purpose have been discussed. 18 ref. – AA (Fischwasser, K.; Grothkopp, H.; Powloki Ochronne, 1989, 17, (1-2), 10-16 [in Polish].)

1596 ELECTRODIALYSIS FOR CONCENTRATING AND RECOVERING METAL SALT SOLUTIONS. [MATE-199102-58-0176]
Electrodialysis, which has been under discussion for many years, is presently applied in electroplating with good technical and economical results. Practical use of this "elegant" and ecologically rather effective process became possible with the development of synthetic membranes featuring a high selectivity, chemical resistance, mechanical strength and a low electrical resistance. An application example for Ni recovery is introduced. 7 ref. – AA (Fischer, G.; Recon Verfahrenstechnik; Metalloberflache, July 1989, 43, (7), 309-313 [in German]. ISSN 0026-0797)

1597 DETERMINATION OF HEXAVALENT CHROMIUM AND TOTAL CYANIDE IN WASTEWATER USING LIQUID CHROMATOGRAPHY. [MATE-199103-23-0201]
Two separate chromatographic systems, one for the determination of hexavalent Cr and another for the determination of total and labile cyanide were studied with various waste water solutions. The automated chromatographic systems eliminate the need for laborius extraction or distallation pretreatment before determination. The Cr and cyanide analyzer systems are being evaluated by several US EPA groups and the ASTM. The new analyzer systems are ideally suited for continuous on-line monitoring of hexavalent Cr and cyanide in wastewater and process streams. Graphs. 7 ref. – J.H. (Heberling, S.; Joyce, R.J.; Dionex; Metal Finishing, Nov. 1990, 88, (11), 35-38 [in English]. ISSN 0026-0576)

1598 THE WEAR OF PUMP VALVES IN FINE PARTICLE QUARTZITE SLURRIES. [MATE-199103-31-1085]
Disc poppet valves which are similar to those used in reciprocating slurry pumps have been subjected to a laboratory wear test in slurries consisting of reduction plant tailings of quartzite with a nominal diameter of 200 mu m. Wear has been studied as a function of valve hardness, valve closure velocity, slurry density and valve angle. It has been shown that large decreases in the wear rate can be achieved by control of operating parameters. An explanation for such behaviour has been made based on the mechanisms of impact wear, which predominates during operation of the valves. The material tested was a Ni/Cr/Mo steel conforming BS817M40. Graphs, Photomicrographs. 7 ref. – AA (Joffe, S.H.D.; Allen, C.; University of Cape Town; Wear, Jan. 1990, 135, (2), 279-291 [in English]. ISSN 0043-1648)

1599 ANODIC REACTIONS AND THE RECYCLING OF METALS UTILIZING ELECTROLYSIS. [MATE-199103-42-0238]
The anodic reactions which accompany the electrolysis of heavy metals in industrial effluents prove to be complementary to the cathodic reactions. In a number of applications the anodic process can become the principal objective in the treatment of industrial effluents. Some examples are: the simple oxidation of OH^- ions to regenerate the acidity in an etch bath, the destruction of inorganic anionic species such as cyanides, the degradation of components present in electroplating baths. The examples cited have been developed and applied on an industrial scale. The electrochemical oxidation process combined with the heavy metal recovery on the cathode can be a

reliable economic technique for the complete treatment of industrial effluents. Graphs. 4 ref. – J.H. (Wiaux, J.P.; Nguyen, T.; Titalyse; Metal Finishing, Nov. 1990, 88, (11), 49-55 [in English]. ISSN 0026-0576)

1600 EFFECT OF PROCESSING CONDITION ON THE MICROSTRUCTURE OF RHEOCAST AL—CU ALLOYS. [MATE-199103-51-0444]
The effect of processing condition on the microstructure of rheocast alloys has been theoretically analysed. The average particle size may increase, decrease or remain unaltered with the change in rheocasting temperature depending upon the prevailing nucleation and growth conditions. Experimental results of Al – Cu alloys are in agreement with the theoretical predictions. Increasing the Cu content makes the transformation nucleation dominant and therefore the variation of size and distribution of alpha -particles with rheocasting temperatures and stirring rate is a function of alloy composition. Graphs. 21 ref. – AA (Prasad, P.R.; Ray, S.; Gaindhar, J.L.; Kapoor, M.L.; Bihar Institute of Technology; University of Roorkee; Zeitschrift fur Metallkunde, June 1989, 80, (6), 425-427 [in English]. ISSN 0044-3093)

1601 MICRO BUBBLES KEEP COOLANT CLEAN. [MATE-199103-53-0211]
The breakdown of bond between oil droplets and water molecule in emulsion-type metalworking fluid is caused by the positively charged metal particles released during the machining operation. This type of bond rupture can be minimised using dissolved air flotation technology (DAF). It is based on a mechanism of saturating the fluid with dissolved air forming small flotating bubbles with negative surface charge which attracts metal particles and rise to the top to be skimmed off eventually. The performance of DAF process depends on the metal to be machined, machining type and the overall size of the system. – B.C. (Macaulay, D.; Eaton; Modern Machine Shop, Sept. 1990, 63, (4), 90-96 [in English]. ISSN 0026-8003)

1602 ELIMINATING WASTEWATER DISCHARGE. [MATE-199103-55-0540]
Closed-loop electroplating systems are an effective means of meeting increasingly stringent regulations governing the discharge of hazardous wastewaters. Unlike conventional precipitation systems for wastewater treatment, the equipment involved is an integral part of the plating equipment, comprising an inter-related system. Wastewater is purified and returned for reuse and extracted metal residuals, previously regarded as waste, are collected for recovery. The closed-loop electroplating system at The Robbins Co., manufacturer of jewelry, emblems, and plaques, is reviewed. The company electroplate Au, Ag, Rh, Ni and Cu. Information sources for elminating wastewater discharge in electroplating by in-process modifications is provided. – A.R. (Vaccari, J.A.; Robbins; American Machinist, Nov. 1990, 134, (11), 87-88 [in English]. ISSN 0002-9858)

1603 APPARATUS FOR THE DISCONTINUOUS DESLUDGING OF SALT BATHS. [MATE-199103-56-0272]
Discontinuous desludging of metal treatment salt baths (e.g. for the heat treatment of ferrous component) is carried out in apparatus comprising a feed tube, an air line and a filter unit. A non-obstructing bottom plate on the feed tube has spacers in the direction of the bath crucible bottom supplementing a suction pipe in the feed tube and moving telescopically upwards and downwards, while the filter unit is set to a height ensuring total or partial immersion of it in the salt bath. (Wahl, G.; Breitwieser, K.; Degussa; Auszuge aus den Europaischen Patentanmeldungen, Teil I, 16 May 1990, 6, (20), 2874 [in German]., Patent no.: EP0368035 (European Patent) Convention date: 17 Oct. 1989)

1604 METAL WORKING—CLEANING—WASTE WATER TREATMENT. [MATE-199103-57-0296]
The critical interrelationships between the quality (hardness) of process water, selection of coolant – lubricant and cleaning respectively are discussed. To be environment-friendly, the three aspects must be viewed early and together. Materials and methods offered by the Henkel organisation of Dusseldorf are mentioned. – R.N.B. (Lingmann, H.; Olscher, H.-P.; Henkel; Oberflache Surface, Oct. 1990, 31, (10), 8, 10 [in German]. ISSN 0048-1270)

1605 ANALYSIS OF CHROMIUM PLATING SOLUTIONS AND WASTEWATERS BY ION CHROMATOGRAPHY. [MATE-199103-58-0257]
The need to assay major constituents in Cr plating baths more accurately and rapidly has led to investigation of ion chromatography as an alternative to physical and wet chemical Cr bath analyses. Ion chromatography can track chromic acid, sulfate, silicofluoride, chloride, trivalent Cr, transition metal contaminants, organic acids and surfactants in Cr plating baths. Determination of hexavalent Cr in water, wastewater and solid state extracts is being evaluated by the US EPA and ASTM, which is found to be more sensitive and interference free than conventional atomic absorption spectroscopy analysis. The ion chromatographic system consists of four modes: a sample delivery mode, a separation mode, a detection mode, and a data reduction mode. 9 ref. – A.R. (Heberling, S.S.; Campbell, D.; Carson, S.; US Environmental Protection Agency; ASTM; Dionex; Plating and Surface Finishing, Nov. 1990, 77, (11), 58-62 [in English]. ISSN 0360-3164)

1606 REDUCE WATER USAGE AND HAZARDOUS WASTES. [MATE-199103-58-0272]
A waste minimization project is reported. The goals were twofold: first to reduce water usage, and second, to reduce or eliminate hazardous wastes. The project involved integrating process evaluation and equipment design. The shop is a large production rack plater. The experimental equipment was installed on an automated hoist, Cu – Ni – Cr plating line. On this particular line, Zn die cast parts are plated with Cu, Ni, and Cr. The equipment was introduced in two steps to insure that each piece achieved the specific goal. Graphs. – J.H. (Kovach, J.; Kinetico Engineered Systems; Metal Finishing, Nov. 1990, 88, (11), 15-18 [in English]. ISSN 0026-0576)

1607 COATED METALLIC PROSTHETIC COMPONENT. [MATE-199103-58-0316]
A method of applying a fully alloyed porous metallic coating to a surface of a metallic component is disclosed in which the coating is produced from a slurry which comprises a suspension of the alloy in particulate form in solution of water containing a film-forming binder material. The method is characterised in that the slurry is applied to one or more surfaces of a metallic prosthetic component, is heated to dry the same, and is subsequently sintered to bond the particulate alloy content of the coating onto the respective surface of the component. The coating may be a cobalt-base composition, a typical slurry composition being 27% Cr, 0.25% C, 5% Mo, 2.8% Ni, and the balance Co. The mean particle size is = 250 mu m. (Bellis, J.; Mixalloy; Auszuge aus den Europaischen Patentanmeldungen, Teil I, 30 May 1990, 6, (22), 3085 [in English]. Patent no.: EP0370618 (European Patent) Convention date: 18 Oct. 1989)

1608 A REVIEW OF SEMI-SOLID SLURRY PROCESSING OF ALUMINUM MATRIX COMPOSITES. [MATE-199103-62-0245]
Semi-solid slurry processing of metal matrix composites involves first the insertion of the particle into the matrix without entrapping air. This insertion process is discussed in terms of particle-matrix wettability and the surface energies that control wettability and in terms of the fluid velocity that is required to drag a particle below the surface of the liquid matrix alloy. Brute force methods such as vigorous stirring in an evacuated crucible vessel or pressure infiltration followed by shear dilution are discussed as the most successful methods of composite slurry formation. Dendritic segregation and insufficient dispersion due to incomplete shearing of the slurry are the primary reasons for poor particulate distribution in most cast slurries. Better particulate distributions can be achieved if the particulate size is chosen based upon the secondary dendrite arm spacing characteristic of the casting process. The rheologies of composite slurries are similar in behavior to those of metallic slurries. The rheological behavior of SiC particulate/Al – 6.5Si composite slurries was reviewed. Semi-solid composite slurries sheared in the semi-solid state of the matrix display an added shear thinning effect and have a lower viscosity than the matrix slurry at the same total volume fraction of SiC plus alpha primary solid. Microstructures of quenched slurries show that improved particulate distribution can be achieved from prolonged shearing in the semi-solid region of the matrix. Photomicrographs, Graphs. 49 ref. – AA (Cornie, J.A.; Moon, H.K.; Flemings, M.C.; Massachusetts Institute of Technology; Research Institute of Industrial Science and Tech-

nology (Korea); Fabrication of Particulates Reinforced Metal Composites, Montreal, Quebec, Canada, 17-29 Sept. 1990, Publisher: ASM International (1990), (Met. A., 9103-72-0136), 63-78 [in English].)

1609 ANNUAL REVIEW OF ENVIRONMENTAL PROTECTION. XVI. [MATE-199104-51-0607]
Topics discussed were laws and directions, air impurities, examples of waste gas purification systems, waste water purification, avoiding, utilizing, or reducing concern about foundry residues such as by sand regeneration. – B.L. (Winterhalter, J.; Giesserei, 23 July 1990, 77, (15), 521-526 [in English]. ISSN 0016-9765)

1610 CAN THE LONG-TERM BEHAVIOR OF ELECTROPLATING SEDIMENTS BE PREDICTED? [MATE-199104-58-0379]
Electroplating slimes in dumps are anthropogenetic sediments. Their long-term behavior cannot be predicted. It is known of geognostic sediments that their behavior relative to diagenesis and weathering depends on chemical, mineralogical, and physical composition as well as media factors such as climate. Prediction of long term behavior is possible only if all these factors are known. Comparisons are made of the chemical compositions of electroplating wastes, the earth's crust, and ores. The yearly load of Cu and Zn in Switzerland from electrofilter dust from the burning of garbage, from household waste, and from electroplating wastes are compared relative to amounts and composition. Use of dumps exclusively for electroplating wastes presents less environmental risk than disposal of them in mixed dumps. 9 ref. – B.L. (Lichtensteiger, T.; Oberflache Surface, June 1990, 31, (6), 20-23 [in German]. ISSN 0048-1270)

1611 SO YOU WANT TO PLATE EN? [MATE-199104-58-0380]
American Metaseal corrected its problems, retained its customers and through much trial and error developed a first-rate electroless Ni (EN) system. The company contemplated two main considerations before beginning their rennovation for EN plating: keeping it free of EPA entanglements and keeping plating-out of Ni on tank walls and on the heater from occurring. Problems not considered included no DI water which is required for Al plating, wrong evaporator plumbing, the use of one bath for Al and steel was not producing high quality and the acid rinse water needed to be neutralized. – A.R. (Daniels, C.; American Metaseal; Products Finishing (Cincinnati), Nov. 1990, 55, (2), 66-72 [in English]. ISSN 0032-9940)

1612 A MANAGEMENT TECHNIQUE FOR WASTE PRODUCTS IN ELECTROPLATING. [MATE-199104-58-0456]
Electroplating wastes include liquids and muds containing toxic products and heavy metals. Removal by electrolysis is performed in line or by batch, and where possible, chemicals and metals are recycled. Reviewed in detail are the processing of solutions containing Cu, Ni, Zn in acids, Zn in cyanides, Sb, potassium permanganate and degreasers. Graphs. 7 ref. – F.H.H. (Nguyen, T.T.; Wiaux, J.-P.; Titalyse; Oberflache Surface, Nov. 1990, 31, (11), 17-18, 20-21, 23-25, 27-29 [in French]. ISSN 0048-1270)

1613 THE EFFECT OF ABRASIVE PARTICLE SIZE ON THE SLURRY EROSION RESISTANCE OF PARTICULATE-REINFORCED ALUMINIUM ALLOY. [MATE-199104-62-0385]
The slurry erosion behaviour of alumina-particle-reinforced Al alloy was investigated for three different ranges of abrasive size: 106, 180-300 and 600 mu m. The silica particles content of the slurry was 10 wt.% and the slurry velocity was maintained constant at 15 m s^{-1}. The reinforcement helps to protect the surrounding matrix in shallow-impingement-angle conditions. For large impact angles the fine particles strongly deviate near the surface while the coarse particles have sufficient energy to cause the breakage of reinforcing particles. These basic mechanisms are discussed in parallel with the predicted trajectories of abrasive particles near the test surface. Graphs, Photomicrographs. 11 ref. – AA (Turenne, S.; Chatigny, Y.; Simard, D.; Caron, S.; Masounave, J.; National Research Council of Canada; Wear, Dec. 1990, 141, (1), 147-158 [in English]. ISSN 0043-1648)

1614 EXAMINATION OF THE ZINC CONTENTS OF GAS SCRUBBING SLUDGE AT BLAST FURNACE AND THE POSSIBILITY OF ITS DECREASE. [MATE-199105-22-0526]
Investigation of the Zn content distribution in different grain size was made by electron-microscopy and X-ray diffraction. The Zn contents are decreased using the sulfuric acid method under 0.2%. Graphs. 13 ref. – AA (Tothne Eross, M.; Berecz, E.; Banyaszati es Kohaszati Lapok (Kohaszati), May 1989, 122, (5), 205-209 [in Hungarian]. ISSN 0005-5670)

1615 RELATIONSHIP BETWEEN THE STRUCTURE OF DISTURBED FLOW AND EROSION-CORROSION. [MATE-199105-31-2036]
Flow-dependent erosion-corrosion often occurs under disturbed flow conditions at geometrical irregularities such as fittings, valves, and weld beads. Flow separation and reattachment produces high turbulence intensity and particle – wall interactions that can lead to high erosion-corrosion rates. The predictions of 2-D turbulent, single and two-phase liquid/particle flow with recirculation, after a sudden constriction and expansion are presented. The model is based on a two-phase flow version of a standard k- epsilon model of turbulence and a stochastic simulation of particle – fluid turbulence interactions. It is capable of successfully predicting local values of time-averaged fluid velocities and turbulence intensities, and predicting particle dispersion, and particle – wall interaction. The numerical predictions of the flow structure are used to explain the results of an experimental erosion-corrosion study of water and water/sand mixture flowing in a pipe with a sudden constriction and expansion. It is shown that in case of disturbed single-phase flow, it is appropriate to correlate local near-wall parameters of flow with the metal loss rates. The simulations have shown that local near-wall intensity of turbulence is the important factor affecting mass transfer-controlled corrosion in disturbed flow, rather than the wall shear stress. In case of single-phase flow, comparisons revealed a significant effect of local turbulence intensity on corrosion rate of the base metal (e.g. AISI 1015). In case of two-phase flow, maximum metal loss coincided with local maximums of particle – wall mean impact frequency. Graphs. 19 ref. – AA (Nesic, S.; Postlethwaite, J.; University of Saskatchewan (Canada); Corrosion , Nov. 1990, 46, (11), 874-880 [in English]. ISSN 0010-9312)

1616 THE EFFECT OF IMPINGEMENT ANGLE ON SLURRY EROSION. [MATE-199105-31-2103]
The slurry erosion behaviour of metallic and non-metallic materials eroded by sand and water slurry was investigated. Under different test conditions, the erosion behaviour of the two kinds of materials followed two different patterns. A graph of erosion rate vs. impingement angle for metallic materials (e.g. Al 1020 steel, and high-Cr cast iron) showed two peaks and a trough, whereas there was only one peak at an intermediate angle of approx 80° on the erosion curve of brittle non-metallic materials. The results were discussed and explained by fluid mechanics. It is conluded that the spreading of the slurry has an important effect on slurry erosion. Graphs. 9 ref. – AA (Lin, F.; Shao, H.; China University of Mining Technology; Wear, Jan. 1991, 141, (2), 279-289 [in English]. ISSN 0043-1648)

1617 AUTO CLEANING AUTOMAT DEGREASES AND DRIES GRILLS. [MATE-199105-57-0530]
Programmed cleaners which work with aqueous media, instead of the conventional chlorohydrocarbons, are introduced. Grills and other stamped metal parts are fed by conveyor belt into different stations for washing, passivating and rinsing. Cleaning media are recirculated without producing waste water. – R.N.B. (Bander Bleche Rohre, Sept. 1990, 31, (9), 51 [in German]. ISSN 0005-3848)

1618 UTILIZATION OF INDUSTRIAL REJECTS IN ELECTROPLASTICS INDUSTRY. [MATE-199105-58-0570]
The technical and economic benefits of modern techniques of recycling and reconcentration of the effluents of electroplastic industry are discussed. The example chosen is that of galvanic deposition of Ni. Conventional pretreatment is by (a) neutralization by chemicals, (b) with ion-exchange resins.

Starting from basics, it is shown how an electrolysis option in both these cases proves to be superior and simpler. Complementarity of electrolysis and pretreatment of water is examined. Annual balance of materials and parameters of economic calculation are given. Efficiency of electrolysis of Ni is shown to rise with concentration in g/l. Graphs. 5 ref. – R.N.B. (Wiaux, J.-P.; Nguyen, T.; Oberflache Surface, July 1989, 30, (7), 13-16, 18-20 [in French]. ISSN 0048-1270)

1619 DEVELOPMENT OF NON-CYANIDE CADMIUM PLATING BATHS. [MATE-199105-58-0594]

One approach to minimizing toxic wastes is to eliminate the use of cyanide plating baths for steels. Non-cyanide Zn plating baths have been successfully developed and have found widespread use. An investigation was conducted to accomplish similar results with Cd plating baths. The focus of this study was on additives to a near neutral Cd bath, free of complexing agents. A Hull cell was used to enable visualization of deposits over a broad range of cathode current densities. An experimental design method (Taguchi method) was used to optimize the bath parameters and constituent concentrations. Baths have been developed which indicate promise for producing dense deposits with good covering power, and low hydrogen embrittlement property. 9 ref. – AA (Pearlstein, F.; Agarwala, V.S.; Chan, D.B.; US Naval Air Development Center; US Naval Civil Engineering Laboratory; Advanced Materials: Looking Ahead to the 21st Century, Boston, Massachusetts, USA, 6-8 Nov. 1990, Publisher: Society for the Advancement of Material and Process Engineering (1990), (Met. A., 9105-72-0259), 883-894 [in English].)

1620 MATHEMATICAL MODEL FOR THE CALCULATION OF THE USABLE VOLUME CAPACITY OF CATION EXCHANGERS FOR THE PURIFICATION OF RINSE WATER IN ELECTROPLATING WORKS. [MATE-199105-58-0600]

On the basis of results obtained in the purification of waste waters from electroplating works by ion exchange, regression equations for the calculation of the usable volume capacities of various commercial cation exchangers for different concentrations of Ni, Zn, and Cd ions in the water to be treated were derived. Besides this, regression equations for the determination of the concentration of these ions in the regenerate solutions in relation to the amount of regenerating medium used were also derived. The equations can be employed for the planning of ion exchanger plants. Graphs. 9 ref. – AA (Dobrevski, Iv.; Dimova-Todorova, M.; Panajotova, T.; Dimitrova, N.; Galvanotechnik, Nov. 1989, 80, (11), 3817-3821 [in German]. ISSN 0016-4232)

1621 ELECTROPLATING SLUDGE AS A PROBLEM MATERIAL. [MATE-199105-58-0602]

The end product of neutralization and detoxification of waste water from electroplating operations are sludges containing Cr, Ni, Cu, Zn, Fe, Al, Sn ions and other metals as hydrated oxides, hydroxides, and hydroxycarbonates. To be acceptable for disposal, CN content must be 20 mg/l, Cr 10 mg/l and pH 6.5-10. Typical analyses of sludges from electroplating, Eloxing, and Zn pickling installations are tabulated. It is concluded that disposal of sludges presents no environmental hazard if strict controls and exact knowledge of the product to be disposed of are maintained. Graphs. – B.L. (Scholler, F.; Galvanotechnik, Nov. 1989, 80, (11), 3923-3928 [in German]. ISSN 0016-4232)

1622 NEW AND ANTICIPATED ENVIRONMENTAL PROTECTION LAWS AND THEIR EFFECT ON ELECTROPLATING PLANTS. [MATE-199105-58-0603]

Limitations posed by waste water standards relative to chemical oxygen deficiency, adsorbed organic halogen compounds, heavy metal concentration, and fish poisoning are listed. Air purity standards relative to NO_x emissions and degreasing vapors are described. Effects on electroplating technology include lengthening of holding time of process baths, retaining bath additives, use of cascade rinsing, and reduction of EDTA in waste water. Limits in waste water of heavy metal concentrations and active carbon adsorbable halogen compounds are presented. In case of wastes from plants with mixed operations, limits of each operation must be met without dilution from less polluting sources. 7 ref. – B.L. (Greiner, D.; Galvanotechnik, Nov. 1989, 80, (11), 3929-3934 [in German]. ISSN 0016-4232)

1623 THE SOIL, A CRITERION FOR ENVIRONMENTAL CARRYING CAPACITY. [MATE-199105-58-0604]

Environmental protection begins with waste water and the measures used for its treatment, such as neutralization with dolomite. To this is added concern with polluted air emissions and disposal of water used for cleaning air. Finally, disposal of solid wastes contributes to the soil burden. Development of governmental standards for wastes is discussed. – B.L. (Winkel, P.; Galvanotechnik, Nov. 1989, 80, (11), 3935-3937 [in German]. ISSN 0016-4232)

1624 CONSEQUENCES OF ENVIRONMENTAL POLITICS. [MATE-199105-58-0605]

At a meeting entitled "Wasser Berlin, '89" held 10 April 1989 in Bonn, problems posed by ever more restrictive polluted water purification requirements were raised. The electroplating industry is particularly affected. More restrictive water laws have resulted in decreased use of water, in spite of increased levels of production. Further measures for improving water quality are expected from actions instituted by "Rhine Action Program" and North Sea Protection Conference. Water purification is closely tied to preservation of the soil. – B.L. (Winkel, P.; Galvanotechnik, Nov. 1989, 80, (11), 3938-3942 [in German]. ISSN 0016-4232)

1625 THE MICROSTRUCTURE OF THIXOTROPIC ALLOY SLURRIES. [MATE-199106-12-1092]

The mechansim of solid fragmentation was studied on two Al – Cu alloys containing 4.5 and 10% Cu which were heated to 585 and 607 °C, respectively, before quenching into a brine solution to fragment the dendritic structure forming thixotropic slurries. The microstructural changes with Al – 4.5Cu alloy annealed at 585 °C showed the second phase to dissolve with the liquid phase fully formed after 2 min; most of the grain boundaries, however, remained non-wetted by the liquid. Equiaxed grains were formed after 5 min when only the high-angle boundaries of high interfacial energies became wet by a thin film of liquid. Melting was not so rapid with Al – 10Cu alloy which took 5 min to form all liquid. For both alloys, when the surface energy of the solid/liquid interface is greater than half the grain boundary energy of the solid, liquid will no longer wet the boundary, but establish a dihedral angle against it. Metallography of fragmentation of both alloys also showed similar dihedral angle. Graphs. 7 ref. – B.C. (Kapranos, P.; Kirkwood, D.H.; Cellars, C.M.; University of Sheffield; Advanced Materials and Processes – Proceedings of the First European Conference. EUROMAT '89. Vol. 1, Aachen, FRG, 22-24 Nov. 1989, Publisher: DGM Informationsgesellschaft (1990), (Met. A., 9106-72-0315), 165-168 [in English].)

1626 DESIGN OF A SLURRY EROSION TEST RIG. [MATE-199106-31-2631]

The design of a jet impingement slurry erosion test rig, built for laboratory use, is presented. This apparatus gives good control over many of the important test parameters, such as impact velocity, solid particle concentration and impact angle. An ejector nozzle is employed to entrain sand particles from a sand bed into a stream of water to form a slurry; after impingement, the abrasive particles and the water phase are separated and recycled. This makes the rig simple, economical and easy to operate, and its pump and pipline remain free from erosive wear. Experimental results on commercial purity Al, Cu, and mild steel are presented to illustrate the operation and performance of the rig. Graphs. 26 ref. – AA (Zu, J.B.; Hutchings, I.M.; Burstein, G.T.; University of Cambridge; Wear, Nov. 1990, 140, (2), 331-344 [in English]. ISSN 0043-1648)

1627 HIGH-TEMPERATURE FAILURE OF AUSTENITIC STAINLESS-STEEL TUBING IN A WASTEWATER-RECLAMATION FACILITY. [MATE-199106-35-1136]

Type 303Se stainless-steel tubing failed by high-temperature intergranular corrosion after 18 months service as a conduit for waste gases from a fluidized-bed reactor in a wastewater-reclamation facility. EDX analysis showed that chromium sulfide had formed in grain boundaries of the base metal in the heat-affected zone of a peripheral weld. Superficial intergranular sulfidation, extending only one or two grains, occurred in the base metal away from the weld. Chlorine and Ca were observed in the corrosion

products also. Chlorine exacerbated the corrosion, whereas Ca reacted subsequently with chromium sulfide to form a more stable reaction product. The combined oxidizing/sulfidizing atmosphere would not have caused failure in the absence of the heat-affected zone of the weld. Remedial measures are discussed. Photomicrographs, Diffraction patterns. – AA (Douglass, D.L.; University of California (Los Angeles); ISTFA 90, Los Angeles, California, USA, 29 Oct.-2 Nov. 1990, Publisher: ASM International (1990), (Met. A., 9106-72-0287), 393-396 [in English].)

1628 TESTS OF IRON-OXIDE-COATED SAND FOR TREATMENT OF PLATING RINSEWATERS. [MATE-199106-42-0534]

A method to treat metal etching wastes with iron oxide coated sand has been developed and tested. Tests show that Cu ion removal by precipitation occurs at pH 11.5 or greater, whereas the addition of iron oxide coated sand changes the removal to adsorption and the process occurs at pH 6.5 and higher. On site tests demonstrated the advantages of this process. The coated sand removed Pb, Zn and Cu ions from the waste water to levels of 0.7-0.1 mg/h. Additional development work is required due to inconsistencies in ion removal. It is felt this can be easily resolved. Graphs. 1 ref. – R.A.S. (Benjamin, M.M.; Chang, S.; Bailey, R.; University of Washington; Plating and Surface Finishing, Feb. 1991, 78, (2), 35-40 [in English]. ISSN 0360-3164)

1629 CYANIDE REGENERATION PROCESS. [MATE-199106-42-0565]

A process for removing and recovering cyanide from a cyanide-containing solution is developed. The process includes the steps of adjusting the pH of the cyanide-containing solution to between approx pH 6-9.5, volatilizing the HCN contained in the pH adjusted solution and contacting the volatilization HCN with basic material. Preferably, the cyanide recovery process is performed on tailings slurries resulting from metal recovery processes. – USPTO (Goldstone, A.J.; Mudder, T.I.; Cyprus Minerals; 19 Feb. 1991 [in English]. Patent no.: US4994243 (USA) Convention date: 21 Oct. 1988)

1630 PROCESS FOR SEPARATING AND RECOVERING DISSOLVED AND PRECIPITABLE METALS, IN PARTICULAR HEAVY METALS, FROM AQUEOUS SOLUTIONS. [MATE-199106-43-0181]

A process for the separation and recovery of dissolved, precipitable metals, in particular heavy metals, from aqueous solutions, especially waste water, is characterized in that the solutions are changed with respect to their pH value or redox potential for the formation of precipitation products, the precipitation products concentrated and separated as an aqueous suspension, the suspension then undergoes a known selective liquid/liquid extraction process with ion exchangers and/or chelate formation, and the charged ion exchanger and/or chelate former are finally stripped. (Prior, A.; Prior Engineering; Auszuge aus den Europaischen Patentanmeldungen, Teil I, 5 Sept. 1990, 6, (36), 4716-4717 [in German]. Patent no.: EP0385968 (European Patent) Convention date: 26 Feb. 1990)

1631 NEW METHOD OF RECOVERING SILVER FROM ANODIC SLURRIES. (RETROACTIVE COVERAGE). [MATE-199106-43-0188]

A new method has been developed by the Institute for Non-Ferrous Metallurgy at the Silesian Technical College in Poland for the recovery of Ag from anodic slurries arising in the electrolytic refining of Cu. In Poland these slurries contain principally 35-40% lead sulphate, 20-25% Ag and 5-13% Cu. The method involves (i) alkaline leaching of the decopperised slurries with a caustic soda solution, (ii) oxidising remelting of the leached and dried slurries in a Hoboken converter, using caustic soda and silica as fluxes and (iii) electro-finishing of the resultant dore metal (= 98.5% Ag). The residual slag, containing 2-6% Ag, is smelted with caustic soda and coke and refined. Alternative treatments of the post-leaching solution comprise neutralisation with acidic effluent from sulphuric acid production followed by recycling of the resultant lead sulphate to Pb production, or electrolytic recovery of = 99.5% pure Pb with simultaneous caustic soda regeneration. – L.T. (Wolff, S.; Tumidajska, Z.; Szymanski, J.; Silesian Technical University; Evaluation of Nonferrous Metallurgical Secondary Raw Materials (Verwertung NE-Metallurgischer Sekundarrohstoffe), Freiberg, Germany, 1986, Freiberger Forschungshefte B, Metallurgie Werkstofftechnik, 1987, (B260), 67-70 [in German]. ISSN 0071-9420)

1632 USE OF BIOTECHNOLOGY FOR THE RECOVERY OF METALS FROM EFFLUENTS. (RETROACTIVE COVERAGE). [MATE-199106-43-0192]

In the biotechnical treatment of effluents, the two groups of reactions between micro-organisms and metals, namely metal uptake and transformation, comprise respectively accumulation in the cell interiors and sorption on the cell walls, and oxidation, reduction and synthesis. Accumulation and sorption processes can involve growing, dormant or destroyed micro-organisms, whereas transformations are restricted solely to those still active. Following a brief critical review of the transformation reactions, a method of storing by sorption of micro-organisms on the cell walls of the metals contained in aqueous communal effluents and subsequent recovery of the metals by desorption is described in detail, using Cd and Hg as examples. The technical and economic advantages of the method are considered briefly. Graphs. 30 ref. – L.T. (Ringpfeil, M.; Glombitza, P.; Evaluation of Nonferrous Metallurgical Secondary Raw Materials (Verwertung NE-Metallurgischer Sekundarrohstoffe), Freiberg, Germany, 1986, Freiberger Forschungshefte B, Metallurgie Werkstofftechnik, 1987, (B260), 98-108 [in German]. ISSN 0071-9420)

1633 DISPOSAL OF SPENT COPPER DRAWING LUBRICANTS. [MATE-199106-52-0779]

Copper wire is normally drawn and annealed with emulsions or solutions containing 90% water. A generation ago, the disposal of these spent lubricants and coolants received little attention. With the increasing environmental awareness that took place in the 1960s, it was decided to do differently when the Atlanta Works of AT&T was engineered at Norcross, Georgia, between 1969-1971. AT&T and Filtertech engineers developed a unit that used evaporation as the separating principle and is called a thermal emulsion breaker (TEB). Local government regulations place limitations on Cu, Zn, Cr, Ni, Pb, total organics, oil and grease, and pH. In 1987, a separate sampling station was built to better monitor the small discharge from Cu forming. Recent engineering has shown that the TEB discharge water, if slightly improved, could be used as makeup water for coolant additions. Bacteria control would be required. This would eliminate the discharges to the county sewer. The direction in which the regulatory process appears to be moving would indicate that a zero discharge will be necessary in the not-too-distant future. AT&T expects to have that modification in place in the near future. 5 ref. – M.W.C. (Willby, R.A.; AT&T Technologies; Wire Journal International, Feb. 1991, 24, (2), 43-46 [in English]. ISSN 0277-4275)

1634 ENVIRONMENT-FRIENDLY METAL-WORKING FLUIDS—PROPHYLAXIS IS DEMANDED. [MATE-199106-53-0485]

New super-sensitive detection and analysis methods in the ppb range developed to meet the requirements of environmental regulations in Germany are indicated. In the metal working industry, status quo for water-miscible coolants/lubricants have been defined. Use indicated new friendlier substitutes, i.e. synthetic esteroils, polyalphaolefines and polyglycolesters. Also mentioned are water-miscible hydraulic oils which are multifunctional, e.g. Hycut 46. It can be economically and ecologically recycled. – R.N.B. (Muller, J.; Industrie-Anzeiger, 28 Aug. 1990, 112, (69), 82-83 [in German]. ISSN 0019-9036)

1635 MORE COST EFFECTIVE STAINLESS PICKLING. [MATE-199106-57-0704]

Many sheet steel producers are updating their continuous pickle lines and some new continuous capability has recently come on-line. In addition, a number of new pickle lines of the push – pull type are being installed by toll processors and service centers. The new continuous pickle lines are integrated with cold rolling, annealing, temper rolling, and inspection facilities. – D.O.N. (Feit, E.; Thirty-Three (33) Metal Producing, June 1990, 28, (6), 40-41, 43 [in English]. ISSN 0149-1210)

1636 PLANNING, PROCUREMENT AND OPERATION OF SURFACE TREATMENT PLANTS: VOLATILE HALOGENATED HYDROCARBONS. (RETROACTIVE COVERAGE). [MATE-199106-57-0754]

In planning, close cooperation between user, chemical supplier and equipment maker is stressed. For the degreasing of metals, plastics, glass and

ceramics, the solvents R112, R113, R11, TRI and PER are permitted. Dissolved material must be removed by filtration and distillation, water by gravity separation. Solvent recycling is important. Chlorinated hydrocarbons are stabilized against acid and heat. Stabilizer levels must be checked and replenished. Fluorocarbons for the treatment of reactive metals come with alcohols. Better drying facilities are required. Further questions of installation, environmental protection, storage, safety and disposal are discussed. Materials mentioned include bismuth, magnesium, Al, Zn, and brass. – R.v.M. (Galvanotechnik, Oct. 1988, 79, (10), 3280-3286 [in German]. ISSN 0016-4232)

1637 THE AIR FORCE HAZARDOUS WASTE MINIMIZATION PROGRAM. [MATE-199106-58-0716]

The US Air Force will reduce its hazardous waste by 50% by 1992. Approaches to meet this goal are described. The following topics are described: laser-enhanced electroplating, ferrous sulfate sodium sulfide reduction of hexavalent Cr and metals precipitation, non-cyanide metal stripper replacement, solvent substitution and ion-vapor deposition of IVD Al on steel surfaces. – T.Z. (Carpenter, C.J.; Air Force Engineering and Services Center; Plating and Surface Finishing, Apr. 1990, 77, (4), 35-36 [in English]. ISSN 0360-3164)

1638 OPTIMIZED WASTEWATER TREATMENT FOR A PRINTED CIRCUIT BOARD FACILITY. [MATE-199106-58-0717]

A case history is given of how Hughes Aircraft's printed circuit board manufacturing facility developed a method using ion-exchange, membrane-filtration and electrowinning to recover Cu of 97% purity. Sludge reduction is three to four times better than in conventional systems. Flowsheets are shown of the ion-exchange and wastewater treatment schemes. 3 ref. – T.Z. (Stuart, L.G.; Greenberg, L.A.; Post; Buckley; Schuh & Jernigan; Plating and Surface Finishing, Apr. 1990, 77, (4), 38-42 [in English]. ISSN 0360-3164)

1639 EXPERIENCES OF AN ENVIRONMENTAL ADVISOR TO THE GALVANIZING AND METAL PRODUCTION INDUSTRY. (RETROACTIVE COVERAGE). [MATE-199106-58-0747]

Ten years experience as environmental advisor is summarized. Knowledge of the law and environmental data are often missing. Can the whereabouts of used dangerous chemicals be proven? Advice is generally requested only after complaints. Early considerations of off-water treatment can save money and trouble. Regulations are increasing exponentially. Halogenated hydrocarbon equipment must be approved. SO_4 in water is environmentally safe and often not enforced, but can lead to later claims of damage to concrete piping systems. Damage claims do not have to show intent and can occur long after the contamination and can ruin a company. Automatic treatment must be supervised. Regular updating of personnel training is required. Risk evaluation of regular operation and possible accidents is required. The responsibility for environmental safety lies with the entrepreneur. Graphs. 1 ref. – R.v.M. (Winkler, L.; Galvanotechnik, Oct. 1988, 79, (10), 3392-3397 [in German]. ISSN 0016-4232)

1640 FASTENER JOBSHOP FINDS BENEFITS IN TOTAL QUALITY MANAGEMENT. [MATE-199106-58-0757]

The implementation and maintenance of a total quality management program at API Industries are followed. The various stages that management went through are detailed. it involves identification of problems, train selected individuals who become implementation teams, and then introduce the program to the general workforce. The key to success is a total, company wide commitment to quality, and precise record keeping. The results are greater customer satisfaction, high employee morale and outstanding quality at low final cost. API Industries is one of the largest finishers (e.g. Zn plating) of primarily automotive fasteners. – R.A.S. (API Industries; Plating and Surface Finishing, Feb. 1991, 78, (2), 32-34 [in English]. ISSN 0360-3164)

1641 VACUUM EVAPORATION. [MATE-199106-58-0766]

Ion-exchange systems with discontinuous discharge, such as used in the treatment of wash waters and effluents from galvanic processes, entail the problem constituted by the strong presence of chlorides and sulfates in the process of regeneration of the cationic resins. The design and operation of a vacuum concentrator which extracts water, by distillation, from the effluents to be regenerated are described. The system is based on the principle of boiling under vacuum. – S.M. (Alessandri, C.; Trattamenti & Finiture, Aug.-Sept. 1989, 29, (8-9), 106-107, 109 [in Italian]. ISSN 0041-1833)

1642 THE COMMISSIONING, OPERATION, AND MAINTENANCE OF AN ON-LINE CORROSION-MONITORING STATION FOR THE MINING INDUSTRY. (REPORT). (RETROACTIVE COVERAGE). [MATE-199107-22-0699]

The report describes a station that is used for the monitoring of pipe corrosion in the mining industry. The system provides on-line logging of various parameters related to the quality and flow of water through the monitoring system. Up to four different materials (e.g. carbon steel, 316, 3CR12, Al, and Cu) are monitored continuously by the use of linear polarization resistance, together with traditional methods of measurement such as that involving corrosion coupons. The system is relatively compact, and has proved to be sufficiently robust to withstand mining environments. It is hoped that it will be used in the monitoring of parameters on individual sites at mines as an aid to the selection of materials and to problem-solving. The report includes results from a site survey and illustrates the masking of conditions that can occur when on-line equipment is not used. Graphs, Photomicrographs. 6 ref. – AA (White, R.T.; Mintek; 1985, Mintek Rep. M225, Pp 33 [in English].)

1643 SILVER CONCENTRATIONS IN RADIOGRAPHIC PROCESSING WASH WATER AND WASTE MINIMIZATION. [MATE-199107-22-0737]

Federal, state, and local governments are imposing stricter limits on Ag in radiographic effluents. Many users are concerned about Ag carried out of the fixer tank, within the film, into the wash tank. Some codes require the waste wash water to be contained and then hauled away for treatment. Evidence of the relatively low Ag content in the wash water and ways to reduce both Ag content and total water volume are presented. There are many factors that affect Ag carry-forward. This includes chemical quality, processor quality in squeegee rollers, wash water flow rate, temperature, film feeding practices, and the mix of film type, size, and percentage of exposure. To be able to meet regulations in the least expensive manner, it is important to understand the circumstances or levels of compliance and ways to maintain or meet compliance. Graphs. – AA (McKinney, W.E.J.; Du Pont NDT Systems; Materials Evaluation, Apr. 1991, 49, (4), 482-486 [in English]. ISSN 0025-5327)

1644 CORROSIVE WEAR BEHAVIOUR OF CR—MN—CU WHITE CAST IRONS IN SAND-WATER SLURRY MEDIA. [MATE-199107-31-3074]

An attempt has been made to develop Cr – Mn – Cu white cast irons for applications requiring corrosive and erosive wear resistance properties. Alloys with different compositions and heat treatments were subjected to wear tests under corrosive wear conditions. The relative wear index of each alloy after specific heat treatments was evaluated with respect to standard Ni-hard type IV cast iron. The corresponding test results indicate that the addition of 3% Cu to Cr – Mn cast irons in the ausaged condition markedly reduces (approx 35%) the corrosive wear loss in saline slurry media. The as-cast austenitic alloy with Cu exhibits a better corrosive wear resistance performance (approx 43-47%) than those of the hardened and tempered or ausaged alloys, and is comparable to that of Ni-hard type IV irons. Graphs, Photomicrographs. 19 ref. – AA (Chakraborty, I.; Basak, A.; Chatterjee, U.K.; Indian Institute of Technology; Wear, 20 Mar. 1991, 143, (2), 203-220 [in English]. ISSN 0043-1648)

1645 EFFECT OF IMPACT VELOCITY ON SLURRY EROSION AND A NEW DESIGN OF A SLURRY EROSION TESTER. [MATE-199107-31-3075]

Experimental technique has been a main block in the study of slurry erosion. A new design for a slurry erosion tester is presented. The tester uses a variable speed electric motor to drive a rotator that rotates in a vacuum chamber. The specimens (e.g. Al, 1020 steel, high Cr cast iron) are clamped in specimen fixtures on the ends of four arms of the rotator and impacted by a falling slurry stream. With the tester, erosion velocity and impingement

angle can be measured and controlled accurately. Primary slurry erosion tests were carried out with the tester and the effect of velocity on slurry erosion was studied. It was concluded that velocity has less effect on slurry erosion than on gas–solid particle erosion. Velocity exponents of 1.87-2.48 were observed for different impingement angles. Graphs. 16 ref. – AA (Lin, F.Y.; Shao, H.S.; China University of Mining Technology; Wear, 20 Mar. 1991, 143, (2), 231-240 [in English]. ISSN 0043-1648)

1646 SILVER-RECOVERY APPLICATIONS FOR BETTER EFFLUENT MANAGEMENT. [MATE-199107-42-0635]

The two most commonly used Ag recovery techniques are metallic replacement and electrolysis. The most important factor in any system is to have the solution containing the Ag retained in the recovery unit long enough to achieve optimum recovery. Centralized and noncentralized systems are described. Three problems often encountered are chemical changes due to electrolysis of the fixer solution, physical and sensitometric effects resulting from reduced fixer replenishment rate, and equipment problems. Two approaches to treating wash water are (1) using steel wool and (2) using an ion exchange resin. Other methods that have had some preliminary testing include reverse osmosis and electrodialysis. – M.W.C. (Chilton, A.D.; Eastman Kodak; Materials Evaluation, Apr. 1991, 49, (4), 509-513 [in English]. ISSN 0025-5327)

1647 PROCESS FOR PRECIPITATION OF CHROMIUM FROM TANNERY EFFLUENT. [MATE-199107-43-0235]

The invention is concerned with a process for the precipitation of Cr from tannery effluents, which also contain, in addition to Cr, monofunctional and polyfunctional carboxylic acids, which mask and complex the Cr to a reusable precipitate rich in Cr, essentially as chromium (III) hydroxide. The invention is characterised by the fact that the precipitation is undertaken at pH 8.2-9.0, preferably at pH 8.3-8.7, with magnesium oxide or magnesium hydroxide as alkalising agent from hot (= 50 °C) solutions, and the Cr-bearing precipitate is separated out by filtration from the solution, which contains 1 mg/l Cr(III) at this stage. (Block, H.-D.; Makowka, B.; Rosentreter, H.; Wardas, A.; Wehling, B.; Lonhoff, N.; Bayer; Auszuge aus den Europaischen Patentanmeldungen, Teil I, 15 Nov. 1989, 5, (46), 4649 [in German]. Patent no.: EP0341490 (European Patent) Convention date: 26 Apr. 1989)

1648 A PROCESS FOR THE SEPARATION OF SODIUM AND CALCIUM FROM SODIUM SLUDGE. [MATE-199107-43-0236]

In a process for the separation of Na from a sludge containing Na, Ca and oxides thereof the sludge is subjected to a centrifugal force to separate the Na from the Ca. The sludge is placed e.g. in a stainless steel gauze cage which is rotated at 600-3000 rev/min and is immersed in an oil bath at 100-200 °C. Sodium migrates to the cage edge, is flung through the gauze and collects in the bath bottom. Optionally Ca is recovered from the residue by treatment with an alcohol to dissolve sodium oxide, followed by filtration to separate the Ca. (Tucker, K.L.; Ma, U.; Cookson Group; Auszuge aus den Europaischen Patentanmeldungen, Teil I, 25 Oct. 1989, 5, (43), 4382-4383 [in English]. Patent no.: EP0338719 (European Patent) Convention date: 12 Apr. 1989)

1649 EFFECT OF INORGANIC ELECTROLYTES ON THE RHEOLOGICAL PROPERTIES OF THE AQUEOUS YTTRIUM OXIDE/COLLOIDAL ZIRCONIA BINDER SOLS SYSTEM. [MATE-199107-51-1089]

Dip-coating is one of the most common methods in ceramic processing. This method has been used to prepare the ceramic shell mould for precision casting. The development of a suitable slip for successful dip-coating is necessary to understand the rheological properties of the slip. Zirconia and yttrium oxide were adopted for the ceramic shell mould to obtain a thinner reactive layer between the shell mould surface and casting metal compared to that between other refractory shell moulds and casting metal. Some diffiulties exist in making stable yttrium oxide slurry in preparation of the ceramic shell mould. The major one is caking (i.e. serious flocculation) of slurry. Multivalent ions such as La^{3+}, Mg^{2+} function as surface-active counter ions for Y_2O_3 particles in aqueous solution. Due to the addition of these electrolytes, the solid content of Y_2O_3/ZrO_2 binder sols slurry was increased and the stability of the slurry was improved. Both ion valence and ion size of electrolytes added into the slurry are expected to influence the slurry rheological flow behaviour. Graphs. 16 ref. – AA (Fran, Y.S.; Tseng, T.Y.; Lin, Y.L.; Chang, C.P.; National Chiao-Tung University; Chung Shan Institute of Science and Technology; Journal of Materials Science, 1 Apr. 1991, 26, (7), 1834-1838 [in English]. ISSN 0022-2461)

1650 EXPERIENCE WITH THE TREATMENT OF CHROMATE-CONTAINING WASTE WATER AND ACIDS IN THE CONTINUOUS TREATMENT PROCESS. [MATE-199107-58-0908]

The aim of a new process is to treat both the waste water and the used acids jointly in a single low-maintenance, automatic instead of treating and diluted solution by a continuous process, and waste acids by a discontinuous process continuous process. 3 ref. – AA (Reisenhofer, K.; Losch, H.; Bohler; Stahl und Eisen, 15 Mar. 1991, 111, (3), 67-70 [in German]. ISSN 0340-4803)

1651 STUDIES ON CARBON STEEL CORROSION IN MOLYBDATE AND SILICATE SOLUTIONS AS CORROSION INHIBITORS. [MATE-199108-35-1613]

The effects of molybdate (MoO^{2-4}) and silicate (SiO^{2-3}) as carbon steel corrosion inhibitors were studied. Potentiodynamic plots of C steel in the MoO^{2-4} and SiO^{2-3} solution were obtained in the standard electrochemical cell with a saturated calomel electrode (SCE) as the reference electrode. Work includes corrosion in 100 ppm MoO^{2-4}, 100 ppm SiO^{2-3}, and various mixtures of MoO^{2-4} and SiO^{2-3} with the total concentration of 100 ppm. Studies were performed in both aerated and deaerated solutions. After determining the polarization potential at the passive region from the potentiodynamic plot, samples were then passivated for 1 h at the determined polarization, while the products of the passive films were analyzed by the Auger electron spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS) techniques. Results indicate that the metal molybdates can be formed both in the air-saturated solution and in the nitrogen-purged solution with various amounts, depending on the solution, whereas Si can be transformed into either metal silicate or silicon oxides, depending on the environmental conditions. The iron oxides formed are in the layered structure of $Fe_2O_3/FeO/Fe$. Graphs. 24 ref. – AA (Chen, J.-R.; Chao, H.-Y.; Lin, Y.-L.; Yang, I.-J.; Oung, J.-C.; Pan, F.-M.; National Tsing Hua University; Industrial Technology Research Institute (Taiwan); Fourteenth International Seminar on Surface Physics, Przesieka, Poland, 21-26 May 1990, Surface Science, May (II) 1991, 247, (2-3), 352-359 [in English]. ISSN 0039-6028)

1652 HEAVY METALS WASTE MINIMIZATION: PRACTICE AND PITFALLS. [MATE-199108-42-0703]

The capital cost of waste minimization in metal finishing industry is much lower than that for waste treatment, provided careful attention is given to the production changes in order to maintain operational savings. A substantial waste reduction can be achieved through preventive maintenance with the largest savings by reducing drag-out rates. The costs, savings and payback periods of two case histories are detailed. – B.C. (Rosenblum, J.; Naser, M.J.; Plating & Waste Management Consultants; Plating and Surface Finishing, Apr. 1991, 78, (4), 60-64 [in English]. ISSN 0360-3164)

1653 BIOSORPTION OF METAL CONTAMINANTS USING IMMOBILIZED BIOMASS—A LABORATORY STUDY. (REPORT). [MATE-199108-42-0712]

The US Bureau of Mines has developed porous beads containing immobilized biological materials for removing metal contaminants from waste waters. The beads, designated as BIO-FIX beads, are prepared by blending biomass, such as sphagnum peat moss or algae, into a polymer solution and spraying the mixture into water. Laboratory studies were conducted to determine bead sorption and elution characteristics. Batch and continuous tests demonstrated that BIO-FIX beads sorbed arsenic, Cd, Pb, and other toxic metals from acid mine drainage waters collected from several sites. Selectively for heavy and toxic metal ions over Ca and magnesium was demonstrated. The beads exhibited excellent metal sorption and handling characteristics in stirred tanks, column contactors, and a low-maintenance passive system. The sorption process was reversible, and metal ions were eluted from the beads using dilute mineral acids. Cyclic tests indicated that the beads continued to extract metal ions after repeated loading–elution cycles. Photomicrographs, Graphs. 15 ref. – AA (Jeffers, T.H.; Ferguson,

C.R.; Bennett, P.G.; US Bureau of Mines; US Bureau of Mines. Report Investigation, 1991, Rep. Invest. 9340, Pp 9 [in English].)

1654 MEASUREMENT OF CHEMICAL OXYGEN DEMAND IN STEEL PLANT EFFLUENTS. [MATE-199108-45-0963]

Chemical oxygen demand (COD) is an important parameter of any waste effluent intended to be released, as high COD of effluents can be detrimental to the aquatic life in the receiving water body. For this reason, all regulatory bodies have specified maximum COD levels for effluents to be discharged. Actual COD of any waste effluent depends on a number of factors and its measurement must be done under specified conditions. A proprietary method for COD measurement has been investigated and then used to determine COD of different waste effluents from a steel plant in India and results have been discussed. Graphs. 3 ref. – AA (Chattopadhyay, G.; Mukherjee, S.; Wajon, E.; Hine, P.; SAIL; Steel India, Apr. 1991, 14, (1), 18-21 [in English].)

1655 RECYCLING ANODIZING RINSEWATER USING ION EXCHANGE. [MATE-199108-57-0977]

A case history of an anodizer's effluent treatment is detailed where the Cu content of the effluent (discharged at 40 gallon/min) was reduced from 1 to 0.5 mg/l using pH-adjusting unit, coarse and fine filters and three ion-exchange units separately containing chelating, strong acid and strong base resins. A cost comparison with the conventional flocculation-sludge thickener-filter press system shows that although the ion-exchange process has higher capital and chemical costs, it provides considerable savings in water and sewer costs. Graphs. – B.C. (Kirman, L.; Kovach, J.; Kinetico Engineered Systems; Plating and Surface Finishing, Apr. 1991, 78, (4), 65-67 [in English]. ISSN 0360-3164)

1656 PRETREATMENT IN THE 1990S. [MATE-199108-58-0969]

A study of the US pretreatment patents for the last five years shows a distribution of 28% on zinc phosphating, 21% on cleaners (acidic/alkaline), 15% on final rinse/sealers (non-chromate and others), 11% on chromating passivation, 4% on activators and 21% on miscellaneous processes. The development trends for pretreatment technology in the nineties are discussed in terms of chrome replacement, waste treatment, recycling/recovery and reduction of VOC emissions. The innovations of powerful computer-based monitoring and control systems, analytical instrumentation and performance testing are highlighted which will greatly influence the progress in the pretreatment field. Graphs. – B.C. (Wittenbrook, L.; Betz Metchem; Products Finishing (Cincinnati), May 1991, 55, (8), 55-60 [in English]. ISSN 0032-9940)

1657 DEVELOPMENTS IN ALKALINE ZINC—NICKEL ALLOY PLATING. [MATE-199108-58-0974]

The benefits claimed for alkaline Zn – Ni coatings are: a five-fold improvement in corrosion protection, the acceptance of heat-treating after chromating, persistant protection after shape distortions, no chemical attack on interior surfaces and easy waste treatment on account of absence of cyanides. These features are discussed and quantified. Graphs. – T.Z. (Sizelove, R.R.; Frederick Gumm Chemical; Plating and Surface Finishing, Mar. 1991, 78, (3), 26-30 [in English]. ISSN 0360-3164)

1658 WASTE MINIMIZATION AND POLLUTION PREVENTION AT PRATT & WHITNEY AIRCRAFT. [MATE-199108-58-0975]

Waste reduction opportunities are identified and successfuuly implemented at P&WA. Graphs presented include correlation of Ni concentration with conductivity and Ni concentration and conductivity vs. work load vs. water usage. Their conquest over pollution problems has proceeded in five defined phases. Graphs. – T.Z. (Gallerani, P.; McCarvill, R.; Pratt and Whitney; Plating and Surface Finishing, Mar. 1991, 78, (3), 36-39 [in English]. ISSN 0360-3164)

1659 PROCESS FOR PLATING ADHERENT CO-DEPOSIT OF ALUMINUM, ZINC, AND TIN ONTO METALLIC SUBSTRATES, AND APPARATUS. [MATE-199108-58-1011]

A co-deposit of Al, Zn and Sn can be deposited onto metallic substrates including small metal parts. The co-deposit is strongly adherent to the substrate and exhibits improved corrosion resistant properties. The co-deposits are plated onto metallic substrates by a process which comprises the steps of (a) preparing the substrate; (b) forming a slurry comprising a soluble source of stannous ions, impact media, and Al and Zn in particulate form in a liquid medium maintained at a pH approx 4; (c) mechanically impacting the slurry against the surface in a plating container; (d) renewing the stannous ions, Al and Zn in the slurry while maintaining the pH of the slurry approx 4 throughout the plating process until a co-deposit of the desired thickness is obtained. The invention also includes metallic substrates plated with the co-deposit. The invention also includes metal fasteners plated with the co-deposits in contact with Al articles to be fastened. An improved apparatus also is described and claimed. – USPTO (Coch, L.G.; Satow, A.; McGean-Rohco; 14 Nov. 1989 [in English]. Patent no.: US4880132 (USA) Convention date: 15 July 1988)

1660 CHARACTERIZATION OF ALUMINIUM-MATRIX COMPOSITES MADE BY COMPOCASTING AND ITS VARIATIONS. [MATE-199108-62-0868]

Compocasting (semisolid – semisolid, SS) and its two variations: SL (semisolid – liquid) and LL (liquid – liquid) process routes are used to make 2024Al reinforced with 3 and 12 mm long FP-alumina fibres. Squeeze-casting is used as a complementary casting technique. The effect of processing route on microstructure and the mechanical properties of these composites is studied. The SS route produces composites with uniform fibre distribution, but casting is difficult due to the high viscosity of the slurry. The SL route gives good fibre distribution and the casting is easy. The LL route allows addition of a large amount of fibres but gives castings with a non-uniform fibre distribution, which lowers the failure strains and reduces the strength of the composites drastically. The addition of alumina fibres to 2024Al increases its modulus of elasticity considerably. The observed modulus values show good agreement with the theoretical predictions. The strength values are somewhat lower than the theoretical predictions. This is because the composites failed at strains slightly lower than the fibre failure strain. Absence of fibre pull-out indicates that a good fibre matrix bond has been produced in each case. Graphs, Photomicrographs. 16 ref. – AA (Karandikar, P.G.; Chou, T.-W.; University of Delaware; Journal of Materials Science, 15 May 1991, 26, (10), 2573-2578 [in English]. ISSN 0022-2461)

1661 THE USE OF SIMPLE MATERIAL BALANCES TO SOLVE PROBLEMS IN A CIRCUIT BOARD MANUFACTURER'S WASTEWATER TREATMENT SYSTEM. [MATE-199108-63-0160]

Based on the concept of conservation of mass and energy, material balances are estimated using information on the input and output of mass flow rate and the concentration of species to be determined. The case studies on material balances are presented in terms of repeatability of effluent quality in a circuit board shop, an understanding of the type and amount of waste material from a waste treatment process and an economical disposal of hazardous waste using ion exchange/electrolytic recovery system normally associated with low metal concentrations. – B.C. (Wood, D.A.; Teradyne Connection Systems; Plating and Surface Finishing, Apr. 1991, 78, (4), 68-72 [in English]. ISSN 0360-3164)

1662 AUTOMATED DILUTION IN FLOW INJECTION ANALYSIS WITH DOUBLE ON-LINE DIALYSIS. A SYSTEM FOR THE DETERMINATION OF CHLORIDE IN INDUSTRIAL EFFLUENTS AND PLATING BATH SOLUTIONS. [MATE-199110-23-0662]

An automated on-line system for the determination of chloride in industrial effluents and plating bath solutions based on the concept of flow injection analysis is described. Samples with a very high chloride content up to 6 g/100 ml (60 g/l) are analysed by using an automated in-manifold double on-line dialysis technique. The sampling rate is 100 samples/h. The method is suitable for the analysis of chloride with a relative standard deviation of 0.8%. The measurement is based on the red-coloured iron thiocyanate complex. Graphs. 21 ref. – AA (van Staden, J.F.; Fresenius' Journal of Analytical Chemistry, 1991, 340, (7), 415-418 [in English]. ISSN 0937-0633)

1663 THE REACTION OF THE SULPHITE/BISULPHITE COUPLE ON SMO STEEL UNDER ANAEROBIC CONDITIONS. [MATE-199110-34-0766]

The reactions of sulphite ions on SMO steel (and St52 and 13Cr) have been studied under anaerobic conditions in a 0.5 M NaCl solution adjusted to pH = 7. The solution is purged with nitrogen, and kept under N atmosphere during measurements. The study has been performed with rotating disk electrodes, and a quasi-potentiodynamic technique has been used. The results show that the reduction of the sulphite ions, probably to dithionite ions, is the dominant reaction. In the anodic direction, the passive current through the oxide layer is dominant. Graphs. 13 ref. – AA (Hemmingsen, T.; Valand, T.; Rogaland Research Institute; Electrochimica Acta, 1991, 36, (8), 1367-1375 [in English]. ISSN 0013-4686)

1664 REVERSE OSMOSIS—WHICH STAINLESS STEEL TO USE? [MATE-199110-35-2062]

Reverse osmosis (RO) plants are used for treating a wide variety of water compositions, including seawater. Stainless steels are well suited to the requirement of RO as their resistance to aqueous corrosion is high, so avoiding potential membrane-scaling ions contaminating the process. Unfortunately, some stainless steels are prone to pitting and crevice corrosion in certain waters – notably those containing chlorides. Great care is needed in selecting the optimum grade of stainless steel for a particular water so as to avoid costly corrosion failures without specifying too highly alloyed and expensive a material. The purpose is to describe the behaviour of stainless steels in aqueous environments and to assist in the selection of suitable alloys for particular conditions. Materials discussed include AL6XN, Uranus SB28, 316L, AL6X, 254SMO, A965, HR8N, Cronifer 1925HMO, Sanicro 28, Alloy 20, 304, S31803, S31254 and Inconel 625. Graphs. 6 ref. – AA (Todd, B.; Oldfield, J.W.; Nickel Development Institute; acom, 1991, (1-2), 1-4 [in English].)

1665 EXPERIENCES WITH A HIGHLY ALLOYED STAINLESS STEEL IN DESALINATION PLANTS AND OTHER ARABIAN GULF INDUSTRIAL PLANTS. [MATE-199110-35-2080]

The experiences from installations of the highly alloyed stainless steel UNS S31254 in desalination plants, MSF and RO, and other industrial plants in the Arabian Gulf countries are reported. More than seven years of successful operation has shown that this material resists corrosion in seawater handling systems such as high pressure piping in RO-plants, ejector condensers in MFS-plants, and cooling water piping in other industrial plants. The higher strength of UNS S31254 in comparison to AISI 316L enables a considerable reduction in wall thickness of high pressure piping in e.g. RO-plants. 13 ref. – AA (Olsson, J.; Erbing, M.L.; Avesta; acom, 1991, (1-2), 5-7 [in English].)

1666 THE ROLE OF PASSIVATING FILM IN PREVENTING SLURRY EROSION—CORROSION OF AUSTENITIC STAINLESS STEEL. [MATE-199110-35-2085]

Slurry erosion – corrosion tests were conducted on type 340 stainless steel in order to investigate whether the passivating film has any effect of decreasing the damage to the material. Two environments which contrasted with each other were chosen: a slurry consisting of silica sand particles and a 1% sulfuric acid solution where the passivating film is stable, and a slurry of the same particles and a 5% hydrochloric acid solution where it is not. As a result, the material was damaged at higher erosion – corrosion rates in the environment where the film was stable than in that in which it was not. Thus, the ability of the film to decrease the damage appeared to be denied. Nevertheless, the anodic polarization curve of the material in the 1% sulfuric acid solution slurry revealed that the passivating film was mechanically broken by the impact of the particles but it was repaired rapidly enough to inhibit corrosion. Further it was found that in the 5% hydrochloric acid solution slurry, erosion as well as corrosion was inhibited by chloride ions absorded on this surface. Consequently it was concluded that the passivating film has an ability to inhibit erosion – corrosion damage to a certain extent through inhibiting corrosion so long as it is chemically stable in the environment. Graphs. 14 ref. – AA (Matsumura, M.; Oka, Y.; Hiura, H.; Yano, M.; Hiroshima University; ISIJ International, Feb. 1991, 31, (2), 168-176 [in English]. ISSN 0915-1559)

1667 DISSIPATIVE STRUCTURES IN LIGAND-ACCELERATED METAL EXTRACTION SYSTEMS. [MATE-199110-42-0852]

Interfacial turbulence created by the addition of a ligand during the extraction of metal ions by an organic extractant can considerably enhance the speed of extraction. In the extraction of Ni with di-2-ethylhexyl phosphoric acid, interfacial turbulence in the oil phase was observed at the oil/water interface, accompanied by spontaneous emulsification, in the presence of acetate ligand. The dissipative structures were studied by Schlieren photography and found to consist of two distinct patterns of roll cells in addition to rapid twitching and fluctuation of the interface: (1) small roll cells originating at the interface, moving rapidly along the interface and dissipating at the interface; (2) large roll cells originating in the bulk aqueous phase, traveling toward the interface while gaining momentum, bouncing back from the interface, and dissipating as they receded. Both flow patterns were confined to the oil phase, the aqueous phase being virtually quiescent. The turbulence lasted for a minute, and rapid extraction of Ni ions was observed during this time period. The turbulence was completely damped out when surfactants were added to the system, and no turbulence was observed in the absence of ligand. The observations were interpreted in terms of interfacial instability theories. They are important for liquid membrane technologies because they suggest that systems with high extraction efficiencies can be engineered, even when the dispersed phase lifetimes are short. 18 ref. – AA (Thomas, C.; Nikolov, A.D.; Wasan, D.T.; Illinois Institute of Technology; Separation Science and Technology, Apr. 1991, 26, (4), 539-557 [in English]. ISSN 0149-6395)

1668 TURBOCEL—A HIGH EFFICIENCY METAL RECOVERY FACILITY. [MATE-199110-42-0853]

Turbocel is a cell for electrolytic recovery of metal which employs a highly turbulent flow within a rotating cylinder. Three models are described. Recovery results are presented for Au, Ag and Ni from waste water. Other metals in solution can also be effectively processed. – F.H.H. (Puippe, J.Cl.; Werner Fluhmann; Oberflache Surface, Jan.-Feb. 1991, 32, (1-2), 17-20 [in German]. ISSN 0048-1270)

1669 NEW SPECIFIC CHELATING ION EXCHANGERS FROM METALFIX. [MATE-199110-42-0886]

The extraction of heavy and precious metals with resins is covered. Described are the recovery of Au and cobalt from a bath of Au – Co – citric acid, the recovery of either Au or Ni from cyanide baths, the purification of the bath waters and the washing of the fumes from the bath, recovery of Rh from acid, and the detoxification of industrial waste water by the use of special resins. Metalfix is a producer of the resins which are used in all of these operations. The details of each of the procedures are fully covered with the potential hazards and problems carefully explained. Graphs. 8 ref. – C.W.M. (Jeanneret, G.; Jeanneret, J.M.; Pousaz, P.; Soerensen, C.; Metalfix; Oberflache Surface, Apr. 1991, 32, (4), 15, 17-19 [in French]. ISSN 0048-1270)

1670 RECOVERY OF CHROMIUM FROM PLATING SHOP WASTEWATERS. REPORT NO. EPS 3/SF/1. [MATE-199110-43-0301]

The objective of this project was to conduct industrial-scale tests to prove the validity of a new technology for the extraction and recovery of hexavalent Cr from plating rinse waters. The process involves the use of an inorganic compound with a high affinity for dissolved Cr ions. The project consisted of three phases: laboratory tests and design, production and installation, and operation. – GRAI (Thermonics; 1990, MIC-91-02352/XAB, Pp 92 [in English, French].)

1671 RECOVERY OF METAL VALUES AND HYDROFLUORIC ACID FROM TANTALUM AND NIOBIUM WASTE SLUDGE. [MATE-199110-43-0316]

A metallurgical processing system for economically recovering metal values, such as Nb, Ta, Th, and uranium from dilute source solids, such as digestion sludges, by a series of steps was developed. It includes: slurrying the source solids with dilute hydrofluoric acid to produce a solid phase and a liquid phase containing dissolved Ta and Nb, then extracting Ta and/or Nb from the liquid phase by means of a liquid ion-exchange process; and roasting the solid phase with sulfuric acid to recover and recycle hydrofluoric acid,

leaching the roasted solids with dilute sulfuric acid to produce a disposable solid phase and a liquid phase containing Th and U, and extracting Th and U from the liquid phase by means of a liquid–liquid amine extraction process.–USPTO (Bielecki, E.J.; Romberger, K.A.; Bakke, B.F.; Hobin, M.A.; Clark, C.R.; 11 June 1991 [in English]. Patent no.: US5023059 (USA) Convention date: 2 Nov. 1988)

1672 DISPOSAL AND RECUPERATION OF MATERIALS, ILLUSTRATED WITH REFERENCE TO HYDROXIDE SLUDGES CONTAINING NON-FERROUS METALS FROM THE ELECTROPLATING INDUSTRY. [MATE-199110-43-0331]

At present, Western Germany mainly uses special waste dumps for its annual 250 000-300 000 t of neutralization and galvanic sludges containing non-ferrous metals produced in surface treatment. A process has been developed for mixing the approx 10 wt.% metal hydroxide sludges with process H_2O and applying H_2SO_4 leaching at room temperature and pH = 1-3. This dissolves 90-100% of the non-ferrous metal and approx 60-80% of the Fe. The filtered residue after repeated washing and neutralization gives eluate metal concentration of 1 ppm. The filtrate undergoes solvent extraction to 200 ppm residual metal contents and special extraction processes separate and concentrate the individual metals. Processing costs are 500-900 Dm/t at 13 000 t/year, subject to acceptable Cr and Cd contents.–R.H. (Knoblauch, T.; ZVSMM; Metalloberflache, Aug. 1990, 44, (8), 373-376, 377 [in German]. ISSN 0026-0797)

1673 HISTORY OF A FOUNDRY'S CONVERSION FROM AN ALCOHOL- TO A WATER-BASE SLURRY SYSTEM. [MATE-199110-51-1662]

The environmental impact of manufacturing processes has become a critical factor to the investment caster. The use of volatile organic compounds such as alcohols, ethers, and solvents has been common in the manufacture of investment molds for many years. Recent research has associated volatile organic compound emissions with a potential reduction in ozone levels in the upper atmosphere. The history of one foundry's response to the use and control of volatile organic compounds in the shell building operation is presented. Specific alternatives considered to address this issue are reviewed, and the logic behind the choice to convert from an alcohol-base slurry system to a water-base slurry system are explained. In addition, the problems and benefits in converting from an alcohol-base to a water-base slurry system are highlighted.–AA (Armstrong, M.E.; Stickle, D.R.; Duriron; Transactions of the American Foundrymen's Society. Vol. 97, San Antonio, Texas, USA, 7-11 May 1989, Publisher: American Foundrymen's Society, Inc. (1990), (Met. A., 9110-72-0460), 153-156 [in English].)

1674 ULTRASONIC CLEANING. [MATE-199110-57-1224]

An ultrasonic cleaning unit manufactured by VEB Messgerat Ballenstadt is described and operating procedures outlined. Operating frequencies are between 20-50 kHz, and power output reaches 10 W/l. The unit is suitable for cleaning all types of metals (e.g. Fe, steels, Cu, brass, bronze, Al-base alloys, magnesium-base alloys, Sn-base alloys, Zn-base alloys, and Pb-base alloys), but cleaning solutions must be treated before discharging to the environment.–F.H.H. (Schmidt, A.; Banse, W.; Kombinat Anlagen-und Geratebau Halle; VEB Messgeratewerke Ballenstedt; Fertigungstechnik und Betrieb, June 1990, 40, (6), 336-337 [in German]. ISSN 0015-024X)

1675 PREVENTING WASTE AND WASTE WATER IN GALVANIZING—NO WAY OF AVOIDING RECYCLING. [MATE-199110-58-1224]

Galvanizing residues present a disposal problem due to their potential for contaminating the environment. Therefore, recovery of metal and bath components is essential. Recovery methods include ultrafiltration, electrolysis, electrodialysis, reverse osmosis and thermal processes, none of which require adding chemicals. The metals are recovered as muds and can be extracted by reprocessors.–F.H.H. (Benitz, G.; Industrie-Anzeiger, 21 Dec. 1990, 112, (102), 10-12 [in German]. ISSN 0019-9036)

1676 MICROSTRUCTURES AND RHEOLOGICAL FEATURES OF PARTIALLY SOLIDIFIED EUTECTIC SN—PB ALLOY. [MATE-199109-31-3811]

The microstructures and rheological features of partially solidified eutectic Sn–15Pb alloy were studied in shear flows using a concentric cylinder viscometer (Searle-type). It is found that the alloy has its structure of spheroidal particles which could be composed of three colonies different in the eutectic morphology, and that the slurry flows with the properties of a non-Newtonian fluid. Graphs, Photomicrographs. 5 ref.–AA (Wang, N.; Shu, G.; Yang, H.; Southeast University (China); Chinese Journal of Mechanical Engineering, Aug. 1990, 26, (4), 25-28 [in Chinese]. ISSN 0577-6686)

1677 EROSION—CORROSION MEASURING DEVICES. [MATE-199109-35-1830]

Two instruments for the study and measurement of erosion–corrosion (EC) were developed and built: the erosion–corrosion unit (ECU) and the erosion–corrosin tester (ECT). These instruments simulate the shear and impact forces acting on industrial equipment to evaluate the corrosive wear effects of the fluid on the equipment and their interaction. The specimen in the ECU consists of a cylinder rotated about a vertical axis while a jet of slurry impinges continuously onto its curved surface through an interchangeable nozzle. The ECT applies rotational sliding abrasion by the slurry on a static disk specimen. In both devices, a three-electrode system (working, reference, and counter electrodes) is used to evaluate the electrochemical corrosion component by the polarization resistance technique. The contribution of mechanical erosion to the synergetic EC process is measured by weight loss on long-term exposures. The instruments were applied as follows: in industrial plants to monitor the influence of corrosion parameters during production, in pilot plants and in the laboratory to evaluate and select corrosion-resistant alloys, to assess the corrosivity of the ores and slurries handled, and for analysis of EC failures (in SS316, Fe–20Cr–25Ni and a Ni alloy). Graphs. 12 ref.–AA (Schorr, M.; Weintraub, E.; Andrasi, D.; Institute for Research and Development (Israel); Corrosion Testing and Evaluation: Silver Anniversary Volume, Orlando, Florida, USA, 6-10 Nov. 1989, Publisher: ASTM (1990), STP 1000, (Met. A., 9109-72-0431), 151-159 [in English].)

1678 SEPARATION AND RECOVERY OF HEAVY METALS FROM HYDROMETALLURGICAL EFFLUENTS BY SOLVENT EXTRACTION. [MATE-199109-42-0780]

The possibility of separating and recovering heavy metals from hydrometallurgical effluents by successive solvent extractions has been investigated by two different procedures with liquid waste from the Espindesa Zn process. The waste (pH value approx 1.5) includes significant amounts of Zn (approx 1.35), Cu (approx 0.12), cobalt (approx 0.32) and Mn (approx 0.6 g/l) in the presence of big concentrations of macroconstituents (sulphate, chloride, Na) and Fe (approx 8.8 g/l, mostly as Fe(II) salts). As extractants, Amberlite La-2 (a secondary ammine, as chlorohydrate), and DEPHPA (di-2-ethylhexyl-phosphoric acid) at 25 vol.% in kerosene were selected. The first method includes two extraction stages with LA-2 for Zn and Cu separation (the last one with 60 g/l of chloride ions) and three stages with DEPHA at pH values near to 1.5, 2.0, and 3.5 for isolating Fe, Mn, and Co. The second method separates firstly Fe (as ferric salts) with DEHPA. Afterwards, one stage with LA-2 isolates Zn and three stages with DEHPA at pH values near to 2.0, 3.0, and 3.5 lead to fractions rich in Mn, Cu, and Co. Reextractions from organic layers with water or HCl at different concentrations lead to purer solutions of the isolated metals. With both methods, the liquid waste can be converted into a saline solution with lesser problems for disposal. Graphs. 5 ref.–AA (Elejalde, C.; Romero, F.; Diaz, J.M.; Escuela de Ingenieros (Bilbao); Fresenius' Journal of Analytical Chemistry, 1991, 340, (3), 182-185 [in English]. ISSN 0937-0633)

1679 PRODUCTION OF TECHNICAL ALUMINIUM SULPHATE FROM ALUMINIUM SCRAP. [MATE-199109-43-0293]

Aluminium sulphate was formed by the continuous percolation of a hot 18% H_2SO_4 solution through a bed of Al scrap. The temperature of the acid was held between 75-95 °C. Water was added to the circuit to produce a solution containing 70 g l^{-1} Al_2O_3 and 10 g l^{-1} H_2SO_4. The solution was filtered on a vacuum filter before dispatch. Most of the non-ferrous metal impurities, silica, Fe and Mn were discarded with the filter sludge. A process flow sheet

is given. 8 ref.—A.S.W. (Kanev, R.; Vafyadi, K.; Andonov, A.; Koleva, M.; Shloser, S.; Metalurgiya (Sofia), Sept. 1990, 45, (5), 2-6 [in Bulgarian]. ISSN 0543-5838)

1680 WASTE TREATMENT OF METALWORKING FLUIDS, A COMPARISON OF THREE COMMON METHODS. [MATE-199109-53-0711]
The types of wastes, the desired quality of the effluent and the types of treatment system are discussed. The types are listed, such as emulsifiable oils. Another list shows the different types of outfalls, like the sanitary sewer. The treatment types described are evaporation, chemical, and membrane separation. Influent characteristics are tabulated. An atmospheric evaporator is described with the aid of a diagram. Chemical methods, such as the acid-alum and polymer methods, and membrane separation methods are described and a detailed flow schematic of a hollow-fiber ultra-waste treatment system is given. Graphs. 12 ref.—T.Z. (Burke, J.M.; Eaton; Lubrication Engineering, Apr. 1991, 47, (4), 238-246 [in English]. ISSN 0024-7154)

1681 EFFECT OF ALKALI METAL IONS ON THE CHARACTERISTICS OF HIGH TEMPERATURE LEACHING OF ZINC SLUDGES UNDER CONDITIONS OF A CONTINUOUS PROCESS. [MATE-199111-42-0964]
Transition from the batch to continuous leaching of Zn sludges reduces by half the amount of equipment required. The efficiency of the process at potassium content not 1 g/dm^3 does not decrease compared to the batch process. Effect of K concentration on Pb and Fe content in sludge during the leaching was studied. Graphs. 4 ref.—T.G. (Zyuzikov, V.E.; VNIItsvetmet; Tsvetnye Metally, Mar. 1991, (3), 20-22 [in Russian]. ISSN 0372-2929)

1682 IMPROVING ENVIRONMENTAL PERFORMANCE IN MINI-MILLS. II. [MATE-199111-45-1469]
Mini-mills are under pressure to improve product quality, decrease delivery lead times, reduce conversion costs, and meet stringent environmental regulations. The future course of clean technology for mini-mills is predictable to some extent, as it is influenced by impending environmental standards, green consumerism, global warming, and current economic and market factors. In the years ahead, five underlying factors will largely steer the pace and nature of this technology. They are efficient use of all resources, safe waste management, resource recovery, improvement of existing performance, and environmentally sound design. 28 ref.—M.W.C. (Teoh, L.L.; Steel Times International, Mar. 1991, 15, (2), 44-46 [in English]. ISSN 0143-7798)

1683 DISCHARGE TOXICITY OF A STEEL MILL COOLING WATER EFFLUENT. [MATE-199111-45-1475]
The era of wastewater discharge permits based only on treatment technology is gone. Now wastewater permits will also be based on the discharge's toxicity to the stream. Discharge toxicity limits are often more difficult to meet than technology-based limits. A case history of a Connecticut steel mill's attempt to meet toxicity limits with its cooling water discharge attempted to determine what could be causing the toxicity of the effluent by initially reviewing the chemicals used in the process—sodium aluminate, biocide containing isothiazolin, organic polymer flocculant, an aluminum hydroxychloride coagulant, sodium molybdate, and sodium and potassium hydroxides. The specific compound which was toxic was not identified, but the next phase may possibly identify the class of compounds in which it belongs. A typical effluent and typical instream criteria for selected compounds are reviewed.—A.R. (Katz, P.B.; Connecticut Resource Recovery Authority; Wire Journal International, Jan. 1991, 24, (1), 35-36 [in English]. ISSN 0277-4275)

1684 TECHNICAL DEVELOPMENTS IN 1990 ORGANIC COATINGS, PROCESSES AND EQUIPMENT. [MATE-199111-57-1470]
A review of technical developments in 1990 in organic coatings, processes and equipment covers: surveys and general references; pretreatment; powder coating; electrocoating; waterborne coatings; other coating formulations including acrylics, alkyds, epoxies, polyester, polyurethanes, and vinyls; application and curing methods and equipment; paint stripping; testing and control; and waste treatment and recovery. 263 ref.—A.R. (Murphy, M.; Metal Finishing, Feb. 1991, 89, (2), 71-75 [in English]. ISSN 0026-0576)

1685 TECHNICAL DEVELOPMENTS IN 1990 INORGANIC "METALLIC" FINISHES, PROCESSES AND EQUIPMENT. [MATE-199111-58-1429]
A review of technical developments in 1990 for inorganic "metallic" finishers, processes and equipment covers: surveys and general references; cleaning and degreasing; abrasive blasting; pickling and descaling; plating preparation cycles; etching; metal stripping; polishing and buffing; mass finishing; electropolishing and electrodeburring; anodizing; electrodeposited metals including Cr, Cu, Ni, and Ni alloys, Sn, and Sn—Pb, Zn, and Zn alloys, precious metals and their alloys, and other metals and alloys; vacuum coating; thermal spraying; electroless coatings; electroforming; electrodeposited composites; conversion and immersion coatings; hot dipping; strip and selective plating; miscellaneous methods and equipment; testing and control; and waste treatment and recovery. 726 ref.—A.R. (Murphy, M.; Metal Finishing, Feb. 1991, 89, (2), 41-50, 52-56 [in English]. ISSN 0026-0576)

1686 THE RECYCLING OF HAZARDOUS METAL PLATING WASTES. [MATE-199111-58-1433]
During electroplating operations, metal-rich sludges are generated which have been classified as hazardous by the US Environmental Protection Agency (EPA). Despite a regulatory situation which sometimes hampers rather than assists recycling efforts, these plating wastes, designated F006, can be viewed as a natural resource if properly handled. Specifically, F006 wastes can be effectively treated using hydro- and/or pyro-metallurgical techniques to recover such metals as Cu, Ni, Zn, Cr, Pb and Sn. To do this, however, a number of procedural obstacles must be conquered, including more thoughtful management of the waste stream by electroplaters and the exercise of greater caution by the EPA to make sure that regulations do not discourage recyclers from handling materials classified as hazardous. 11 ref.—AA (Odle, R.R.; Martinez, I.; Deets, L.A.; Encycle Texas; JOM, June 1991, 43, (6), 28-31 [in English]. ISSN 0148-6608)

1687 THE ELECTROCHEMICAL RECOVERY OF NICKEL FROM PLATING RESIDUES. [MATE-199111-58-1434]
In view of the increasing demand for Ni and its compounds, the recovery of Ni values from any secondary source is of great importance, particularly in countries such as India where there is no domestic source of the metal. The buildups (or nodules) that accumulate during the Ni plating processes are one secondary source of metal. To take advantage of this resource, an electrochemical approach has been attempted to recover the Ni from plating wastes in the form of nickel sulfate. The approach involves selective anodic dissolution of the Ni nodules in a sulfuric acid medium and crystallization of the resultant nickel sulfate. Acidity, Ni concentration in the electrolyte and the extent of dissolution of the nodules have been examined with the intent of avoiding the loss of Ni at the cathode and reducing Cu contamination in the electrolyte. 6 ref.—AA (Ramachandran, P.; Venkateswaran, K.V.; Visvanathan, S.; Central Electrochemical Research Institute (India); JOM, June 1991, 43, (6), 34-36 [in English]. ISSN 0148-6608)

1688 WATER CONSERVATION AND WASTE MINIMIZATION AT HUDGINS PLATING. [MATE-199111-58-1440]
With the advent of increasing regulation from the US Environmental Protection Agency (EPA), water is no longer inexpensive. As water usage increases, so does the waste treatment that has to be done for the removal of any heavy metals and cyanides. As a result of two years of experimentation and concentrated efforts, C.R. Hudgins Plating Inc. has significantly reduced the level of water usage. The plant's water usage was approx 100 000 gallon/day in 1985; today, it is approx 14 000 gallon/day. Details are given of flow reduction, hazardous waste reduction, and recycling non-hazardous waste. Graphs.—M.W.C. (Dalton, P.J.; C.R. Hudgins Plating; Plating and Surface Finishing, July 1991, 78, (7), 28, 48-50 [in English]. ISSN 0360-3164)

1689 APPLICATION OF ELECTROLYSIS FOR THE RECOVERY OF ELECTROPLATING BATH COMPONENTS FROM WASHING WASTE WATERS. [MATE-199112-43-0434]
A new type of electrodialyser used for the recovery of the components of

electroplating baths from the solution orginating from the recovery washer is described. The electrodialyser is placed directly in the electroplating tank, its operation being assured by the current flowing through the bath. The paper presents the results of recovery acheived in the case of a Ni plating bath, a weak-acid galvanizing bath and an acid coppering bath. Graphs. 4 ref. – AA (Ragauskas, R.A.; Academy of Sciences of the Lithuanian SSR; Powloki Ochronne, 1989, 17, (5-6), 21-24 [in Polish].)

1690 PROCESS AND PRECIPITANT FOR SEPARATING HEAVY METALS FROM WASTE WATER, AND PROCESS FOR MANUFACTURING THE PRECIPITANT. [MATE-199112-43-0442]

A method for separation of heavy metals from waste water combines the advantages of sulphidic precipitation in an acidic medium with reduced danger of overdosage. Alkaline earth polysulphides are employed as the precipitant. (Fulop, J.; Thyssen; Auszuge aus den Europaischen Patentanmeldungen, Teil I, 10 Jan. 1990, 6, (2), 173-174 [in German]. Patent no.: EP0349671 (European Patent) Convention date: 19 Oct. 1988)

1691 INTERFACES OF POLYPHENYLENE SULPHIDE-TO-METAL JOINTS. [MATE-199112-55-2905]

High-temperature polyphenylene sulphide (PPS) film was deposited on the surface of cold-rolled (e.g. 1010), stainless (e.g. 304), and galvanized steels (e.g. G90) by slurry coating in N_2 and O_2 gases at 350 °C. The value of the interfacial PPS/steel bond strength depended primarily on the species of sulphur-related Fe compounds formed as reaction products at the interfaces. The order of these reaction products, which play an important role in developing bond strength, was $Fe_2(SO_4)_3$ $FeSO_4$ FeS. In contrast, the conversion of ZnS, formed at the PPS/galvanized steel interfaces, into $ZnSO_4$ led to a catastrophic loss of bond strength. Graphs. 19 ref. – AA (Sugama, T.; Carciello, N.R.; Brookhaven National Laboratory; International Journal of Adhesion and Adhesives, Apr. 1991, 11, (2), 97-104 [in English]. ISSN 0143-7496)

1692 GALVANIZING PLASTIC ARTICLES IN LARGE LOTS—IMPROVEMENTS IN ENVIRONMENTAL MATTERS. [MATE-199112-57-1536]

Commercial galvanization of plastics is used for decorative and electrical purposes. 90% of the plastics so processed are ABS and blends, but other types can also be coated. Preparation of the parts begins with their molding. Parts undergo a Chrom VI treatment. Chemical metallizing follows in plastic drums with central anodes. Computer control can be used for process control. Waste waters are treated in conformance with environmental protection regulations. – F.H.H. (Riedel, W.; Industrie-Anzeiger, 4 Dec. 1990, 112, (97), 16, 18 [in German]. ISSN 0019-9036)

1693 CHEMICAL SURFACE TREATMENT OF BANDS WITHOUT WASTE WATER. [MATE-199112-57-1641]

An economical and environment-friendly method of chemical surface treatment (etching) without waste water is described. In this method, the mixed acid etchant is regenerated after several uses, and the dissolved metals, i.e. steels, nonferrous metals, etc. are recovered. Normally, these build up in the recirculating etchant and neutralize it, and the used-up acid is dumped with the waste water. In the new method, diffusion analysis and electrodialysis are used. – R.N.B. (Sturm, W.; Bander Bleche Rohre, Feb. 1991, 32, (2), 20-24 [in German]. ISSN 0005-3848)

1694 A CASEBOOK STUDY ON CONFORMING TO TODAY'S ENVIRONMENTAL REGULATIONS. [MATE-199112-58-1493]

Historically, water pollution has been considered the problem of electroplaters and not a concern for vacuum coaters. However, with regard to substrate cleaning, vacuum coaters have just been using air pollution in exchange for water pollution. With the advent of much tougher federal, state, and local air pollution control laws and, in particular, the evolving effective ban of most halogenated solvents, this exchange is in many cases no longer feasible. The experience of Providence Metallizing in both of these deposition techniques indicates that the choice of techniques should not be based on pollution considerations since each technique has its own pollution problems. The inherent advantages and disadvantages of each type of coating techique are discussed. 2 ref. – AA (Goldstein, I.S.; Providence Metallizing; Society of Vacuum Coaters 34th Annual Technical Conference, Philadelphia, Pennsylvania, USA, 17-22 Mar. 1991, Publisher: Society of Vacuum Coaters (1991), (Met. A., 9112-72-0535), 62-64 [in English].)

1695 WASTE TREATMENT PROCESS FOR ELECTROLESS COPPER. [MATE-199112-58-1572]

Spent electroless Cu can plate out in drain lines if the solution is still active when it reaches the overflow valve of the plating tank. This can result in clogged drain lines, necessitating more frequent cleaning and/or replacement. Correcting this problem with chemical additions to deactivate the solution requires careful analysis of the waste treatment process. A review covers how Tektronix Inc., a circuit board manufacturer in Oregon, USA, corrected its problem with electroless Cu plating out in its drain lines. The plating reaction for electroless Cu is catalyzed by a Pd and/or Sn catalytic material. If either the formaldehyde (HCHO) or caustic (OH^-) are not present, the Cu will not plate out. Hydrogen peroxide is used to destroy the formaldehyde in a timely manner. Laboratory tests were performed to see if Al would rapidly plate out of an electroless Cu bath by using reagent-grade powdered Al, Al fines, commercial-grade powdered Al, and by adding HCHO. The Cu removal portion of the waste treatment process was developed prior to the deactivation portion. – A.R. (Holly, J.D.; Tektronix; Plating and Surface Finishing, Jan. 1991, 78, (1), 24-27 [in English]. ISSN 0360-3164)

1696 WASHING METHOD AND WATER USE IN GALVANO-TECHNIQUE. [MATE-199112-58-1580]

German laws for water use, passed on 1 January 1990 have laid down limits for waste water in galvanic processes. The following limits are examples (in mg/l): Cr 0.5, Cr VI 0.1, Cu 0.5, Ni 0.5, Zn 2. Measure adopted to meet these limits, i.e. better washing and recycling techniques, are described. – R.N.B. (Kuhner, H.; Anders, M.; Fertigungstechnik und Betrieb, Jan. 1991, 41, (1), 31-32, 35 [in German]. ISSN 0015-024X)

1697 PROCESS FOR SEPARATING NICKEL FROM DILUTED AQUEOUS SOLUTIONS CONTAINING NICKEL IONS. [MATE-199112-58-1647]

Separation of Ni from diluted aqueous solutions containing Ni-ions (e.g. for the recovery of Ni from plating bath wastes) comprises use of a dissolved ion-exchanger-containing organic extraction phase, where the aqueous solution is treated in conventional extraction apparatus optionally in several stages with the organic extraction phase, the aqueous phase is separated from the organic phase and the latter is treated with an acid to obtain a concentrated aqueous solution of a Ni-salt and a regenerated extraction phase, where the treatment of the extraction phase with the acid is carried out in a homogeniser. (Marr, R.; Lackner, H.; Bart, H.-J.; M & T Chemicals; Auszuge aus den Europaischen Patentanmeldungen, Teil I, 17 Jan. 1990, 6, (3), 403 [in German]. Patent no.: EP0350858 (European Patent) Convention date: 11 July 1989)

1698 THE "GPA" MECHANICAL SEAL AND THE "GPAC" CARTRIDGE DESIGN FOR LIQUOR AND SLURRY PUMPS. [MATE-199201-41-0029]

Pumping fluids with abrasive particles, crystalline materials, and/or scale deposits has always been difficult because of the nature of the usual seal design. Conventional seals need flush water for protection; most of this flush water enters the process fluid and has to be seaparated. The removal of this water is a process with high energy costs. The GPA mechanical seal, developed by LCL-Cefilac and which does not require an external water flush, is discussed. Some typical design configurations are shown. Results from alumina plants where the GPA steel is widely used are presented. Graphs. (Heutier, J.-P.; Marchand, J.; Powell, J.; Light Metals 1991, New Orleans, Louisiana, USA, 17-21 Feb. 1991, Publisher: The Minerals, Metals & Materials Society (1991), (Met. A., 9201-72-0039), 247-256 [in English].)

1699 CADMIUM COMPLIANCE ACHIEVED WITH ELECTROWINNING. [MATE-199201-42-0018]

For two years, Specifications Plating, Inc. had difficulty staying in compliance with Cd discharge limits, using its existing waste-treatment system. A low-

cost method of recovering Cd from wastewater was devised, using electrowinning technology and high-surface-area cathodes. Cadmium and cyanide levels have been lowered significantly and the shop now operates in compliance with environmental regulations. The electrowinning cell used at the company has a working volume of 38 gallons and is equipped with 16 precious-metal-oxide-coated Ti-mesh anodes and 15 high-surface-area-reticulated cathodes. Evaluation of the system was performed after two months of operation by analyzing the rinse water tanks with and without the electrowinning cell in line. Graphs. (Shaulys, J.; Rovinelli, B.; Plating and Surface Finishing, Sept. 1991, 78, (9), 42-44 [in English]. ISSN 0360-3164)

1700 THE TREATMENT OF EFFLUENTS IN BERYLLIUM PRODUCTION. [MATE-199201-42-0025]

A beryllium pilot plant has been set up at Turbhe, New Bombay, to extract Be metal and Cu – Be alloy from Indian beryl ore. This pilot plant uses the fluoride process as the method of extraction. The liquors generated as effluents in this plant from the process and laundry washing, etc. contain two pollutants, Be and fluorine. How these pollutants have been controlled by effluent treatment is described. Graphs. 5 ref. (Saha, S.; Indian Chemical Engineer, Apr.-June 1991, 33, (2), 62-64 [in English]. ISSN 0019-4506)

1701 UTILIZATION OF IRON AND STEEL WASTES AND DUSTS. [MATE-199201-43-0023]

The problem of re-utilizing Fe-rich wastes from integrated iron and steel plants was unsolved until now, especially due to their unattractively low (yet harmful) level of Zn and Pb. Solutions must be found, however, because of the tightening rules for waste disposal in general, and due to an actual situation in the Saar steel industry in particular. In this context, the applicability of the INMETCO process became of special interest, because this process is already working on an operational scale in the USA for the re-utilization of residues from alloyed steel producers. In the present project, extensive investigations with various dusts and sludges from integrated European steel plants were carried out. This work – together with another ECSC-funded study – has proven the particular qualification of the INMETCO principle for the re-utilization of residues, which are rich in Fe and low (yet harmful) in Zn and Pb. As these residues under INMETCO conditions are charged in the form of green (i.e. unfired) pellets, the process allows the utilization of the wastes' own carbon as a reductant. An intimate contact of oxides and reductants in the green pellet and the unproblematic use of temperatures up to 1350 °C without sticking enable both a virtually full metallization and a complete volatilization of the heavy metals within approx 15 min at variably adjustable C contents in the sponge iron. As the packed bed rests motionless on the rotary hearth during reduction, a rich secondary dust is simultaneously produced, which is almost free of pellet and coal fines and therefore has a Zn + Pb level of 50%. This INMETCO secondary dust can directly be converted into Zn and Pb without intermediate concentration. Graphs, Photomicrographs. (Commission of the European Communities. Report, 1991, EUR 13420, Pp 210 [in German].)

1702 TREATABLE CLEANERS. [MATE-199201-57-0081]

Removal of heavy metals from waste streams produced by metal finishing is commonly performed by precipitation. Cleaners are designed to remove soils and prepare the metal surface for subsequent finishing. Improvements in waste treatment can be provided by controlling the concentration of cleaner in the waste stream, using the proper pH of approx 10 before the waste stream enters the clarifier, use of nucleation agent which best fits the waste stream, and use of a cleaner that has a complexing agent friendly to waste treatment. The cyanide waste stream is treated with sodium hypochlorite to remove all cyanides and cyanates. Chromium waste stream is treated with acid to decrease pH, then treated with sodium bisulfite. The effect of final pH on waste treatment of the following materials was reviewed: Cu, Ni, Zn, Cr, Fe, Ca, Al or cationic polymers. The treatment and variables affecting the treatment of Zn, Ni, Cu, and Cr are reviewed. An example of metallic organic compounds formed that are hard to remove and are a source of contamination is tubular steel produced on a seam welder. Complexing agents used in metal processing are reviewed. Graphs. 2 ref. (Detrisac, M.A.; Metal Finishing, Sept. 1991, 89, (9), 15-18 [in English]. ISSN 0026-0576)

1703 VACUUM DEOILING FOR ENVIRONMENTALLY SAFE PARTS CLEANING. [MATE-199201-57-0082]

Faced with stringent EPA air quality requirements, solvent consumption taxes, and complex usage reporting paperwork, the metalworking and metal-finishing industries are looking hard at alternatives to solvent vapor degreasing for high quality cleaning of parts. Vapor degreasing systems use chlorofluorocarbons (CFCs) to clean metal by vapor condensation on cool parts. CFCs are environmental hazards, making an alternative to vapor degreasing systems imperative. Vacuum deoiling is a viable alternative to solvent vapor degreasing systems, representing a potential investment that can lower operating costs while providing a cleaner environment and a safer workplace. A review of vacuum deoiling covers: adapting existing technology; new component designs involving a new type of vessel design and an appropriate condenser system; basic configurations for horizontal or vertical operations; environmental concerns; recycling oils; and economic considerations. (Mitten, W.; Metal Finishing, Sept. 1991, 89, (9), 29-31 [in English]. ISSN 0026-0576)

1704 PAINTING TECHNOLOGY SOARS AT BOEING. [MATE-199201-57-0140]

At Boeing's manufacturing/painting facility at Everett, Washington, 747 and 767 models are produced. Commercial airplane paint must meet stringent specifications including ones pertaining to temperature resistance, corrosion resistance, and Skydrol (fuel blended for fire protection on commercial planes) resistance. The paint system consists of a yellow two-component urethane-compatible epoxy primer and a two-component flexible polyurethane topcoat. Accessing the planes for painting is achieved using movable work platform lifts, wing stands and tail stands. Preparation of the Al, a "sandwich" construction with 20-series Al on the outside for corrosion resistance and 60-series on the inside for strength, involves a green protective coating applied prior to shipping to Everett, an alkaline soap to wash off the protective coating, and alodine application to etch the surface to enhance adhesion and corrosion resistance. Masking and painting is accomplished in four days. The primer is applied electrostatically. Decorative markings and speed stripes are completed after the topcoat air-dries and additional masking is done. Graco ProAA 4000 air-assisted airless guns are used for primer, topcoat and some decorative work. Quality control is performed before shipment of parts to Everett and once it arrives. Painters wear body suits, gloves and full face/head masks with breathing apparatus. Waste treatment involves recycling all materials that can be recycled, and the protective coating, solvent and alkaline cleaning solution. Alodine and paint overspray are hosed down to a waterwash trench below and piped to a waste treatment plant. (Bailey, J.M.; Industrial Finishing, Sept. 1991, 67, (9), 18-21 [in English]. ISSN 0019-8323)

1705 ATWOOD AUTODEPOSITS FOR AUTOMOTIVE. [MATE-199201-57-0145]

Atwood Automotive is on-line with a new autodeposition system that is helping the company maintain its reputation for quality seat adjusters and related hardware. The new water-borne autodeposition system yields a coating with a high degree of abrasion resistance and thickness uniformity. The autodeposition system is a water-borne, organic coating process that uses chemical reactions rather than electrical energy to deposit on steel surfaces. Evaluation of the autodeposition system included stringent physical and chemical tests, including salt spray, humidity, adhesion, dry film uniformity, and abrasion. Advantages of the new coating system includes: zero VOC emissions, and no Ni, magnesium, Cr, or other heavy metals to treat; outstanding corrosion resistance as compared to phosphate and oil; its ability to coat sub-assemblies and fully-assembled parts; chemical costs are approx $0.04/piece treated vs. approx $0.09 for spray painting; and equiment installation costs are 30-40% less than for electrocoat. The autodeposition process is a seven-stage operation: an alkaline spray cleaner; an alkaline immersion step; water rinse; a spray deionized water rinse; application of an organic coating; plant water rinse; and a sealing rinse, utilizing a non-toxic chemical that insolubilizes any residual Fe in the film. QC and control of the autodeposition process include automated monitoring equipment that does a coating bath conductivity analysis every 2 h, and a run of two film thickness tests each day. Parts are routinely checked for corrosion resistance, unifor-

mity of film thickness, abrasion resistance, and other factors. (Products Finishing (Cincinnati), June 1991, 55, (9), 40-46 [in English]. ISSN 0032-9940)

1706 REMOVAL OF PHOSPHORUS COMPOUNDS FROM ELECTROLESS NICKEL PLATING WASTES WITH CALCIUM HYPOCHLORITE. [MATE-199201-58-0027]

To remove the phosphorus compounds from an electroless Ni plating wastewater, the oxidation of hypophosphite and phosphite ions was studied. These ions were easily oxidized in a neutral condition to form phosphate ion with calcium hypochlorite in the presence of Ni ion, and were precipitated as calcium phosphate. The oxidation was achieved in approx 45 min, and the concentration of residual phosphate ion in the wastewater was 1 mg/l. Graphs. 1 ref. (Higashi, K.; Kosaka, Y.; Tokyo Konye Kaisuz Centa, Kenkyu Hoko (Report of the Tokyo Metropolitan Industrial Technology Center), Mar. 1991, (20), 53-56 [in Japanese]. ISSN 0285-6670)

1707 POLLUTION SOLUTIONS FOR AN OHIO PLATER. [MATE-199201-58-0073]

Operating the best pollution control system does not always mean installing new, expensive equipment. Often, as Elyria Plating found, it is a matter of managing the plating lines more closely to eliminate the variables that create problems downstream in the system and upgrading some basic waste treatment equipment. The Pollution Control Board met with the Waste Water Pollution Control Board to discuss the high pollutant levels at Elyria Plating. The plant was given 60 days to solve its waste problem. The company plates and uses solutions such as cyanide, Cr, electroless Ni, Cd, zinc chloride, Cu stripping, zinc phosphate, and black oxide treatments. The plan of attack called for simultaneous action on two fronts – the plating lines and the waste treatment systems. A review of the changes occuring at Elyria in response to solving its pollution problem covers: installing four collection sumps to segregate the wastewater from the plating lines: the cessation of dumping oil into the pollution control system; a modern clarifier and filter press were installed for sludge disposal; a polymer feed pump was added to pump the polymer into the flash mix tank just ahead of the clarifier; four pH meters and three Redox meters were calibrated; and calcium chloride in conjunction with alum was added to remove the last traces of Zn and Cd in the waste water. (Products Finishing (Cincinnati), Sept. 1991 , 55, (12), 68-71 [in English]. ISSN 0032-9940)

1708 ON THE PARTICLE SIZE EFFECT IN SLURRY EROSION. [MATE-199202-31-0693]

The erosion rates of cylindrical steel and Cu specimens tested at a constant speed of 18.7 m s^{-1} in an erosion pot tester using 1.2 wt.% suspension of SiC in oil for particle diameters between 20-500 mu m have been determined. The rate of particle impact on unit area of the surface at the stagnation line of erosion specimens was established as a function of particle size by short-time erosion tests, allowing a calculation of the mean mass removal for each particle impact as a function of particle size. These values were compared with the kinetic energy of particles using impact velocity values derived from a model of suspension flow. Results show that the decrease in erosion rate with decreasing particle size for suspensions of constant solids loading reflects the decrease in the proportion of particles impacting the target surface and the decrease in impact velocity. A value of approx 24 kJ g^{-1} is tentatively suggested for the energy of removal of P110 steel by erosion. It is concluded that for these dilute suspensions with particle sizes approx 100 mu m the erosion rate is proportional to the kinetic energy dissipated by particles during impact, but for particle sizes 100 mu m other metal removal mechanisms become increasingly significant. Graphs, Photomicrographs. 27 ref. (Lynn, R.S.; Wong, K.K.; Clark, H.McI.; Wear, 30 Sept. 1991, 149, (1-2), 55-71 [in English]. ISSN 0043-1648)

1709 A COMPARATIVE STUDY OF THE SLURRY EROSION AND FREE-FALL PARTICLE EROSION OF ALUMINIUM. [MATE-199202-31-0694]

A study has been performed of the erosion of Al by silica sand particles at a velocity of 4.5 m s^{-1}, both air borne and in the form of a water-borne slurry. Measurements made under similar experimental conditions show that slurry erosion proceeds at a rate several times that of air-borne erosion, the ratio of the two rates depending strongly on the angle of impact. Sand particles become embedded in the metal surface during airborne particle erosion, forming a composite layer of metal and silica, and provide the major cause of the difference in wear rate. The embedded particles give rise to surface hardening and a significant reduction in the erosion rate. Embedment of erodent particles was not observed during slurry erosion. Lubrication of the impacting interfaces by water appears to have minimal effect on the wear of Al by slurry erosion. Graphs, Photomicrographs. 8 ref. (Zu, J.B.; Burstein, G.T.; Hutchings, I.M.; Wear, 30 Sept. 1991, 149, (1-2), 73-84 [in English]. ISSN 0043-1648)

1710 AN INVESTIGATION OF THE MECHANISM OF THE R12-OIL-STEEL REACTION. [MATE-199202-34-0116]

Past work has shown that the chemical stability of hydrocarbon lubricating oils used in closed refrigeration compressor systems containing the refrigerant CCl_2F_2 (R12) is diminished by a chemical interaction between the oil, the R12, and the steel surfaces present in the compressor. The present study was undertaken to better understand and control this negative interaction. Using three day-200 °C sealed tube reactions with R12 and steel to simulate the conditions existing in an operating refrigeration compressor, the mechanism of the R12-oil-steel degradation reaction was explored by testing the effect of the presence of various probe and model compounds. The results indicate that, except perhaps for the formation of $FeCl_3$ and some $CHClF_2$ (R22), free radical reactions do not appear to play a major role in the oil-R12-steel reaction. The preponderance of the data indicates that Friedel – Crafts reactions, especially alkylation reactions, play a key role in the oil-R12-steel degradation chemistry. 19 ref. (Factor, A.; Miranda, P.M.; Wear, 21 Oct. 1991, 150, (1-2), 41-58 [in English]. ISSN 0043-1648)

1711 A PREDICTIVE MODEL FOR LOCALIZED EROSION—CORROSION. [MATE-199202-35-0406]

A predictive numerical mode for localized erosion – corrosion of metals in disturbed two-phase flow has been developed. The flow structure is determined by the application of a two-phase flow version of $k-\varepsilon$ eddy viscosity, low Reynolds number model of turbulence. The Eulerian approach for the fluid flow is coupled with a Lagrangian approach for particle motion. Local values of fluid velocity and turbulent and molecular transport coefficients are determined along with particle – wall interactions in terms of impact velocity, angle, and frequency. The corrosion component of the model assumes mass-transfer control. The mass-transfer rates are determined by the solution of the mass transport equation simultaneously with the fluid flow equations. The erosion is determined on the basis of the computed particle – wall interactions and cutting-wear erosion equations. Simulation results for the erosion of stainless steel and the erosion – corrosion of mild steel at a sudden expansion in a vertical pipe carrying a dilute 2% sand/water slurry are compared with previously measured values. The erosion – corrosion rates at a groove in a steel pipe are also presented to demonstrate the generality of the model. Graphs. 23 ref. (Nesic, S.; Postlethwaite, J.; Corrosion, Aug. 1991, 47, (8), 582-589 [in English]. ISSN 0010-9312)

1712 REMOVAL OF TOXIC METAL IONS FROM SMELTER EFFLUENTS USING FUNCTIONALIZED GUAR POLYMERS CONTAINING THIOL GROUP. (RETROACTIVE COVERAGE). [MATE-199202-42-0151]

Mineral and metallurgical industries discharge effluents which contain heavy metal ions that are toxic. These deteriorate the quality of surface waters significantly. Cross-linked thiol and trimethyl derivatives of guar gum developed in this laboratory were used to scavenge the heavy metal ions in the effluent from Zn smelter. The results are reported and compared with the outcome of lime treatment of such wastes. 7 ref. (Menaria, K.L.; Mathur, O.P.; Joshi, I.K.; Mathur, N.K.; International Symposium on Industrial Metal Finishing, Karaikudi, India, 1-5 Feb. 1989, Publisher: Central Electrochemical Research Institute (1989), (Met. A., 9202-72-0081), 257-260 [in English].)

1713 CHARACTERIZATION AND CONTROL OF SLUDGE FORMATION IN MAGNESIUM DIE CASTING ALLOYS. [MATE-199202-51-0203]

A series of AZ91D and AM60B magnesium alloys were melted and handled utilizing procedures designed to simulate a variety of industrial practices.

Samples of metal were collected from different heights in the furnace at appropriate time using a sampling tube arrangement. The amount, composition and nature of the sludge generated were characterized by a variety of methods. The results indicated the relative importance of temperature variation of the melt, holding time, melt stirring and other factors to the sludge formation process. Graphs, Spectra, Photomicrographs. 9 ref. (Albright, D.L.; Transactions: 16th International Die Casting Congress and Exposition, Detroit, Michigan, USA, 30 Sept.-3 Oct. 1991, Publisher: North American Die Casting Association (1991), (Met. A., 9202-72-0080), 101-108 [in English].)

1714 CHRYSLER BIDS GOOD-BYE TO SLUDGE. [MATE-199202-57-0227]

The sludge from paint overspray at Chrysler's Dodge City Truck plant is converted into dry powder for recirculation as ingredients for coating, caulk, and sealants. The processing details are highlighted which include removal of sludge from the pit, addition of deflocculant to make the sludge float and removal of sludge to a dryer with rotating screws where the sludge is converted to dry powder by heating to 350 °C (177 °C) which drives off water. (Industrial Finishing, July 1991, 67, (7), 28-30 [in English]. ISSN 0019-8323)

1715 PREVENTION OF NOXIOUS EMISSIONS FROM CHROMIUM PLATING BATH WITH FLUORATED SAS. [MATE-199202-58-0215]

Application of surfactants for environmental protection from toxic substances evolved during Cr plating was studied. Effectiveness in reduction of chromium oxide emissions into the atmosphere was determined. The most effective conditions for reduction in toxic compounds release were determined. Graphs. 5 ref. (Plekseev, E.V.; Ovsyannikova, L.V.; Bezhanova, V.V.; Kurdukova, E.A.; Mikheev, N.I.; Zashchita Metallov, Mar.-Apr. 1991, 27, (2), 320-322 [in Russian]. ISSN 0044-1856)

1716 WASTE METAL EXTRACTION APPARATUS. [MATE-199202-61-0098]

A waste metal extraction apparatus is disclosed. The apparatus includes a tank having a plurality of oppositely disposed arcuate baffles disposed on the sidewalls. The baffles are placed in an offsetting relation to direct the flow of a fluid through the cell in essentially a serpentine fashion. The arcuate baffles facilitate maintaining a maximum velocity through the turning radius of the fluid passing therethrough to prevent a solids buildup. The tank bottom includes a plurality of sockets sized to engage a plurality of cathode supports with each support including a mating end for mating with the socket. The tank further includes a sludge gate. Utilizing the combination of flow modifying baffles, a sloped bottom and enhanced electrical contacting means provides for use of electrolytic cells for removing heavy metals from streams containing approx 1-15% solids without requiring frequent down time for tank cleaning. (Epner, R.L.; 2 Oct. 1990 [in English]. Patent no.: US4960500 (USA) Convention date: 2 Aug. 1989)

1717 INFLUENCE OF STRUCTURAL PARAMETERS ON THE SLURRY EROSION RESISTANCE OF SQUEEZE-CAST METAL MATRIX COMPOSITES. [MATE-199202-62-0156]

Metal matrix composite specimens were made by squeeze casting, where 5083 Al alloy infiltrates a fiber preform. The ceramic fibers consisted of Al_2O_3 (47%) and SiO_2 (53%). The use of different preforms resulted in specimens with fiber volume fractions of 10, 15, and 20%. Erosion tests were performed with a slurry jet having a velocity of 15 m s^{-1} and a sand concentration of 10 wt.%. Different size distributions of silica sand particles were chosen as abrasive. The results are presented in the form of erosion profiles of different specimens. Although the erosion resistance increases with fiber volume fraction, the erosion profile variations are negligible. Due to the trajectory deviation of abrasive particles near the surface, the erosion conditions (particle velocity, local impact angle) are greatly modified for different abrasive particle sizes. Large abrasive causes fiber fracture which results in poor protection of the matrix by the fibers. This results in gradual erosion of the surface with no relief. For small abrasive particles, the erosion of the matrix is more important than that of the fibers, resulting in a rough eroded surface, especially in the region where the local impact angle is small. These results are interpreted in terms of the structural parameters of the composites. Graphs, Photomicrographs. 9 ref. (Turenne, S.; Simard, D.; Fiset, M.; Wear , 30 Sept. 1991, 149, (1-2), 187-197 [in English]. ISSN 0043-1648)

1718 THE EROSION PROPERTIES OF ALLOYS FOR THE CHEMICAL PROCESSING INDUSTRIES. [MATE-199204-31-1273]

Several alloys designed for use, or commonly used, in the chemical processing industries were subjected to three forms of erosion, solid particle impingement, slurry, and cavitation. The test conditions were selected to make it possible to directly compare the behavior of the alloys subjected to the three types of impact. The solid particle impingement tests were performed in an air blast rig at room temperature using 400 mu m silicon carbide erodent and 850 °C using 80 mu m diameter alumina. The slurry tests were carried out in a rotating paddle slurry pot, using a dispersion of 80 mu m alumina particles in tap water, agitated by a propeller at the base of the pot. The cavitation erosion tests used a vibratory cavitation unit and the procedures described in ASTM Standard G32. In the solid particle impingement tests, most of the alloys fell within a narrow performance range, at both room and elevated temperatures. The exception was Type 316L stainless steel, which exhibited a much lower erosion rate than the other materials tested at 850 °C. In both the slurry and cavitation erosion tests, the cobalt-based materials, Haynes alloy 6B and Ultimet alloy, exhibited low erosion rates compared to the other alloys tested, suggesting that a low stacking fault energy, face centered cubic structure, and/or the tendency of the structure to transform under the action of mechanical stress are beneficial. The slurry erosion caused the least metal wastage, and the solid particle erosion the most, under reasonably comparable test conditions. Alloys tested were 1233, 6B, 25, C-276, 625, 316L and 20Cb-3. Photomicrographs, Graphs. 9 ref. (Levy, A.V.; Crook, P.; Wear of Materials 1991. Vol. 1, Orlando, Florida, USA, 7-11 Apr. 1991, Publisher: The American Society of Mechanical Engineers (1991), (Met. A., 9204-72-0155), 3-10 [in English].)

1719 INFLUENCE OF STRUCTURAL PARAMETERS ON THE SLURRY EROSION RESISTANCE OF SQUEEZE-CAST METAL MATRIX COMPOSITES. [MATE-199204-31-1276]

Metal matrix composite specimens were made by squeeze-casting where 5083 Al alloy infiltrates a fiber preform. The ceramic fibers consisted of Al_2O_3 (47%) and SiO sub 2 (53%). The use of different preforms resulted in specimens with fiber volume fractions of 10, 15 and 20%. Erosion tests were made with a slurry jet having a velocity of 15 m/s and a sand concentration of 10 wt.%. Different size distributions of silica sand particles were chosen as abrasive. The results are presented in the form of erosion profiles of different specimens. Although the erosion resistance increases with fiber volume fraction, the erosion profile variations are negligible. Due to the trajectory deviation of abrasive particles near the surface, the erosion conditions (particle velocity, local impact angle) are greatly modified for different abrasive particle sizes. Large abrasive causes fiber fracture which results in poor protection of the matrix by the fibers. This results in gradual erosion of the surface with no relief. For small abrasive particles, the erosion of the matrix is more important than that of fibers, resulting in a rough eroded surface, especially in the region where the local impact angle is small. These results are interpreted in terms of the structural parameters of the composites. Graphs, Photomicrographs. 9 ref. (Turenne, S.; Simard, D.; Fiset, M.; Wear of Materials 1991. Vol. 1, Orlando, Florida, USA, 7-11 Apr. 1991, Publisher: The American Society of Mechanical Engineers (1991), (Met. A., 9204-72-0155), 27-32 [in English].)

1720 IMPACT WEAR MECHANISMS OF MEDIUM CARBON STEEL UNDER VARIOUS DRY AND WET CONDITIONS. [MATE-199204-31-1277]

Impact wear mechanisms of quenched and tempered 0.45% carbon steel were studied on a test machine with an impact energy of 9.07 J in various media. The results showed that: In dry plain impact, the wear mechanism is fatigue spalling by plastic deformation. In water (or kerosene or oil) impact, the wear mechanism is "water wedge" action. In silica sand slurry, the mechanism is combined cutting action of the sand particles, notch effect of the embedding action of the particles and the "water wedge" effect; and corrosion effects caused by acidic (pH = 3.3) and basic (pH = 9.0) media are much less than that of cutting and notch action. Corrosion is negligible;

the wear mechanism under wet conditions is controlled by cutting wear caused by hard abrasives, surface cracks formed by the notch action and the propagation of lateral cracks in the plasticity deformed layer. Photomicrographs, Graphs. 16 ref. (Xu, Y.H.; Tan, C.-Y.; Zhou, Q.D.; Wear of Materials 1991. Vol. 1, Orlando, Florida, USA, 7-11 Apr. 1991, Publisher: The American Society of Mechanical Engineers (1991), (Met. A., 9204-72-0155), 33-40 [in English].)

1721 ON THE PARTICLE SIZE EFFECT IN SLURRY EROSION. [MATE-199204-31-1281]

The erosion rates of cylindrical steel specimens tested at a constant speed of 18.7 m/s in an erosion pot tester using 1.2 wt.% suspensions of SiC in oil for particle diameters between 20-500 mu m have been determined. The rate of particle impact on unit area of the surface at the stagnation line of erosion specimens was established as a function of particle size by short-time erosion tests, allowing a calculation of the mean mass removed for each particle impact as a function of particle size. These values were compared with the kinetic energy of particles using impact velocity values derived from the model of suspension flow. Results show that the decrease in erosion rate with decreasing particle size for suspensions of constant solids loading reflects the decrease in the proportion of particles impacting the target surface and the decrease in impact velocity. A value of −24 kJ/g is tentatively suggested for the energy of removal of P110 steel by erosion. It is concluded that for these dilute suspensions with particle sizes −100 mu m erosion rate is proportional to the kinetic energy dissipated by particles during impact, but for particle sizes 100 mu m other metal removal mechanisms become increasingly significant. Photomicrographs, Graphs. 27 ref. (Lynn, R.S.; Wong, K.K.; Clark, H.McL.; Wear of Materials 1991. Vol. 1, Orlando, Florida, USA, 7-11 Apr. 1991, Publisher: The American Society of Mechanical Engineers (1991), (Met. A., 9204-72-0155), 77-82 [in English].)

1722 A COMPARATIVE STUDY OF THE SLURRY EROSION AND FREE-FALL PARTICLE EROSION OF ALUMINUM. [MATE-199204-31-1299]

The erosion of Al by silica sand particles at a velocity of 4.5 m s^{-1}, both air-borne and in the form of a water-borne slurry, was studied. Measurements made under similar experimental conditions show that slurry erosion proceeds at a rate several times that of air-borne erosion, the ratio of the two rates depending strongly on the angle of impact. Sand particles become embedded into the metal surface during air-borne particle erosion, forming a composite layer of metal and silica, and provide the major cause of the difference in wear rate. The embedded particles give rise to surface hardening and a significant reduction in the erosion rate. Embedment of erodent particles was not observed during slurry erosion. Lubrication of the impacting interfaces by water appears to have minimal effect on the wear of Al by slurry erosion. Graphs, Photomicrographs. 7 ref. (Zu, J.B.; Burstein, G.T.; Hutchinings, I.M.; Wear of Materials 1991. Vol. 1, Orlando, Florida, USA, 7-11 Apr. 1991, Publisher: The American Society of Mechanical Engineers (1991), (Met. A., 9204-72-0155), 417-423 [in English].)

1723 TREATMENT OF GALVANIC SLUDGES—RECOVERY OF METAL VALUES—CONDITIONING OF RESIDUES. [MATE-199204-42-0289]

Due to a lack of external plants for the treatment, recovery and landfilling of dangerous waste such as galvanic sludges containing toxic heavy metals. Austria has to a face a "disposal crisis". Therefore the only way to dispose of the dangerous waste is to export it. The amount of this kind of sludge – approx 10 000-20 000 tons/year in Austria – cannot be prevented/minimized by measures taken by the waste-producing plants only. Due to their high metal content (approx 5-15 wt.% Cr, Cu, Ni, Zn, Sn...), the majority of galvanic sludges can be considered ore minerals. Therefore, they should be looked upon not only as hazardous waste products but also as secondary anthropogenic raw materials and treated accordingly. In view of today's ecological, economic, and legal conditions, the current practise of waste disposal, such as landfilling and/or exporting, is no longer acceptable. It should be considered within the framework of a progressive and integrated concept aiming mainly at preventing/minimizing (prevention of waste and emissions) and recycling/recovering rather than disposing/landfilling of waste. The Austrian Research Centre Seibersdorf offers a promising alternative to previously practised methods of the recovery of metal values and the disposal of galvanic sludges containing heavy metals in conformity with laws, standards, and regulations. It is an integrated, waste- and branch-specific concept with innovative process steps (for instance leaching, solvent extraction, electrolysis SULKO-solidification process, etc.) partly developed on a laboratory and/or pilot scale. Graphs. 18 ref. (Forster, H.L.; Radex Rundschau, Nov. 1991, (3-4), 553-582 [in German]. ISSN 0370-3657)

1724 PROCESS ROUTES FOR THE TREATMENT OF SLUDGES CONTAINING HEAVY METALS. [MATE-199204-43-0097]

The waste water treatment of plants processing non-ferrous metals leads to the formation of sludges containing heavy metals (e.g. Pb, Cd, Cr, Cu, Ni, Ag, Sn, Zn, Hg) which have to be dumped expensively. To reduce environmental hazards and to recover the heavy metals for industrial reuse, processes have to be developed to enable the treatment of the sludges. Different possible hydrometallurgical ways are described and technical limits are outlined. Graphs. 14 ref. (Kerney, U.; Magill, M.; Erzmetall, Nov. 1991, 44, (11), 548-556 [in German]. ISSN 0044-2658)

1725 ENVIRONMENT/HEALTH/SAFETY. [MATE-199204-51-0568]

Federal laws, coupled with rules of the Environmental Protection Agency, regulate practically every actual and potential industrial and municipal pollution source. State and local laws and regulations place further restrictions on discharges to the air, water, and land. A review covers brief descriptions of the major federal environmental laws that affect foundries including: the Comprehensive Environmental Response, Compensation and Liability Act of 1980; Resource Conservation and Recovery Act; the Federal Water Pollution Control Act (Clean Water Act); Toxic Substances Control Act; Clean Air Act of 1990; storm water regulations; and liquid materials storage. Other issues addressed are the cost of solid waste, solid waste alternatives, worker health issues, higher OSHA penalties, and ergonomics. (Foundry Management and Technology, Dec. 1991, 119, (12), I3-I6 [in English]. ISSN 0360-8999)

1726 GOLD IS OUR FORTE. [MATE-199204-58-0614]

Artistic Plating, Milwaukee, Wisconsin, USA, plates precious metals and other metals (e.g. Cu, brass, stainless steel, Zn) and also does electrostatic powder coating. Antique brass and then bright brass were popular decorative finishes for plumbing fixtures. Problems in applying decorator brass finishes include outgassing from solvents or air trapped in casting pores, and brown spots from the reaction of cyanide and water resulting in the formation of copper oxide. Artistic Plating developed an Au alloy for Zn die-cast parts resulting in plating having good hardness and excellent field durability. In 1986, Artistic upgraded its laboratory and emphasized quality production. They have also installed wasted treatment steps and recovery methods for Au, Ag, and Cu. A description of the methods is provided and the effectiveness of the techniques is emphasized. (Graves, B.A.; Products Finishing (Cincinnati), Jan. 1992, 56, (4), 42-51 [in English]. ISSN 0032-9940)

1727 A REVIEW OF SEMI-SOLID SLURRY FORMATION AND THE RHEOLOGICAL BEHAVIOR OF AL—6.5SI/SICP SLURRIES. [MATE-199204-62-0428]

The rheology of SiC particulate/Al – 6.5Si composite slurries was explored. The rheological behavior of composite slurries shows both thixotropic and pseudoplastic behaviors. Isostructural experiments on the composite slurries revealed a Newtonian behavior beyond a high shear rate limit. The rheology of fully molten composite slurries over the low to high shear rate range indicates the existence of a low shear rate Newtonian region, an intermediate pseudoplastic region and a high shear rate Newtonian region. The isostructural studies indicate that the viscosity of a composite slurry depends upon the shearing history of a given volume of material. An unexpected shear thinning was noted for SiC particulate + alpha slurries as compared to semi-solid metallic slurries at the same fraction solid. The implications of these findings for the processing of slurries into cast components are discussed. Photomicrographs, Graphs. 33 ref. (Moon, H.-K.; Ito, Y.; Cornie, J.A.; Flemings, M.C.; Science And Engineering of Light Metals. Raselm '91, Tokyo, Japan, Oct. 1991, Publisher: Japan Institute of Light Metals (1991),

(Met. A., 9204-72-0140), 1093-1103 [in English].)

1728 METAL RECOVERY PROCESS USING WATERGLASS. [MATE-199204-71-0068]
Sodium silicate (waterglass) is added to a waste process stream containing metal to form a waterglass sludge containing the metal contaminants. The waterglass sludge matrixed with the metal is removed from the stream. Thereafter, a caustic is added to the separated waterglass sludge which dissolves the sodium silicate, leaving a metal solid in suspension. The sodium silicate solution is filtered off and recycled for use in the waterglass precipitation process. The metal solid remains and concentrated acid is added to form a metallic acid solution which is substantially free of silicates. This solution may then be treated by solvent extraction or other means to recover the metal. The process provides substantial metal recovery from the process waste stream and eliminates the need for burial of the waste, thereby eliminating burial costs. (Lahoda, E.J.; Parks, B.H.; 31 Dec. 1991 [in English]. Patent no.: US5077020 (USA) Convention date: 8 Feb. 1991)

1729 ION EXCHANGE TRAINING MANUAL. [MATE-199205-34-0416]
Ion exchange applications for water treatment, industrial applications, deionization, continuous ion exchange, electrodialysis, electric power generation and pollution control (such as for the removal of heavy metals) are described. Methods of design calculations to establish effluent purity requirements, analyze water supplies, evaluate types of systems and resins, determine regenerant levels and capacities and evaluate treated water and regenerant storage are explained. The interdependence of applications and exchange products is emphasized. Appendices address laboratory safety, commercial sources of ion exchange products, conversion tables and glossary of terms. Graphs. 16 ref. (Simon, G.P.; Publisher: Van Nostrand Reinhold (1991), (Met. A., 9205-72-0226), Pp 227 [in English].)

1730 CATHODIC PROTECTION APPLICATIONS FOR ABOVEGROUND WASTE WATER STORAGE AND TREATMENT TANKS. [MATE-199205-35-0829]
Cathodic Protection Services Company has designed, furnished, and installed cathodic protection systems for several aboveground wastewater storage and treatment tanks. The tanks range in diameter from 110-140 ft (33.5-42.7 m) and contain up to three million gallons (11 360 m^3) of process wastewater from agricultural chemical protection facilities. The first group of tanks contains process wastewater having varying concentrations of organic solvents. The second group of tanks is used to aerate wastewater prior to additional treatment processes. Successful cathodic protection systems using mixed-metal oxide-coated tubular Ti anodes are in operation for the first group of tanks. The second group of tanks utilize cast iron anodes. Each tank's system is energized by an automatic potential-controlled rectifier. Permanent reference electrodes are installed within the vessels to provide an input signal to each rectifier's automatic controller. Experience with these systems has indicated that their proper design and operation is critically dependent upon the condition of the tank's internal coating, the characteristics of the wastewater (pH, velocity, conductivity) and the degree of organic contaminants which can be expected in the wastewater. Graphs. 4 ref. (Schramuk, J.A.; Above Ground Storage Tanks. Current Issues: Design, Operation, Maintenance, Inspection, & the Environment, Houston, Texas, USA, 14-16, Jan. 1992, Publisher: The Materials Technology Institute of the Chemical Process Industries, Inc. (1992), Paper No. 41, (Met. A., 9205-72-0211), Pp 13 [in English].)

1731 A STUDY OF THE DE-ALLOYING OF 70CU—30NI COMMERCIAL ALLOY IN SULPHIDE POLLUTED AND UNPOLLUTED SEA WATER. [MATE-199205-35-0926]
The behaviour of 70Cu – 30Ni commercial alloy in quiescent sulphide polluted and unpolluted sea water at 25 °C was examined by free corrosion and electrochemical tests. In aerated sea water the presence of sulphides enhances the average corrosion rate in a range of concentrations (0-10 ppm) while promoting preferential Cu dissolution. In de-aerated sea water, alloy corrosion behaviour is strictly linked to sulphide concentration. In low polluted sea water, the mean corrosion rate of the alloy increases and slightly selective Cu dissolution takes place. In highly polluted sea water, the corrosion rate decreases while slightly selective Ni dissolution takes place. Graphs. 25 ref. (Beccaria, A.M.; Poggi, G.; Traverso, P.; Ghiazza, M.; Corrosion Science, Nov. 1991, 32, (11), 1263-1275 [in English]. ISSN 0010-938X)

1732 NICKEL MIGRATION FROM CR—NI STAINLESS STEEL EXPOSED TO POTABLE WATER. [MATE-199205-35-0942]
Studies of Ni migration from Cr – Ni stainless steel exposed to potable water indicate that there is a "stagnant water problem", which is also known to occur with other pipe materials. The Ni levels can reach the EC recommended upper limit within a period of one week, depending on the surface condition and volume:surface area ratio. The fact that hardly any Cr is found in the water indicates that the presence of Ni is not attributable to corrosion of Cr – Ni stainless steel (e.g. X5CrNi18 10) pipes but rather to leaching of Ni from the passive layer rich in chromium oxide. The leaching stops after a few weeks, indicating that Ni migration is only a matter of concern during commissioning. Unlike Cu and hot dip galvanised steel pipes, stainless steel pipes do not undergo any general corrosion in potable waters. This is also true for waters that are highly acidic (pH 4) or contain strong complex forming species, e.g. cyanides and EDTA. From the point of view of health, therefore, stainless steel pipes can be used for all types of potable water. 18 ref. (Schwenk, W.; British Corrosion Journal, 1991, 26, (4), 245-249 [in English]. ISSN 0007-0599)

1733 FLUIDIZED BED PELLET REACTOR TO RECOVER METALS OF ANIONS. [MATE-199205-42-0331]
The development of a fluidized bed crystallizer based on 20 years of experience with the softening of drinking water and the removal of phosphates from the wastewater is described. The principle of the process and the circulation system is presented and three applications are evaluated. Some new developments and promising applications are presented. The pellet reactor system is compact and requires a relatively small investment. The crystallization process is stable and efficient, and process operation is easy making the process control relatively simple and cheap. The cost of the chemicals is about the same as the cost of a hydroxide precipitation plant. The cost of energy is relatively low. The pellets (e.g. Ni) can be reused or solid resulting in savings on the purchase of anions or heavy metals. There is no sludge or waste production, and thus no disposal problem. 4 ref. (Scholler, M.; Dijk, J.C.; Wilms, D.; Metal Finishing, Nov. 1991, 89, (11), 46-50 [in English]. ISSN 0026-0576)

1734 CELLULOSE FIBROUS SORBENTS WITH CONFORMATIONALLY FLEXIBLE AMINOCARBOXYLIC GROUPS FOR PRECONCENTRATION OF METALS. [MATE-199205-43-0106]
New cellulose fibrous sorbents, containing a diethylenetriamine tetraacetate groups, are proposed for the preconcentration of heavy metals (e.g. Mn, Co, Zn, Eu). Quantitative extraction of heavy metals from river and sea water is achieved in a wide pH range (3-8) at a high solution flow rate (up to 100-150 volumes of sorbent/min). Quantitative desorption of metals is achieved with a very small volume of the acid. 19 ref. (Tsysin, G.I.; Mikhura, I.V.; Formanovsky, A.A.; Zolotov, Y.A.; Mikrochimica Acta, 1991, 3, (1-3), 53-60 [in English]. ISSN 0026-3672)

1735 ENVIRONMENTAL REGULATIONS AND PAINT SLUDGE MANAGEMENT ALTERNATIVE FOR COMPLIANCE. [MATE-199205-57-0657]
Proposed regulations by the US Environmental Protection Agency (EPA) forced the automotive industry to seek alternatives to landfilling of paint sludge. Companies serving the automotive industry developed unique processes to manage paint sludge, but the EPA did not cooperate. The final regulations were relaxed and paint sludge continued to be landfilled. Now the service industry is offering cost-effective alternatives, including converting the paint sludge to a solid fuel for use as a coal substitute. The key feature is more effective dewatering at a low cost. (Nassos, G.P.; Finishing '91, Cincinnati, Ohio, USA, 23-25 Sept. 1991, Publisher: Society of Manufacturing Engineers (1991), Paper FC91-361, (Met. A., 9205-72-0245), Pp 12 [in English].)

1736 ENVIRONMENTAL REGULATIONS AND PAINT SLUDGE MANAGEMENT ALTERNATIVES FOR COMPLIANCE. [MATE-199205-57-0670]
Proposed regulations by the US Environmental Protection Agency forced the automotive industry to seek alternatives to landfilling of paint sludge. To the benefit of the automotive industry the final regulations were relaxed and the disposal alternatives would be acceptable only if cost-effective. More effective dewatering of the paint sludge provides flexibility in the ultimate disposal and cost efficiencies. Graphs. (Nassos, G.P.; Finishing West '90, Anaheim, California, USA, 25-27 Sept. 1990, Publisher: Society of Manufacturing Engineers (1990), Paper No. FC90-635, (Met. A., 9205-72-0249), Pp 13 [in English].)

1737 CYANIDE DESTRUCTION IN PLATING SLUDGES BY HOT ALKALINE CHLORINATION. [MATE-199205-58-0675]
Case histories of two cyanide sludge generators who have been able to reduce the cyanide levels of their plating sludges from concentrations 700 ppm total cyanide to a concentration 500 ppm total cyanide by utilizing the hot alkaline chlorination procedure are presented. This procedure has allowed the generators to dispose of their cyanide wastes by conventional means with a projected annual cost savings $250 000/year. The operations of these systems are explained along with a financial assessment of disposal alternatives and additional operational benefits. (Wedl, D.J.; Fulk, R.J.; Metal Finishing, Nov. 1991, 89, (11), 33-37 [in English]. ISSN 0026-0576)

1738 CYANIDE DESTRUCTION BY CATALYTIC OXIDATION. [MATE-199205-58-0678]
Results of carbon adsorption-cupric ion/sulfite promoted air oxidation of free and complexed cyanide species, which were present in actual chemical plant effluents, in laboratory bench-scale and on-site pilot-scale activated C adsorbers. In a down-flow, co-current, aerated, activated C adsorber, cyanide was first adsorbed, then oxidized by dissolved oxygen. Presence of cupric ions enhanced adsorption of cyanide and catalyzed oxidation of cyanide in the aerated C adsorber, resulting in a much longer service life for the C adsorber. Addition of sulfite in the wastewater feed further enhanced cyanide oxidation in the C adsorber. Sulfite was oxidized to sulfate. Cyanide removal was most efficient when the adsorption – oxidation treatment was conducted at a pH level of 8. Graphs, Numeric Data. 16 ref. (Chen, Y.-s.; You, C.-g.; Ying, W.-c.; Metal Finishing, Nov. 1991, 89, (11), 68-71 [in English]. ISSN 0026-0576)

1739 POLLUTION ABATEMENT OF METAL FINISHING/MANUFACTURING WASTES. [MATE-199205-58-0710]
The quest for a clean and habitable environment has prompted the development of treatment technology for, among other things, industrial and manufacturing wastes. Metal finishing wastes incorporate wastes and wastewaters from chemical drag-outs and spent chemical/processing baths (solutions). Each of these waste streams require specific treatment chemistries. The chemical application for each treatment train is subject to the compound's stoichiometric reactivity and its ionic potential. The applied precipitation and flocculation are common place technologies used and needed for effective waste treatment and removal of toxic constituents. 7 ref. (Olaluwoye, S.; Finishing West '90, Anaheim, California, USA, 25-27 Sept. 1990, Publisher: Society of Manufacturing Engineers (1990), Paper No. FC90-636, (Met. A., 9205-72-0249), Pp 10 [in English].)

1740 ALKALINE COPPER-PLATING PROCESS ELIMINATES CYANIDE AND IMPROVES PRODUCT QUALITY. [MATE-199205-58-0730]
An alkaline Cu-plating process has been proposed as a replacement for cyanide baths. The process, called Cupral, produces uniform coatings and the coatings are more evenly distributed over high and low current densities. This results in better adhesion and less flaking from bridging across flaws. Besides a strike application, this process is also suggested for masking steel prior to selective surface hardening such as carburizing or nitriding. Other advantages include reduced environmental hazards, elimination of drag out concerns since the alkaline bath is non-hazardous, and the overall process is less labor intensive. Photomicrographs Numeric Data. (Davidson, T.; JOM, Dec. 1991, 43, (12), 46-47 [in English]. ISSN 0148-6608)

1741 WET CORROSIVE WEAR CHARACTERISTICS OF HIGH CHROMIUM CAST IRON SUBJECTED TO REPEATED IMPACT AND HIGH STRESS. [MATE-199203-31-1154]
The corrosive wear characteristics of high Cr cast iron (HCCI) were studied under conditions of wet ore grinding. The repeated impact and high stress were involved and different minerals and different modes of aeration (N_2, air, O_2) were used. The principle test parameters were impact work of 1.47 J, slurry concentration of 72% (ore) and slurry temperature of 28-30 °C. The quantitative relationship between abrasive wear and corrosive wear was discussed. It is proposed that the corrosive wear is approx 10-20% of the total wear. The sulfide in mineral promotes corrosive wear in grinding sulfide ore. Finally, the corrosive wear mechanism of HCCI was investigated. It is pointed out that the corrosion of the carbide interface is the cause of carbide early spalling, which is the main reason for wear increase of HCCI in wet ore grinding. Graphs, Photomicrographs. 6 ref. (Sun, C.; Piao, D.; Journal of Iron and Steel Research, 1991, 3, (2), 63-69 [in Chinese]. ISSN 1001-0963)

1742 DISSOLUTION OF PLATINUM METAL ALLOYS CONTAINED IN THE FEED CLARIFICATION SLUDGE. [MATE-199203-34-0207]
The dissolution behaviour of two alloys, which represent the metallic precipitates, occurring in the dissolution step of a nuclear reprocessing plant was investigated. The solubility of these alloys, containing Mo, Ru, Rh and Pd, in HNO_3-solutions is rather low and dissolution ceases after some time, caused by passivation. A significant acceleration of the dissolution rate takes place if ozone is passed through the alloy/HNO_3 -suspension, or if an electrolytic dissolver with or without an oxidation catalyst is used. Moreover, Ru can be separated as RuO_4 by distillation. Graphs, Photomicrographs. 8 ref. (Geckeis, H.; Neumann, W.; Muller, W.; Journal of Radioanalytical and Nuclear Chemistry, Articles, Nov. 1991, 152, (1), 199-206 [in English]. ISSN 0236-5731)

1743 A STUDY OF THE CORROSION RESISTANCE OF METAL STEAM GENERATING AND WATER PURIFICATION PLANT WITH OPERATION ON NATURAL AND TOWN SEWER WATERS. [MATE-199203-35-0479]
A study is presented on the corrosion behaviour of low carbon steel 20 using a mathematical modelling method over the temperature range 100-250 °C. This shows that the corrosion depends on three factors K_y, t, and pH where K_y is the steam factor and t the temperature. It is concluded that the rates of corrosion of C steels in g/(m^2h) in natural and town sewer waters 100-250 °C differ by only one hundredth part. Graphs. 10 ref. (Malakhov, I.A.; Azimov, B.S.; Teploenergetika, Aug. 1990, (8), 45-48 [in Russian]. ISSN 0040-3636)

1744 A STUDY OF THE DE-ALLOYING OF 70CU—30NI COMMERCIAL ALLOY IN SULPHIDE POLLUTED AND UNPOLLUTED SEA WATER. [MATE-199203-35-0508]
The behaviour of 70Cu – 30Ni commercial alloy in quiescent sulphide-polluted and unpolluted sea water at 25 °C was examined by free corrosion and electrochemical tests. In aerated sea water the presence of sulphides enhances the average corrosion rate in a range of concentrations (0-10 ppm) while promoting preferential Cu dissolution. In de-aerated sea water, alloy corrosion behaviour is strictly linked to sulphide concentration. In low polluted sea water, the mean corrosion rate of the alloy increases and slightly selective Cu dissolution takes place. In highly polluted sea water, the corrosion rate decreases while slightly selective Ni dissolution takes place. Spectra, Graphs. 25 ref. (Beccaria, A.M.; Poggi, G.; Traverso, P.; Ghiazza, M.; Corrosion Science, Nov. 1991, 32, (11), 1263-1275 [in English]. ISSN 0010-938X)

1745 EFFECT OF PSEUDOLIQUEFIED LAYER OF GLASS PARTICLES ON CATHODE PROCESSES UNDER ELECTROREDUCTION OF CADMIUM IONS. [MATE-199203-43-0055]
Effects of hydrodynamic and mechanical factors on electrolysis intensity in a fluidized bed of glass particles, the degree of metal extraction, and the quality of the metal deposit were studied with electroreduction of Cd present in spent Cd electrolytes and plating rinse waters. Diffusion limit current was measured in dependence on electrolyte flow rate and was calculated with the

use of a proposed equation applicable for glass beads. Effects of the supporting electrolyte on limit current and of operating current density on cathodic Cd deposits were also measured. Changes in Cd concentration in dependence on the number of electrolysis cycles were measured and calculated from a known equation. The mechanism of mass transfer during collisions of particles with the cathode surface was studied. Graphs. 11 ref. (Shvab, N.A.; Stefanyak, N.V.; Kondruk, E.I.; Sobkevich, V.A.; Kazdobin, K.A.; UKRainskii Khimicheskii Zhurnal, Oct. 1990, 56, (10), 1057-1062 [in Russian]. ISSN 0041-6045)

1746 RECOVERY OF ELECTROLYSERS AND RELATED TECHNIQUES. [MATE-199203-43-0056]
The growing interest in recovering heavy metals from industrial wastes has intensified still further as pollution standards have become stricter and the problem of storing sludges on approved sites even more difficult. Amongst the various methods that can help resolve the problem of upstream pollution, electrolysis is very suitable for treating electroplating effluent containing heavy metals. It leads to lower discharges of toxic substances and less sludge. This is a simple process with a final cost that will be attractive to industry, particularly small and medium-sized enterprises. Graphs. (Galvano-organo-traitements de Surface, Dec. 1991, (621), 1147-1153 [in French]. ISSN 0302-6477)

1747 RATE OF MASS TRANSFER IN REMOVAL OF HEAVY METAL IONS FROM WASTE WATER STREAMS USING ION EXCHANGE. [MATE-199203-43-0064]
A cation exchange resin was used as a possible technique for the removal of cupric ions from a simulated waste water effluent consisting of a copper sulfate solution. The volumetric mass transfer coefficients were estimated from the breakthrough curves and the diffusion-controlled plug flow relationship. Variables studied were the volumetric flow rate of the simulated waste water effluent and the initial concentration of cupric ions in the solution. The volumetric mass transfer coefficient was found to increase with increasing the volumetric flow rate of the simulated waste solution. Increasing the initial concentration of cupric ions in the solution was found to decrease the volumetric mass transfer coefficient. In parallel with measuring the volumetric mass transfer coefficients, the total capacity of the cation exchange resin was also determined before and after regeneration of the resin. The results show that the resin has a high capacity for the ion exchange of cupric ions. Graphs. 25 ref. (Zarraa, M.A.; Indian Chemical Engineer, July-Sept. 1991, 33, (3), 10-15 [in English]. ISSN 0019-4506)

1748 HARMONY BETWEEN MAN AND MACHINE—ELORA IS SUCCESSFUL WITH QUALITY TOOLS. [MATE-199203-52-0456]
Elora is a tool manufacturing company founded in 1924, with sales of approx DM24 000 000. Its 280 employees produce mainly wrench sockets hot-forged from Cr–V steel. The operations employ computer control and robots. Cutting oils, plating solutions and emissions are treated to conform to regulations for environmental protection. (Reich, F.; Industrie-anzeiger, 25 Oct. 1991, 113, (86), 52-54 [in German]. ISSN 0019-9036)

1749 PURIFICATION OF FLUONITRIC PICKLING BATH IN THE STAINLESS STEEL INDUSTRY. [MATE-199203-57-0348]
Iron build-up in stainless steel pickling operations results in a loss of productivity and a frequent replacement of pickling bath. Valuable chemical products are discarded. The resulting sludge is stored at a high cost in special facilities. The APU continuously removes dissolved Fe and allows a much longer life of the bath. Tyical benefits of the system are: reduction of nitric acid and hydrofluoric acid purchases; constant pickling rate; no more bath dumping; significant reduction of nitric and fluoric sludge. Average payback is less than two years. (Gernath, E.; Galvano-organo-traitements de Surface, Dec. 1991, (621), 1130-1132 [in French]. ISSN 0302-6477)

1750 LIMITING TIN SLUDGE FORMATION IN TIN OR TIN/LEAD ELECTROPLATING SOLUTIONS. [MATE-199203-58-0338]
Baths and methods for electroplating Sn or Sn–Pb alloys wherein the formation of tetravalent Sn and stannic oxide sludge is reduced or prevented are disclosed. These baths contain a soluble divalent Sn compound, a soluble alkyl or alkylol sulfonic acid, at least one wetting agent, and a hydroxyl phenyl compound reducing agent. Other compounds may be added to the bath for improving its performance during electroplating. (Nobel, F.I.; Ostrow, B.D.; 19 Nov. 1991 [in English]. Patent no.: US5066367 (USA) Convention date: 20 Sept. 1990)

1751 WASTEWATER TREATMENT. [MATE-199203-58-0377]
The subject of treating wastewater from metal finishing operations is dealt with comprehensively. Federal and local discharge regulations applicable to metal finishers are discussed and a table showing more stringent federal metal finishing regulations applicable to all electroplating shops are provided. Laboratory and engineering work required prior to selection of a wastewater treatment system is delineated. A primary consideration is said to be the determination of whether waste will be treated continuously or in batches. Classic or conventional treatment chemistry which has been used for years is indicated to be suitable to meet federal pretreatment regulations. Recommendations for chemical usage and control parameters for classic treatment chemistry are given. Other processes which may be used including hexavalent Cr reduction; cyanide oxidation and neutralization are also summarized along with new treatment technologies which have been developed to treat electroless Cu, electroless Ni, and some baths used in the printed circuit industry which are virtually impossible to treat with conventional chemicals. (Philipp, C.T.; Metal Finishing, Mid-Jan. 1991, 89, (1A), (Guidebook Directory), 787-788, 790, 792, 794, 796, 798, 801-802, 804, 806, 810, 812, 814, 818 [in English]. ISSN 0026-0576)

1752 WASTE MINIMIZATION TECHNOLOGIES. [MATE-199203-58-0378]
The current expense of disposing of metal finishing wastes and the resultant pressure to reduce the amount of waste generated in metal finishing operations are noted. In view of these factors, generalized information on the applicability and acceptability of established recovery techniques used to limit the amount of metal finishing waste is reviewed and the tradeoffs among those techniques which have attained a reasonable degree of commercial acceptance and practice are illustrated. Recovery techniques described are: reverse osmosis, electrodialysis, ion exchange and electrolytic metal recovery. Approaches which can be taken to evaluate the recovery (as opposed to treatment) potential for a given metal finishing operation are delineated and methods for recycling treated wastewaters and regenerating baths are described. (Steward, F.A.; McLay, W.J.; Metal Finishing, Mid-Jan. 1991, 89, (1A), (Guidebook Directory), 819-820, 822, 824, 826, 828, 830-832, 834-839 [in English]. ISSN 0026-0576)

1753 CHROMIUM PLATING AND THE ENVIRONMENT. [MATE-199203-58-0379]
The environmental protection system is increasingly strict. Across Europe it has become difficult and costly to dispose of wastes containing acids and heavy metals, but the electroplating industry has adapted to this new situation. Chromium plating in particular produces large amounts of harmful wastes, notably Pb sludges containing chromates, and wash water containing Cr. Technical solutions to these problems do exist and these are illustrated. Graphs. (Galvano-organo-traitements de Surface, Dec. 1991, (621), 1118-1120 [in French]. ISSN 0302-6477)

1754 LIQUID FILTRATION. [MATE-199203-58-0423]
Filtration is the removal of suspended solids, including very small particles and colloids, from plating baths. It is carried out by passing the solution through a porous barrier that retains the suspended solids and allows the clean solution to pass through. The major contaminants removed from solutions in the metal products finishing industry are precipitates, dirt particles and, solid adsorbents. Factors that determine the degree of filtration needed include type of plating solution, part shape, and plating specifications. Filtration as employed by electroplaters can be continuous, intermittent or batch-type. Filter element types include natural and synthetic cloths, paper with varying porosities, screens of fine wire mesh or cloth, and tubes consisting of wound fabric on a suitable support of stainless steel or plastic. (Gennaro, P.; Buck, C.F.; Products Finishing (Cincinnati), Oct. 1991, 56, (1-A), (Suppl. Directory), 246-251 [in English]. ISSN 0032-9940)

1755 TROUBLESHOOTING PLATING WASTE TREATMENT SYSTEM. [MATE-199203-58-0424]
An operating manual for troubleshooting a plating waste treatment system should contain a schematic flow chart of the system, a description of the processes, and recommendations for monitoring and maintaining all items in the system. Malfunctions of waste treatment systems occur because of either a failure of the waste-segregation system or equipment malfunctions. Troubleshooting guidelines are illustrated through a hypothetical case involving a job shop doing Cu – Ni – Cr plating on steel and Zn die cast parts that is in violation of Cu discharge limits. The waste treatment system used in the case is a conventional chemical-destruct system. (Gary, S.P.; Products Finishing (Cincinnati), Oct. 1991, 56, (1-A), (Suppl. Directory), 264-278 [in English]. ISSN 0032-9940)

1756 SILVER AND SILVER ALLOY PLATING. [MATE-199203-58-0432]
The economics, technical and practical information is briefly reviewed for Ag plating. Since Ag is relatively low priced, the recovery processes generally stop at solution concentrations of 100 ppm Ag. Surface preparation, bath composition, and plating parameters are given for electroplating, electroless plating, immersion plating, conductive paints, electroforming, and jet plating. Schloetter has a proprietary bath for post plating treatment to prevent Ag tarnishing in oxygen and sulfur oxide environments. Usually Ag is plated over Cu or Ni alloys. Most commercial plating solutions are cyanide based. Also, the safety hazards of cyanide and silver azide salts are discussed. 20 ref. (Surface Treatment Plant & Processes, May-June 1991, 27, (3), 96-99 [in English]. ISSN 0950-5202)

1757 REGENERATION OF SOLUTIONS FOR CHROMIZING OF ZINC COATINGS. [MATE-199203-58-0460]
The application of Zn coatings as galvanisation requires that solutions containing Cr(IV) are used to improve the corrosion resistance of the finished article. Considering the high toxicity of Cr and its relatively limited usage in the framework of existing technology, it is useful to be able to regenerate the chromating solutions and recycle them to the process. A study was carried out of the dynamics of change of Zn and Cr concentrations in a chromatisation solution in a process of chromatisation – regeneration. Experimental details are given of a system which used a solution of (g/l) $CrO_3$60; H_2SO_4 10; and $HNO_3$15, and anode of PbO_2 and an electrolyser membrane MK – 41L. The possibility was demonstrated of Cr(VI) regeneration using a membrane exchange electrolyser which both gave Cr coatings of two to three times the normal corrosion resistance and recyclable chromatising liquid which compared well with fresh material. Graphs. 6 ref. (Voropaev, L.E.; Kozhukh, A.V.; Martinovich, V.L.; Zharskii, I.M.; Zhurnal Prikladnoi Khimii, Oct. 1990, 63, (10), 2381-2383 [in Russian]. ISSN 0044-4618)

1758 REGENERATION OF SOLUTIONS FOR CHROMIZING OF ZINC COATINGS. [MATE-199203-58-0461]
See preceding abstract. The application of Zn coatings as galvanisation requires that solutions containing Cr(IV) are used to improve the corrosion resistance of the finished article. Considering the high toxicity of Cr and its relatively limited usage in the framework of existing technology, it is useful to be able to regenerate the chromating solutions and recycle them to the process. A study was carried out of the dynamics of change of Zn and Cr concentrations in a chromatisation solution in a process of chromatisation – regeneration. Experimental details are given of a system which used a solution of (g/l) $CrO_3$60; H_2SO_4 10; and $HNO_3$15, and anode of PbO_2 and an electrolyser membrane MK – 41L. The possibility was demonstrated of Cr(VI) regeneration using a membrane exchange electrolyser which both gave Cr coatings of two to three times the normal corrosion resistance and recyclable chromatising liquid which compared well with fresh material. Graphs. (Voropaev, L.E.; Kozhukh, A.V.; Martinovich, V.L.; Zharskii, I.M.; Journal of Applied Chemistry of the USSR, Oct. 1990, 63, (10), Pt. 2, 2195-2197 [in English]. ISSN 0021-888X)

1759 A NEW METHOD FOR DETERMINATION OF RARE EARTH ELEMENTS VAPORIZED IN GRAPHITE FURNACE WITH A POLYTETRAFLUORETHYLENE SLURRY FLUORINATING REAGENT BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY. [MATE-199206-23-0329]
A new method based on fluorinating vaporization from a graphite furnace for ICP-AES by using a polytetrafluoroethylene slurry as a fluorinating reagent has been established to determine rare earth elements which are easily formed into refractory carbides. The detection limits were within the range 10^{-10}–10^{-12}g, and were typically two orders of magnitude better than that obtained with conventional electrothermal vaporization (ETV)-ICP-AES. No memory effect was observed. The relative standard deviation was 5%. Some factors which affected fluorinating vaporization are also discussed. It is concluded that ETV-ICP-AES is superior to GFAAS when the carbide-forming elements are determined. Graphs. 16 ref. (Huang, M.; Jiang, Z.; Zeng, Y.; Analytical Sciences, 1991, 7, (5), 773-778 [in English]. ISSN 0910-6340)

1760 A STUDY ON METAL CORROSION CAUSED BY SULFIDES IN COAL-WATER SLURRY (CWS) AND INHIBITION ACTION OF TUNGSTATE BLEND. [MATE-199206-35-1017]
The sulfide patterns and sources in CWS were discussed. Experimental coal used contained 0.675 wt.% sulfur. Totals of coal includes two main forms: inorganic and organic S. Two modern physical techniques, i.e. SEM and ESCA with argon + sputtering, were applied to study metal corrosion caused by sulfides in CWS. Corrosion mechanism of metal in CWS is proposed. Inhibition action of tungstate blend is explained. A three-dimensional layer structure is proposed to illustrate inhibition mechanism (of ferrous materials). Photomicrographs, Spectra. 8 ref. (Jia, N.; Lu, Z.; Corrosion Control – 7th Apccc. Vol. 2, China, 1991, Publisher: International Academic Publishers (1991), (Met. A., 9206-72-0284), , 857-861 [in English].)

1761 INFLUENCE OF PARTICLES HARDNESS IN SALT SLURRY ON THE EROSION—CORROSION RULE OF MATERIAL. [MATE-199206-35-1071]
Erosion – corrosion of three cast irons and a carbon steel was investigated by measuring the weight loss in salt slurries in a stirring flow system. The erosion – corrosion tests, carried out at the slurry velocity of 9.6 m/s in brine containing 30% NaCl, or quartz particles, revealed that the hardness of particles in salt slurry played an important role in the erosion – corrosion process. In salt slurry of the soft particles – NaCl, the erosion – corrosion behavior of material depended not on its hardness, but on its corrosion resistance. Material which had excellent corrosion resistance showed a good erosion – corrosion resistance. In salt slurry containing the hard particles – quartz, the hardness of material had an obvious influence on the erosion – corrosion rate of material. The higher the hardness of material, the lower the erosion – corrosion rate. In NaCl salt slurry, high Si – Cu cast iron had excellent corrosion and erosion – corrosion resistance; it was an ideal material to use. Graphs. 7 ref. (Wang, G.; Wan, P.; Liu, Z.; Corrosion Control – 7th Apccc. Vol. 2, China, 1991, Publisher: International Academic Publishers (1991), (Met. A., 9206-72-0284), , 1250-1255 [in English].)

1762 AN ATTEMPT IN EVALUATING THE EROSION—CORROSION RESISTANCE OF STAINLESS ALLOYS BY USING THE REPASSIVATION KINETICS PARAMETERS. [MATE-199206-35-1073]
The true current density decay law at initial stage of eight types of stainless alloys has been determined by using scratching rotating disk electrode under potential control in the solution simulating the corrosion medium for slurry pumps in wet process phosphoric acid production (WPA), and can be expressed by an equation $i(t) = i_0\exp(-\beta t)$. The erosion-corrosion rates V of alloys were determined by the method of weight loss of rotating specimen with the linear velocity of 20 m/s in the slurry in WPA. The hardness HB of eight types of alloys was also determined. According to the result that the

orders of tested alloys arranged by the values of i_0 or by the values of V are about the same, it was considered feasible to evaluate the erosion-corrosion resistance of stainless alloys by using the repassivation kinetics parameters i_0 and beta . Comparing the order of eight types of alloys arranged by the values of HB with those arranged by the values of V, it is clear that there is no regular relationship between the erosion–corrosion resistance in the slurry of WPA and the hardness for stainless alloys. Graphs. 7 ref. (Yu, F.; Zheng, Y.; Gong, M.; Wang, Y.; Wang, J.; Corrosion Control – 7th APCCC. Vol. 2, China, 1991, Publisher: International Academic Publishers (1991), (Met. A., 9206-72-0284), 1264-1269 [in English].)

1763 FOAM/FROTH FLOTATION. II. REMOVAL OF PARTICULATE MATTER. [MATE-199206-41-0146]

Many aspects of the flotation process are examined, referring mainly to the separation of particulate matter. The effect of particle size is analyzed, stressing the effect of the finer fractions; the role of bubble size is also examined. Among the flotation techniques investigated are those capable of treating fines, such as electrolytic flotation, dissolved-air flotation and column flotation. Operation and design are also discussed. The subject of mineral processing is finally addressed, since it is the main application of the process. Minerals discussed are: barite, cassiterite, fluorite, galena, pyrite, pyrrhotite, quartz, sphalerite and tungsten ores. Graphs. 80 ref. (Matis, K.A.; Mavros, P.; Separation and Purification Methods, 1991, 20, (2), 163-198 [in English]. ISSN 0360-2540)

1764 CRUST FORMATION AND DETERIORATION IN INDUSTRIAL CELLS. [MATE-199206-42-0429]

The formation and deterioration of crust in industrial Al reduction cells have been investigated. Temperature profiles of several crusts were recorded continuously over a period of three to ten days and process events examined. Crust samples were taken and analysed for composition, structure and density, etc. Results indicate that an alumina network formed during sintering of a crust is an important factor in the formation of a hard crust. However, observation and calculation show that a proportion of crust was in the liquid phase 740 °C. Liquefaction and loss of the bath from the crust is one cause of deterioration. The dynamics of heat transfer into and through the crust is a major factor in the destabilisation of the crust through liquefaction and other phase transformation. Transient simulations show that heat accumulated inside the crust can conspire with phase transformation there to cause continual melting of the bath components and degradation of the crust. Graphs, Photomicrographs. 13 ref. (Liu, X.; Taylor, M.P.; George, S.F.; Light Metals 1992, San Diego, California, USA, 1-5 Mar. 1992, Publisher: The Minerals, Metals & Materials Society (1992), (Met. A., 9206-72-0273), 489-494 [in English].)

1765 ALUMINA CRUSTING IN CRYOLITIC MELTS. I. PENETRATION OF MOLTEN ELECTROLYTE INTO ALUMINA. [MATE-199206-42-0430]

Crust formation was studied in bench scale tests by adding cold alumina to a bath contained in a 160 mm (id) graphite crucible. A heat flux probe and a set of thermocouples embedded in the alumina in fixed positions above the bath level allowed dynamic studies of the crusting process. By applying a potential between the graphite crucible and the thermocouples, the time when the liquid bath arrived at each of the thermocouples could be detected as a current signal. The measured bath penetration rates, temperatures at the bath front and heat fluxes are discussed in relation to the experimental variables: bath composition, bath temperature and alumina properties. Graphs, Phase diagrams. 16 ref. (Eggen, T.; Rolseth, S.; Rye, K.A.; Thonstad, J.; Light Metals 1992, San Diego, California, USA, 1-5 Mar. 1992, Publisher: The Minerals, Metals & Materials Society (1992), (Met. A., 9206-72-0273), 495-502 [in English].)

1766 ALUMINA CRUSTING IN CRYOLITIC MELTS PART II. BULK PROPERTIES OF CRUST. [MATE-199206-42-0431]

The density, thickness and thermal conductivity were determined for a number of crusts formed in the laboratory. The results were treated statistically to uncover the influence of the individual properties of the bath and the alumina. The results indicate that a thick crust is obtained if the bath has a high temperature, high superheat and a low excess AlF_3 (high CR) and the alumina is low in fines and alpha . A high heat loss from the bath through the crust (high heat flux) is obtained for the same parameters. Graphs. 10 ref. (Rye, K.A.; Light Metals 1992, San Diego, California, USA, 1-5 Mar. 1992, Publisher: The Minerals, Metals & Materials Society (1992), (Met. A., 9206-72-0273), 503-509 [in English].)

1767 THE EFFECT OF A FLUIDIZED BED OF GLASS PARTICLES ON CATHODIC PROCESSES DURING REDUCTION OF CADMIUM IONS. [MATE-199206-43-0138]

Previously abstracted from original as item 9203-43-0055. Effects of hydrodynamic and mechanical factors on electrolysis intensity in a fluidized bed of glass particles, the degree of metal extraction, and the quality of the metal deposit were studied with electroreduction of Cd present in spent Cd electrolytes and plating rinse waters. Diffusion limit current was measured in dependence on electrolyte flow rate and was calculated with the use of a proposed equation applicable for glass beads. Effects of the supporting electrolyte on limit current and of operating current density on cathodic Cd deposits were also measured. Changes in Cd concentration in dependence on the number of electrolysis cycles were measured and calculated from a known equation. The mechanism of mass transfer during collisions of particles with the cathode surface was studied. Graphs. 11 ref. (Shvab, N.A.; Stefanyak, N.V.; Kondruk, E.I.; Sobkevich, V.A.; Kazdobin, K.A.; Soviet Progress in Chemistry, Oct. 1990, 56, (10), 49-53 [in English]. ISSN 0038-5743)

1768 LAYOUT OF A LOW TEMPERATURE INCINERATOR: PROCESS AND MATERIAL CONCEPT. [MATE-199206-43-0145]

Feed for the incinerator consists of household and similar industrial wastes, to which sewage sludge can be added. Heated gas flows through the mixture for approx 1 h, heating the waste to approx 450 °C. The product gases flow into a combustor. Solid wastes are sieved, fractions 5 mm contain approx 30% carbon and are charged into the combustor maintained at 1300 °C. Residues and gases are treated further before release to the environment. The incinerator requires non-identified materials, which dependent on their location are exposed to corrosion, wear, or high temperatures. (May, K.W.; Langer, R.; Kilian, R.; Wieling, N.; Ingenieur Werkstoffe, June 1991, 3, (6), 35-36,38 [in German]. ISSN 0935-5715)

1769 PERFORMANCE OF SOIL FLUSHING AND GROUNDWATER EXTRACTION AT THE UNITED CHROME SUPERFUND SITE. [MATE-199206-43-0151]

In 1987, CH2M Hill, under contract to the US EPA, undertook the cleanup of the United Chrome Superfund site in Corvallis, Oregon. Waste disposal practices and leaky plating tanks at this chrome plating facility had resulted in heavy contamination of soil and groundwater by hexavalent Cr. Distinguishing elements of this site remediation project were two infiltration basins to flush contaminated soils, a 23-well groundwater extraction network in low permeability soils, and treatment of the concentrated Cr wastewaters. Remedial actions also included decontamination and demolition of structures, and offsite disposal of 1100 tons of contaminated soil and debris. The infiltration basins and groundwater extraction and treatment system have been operating since July 1988. The data and experience gathered on the system's performance during the two years of operation, and points to potential applications at other sites, are reported. 8 ref. (Sturges, S.G.; McBeth, P.; Pratt, R.C.; Symposium on Characterization and Cleanup of Chemical Waste Sites, Washington, D.C., USA, 29 Aug. 1990., Journal of Hazardous Materials, Dec. 1991, 29, (1), 59-78 [in English]. ISSN 0304-3894)

1770 BASIC FERRIC ARSENATES—NON EXISTENT. [MATE-199206-44-0061]

The effective removal of arsenic (V) from process streams and waste waters by precipitation with excess iron (III) is sometimes attributed to the formation of basic ferric arsenates. This system was investigated extensively using a variety of techniques and it was concluded that the solid phase produced is iron (III) oxyhydroxide (ferrihydrite) with As (V) adsorptively bound to the 2-3 nm particles. 16 ref. (Robins, R.G.; Wong, P.L.M.; Nishimura, T.; Khoe, G.H.; Huang, J.C.Y.; EPD Congress 1992, San Diego, California, USA, 1-5

Mar. 1992, Publisher: The Minerals, Metals & Materials Society (1991), (Met. A., 9206-72-0283), 31-39 [in English].)

1771 RECOVERY OF METALS FROM WASTEWATER. [MATE-199206-44-0067]

To avoid the escalating cost of disposal of metals-containing wastewater and residues, new wastewater treatments will focus on the recovery of the metals. A combination of ion exchange and electrowinning can produce water suitable for discharge and relatively pure metals (e.g. Cu, Cd, Zn, Pb, Ni). The use of a celating resin can enhance the selectivity of both the removal process and the elution of metals from the resin. A new, simple method of preparing a variety of chelating resins is being developed. The materials produced by this method exhibit interesting, and potentially useful, elution behavior. The performance of one test resin is described. Graphs. 3 ref. (Harris, T.M.; Jones, D.B.; Shang, A.; Berkenbile, L.; Logsdon, G.; EPD Congress 1992, San Diego, California, USA, 1-5 Mar. 1992, Publisher: The Minerals, Metals & Materials Society (1991), (Met. A., 9206-72-0283), 155-163 [in English].)

1772 NEW ELECTROMAGNETIC RHEOCASTERS FOR THE PRODUCTION OF THIXOTROPIC ALUMINUM ALLOY SLURRIES. [MATE-199206-51-0818]

The working principle and the peculiarities of new electromagnetic rheocasters, which are based on the use of rotating permanent magnets and which allow the production of intense stirring in solidifying semi-solid alloy slurries, are described. These processes are likely to be applied to the direct continuous casting of billets, tubes and slabs and to the production of metal matrix composites. They are also characterized by a very low electric power consumption. Local measurement techniques are applied to the study of the evolution of the electromagnetic, hydrodynamic and thermal phenomena with the solid fraction, inside vigorously agitated melt–solid mixtures. Satisfactory performances concerning the microstructure of solidified Al thixotropic slurries (homogeneity, crystal shape, grain size, fraction of primary solid) were obtained. Alloys studied were 1050, 2024 and AS7G. Graphs, Photomicrographs. 15 ref. (Vives, C.; Light Metals 1992, San Diego, California, USA, 1-5 Mar. 1992, Publisher: The Minerals, Metals & Materials Society (1992), (Met. A., 9206-72-0273), 1257-1262 [in English].)

1773 DROSS AND ULTRAFINE PARTICULATE FORMATION IN UNDERWATER PLASMA-ARC CUTTING. [MATE-199206-53-0379]

Production rates and detailed chemical and physical characteristics of solid emissions from underwater plasma-arc cutting of non-active 304 grade stainless steel have been studied. Steel thicknesses to 40 mm have been cut in water depths of up to 10 m. A hyperbaric vessel and a deep water test column and associated experimental equipment and techniques were developed for these studies. Concentrations and compositions of effluent by-product gases were also investigated. Quantitative data and possible mechanisms involved in the following aspects of the project were achieved: (1) distribution, particle size and composition of solid emissions; (2) composition and flowrates of effluent gases; (3) effect of depth and other cutting conditions on solid and gaseous emissions; (4) filtration resistance characteristics of water suspended particles; and (5) repeatability of cut quality and yields of emissions under standard cutting conditions. Graphs, Spectra. 12 ref. (Waldie, B.; Harris, W.K.; Commission of the European Communities. Report, 1991, EUR 13798, Pp 147 [in English].)

1774 METHOD OF CONTINUOUSLY REMOVING AND OBTAINING ETHYLENE DIAMINE TETRACETIC ACID (EDTA) FROM THE PROCESS WATER OF ELECTROLESS COPPER PLATING. [MATE-199206-58-0821]

The invention relates to a method of continuously removing and obtaining ethylene diamine tetracetic acid (EDTA) from the process water of electroless Cu plating. For that purpose, the process water containing the EDTA is directed into an electrodialysis cell alternatingly equipped with bipolar membranes and anion exchange membranes and/or cation exchange membranes, and to which a potential difference is applied. The EDTA is converted into its charge-neutral form by means of protonation, and the protons required for that purpose are generated via bipolar membranes through electrodialysis. The required pH- value is adjusted by a pH-controlled electric field regulation via the bipolar membranes. (Bauer, B.; Erlmann, W.; 25 Feb. 1992 [in English]. Patent no.: US5091070 (USA) Convention date: 30 Aug. 1990)

1775 WET OXIDATION OF OIL-BEARING SULFIDE WASTES. [MATE-199206-58-0834]

Oil-bearing metal sulfide sludges produced in treatment of an industrial wastewater, which includes plating wastes, have yielded to treatment by electrooxidation and hydrogen peroxide processes. The oxidation can be controlled to be mild enough to avoid decomposition of the organic phase while oxidizing the sulfides to sulfates. The pH is controlled to near neutral conditions where Fe, Al and Cr (III) precipitate as hydrous oxides. Other metals, such as Pb and Ba, may be present as sulfate solution. The oxidations were found to proceed smoothly, without vigorous reaction; heat liberation was minimal. Graphs. 2 ref. (Miller, R.L.; Hotz, N.J.; EPD Congress 1992, San Diego, California, USA, 1-5 Mar. 1992, Publisher: The Minerals, Metals & Materials Society (1991), (Met. A., 9206-72-0283), 183-193 [in English].)

1776 FROTH FLOTATION OF OIL-BEARING METAL SULFIDE WASTES. [MATE-199206-58-0835]

An industrial wastewater, including plating wastes, is treated with sodium sulfide and ferrous sulfate to form a sulfide–oxide precipitate containing Cr and other toxic metals. Hydrocarbons, in the water, coat the sulfide–oxide particles, impeding metal recovery. Froth flotation, without reagent addition, was found to recover 93.9% of the solids from the sludge with simultaneous rejection of 89% of the water. Methyl isobutyl carbinol (MIBC) improved recovery and potassium amyl xanthate improved both recovery and grade. The process design has wastewater feed (without MIBC) to the rougher circuit. The rougher concentrate is conditioned with MIBC and fed to a cleaner circuit to achieve a high grade concentrate. About 95% of the water is recirculated to the waste treatment plant. Graphs. 3 ref. (Miller, R.L.; Atwood, R.L.; Ye, Y.; EPD COngress 1992, San Diego, California, USA, 1-5 Mar. 1992, Publisher: The Minerals, Metals & Materials Society (1991), (Met. A., 9206-72-0283), 195-204 [in English].)

1777 THE INFLUENCE OF THE FLOW FIELD IN SLURRY EROSION. [MATE-199207-31-2259]

The importance of knowledge of the flow field surrounding impinging particles and target is emphasized for an understanding of slurry erosion. The influence of the flow field on the rate of material loss through erosion in the absence of corrosion by slurries of small particle size (1 mm) and low solids loading is reviewed by examining experimental data on the effect of several factors on the rate of material removal, including liquid viscosity and density, particle size and size range, density and concentration, and target shape and the free stream velocity of the suspension. It is concluded that experimental data on material (steels, stainless steels, Al) erosion rates can only be understood if particle impact velocities and trajectories and the numbers of particles impacting the target surface are known. Some comments on slurry erosion test methods in the light of these considerations are presented. Graphs. 51 ref. (Clark, H.McI.; Wear, 31 Jan. 1992 , 152, (2), 223-240 [in English]. ISSN 0043-1648)

1778 EVALUATION OF COLD-BONDED REVERT BRIQUETTES AT THE USS GARY NO. 8 BLAST FURNACE. [MATE-199207-42-0537]

A trial was held at the USS Gary No. 8 blast furnace with 12 600 tonnes (15 000 net tons) of briquettes produced from a revert mixture of 39% mill scale, 33% C-fines (steelmaking slag fines), and 28% blast-furnace flue dust and sludge. When used a 5% of the furnace burden, no detrimental change in furnace operation was evident. At 10%, however, there was an increased tendency for the furnace to hang and slip, but at 15%, severe hanging and slipping occurred. The trial is discussed along with pertinent background information. (Wargo, R.T.; Bogdan, E.A.; Myuklebust, K.L.; White, D.G.; Ironmaking Conference Proceedings. Vol. 50, Washington, DC, USA, 14-17 Apr. 1991, Publisher: Iron and Steel Society (1991), (Met. A., 9207-72-0296), 69-87 [in English].)

1779 NITE/DENITE BAT TREATMENT OF COKE WASTEWATER. [MATE-199207-42-0585]
The installation and first 120 days of start-up and operation of Nite/Denite at the Geneva Steel Works in Orem, Utah, are presented. Nite/Denite is an EPA recognized innovative technology for the BAT level biological treatment of high nitrogen strength coke plant wastewaters. The Geneva Nite/Denite plant was designed and constructed on schedule and started up without incident and in record time. Successful use of the Nite/Denite system has avoided the need for an ammonia still and minimized overall coke plant costs for achieving BAT-level treatment of its coke plant process water and groundwater. The Geneva Nite/Denite plant processes approx 150-180 gallon/min of combined process and ground waters containing up to 3000 ppm of free/fixed ammonia, cyanide, thiocyanate and approx 9000 ppm of phenols and other organics in a patented, single-stage biological reaction system wherein organics are completely oxidized and N compounds are completely nitrified and denitrified. Treated water meets all BAT requirements and contains 10 ppm of ammonia. Substantially complete denitrification can result in the discharge of 20 ppm residual nitrite/nitrate. Graphs. (Darian, S.; Arabshahi, S.-H.; Shaw, K.C.; Ironmaking Conference Proceedings. Vol. 50, Washington, DC, USA, 14-17 Apr. 1991, Publisher: Iron and Steel Society (1991), (Met. A., 9207-72-0296), 579-585 [in English].)

1780 WASTEWATER TREATMENT CONTROL AT USS CLAIRTON COKE WORKS. [MATE-199207-42-0586]
The USS Clairton Coke Works (Clairton) operates a single stage activated sludge treatment system for the treatment of wastewater. The activated sludge treatment system was originally designed for organics removal from the wastewater. Since its installation in the 1970's, the NPDES permit limits have become more stringent. In the late 1980's, Clairton initiated a "Continuous Improvement to Environment" (CITE) employee training and operating improvement program. During 1990, Clairton made a concerted effort to put controls into place. The main strategies consisted of monitoring and controlling operating parameters within rigid limits. This treatment approach met with immediate success. The strategy adopted by Clairton is adapting statistical control format and graphical control with engineered limits of selected critical process control parameters and the monitoring program used to improve environmental discharges are addressed. (Terza, R.; Bhattacharyya, A.; Dern, J.; Ironmaking Conference Proceedings. Vol. 50, Washington, DC, USA, 14-17 Apr. 1991, Publisher: Iron and Steel Society (1991), (Met. A., 9207-72-0296), 587-600 [in English].)

1781 HIGH TEMPERATURE RECOVERY AND REUSE OF SPECIALTY STEEL PICKLING MATERIALS AND REFRACTORIES AT INMETCO. [MATE-199207-45-0727]
Since 1978, INMETCO has been well known for recycling byproducts from the production of stainless steel: EAF baghouse dust; mill scale; and grinding swarf. INMETCO operates the only smelter in North America dedicated to the recovery of Ni, Cr, and Fe from hazardous and nonhazardous waste. In recent years, the process has been successfully modified to accept and recycle a wider variety of other specialty steel waste streams including: spent pickling solutions, pickling and waste water treatment filter cakes, acid scale, carbon brick from pickling tanks, K061 baghouse bags, torch cutter dusts and spent dolomitic and Cr-bearing refractories. A detailed review of the complete INMETCO process, with special emphasis on processing pickling wastes and spent refractories, is discussed including environmental and liability considerations. (Hanewald, R.H.; Schweyer, D.L.; Hoffman, D.M.; Electric Furnace Conference Proceedings. Vol. 49, Toronto, Canada, 12-15 Nov. 1991, Publisher: Iron and Steel Society, Inc. (1992), (Met. A., 9207-72-0313), 141-146 [in English].)

1782 MANAGEMENT OF ENVIRONMENTAL CONTROL IN THE JAPANESE STEEL INDUSTRY. [MATE-199207-45-0750]
The efforts of the Japanese steel industry to build plants which are clean and energy efficient are described and future subjects for study are outlined. The primary environmental concerns addressed are air pollution, water pollution, noise control, waste utilization and development of energy saving measures and global warming. Measures to address the environmental problems both at the level of individual steelmakers and in cooperation with other companies are discussed. Efforts made by individual steelmakers include improvement of production equipment and operation modes, improvement and consolidation of environmental control systems and creation of desirable environment and enhancement of regional cooperations. Specific control measures incepted in each area are briefly described. Efforts made by the industry include establishment of a nitrogen oxide fund and a nitrogen oxide research association and involvement in an International Committee on Environmental Affairs. Graphs. 6 ref. (Yoshida, M.; Publisher: International Iron and Steel Institute (1992) Environmental Control in the Steel Industry, (Met. A., 9207-72-0323), 27-57 [in English].)

1783 AN INTERNATIONAL CHALLENGE: ENVIRONMENTAL AND LEGAL REALITIES IN THE STEEL INDUSTRY. [MATE-199207-45-0751]
The environmental and legal realities confronting the steel industry are discussed in terms of stimulus and response. Current and future regulatory stimuli facing the steel industry are delineated and industry response is described in the form of a proactive environmental management plan created to assure achievement of environmental compliance consistent with thee highest global, corporate, regulatory and community standards. Case studies which illustrate the use of the method described are provided. These are: an auditing program example based on an effluent survey in the steel industry; handling of spent pickle liquor; and mill scale blending. Graphs. 14 ref. (Kannar, A.; Poulsen, D.; Stanier, R.J.; Publisher: International Iron and Steel Institute (1992) Environmental Control in the Steel Industry, (Met. A., 9207-72-0323), 68-84 [in English].)

1784 POLLUTION CONTROL IN THE IRON AND STEEL INDUSTRY OF CHINA. [MATE-199207-45-0754]
Laws, policies, regulations and standards related to environmental protection which have been established by the Chinese government are discussed with a focus on those pertinent to the steel industry. The directives make known the requirements for environmental management and monitoring, design needs for pollution control (waste water, fumes, slag, noise, etc.) and targets that should be attained. Environmental monitoring organizations have been set up to form a monitoring network that consists of a ministerial monitoring center, 25 provincial monitoring stations and 82 stations in main enterprises. The main pollution sources in the iron and steel industry are reviewed. Control measures taken in the areas of sintering plant and open hearth fume control, blast furnace and coke plant waste water treatment, sinter plant and blast furnace noise abatement and slag handling and utilization are briefly described. (Liu, Y.; Zhu, Q.; Publisher: International Iron and Steel Institute (1992) Environmental Control in the Steel Industry, (Met. A., 9207-72-0323), 119-123 [in English].)

1785 WASTE WATER CONTROL IN THE JAPANESE IRON AND STEEL INDUSTRY. [MATE-199207-45-0771]
National, local and COD_{mn} load control standards in Japan are discussed and water treatment measures used in the iron and steel industry to comply with them are described. All waste water used in the industry is suitably treated and then recycled or re-used. Discharge into public water is very small and the circulation rate is 90%. The steel industry uses both fresh and salt water. Water treatment procedures described include: suspended solid treatment for converter gas cleaning water; oil treatment for cold strip mill water; treatment for Cr in water from the galvanizing process; and activated sludge process in COD treatment for coke oven water. In addition to water treatment procedures, treatments used for hydrogen chloride and ferrite recovery from waste acid and nitric and hydrofluoric acids recovery from waste acid using diffusion dialysis are also described. Graphs. (Nagasawa, T.; Kawaura, T.; Publisher: International Iron and Steel Institute (1992) Environmental Control in the Steel Industry, (Met. A., 9207-72-0323), 385-397 [in English].)

1786 RECENT DEVELOPMENTS IN THE TREATMENT OF COKE OVEN WASTE WATER. [MATE-199207-45-0772]
Major developments that have taken place in each of the stages involved in the treatment of coke plant effluents are reviewed. Emphasis is placed on those techniques which are already being fully applied, rather than innovative

methods that are still at an early stage of development. Techniques discussed in the area of pretreatment of coke plant effluents include ammonia stripping and biological treatment. Post-treatment processes, designed to effect final polishing of the effluent before discharge, deal primarily with methods to meet discharge limits for suspended solids. The two most widely used processes in this are are air flotation and gravity filtration through sand beds. Granular activated carbon may be used for removal of color or residual organics. Graphs. 20 ref. (Prater, B.E.; Fisher, R.; Publisher: International Iron and Steel Institute (1992) Environmental Control in the Steel Industry, (Met. A., 9207-72-0323), 398-417 [in English].)

1787 NEW FINDINGS ON THE WAY TO A WASTE WATER FREE OPERATION OF A COKE OVEN PLANT. [MATE-199207-45-0773]
The question of whether it would be possible to clean coking plant surplus water so that it was equivalent to that of the process water grade and avoid the draining of waste water completely is discussed. The practical method to yield process water is to clean waste water by reverse osmosis. To use this process, the process of modifying coke oven gas cooling needed to be addressed. Methods for gas cooling and surplus water recovery had to be developed. Based on preliminary tests to accomplish the desired process, a test plant was built at an operating coke oven plat. While the surplus water recovery facilities of the test plant were more or less identical with the original layout, downstream cleaning was added. The surplus water from the first condensation stage was finally cooled and pretreated by multilayer back flush filter. Subsequently, it was treated by a 2 x 2 module microfiltration unit. The residual concentrate was recirculated to the tar/water separator and the filtrate fed to the two stage reverse osmosis unit. The concentrate yielded in the second stage was recirculated to the first stage while the first stage concentrate was piped into the liquor circuit via a liquid/liquid exchanger. It is expected that a new system for process water recovery from coking plant surplus water will be developed and working within the next two years. (Eisenhut, W.; Orywal, F.; Pollert, G.; Publisher: International Iron and Steel Institute (1992) Environmental Control in the Steel Industry, (Met. A., 9207-72-0323), 418-422 [in English].)

1788 ESTABLISHMENT OF ACTIVATED SLUDGE TREATMENT OF AMMONIA LIQUOR FROM A COKE PLANT. [MATE-199207-45-0774]
The causes of the various types of abnormal phenomena which occurred in the activated sludge treatment of ammonia liquor from a coke plant are explained. Details are given of the restoration technologies such as the control of the oxidation/reduction potential (ORP) in the aeration tank. Balancing the ORP levels formed in the activated sludge treatment process was found to be very effective in controlling abnormal phenomena and, when combined with rice bran addition, facilitated early restoration of normal operating conditions. Graphs. (Fujii, M.; Publisher: International Iron and Steel Institute (1992) Environmental Control in the Steel Industry, (Met. A., 9207-72-0323), 443-453 [in English].)

1789 NEW PROCESS FOR THE TREATMENT OF RESIDUES FROM INTEGRATED STEEL MILLS. [MATE-199207-45-0834]
The selective reduction process was verified by tests with residues from Thyssen Stahl AG in a modified 0.2 m CFB plant at Lurgi's R&D facility. An extended pilot plant to be used for long-term tests and to derive upscaling data is currently being constructed on the premises of Thyssen Stahl AG. To ensure that all aspects of CFB technology can be covered, this pilot plant will be equipped to reduce the Fe content of the residues to metallic Fe. After approx 20 000 t of Thyssen residues have been treated, the data collected by then will allow one to say whether the concept is technically and economically feasible on an industrial scale. Further tests will then follow to find out whether the know-how derived in this way can also be applied to steel mill residues from other producers. Graphs. 7 ref. (Kaune, A.; Peters, K.-H.; Harter, U.; Hirsch, M.; Janssen, K.; Ironmaking Conference Proceedings. Vol. 50, Washington, DC, USAa, 14-17 Apr. 1991, Publisher: Iron and Steel Society (1991), (Met. A., 9207-72-0296), 129-137 [in English].)

1790 THE PRODUCTION OF FERRITE COMPLEX FLUXES (FCF) AT NOVOLIPETSK IRON AND STEEL WORKS. [MATE-199207-45-0835]
The problem of steelmaking sludges preparation and utilization is complicated and has no universal solution for the present. In the US, sludge reprocessing developed by Inmetco and in Japan, developments of the Kawasaki Satatsu and Kawasaki Dzakoge firms with reprocessing of steelmaking sludges containing Zn, Pb and alkali metals have been successful. Analysis of efforts of steelmaking sludge use in BOF heats reveal that the most rational way to organize a closed loop of sludges utilization is in the production of complex ferrite slag-forming fluxes by agglomeration. A process flow diagram of BOF sludge preparation and their utilization with Zn content have been worked out in an industrial scale. It consists of the following operations: thickening, filtration, mixing with fine-grained limestone and sintering. Experiments of ferrite complex fluxes at the Novolipetsk Iron and Steel Works are described. 5 ref. (Khaidurov, V.P.; Karpenko, E.V.; Zevin, S.M.; Tumanova, T.A.; Ironmaking Conference Proceedings. Vol. 50, Washington, DC, USA, 14-17 Apr. 1991, Publisher: Iron and Steel Society (1991), (Met. A., 9207-72-0296), 139-143 [in English].)

1791 APPARATUS FOR RECOVERY OF HEAVY METALS FROM HIGHLY CONCENTRATED WASTEWATER SOLUTIONS. [MATE-199207-61-0512]
A reactor for recovering metals such as Cu, Sn and Pb from concentrated, acidic aqueous solutions is disclosed. The reactor includes a reaction vessel retaining a bed of scrap Al in a packed bed above the bottom of the vessel, a plenum below the packed bed of scrap Al, and a filter situated within the plenum, including a first perforated pipe enclosing a coaxial second perforated pipe, through which liquid can be filtered and withdrawn for recirculation into the reactor above the packed bed of scrap Al. Metal recovery is effected by reduction of metal ions in solution and precipitation onto the scrap Al. Multiple reactor systems including equipment required for pH adjustment of the wastewater also may be used. (Fehsenfeld, J.; Vujasin, B.; 3 Mar. 1992 [in English]. Patent no.: US5092563 (USA) Convention date: 26 Sept. 1990)

1792 INDUSTRIAL WASTEWATER PRETREATMENT: NECESSITY AND METHODS. [MATE-199207-71-0162]
Regulations establishing a national pretreatment program for industrially generated wastewater are discussed and standards for existing and new industrial sources which resulted from the regulations are described. The primary emphasis of these standards is to control the discharge of toxic and hazardous substances into the environment. Options and alternatives for pretreating industrial wastewaters on-site to meet discharge limits are presented. On-site wastewater treatment technologies described are sedimentation, ultrafiltration, evaporation, reverse osmosis, chemical treatment, filtration and sludge treatment. (Houghton, E.J.; Manfacturing Solutions. Vol. 2, Nashville, Tennessee, USA, 23-26 Feb. 1992, Publisher: Precision Metalforming Association (1992), (Met. A., 9207-72-0325), 555-568 [in English].)

1793 EFFECT OF GAS SPARGING ON THE REMOVAL OF HEAVY METAL IONS FROM INDUSTRIAL WASTEWATER BY A CEMENTATION TECHNIQUE. [MATE-199208-34-0739]
The effect of nitrogen sparging on the rate of diffusion controlled cementation of Cu on a single vertical Zn rod from a simulated waste solution of copper sulphate was studied. Variables investigated were N superficial velocity, diameter and height of the Zn rod, and the physical properties of the solution (adding glycerol). These variables were studied for their effect on the mass transfer coefficient of Cu cementation. The mass transfer coefficient was found to increase with increasing superficial gas velocity. Increasing both diameter and height of the Zn rod were found to decrease the mass transfer coefficient. Mass transfer data were correlated by the equation: $j = 0.48\,(Fr.Re)^{-0.13} x\,(d_r/d)^{-0.83} x\,(L/d)^{-0.61}$ for the conditions: 1430 Sc 2488; 0.041 Fr x Re 1.41; 0.07 d_r/d 0.3 and 0.2 L/d 1. Graphs. 33 ref. (Zarraa, M.A.; Hydrometallurgy, Apr. 1992, 28, (3), 423-433 [in English]. ISSN 0304-386X)

1794 NEW SPECIFIC CHELATE-FORMING METALFIX ION EXCHANGERS. II. [MATE-199208-42-0634]
Synthetic resins can extract heavy and non-ferrous metals from solutions. Processes described include the cleaning of an Au – Co bath with Chelamin

or Chelosolve, rejuvenation of an Au – Ni bath with Chelammonium, smoke and waste water cleaning with Pappett media, and recovery of Rh with Chelamin. Graphs. 8 ref. (Jeanneret, G.; Jeanneret, J.M.; Pousaz, P.; Soerensen, C.; Oberflache Surface, Aug. 1991, 32, (8), 20-23 [in German]. ISSN 0048-1270)

1795 KINETICS OF ZINC AND COBALT SULPHIDE PRECIPITATION AND ITS APPLICATION IN HYDROMETALLURGICAL SEPARATION. [MATE-199208-42-0639]

Zinc and cobalt sulphides are precipitated from an ammoniacal solution containing ammonium sulphate by controlled addition of sodium sulphide solution. The kinetics of the reaction have been studied. Zinc shows first order kinetics, whereas Co shows three kinetic regions with an induction period in the first region. This difference is exploited to obtain differential precipitation of sulphides. Graphs. 21 ref. (Mishra, P.K.; Das, R.P.; Hydrometallurgy, Apr. 1992, 28, (3), 373-379 [in English]. ISSN 0304-386X)

1796 CHLORIDE HYDROMETALLURGY. [MATE-199208-42-0643]

In hydrometallurgy, chloride solutions may be used instead of sulfate solutions. Due to complexation by chloride ions, most metals of interest in non-ferrous metallurgy are highly soluble in water. Potential series are different from the standard ones. Electrochemical reactions are highly reversible. The structure of metal deposits is worse for normal or intermediate metals but better for inert metals in chloride than in sulfate solutions. Solutions are highly conductive. Leaching of sulfides usually occurs more easily in chloride than in sulfate solutions. Regeneration of the leaching power can be achieved by oxidation or by pyrohydrolysis. Solvent extraction is a very powerful tool for purification of solutions. A number of processes have been proposed in chloride hydrometallurgy. So far, with one exception, only processes based on intermediate metallurgical products are still in operation. Recycling metallurgy and precious metals recovery will probably be developed next, followed later by complex sulfide concentrates processing. Recovery of Cu, Zn, Pb and Fe is discussed. Photomicrographs, Graphs. 92 ref. (Winand, R.; Hydrometallurgy, Dec. 1991, 27, (3), 285-316 [in English]. ISSN 0304-386X)

1797 THE REMOVAL OF CHROMIUM, NICKEL, AND ZINC FROM ELECTROPLATING WASTEWATER BY ADSORBING COLLOID FLOTATION WITH A SODIUM DODECYLSULFATE/DODECANOIC ACID MIXTURE. [MATE-199208-43-0192]

The removal by adsorbing colloid flotation of Cr(III), Ni(II), and Zn(II) from Cr stream electroplating wastewater was investigated. Adsorbing colloid flotation involves the stripping of contaminants by adsorption or coprecipitation onto added colloidal material and its subsequent flotation by column flotation. The added colloid may be prepared prior to the adsorption step or, as in this case, prepared in situ by the hydrolysis of added metal Fe(III) ions. Adsorbing colloid flotation using a single surfactant (SDS) in the batch mode was shown to result in poor results for "real" industrial samples, presumably due to the chemical complexity of such samples. However, a dual surfactant system sodium dodecylsulfate (SDS) + dodecanoic acid (DA) provided encouraging results. By using such a dual surfactant system, Cr stream electroplating wastewater was treated, successfully lowering metal ion contamination levels to below that required for discharge into typical metropolitan drainage systems. Flotation was found to be successful at near neutral pH conditions (7.5) and for several different (electroplating) industrial samples. Adsorbing colloid flotation in the continuous mode was investigated by using the dual surfactant system optimized in batch experiments. At flow rates encouraging to full-scale commercial applications, toxic metal ions Cr(III), Ni(II), Zn(II) were stripped from contaminated industrial samples to 10 ppm typically required for metropolitan discharge. A two-stage continuous processing scheme was investigated where once-treated effluent was passed through a second "polishing" column. Use of this two-stage process typically resulted in the stripping of toxic metal ions (from similar samples) to well below the 1 ppm level typically required for environmental discharge. Graphs. 14 ref. (Sanciolo, P.; Harding, I.H.; Mainwaring, D.E.; Separation Science and Technology, Mar. 1992, 27, (3), 375-388 [in English]. ISSN 0149-6395)

1798 WASTE MANAGEMENT IN STEEL INDUSTRY—A SUGGESTED APPROACH. [MATE-199208-43-0206]

Integrated iron and steel works utilise approx 5-6 t of raw materials such as, fuel, air, water and power to produce 1 t of steel. Almost all the steel produced in India comes from the conventional blast furnace route – where approx 4-5 t of wastes are generated/tonne of steel produced. At present 15-20% of these wastes are utilised in the process of iron and steel making and the rest are dumped in the surroundings. The utilisation figure in advanced countries is 80% and in one of the steel plants in Japan it is 98%. The utilisation of wastes largely depends upon the technology adopted and the quality of raw materials. Such utilisation cuts down the production cost and ensures a better environment. There is tremendous scope for proper management of wastes in Indian integrated steel works. The nature of wastes and their present and proposed utilisation are discussed. The alternate route of steel making through direct reduction and the mini steel plant producers have not been considered. The methodology suggested for wastes utilisation generated from various processes of conventional integrated steel works can also be selectively used for the alternate routes of steel making. 16 ref. (Saxena, A.K.; Roy, A.P.; Journal of the Institution of Engineers (India), Metallurgy and Material Science, Mar. 1991, 71, (MMSP), 77-85 [in English]. ISSN 0257-4411)

1799 WASTE MANAGEMENT IN STEEL INDUSTRY—A SUGGESTED APPROACH. [MATE-199208-43-0207]

The manufacture of steel is a complicated and costly business and large quantities of waste are inevitably produced and have to be disposed of. Typical wastes are from coal, coke, ore, fly ash, slag, effluents from coke ovens and pickling plants. These wastes are considered separately with the usual methods of their disposal, wherever possible for useful purposes. Further consideration is given to gaseous wastes, heat and energy, all of which are also produced. In many respects, the Indian steel industry is not as efficient as it could be. The management of waste has to be improved in efficiency, including the use of manpower. 22 ref. (Raja, K.; Mitra, P.K.; Haque, R.; Journal of the Institution of Engineers (India), Metallurgy and Material Science , Mar. 1991, 71, (MMSP), 91-100 [in English]. ISSN 0257-4411)

1800 SELECTIVE RECOVERY OF PRECIOUS METALS IN ELECTROPLATING. [MATE-199208-43-0210]

For economic reasons, the electroplating industrialist has been occupied with the recovery of precious metals introduced into rinsing waters during surface treatments. Recovery on ion exchanging resins was traditionally used to decrease the metal content in rinsing baths. Recently, high efficiency recovery electrolysers have reached the market. These improve workshop productivity by offering a better quality in rinsing waters, a decrease in losses by draw-off and better management of toxic wastes. A description of the performances of these new techniques for treatment of waters by electrolysis is given. Metals removed include: Ni, Au, Pd, Cd, Cu. Graphs. 7 ref. (Wiaux, J.-P.; Nguyen, T.; Galvano-organo-traitements de Surface, May 1991, (616), 587-593 [in French]. ISSN 0302-6477)

1801 TREATMENT OF AN ANODIZING WASTE TO WATER-QUALITY-BASED EFFLUENT LIMITS. [MATE-199208-43-0211]

Treatability tests performed on anodizing wastewaters demonstrated that hydroxide precipitation was a very effective treatment process for removal of Al, Cu, Ni, and Zn. The tests showed that water-quality-based limits for these metals could be achieved by single-state precipitation consisting of pH adjustment, clarification and filtration. The optimum pH range for precipitation was 7.0-8.0. Because one set of tests showed optimum metal performance at pH values of 7. and 9.0, two-stage metal precipitation capabilities were incorporated into the design. Under this arrangement, the first stage would consist of pH adjustment to 9.0 followed by clarification, and the second stage would consist of pH adjustment to 7.5 followed by filtration. Graphs. 3 ref. (Naziruddin, M.; Patrick, G.C.; McCune, L.; Metal Finishing, Feb. 1992 , 90, (2), 69-74 [in English]. ISSN 0026-0576)

1802 BACTERIAL LEACHING OF GALVANIC SLUDGE FROM METAL PROCESSING INDUSTRIES. [MATE-199208-43-0216]

Different strains of Thiobacillus ferrooxidans and Thiobacillus thiooxidans

were used for the leaching of galvanic sludge. The results were determined from the extraction values of three reference metals (Cu, Ag and Pb) and from the pH-development of the lixiviant. Biogenic activities of T. ferrooxidans at 30 and 35 °C, respectively, were not significantly different. The $FeSO_4$ concentration in the nutrient medium of T. ferrooxidans was found to be 4 g/l for the maximal extraction of Ag and Pb. The semicontinuous leaching with T. thiooxidans resulted in extraction of 62% Cu, 1.5% Ag, 1.3% Pb with TO 62, and 60% Cu, 1.0% Ag, 1.4% Pb with TO 80, respectively. Graphs. 10 ref. (Brunner, H.; Schinner, F.; Metall, Sept. 1991, 45, (9), 898-899 [in German]. ISSN 0026-0746)

1803 HANDLING AND DISPOSAL OF LUBRICANTS? [MATE-199208-52-1148]

Health, safety, and ecological considerations are necessary when disposing of lubricants. Dry lubricants, i.e. soaps, can be disposed in refuse dumps if not contaminated with metal or process residues. Wet lubricants are usually high in hydrocarbon contents and disposal must take this into consideration. Various disposal schemes are discussed. The applicability of each one depends upon the characteristics of the oil, its biodegradability, and levels of synthetic constituents and additives. Steel wire drawing is discussed as a common lubrication-intense process. (Wire Industry, Dec. 1991, 58, (12), 735-736 [in English]. ISSN 0043-6011)

1804 REMOVAL OF VOLATILE ORGANIC COMPOUNDS IN AUTOMOTIVE FINISHING BY USING ENERGY EFFICIENT THERMAL TECHNOLOGY. [MATE-199208-57-1010]

Protecting the environment has been a long-standing goal of Jeep and the trend continues with the new Jeep Grand Cherokee and the new plant where it will be built. This new Jefferson North Assembly Plant of Chrysler Corp. in Detroit will use three specifically developed environmental systems involving thermal processing to greatly reduce releases of volatile organic compounds (VOCs) created by coating and painting vehicles. One technology will reduce VOCs in the paint spray booth air by a purification technique, another will reduce VOCs in the water collecting paint overspray by recycling wet paint sludge and the third changes a coating material to use an anti-chip powder instead of a liquid material that contains VOCs to prevent stones from chippng paint off the lower portions of a vechicle's body panels. The three unique ways, involving thermal technology, to provide environmentally-safe painting operations can be justified economically. Controlling pollution is a primary goal of every Chrysler plant. Since 1987, chemical releases have been reduced 70%. Phase diagrams. (Lasday, S.B.; Industrial Heating, Feb. 1992, 59, (2), 18, 20-21 [in English]. ISSN 0019-8374)

1805 CLOSED LOOP IN TWO STEPS. (A PRACTICAL APPROACH TO ZERO DISCHARGE OF WASTEWATER). [MATE-199208-57-1015]

Predicting and minimizing the volume of wastewater at the source of generation is the first step toward achieving a cost effective closed loop rinsing system. This task is simplified through the use of the rinsing formula. The initial goal is to reduce wastewater at the source by 80-95% through effective counterflow cascade rinsing, drag-out control and close monitoring of bath and rinse concentrations. Closed loop should be implemented when the volume of wastewater is successfully minimized and controlled. The choice of the most economical recycling and recovery methods is then made easier for integration in a second phase. 4 ref. (Whitmore, P.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 621-629 [in English].)

1806 AN OVERVIEW OF INORGANIC WASTEWATER SYSTEM OPERATIONS AND EQUIPMENT. [MATE-199208-57-1016]

The treatment of metal finishing wastewaters has matured over the last 20 years. Treatment chemistries of many different classes of wastewaters have been well-characterized with many references in the literature. During this time, there have been many wastewater treatment system (WWTS) failures. The major reasons for WWTS failure are improper system chemistry, improperly designed unit operations, and poor maintenance and operation. Today, higher discharge fines, more in-plant processes, and tougher regulations are making ever increasing demands for performance and reliability. The current thinking for the design and operation of an inorganic wastewater treatment system is reviewed. The areas examined are: system chemistry, influent pumping, chrome reduction/oxidation, segregated wastes and pretreatment, oil splitting, effluent filtration, clarification, reactions and reaction tanks, solids handling, chemical feeds, and system controls. Graphs. (Daily, T.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 631-645 [in English].)

1807 WHEN DO I NEED A WASTEWATER TREATABILITY STUDY? [MATE-199208-57-1017]

A well-conducted treatability study is an important initial step in any wastewater management program. The wastewater treatment industry has responded well to the ever-increasing demand for decreased wastewater discharge and improved treated effluent quality. Over the years, the result has been improved wastewater treatment technology. Due to time restraints, the end user who needs this technology has only general literature or the occasional sales visit to supply information. Unfortunately, wastewater treatment choices made from this limited information can yield insufficient and often costly results. The main elements which make up a proper treatability study are outlined. By way of selected case histories it is shown that initial treatability studies enabled clients to choose the most effective wastewater treatment approaches. The results are well selected wastewater treatment systems to meet future needs as well as current ones. (Henley, T.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 647-663 [in English].)

1808 THE ECONOMIC ANALYSIS OF WASTEWATER SYSTEM RETROFITS FOR THE METAL SURFACE FINISHER. [MATE-199208-57-1018]

Metal finishing and coating plant managers are facing escalating costs for the disposal of wastewaters generated in their production processes. This trend is expected to continue over the foreseeable future. With disposal costs increasing, retrofit technologies, treatment techniques, and equipment options, which in the past have not been economical, have become more attractive as an investment opportunity for reducing overall wastewater disposal costs. Engineers faced with the task of finding ways to reduce overall plant costs can turn to the waste disposal system as a way of generating savings. The factors affecting economics of a retrofit project are presented and methods for analyzing the economic justification of a project are discussed using examples. (Daily, T.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 665-692 [in English].)

1809 A STUDY OF THE EFFECTIVENESS OF CYANIDE DESTRUCTION USING FREE RESIDUAL CHLORINE MEASUREMENT TO CONTROL THE ALKALINE CHLORINATION PROCESS. [MATE-199208-57-1020]

The use of free residual Cl (FRC) as the control parameter for the alkaline chlorination process was investigated. An automatic process control algorithm was developed for application of this control strategy to a metal finishing wastewater. Bench-scale testing of several FRC analyzers under the harsh conditions of a metal finishing wastewater, resulted in the selection of three analyzers for subsequent pilot-scale testing at a metal finishing plant. Data from the bench-scale evaluations of the analyzers and results from the pilot-scale development and demonstration of FRC based process control are presented. Graphs. 10 ref. (Whittle, L.; Vachon, D.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 705-716 [in English].)

1810 CLEANING PAINT BOOTH WATER WITH INDUSTRIAL CENTRIFUGES. [MATE-199208-57-1022]

The basic principles of a paint booth centrifuge system are discussed and three systems currently in use are described. Centrifuges have been used very successfully to remove paint sludge from water in many different paint shop environments. Most applications today are on existing systems. They are easy

to install on existing systems and new installations. (Hampton, P.M.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 727-735 [in English].)

1811 ENVIRONMENTAL REGULATIONS AND SOLUTIONS IN SURFACE TECHNOLOGY IN THE SOVIET UNION. [MATE-199208-58-1078]
The size, structure and basic operations of the plating industry in the Soviet Union are described, with particular attention being paid to the level of water use, waste water regulations and water treatment methods employed to meet these regulations. Waste water from plating operations is regulated by the USSR State Standards. Local authorities in various regions and cities may also establish local regulations for plating shops in their areas. Compliance level is reported to be low due to inadequate laboratory and treatment facilities. The reagent method of water treatment has been the most commonly used water treatment procedure in the past. Due to the shortage of alkali and the problems encountered with clogging of pipelines by the formation of gypsum, the use of several other water treatment methods has been increasing. These alternative methods include electrocoagulation, galvanocoagulation, electroflotocoagulation with soluble anodes, ion exchange with electrolysis of eluates, reverse osmosis and electrolysis with large porous electrodes. Of these, electrolysis with large porous electrodes has been developed intensively for use in conjunction with production of PC boards. (Kudryavtsev, V.N.; Kotesnikov, V.A.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 127-132 [in English].)

1812 ADVANCES IN METAL RECOVERY. [MATE-199208-58-1098]
A lab study dealing with recovery of metal salts from aqueous solutions using organic agents by two different methods is described. The methods used were: (A) reduction under pressure to metal, and (B) precipitation followed by thermal decomposition in an inert atmosphere to carbon dioxide and the metal. Both processes and their applications are discussed. (Klos, K.-P.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 919-925 [in English].)

1813 RECOVERY OF PRECIOUS METALS WITH A PLATING BARREL. [MATE-199208-58-1100]
The feasibility of using an electroplating barrel to recover metals from waste plating solutions and rinse waters was investigated. Several experiments were carried out to recover Cu from waste acid copper sulfate and waste copper cyanide solutions. The method was found to have a high mass transfer rate and a low capital investment due to the use of existing barrels and power supplies in a plating shop. 3 ref. (Chin, D.-T.; Zhou, C.D.; SUR/FIN '91, Toronto, Canada, 24-27 June 1991, Publisher: American Electroplaters and Surface Finishers Society, Inc. (1991), (Met. A., 9208-72-0365), 969-976 [in English].)

1814 UP-TO-DATE SITUATION AND POSSIBILITIES OF FURTHER DEVELOPMENT IN UTILIZATION AND LIQUIDATION OF HOT-DIP GALVANIZING PLANTS WASTES. [MATE-199208-58-1151]
Hot-dip galvanizing of steel is a significant source of different solid and liquid waste products. Different possibilities of waste processing are discussed from both the environmental and economical point of view. 5 ref. (Havrankova, Z.; Koroze a Ochrana Materialu, 1991, 35, (2-3), 27-30 [in Czech]. ISSN 0023-4095)

1815 CLEAN WATER FOR BETTER PLATING. [MATE-199208-58-1159]
Continuous deionization (CDI) is being used to improve the water quality on plating lines. CDI combines an ion-exchange resin, ion-exchange membranes and electricity to purify water. Compared to traditional deionization, CDI has a number of advantages. Storage, handling and neutralizing regeneration chemicals are avoided, and waste disposal and ventilation problems are eliminated. Graphs. 4 ref. (Pacek, M.R.; Products Finishing (Cincinnati), Mar. 1992, 56, (6), 70-74 [in English]. ISSN 0032-9940)

1816 EFFICIENT FILTRATION. [MATE-199208-58-1160]
Filtration is an indispensable part of the metal plating process and has become of increasing importance to platers and finishers. Filtration efficiency is examined from three different perspectives: (i) particle retention, (ii) element life potential (dirt holding capacity), and (iii) bath turnover rate. Hazardous waste reduction can be handled best by means of source reduction. Filter elements laden with heavy metals and other toxics are a concern. Some new filters for chloride Zn require no media or backflushing. Nickel plating is discussed. Graphs. (Warrender, B.; Products Finishing (Cincinnati), Mar. 1992, 56, (6), 76-78 [in English]. ISSN 0032-9940)

1817 RUBBER LININGS IN NUCLEAR POWER PLANT WATER TREATMENT SYSTEMS. [MATE-199208-61-0606]
The type of rubber and the method of cure selected for lining and repairing demineralizer vessels can have a potentially significant impact on sulfate levels. Pressure-vulcanized, semi-hard natural rubber, which has been the standard for power industry stainless and carbon steel water-treating vessels, does not appear to be the best choice because it can leach sulfates. However, certain proprietary, chemically-cured rubbers will contribute only minimal amounts of sulfate ions to the reactor water. In situ relining with chemically-cured, steam-assisted, semi-hard rubber is technically advisable and is readily achievable. Interim patch repair with the same materials, using a heat lamp-assisted cure, is the most conservative approach since distress to the existing embrittled rubber is minimized. Where repairs are constrained by schedule or where the physical scope of repairs is extensive, a steam-assisted chemical cure should be considered. Finally, further testing of pre-cured neoprene stock to evaluate its serviceability in high pressure demineralizers is warranted. Preliminary leach testing indicates this type of rubber may have a place in relining and repairing water treating vessels. (Spires, G.V.; Tombaugh, R.S.; Doebler, R.F.; Journal of Protective Coatings & Linings, Dec. 1991, 8, (12), 50-59 [in English]. ISSN 8755-1985)

1818 ECOLOGY IN THE ANODIZING SHOP. [MATE-199208-71-0184]
An overview is given of revised environmental regulations as they affect water-consuming and waste-generating enterprises. The regulations concern packaging materials, water purification, rinsing baths, degreasing, etching, neutralization, anodizing, electrocoloration, densification, recovery of chemicals and cleaning of waste waters. Reduction of sulfates constitutes the major challenge in the anodizing process and this challenge requires motivation of all employees. (Gretler, O.; OBERFLACHE SURFACE, AUG. 1991, 32, (8), 8-12 [in German]. ISSN 0048-1270)

1819 ELECTROCHEMICAL DECONTAMINATION OF METALLIC SURFACES CONTAMINATED BY SPENT-FUEL STORAGE POOL WATER. [MATE-199209-34-0983]
It was earlier shown theoretically that the radioactivity released by spent-fuel elements into storage pool water is predominantly carried by positive ions (e.g. Cs,Mn, cobalt and Sr). A new decontamination method is described in which freshly contaminated metallic surfaces are decontaminated electrochemically, resulting in smooth, shiny surfaces. This method, which uses current densities of approx 15 mu A/cm^2, is quantitatively and qualitatively different from earlier electrochemical procedures, where higher current densities of the order of mA/cm^2 or even A/cm^2 were used. 4 ref. (Chaudhary, P.B.; Bhide, M.G.; Nuclear Technology, May 1992, 98, (2), 242-244 [in English]. ISSN 0029-5450)

1820 ELECTRODIALYSIS AND DIFFUSION DIALYSIS. [MATE-199209-43-0251]
The differences between electrodialysis and diffusion dialysis are explained. Because in diffusion dialysis no electric current is employed, it is best suited for the simpler metal – acid separations. Electrodialysis is more versatile and details, applications, and performance are provided for the membrane stacks, ion exchange membranes, bipolar membranes, electrodialysis with polar reversal, batch feed and bleed, and continuous operations. Separation of Cu, Pd, Cd, Zn, Al and Cr from plating bath waste is discussed. 20 ref. (Marquardt, O.K.; Schmid, G.; Fritsch, J.; Scharff, K.; Strathmann, H.; Oberflache Surface, Mar. 1991, 32, (3), 8-13 [in German]. ISSN 0048-1270)

1821 A NEW COMPACT ELECTROLYSIS CELL FOR THE RECOVERY OF HEAVY METALS FROM ELECTROPLATING EFFLUENTS. [MATE-199209-43-0255]
A unit is described, based on a compact electrolysis cell, for recovery of heavy metals (e.g. Zn, Cu, Cd) from plating effluents. The cell is built up with alternate anodes and cathodes. The cathodes are of sheet metal, preferably expanded mesh. At the anode, cyanide (when present) is anodically oxidised, thereby resulting in the breakdown of complexed and free cyanide, when the metal ion content is high enough for this to take place. Graphs. (Mayr, M.; Blatt, W.; Stroder, U.; Heinke, H.; Galvanotechnik, June 1991, 82, (6), 2068-2073 [in German]. ISSN 0016-4232)

1822 PLATING TECHNIQUE AND BIOTECHNOLOGY? [MATE-199209-43-0256]
Removal of metal residues (e.g. Fe, Ni, Cu, Pb, Zn, Cr, Ag) from chemical processing and plating wastes presents a considerable environmental problem. In addition to galvano-technical methods, biotechnology now plays an important role in three processes. Micro-organisms are employed to absorb metal ions on their surface or in extracellular matrices. A second approach involves intracellular reception. The third is a metabolic post-reaction, such as bacteria reducing sulfates. In addition, there are specific plants which prosper from the absorption of waste metals. Graphs. 9 ref. (Unruh, J.; Galvanotechnik, June 1991, 82, (6), 2077-2082 [in German]. ISSN 0016-4232)

1823 TECHNICAL NOTE: MINIMIZING THE RELEASE OF HEAVY METALS IN WATER EFFLUENTS FROM A NON-FERROUS METALS SMELTING OPERATION. [MATE-199209-43-0258]
The waste-water treatment plant of the Belgian Hoboken smelter was commissioned in 1980. Though using conventional processes, the plant was designed from the beginning with the purpose of minimizing discharge of effluents; in other words, to minimize water consumption by reusing the water as much as possible. The water-treatment plant has been in operation for more than ten years now and has given full satisfaction. Meanwhile, it was expanded in 1987. The plant's two-circuit heavy metal recovery system design and its efficiency are discussed. Data are included for: Pb, Cu, Cd, Zn, Hg, Ag, Ni, Cr, Fe. (Vanhecke, L.; International Journal of Materials and Product Technology, 1992, 7, (1), 119-123 [in English]. ISSN 0268-1900)

1824 WASTE WATER PURIFICATION WITH METAL RECOVERY—APPLICATION IN PLATING SHOPS. [MATE-199209-43-0273]
Waste water purification is critical for meeting legal requirements. The approach taken by a plating shop is described. This shop cleans metals by degreasing and acid dips, and plates Cu, Ni, Cr and Zn. Treatments of the waters recycle where possible, neutralize acids and cyanides, and recover metals. (Industrie-anzeiger, 7 June 1991, 113, (46), 26-28 [in German]. ISSN 0019-9036)

1825 PICKLING STAINLESS STEEL, AND THEN...? [MATE-199209-57-1138]
It is evidently quite possible to clean effluent resulting from the pickling of stainless steel by membrane filtration. Although effluent is visually very greasy, there are few existing materials which quickly foul the membrane. Also, because of the small size and weight of the installation, the ease of servicing and the low cost, membrane filtration is an attractive alternative for this purpose. The installation and operational principle of membrane microfiltration are illustrated. (Duijn, A.; Beumer, R.F.M.; Roestvast Staal, Apr. 1992, 8, (4), 31-34 [in Dutch]. ISSN 0169-3328)

1826 DEFECTS IN ZINC AND IRON PHOSPHATING—THEIR ORIGINS AND AVOIDANCE. V. SLUDGE PROBLEMS IN PHOSPHATING PLANTS. [MATE-199209-57-1189]
Defects occurring immediately after phosphating, after organic finishing or after short-term load tests of the coated surfaces may have their origins in the pre-history of the metal being phosphated, in the pre-treatment stages, in the actual phosphating process or in its post-treatment. An effective policy for avoidance of defects calls for an understanding of the overall process, the possible origins of defects and the necessary means for their avoidance. Problems of sludge formation during the phosphating process are discussed. Photomicrographs, Graphs. (Lohmeyer, S.; Galvanotechnik, June 1991, 82, (6), 1963-1969 [in German]. ISSN 0016-4232)

1827 EMPHASIS: RECLAMATION. WASTE MINIMIZATION AND RECOVERY TECHNIQUES FOR ACID PICKLING SOLUTIONS. [MATE-199209-57-1224]
Waste minimization and recovery of the HCl and H_2SO_4 used in steel pickling baths is not only environmentally sound, but very cost effective. Acid recovery is one of the few pollution control systems that can show a payback in less than two years, and produce a byproduct commodity that is needed in the water treatment industry. Graphs. (Peterson, J.C.; Wire Technology International, Jan.-Feb. 1992, 20, (1), 25-28 [in English]. ISSN 0898-9850)

1828 PROCESS FOR RECOVERING CHROMIC ANHYDRIDE FROM EXHAUSTED AQUEOUS CHROMIUM PLATING BATH SOLUTIONS WITH EXPLOITATION OF THE RECOVERED CHROMIUM. [MATE-199209-58-1255]
The chromic anhydride contained in soluble form (chromic acid) in exhausted, polluted Cr plating baths is recovered by alkalizing the exhausted Cr plating liquid to a pH between 3-7 at a temperature of 70 °C with a commercial sodium hydroxide solution, keeping the mass in reaction at this temperature for 1 h and filtration separating the precipitate obtained. The filtered solution, having a specific gravity of 1.25 kg/l, contains CrO_3 (22 wt.%) which is then reduced with sulphur dioxide to obtain a solution containing basic chromium sulphate and sodium sulphate, suitable for use as a tanning bath; in this manner pollution is avoided and the waste Cr is exploited. The solution containing CrO_3 can also be introduced into a hexavalent Cr salt production cycle. (Bruzzone, G.; Ghelli, G.; Perrone, D.; Auszuge aus den Europaischen Patentanmeldungen, Teil I, 9 Jan. 1991, 7, (2), 138 [in English]. Patent no.: EP0406234 (European Patent) Convention date: 24 May 1988)

1829 ELECTROLUX—ITS SWEEPING SUCCESS DEPENDS ON QUALITY. [MATE-199209-61-0695]
A profile is given of the Electrolux vacuum cleaner company with emphasis on their quality control and employee involvement to provide a superior product. The company started in Sweden and came to the US in 1924 keeping it "old world" tradition of craftsmanship. Highlighted in the story are the Ni-plating and painting operations where 10 h shifts have reduced startup, shut down, and change over problems. Waste treatment is actively minimized by using safer products and ergonomics is considered whenever jobs are tedious. Robots perform many jobs where repeat motion can cause medical problems and automatic screwdrivers are used on the assembly line with special screws. (Plating And Surface Finishing, Oct. 1991, 78, (10), 24-27 [in English]. ISSN 0360-3164)

1830 DIRECT METALLIZING DMS-2—INTRODUCTION INTO THE MANUFACTURING AND EARLY EXPERIENCES. [MATE-199209-63-0538]
DMS-2 is a specific process for metallizing printed circuits. Grundig has installed a facility for the automatic fabrication of printed circuits. The sequence includes CNC drilling, through metallizing by DMS-2, photographic sensitizing, Cu – Sn plating, etching and stripping, electrostatic coating, HAL process and finishing. The DMS-2 resolves a previous bottleneck by providing a high quality metal coating at the relatively high rate of 1.7 m/min, while waste water and air pollution are reduced. Photomicrographs. (Stuckmann, H.; Galvanotechnik, June 1991, 82, (6), 2119-2126 [in German]. ISSN 0016-4232)

1831 PROTECTION OF HEATING AND COOLING SYSTEMS BY ELIMINATION OF AIR—CORROSION IS STOPPED. [MATE-199209-71-0208]
METEM is a formula for protecting heating systems from corrosion and erosion. METEM means material + erosion + time + elimination to magnetite. Air is removed by cyclical pressurization and release. A homogeneous water flow without bubble formation results. The process also eliminates the formation of magnetite sludge in the system. (Bernstein, H.F.; Industrie-anzeiger, 24 May 1991, 113, (42), 28-30 [in German]. ISSN 0019-9036)

1832 REDUCTION OF WASTE. PROCESS OPTIMIZATION IN ELECTROPLATING PLASTIC PARTS. [MAT3-9012-E7-P-0277]
The large-scale industrial electroplating of acrylonitrile – butadiene – styrol (ABS) plastics has taken a leading place in manufacture, especially of sanitary fittings, during the past 20 years. The quality of the product depends initially on its quality as formed by spray injection. Here, plastifier properties, temperature stability, and mechanical strength are important. Steam inclusions under the surface may not be noted until the part is metallized. Where higher strength is required for parts such as threads, these may be fabricated as a polycarbonate – ABS-copolymer and attached to the other parts by thermal welding. The combined part is then plated. After washing in hot water, parts are pickled in a bath containing 900-950 g/l CrO_3, or 450 g/l CrO_3 and 300 g/l H_2SO_4. Cr(III) content must be controlled to 70 g/l. – B.L. (Schulze-Berge, K.; (1990), 20 Mar. 1990, 0341-5775, (Eng. Mat. A., 96, (12)), 58-62, 64 [in German].)

1833 THE DISCOVERY OF HYGIENE IN THE FACTORY. [MAT3-9011-G1-P-0113]
The principles of workplace hygiene in the plastics industry are considered. Production statistics for the principal polymers are given with details of the particular additives used. Ecological and sanitary aspects are discussed including environmental and workplace hazards as well as the risks of damage to finished products through contamination with waste materials. Emissions may include gases, fine powders, liquids and solid wastes. Details are given of risks to operators and a precautionary safety code is recommended. – P.C.K. (Canziani, G.; (1990), June 1990, 0032-2768, (Eng. Mat. A., 38, (391)), 108-111 [in Italian].)

1834 DEVELOPMENT OF TEST METHODS TO DETERMINE THE COMPATIBILITY OF LIQUID HAZARDOUS MATERIALS WITH POLYETHYLENE PACKAGINGS. FINAL REPORT, 18 JUNE 1989-18 DECEMBER 1989. [MAT3-9011-F1-P-0908]
The report describes work done for the Department of Transportation, Office of Hazardous Materials Transportation, to develop test methods which can be used to determine whether a liquid hazardous material may be shipped in a specific type of polyethylene packaging. Current federal regulations require that each prospective loading be tested individually in proposed polyethylene packagings and do not make provision for liquids which may be unstable at 21 °C. One area being explored is the possibility of dividing the liquids into groups and authorizing the transportation of all the liquids into groups and authorizing the transportation of all the liquids in the group based on tests done using one standard liquid from that group. The feasibility of basing compatibility tests on the use of standard liquids is assessed and recommendations are made as to the conditions under which such a scheme can be used. An empirical scheme known as the "Permachor" method for ranking the permeability of liquid hazardous materials is proposed. – GRAI (Crissman, J.M.; National Institute of Standards and Technology (US); (1990), May 1990, PB90-235417/XAB, Pp 52 [in English].)

1835 TESTING METHODS AND RESULTS ON ACID AND ALKALI CORROSION RESISTANT PROPERTIES OF FRP LINING OF CONCRETE SEWER PIPELINE. [MAT3-9011-C5-D-0270]
It was recognized that the corrosive behaviour of the waste water from the leather industry is characterized by: (1) The pH value of effluent from the waste water pretreatment facility at its outlet varies from 4.4-13.3. (2) The effluent is rich in sulfide and sulfate ions; the former generates H_2S merely due to the change of pH from basic to acidic, and the latter is converted to H_2S by the action of sulfate-reducting bacteria. Corrosion-proofness of an FRP lining to be applied to the interior surface of a concrete sewer pipeline which is scheduled to flush the waste water, was evaluated by various testing methods. Visual observation, dye penetration test, microscopic observation of surface and cross section, weight change, Taber abrasion test, Barcol hardness, thickness check and measurement of adhesion strength were all valuable for the purpose. However, the last one still leaves room for further study in terms of the accuracy and the correspondence between actual linings and test results Photomicrographs. 3 ref. – AA (Urakami, Y.; Takashima, S.; Ishii, K.; Himeji Public Works Office of Hyogo Prefecture; Daicel Technology Service; (1990), Mar. 1990, 0514-5163, (Eng. Mat. A., 39, (438)), 277-282 [in Japanese].)

1836 USE OF SECONDARY ALKALI CONTAINING RAW MATERIALS IN THE GLASS INDUSTRY. [MAT3-9009-D1-C-1680]
At the present time in the USSR there is no unified means of collecting or storing data on the waste products and effluents generated by manufacturing industry. The authors of this work conducted a search for sources of low cost secondary alkali raw materials for use in making glass and glass articles. The waste streams located were liquid and solid and included liquid waste from fatty acid production and solid cement fines arising from electrostatic deposition. The possibility was demonstrated of using at least some of the secondary alkali raw material in the glass industry. The evidence of this was based on laboratory, experimental production, and manufacturing development work using these wastes. – M.H.M. (Min'ko, N.I.; Onishchuk, V.I.; (1990), Feb. 1990, 0131-9582, (Eng. Mat. A., (2)), 2-3 [in Russian].)

1837 ELECTROPLATING TECHNOLOGY IN QUESTIONS AND ANSWERS (GALVANOTECHNIK IN FRAGE UND ANTWORT). (BOOK). [MAT3-9007-E7-P-0161]
Technology of coating processes is covered, with the emphasis on electrolytic processes. The theoretical basis for electrodeposition, and the electrochemistry involved are explained for metallic, nonmetallic and alloy plating. The equipment used for these processes is described. Pretreatments for the various substrates, including ferrous alloys, steels, Al, Al base alloys, Cu, and Cu base alloys are outlined. These include degreasing, conversion coating, polishing, mechanical finishing and activation. The processes necessary for depositing Ni, Cr, Cu, Cu alloys, Zn, Cd, Sn, Ag, Au, Pt, Rh, and Pd are detailed. Electroplating of non-conductors such as plastics (e.g. ABS resins) and circuit boards is also explained. The surface treatment processed for Al are shown in detail, particularly those used for anodizing. Electroforming processes are discussed. Coloring procedures for metal surfaces, including electroplates, are presented in detail. Removal of metallic coatings is discussed, as is the treatment of water used for these processes and waste water from them. The standards for these coatings are given. Safety procedures and hazards are discussed. Photomicrographs, Graphs. – A.D.W. (Gaida, B.; Publisher: Eugen G. Leuze Verlag (1989), Pp 394 [in German].)

1838 COMPOSITES BASED ON WASTE-FERRITES AS MICROWAVE ABSORBERS. [MAT3-9004-F1-D-0297]
The sol – gel technique has been successfully utilized and optimized for the synthesis of various spinel ferrites of different chemical compositions as a cheap byproduct from various heavy metal ion containing waste water effluent. Physical characterization based on X-ray, IR and TGA/DTA studies have confirmed that the formation of the ferrite phase is essentially complete at a significantly lower temperature and is partially amorphous in nature along with small crystallites approx 40 A as prepared. Further heat treatment increases the crystallite size. These inexpensive ferrite impregnated epoxy composites exhibited approx 75% microwave absorptivity within 10-12 GHz for 1 mm thick epoxy composite containing 55 wt. % of ferrite filler. Microwave absorptivity increases linearly with composite thickness and/or ferrite content. Conceptually these ferrite – epoxy composites may find wide applications as inexpensive microwave absorbers, not withstanding their role in reducing environmental pollution. Graphs, spectra, diffraction patterns. 6 ref. – AA (Jha, V.; Banthia, A.K.; Indian Institute of Technology; National Seminar on Physics and Applications of New Materials (India), Calcutta, India, 22-24 Mar. 1988, (1989), July 1989, 0019-5480, (Eng. Mat. A., 63A, (5)), 514-525 [in English].)

1839 NEW APPLICATIONS FOR CENTRIFUGALLY CAST GRP PIPES. [MAT3-9004-F1-D-0277]
The paper gives a short description of the centrifugal casting process and the general possibilities that exist for the application of centrifugally cast pipes. It then describes the development of GRP pipes for drilling in the nominal width ranges for pipes subject to foot traffic and those not subject to foot traffic. The experience gained from this and from the application of large diameter, thick-walled pipes in waste water systems, with temperatures of up

to 90 °C, led on to the most recent application for centrifugally cast GRP pipes – shafts for refuse tips. 1 ref. – AA (Bloomfield, T.D.; Hobas Durotec; (1989), 0952-6919, (Eng. Mat. A., 2, (6)), 512-525 [in English].)

1840 PHYSICO-CHEMICAL CHARACTERISTICS OF INTERMEDIATE REACTION MATERIALS AND WASTE LIQUIDS IN THE PRODUCTION OF EPOXY RESINS. (TRANSLATION). [MAT3-9003-D1-P-0492]
Experimental values of the refractive index, density and viscosity of solutions of epichlorohydrin and ED-22F resin in toluene, and of aqueous solutions of sodium chloride and hydroxide, are used to design equipment for epoxy resin production. The investigation was conducted on intermediate binary reaction systems toluene + epichlorohydrin and toluene + ED-22F resin, and on waste water containing sodium chloride and hydroxide. The density, refractive index and viscosity of the solutions were determined, and the solubility of sodium chloride was established as a function of the sodium hydroxide content. (Original in Russian). 5 ref. – A.R. (Sorokin, V.P.; Turchanina, S.Yu; Dzumedzei, N.V.; Rudnenko, E.V.; (1989), 0307-174X, (Eng. Mat. A., 16, (6)), T/80-T/82 [in English].)

1841 RECOVERY OF EPICHLOROHYDRIN FROM EPOXY RESIN-PRODUCTION WASTE WATERS. [MAT3-8909-D1-P-1300]
Feasibility of adsorption and extraction of epichlorohydrin from epoxy resin-production waste waters was demonstrated. For adsorption by activated and recovered granulated carbons BAU-A and AR-A, having adsorption capacities of 3.4 x 10^{-3} and 1 .65 x 10^{-3} mol/g, adsorption equilibrium constants of 129 and 176 and adsorption free energy of changes of 14.7 and 12.0 kJ/mol, respectively, were calculated. Isopropanol was used for desorption. For extraction of epichlorohydrin from aqueous solutions, distribution constants were determined and from them the changes in Gibbs' free energy and enthalpy (Delta H = 24.9 kJ/mol) of extraction were calculated. The probability of endothermic formation of toluene-epichlorohydrin pi-complexes decreased with increasing temperature. Higher epichlorohydrin recovery by extraction than by adsorption made extraction preferable. Graph. 7 ref. – L.S.D. (Sorokin, V.P.; Men'shikh, T.A.; Dzumedzei, N.V.; Rudnenko, E.V.; (1989), 0554-2901, (Eng. Mat. A., (3)), 81-82 [in Russian].)

1842 LOCAL MICROBIOLOGICAL PURIFICATION OF STYRENE-CONTAINING WASTE WATERS. [MAT3-8812-D1-P-1781]
The objective was to investigate the possibility of purifying the waste waters of polystyrene production containing large amounts of styrene (50-1200 mg/l) by using the method of aerobic oxidation in an aeration tank, anaerobic fermentation in a methane tank, and oxidation in a biofilter by immobilized microorganisms. It is demonstrated that local biological purification of styrene-containing waste waters by immobilized microorganisms using a biofilter and an aeration tank is very effective, energy-efficient, and does not require complex equipment. 5 ref. – V.L. (Bystrov, G.A.; Zaitseva, M.P.; Abelskaya, B.Ya.; Voznyi, A.S.; (1988), 0554-2901, (Eng. Mat. A., (4)), 56-58 [in Russian].)

1843 CHLORINATED PVC ITS FABRICATION PROPERTIES AND APPLICATION. [MAT3-8811-D1-P-1674]
The fluidized bed photo chlorination of PVC and the main characteristics of products obtained are described. While the morphology of the grain is not affected by the chlorination, the thermomechanical properties of the CPVC are mainly dependent on the amount of the chlorine content of the molecule. Different applications of CPVC are presented: films processed by calendering, hot water pipes – waste water, pressure pipe, central heating – and rigid fittings and the choices of the polymers for a given application related to their performance temperature, long term resistance are indicated. 2 ref. – AA (Fisher, K.; Atochem; PVC 1987, Brighton, UK, 28-30 Apr. 1987, Publisher: The Plastics and Rubber Institute (1987), 9.1-9.18 [in English].)

1844 ANALYTICAL METHODS OF MONITORING THE COMPOSITION OF WASTE WATERS. SURVEY. [MAT3-8811-D1-P-1593]
After a survey of literature, it was found that, for analysis of waste waters from production of plastics, practically all the known methods of chemical analytical control of aqueous solutions are useful. It is necessary to have preliminary distribution of components and concentrations for determining small content of substances and analysis of mixtures of a complex composition. For separation of substances in waste water, the following are widely used: distillation, ion-exchange resins, non-aqueous solvents. The concentration is accomplished by all known methods – evaporation, sorption, and extraction. The most promising method for determining the content of the majority of compounds in the composition of waste waters from the production of plastics is chromatography. 60 ref. – M.B.P. (Pevzner, I.D.; Zhegulova, I.A.; Gracheva, N.N.; Fishman, G.I.; (1988), 0554-2901, (Eng. Mat. A., (5)), 34-37 [in Russian].)

1845 BIOTECHNOLOGY FOR THE PURIFICATION OF THE CONCENTRATED WASTE WATERS OF METHACRYLATE PRODUCTION. [MAT3-8809-G1-P-0114]
A method for the preliminary purification of the concentrated waste waters of methacrylate production is described, which is based on the biochemical fermentative oxidation of the organic compounds contained in the waste waters by anaerobic microorganisms. The method is demonstrated for waste waters containing methylmethacrylate, acetone, methanol, and methacrylic acid. An expression for calculating the required bioreactor volume is presented. 6 ref. – V.L. (Sukharev, Yu.G.; Chekhova, T.K.; Abaev, G.N.; (1987), 0554-2901, (Eng. Mat. A., (11)), 52-54 [in Russian].)

1846 A STUDY OF THE COMPOSITION OF THE WASTE WATERS OF CYCLO-ALIPHATIC EPOXY RESIN PRODUCTION. [MAT3-8808-D1-P-1112]
The waste waters of cycloaliphatic epoxy resin production contain acetic acid, hydrogen peroxide, peracetic acid, and sodium acetate. A potentiometric method is proposed which can be used for determining the contents of sodium acetate and acetic acid simultaneously present in the waste waters, with sodium acetate content ranging from 45-200 g/l. 7 ref. – V.L. (Rudnenko, E.V.; Dzumedzei, N.V.; (1987), 0554-2901, (Eng. Mat. A., (12)), 43-44 [in Russian].)

1847 GLYCERIN REMOVAL FROM THE WASTE WATERS OF EPOXY PRODUCTION. [MAT3-8804-D1-P-0499]
Glycerin recuperation from the waste waters of epoxy production, which contain 4% glycerin, 1% epichrohydrin, and 24% NaCl, is important in the development of a waste-free epoxy process. The kinetics of glycerin adsorption by activated anthracite, including anthracite modified by various water-soluble polymers and monomers, is investigated experimentally. It is shown that repeated absorption of glycerin by modified activated anthracite provides for a high degree of waste water purification. 9 ref.- -V.L. (Rudnenko, E.V.; Dzumedzei, N.V.; Sorokin, V.P.; Alekseev, N.N.; Voloshkina, B.T.; (1987), 0554-2901, (Eng. Mat. A., (1)), 54-55 [in Russian].)

1848 DECREASING PRODUCT LOSS IN THE PRODUCTION OF SUSPENSION POLYVINYL CHLORIDE. [MAT3-8801-D1-P-0048]
The various stages in the production of PVC are reviewed, and the loss of monomer and polymer in the various stages is analyzed. Low waste technology for the production of suspension PVC involves controlling gas and solid losses in each stage. Polymerization of vinyl chloride in 80 m^3 steel reactors with safety seals, utilization of the reactor crust in linoleum manufacture, degassing of the suspension in special equipment, removal of the solid polymer in suspension with special centrifuges, and closed-cycle drying all contribute to decreasing product loss. Low waste production of PVC has the side benefit of a decreased need for fresh water and the amount of waste water generated. – J.B. (Kamenko, B.L.; Sukharev, Yu.G.; Boldyrev, V.I.; (1986), 0554-2901, (Eng. Mat. A., (5)), 50-51 [in Russian].)

1849 ENVIRONMENTALLY SAFE METHOD FOR THE REMOVAL OF RESIDUAL POLYETHERS FROM AQUEOUS WASTE STREAMS. [MAT3-199207-D1-P-1625]
An environmentally safe method is given for the removal and disposal of residual water soluble polymers from waste streams, wherein the polymers have a molecular weight of approx 200 and are present in the waste stream in a concentration of approx 1%. The method comprises the steps of: (a) pretreating a bentonite adsorbent having a surface area of from approx 500-1000 m^2/g by heating at a temperature of from approx 650-750 °C; (b)

contacting the waste stream with the bentonite adsorbent for a period of time of from approx 1-10 min; (c) separating a waste stream essentially free of the polymers from the bentonite adsorbent; (d) heating the bentonite adsorbent to a temperature of from approx 650-750 °C for a period of time sufficient to convert the polymers to carbon dioxide and water; (e) treating the bentonite adsorbent after heating with at least one acid, alkali or neutral wash for a period of at least 1 h to restore the interlayer spacing of the bentonite to at least approx 10 Aas determined by X-ray diffraction analysis; and (f) recycling the bentonite adsorbent for contact with additional aqueous waste stream containing polymers. (Ananthapadmanabhan, K.; Goddard, E.D.; Union Carbide Chemicals and Plastics; (1991), 9 Jan. 1991, (Eng. Mat. A., 7, (2)), 139 [in English]., Patent no.: EP 0406846 (European Patent) Convention date: 4 July 1990)

1850 APPLICATION OF FRP IN THE WATER AND WASTEWATER TREATMENT INDUSTRIES. [MAT3-199204-F1-D-0249]

A number of aspects of the use of fiberglass reinforced plastics (FRP) in the water and wastewater treatment industries are discussed. Selection factors, design, costs, and longevity are highlighted. The two factors which have pushed FRP to the force in these industries are the wide range of resins available to ensure corrosion resistance and the adoptive nature of the material which permits fabrication of unusual shapes and variations in wall thicknesses. It is cost competitive in applications requiring good corrosion resistance and competes well with stainless steels, thermoplastics, coated mild steel, and coated concrete. Cost comparisons between FRP and other materials for a range of storage tanks are illustrated. (Curran, L.G.; Aqua Clear Technology; Materials Processing and Performance, Melbourne, Victoria, Australia, 2-5 Sept. 1991, Publisher: Institute of Metals and Materials Australasia (1991), 185-186 [in English].)

1851 PAINTING PLASTICS: CLEAN IS THE KEY. [MAT3-199204-E7-P-0095]

Plasti-Paint, Inc. paints all types of plastics including ABS, EHA, polycarbonate, polypropylene, nylon, Bexloy, TPU, TPO, RIM and most other paintable thermoplastic or thermoset materials. The company prides itself on clean air, clean water, and a spotless facility to provide a painting advantage. A review of the operations at Plasti-Paint covers pretreatment, eliminating static, a clean room with four water-wash paint booths, filtering, static control, inspection, and the process of keeping the plant clean. (Graves, B.A.; (1991), Oct. 1991, 0032-9940, (Eng. Mat. A., 56, (1)), 60-64 [in English].)

1852 REMOVAL OF BORON IN WASTEWATER FROM THE CERAMIC FLOOR AND WALL TILE INDUSTRY: TECHNICAL, ECONOMIC, AND MANAGERIAL EVALUATION. [MAT3-199202-D1-C-0246]

The results of experimentation carried out on a wastewater treatment system, complete with removal of boron via an ionic exchange resin, installed in a ceramic floor and wall tile factory located in the ceramic district of Sassuolo, Italy, are reported and discussed. A technical, economic, and managerial evaluation of the system is made for the purpose of obtaining some general indications on the feasiblity of the removal of boron on an industrial level, with a view toward suitable intervention regarding the problem of B pollution in surface water characteristic of the entire sector of the ceramic floor and wall tile industry. The efficiency and reliability of the process is shown, operating and investment costs are determined, and the main managerial problems are discussed, in particular that of the disposal of the eluates. Graphs. (Busani, G.; Timellini, G.; Salvatori, S.; Zoli, M.; USI; (1991), July-Oct. 1991, (Eng. Mat. A., (45)), 35-52 [in Italian].)

1853 GALVANIZING PLASTIC ARTICLES IN LARGE LOTS—IMPROVEMENTS IN ENVIRONMENTAL MATTERS. [MAT3-9112-E7-P-0238]

Commercial galvanization of plastics is used for decorative and electrical purposes. 90% of the plastics so processed are ABS and blends, but other types can also be coated. Preparation of the parts begins with their molding. Parts undergo a Chrom VI treatment. Chemical metallizing follows in plastic drums with central anodes. Computer control can be used for process control. Waste waters are treated in conformance with environmental protection regulations. – F.H.H. (Riedel, W.; (1990), 4 Dec. 1990, 0019-9036, (Eng. Mat. A., 112, (97)), 16, 18 [in German].)

1854 PROCESS FOR PRODUCTION OF BRANCHED POLYCARBONATE. [MAT3-9111-D1-P-2269]

A process for producing a branched polycarbonate by an interfacial polycondensation method comprises condensing a first reaction mixture comprising an inert organic solvent, an alkaline aqueous solution of divalent phenol, a branching agent, and phosgene, the branching agent having a partition coefficient of at least one, wherein the partition coefficient is defined as the ratio of the concentration in inert organic solvent/concentration in water, to form a second mixture containing a polycarbonate oligomer or a polycarbonate and unreacted branching agent, separating the second mixture into an organic solvent layer and an aqueous layer which contains the unreacted branching agent, extracting the unreacted branching agent from the aqueous layer with inert organic solvent and recycling the inert organic solvent which contains the unreacted branching agent extracted from the aqueous layer to the first reaction mixture. The invention has the advantages of preventing waste water pollution and at the same time, increasing the efficiency of use of the branching agent, because it permits the efficient extraction recovery of the unreacted branching agent contained in waste water. The branched polycarbonate obtained by the process by the invention has good melt characteristics, is great in dependency on a rate of shear, and has a small drawn down. Thus, the branched polycarbonate is suitable for extrusion molding. – USPTO (Kuze, S.; Terada, E.; Idemitsu Petrochemical; (1991), 20 Aug. 1991 [in English]., Patent no.: US 5041523 (USA) Convention date: 22 Feb. 1990)

1855 A METHOD FOR WASTE GAS CLEANING IN CERAMIC INDUSTRIES. [MAT3-9109-D1-C-1628]

The waste gas from the production process of technical ceramics contains hydrogen fluoride and hydrocarbons. The concentrations of these air pollutants have to be reduced to the legal limit values. To solve these waste gas problems, a combination of a regenerative afterburner and a fluorine scrubber is introduced. The regenerative afterburner was chosen because even at low loads of organic components an autothermic operation is possible and the energy costs can be minimized. The scrubber, working wit h a lime suspension, does not produce any waste water and supplies a final product, which can be dumped without any problems. Graphs. 1 ref. – AA (Geipel, W.; Welzel, U.; (1991), June 1991, 0039-0771, (Eng. Mat. A., 51, (6)), 219-223 [in German].)

1856 EXPERIENCE RESULTING FROM THE USE OF PE-TUBES IN THE FIELD OF RECONSTRUCTION OF WASTE WATER CANALIZATION IN THE CHEMIE AG BITTERFELD WOLFEN. [MAT3-9108-F1-P-0665]

The waste water network in question dates from before the First World War. It was enlarged during the 1930s and after 1945. Hence the need exists for extensive reconstruction. Such reconstruction of a waste water network in the chemical industry always takes up a larger area than the original. Methods are described for the withdrawal of plastic tubes in existing canalization channels and the covering of waste water drains. Since 1978 some 10.3 km of tubing of various nominal diameters have been fitted. The resulting experience gained in the choice of material and the fitting and jointing techniques are described. – H.C.C. (Steckel, E.; (1990), July 1990, 0863-2162, (Eng. Mat. A., 1, (7)), 19-20 [in German].)

1857 INDUSTRIAL WASTE WATER DISPOSAL TO LAND: A CASE STUDY. [MAT3-9102-D1-P-0314]

Commercial Polymers Pty. Ltd. (COMPOL), is a polyethylene resin producer operating in the Altona Petrochemical Complex, Victoria, Australia. For the past six years, COMPOL has successfully operated a waste water treatment, recycling and land disposal system for the effluent produced in its manufacturing process. Experience has shown this means of disposal is both cost effective and environmentally preferable to disposal to local streams or municipal treatment works. 8 ref. – AA (McKie, C.J.; Clements, J.W.; Gaskell, N.; Commercial Polymers; Chemeca '90: Processing Pacific Resources. Vol. I, Auckland, New Zealand, 27-30 Aug. 1990, Publisher: The University of Auckland (1990), 509-516 [in English].)

1858 UNC ADAPTS URANIUM PROCESSING TECHNIQUE FOR REMOVING METALS FROM (PLATING BATH) WASTEWATER. [MAT2-198901-S4-0002]
A wastewater cleanup service that uses liquid membrane/ion exchange technology is being marketed for electroplaters by UNC Reclamation, Norwich, Connecticut, USA. The techniques are based on those originally developed for uranium processing by the company's parent firm, UNC, formerly United Nuclear Corp., Annapolis, Maryland. The company provides electroplaters with equipment that concentrates metal wastes to a 25 wt.% aqueous solution, which is shipped to a central facility in Mulberry, Florida, that began processing wastes in September 1988. There, the metals are recovered as metal oxides. The result is the elimination of the electroplater's liability for the metal sludge produced by other treatment systems. (UNC Reclamation; HazTECH News, 17 Nov. 1988, 3, (23), 175 [in English].)

1859 3CR12 USAGE IN SEWAGE WORKS. [MAT2-198901-S6-0002]
Successful applications of 3CR12 have included baffles, weirs, scum boxes, scraper blades and pipe work and steel work in contact with raw sewage. 3CR12 should not be used where there are heavy concentrations of hydrogen sulphide gas (e.g. directly above a septic main outfall), or in direct contact with ferric chloride. In addition, 3CR12 should not be specified in areas where there is a build up of thick anaerobic slime deposits (i.e. bio-filter centre columns and arms), as these deposits lead to conditions favourable to attack by sulphate reducing bacteria. However, 3CR12 has proved itself in most other aspects of waste water treatment, especially in the critical and highly aggressive clarifier splash zones. Most major consultant engineering firms are now specifying 3CR12 in waste water treatment because it solves corrosion and maintenance problems and has a long life. (News Brief). (Stainless Steel High Perform. Alloys, July-Aug. 1988, 24, (4), 25 [in English].)

1860 IMPROVED CONSOLIDATION OF SILICON CARBIDE. [MAT2-198902-C5-0033]
Agglomerates in the starting powders control the flexural strengths of sintered SiC test specimens. The dependnece of mechanical properties upon these flaws obscures the effects of such important processing variables as compositions, sintering times, and sintering temperatures on the properties of sintered SiC. Slurry pressing, developed as a technique to avoid or eliminate agglomerates as sources of critical flaws, is described briefly. The slurry-pressing die is shown schematically. The die works on a push – pull principle to draw the liquid out of the slurry. (NASA Lewis Research Center; NASA Tech. Briefs, Dec. 1988, 12, (11), 54, 56 [in English]. ISSN 0145-319X)

1861 STAINLESS STEEL IN WATER POLLUTION CONTROL. [MAT2-198902-S6-0038]
A number of examples serve to illustrate the growing contribution of stainless steel in environmental engineering, in particular to water pollution control. The "Boat" clarifier, now built in the UK almost entirely in stainless steel by Simon-Hartley Ltd. of Stoke-on-Trent, is used for sludge clarification. Other applications include a rotating drum screen for filtration, centrifuges, disc skimmers for the removal of surface pollutions, as well as range of ancillary equipment. (Simon-Hartley; Stainless Steel Ind., Nov. 1988, 16, (94), 16 [in English]. ISSN 0306-2988)

1862 LOW-COST ION EXCHANGE SYSTEMS TO BE MARKETED FOR METAL FINISHERS. [MAT2-198903-G4-0005]
M.E. Baker and Kemp and Associates, both of Cambridge, Massachusetts, USA, plan to begin marketing, in 1989, a low-cost ion exchange systems for metal finishers. The goal is to enable installation of ion exchange columns at each rinse tank or for rinsewaters containing the same metal, rather than have a single system to treat combined metal waste streams. This would reduce engineering requirements and decrease capital costs. The firms also expect their experience with ion exchange systems to help in designing low-cost units. The system will automatically regenerate the cation resin each day. For cyanides, an anion resin may be needed or the column could be installed at the end of an existing cyanide destruction unit. The regenerate for each metal would be sent to a separate tank, so it could be recycled. The firms also are investigating chemistries for converting the ionic metals to non-hazardous metallic metal, thus facilitating recovery. (News Brief). (M.E. Baker; Kemp and Associates; HazTECH News, 12 Jan. 1989, 4, (1), 5 [in English].)

1863 STEEL REINFORCED GRP PIPE COPES WITH STRONG SEWAGE/TRADE EFFLUENT. [MAT2-198904-D6-0099]
The Britpipe system of steel reinforced resin pipe (SRTR) is successfully handling septic sewage, above ground, at 46 °C in the shade and with humidities up to 100% in the Middle East. Further similar applications in Bahrain and the UK are also operating well. The Britpipe system uses Viking Johnson couplings and can flex under heavy loads such as railway traffic. It is a low weight variety and easy to handle in difficult situations and is very cost effective in terms of the full installation costs. (News Brief). (Britpipe; British Aerospace; Reinf. Plast., Feb. 1989, 33, (2), 50 [in English]. ISSN 0034-3617)

1864 EPA ACTIONS AND THE (US) PLASTICS INDUSTRY. [MAT2-198904-P4-0004]
The US Environmental Protection Agency (EPA) has proposed requirements for manufacturing industries and large cities to file permit applications for storm water discharges under the national Pollutant Discharge Elimination Program. In other actions, the EPA issued a final rule in November 1988 renewing the Uniform Hazardous Waste Manifest form and extending its expiration data to 30 September 1991. Also, the EPA is expected to propose regulations for 38 contaminants by early spring. Under the Safe Drinking Water Act amendments of 1986, the EPA is required to set maximum contaminant levels for 83 compounds. Chemicals used in the plastics industry that are on the list include styrene, epichlorohydrin, acrylamide, ethylbenzene, ethylene dibromide, tetrachloroethylene, toluene, and xylene. (US Environmental Protection Agency; Plast. Eng., Feb. 1989, 45, (2), 10 [in English]. ISSN 0091-9578)

1865 GULF STATES STEEL SETS $5M CLEANUP. [MAT2-198904-S9-0096]
Gulf States Steel Inc., Gadsden, Alabama, USA, will spend $5 million in the next year to construct wastewater treatment plants to remove hazardous materials discharged by its galvanizing operation, coke plant and blast furnace. Roy F. Weston Inc., a West Chester, Pennsylvania-based waste removal company, has been awarded a contract by Gulf States to design two treatment plants to handle removal of Zn, cyanide and ammonia from wastewater caused by galvanizing and by a coke plant and blast furnace. (News Brief). (Regan, J.G.; Gulf States Steel; R.F. Weston; Am. Met. Mark., 9 Jan. 1989, 97, (5), 2 [in English]. ISSN 0002-9998)

1866 NEW EFFLUENT RULES END UNCERTAINTIES (FOR ALUMINUM EXTRUDERS). [MAT2-198905-G4-0017]
New Al-forming regulations on water consumption and oil and grease alternate monitoring became effective on 9 February 1989, after a settlement was reached between the EPA and the Aluminum Extruders Council (AEC) on the stringency of the original proposal. The cleaning or etching rinse guideline would have reduced the amount of water extruders could use on coated Al parts by setting a 90% flow reduction cap. The council and the Aluminum Association contended that a 90% flow reduction could not be achieved with the best available technology, and that the cost to comply would be exorbitant. The settlement reached with the EPA decreased the amount of flow reduction to 72%. (Snoddy, W.; Aluminum Extruders Council (US); US Environmental Protection Agency; Am. Met. Mark., 17 Mar. 1989, 97, (53), (Suppl. Extrusions), 16 [in English]. ISSN 0002-9998)

1867 FUNGAL BIOSORPTION OF METAL IONS. [MAT2-198907-G7-0200]
BNF Metals Technology Centre and BTTG are to collaborate on the development of a commercial biosorption process for the extraction of metal ions from industrial effluents, thereby improving water quality. Selection and improvement of strains of micro-organisms is the aim of the programme in order to increase the efficiency and rate of absorption of metal ions. (BNF Metals Technology Centre; Publisher: BNF Metals Technology Centre (June 1989),7 Pp 1 [in English].)

1868 22 PIG IRON PROJECTS IN EASTERN AMAZON FACE GOVERNMENT CIVIL SUIT. [MAT2-198907-S4-0017]
Brazil's attorney general has filed a civil suit against 22 government-approved eastern Amazon pig iron projects, threatening to reduce drastically this country's pig iron expansion plans. The suit was brought because the proposed charcoal-burning units, have not submitted the necessary environmental impact statements and threaten to cause the destruction of 250 000 km exp 2 of Amazon rain forest over the next 20 years. The 3 operating and 19 proposed projects affected lie along a 500 km stretch of the eastern Amazon railroad connecting the Carajas open-pit iron ore mine with a northern port. Using Carajas ore, the 22 projects plan to make pig iron with charcoal from slashed rain forests. The projects are part of the Greater Carajas Program, a government plan to industrialize the Amazon, in part with mining and metal industries and dams to power them. (Kepp, M.; Am. Met. Mark., 16 May 1989, 97, (95), 3 [in English]. ISSN 0002-9998)

1869 A PROBLEM SOLVED FOR ELECTROPLATING FIRMS. [MAT2-198908-G1-0119]
An electroplating operation produced 6 m^3 of waste water from the anodizing unit and 3 m^3 from the galvanizing and chroming units every hour. Hitherto, the waste was neutralised and filtered, the filtrate going into the drains and the filter mass to a dump. The 450 tonnes of waste resulting from a year of 3-shift operation ceased to be acceptable to the authorities and closure of the unit was threatened. The solution to the problem was a waste water removal unit designed to suit the customer and which treated the two effluents separately. The treatment system produced an aluminium hydroxide sludge from the anodising section, pure enough to be sold for smelting. The filtrate was of sufficient quality to enable it to be used in the washing bath. The system has a cross-flow micro filter. The plant has been operating for a year and paid for itself within months. The system also proved effective in handling waste from the heavy metals sector. (Aluminium, Apr. 1989, 65, (4), 355-356 [in German]. ISSN 0002-6689)

1870 STEEL TANKS CUT COSTS OF SEWAGE PLANT. [MAT2-198908-S6-0110]
Thames Water is installing its first modular sewage treatment works at Wroughton, near Swindon. Nash Plant and Vessel (Rochester) are fabricating six steel treatment tanks each weighing 18 tonnes with dimensions 9 m x 3 m x 4 m. The 6 mm thick Brazilian plate steels used will be given a 100 mu m thick coating of Zn and three coats of epoxy paint. Some parts will be galvanised. Granular shale will be laid in the tanks and Howden Wade will supply air blowing plant to help bacteria work and clean filters. (Nash Plant and Vessel; Thames Water; Engineer, 18 Mar. 1989, 268, (6947), 41 [in English]. ISSN 0013-7758)

1871 SEWAGE TREATMENT "BOAT". [MAT2-198908-S6-0119]
The Anglia Water Authority has ordered two units from Simon-Hartley, Stoke on Trent, in a contract which has a value of pounds sterling 2 million. The first was due for delivery at the start of 1989 and both are to extend sewage treatment works at Mablethorpe. The "Boat" is patented system for the in-channel clarification of sewage, separating sludge from water to give a high quality effluent. Each of them is 33 m long and 5.5 m wide and a great deal of stainless steel is used in their construction. (Stainless Steel Ind., May 1989, 17, (97), 17 [in English]. ISSN 0306-2988)

1872 COATING THE ENVIRONMENTALLY FRIENDLY WAY. [MAT2-198909-G4-0031]
A powder coating is applied to rows of vertically held Al shapes with lengths of up to 11 m. Precautions protect the environment during degreasing, etching, and final rinsing. Special equipment removes sediments, desalinizes and controls all effluents. (KB Kunstoffbeschichtung-Gesellschaft; Ind.-Anz., 26 May 1989, 111, (42), 7 [in German]. ISSN 0019-9036)

1873 NAVY HAS ITS TROUBLES MARAGING SOLID WASTE. [MAT2-198910-P4-0022]
US Navy researchers are seeking ways to recycle the plastic and other waste generated onboard the nation's 600-ship fighting fleet. A successful effort would pave the way for limiting marine plastics debris from other major sources, including merchant and fishing fleets and leisurecraft. The program follows a string of recent edicts: federal approval of Annex V of the Marpol Agreement, barring ships from discharging plastics at sea; Congressional enabling laws committing the Navy to comply by 1993; and the fleet guidelines implemented in early 1989, requiring that ships retain plastics not used in food contact for at least 20 days and plastics used in food contact at least three days. The Navy has already developed the necessary densification technology, and specifications are to be issued soon for waste reduction equipment capable of producing a 30:1 reduced, sanitized block of waste that can be stored for onshore disposal. (US Navy; Mod. Plast., Aug. 1989, 66, (8), 17-18 [in English]. ISSN 0026-8275)

1874 SLUDGE CONVERSION PROCESS HELPS USS CUT COKE PLANT WASTE. [MAT2-198910-S1-0043]
USX Corp.'s USS Div. recently revealed that its Clairton, Pennsylvania Works is saving nearly $2 million/year in energy, landfill and coal costs by applying a TDS conversion method developed by AKJ Industries. AKJ's process involves treating coal tar sludge separated from gas-main flushing liquor at a coke plant's tar decanter. Emerging from the decanter with the consistency of asphalt, the sludge is diluted, steam heated, and its contained solids chopped and ground to leave a homogeneous, pumpable liquid having the viscosity of No. 6 fuel oil that can be applied as-is or further processed, depending on intended end use. At Clairton, the AKJ product is replacing fuel oil sprayed on incoming coking coal to increase bulk density. It improves coke-oven performance by taking advantage of the liquid's 150 000/165 000 Btu/gallon fuel value. (USS; AKJ Industries; Iron Age, Aug. 1989, 5, (8), 15 [in English]. ISSN 0897-4365)

1875 ZERO DISCHARGE SYSTEM USES REVERSE OSMOSIS MEMBRANES DEVELOPED FOR METAL WASTEWATERS. [MAT2-198911-G1-0176]
A closed-loop system that uses reverse osmosis membranes to recycle metal-contaminated rinsewaters and plating salts has been developed by Water Technologies, Inc., Minneapolis, Minnesota, USA. Rinsewaters with pH in the range of 0-13.5 can be treated. In WTI's zero discharge recovery system, wastewater is fed under pressure through the RO membrane. This produces clean water that is recycled to the plating rinse tanks. The concentrated waste metal solution is passed through the membrane until it reaches the solution strength (40-70%) necessary for recycling to the plating baths. Tests are being conducted to test the method's ability to handle wastes from electroless Ni, electroless cobalt, acid Cu and Watts Ni plating operations. (Water Technologies; HazTECH News, 7 Sept. 1989, 4, (18), 135 [in English].)

1876 EPA SUPERFUND ORDERS GO TO ALCOA, REYNOLDS. [MAT2-198911-G4-0041]
The US Environmental Protection Agency (EPA) has issued Superfund administrative orders to Aluminum Co. of America and Reynolds Metals Co. to perform the necessary studies and cleanups of sediments tainted with polychlorinated-biphenyls (PCBs) in the St. Lawrence River system near Massena, New York, USA. The orders are part of a joint effort by the EPA, the New York State Department of Environmental Conservation and the St. Regis Mohawk Tribe to clean up pollution in the area. The two agencies and the Indian tribe have formed a committee to monitor the progress of the two companies in complying with the Superfund orders. (US Environmental Protection Agency; Reynolds Metals; Aluminum Co of America; Am. Met. Mark., 11 Oct. 1989, 97, (198), 2, 20 [in English]. ISSN 0002-9998)

1877 PLASTIC PLATING REDUCES WASTE. [MAT2-198911-P5-0280]
A new chromic acid regeneration system was designed and installed to maintain a low concentration of trivalent Cr in the saturated chromic acid etchant for plated ABS and polyphenylene oxides. With the help of Udylite (Warren, Michigan, USA) and Edison, New Jersey's Engelhard Corp., a system was designed using platinized Ti anodes and CP Pb cathodes. With this new regeneration system, Jay Plastics saves both on chromic acid, because less is required, and in waste treatment/disposal costs. (Jay Plastics; Udylite; Engelhard; Automot. Ind., Sept. 1989, 169, (9), 114 [in English]. ISSN 0273-656X)

1878 TWO YEARS OF CONTINUOUS COMPLIANCE AT HI-TECH PLATING. [MAT2-198912-G1-0188]
Hi-Tech Plating, Everett, Massachusetts, USA, had to devise a wastewater treatment system to handle not only its own discharges, but also that of its sister company's, the Tinning Company. Hi-Tech installed an advanced membrane filtration system to handle its own plating bath wastes and those from the hot solder coating operations next door. Since installing the membrane filtration system, the company has never been out of compliance with the stringent limits enforced by the Massachusetts Water Resources Authority. The new system, installed by Ferrari Engineering and made by the Memtek Corporation, requires little maintenance, is easily operated, and has a high capacity. (Hi-Tech Plating; Finish. Manage., Oct. 1989, 34, (9), 30, 34-35, 61 [in English]. ISSN 0015-2358)

1879 WATER TREATMENT: THE LATEST AT ACTIMAG. [MAT2-198912-G4-0046]
Actimag is a company which treats water to remove residual hexavalent Cr and Cu. The principle is very simple – a fluidized bed of Fe granules is subjected to a magnetic field and the particles are set in motion. The residuals are deposited to the surface of the Fe and are separated later by filtration. With hexavalent Cr the concentration can be reduced from 3 g/l to 0.1 mg/l and with Cu 99% can be extracted. A small pilot installation permits potential customers to test their own solutions. (Actimag; Galvano-Organo-Trait. Surf., June-July 1989, 58, (597), 582 [in French]. ISSN 0302-6477)

1880 FUNGUS REMOVES COPPER FROM WASTEWATER. [MAT2-199001-G1-0008]
The fungus penicillium ochro-chloron can effectively remove heavy metals from almost any aqueous waste stream, concluded researchers from Worcester Polytechnic Institute, Worcester, Massachusetts, USA. The material should be capable of heavy metal uptake and recovery from both electroplating wastewaters and contaminated aqueous environments. The lab tests measured the potential of p. ochro-chloron mycelia beads as a biotrap for Cu. The fungus was cultivated and then killed with 80% ethanol and resuspended in an aqueous slurry at pH 4.0. The mycelia were then used as an adsorbent in a batch experiment. The maximum binding of Cu to mycelia was calculated to be 3.73 mu g/mg, with a distribution coefficient of 0.02. The uptake of Cu was enhanced if the ethanol-treated beads were washed with a solution of 90 g sodium carbonate and 60 g sodium bicarbonate/liter for 30 min and then exhaustively washed with distilled water adjusted to a pH of 4.0. Use of the ethanol-killed mycelia beads eliminates the need to immobilize cells or use heavy mats of fungal mycelia. The beads are easy to handle. Because of lower cost, lower weight/unit of exchange capacity and ease of application, the fungus biotrap will rival synthetic cation exchange resins as a treatment option for metals. (Worcester Polytechnic Institute; HazTECH News, 21 Sept. 1989, 4, (19), 143 [in English].)

1881 JOINT VENTURE PLANNED TO BUILD FOUR METAL RECYCLING FACILITIES. [MAT2-199001-G4-0005]
A joint venture to build four metal waste recycling centers in the US is being planned by Compliance Recycling Industries, Inc., Englewood, Colorado, and Sybron Chemicals Inc., Birmingham, New Jersey. The centers would supply individual ion exchange cleanup units to metal wastewater generators, such as electroplaters and makers of electronic components, and regenerate the units at a central site. The CRI unit installed at the generator's site includes a sand filter to remove particulates from the wastewater, and two modules containing plastic beads that serve as ion exchange resin to remove metal contaminants. The treated water can be released to a sewer or reused. When the beads are saturated, CRI picks up the material for regeneration at the central site. (Compliance Recycling Industries; Sybron; HazTECH News, 2 Nov. 1989, 4, (22), 167, 168 [in English].)

1882 VACUUM DISTILLATION USED TO CONCENTRATE METAL WASTES. [MAT2-199001-G4-0006]
A vacuum distillation system for treating electroplating wastewater is being distributed in the US by Drew Resource Corp., Berkeley, California. Developed by Led Italia, Por-de-none, Italy, the FTS distillation unit operates in a residual vacuum of 30-40 mmHg, allowing distillation to occur at 30-35 °C. Consequently, energy costs are 80% less than distillation at standard atmospheric pressure. The wastewater is pressurized and then heated to vaporize the water, leaving behind a metal concentrate. The water vapor is condensed and captured as distilled water. If a cyanide waste is treated, most of that contaminant remains behind in the metal sludge, and the small amount that goes with the water can be handled by a resin system. The metal concentrate can be treated to recover the metals or be sent for disposal, depending on the contaminants. (Drew Resource; HazTECH News, 2 Nov. 1989, 4, (22), 166 [in English].)

1883 COUPLED MEMBRANE SYSTEM DEVELOPED TO REMOVE METALS FROM WASTE. [MAT2-199001-G4-0007]
Two methods for selectively removing metals from aqueous wastes have been developed by Bend Research, Inc., Bend, Oregon, USA. The firm's coupled transport membrane system can treat wastes containing high levels of metals, while low concentrations (a few parts per million down to parts per billion levels) can be handled by a system using polymeric beads containing solvents. Bend has operated a pilot-plant system to recover pure Cu, Ni and chromic acid from chrome-plating waste sludges. Based on today's prices, a payback period of less than two years is projected for a system to process 520 000 lb of sludge/year. Long-term field tests on chromeplating rinsewaters suggest that a system designed to recover 5000 lb/year of Cr would have a payback period of about one year. (Bend Research; HazTECH News, 5 Oct. 1989, 4, (20), 149, 150 [in English].)

1884 ALUMINUM AND ACID: A SINISTER SYNERGY. [MAT2-199001-G4-0010]
Acid water, combined with dissolved Al salts, is the major cause of inland water pollution. The presence of Al greatly enhances the activity of acids, upsetting the ability of algae, plants, shrimp, and fish to regulate salts and exchange gases with the water. The most vulnerable lakes are those with soft water lying on granite bedrock. The Al seems to bind with phosphate groups in the DNA, possibly disabling needed enzymes. (Gotfryd, A.; University of Toronto; Can. Res., June 1989, 22, (4), 10-11 [in English]. ISSN 0319-1974)

1885 MIDWEST STEEL SETTLES WITH EPA. [MAT2-199001-S4-0005]
Midwest Steel, a division of National Steel Corp., will pay a $14 500 fine in a settlement with the US Environmental Protection Agency and is expected to spend approx $1 million to clean and close four lagoons holding waste water at its plant in Portage, Indiana. The EPA charge, filed in December 1986, said Midwest Steel had failed to properly treat waste water at the disposal sites and test groundwater in the area. Midwest Steel will turn over the lagoons to the National Park Service and, if found safe for public use, they will be included in the Indiana Dunes National Lakeshore expansion plan. (Midwest Steel; US Environmental Protection Agency; Am. Met. Mark., 30 Nov. 1989, 97, (232), 3 [in English]. ISSN 0002-9998)

1886 COPPER REMOVAL FROM WASTEWATER BY LIQUID MEMBRANES UNDER STUDY. [MAT2-199002-G4-0015]
The use of hollow fiber contained liquid membranes (HFCLM) to remove Cu from wastewater is being studied by researchers at Stevens Institute of Technology, Hoboken, New Jersey. Experiments indicate heavy metals can be extracted efficiently from water in a stable fashion. Experiments were conducted with Cu present as $CuSO_4$ (1000 mg/l as Cu) in a feed solution (pH approx 4.25), a strip solution of very low pH, and a liquid membrane of n-heptane containing 10 vol.% of LIX84. Because there is no carrier for the Cu, it is removed from the waste stream when the LIX in the membrane releases a proton to the waste. The Cu is in turn transferred to the strip solution when that releases a proton to the membrane. (Stevens Institute of Technology; HazTECH News, 11 Jan. 1990, 5, (1), 3 [in English].)

1887 DATED DEPOSITS AND CONTAMINANTS—A PRESENT TASK NOT TO BE UNDERESTIMATED. [MAT2-199003-G4-0022]
Soil contamination that has accumulated over the years has become an increasingly urgent problem. Abandoned dump sites with communal or industrial waste, sources of corrosive chemicals deposited on industrial land, soil and groundwater pollution caused by corroded or broken pipe systems, improper storage of water-contaminating fertilizers and chemicals, all make

a contribution to a gradual and permanent spoilage of the water supply needed for human consumption, animal husbandry and agricultural operations. A significant share of concern in this respect must be borne by the nonferrous metal industry. This is particularly serious in cases where renovations or structural changes are undertaken on factory sites, where production facilities are altered to handle new product lines, or where entirely new plants and facilities are inaugurated. But most significant for the nonferrous metal industry are probably those problem sites where heavy metal or even radioactive elements are contained in waste and scrap deposits mixed with soil, clay and other substances in the ground. The problem is very complex, and expert advice is needed in most instances to bring the matter under control. (Neumaier, H.; Vermittlungsstelle der Wirtschaft fur Atlastensanierungs-Beratung; Metall, Sept. 1989, 43, (9), 878-881 [in German]. ISSN 0026-0746)

1888 REDUCING AGENT FOR HEXAVALENT CHROMIUM IN WATER. [MAT2-199003-G4-0024]
Environmental Technology, Sanford, Florida, USA, has developed a material, tradenamed Thio-red, which it claims is effective for treatment of soil and groundwater contaminated with hexavalent Cr and other heavy metals. It is injected into the groundwater plume, reducing the hexavalent Cr and converting it to a safer trivalent form which is insoluble and will not migrate in groundwater. The cost of treatment is said to be a fraction of that of conventional methods. The reducing agent is a patented polymer – sodium polythiocarbonate – which is environmentally safe and non-toxic. After reducing the polluting metals to their safer and amenable lower valency, it then acts as a precipitant, converting the metals to a very insoluble, leach-proof thiocarbonate form. Pilot studies at individual sites are usually required to develop the most appropriate injection methodology. (News Brief). (Environmental Technology; New Mater. World, Feb. 1990, 1, 2 [in English].)

1889 FIRM SAYS POLYMER CAN IMMOBILIZE METALS IN GROUND WATER, SOIL. [MAT2-199003-G4-0031]
Environmental Technology, Inc., Sanford, Florida, USA, reports that its Thio-Red polymer can be injected into ground water to immobilize hexavalent Cr and other heavy metals. The sodium polythiocarbonate converts soluble, high-valence metals, such as chromates and arsenic, to their lower valence form. The material then acts as a precipitant, converting the metals to a very insoluble, leach-proof thiocarbonate form. The carbonate is trapped in the soil and will not migrate or move back to the ground water. The material can be put into the ground through an inspection well. Injection of the dilute polymer should occur at a rate about equal to the percolation rate. In the case of a spill, delivery can be through a trench system. (Environmental Technology; HazTECH News, 25 Jan. 1990, 5, (2), 15 [in English].)

1890 SHARON STEEL TO SETTLE POLLUTION VIOLATIONS. [MAT2-199003-S4-0014]
Sharon Steel Corp., Pittsburgh, Pennsylvania, USA, has agreed to pay a civil penalty of $175 000 to settle past violations of water pollution laws at its shuttered Brainard Strapping division plant in Warren, Ohio. The company also agreed to bring the plant into compliance if it is ever to be reopened. Sharon Steel filed for Chapter 11 creditor protection a month after the environmental lawsuit, and shuttered the Brainard facility in July 1989. (Sharon Steel; Am. Met. Mark., 7 Feb. 1990, 98, (27), 2 [in English]. ISSN 0002-9998)

1891 TEXAS COPPER SMELTER PROJECT DELAYED. [MAT2-199004-G4-0037]
Texas Copper Corp's (TCC) plans to begin construction of its new 200 000 t/year Cu smelter are now subject to delays caused by problems in receiving the necessary permits as stipulated by the Texas Water Board. Preliminary construction work on the new smelter was to have begun in April 1990. The pollution problems centre on the discharge of water from the plant's cooling system into Galveston Bay. Particular concern has been expressed about the temperature of the water discharged. (Texas Copper; Texas Water Board; Met. Price Rep.: Base Met. Mark., 20 Feb. 1990, (45), 4 [in English].)

1892 CHICAGO ELECTROPLATER TO STUDY REUSE OF ZINC FROM RINSEWATER. [MAT2-199004-G4-0040]
The reuse and recovery of Zn from an alkaline non-cyanide Zn plating line is being studied by the Center for Neighborhood Technology, Chicago, with funding from the Illinois Hazardous Waste Research and Information Center, USA. The rinsewater will be collected and its pH adjusted to 9.5 to precipitate the Zn as a metallic zinc hydroxide. The Zn and other solids will be collected in a bag filter. The cleaned water can be recycled back to the rinse system, while the Zn will be reused in the plating bath. (Illinois Hazardous Waste Research and Information Center; HazTECH News, 22 Feb. 1990, 5, (4), 27 [in English].)

1893 EPA ORDERS BETHLEHEM (WATER POLLUTION) STUDY. [MAT2-199004-S4-0023]
The US Environmental Protection Agency is mandating that Bethlehem Steel Corp. undertake a study to determine if past, and possibly current, benzene and phenol emissions from the Lackawanna, New York, site are polluting groundwater, surface water and soils. Prior to its closure in the early 1980s, Lackawanna was an integrated facility which included six blast furnaces and three basic oxygen furnaces. Bethlehem, through its subsidiaries and divisions, still operates coke batteries, a 14 in. bar mill and a sheet galvanizing line at the mill. (Scolieri, P.; Bethlehem Steel; US Environmental Protection Agency; Am. Met. Mark., 19 Feb. 1990, 98, (35), 2, 12 [in English]. ISSN 0002-9998)

1894 EMISSION CONTROLS: NEWEST SYSTEMS MEET REGS, DELIVER EXTRA BENEFITS. [MAT2-199005-G4-0043]
Combustion Engineering, Wellsville, New York, USA, produces the Combu-Changer regenerative oxidizer system which can eliminate not 95% of volatile organic compounds from air streams in a bed of silica gravel heated to 1000 °C. Up to 98% of the heat can be recovered. The capacity of an operational unit in a paint finishing plant is 100 m^3s^{-1}. The waste water is treated to remove organics and metals. American Colloid and NALMET by Nalco Chemical are other systems widely used in the plating industry. The systems remove residual metals from waste water as a dewatered sludge ready for disposal in hazardous landfills. By compliance with EPA regulations, substantial fines can be avoided. (Cassidy, V.M.; Combustion Engineering; American Colloid; Nalco Chemical; Mod. Met., Jan. 1990, 45, (12), 20-22, 24, 26, 28 [in English]. ISSN 0026-8127)

1895 EFFLUENT RULE COULD COST MILLIONS. [MAT2-199005-P4-0013]
The Environmental Protection Agency will require the plastics, pharmaceutical, and synthetic rubber and fiber industries to test their effluents for 25 additional organic chemicals. The final rule expands testing mandated under the Resource Recovery and Conservation Act (RCRA) and will cost industry $250-450 million/year. Approximately 17 000 additional waste generators will be affected. Large generators of affected wastes must adopt the new "toxicity characteristic leaching procedure" (TCLP) in six months. Small waste producers – those generating 220-2200 lb of hazardous waste/month – will have one year to comply. (Sternberg, K.; US Environmental Protection Agency; Synthetic Organic Chemical Manufacturers Association; Chem. Week, 14 Mar. 1990, 146, (10), 10 [in English]. ISSN 0009-272X)

1896 NO SLICK ANSWERS FOR SHELL. [MAT2-199005-S4-0035]
The main reasons for the failure of Shell's Mersey oil pipeline in 1989 have been established. The pipe's insulation first became detached bringing localised seawater corrosion. Over time, it became dangerously thin at corrosion points. A pressure surge then caused rupture and oil leakage. (Shell; Engineer, 8 Mar. 1990, 270, (6989), 22 [in English]. ISSN 0013-7758)

1897 DAYTON, OHIO, PLANT PROCESSES TOXIC ELECTROPLATING EFFLUENTS. [MAT2-199007-G4-0065]
A processing facility to handle hazardous effluents from electroplating plants has been put into operation in Dayton, Ohio, USA. The plant is a joint venture between Delco products division of General Motors Corp. and the Environmental Protection Agency and utilizes proprietary technology developed by Inorganic Recycling Inc., Columbus, Ohio. The end product is an environmentally safe and non-reactive ceramic material. (News Brief). (Delco Products; General Motors; Inorganic Recycling; Am. Met. Mark., 1

June 1990, 98, (107), 9 [in English]. ISSN 0002-9998)

1898 ENVIRONMENT FEARS MAY SLOW GEDDES COPPER MINE DEVELOPMENT. [MAT2-199007-G4-0069]
The US Fish and Wildlife Service has complained to the Canadian environmental officials that the run off of the Windy Cragg Cu mine developed by Geddes Resources to produce 120 000 tonnes of Cu ore/year in British Columbia, would harm Alaska waterways. The poisoning of rivers, fish and wildlife would continue long after the mine's expected life of at least 20 years. (News Brief). (Geddes Resources; Cominco; Northgate Exploration; Met. Bull., 21 May 1990, (7484), 7 [in English]. ISSN 0026-0533)

1899 BIOLOGICAL RESIN REMOVES MERCURY FROM WATER DURING SITE TEST, FIRM SAYS. [MAT2-199007-G4-0075]
On-site pilot-scale testing of the "biological" ion exchange resin developed by Bio-Recovery Systems, Inc., Las Cruces, New Mexico, USA, indicate that the material has promise for recovering Hg from ground water. Bio-Recovery produces AlgaSORB, a material made primarily of algae, which have been immobilized in a silica gel polymer. This product has an affinity for heavy metal ions and can concentrate them by a factor of many thousand-fold, it was noted that the bound metals can be stripped and recovered in a manner similar to conventional resins. Hard water components and monovalent cations do not significantly interfere with the binding of heavy metal ions, and efficiency is not diminished by organics. (Bio-Recovery Systems; HazTECH News, 17 May 1990, 5, (10), 71 [in English].)

1900 W-P STEEL TACKLES WASTEWATER EFFORT. [MAT2-199007-S4-0045]
An extensive $17 million wastewater recycling project at Wheeling-Pittsburgh Steel Corp.'s Steubenville South plant recently got under way, marking the beginning of an environmental spending program expected to cost $100 million through 1995. The Steubenville project will treat water from the Ohio River used at the plant's 80 in. hot strip mill. Eighteen new filters will be added to 12 filters already in service. The filters, fed by a complex piping system, will strain out oil, grease and other impurities so the water can be reused for hot metal cooling purposes or returned to the river if necessary. (Balcerek, T.; Wheeling-Pittsburgh Steel; Am. Met. Mark., 5 June 1990, 98, (109), 9 [in English]. ISSN 0002-9998)

1901 CERRO TO CLEAN UP POLLUTED WATERWAY. [MAT2-199008-G4-0083]
Cerro Copper Products Co. will clean up a contaminated creek located at the site of the company's Sauget, Illinois, USA, copper tubing plant at a cost of $12 million. Dead Creek was polluted by years of industrial waste from manufacturing companies in the Sauget area, but the company agreed to finance the cleanup because the contaminated creek segment was on Cerro's property. As part of the agreement, Cerro will stop all discharge flows into the 1600 ft creek segment crossing its property, construct an alternate storm water collection and retention system and remove contaminated sediment from the creek bed. (Farricker, M.; Cerro Copper; Am. Met. Mark., 12 July 1990, 98, (135), 3 [in English]. ISSN 0002-9998)

1902 ENVIRONMENTALLY SAFER ALTERNATIVES TO CADMIUM PLATING. [MAT2-199008-G4-0088]
In the past, in spite of the toxicity, Cd has been economical to plate and reasonable to waste treat so the investigation of an alternative has not been pursued to a great degree. One of the things that has happened to change this is the development of new chromate finishes which will extend the salt spray resistance of Zn plate which allows the replacement of Cd in several bolt applications for the military. A new two-part chromate process extends the salt spray and produces a hard film with improved wet strength. The alloy Zn plating systems are either Co, Ni, or Fe. New developments using inorganic sealants are being investigated as a viable Cd replacement. Graphs. (Griffin, R.; Kasper, P.; MacDermid; Met. Finish., Apr. 1990, 88, (4), 51-52 [in English]. ISSN 0026-0576)

1903 USX TO PAY $34.1M FOR CLEANUP, FINES. [MAT2-199009-S4-0060]
USX Corp. has agreed to pay $34.1 million in cleanup costs and penalties arising from water pollution violations at the USS Gary Works plant in Indiana, USA. The payment was part of a consent decree with the Environmental Protection Agency. Specifically, the EPA cited the steelmaker for bypassing its blast furnace water treatment facilities and discharging polluted water into the Grand Calumet River and Lake Michigan on several occasions during the mid-1980s. The EPA also held USS responsible for several oil spills that occurred in the lake and the river during the same period. (Bierne, M.; USX; US Environmental Protection Agency; Am. Met. Mark., 31 July 1990, 98, (148), 2, 16 [in English]. ISSN 0002-9998)

1904 RECOVERED METAL RECOVERED MONEY. [MAT2-199009-S4-0061]
Metal loss can be high when operating Zn–Ni and Ni coating lines. The economics of recovery and the environmental benefits can be attractive even on relatively high capital investments. A metal recovery unit (MPU) developed by Eco-Tech can be used for the recovery of Zn and Ni cations for return to electro-galvanising plating baths. Some 95% of the metal which would otherwise go to waste can be recovered. (Eco-Tec; Steel Times Int., July 1990, 14, (4), 50 [in English]. ISSN 0143-7798)

1905 CORNIGLIANO FACES POLLUTION PROBLEM. [MAT2-199009-S4-0062]
Residents in the neighbourhood of the Genoa works of the Acciaierie di Cornigliano (ADC) are petitioning the company to take speedy action concerning pollution by its blast-furnace. Ligurian authorities have additionally banned effluents into a nearby river, and have demanded the Riva organization, ADC's parent company, undertake improvements costed at approx 30 000 million lire. (News Brief). (Riva; Acciaierie di Cornigliano; Met. Bull., 19 July 1990, (7500), 21 [in English]. ISSN 0026-0533)

1906 POLLUTION AND ITS EFFECTS ON THE NATURAL AQUATIC ENVIRONMENT. [MAT2-199010-G4-0105]
Pollution has been defined as a physical, chemical or biological alteration, usually caused by humans, which results in harmful effects to health, safety and well-being. The major sources of water pollution are found in urban, industrial and agricultural environments. The major pollutants are materials in suspension, organic materials which remove oxygen from the water, nutritives which increase vegatives in the water. The problems are not great in mountain streams where the water is flowing rapidly over rocks and is usually fairly shallow, all of which move the bottom water to the surface. Slow flowing streams have none of these advantages and consequently are more subject to pollution. Marine water, especially along the shore line, is at risk. Procedures must be developed to prevent pollutants from entering the water, because their disastrous effects kill marine life and purification for human consumption is extremely costly. (Galvano-Organo-Trait. Surf., Dec. 1989, (601), 1009-1012, 1014 [in French]. ISSN 0302-6477)

1907 SPI PRESIDENT URGES PROPER PELLET HANDLING. [MAT2-199010-P4-0028]
The Society of the Plastics Industry is offering a "Plastics Marine Debris Education Kit". A focal point of the kit is a brochure, which suggests a number of specific corrective actions, including: installation of closed-loop pellet containment and collection system in resin-production facilities; prompt cleanup of pellet spills, followed by recycling or proper disposal; increased attention to pellet containment during cleaning of hopper cars; closing of valves on unloading shoes of rail cars and hopper trucks after they have been unloaded; and storage of pellets away from areas subject to flooding. (Society of the Plastics Industry; Plast. Eng., Sept. 1990, 46, (9), 5 [in English]. ISSN 0091-9578)

1908 PENNSYLVANIA CITES LTV FOR TOXIC WATER. [MAT2-199011-S4-0074]
The Pennsylvania Department of Environmental Resources has ordered LTV Steel Co. to stop discharging wastewater into the Monogahela River from its Pittsburgh coke works. The DER said that wastewater containing naphthalene and organic waste was being discharged by the steelmaker's coke plant into the river, threatening nearby water systems. The DER said

LTV must eliminate the discharge by 30 November 1990 and provide a proposal to continuously monitor discharges. (Pennsylvania Department of Environmental Resources; LTV Steel; Am. Met. Mark., 2 Oct. 1990, 98, (192), 9 [in English]. ISSN 0002-9998)

1909 INDIANA CHARGES LTV WITH WATER POLLUTION. [MAT2-199011-S4-0079]
LTV Steel Co. Inc. was hit with a lawsuit seeking $30 million in civil penalties as well as an injunction petition to stop it from allegedly violating clean-water standards. The suit and petition were filed in Lake County Circuit Court by the Indiana Department of Environmental Management. LTV claims it has a demonstrated record of environmental responsibility and will oppose the department's legal action. (Beirne, M.; LTV Steel; Indiana Department of Environmental Management; Am. Met. Mark., 10 Oct. 1990, 98, (198), 2, 16 [in English]. ISSN 0002-9998)

1910 HOW TO SOLVE COMPLIANCE, LIABILITY PROBLEMS. [MAT2-199012-G4-0134]
Compliance with disposal law for hazardous wastes threatens to force many plating companies out of business, but a unique ion exchange equipment offers an affordable alternative in the form of an ion exchange unit that removes hazardous metals and is then recharged by the supplier who recovers the metal ions. Several companies use batch processes to treat waste and then have the smaller volumes of truly hazardous product removed by firms used to dealing with such materials. Many such companies for handling hazardous wastes have been in business for years and are fully permitted to receive, transport and treat hazardous wastes of many kinds. (Compliance Recycling Industries; Technotreat; GSX Services; Pollution Control Industries of America; Mod. Met., Aug. 1990, 46, (7), 147-149 [in English]. ISSN 0026-8127)

1911 GERMANY HELPS BRAZIL COMBAT MERCURY WOES. [MAT2-199012-G4-0138]
The Brazilian government has announced a project, financed by Germany, to begin combatting the widespread Hg pollution of Amazon rivers by Au miners. In the Au separation process, Hg is washed indirectly into the rivers or ends up there when the Hg vapor condenses. According to the National Department of Mineral Production, 600 tons of Hg already have been dumped in the Amazon Basin's most polluted tributary, the Tapajos River. The Brazilian government plans to use the $17 million that Germany has donated in 1990 alone to determine the extent of the Hg poisoning and to study alternatives for decontaminating the rivers. (Kepp, M.; National Department of Mineral Production (Brazil); Am. Met. Mark., 31 Oct. 1990, 98, (213), 5 [in English]. ISSN 0002-9998)

1912 WHEELING-PITTSBURGH SLAPPED WITH EPA SUIT. [MAT2-199012-S4-0085]
The Environmental Protection Agency has filed a civil lawsuit in US District Court against Wheeling-Pittsburgh Steel Corp. for discharging more than the allowable amount of pollutants into the Monongahela River. Specifically, the suit against the steelmaker charges that its Allenport, Pennsylvania, plant exceeded the permitted discharge levels of total Fe, oil, grease, naphthalene and tetrachloroethylene. The suit is seeking a permanent injunction against the steelmaker for any future violations of the Clean Water Act and of its National Pollutant Discharge Elimination System permit. It also seeks a court order requiring Wheeling-Pittsburgh to bring the Allenport facility into immediate compliance with the act and the discharge permit. (Scolier, P.; Wheeling-Pittsburgh Steel; US Environmental Protection Agency; Am. Met. Mark., 1 Nov. 1990, 98, (214), 2, 12 [in English]. ISSN 0002-9998)

1913 WATER CLEAN-UP AT KEMBLA. [MAT2-199012-S4-0087]
BHP's Port Kembla works is taking further action to cleanse effluent from its cokemaking plant following progress already made in reducing cyanide, ammonia and other noxious discharges. New biological water treatment facilities will be operational in 1991 and a new system to reduce emissions at source will be in the first stage of installation. Charger cars, to be supplied by Hoogovens, should ensure that all gases are retained in the coke oven during charging. (BHP Steel; Hoogovens; Steel Times Int., Sept. 1990, 14, (5), 22 [in English]. ISSN 0143-7798)

1914 ELECTROCHEMICAL TECHNOLOGY FOR WASTE MINIMIZATION. [MAT2-199102-G4-0010]
With increasing enforcement of toxic waste programs, metal finishing companies such as platers have had to resort to numerous methods to remain in compliance. Discussed are the techniques of evaporation, reverse osmosis, ion exchange, electrodialysis, ultrafiltration, and electrowinning. Electrowinning is touted as advantageous for waste minimization since it can be applied at many points in the electroplating process. Combined with other processes, such as ion exchange, many closed loop systems can be developed to eliminate or greatly reduce sludge volume. (Horvath, R.J.; Eltech Systems; Automation, Dec. 1990, 37, (12), 12 [in English]. ISSN 0896-6052)

1915 ELECTROWINNING METAL RECOVERY SYSTEMS. [MAT2-199102-G4-0012]
The patented high-mass transfer (HMT) system was specifically developed for pollution control of dissolved metals found in electroplating and wet-processing rinse-water waste effluent. The system features the application of a high-surface-area carbon-fibre cathode that promotes the removal rate of metals by increasing the mass-transfer efficiency. The chemically inert nature of the C fibres enables the system to handle acidic, alkaline, chelated and non-chelated solutions. The system can economically reclaim, and reduced to below detectable levels such metals as Cd, Cu, Sn, Pb, Zn, precious metals, etc. The system also offers the following benefits: converts toxic metals at point of production into high purity, saleable scrap products; no treatment chemicals are required; no hazardous waste by-products eliminates disposal costs; familiar technology – easily operated by existing personnel; corrosion-resistant construction for long life and low maintenance; and space-saving modular designs – ready for installation and operation. (Baker Brothers/Systems; New Coatings & Surfaces, Jan. 1991, 1 [in English].)

1916 ANION EXCHANGE FOR HEAVY METAL COMPLEXES. [MAT2-199102-S4-0009]
In the galvanizing process, those in charge of disposal are constantly being confronted with the problem of complexing and chelating agents which, when combined with heavy metal ions, make costly waste water purification necessary. Recovery of the heavy metals and complexing agents which no longer contain metals during this process would offer advantages; the heavy metal complexes could simply be split up. The Karlsruhe Nuclear Research Centre, Germany, is using chloride or hydrogen carbonate ion exchangers to retrieve heavy metals out of a solution enriched with them using medium-strength complexing agents. After it has passed through the anion exchanger, the solution is largely free from heavy metals and can be used again immediately. An acidified salt solution is suitable for regenerating the resin, converting it into chloride form. The outgoing regenerated sbustance still contains low concentration heavy metal complexes as well as non-complex heavy metals. If the anion exchanger is used in the form of HCO_3 ions, $NaHCO_3$ can be used for regeneration. This offers the advantage that non-complex heavy metals emerge as carbonates and are easy to recover. The research institute is now looking for ajoint venture partner and licensee. (News Brief). (Kernforschungszentrum Karlsruhe; New Coatings & Surfaces, Jan. 1991, 1 [in English].)

1917 HYDRATED SPHERICAL ALUMINA PARTICLES. [MAT2-199103-C5-0061]
Saga University, Japan has used a uniform precipitation method to produce uniform spherical mono-dispersed hydrated alumina particles which are suited to sintering. The hydrated alumina was formed by mixing aluminium sulphate with urea, dissolving the mixture in water and heating to 98 °C. It was retrieved by sedimentation or centrifugal separation and then dried. The shorter the growth time and the lower the aluminium sulphate concentration, the smaller was the size of the particles formed. (News Brief). (Saga University; Technical Ceramics International, Jan. 1991, 1 [in English].)

1918 WATER, WATER EVERYWHERE (FOR METAL INDUSTRY TO CLEAN UP). [MAT2-199104-G4-0040]
With new government regulations for effluent water quality, many com-

panies are working to improve their existing treatment facilities or reuse water so that it doesn't have to be treated. The size of the problem is obvious when one considers the primary metals industry uses 6 trillion gallons/year, 70% of which is for some form of cooling. Unique systems to recycle water such as Dofasco's blast furnace system and Geneva Steel's biological treatment are described. Cerro Copper Products Co.'s initiation of the cleanup of a loal creek is cited as an example of corporate environmental responsibility. (Wright, J.R.; Cerro Copper Products; Geneva Steel; Dofasco; Thirty-Three (33) Metal Producing, Feb. 1991, 29, (1), 19-21 [in English]. ISSN 0149-1210)

1919 STEEL FROM SEWAGE SLUDGE? THE ENVIRONMENT PROCESS...UTILISING WASTE MATERIALS TO MANUFACTURE PIG IRON. [MAT2-199104-S5-0068]

The EnvIRONment Process, developed by the University of Wollongong's Microwave Applications Research Centre (MARC) promises to be a novel ironmaking process which could have far-reaching consequences in a society which has an ever-growing preoccupation with all things "green". While the process is currently seen as best being fully integrated to optimise fuel and energy usage, it may prove to be more practical to separate certain production stages, for example, to locate the smelting plant remote from the sewage plant. (Smith, B.; University of Wollongong (Australia); Metals and Castings (Australasia), Nov.-Dec. 1990, 36, (11-12), 25-27 [in English]. ISSN 0008-7521)

1920 BARMET ALUMINUM INNOVATION ELIMINATES ENVIRONMENTAL PROBLEM. [MAT2-199107-G4-0060]

Barmet Aluminum Corp., a leading Al recycler and coil producer based in Akron, Ohio, USA, is the first Al manufacturer to treat Al strip for the exterior building products market with a Cr-free system. Barmet commissioned Parker + Amchem, Madison Heights, Michigan, to develop a highly customized system. The system that Parker + Amchem developed for Barmet utilized Barmet's five-stage pretreatment line. The Al is first cleaned with an alkaline solution to remove oils and Al fines. After a warm water rinse, an organo-metallic, chrome-free treatment is applied by spray application. After a second water rinse, the material is treated with a chrome-free final rinse that seals the coating. This entire process produces a Ti-based, organo-metallic complex, ready for paint application. (Barmet Aluminum; Parker + Amchem; Metal Fabricating News, Apr.-June 1991, 30, (2), 14 [in English]. ISSN 0026-055X)

1921 WHEELING-PITTSBURGH STEEL TO PAY $6M PENALTY FOR WATER POLLUTION. [MAT2-199107-S4-0043]

Wheeling-Pittsburgh Steel Corp. has agreed to pay what the US Environmental Protection Agency called the largest fine ever assessed by the federal government for violating provisions of the Clean Water Act. The Wheeling, West Virginia-based steelmaker, which recently emerged from Chapter 11 creditor protection has agreed to pay the $6 million civil fine for discharging more than the allowable limits of pollutants into the Ohio River from its Steubenville, Mingo Junction and Yorkville, Ohio, plants. The steelmaker said the consent decree signed with the EPA represents a fair compromise of claims and defenses of the parties and constitutes a major step in its efforts to develop constructive rather than confrontation relationships with government and community programs. (Scolieri, P.; Wheeling-Pittsburgh Steel; American Metal Market, 17 May 1991, 99, (95), 2, 16 [in English]. ISSN 0002-9998)

1922 ARTEK ALLOWED TO OPERATE PILOT-SCALE METAL RECYCLING PLANT AS COMMERCIAL FACILITY. [MAT2-199108-G1-0122]

The California Department of Health Services has granted a one-year variance that allows Advanced Remediation Technology, Inc., San Diego, California, USA, to operate its pilot/research plant as a commercial facility for recycling metal wastewaters. The plant recovers metals, primarily through hydrometallurgy, using no organic solvents. With a capacity of 100 tons/month, the facility has been handling cyanide solutions from the metal finishing industry, acid solutions, Cr solutions and solids, and metal hydroxide cake. Artek plans to recycle alkaline solutions as well. Because the facility has been designed to accept wastes directly into the process, no RCRA storage permit is required. Based on this design and the fact that the process recycles the wastewaters without producing residues, regulatory agencies in Ohio, Michigan, Maryland, Louisiana, Tennessee, and South Carolina have already granted the firm exemptions from hazardous waste treatment and storage permit regulations. (Advanced Remediation Technology; HazTECH News, 27 June 1991, 6, (13), 103 [in English].)

1923 VON DUPRIN CUTS WASTE GENERATION THROUGH METAL RECOVERY. [MAT2-199109-G1-0142]

Von Duprin, Inc., the Indianapolis, USA-based leader in the manufacture of door exit hardware, has engaged in a major effort to reduce wastewater treatment sludge volume from its plating operation. The initial engineering study recommended a goal of a 90% reduction in sludge volume. With the recommended metal recovery and waste reduction equipment now in place, Von Duprin is making substantial progress toward its goal. Von Duprin's plating processes include cyanide Cu, satin and bright Ni, chrome, brass, and alkaline non-cyanide Zn. Substrates include Zn, Al, brass, and steel. (Reinke, D.P.; Bayman, M.A.; Capsule Environmental Engineering; Von Duprin; Finishers' Management, June-July 1991, 36, (6), 23-24, 26, 28-29 [in English]. ISSN 0015-2358)

1924 NEW SYSTEM RECYCLES WASTES FROM ELECTROLESS NICKEL PLATING. [MAT2-199110-G5-0240]

A new process, trade-named ENVIRO-CP, eliminates electroless Ni plating wastes, improves plating quality and speed, and cuts costs by 25% or more. As electroless Ni plating progresses, the chemical bath accumulates impurities which eventually render the bath ineffective. The ENVIRO-CP process removes undesirable byproducts in forms that allow for their reuse as fertilizer. Nickel and other valuable chemicals are recovered form the plating solution and returned to the bath. No hazardous wastes are discharged. The process was developed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA, which is managed by Martin Marietta Energy Systems, Inc. for the US Department of Energy. (News Brief). (Martin Marietta Energy Systems; Oak Ridge National Laboratory; Modern Metals, Aug. 1991, 47, (7), 103 [in English]. ISSN 0026-8127)

1925 BATTLE MOUNTAIN GOLD FINED FOR CYANIDE PROBLEM. [MAT2-199206-G4-0041]

Battle Mountain Gold Co., Houston, (BMG) has received a $168 000 fine from the Mined Land Reclamation Division (MLRD) of the state of Colorado in relation to previously reported higher than anticipated cyanide levels that occurred in the tailing pond at its San Luis mine in Costilla country. The BMG chairman said the company has been aggressively working to bring the cyanide content to satisfactory levels since its voluntary six-day shutdown of the facility in early April. (Skillings' Mining Review, 2 May 1992, 81, (8), 9 [in English]. ISSN 0037-6329)

1926 RURAL WALES BENEFITS FROM COMPOSITES. [MAT2-199207-D6-0181]

Thermosets and thermoplastics came together to make 25 complex sludge holding tanks for small sewage treatment plants throughout Wales. Ranging in volume from 10-60 m^3, all are made from Edinburgh's Royalite Plastic's Celmar polypropylene sheet and reinforced with glass fibre laminate made using Crystic 397 from Scott Bader which is based in Wellingborough. The tanks are made by Forbes Plastics. (Plastics and Rubber Weekly, 16 May 1992, (1436), 9 [in English]. ISSN 0032-1168)

1927 COMMISSION RECOMMENDS CHLORINE PHASEOUT. [MAT2-199208-P7-0239]

The United States – Canadian International Joint Commission on Great Lakes Water Quality has recommended phasing out the use of chlorine and chlorine-containing compounds as industrial feedstocks in the Great Lakes Basin. In its Sixth Biennial Report on Great Lakes Water Quality, the commission said that because these substances, which presumably could include polyvinyl chloride, remain in the environment for long periods of time, the chemicals are too dangerous to the biosphere and to humans to permit their release in any quantity. The commission also recommended that the two countries should: expand the definition of persistent toxic substances

to encompass all toxic substances with a half-life in any medium of greater than eight weeks; review the use of, and disposal practices for, Pb and Hg and phase out their use whereever possible; and established a specific data at which no point source release of any persistant toxic substances will be permitted into Lake Superior or its tributaries. (Plastics Engineering, June 1992, 48, (6), 6 [in English]. ISSN 0091-9578)

1928 LARGE GLASS-REINFORCED PLASTIC STRUCTURES FOR THE WATER TREATMENT INDUSTRY. [MAT2-199209-D6-0217]
Steel Pickling Services of Bridgenorth in the UK has completed a 10 m rotating biological contactor (RBC) made from glass-reinforced plastic (GRP) for the water treatment industry. The large tank-like structure was produced from E-glass reinforcement and Beetle resin 890, an isophthalic polyester resin developed by BIP Chemicals, Warley, UK, specifically for large marine structures. Steel Pickling Services, which has a production facility at Bridgenorth, specializes in producing one-off mouldings for the water treatment and chemical industries, but has adopted a modular approach to its plant design. As a result, it has approx 600 standard GRP mouldings on which construction is based. This allows rapid turnaround of orders, even one-off ones. (Advanced Composites Bulletin, July 1992, 6 [in English]. ISSN 0951-953X)

1929 COURT SAYS STEELMAKER HARMED OLIVES, FISHING. [MAT2-199209-S4-0073]
Chile's Supreme Court upheld a lower-court ruling against Cia Minera del Pacifico (CMP) over air and water pollution in the Huasco Valley in northern Chile. The court found that CMP has been contaminating the air with emissions from its pellet plant, to the detriment of the region's olive growers, whose production has fallen drastically since the plant began operations. The court also found the CMP had caused irreversible damage to Chapaco Bay, into which the company has been dumping its industrial wastes for 13 years. CMP is a unit of Cia de Acero del Pacifico (CAP), Chile's previously state-owned steel company that was privatized in 1985. (Frasca, T.; American Metal Market, 18 Aug. 1992, 100, (160), 4 [in English]. ISSN 0002-9998)

1930 FERRIC SALTS - APPLICATION OPPORTUNITIES IN PAPER MILL EFFLUENT TREATMENT PLANTS [PIRA-10116184]
Ferric salts have established themselves as an essential auxiliary in the treatment of waste paper in papermaking. They provide a significant contribution to the purification of paper mill effluent. Two different salts in common use today to activate precipitation reactions are the ferrous sulphate heptahydrate Quickfloc and the ferric chloride sulphate solution Ferrifloc. They are primarily employed for the abatement and discharge of activated sludge plants. (Uebel, O.; no. 3, 1991, pp T14, T16, T18, T20, (1991) Dtsch. Papwirtsch., 9206 [in German]. 0070-4296)

1931 ENVIRONMENTAL ISSUES FACING THE PAPER INDUSTRY [PIRA-10116223]
An analysis is made of the issues facing the paper manufacturing industry in making itself environmentally acceptable. Environmentalism is divided into 3 categories: raw material sourcing; manufacturing process; and end product. Individual issues within each category are discussed - such as forestry, landfill shortage, waste paper, alternative fibres, energy, effluent treatment, and chemicals. The major issues are listed in order of priority. Eco-labelling is also discussed. The pragmatic approach of the papermakers towards these issues is stressed. (Fraser, J.; Paper presented at Paper Industry and the Environmental Challenge: Which Way Forward held 21 Oct. 1991 at London, UK, 10pp [Reading, UK: Conservation Papers Ltd, 1991, 83pp, £50.00 (9370)], (1991), 9206 [in English].)

1932 TOWARDS A SUSTAINABLE PAPER INDUSTRY [PIRA-10116225]
This paper surveys the progress being made towards a more environmentally acceptable paper industry in Europe. Success has been achieved with the introduction of chlorine-free bleaching, accelerated by the public's demand for chlorine-free products. However, the application of national and international legislation has been disappointing with respect to technological improvements, especially effluent treatment. It is claimed that the ever increasing demand for paper products is destroying the forests in Canada and Scandinavia and that the public awareness of this destruction and of the pollution associated with a paper mill and pulp mill is growing. Continued increase in paper consumption rates in the developed world is unsustainable, and the industry must replace quantity with quality. (Blake, M.; Paper presented at Paper Industry and the Environmental Challenge: Which Way Forward held 21 Oct. 1991 at London, UK, 3pp [Reading, UK: Conservation Papers Ltd, 1991, 83pp, £50.00 (9370)], (1991), 9206 [in English].)

1933 CONCENTRATING AND DEWATERING OF WASTE WATER SLUDGE (1) [PIRA-10116240]
Waste water sludge in pulp and paper mills is removed from the mechanical and biological effluent treatment plants in concentrations from 1 to 4%. The characteristics of the water in the sludge are described - free water, capillary water and adsorption-bound water. The operations for thickening and dewatering of the sludge to increase its dry substance content to 40% and the equipment used for such processes (Dorr-Oliver, Turbodrain and Polydisc disc filters) are discussed. (Przybysz, K.; Sipa, K.; no. 1, 1992, pp 26-29, (1992) Przegl. Papier., 9206 [in Polish].)

1934 AHLSTROM BIO PLANT TO SAUGBRUGS [PIRA-10116265]
Norske Skog, Saugbrugs, Norway have ordered an external biological cleansing plant from Ahlstrom Aquaflow Oy. It will treat the waste waters from the three paper machines. There will also be internal cleansers. Total costs are NOK200m. Installation and building work started in November 1991, and the whole system comes on stream at the end of 1992. The cleansing plant is amongst the largest and all encompassing ones in the paper industry. (Short article) (Anon; vol. 45, no. 11, 1991, p. 51, (1991) Skogindustri, 9206 [in Norwegian]. 0800-8582)

1935 CLEAN AIR REQUIREMENTS TIGHTEN AND MILLS BEGIN TO FEEL THE PINCH [PIRA-10116414]
The US Clean Air Act Amendments 1990 will affect all parts of the pulp and paper industry particularly the areas of power and recovery, pulping, bleaching and effluent treatment. The act covers 190 air toxins whose emissions must be controlled including chlorine, chloroform, dibenzofurans, dioxins, formaldehyde, hydrogen sulphide and methanol. These chemicals are either used in the paper industry or produced as by-products. Power and recovery boilers are regulated in terms of emissions of particulates, nitrogen oxides, sulphur oxides and total reduced sulphur (TRS). Details are given of wet and dry scrubbing processes to remove sulphur dioxide, and of odour reducing techniques. Fluidised bed combustion is recommended as a technique with low gas emissions which can burn a wide range of fuels. (Seay, R.; vol. 55, no. 1, Jan. 1992, pp 29-31, (1992) Am. Papermaker, 9206 [in English]. 0270-5222)

1936 WILLAMETTE BUILDS ENVIRONMENTAL PROTECTION INTO GREENFIELD MILL DESIGN [PIRA-10116415]
Willamette Industries Inc. started up a greenfield fine paper mill at Marlboro, Bennettsville, SC, USA, in December 1990. After a year of operation, the mill is producing 710tpd of uncoated printing and copying papers and 130tpd of wet lap pulp. The environmental protection features of the new installation include an Ahlstrom single drum, low odour recovery boiler fitted with an electrostatic precipitator. The recovery boiler and the lime kiln are fitted with total reduced sulphur (TRS) monitors, and the mill has a total TRS control and collection system from all non-combustion sources. The bleach plant features 50% chlorine dioxide substitution for chlorine, and the bleaching system was chosen to reduce environmental impact. Details are given of the mill's effluent treatment and water protection systems. A distributed control system (DCS) controls effluent and air emissions. (Swann, C.E.; vol. 55, no. 1, Jan. 1992, pp 34-35, (1992) Am. Papermaker, 9206 [in English]. 0270-5222)

1937 EFFLUENT TREATMENT GIVES COMPLETE RECYCLING [PIRA-10116425]
Cellier based in Aix-les-Bains (France) have designed an ultrafiltration treatment for coating effluent. It generates 0% waste - the treated water is recycled in the process and the expensive products contained in the water (coating residues and other raw materials used in paper-making) are totally recovered and re-used. (Short article) (Anon; vol. 217, no. 1, 14 Jan. 1992, p. 13, (1992) Paper, 9207 [in English]. 0306-8234)

1938 CLOCK TICKING ON CLEAN-UP [PIRA-10116428]
Canada has introduced new emission standards which have to be met by 1994. They include decreasing dioxins and furans to non-detectable levels, decreasing AOX levels to below 2kg per ton, decreasing BOD to 5kg per ton and decreasing total suspended solids to 7.5kg per ton. All mills will have to provide government authorities with regular effluent test results which will then be used to formulate more stringent requirements. The industry is having to implement these changes, some involving large investment, at a time when profits are low or non-existent. Some companies have therefore been given a longer time in which to meet the requirements. Environmental pressure groups in Canada are not impressed with the new regulations because they do not include limits on the discharge of organochlorines. (Turner, C.; vol. 217, no. 1, 14 Jan. 1992, p. 20, (1992) Paper, 9207 [in English]. 0306-8234)

1939 THE EFFLUENT-FREE NEWSPRINT MILL [PIRA-10116447]
The newsprint project was divided into two parts; the first part involved designing and studying an effluent-free greenfield mill. Included in the study were capital and operating costs for internal water treatment and for the whole mill. These values were then compared with a conventional greenfield newsprint mill. The mill's capacity was 250,000tpy and the mill included a wood room, thermomechanical pulp (TMP) and pressure groundwood (PGW) lines and a paper machine. The mechanical pulps were bleached with dithionite. The mill purchases 5% of kraft pulp. A RAMI simulation program developed by PI Process Consulting Ltd was used for the work. The possibility of closing the water circulation of an existing newsprint mill was investigated in the second part of the project. (Jantunen, E.; Paavola, A.; Soderstrom, M.; vol. 74, no. 1, 1992, pp 41-44, (1992) Pap. Puu, 9207 [in English]. 0031-1234)

1940 PART VI OF THE REPORT ON THE ANNUAL GENERAL MEETING OF ZELLCHEMING IN HAMBURG [PIRA-10116471]
This report features presentations on paper processing and water treatment.

A new extended flotation deinking model was introduced which may be applied to different water and oil-based printing colours and tenside species. Particular consideration was given to the effects of non-ionic tensides. A second paper focused on the influence of different printing colours and printed materials on print colour removal. A further contribution discussed the use of biofiltration as a practical means to meet the water regulatory requirements. The final report was concerned with the anaerobic degradation of waste waters from paper mills converting recycled paper. (Anon; no. 1, 7 Jan. 1991, pp 13-14, 16-17, (1992) Allg. Pap.-Rundsch., 9207 [in German]. 0002-5917)

1941 EFFLUENT TREATMENT BY ULTRAFILTRATION [PIRA-10116481]

Paper or board coating plant effluents contain the residues of the coating colours, together with other raw materials and washing waters from different pieces of equipment. The two types of pollution generated from these residues are: organic chemical dissolved or suspended together with oxygen consumers; and mineral matter in suspension. These coating effluents disturb the efficient running of waste water treatment plants because of the variable flows and concentrations. Therefore specific treatment for these effluents are required, and one promising separation technique is ultrafiltration. Details are given on the principle of ultrafiltration, the advantages of this technique and a description of an ultrafiltration system. Parameters and performances are included, together with the layout of a system and preconditions necessary. (Camatta, R.; vol. 41, no. 1, Jan. 1992, pp 33-36, (1992) Pap. Carton Cellul., 9207 [in English]. 0031-1367)

1942 ULTRAFILTRATION TREATMENT [PIRA-10116514]

Cellier have developed a new ultrafiltration system for treating coating waste waters. All the products contained in the water are extracted for re-use in the process, and the water itself can also be re-used. No waste is generated during the process. (Short article) (Anon; vol. 41, no. 2, Feb. 1992, p. 45, (1992) Pap. Carton Cellul., 9207 [in French]. 0031-1367)

1943 CSIRO'S NATIONAL PULP MILLS RESEARCH PROGRAMME [PIRA-10116735]

Two current CSIRO programmes are outlined. The first covers modern pulping and bleaching processes, effluent composition and treatment. The work is concerned with processes that could lead to the elimination of chlorinated organic compounds from bleached eucalypt kraft effluents. The programme will include developing reliable local methods to measure dioxins and other chlorinated pollutants. The second programme deals with effluent dispersal, biological effects on marine species and populations and risk assessment. It is noted that eucalypt wood contains some compounds that differ from those found in other woods, and that processing may affect the toxicity of the resulting effluents. (Short article) (Anon; vol. 45, no. 1, Jan. 1992, p. 46, (1992) Appita, 9207 [in English]. 0003-6765)

1944 AT CELLIER: A "FIRST" FOR PAPER TECHNOLOGY - THE USE OF ULTRA-FILTRATION TO TREAT COATING EFFLUENT [PIRA-10116888]

A brief description is given of the new ultrafiltration method for treating coating waste water, developed at Cellier (France). It enables 100% of the waste to be recycled and re-used. The first part of the treatment removes the majority of the suspended matter and dissolved polymers leaving water containing a very small quantity of dissolved low molecular weight compounds which is pumped back into the system. The concentrate is then separated into its individual components for re-use. (Short article) (Anon; vol. 46, no. 1, 1992, p. 30, (1992) Rev. ATIP, 9208 [in French]. 0750-7666)

1945 A STUDY ON THE REDUCTION OF CHLORINATED ORGANICS IN BLEACH PLANT EFFLUENT BY OXIDATION WITH OXYGEN [PIRA-10116961]

The mechanisms of formation of chlorinated organic compounds during conventional kraft pulp bleaching are discussed, and the possible environmental effects of these compounds are examined. The Department of Wood and Paper Science at North Carolina State University has investigated an oxygen treatment process for reducing total organic chlorine (TOCl) and colour in the extraction stage effluent. Effluent was obtained from a conventional kraft softwood bleach plant using a CEDED sequence. Oxygen treatment of this effluent indicated that overall reduction of TOCl and colour is very much dependent on treatment of the fraction of high molecular weight chlorolignins. The three mechanisms potentially involved are hydrolytic splitting of chlorine from chlorolignins, oxidation of chlorolignins, and degradation of chlorolignins. (Sun, Y.-B. et al; vol. 18, no. 2, Mar. 1992, pp 49-54, (1992) J. Pulp Pap. Sci., 9208 [in English]. 0317-882X)

1946 ALGAS FILTERS - A NEW APPROACH TO WATER TREATMENT [PIRA-10116972]

Algas filters were introduced in 1974 for fibre recovery and water re-use applications. The range of applications has widened as improved filter fabrics with much finer meshes have become available. The filters are now used to produce clarified water which can replace fresh water on, for example, wire showers. Another application is in primary treatment of effluent without any form of pre-treatment. Installations from the Algas A/S company have been shown to be able to handle wide variations in flow and in solids from paper mills, to use less power and to take up less space than previous installations. An example relates to the Townsend Hook Smurfit mill where an Algas unit has helped to increase the use of recycled water and to improve the performance of its effluent treatment system. (Anon; vol. 1, no. 3, Mar.-Apr. 1992, p. 17, (1992) Equip. Mach. Mater., 9208 [in English]. 0964-0460)

1947 WASTEWATER AUDITS HELP MILLS TRACK WATER USE AND PLAN TREATMENT PROJECTS [PIRA-10117048]

A wastewater audit, designed to identify patterns of water use and wastewater generation, can help to reduce charges for legal fees, fines, permits and equipment and system modifications. Data from the audit are used to allocate wastewater treatment costs, target unit processes for water reduction or reuse projects and to predict impacts of production growth on wastewater treatment costs. The best times for such an audit are when a facility expansion is being considered or when the wastewater treatment facilities are approaching their maximum loading. Advice is given on the scope of the audit and on the equipment and personnel required to carry it out. Primary devices and flowmeters should be left in place for two to three days to record wastewater flows. The data gathered should be put to good use in the form of a wastewater recycling or reuse programme. (Trick, L.C.; vol. 55, no. 4, Apr. 1992, pp 51-53, (1992) Am. Papermaker, 9203 [in English]. 0270-5222)

1948 CHLORINE, AOX AND CELLULOSE: WILL THE ENVIRONMENTAL DEBATE AFFECT PAPER MILLS? [PIRA-10117074]

Many Scandinavian cellulose sulphate mills now produce conifer or broadleaved chlorine-free bleached cellulose. Cellulose sulphite makers can obtain 80-85% ISO bleaching without chlorine derivatives, and almost no AOX production. However, BOD and COD in waste water, and air emissions, remain at high levels. The European Paper Institute says that AOX value cannot measure waste water toxicity, or a cellulose plant's eco-impact. Bleaching processes to reduce AOX include increasing chlorine replacement in the first phase; delignification before bleaching; eliminating chlorine gas use; and better waste water treatment. In future, ozone could be used as a delignification agent to improve bleaching. FPPRI is laboratory-testing ozone bleaching with peroxide treatment. Lowering cellulose bleach levels could also be an option. New developments will affect paper mill image, standards, legislation, technology and costs. Graphs are provided. (Ahtinen, L.; vol. 29, no. 11, Dec. 1991, pp 537-542, (1991) Ind. Carta, 9208 [in Italian]. 0019-7548)

1949 PULP PROGRESS [PIRA-10117084]

The Australian federal and state governments and industry are funding a A$15m national pulp mill study being carried out by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). This will be one of the first studies of pulp mill effluent in the southern hemisphere. It is known that there are differences in effluents produced from hardwoods and softwoods, but it is thought that the differences between eucalyptus and other hardwoods will be marginal. The study will cover chemical composition of mill effluents, kraft pulp bleaching processes, alternative pulping and bleach-

ing processes, effluent treatment, biological effects on single species and on marine populations, and effluent dispersion modelling. (Short article) (Anon; vol. 217, no. 5, May 1992, p. 22, (1992) Paper, 9208 [in English]. 0306-8234)

1950 SCREENING STUDY OF THE TREATABILITY OF DIOXINS AND FURANS IN BLEACH PLANT FILTRATES AND MILL WASTEWATERS [PIRA-10117208]

A study to determine the effectiveness of various physical and chemical treatment options for 2378-TCDD/F (tetrachlorodibenzo-p-dioxins and tetrachlorodibenozfurans) in industry process and waste waters is described in this technical bulletin. The aim of this work was to verify the results of the EPA treatability study and to examine further the effectiveness of different treatment technologies towards removing 2378-TCDD/F from bleach plant filtrates and combined mill effluents. The results from this study confirmed the EPA contractor results and gave additional insight into the use and limitation of these technologies. The work described in this technical bulletin includes a literature review, the treatment technologies applied in the screening study, a description of the 3 mill test sites and results of the screening study. (Barton, D.A.; Technical Bulletin No. 626, New York, NY, USA: NCASI, 1992, 39pp, (9554), (1992), 9209 [in English].)

1951 ODOR: DEMONSTRATING AN IMPROVED IMPACT FROM EXPANDED PULPING OPERATIONS [PIRA-10117478]

When Potlatch Corp. wished to increase pulp capacity at its Cloquet, MN, USA, mill, it was necessary to carry out an environmental review to assess the likely odour effects on the surrounding community. The mill sought to reduce odour impacts and to limit total reduced sulphur (TRS) emissions in accordance with the US Environmental Protection Agency New Source Performance Standards. An odour survey identified two primary odours at the mill and affecting its surroundings. One was a pine scent associated with wood chipping and wood storage and the other was a cabbage-like smell associated with the brownstock washers, lime calciner and wastewater treatment facility. An odour impact analysis was carried out in conjunction with ENSR Corp. Installation of a dedicated non-condensible gas incinerator and new digesters, coupled with elimination of low level TRS emission sources, reduced total TRS emissions by 70%. (Colella, A.; Vanneste, G.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 1, pp 49-61 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9608)], (1992), 9209 [in English].)

1952 WASTEWATER ODOR CONTROL USING FERRIC CHLORIDE [PIRA-10117479]

The groundwood mill operated by Niagara of Wisconsin Paper Corp., USA, produces coated book paper. About 6m gallons of water per day are treated in mill wastewater systems and returned to the Menominee River. The nature of the wastewater treatment process has tended to favour formation of reduced sulphur compounds, particularly hydrogen sulphide. Occasional odour problems at the mill had been partly controlled by chemical treatments, but there was a need to reduce chemical costs and enhance performance. In conjunction with Du Pont Chemicals, the company has developed a wastewater odour control process using ferric chloride and Du Pont's Ferrisorb. Ferric chloride treatment at 150ppm eliminated odours, reduced hydrogen sulphide generation by 70% and gave considerable savings compared with sodium hypochlorite treatment. (Crowder, J.R.; Tinti, G.A.; Niedenzu, P.M.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 1, pp 63-79 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9608)], (1992), 9209 [in English].)

1953 IMPROVED SLUDGE DEWATERING CREATES NEW DISPOSAL OPPORTUNITIES [PIRA-10117484]

Scott Worldwide runs a tissue mill at Fort Edward, NY, USA, producing about 200tpd of single and double ply toilet tissue, facial tissue and napkin products. The mill is located on the upper Hudson River which is classified as suitable only for industrial usage and fish survival. The wastewater treatment plant at the mill has been automated through the installation of the Betz Industrial PaceSetter feed system. Improvements to the sludge dewatering system have enabled the mill to use its dewatered solids as a cover for a municipal landfill. The control system for flocculent feed has eliminated polymer overfeed and has improved the flotation and dewatering operations. Installation of a screw press has increased final cake solids and has introduced options, such as incineration and landfill closures, which were not possible when belt presses were used. (Collins, P.; Hogan, F.; Hartung, R.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 1, pp 121-125 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9608)], (1992), 9209 [in English].)

1954 PAPER MILL EFFLUENT CHARACTERIZATION AND NPDES PERMITTING [PIRA-10117488]

Two paper mills at Turners Falls, Mass., share an industrial wastewater treatment plant with treated effluent being discharged to the Connecticut River. Both mills are categorised as non-integrated fine paper, cotton fibre furnish mills and details are given of their operation and products. The treatment plant had a NPDES permit dating from the 1970s. The wastewater is high in solids (TSS), non-soluble BOD and, at some times, colour. Production of the mills has increased by about 20% since 1984 and the companies sought an NPDES permit modification to obtain higher effluent BOD limits. Representatives of Camp Dresser and McKee Inc., Strathmore Paper Co. and Esleeck Manufacturing Co. discuss the steps to obtaining the new permit and the complications posed by new toxicity requirements, water quality impacts and concerns for fish passage and the needs of a nearby fish research laboratory. (Mobngoski, R.A.; Tackett, J.D.; Blanker W.C.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 1, pp 163-170 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9608)], (1992), 9209 [in English].)

1955 PHOSPHORUS REMOVAL IN AN ACTIVATED SLUDGE PLANT [PIRA-10117491]

The Menominee Paper Co. Inc. (MPC) operates a mill at the mouth of the Menominee River, Mich., USA, with two paper machines and two converting operations. Output is 350tpd of linerboard, corrugating medium and tubestock from 100% recycled furnish, and 55tpd of lightweight speciality grades from purchased lightweight bleached pulp. Some wastewater is treated by dissolved air flotation (DAF) and reused, while the remainder is treated in an activated sludge plant and discharged to the river. The DAF facility is available if tertiary wastewater treatment is required. It is necessary to add nitrogen and phosphorus to maintain a healthy biomass in the activated sludge plant. However, MPC was concerned to comply with the 1.0mg per litre total phosphorus discharge limit (monthly average) and has established, through pilot studies, that DAF treatment, in conjunction with use of a chemical coagulant, is effective in the removal of phosphorus. (Zurawski, S; Doepke, A.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 1, pp 205-217 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9608)], (1992), 9209 [in English].)

1956 DEVELOPMENT AND VALIDATION OF ANALYTICAL METHODS FOR THE DETERMINATION OF CHLORINATED PHENOLICS IN PULP AND WASTE WATER TREATMENT PLANT SLUDGES [PIRA-10117493]

The method introduced by Voss for the determination of chlorinated phenolic compounds by the in-situ acetylation of aqueous matrices represented a significant improvement in characterising chlorinated phenolics in pulp and paper industry effluents. NCASI has developed this method to a gas chromatography-mass spectroscopy (GC-MS) technique which the US Environmental Protection Agency is adapting as an approved method for NPDES compliance monitoring. Details are given of the ethanol and toluene Soxhlet extraction technique which is preferred to achieve the maximum recoveries for the widest range of compounds. The species recovered by direct solvent extraction are, by definition, free and therefore the method allows quantitative analysis of free species at levels below 100ug per kg with a good precision of 20 to 30%. Preliminary findings are reported on freezing as a means of fixing analyte concentrations by limiting bioactivity. (Louch, J.; Bautz, D.; Jones, J.; LaFleur, L.; Mark, M.; Teitzel, M.; Wilson, G.; Woodrow, D.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 1, pp 233-257 [Atlanta, GA,

USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9608)], (1992), 9209 [in English].)

1957 PHOSPHORUS IN PULP AND PAPER MILL EFFLUENT AND BIOLOGICAL TREATMENT PLANTS [PIRA-10117501]

Phosphorus is often the limiting nutrient for algal growth and, in Finland, high phosphorus concentration in effluents has led to the eutrophication of inland waters. Phosphorus loads from the Finnish pulp and paper industry are to be limited to 1.6tpd, which is equivalent to 20g per ton for paper and 60g per ton for bleached kraft pulp. Activated sludge treatment is the normal secondary process used at Finnish mills and the Finnish Pulp and Paper Research Institute has started a three year project on reduction of phosphorus discharges together with a study of phosphorus balances at mills. Five series of measurements were made at two kraft mills and a newsprint mill. The newsprint mill effluent contained less phosphorus than that required by the activated sludge plant. Phosphorus sources in bleached kraft mills are from the bleaching processes and from the lime mud used. (Jarvinen, R.; Valttila, O.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 1, pp 331-338 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9608)], (1992), 9209 [in English].)

1958 TREATMENT TECHNOLOGIES FOR REDUCTION OF COLOR, AOX, AND RESIN AND FATTY ACIDS [PIRA-10117502]

The US Environmental Protection Agency has developed toxicity reduction evaluation (TRE) which is a systematic study designed to identify toxic effluents, isolate toxicity sources and evaluate toxicity control options. Details are given of a TRE study being carried out by Louisiana-Pacific Corp., Samoa, Ca., and Simpson Paper Co., Fairhaven, Ca., to achieve compliance with chronic toxicity requirements for marine species. Techniques studied for removing high molecular weight organic compounds, such as colour causing constituents, included foam flotation, chemical precipitation, activated carbon adsorption, ultrafiltration, ozonation, oxidation with ozone and peroxide, and activated sludge biological treatment. The two mills produce about 600tpd bleached kraft market pulp each and have recently added oxygen delignification and other modifications to their conventional bleaching sequences. (Amoth, A.R.; Hickman, G.T.; Miller, J.P.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 1, pp 339-346 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9608)], (1992), 9209 [in English].)

1959 A TEAM APPROACH TO FALL AND WINTER LANDFILL CONSTRUCTION IN UP-STATE NEW YORK [PIRA-10190207]

The Champion International Corp. Deferiet pulp and paper mill in upstate New York produces 120,000tpy of magazine, brochure and telephone directory paper. The three main solid waste streams from the mill are 147mtpd bark waste, 20mtpd boiler ash and 164mtpd of grit and dewatered sludge from wastewater treatment. The state department landfill being used by Champion for disposal of these solid wastes was due to be closed in 1990 because it was located over a major aquifer. From 1986, Champion, in conjunction with the consultants RMT Inc., began the siting and permit process to establish a new landfill facility. Permission to proceed was not granted until July 1990, and it was necessary to construct the landfill very quickly in order for the mill to remain in operation. Details are given of the project and of the many soil tests required during the construction of the landfill's clay liner. (Strain, J.; Oman, D.E.; Curry, D.A.; Paper presented at 1992 Environmental Conference held 12-15 April 1992, at Richmond, VA, USA, Book 3, pp 965-972 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9209 [in English].)

1960 PILOT WETLAND TREATMENT [PIRA-10117574]

The Pope and Talbot Inc. 500tpd bleached kraft pulp mill in Halsey, Ore, USA, produces market tissue kraft and market newskraft made from 100% Douglas fir chips and sawdust. Normal summer discharges from the primary waste water treatment plant and aerated lagoon are 2000lbs of BOD5 in 15m gallons per day. Future plans to increase pulp production to 1,500tpd must be put into effect without a change to the existing discharge permit conditions. At its Willamette site, the company has the possibility of using a wetland type treatment facility followed by conventional secondary treatment. A pilot wetland system of 10 cells was set up in 1990 and planted with cattail and bulrush. Initial results showed a 50% BOD5 reduction, 85% total suspended solids reduction and 80% reduction in nitrogen and phosphorus in effluents. Little or no benefits have been seen in reductions of colour, AOX or dioxin concentrations. (Sherwood, R.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 395-397 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1961 OPERATING EXPERIENCE WITH CONSTRUCTED WETLAND TREATMENT SYSTEMS [PIRA-10117576]

Natural wetlands and constructed wetlands are both used in the treatment of municipal and industrial wastewaters. Such systems are being evaluated for the treatment of pulp and paper industry wastes. There is one full scale 70 acre, 33 cell construction in operation in the USA being used to treat pulp mill effluents. CH2M HILL is involved in a pilot study with Georgia-Pacific and other paper industry pilot studies in the USA are being evaluated by Weyerhaeuser, Champion International Corp., BowatersInc. and Pope and Talbot Inc. The author, a representative for CH2M HILL, has compiled a wetland treatment data base which will ultimately provide a common basis for the design and operation of new wetland treatment systems. The existing database includes 127 separate systems operating on 96 sites, and tables give average design and performance figures. (Knight, R.L.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 405-409 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1962 LOG VAT WATER TREATMENT FOR PLYWOOD MANUFACTURING TO ACHIEVE ZERO DISCHARGE [PIRA-10117580]

Metcalf and Eddy Inc. were engaged by a Louisiana, USA, plywood maker to recommend a means of reducing or eliminating discharge of log vat water from its production plant. The water used to preheat and soften de-barked log blocks was tending to become contaminated with dissolved organic compounds, such as wood sugars, and with suspended solids. A table gives details of typical log vat water characteristics, and wastewater treatment and sludge disposal options are considered. Metcalf and Eddy recommended a low flow, continuous physical-chemical system for cost effective treatment of the log vat water. Polymers could be used alone without other coagulants, and settled sludge at about 5% solids could be readily burned in hogged fuel boilers. Costs are given to achieve zero discharge of the log vat water. (Mooney, G.A.; Goldman, J.C.; Fuqua, T.M.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 429-434 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1963 ANOXIC SELECTOR TECHNOLOGY FOR CONTROL OF FILAMENTOUS BULKING FOR PAPER MILL WASTEWATER [PIRA-10117581]

Filamentous bulking is a known problem with the activated sludge process and can affect paper industry wastewater treatment systems. McNamee, Mich., of USA has investigated two case histories where anoxic selector technology was evaluated for treatment of paper mill wastewater known to cause filamentous bulking. The first mill produced coated label stock and playing card stock and discharged a wastewater high in suspended solids, organic matter and ammonium nitrate. The second mill produced an extremely strong wastewater rich in organic matter but low in suspended solids. An anoxic selector was found to be effective in controlling filamentous organisms including type O21N and S. natans. Critical parameters are the presence of sufficient nitrate and the operation at sufficiently high retention time and loading rate. (Kang, S.J.; Fifield, C.D.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 435-440 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1964 MAGNESIUM HYDROXIDE FOR PH ADJUSTMENT IN PAPER MILL WASTE TREATMENT [PIRA-10117582]

James River Corp. operates a cascade wastewater treatment plant at its Berlin, NH, USA, mill to treat the wastewater associated with the production

of 550tpd of paper. The mill's six machines produce an average flow of wastewater of 11m gallons per day. After primary treatment, the wastewater flows through an aerated lagoon to a polishing pond before discharge to the Androscoggin River. Sodium hydroxide (50% solution) had been added to the clarifier effluent to achieve the necessary pH adjustment. Magnesium hydroxide was evaluated as an alternative, mainly for safety reasons, but was found also to impart the benefits of better clarifier performance, more stable pH and increased sludge dryness. A result of achieving increased stability of the effluent pH has been that manning of the treatment plant could be reduced from 24 hours to 12 hours per day. (Marshall, J.W.; St Armand, D.E.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 441-447 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1965 BIOPHYSICAL TREATMENT OF WASTEWATER FROM FINE PAPERMAKING OPERATIONS USING THE PACT [PIRA-10117584]

Domtar Fine Papers produces up to 60tpd of air dried and machine dried high quality papers at its Beauharnois mill, Quebec, Canada. Products include Canadian bank note paper, paper for stocks and bonds and map and chart paper. The mill uses up to 2m gallons per day of river water which is subjected to primary sedimentation and secondary filtration on site. In order to meet more stringent discharge limits, Domtar has installed the Zimpro PACT (powdered activated carbon treatment) system to handle high strength cooking liquor from its cotton fibre and cellulose fibre pulping operations. The PACT system is a biophysical process which uses a combination of adsorptive powdered carbon and active aerobic bacteria to achieve both adsorption and metabolism of organic compounds. (Verreault, M.; Depuydt, K.T.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 459-467 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1966 A NOVEL APPROACH TO THE MANAGEMENT OF RECYCLED WHITEWATER AND SOLID WASTE DISPOSAL AT A RECYCLE NEWSPRINT MILL [PIRA-10117585]

In 1990, Augusta Newsprint Co. (ANC) started up a 250tpd deinking line at its Augusta, Ga, USA, mill in conjunction with Abitibi-Price. The line is handling about 115,000tpy of wastepaper comprising about 70% old newspapers and 30% old magazines. The mill's two paper machines can produce newsprint with up to 40% recycled fibre content. Consideration is given to the effluent and solid waste implications of changing the newsprint furnish make up. Through Betz Industrial, ANC has developed a system comprising a Krofta flotation clarifier, an Andritz dewatering table and a Krofta unit for alkaline whitewater clarification. Clarified whitewater is reused and its turbidity is monitored to avoid problems leading to reduced paper brightness. Sludge from the dewatering belt is subjected to screw press treatment, and dewatered sludge is incinerated to provide about 2500Btu per lb. (Smith, J.; Clark, M.; Guidotti, P.; Hartung, R.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 469-473 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1967 UTILIZATION OF COMPUTER MODELING FOR DEVELOPMENT OF AN EFFLUENT DIFFUSER DESIGN [PIRA-10117586]

Stone Container Corp. operated an 844tpd corrugating mill in Coshocton, Ohio, USA. In anticipation of changes to state water quality criteria, the company sought to improve its effluent dispersion after discharge to the Tuscarawas River. Wastewaters from the mill are treated in an aeration stabilisation basin before discharge at a rate averaging 2m gallons per day. The Cornell University mixing zone expert system, CORMIX, was used in the design of an effluent diffuser system. The accompanying design field study involved determining the existing discharge configuration, establishing 13 cross sectional measurement stations and measuring water depth and velocity at six of them, and using Rhodamine WT dye to trace discharge configurations and subsequent diffusion. Significant improvements were obtained by installing a submerged multi-port discharge diffuser with high velocity discharge. (Diehl, D.; Fiss, E.C.; Jirka, G.H.; Jurewicz, D.; Love, D.; Saw, C.C.; Stein, R.M.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 475-485 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1968 INFORMATION TECHNOLOGY: A TOOL THAT HELPS PROTECT PULP AND PAPERMAKING [PIRA-10117588]

Paper companies must act to meet increasing public and legislative expectations about environmental protection without losing competitive advantage. A representative of EMA Technologies Inc. discusses how information technology (IT) applications can assist with this process and, specifically, how the monitoring and control of wastewater treatment facilities can be brought into the overall millwide information system. In the USA, by 1995, there will be the requirement to monitor and report on over 100 specific pollutants, as well as meeting stormwater, clean air and land application regulations. Real-time process control can be used effectively to prevent the type of production problems that result in unscheduled spills or discharges. IT can thus be used by a paper company to show its employees, the public and the legislators that it is taking a responsible attitude towards environmental protection. (Roemhildt, C.M.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 497-501 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1969 A SINGLE TANK ACTIVATED SLUDGE PRE-TREATMENT SYSTEM FOR PAPER MILL WHITEWATER [PIRA-10117592]

Willamette Industries operates a corrugating medium mill in Port Hueneme, CA, USA, producing about 450tpd from a range of wastepaper furnishes. Excess whitewater is discharged to the local municipal wastewater treatment plant. All industrial dischargers were asked voluntarily to reduce biological oxygen demand (BOD) loadings by at least 10%, and Willamette asked Eder Associates Consulting Engineers to design a pretreatment system for the mill. Eder Associates designed a unique single tank activated sludge system which was built in five days and was fully operating within ten days. The new installation uses a 60ft diameter, 26ft deep tank modified to include an internal settling compartment and a 75HP floating surface aerator. About one third of the mill's 500,000m gallons per day effluent flow is pretreated, and its BOD is reduced from 1500-3000mg per litre down to less than 100mg per litre resulting in an overall BOD reduction of 30%. (Eder, L.J.; Hess, C.; Hage, M.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 539-540 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1970 DIAGNOSING AND SOLVING A PULP AND PAPER MILL'S POOR ACTIVATED SLUDGE SETTLEABILITY PROBLEMS THROUGH TREATABILITY STUDIES [PIRA-10117593]

Chesapeake Corp. operates a 2,500tpd integrated kraft pulp and bleaching mill at West Point, VA, USA, using 1,500tpd virgin pulp and 1,000tpd secondary fibre. Details are given of the mill's primary and secondary wastewater treatment operation which includes a UNOX pure oxygen activated sludge system. This system consists of two parallel trains with effluent subsequently discharged to the Pamunkey River. In 1987, treatability studies were carried out to establish why poor mixed liquor settlement was occurring and leading to high effluent suspended solids. Eckenfelder Inc. carried out studies which indicated that sludge settlement was adversely affected by high aeration basin temperatures and increasing secondary fibre wastestream contributions. Suspended solids compliance has been achieved by cooling tower expansion, and operating in a fully aerobic mode with the use of three secondary clarifiers. (Flippin, T.H.; Bellanca, M.A.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 541-548 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1971 TURBIDITY AND BOD CONTROL AT SCHOELLER TECHNICAL PAPERS INC. [PIRA-10117594]

Schoeller manufactures photographic and other speciality papers in Pulaski, New York, USA. Wastewater treatment is carried out using a primary clarifier and two settling lagoons. Effluent is discharged directly to the Salmon River at an average flow of about 1.6m gallons per day. In order to

meet more stringent biological oxygen demand (BOD) and total suspended solids (TSS) discharge limits set by the New York State, Schoeller had to install turbidity equalisation and secondary wastewater treatment. A thorough sampling programme was carried out, and the company then installed an in-mill spill control system and two 30,000 gallon equalisation tanks to control turbidity. The main sources of turbidity were barium sulphate and titanium dioxide used in paper coating and producing a milky white effluent. A secondary treatment system including two separate biotower treatment plants was installed in August 1991. (Danko, J.; Geary, R.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 549-561 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1972 PILOT STUDIES AND FULL SCALE PERFORMANCE EVALUATION OF A MEMBRANE DISC AERATION SYSTEM TREATING COATED PAPER MILL WASTEWATER AT REPAP WISCONSIN [PIRA-10117595]

In September 1988, Repap Wisconsin Inc. increased production of high quality coated paper with the start-up of PM7. In the same year, a failure occurred of the synthetic liner for the single stage jet aeration system. Instead of replacing the liner, the decision was taken to replace the existing single stage jet aeration system with a two-stage design. Fine pore aeration can save 30 to 50% of energy costs compared with coarse bubble or mechanical aeration. The systems examined included ceramic disc diffusers, elastomeric membranes and disc and tube configurations. Tests developed by the Ewing Engineering Co. were carried out and the system selected comprised four elastomeric perforated EPDM (ethylene, propylene, diene co-monomers, polymethylene backbone) membrane tube diffusers. Follow up testing of diffuser performance full scale aeration system oxygen transfer is reported. (Redmon, D.T.; Nessman, M.; Ewing, L.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 563-578 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1973 BENCH SCALE EVALUATION OF ULTRAFILTRATION AND NANOFILTRATION MEMBRANES FOR THE TREATMENT OF A KRAFT-CAUSTIC EXTRACTION STAGE EFFLUENT FROM A SOFTWOOD LINE [PIRA-10117597]

The Wastewater Technology Centre (WTC) operated by Rockcliffe Research Management Inc., Burlington, Ontario, Canada, has developed and evaluated cost effective effluent treatment technologies for the pulp and paper industry. Past studies have concentrated on new biological treatment processes to remove toxic organic chemicals from effluents. Details are now given of an evaluation of membrane technology for recycling process waters, containing toxic organics and recovering process waters, containing toxic organics and recovering valuable by-products. The work has concentrated on small pore ultrafiltration (UF) and nanofiltration (NF) membranes where the latter are capable of separating multivalent ions and even a fraction of the monovalent ions. The selection of the right combination of membrane and operating conditions is critical if UF and NF membranes are to be integrated with existing mill wastewater treatment schemes in a cost effective way. (Buisson, H.; Zaidi, A.; Koski, K.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond,VA, USA, Book 2, pp 585-593 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1974 TREATMENT OF BLEACH PLANT EFFLUENTS BY MEMBRANE FILTRATION [PIRA-10117598]

The Swedish Environmental Research Institute (IVL) has carried out work on membrane treatment of bleach plant effluents. Large pore size microfiltration removes suspended solids and the highest molecular weight substances, while nanofiltration (NF) and ultrafiltration (UF) remove some low molecular weight compounds and reverse osmosis (RO) leaves a pure, almost chlorine-free permeate. Realistically, ultrafiltration can remove much of the colour from first stage extraction effluents, but only 60 to 70% of organochlorine compounds under full scale operation conditions. Chlorine dioxide, used in the bleaching sequence as a complete or partial replacement for chlorine, produces a lower discharge of organochlorine compounds. However, these compounds are of lower molecular weight and require the use of smaller pore membranes. Over 90% of organochlorine compounds were removed in laboratory experiments using UF followed by RO polishing. (Ekengren, O.; Bjurhem, J.-E.; Filipsson, S.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 595-601 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1975 ULTRAFILTRATION OF KRAFT BLEACH PLANT EFFLUENT: PROCESS DESIGN AND COST ESTIMATE [PIRA-10117599]

ABB Flakt and the University of British Columbia, Canada, have carried out a feasibility study of ultrafiltration of the effluent from the caustic extraction stage in a kraft bleach plant. A design with capital and operating costs is given for a possible application at Crestbrook Forest Industries. Ultrafiltration would complement biological wastewater treatment because the latter does not decrease the colour of the effluent and is not very effective at removing high molecular weight chlorinated organic compounds from kraft mill effluents. The proposed process would have a capital cost of C$15m and net operating costs of about C$1.2m per year. The colour of the combined mill effluent would decrease by 40%, and AOX by 25%. The possible candidate mill at Skookumchuck, BC, currently produces about 600adtpd of bleached kraft pulp. (Blackwell, B.; Betts, J.; Cunningham, C.; Dorman, B.; Hitzroth, A.; McNeil, R.; Robinson, L.; Safavi, S.; Tsang, O.; Tsui, C.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 603-614 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1976 REDUCING EFFLUENT TSS FROM AN ANAEROBIC CONTACT PLANT [PIRA-10117607]

The Alaska Pulp Corp. (APC), USA, installed an anaerobic wastewater treatment system at its Sitka mill to operate in conjunction with an existing waste activated sludge system. Since start-up, the plant has been limited to 9,300cu m per day of evaporate condensate and caustic extraction liquor equivalent to 58,000kg chemical oxygen demand (COD) per day. The respective design figures were 14,000cu m of effluent per day and 170,000kg COD per day. To operate for short times at 12,000cu m of effluent per day, it has been necessary to use expensive polymer. Without polymer, at flow rates above 5,000cu m per day, total suspended solids (TSS) in the discharged effluents had exceeded the design value of 350mg per litre. This figure has been increased to the 9,300cu m per day level after major changes to reactor effluent degasifiers, a lamella piping system and the lamella units to reduced TSS carryover. (Evansen, J.A.; Oetken, E.R.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 669-676 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1977 COMPACT ANAEROBIC-AEROBIC WASTEWATER TREATMENT AT THE MINGUET ET THOMAS RECYCLE PAPER MILL IN FRANCE [PIRA-10117608]

OTOR group company, Minguet-Thomas, operates a 48,000tpy mill north of Paris, France, producing corrugating medium, fluting and testliner from 100% recycled fibre. There are plans to increase output from 140 to about 200tpd. The mill uses an average of 9cu m of water from a local stream per ton of product. Wastewater was returned to the stream after primary clarification treatment. Secondary biological wastewater treatment was required to meet new provincial effluent quality standards of 180mg per litre chemical oxygen demand (COD) and 30mg per litre biological oxygen demand (BOD). In 1990, the company made the decision to install a combined anaerobic-aerobic wastewater treatment plant, and the facility was commissioned in April 1991. The new installation includes an anaerobic pretreatment step using BIOPAQ UASB (Upflow Anaerobic Sludge Blanket) technology. Discharge limits were being met within three weeks of installation, and subsequently COD and BOD removal efficiencies of 95% and 90% respectively have been achieved. (Mermillod, P.; Habets, L.H.A.; van de Vegt, A.L.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 677-680 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1978 ANAEROBIC-AEROBIC TREATMENT OF NSSC-CTMP EFFLUENT AND BIOGAS UTLIZATION [PIRA-10117609]

The Stone-Consolidated Inc. Bathurst Division produces 480mtpd of CTMP softwood market pulp and 425mtpd corrugating medium at its Bathurst mill, NB, Canada. The corrugating medium is made from NSSC hardwood pulp and recycled fibre. A pollution abatement agreement made in 1981 required suspended solids and biological oxygen demand (BOD) of effluents to be such that the effluent was not lethal to fish. The company achieved required suspended solids concentrations by re-using some obsolete filter equipment from a former kraft pulp operation. Studies in 1984 indicated the need for a high rate anaerobic process followed by three to five days of aeration to achieve the necessary reduction in BOD and toxicity of mixed NSSC-CTMP effluents. The system installed uses the Upflow Anaerobic Sludge Blanket (UASB) for BOD reduction. (Garvie, R.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 681-685 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1979 STONE CONTAINER'S EXPERIENCE WITH ANAEROBIC PRETREATMENT AT ITS YORK, PA, MILL [PIRA-10117610]

The York, PA, USA, mill of Stone Container uses a furnish of about 80% old corrugated containers (OCC), 15% mixed waste and 5% old newsprint (ONP). The major part of the biological oxygen demand (BOD) in mill effluent derives from starch in the OCC, and Stone therefore examined wastewater pretreatment as a means of meeting new city effluent standards. The success of an anaerobic process was indicated by trials carried out by the University of Kansas in 1988. A Biothane system was chosen on a technical and cost basis and because of a guarantee of achieving an 85% reduction in BOD. Details are given of pilot trials to develop design parameters, and system installation, start-up and operation. Previous BOD levels of 2,000 to 3,500mg per litre were reduced by 85% after initial problems due to high effluent total suspended solids (TSS) levels, and the mill is now saving about $25,000 per month in BOD sewer surcharges. (Jurewicz, D.A.; Hulbert, J.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 687-703 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1980 AN EVALUATION OF MEMBRANE TREATMENT OF A SULFIDE KRAFTMILL WASTEWATER [PIRA-10117611]

Joint work is reported by the University of Arizona and Weyerhaeuser on the use of membranes to treat wastewater from the caustic extraction stage following oxygen delignification. Eight commercially available membranes were evaluated representing the ultrafiltration (UF), nanofiltration (NF) and low pressure reverse osmosis (LPRO) types. The mill used for the evaluation produces about 420admtpd of bleached sulphite market pulp. The membranes were characterised by their abilities to remove total organic carbon (TOC) and colour. A relationship was developed between the integrated ultraviolet absorbence spectra of the permeate and TOC and colour quality parameters. LPRO and NF membranes removed over 90% of colour, but only 27 to 53% of TOC. Over 58% of the TOC in the wastewater was made up of molecules of apparent molecular weight less than 500, but this fraction accounted for only 9.2% of the colour. (Sierka, R.A.; Avenell, J.A.; Angell, H.J.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 705-719 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1981 TREATMENT OF SELECTED CTMP AND BCTMP EFFLUENTS BY ULTRAFILTRATION [PIRA-10117612]

A recent rapid development in the use of CTMP and bleached CTMP pulping processes has occurred at the same time as the introduction of increasingly stringent effluent disposal requirements. Mills now face the challenge of substantially reducing discharge of pollutants without compromising competitiveness. In Canada, a joint study has been carried out by Orgatek, Hymac Ltee, the Wastewater Technology Centre and the Universite de Quebec a Trois Rivieres on the effectiveness of ultrafiltration (UF) and nanofiltration (NF) in wastewater treatment. Selected bleached CTMP effluents were used, and it was found that 70 to 80% of the dissolved solids (DS) had a molecular weight less than 1,000. Developments in UF and NF membranes and the care needed in comparing removal efficiencies are discussed. In an example, removal efficiencies of respectively 36%, 55% and 58% were obtained for DS, total organic carbon (TOC) and biological oxygen demand (BOD). (Beaudoin, L.; Barbe, M.; Buisson, H.; Lavellee, H.-C.; Zaidi, A.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 721-730 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1982 ULTRAFILTRATION APPLIED TO THE TREATMENT OF EFFLUENTS TO THE PAPER AND BOARD COATING PLANTS [PIRA-10117613]

In paper and board coating operations, contributions to plant effluent from the coating process will include organic chemicals, oxygen consumers and a large proportion of mineral matter which makes the wastewater opaque. Coating effluents comprise only a small part of the water volume used by the mill but tend to disturb the efficient running of the wastewater treatment plant because of the variable flows and concentrations. The minerals deriving from pigments cause the opaque appearance and can be very harmful to aquatic life. Work in France is reported by the Centre Technique du Papier, Cellier SA and Koch Membrane Systems, USA, on the use of ultrafiltration to treat effluents with variable flows and concentrations. Pilot plant studies in three paper and board mills are described. (Pichon, M.; Camatta, R.; Tardy, G.; Woerner, D.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 731-736 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1983 RECOVERY OF WASTE COATING BY ULTRAFILTRATION [PIRA-10117614]

The ASSI company, Frovifors Bruk AB, operates a 220,000mtpy sulphate pulp and coated unbleached kraft board mill at Frovi, Sweden. Although the mill was comfortably complying with COD, BOD and suspended solids regulations, there were problems with colour in the wastewater deriving from pigments used in the coating process. After a pilot study in 1990, a latex ultrafiltration process was installed specifically to treat the coating colour effluent. Trials with different coating formulations have all led to stable fluxes although at different capacity levels with about a 40% spread from the highest to the lowest. The concentrate has reached over 46% solids, but more work is required to stabilise the system in operation and to prevent the concentrate from being thixotropic. Further work is required to establish whether the recovered coating pigment can be reused. (Stridsberg, S.; Nyberg, T.; Robinson, L.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 2, pp 737-745 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9609)], (1992), 9210 [in English].)

1984 THE APPLICATION OF SELECTED MICROBIAL FORMULATIONS FOR ENHANCING BOD REMOVAL AND RESIDENCE TIME STUDIES [PIRA-10117650]

The large quantities of water used in papermaking become contaminated with a range of pollutants including lignin and its derivatives, carbohydrates, starches, organic acids, low molecular weight alcohols and inorganic ash. Many of the effluent treatment systems used were not designed to treat these effluent loads nor to produce the quality of effluent now required by the US Environmental Protection Agency. Interbio Inc. and Nalco Chemical Co. have evaluated the use of two commercially available microbial formulations used in two single pass aeration systems on wastewater from a 100% recycled newsprint mill in the south eastern USA. One formulation was able to enhance biological oxygen demand (BOD) removal efficiency by 43% and caused changes in the nature of the biomass which reduced the need for alum and polymers as secondary clarification aids. The use of microbial formulations as hydraulic residence time tracers is also discussed. (Whiteman, G.R.; Holzer, K.A.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 773-781 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1985 USE OF BACTERIAL CULTURES TO INCREASE BOD REMOVAL AT A SULFITE BASED PULP AND PAPER MILL [PIRA-10117651]

A case study is presented of a south eastern US sulphite pulp and paper mill which produces 450tpd of bleached pulp. An average of 17m gallons per day of wastewater are treated using a 150ft diameter primary clarifier and a 34 acre aeration lagoon. In May 1991, after a substantial increase in the biological oxygen demand (BOD) applied to this system, the mill introduced a microbial formulation obtained from Microbe Masters Inc., Batone Rouge, LA. The material was fed on-site into a biomass generator which took an influent slip stream and initiated the reaction with the microorganisms. The formulation contained 14 microorganisms selected for their ability to degrade lignin, aliphatic hydrocarbons and carbohydrates. The mill had been experiencing influent BOD loadings that were 50% above the design capacity of its treatment system. Use of the new microbial system immediately reduced BOD loadings by 33%. (Christiansen, J.A.; Breaux, S.M.; Davis, W.N.; Laborde, S.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 783-793 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1986 A REVIEW OF PULP AND PAPER INDUSTRY EXPERIENCE WITH BIOLOGICAL TREATMENT PROCESS BACTERIAL AUGMENTATION [PIRA-10117652]

A representative of NCASI reports on a study of a northeastern USA mill where the same effluent was received by two parallel and identical activated sludge plants. One unit was used as a control while specific strains of bacteria were added to the other for approximately 60 days. Three supplement levels of respectively 1, 2 and 3mg per litre of the bacterial preparation were used. The evaluation was designed to establish whether effluent quality was improved by bacterial treatment. There was no improvement in discharged effluent biological oxygen demand (BOD) and it was concluded that improvements in suspended solids concentrations were not necessarily the result of bacterial supplementation. Although there were no definable benefits from the particular bacteria used in this study, the guidelines used should assist in the planning of other such studies. (Buckley, D.B.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 795-810 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1987 DEGRADATION OF BOD AND FOAM IN A PAPER MILL AERATED LAGOON BY BIOLOGICAL METHODS [PIRA-10117653]

Problems of fluctuating biological oxygen demand (BOD) levels and considerable amounts of foam in aerated lagoons are typical with pulp and paper operations. Nalco Chemical Co. was involved with a southeastern US bleached kraft pulp mill which had had difficulties meeting its NPDES permit level of 7,037kg per day BOD discharge. Also, waste pond foam had blown off the mill site and had caused complaints. In an attempt to limit the monthly average BOD from 9,400 to 7,000kg per day, a bioaugmentation programme, to supplement the existing biomass, was recommended. A commercially available microbial formulation, containing a specialised mixed microbial product, was used first in laboratory trials and then in the mill's wastewater treatment plant. The mill is now operating well within permit standards and there has been just one foam complaint which occurred immediately after a planned shutdown. (Palermo, D.R.; Holzer, K.A.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 811-819 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1988 PHYSICOCHEMICAL TREATMENT OF BLEACH PLANT FILTRATES AND FINAL EFFLUENTS FOR THE REDUCTION OF CHLORINATED ORGANIC COMPOUNDS [PIRA-10117654]

Many mills have adapted bleaching processes to reduce the generation of chlorinated organic compounds. However, external treatment of waste streams containing chlorinated organics is still an important process for some mills. NCASI in conjunction with Tufts University, USA, has carried out a treatability study with three physiochemical treatment technologies using alum, powdered activated carbon (PAC) and the ionic exchange absorbent, SorbPlus, respectively. Treatments were evaluated using softwood bleach plant filtrates and final effluents collected from three bleached kraft mills, each with existing biological wastewater facilities. Tests based on removal of chlorinated phenolic compounds and AOX indicated that only alum treatment significantly reduced the chronic toxicity associated with the three final effluents. The three technologies all reduced filtrate and final effluent colour by at least 75%. (Barton, D.A.; Bousquet, T.; Drake, E.; Hall, T.J.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 821-830 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1989 AN ANALYSIS OF THE POTENTIAL OF PHOTOCHEMICAL AND ELECTROCHEMICAL TECHNIQUES OF DECOLORIZATION OF BLEACHED KRAFT MILL EFFLUENT [PIRA-10117655]

Bleached kraft mill effluent after secondary biological treatment contains complex organic material and is coloured and sometimes toxic. Research at Miami University is concerned with the total clean up of mill effluent for recycling. Colour in the waste stream is a particular problem to total water reuse, and a photocatalytic decomposition process was examined using ultraviolet light from sunlight and a titanium dioxide catalyst. The rate of decolourisation was slow and UV from an artificial source would probably be required for a viable process to be developed. A more promising approach is electrochemical precipitation. Details are given of the electrochemical system which, in terms of operating costs, could be comparable with ferric chloride addition or other existing treatments. The electrochemical process eliminates corrosive chlorides, and further cost reductions could be achieved with an optimised system. (Springer, A.M.; Hand, V.C.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 831-842 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1990 IS AOX REMOVAL BY BIOLOGICAL EFFLUENT TREATMENT CONSISTENT WITH ENVIRONMENTAL PROTECTION OBJECTIVES? [PIRA-10117657]

The use of the term adsorbable organic halogens (AOX) as a measure of environmentally hazardous organochlorine compounds in bleach plant effluents is discussed and questioned. It is known that chlorinated dioxins and furans (TCDD and TCDF) are potentially very toxic even in trace quantities, and it is often assumed that all organo-chlorine compounds are similarly hazardous. A case study is presented of treatment to reduce AOX levels in effluents to under 2.5kg per tonne of pulp by the installation of one additional brown stock washing stage and high enough chlorine dioxide substitution to reduce TCDD and TCDF concentrates below detection levels. Costings are discussed for retrofilling this stage and for processes involving medium-consistency oxygen delignification or a new digester for extended cooking. It is noted that biological treatment in an aerated stabilisation basin effectively reduced the toxicity of effluents and there is no advantage in using the activated sludge process for AOX removal. (Folke, J.; Landner, L.; McCubbin, N.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 849-857 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1991 A FULL SCALE STUDY OF AUTOMATICALLY CONTROLLING POLYMER DOSAGES THROUGH MEASUREMENT OF FLOC STRUCTURE [PIRA-10117662]

Flocsonde, marketed by Stockhausen Inc., NC, USA, is a device which provides automatic monitoring and controlling of polymer dosage in sludge dewatering operations. The unit uses an infrared transmitter and receiving device to monitor the dimensions of moving floc structures of the conditioned sludge. Signals are compared and a controller makes adjustments to the polymer pumps. Details are given of the first installation of Flocsonde on a belt filter press at Greensboro, NC, Osbourne wastewater treatment facility. The outcome was a 10% reduction of polymer dosages to 13.4kg per ton with cake dryness being maintained at 20%. Thus, polymer dosage and therefore operating costs may be reduced by infra-red transmission. (Jones, H.R.; Bodnar, R.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 905-906 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1992 COLOX AEROBIC BIOREACTOR SYSTEM [PIRA-10117663]
The TETRA Technologies Inc. Colox system is a fixed film biological wastewater treatment process. The system employs aerobic organisms and comprises a deep bed (greater than 3m) of coarse sand (less than 10mm) to give a high specific surface area to promote a high concentration of fixed film organisms. Concurrent upflow of wastewater and process air is provided and the system includes proven heavy duty system components and backwashing technology from TETRA's deep-bed filters. An example shows the use of the Colox system on a paper mill effluent. Effluent biological oxygen demand (BOD) was reduced by 40 to 60% to an average of 107kg per day compared with the NPDES permit level of 191kg per day. Total suspended solids (TSS) were not changed significantly by the treatment but, as the flow became somewhat lower, the TSS concentrations became proportionally higher. (Savage, E.S.; Ellard, G.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 907-909 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1993 PREPARATION OF BEST AVAILABLE CONTROL TECHNOLOGY (BACT) COMPLIANCE PLANS FOR CHLOROFORM AND FORMALDEHYDE FOR SELECTED PULP AND PAPER MILLS IN WISCONSIN [PIRA-10117666]
The Hazardous Air Contaminant Rules NR445 of the State of Wisconsin, USA, required facilities, whose actual 1988 emissions of chloroform of formaldehyde exceeded 250 lbs per year, to provide BACT compliance details by 1 April 1992. Three Wisconsin sulphite mills and one kraft mill retained the services of Dames and Moore to assist in developing compliance plans. Chloroform emissions could be minimised reducing the residual lignin content of the pulp by extended oxidation or by using alternative bleaching sequences involving ozone or peroxide. Add on controls for chloroform such as carbon adsorption, thermal incineration and catalytic incineration are also discussed as well as wastewater treatment options. Formaldehyde may be formed in combustion processes firing wood, bark or wood wastes. Removal technologies include wet scrubbing, carbon adsorption and various incineration processes. (Fisher, P.W.; Foster, J.A.; Deb, K.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 927-933 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1994 INTEGRATION OF AN ODOR CONTROL GAS COLLECTION SYSTEM WITH AN ACTIVE PULP AND PAPER MILL SLUDGE LANDFILL [PIRA-10117672]
Sulphur-containing pulp and paper industry solid wastes can cause odours at landfill sites. The Wausau Paper Mills Co., Brokaw, WI, USA, owns and operates a non-hazardous solid waste landfill occupying an area of 2.3ha and a design capacity of 150,000cu m. The landfill is used to dispose of the mill's wastewater treatment sludge and also small amounts of spent magnesium oxide and wood ash. A landfill gas collection and incineration system was to be installed when the landfill was closed, but this was over two years away and odours were causing problems. Working with environmental consultants, RMT Inc., an interim gas collection was designed and installed. Gas is collected by a floating cover system consisting of geomembrane panels connected to a pipe manifold system. Details are given of the local regulatory review and approval of the installation and its use in reducing odours for the landfill. (Jeffries, D.W.; Martin, D.A.; Yabroff, R.D.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 985-995 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1995 TOXICITY TREATABILITY EVALUATIONS FOR TWO BLEACHED KRAFT PULP MILLS [PIRA-10117674]
Louisiana-Pacific Corp., Samoa, CA, USA, (L-P) and Simpson Paper Co. Fairhaven, CA (SP) each product about 600tpd of bleached kraft market pulp. CH2M Hill is working with the two companies to carry out a joint Toxicity Reduction Evaluation (TRE) which is a systematic, site-specific study designed to find means of reducing effluent toxicity to an acceptable level. Comparisons are made between the bleaching sequences and the furnishes used the two companies. CH2M Hill carried out toxic treatability evaluations on the mill effluents to identify required treatment technologies and to demonstrate their potential at pilot plant scale. It was recommended that the firms should use steam stripping of condensates followed by coagulation and precipitation for alkaline sewer treatment (SP) and for alkaline and acid sewers (L-P). Alternatives for whole mill effluent treatment are the biological activated sludge process or lime or polymer coagulation and precipitation. (Hickman, G.T.; Amoth, A.R.; Miller, J.P.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 1007-1026 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1996 CHLORATE REMOVAL IN A LAB-SCALE SIMULATION OF AN EFFLUENT TREATMENT LAGOON [PIRA-10117676]
Chlorine dioxide is being widely substituted for some of all of the chlorine used in bleached kraft pulp mills in order to reduce chlorinated organics (AOX) formations. However, chlorine dioxide itself and its chloride and chlorate by-products could cause health problems in drinking water supplies in intakes down river from pulp mill discharges. These compounds can cause haemolytic anaemia in concentrations above 10mg per litre. Although more than 98% of chlorate is removed in mill aerated lagoon systems, occasional higher releases have occurred. The Alberta Environmental Centre has investigated the chlorate reduction process using pond influent and a bench top simulation of the lagoon process. There is some evidence that aeration is not a necessary part of the chlorate removal process and that a separate anaerobic unit process may be required for adequate chlorate control to meet new regulations. (Skinner, F.; Davies, S.; James, W.; van Roodselaar, A.; Paper presented at 1992 Environmental Conference held 12-15 April 1992 at Richmond, VA, USA, Book 3, pp 1039-1046 [Atlanta, GA, USA: TAPPI Press, 1992, 1161pp, 3 vols, $140.00 (9610)], (1992), 9210 [in English].)

1997 RECYCLED FIBER SLUDGE: A COMPREHENSIVE UTILISATION PROGRAM [PIRA-10117826]
Scott Paper Co. generates 200tpd of sludge from its waste paper deinking facility plus 65tpd of sludge from the paper mill wastewater treatment plant at Winslow (Maine, USA). In 1987, it employed Resource Conservation Services Inc. to find new ways of disposing of this sludge. They are reviewed here and consist of combustion from which the fly ash and some of the sludge are used in various combinations for agricultural and forest land application, composting, and top soil manufacturing. (Coleman, P.M.; Paper presented at 1992 Contaminant Problems and Strategies in Wastepaper Recycling Seminar held 28-30 April 1992 at Cincinnati, OH, USA, pp 197-202 [Atlanta, GA, USA: TAPPI Press, 1992, 241pp, $58.00 (9714)], (1992), 9210 [in English].)

1998 HIGH-RATE ANAEROBIC WASTEWATER TREATMENT IN THE RECYCLE PAPER INDUSTRY [PIRA-10117828]
The anaerobic waste water treatment plant built by the Stone Container Corp. at their mill in York (Pennsylvania, USA) to enable it to meet the city's new stringent biological oxygen demand (BOD) concentrations in waste water is described. The mill produces 350tpd of paper from 100% recyled fibres (corrugated containers, mixed waste and newsprint). Before the waste treatment plant was built, Stone was releasing effluent with a BOD concentration of 2.5kg per sq m. Under the new legislation it had to be below 1.5kg per sq m. The system they chose uses high rate upflow anaerobic technology to convert the organic pollutants into a methane-rich biogas which can be used as energy elsewhere in the mill. (Blum, M.; Paper presented at 1992 Contaminant Problems and Strategies in Wastepaper Recycling Seminar held 28-30 April 1992 at Cincinnati, OH, USA, pp 223-230 [Atlanta, GA, USA: TAPPI Press, 1992, 241pp, $58.00 (9714)], (1992), 9210 [in English].)

1999 OPERATIONAL CONSIDERATIONS FOR WATER RECLAMATION AND RECYCLING IN SECONDARY FIBER SYSTEMS [PIRA-10117829]
Water recycling is becoming increasingly common in paper mills. Dissolved air flotation, presented here, is used to clarify water in secondary fibre systems and recover components for re-use. Its applications in deinking of various waste papers (ledger, tissue), the white water in a tissue machine and

in liner and corrugating medium mills are outlined. The economics of such a process are also discussed for a paperboard mill. (Mahony, L.H.; Paper presented at 1992 Contaminant Problems and Strategies in Wastepaper Recycling Seminar held 28-30 April 1992 at Cincinnati, OH, USA, pp 231-235 [Atlanta, GA, USA: TAPPI Press, 1992, 241pp, $58.00 (9714)], (1992), 9210 [in English].)

2000 NEW EXPERIENCES IN THE DETERMINATION OF BOD5 IN PAPER MILL WASTE WATER [PIRA-10117850]

German waste water regulations require biochemical oxygen demand in 5 days, BOD5, to be measured by the dilution method DIN 38409 Part 51. A work schedule over a week should be adhered to. The use of an oxygen electrode, rather than the Winkler method, greatly simplifies the measurement of a large number of samples. BOD analysis may be hindered by a high content of solids or by inhibiting substances. Sampling, conservation measures and sampling conditions are all important. In the presence of high concentrations of degradable organic substances, the sample must be highly diluted. It is, however, possible to obtain useful results. The weekly schedule is described. Graphs and tables of results are presented, and a bibliography is included. (vol. 120, no. 9, mid May 1992, pp 335-336, 338-340, (1992) Wochenbl. Papierfabr., 9210 [in German]. 0043-7131)

2001 SLUDGE DEWATERING INTENSIFIES [PIRA-10117862]

Wastewater treatment systems in the paper industry tend to differ depending on whether chlorine-contaminated materials are involved. Alum and lime are used as coagulants for chlorine-containing materials and, more recently, the more selective anioniccationic and non-ionic polymers. For non-chlorine contaminated waste, treatments are more likely to be mechanical. In the early 1980s, sludge dewatering was investigated as a potential energy source but, a decade later, the main consideration is reduction of solid waste bulk for disposal. Details are given of sludge dewatering chemicals available from companies such as Cyanamid (Magnifloc SD 2000), Merck (Calgon), Laporte (Profloc) and Betz which is developing a line of emulsion polymers aimed at the growing paper deinking market. (Ducey, M.; vol. 217, no. 7, July 1992, pp 20-21, (1992) Paper, 9210 [in English]. 0306-8234)

2002 FLOTATION/FILTRATION - A NEW SYSTEM FOR WATER RECYCLING [PIRA-10117966]

The Krofta flotation system was first introduced in 1982. It is used to clarify water used in the paper industry. A new model has recently been developed which combines flotation with filtration - the Sandfloat SASF version. This is presented here. It is a single simple compact unit which has a flotation system at the top and a filter system at the bottom. (Krofta, M.; Guss, D.B.; Paper presented at 78th Annual Meeting Technical Section, held 28-29 Jan. 1992 at Montreal, Canada, Preprints "A", pp A241- 244 [Montreal, Canada: Canadian Pulp and Paper Association, 1992, 418pp, (2 vols) C$47.00 (9724)], (1992), 9211 [in English].)

2003 EFFECT OF CHEMICAL TREATMENTS OF BLEACHERY EFFLUENTS ON AOX REDUCTION. PART I: LABORATORY RESULTS [PIRA-10117967]

It has been proposed that alkali-treatment of effluent can be used to reduce its adsorbable organic halogen (AOX) levels. This is investigated here by determining the decrease in AOX levels of chlorination stage effluent treated with a range of alkali and alkali-sulphide-containing liquors. The combined alkali-sulphide treatments were found to be more effective at decreasing AOX levels than alkali treatments alone. A range of chemicals was assessed for their performance, and these results are also discussed. (Sullivan, J.; Douek, M.; Paper presented at 78th Annual Meeting Technical Section, held 28-29 Jan. 1992 at Montreal, Canada, Preprints "A", pp A245-257 [Montreal, Canada: Canadian Pulp and Paper Association, 1992, 418pp, (2 vols) C$47.00 (9724)], (1992), 9211 [in English].)

2004 RESULTS OF QUESTIONNAIRE SURVEY ON SLIME IN PAPER AND PULP EFFLUENT [PIRA-10117996]

The July 1991 survey conducted by the Japan Tappi Environmental Technical Committee covered 119 mills and drew responses from 102. More than half the respondents (74) reported varying degrees of slime formation. For plants discharging into rivers, the average biological oxygen demand (BOD) was 43ppm in effluent with much slime, and 22ppm in slime-free effluent, indicating that a reduction in BOD is essential for effective control. The sites most frequently affected at 63 mills were the effluent ducts (24) and the area around the treatment plant (14). The average duct cleaning frequency was 3.5 times per month. Seven mills used chlorination chemicals at a cost of Y0.2-0.3 per tonne of effluent; 2 used screens for cleaning at a much reduced running cost of Y0.04/t. Relatively few mills took anti-slime measures. (Anon; vol. 46, no. 4, Apr. 1992, pp 51-56, (1992) Jpn Tappi J., 9211 [in Japanese]. 0022-815X)

2005 REORGANIZATION, INCREASED EFFECTIVENESS AND REDUCTION OF SPECIFIC OPERATIVE COSTS BY MEANS OF AUTOMATION AND PROCESS ADAPTIVE OPTIMISATION [PIRA-10118004]

The sequence of technical processes in the biological purification of waste water depends on a number of different parameters. In order to register, regulate, optimise, adapt and balance the operative parameters the introduction of computer-control becomes a fundamental requirement. The computer will develop process models, in which the various mechanical operations are optimally coordinated. Beginning with sedimentation and flotation of the load right through the activities of aeration, post purification, clean water recycling, sludge disposal by either brattice press, centriguing or chamber filter press, to the final costing of the energy consumption, the maximum efficiency and effectiveness of the different process parameters to the purification plant can only be ensured by the employment of a computer-controlled system. (Meyer, H.F.; vol. 116, no. 22, 1 June 1992, pp 554, 556, 558, 550, (1992) Allg. Pap.-Rundsch., 9211 [in German]. 0002-5917)

2006 ZERO LIQUID EFFLUENT FOR CTMP MILLS [PIRA-10118055]

The Millar Western Pulp Ltd mill in northern Canada produces 240,000tpy of CTMP. In association with NLK-Celpap they have developed a zero effluent technology which became operational in February 1992 and which is described here. The pulp mill effluent is collected and the suspended solids removed. It is then evaporated in one of the world's largest vapour recompression evaporator trains. The distillate from the the evaporation process is treated to remove the organics and then recycled back to the mill. The concentrate from the evaporation process is burned in the chemical recovery boiler. (Fromson, D.A.; Manolescu, D.R.; Mason, J.C.; vol. 45, no. 3, May 1992, pp 160-163, (1992) Appita, 9211 [in English]. 0003-6765)

2007 1991 REVIEW OF THE LITERATURE ON PULP AND PAPER INDUSTRY EFFLUENT MANAGEMENT [PIRA-10118083]

An annual review on the subject of management of effluents from pulp and paper mills is published by NCASI. The 1991 literature review has been arranged into the following subjects: biological treatment, physical-chemical treatment, internal load control, effluent characterisation, and environmental effect. Two other areas discussed are chlorinated organics and sludge management. A total of 354 references are quoted. (Anon; Technical Bulletin no. 632, New York, NY, USA: NCASI, 1992, 52pp (9809), (1992), 9211 [in English].)

2008 NALCO'S UNIQUE "ARC" TREATS EFFLUENT FOR REUSE RATHER THAN DISPOSAL [PIRA-10118231]

The pulp and paper industry is a major user of the 142bn gallons per day of water used by US industry. In July 1991, Nalco Chemical Co. introduced the Advanced Recycle Center (ARC) which is an advanced mobile laboratory designed to help papermakers to define problems and develop water treatment solutions. In an interview with a Nalco waste minimisation manager details are given of the ARC facilities which comprise analytical operations, pilot cooling tower and unit operations. The ARC is a 48ft long fully mobile road vehicle. Nalco will carry out a water treatment audit for its clients to give accurate cost estimates for an integrated operation. The integrated approach would include consideration of use of Nalco's biological treatment technology and would aim to minimise water use and waste production. (O'Brien, J.; vol. 108, no. 4, Apr. 1992, pp 26-27, (1992) Pap. Age, 9211 [in English]. 0031-1081)

2009 TASMAN TO INTRODUCE NEW PROCESS IN BLEACH PLANT [PIRA-10160140]

The Tasman Pulp and Paper mill in Kawerau, New Zealand will introduce a new process in the number one bleach plant late in 1992. The new two-stage sodium hypochlorite process replaces the current three-stage chlorine-based process. Sodium chlorite, a whitener rather than colour extracter has little free chlorine and thus chlorinated organic by-products are reduced. Total chlorinated organic discharge will be reduced by a third (measured as adsorbable organic halides, AOX) to less than 1.3kg/tonne. Dioxin will be reduced to less than 2ppg. The new process produces low brightness, semi-bleached pulp. (Short article) (Anon; Aug. 1992, p. 5, (1992) Pap. Asia News, 9211 [in English].)

2010 SIMULATION OF WHITE WATER MANAGEMENT STRATEGIES FOR AN INTEGRATED NEWSPRINT MILL [PIRA-10118246]

In order to meet new environmental regulations, pulp and paper mills may either introduce new or improved effluent treatment plants or new measures to reduce effluent volume. Paprican and the Ecole Polytechnique de Montreal report on a cost effective means of reducing effluent volume by white water recirculation. A study was carried out at a modern TMP newsprint mill in Canada that had already achieved a high degree of closure. The Paprican PAPMOD process simulation package was used to identify four possible changes comprising water recirculation from the paper machine circuit, improvement of the circuit cleaner, reuse of screw press white water and increased use of white water on paper machine showers. Implementation of a combination of these modifications could reduce fibre loss by 7.5adtpd and freshwater usage by up to 1700mtpd. (Noel, A.; Paris, J.; Roche, A.; Paper presented at 78th Annual Meeting Technical Section, held 30-31 Jan. 1992 at Montreal, Canada, Preprints "B", pp B31-B34 [Montreal, Canada: Canadian Pulp and Paper Association, 1992, 298pp (2 vols), C$47.00], (1992), 9212 [in English].)

2011 DEWATERING OF DEINKING SLUDGES USING TASSTER SCREW PRESSES [PIRA-10118247]

In 1990, Scott Paper Ltd started up a new 185mtpd deinking facility at Crabtree, Que., Canada. This included the first use in North America of the GEC Alsthom International Tasster screw presses which have been designed specifically for dewatering sludges from wastepaper pulp deinking. These sludges contain fine fibres, clays and inks. Start-up experiences are recorded at the new installation, and the importance is demonstrated of providing long fibre which acts as a core for flocculation. Sources of long fibre include reject streams from slotted screens and centrifugal cleaners. It was also necessary to define the sludge sources to be dewatered and to minimise variations from these sources. The flocculant must be selected for the particular application and mixed well without excessive shear. The proper injection point for the flocculant must be found by experimentation. (Jasmin, G.; Bonnelly, B.; Paper presented at 78th Annual Meeting Technical Section, held 30-31 Jan. 1992 at Montreal, Canada, Preprints "B", pp B35-B43 [Montreal, Canada: Canadian Pulp and Paper Association, 1992, 298pp (2 vols), C$47.00], (1992), 9212 [in English].)

2012 ENERGY EFFICIENT DESIGN OF EFFLUENT TREATMENT SYSTEMS [PIRA-10118279]

Stricter limits are being placed on the quality of effluents discharged from pulp and paper mills. Energy consumption represents a significant part of the operating costs of effluent treatment systems. Representatives of NLK-Celpap Canada (Montreal) Inc. and Ontario Hydro discuss the minimisation of energy consumption in effluent treatment systems with particular reference to incentives offered by utility companies in Canada. Aerobic processes require minimal power input and are not producers of energy, while anaerobic processes are energy intensive. An energy efficient aeration system depends on a high transfer rate of oxygen to mill effluent. Ontario Hydro is offering funds for consultant studies to identify energy savings and also incentives for installing energy efficient technologies. Similar incentives are available from British Columbia Hydro, Hydro-Quebec and other utilities. (Hamid, S.; Debeljkovic, D.; Ather, N.; Paper presented at 78th Annual Meeting Technical Section, held 30-31 Jan. 1992 at Montreal, Canada, Preprints "B", pp B261-B263 [Montreal, Canada: Canadian Pulp and Paper Association, 1992, 298pp (2 vols) C$47.00], (1992), 9211 [in English].)

2013 ANAEROBIC TREATMENT OF BLEACH PLANT EFFLUENT: COMPARISON OF REACTOR DESIGNS [PIRA-10118311]

Many countries are introducing legislation to control discharge of adsorbable organic halogen (AOX) from pulp mills. Reduction of AOX discharge can be achieved either by modification to pulping and bleaching processes or by improving wastewater treatment facilities. The Forest Research Institute, New Zealand has studied anaerobic treatment processes which can remove up to 60% of organically bound chlorine. This compares with about 35% by conventional aerated lagoon processes and 30 to 55% by activated sludge processes. The anaerobic processes evaluated at a laboratory scale used a contact reactor, an anaerobic filter, and an anaerobic fluidised bed containing modified polyurethane carrier particles. The fluidised bed reactor performed best with 55%removal of AOX and 80 to 90% removal of chlorinated phenolic compounds at a hydraulic retention time of 12 hours. (Clark, T. et al; Paper presented at 46th Appita Annual General Conference held 30 March-3 April 1992 at Launceston, Tas, Australia, pp 5-13 [Parkville, Vic, Australia: Appita, 1992, 558pp], (1992), 9212 [in English].)

2014 USE OF UASB (UP-FLOW ANAEROBIC SLUDGE BED) SYSTEM FOR BAGASSE SODA PULP, BAGASSE-CTMP AND RECYCLED PLANT EFFLUENT TREATMENT [PIRA-10118312]

The SiamKraft Industry Co. is evaluating the UASB reactor at pilot scale to study treatability of pulp mill effluent at its 850tpd testliner, corrugating medium and multiwall sack kraft mill in Thailand. The other companies in the Siam Pulp and PaperGroup are Siam Pulp and Paper, which produces 140tpd of bagasse pulp by the soda process and 70tpd of bagasse CTMP, and the Thai Paper Co., which produces 220tpd of fine paper and coated paper. The UASB anaerobic process was developed to treat effluents with a high organic content. The wastewater flows upwards through the sludge bed reactor and, after bacterial biodegradation, the biogas and effluent are separated and collected at the top of the reactor. In the pilot trials, chemical oxygen demand (COD)and biological oxygen demand (BOD) reductions of 80 to 85% were achieved, biogas production was 0.3 to 0.4cu m per kg COD removal and contained 75 to 80% methane gas. (Lertchanaruangrit, S.; Paper presented at 46th Appita Annual General Conference held 30 March-3 April 1992 at Launceston, Tas, Australia, pp 15-17 [Parkville, Vic, Australia: Appita, 1992, 558pp], (1992), 9212 [in English].)

2015 EFFECT OF PULP MILL MODERNIZATION ON EFFLUENT QUALITY [PIRA-10118313]

Tasman Pulp and Paper Co. Ltd produces 350,000tpy of newsprint on three machines at its Kawerau, New Zealand, mill. Kraft pulp to meet this demand, and to produce 200,000tpy for export, is produced at two adjacent mills. Kraft mill modernisation has included closure of the batch kraft mill and its replacement by a 530tpd Kamyr continuous digester and fibre line, installation of oxygen delignification, and bleach plant modifications to double the capacity to 500tpd of fully bleached pulp. Effluent treatment comprises a primary clarifier and an aerated lagoon plus seven directional type aerators. Dioxin levels in mill effluent had already been shown to be very low. The net increase in kraft pulping capacity and the product mix switch from 60% unbleached to 70% fully bleached kraft was accomplished with a net reduction in biological oxygen demand (BOD) and colour from the effluent treatment plant. (Sligh, P.; Paper presented at 46th Appita Annual General Conference held 30 March-3 April 1992 at Launceston, Tas, Australia, pp 19-21 [Parkville, Vic, Australia: Appita, 1992, 558pp] , (1992), 9212 [in English].)

2016 PULPING AND PAPER MAKING IN MURRAY-DARLING BASIN [PIRA-10118316]

Australian Newsprint Mills (ANP) set up a 600admtpd TMP mill and newsprint machine in Albury, Australia, in 1981 as part of the decentralisation plans encouraged by federal and state governments. The mill, which incorporated major environmental protection facilities, has been one of the successes of the growth of the Albury-Wodonga area at the headwaters of the Murray River. The mill is a relatively low water user at 35kl per admt, and fibre retention was improved from 33% to 42% from 1988 to 1989 by the

use of retention aids. Approval has been given for peroxide brightening of newsprint to improve quality although wastewater, even after tertiary treatment, must then be disposed of to land rather than to the Murray River. (Thurley, D.S.; Crockett, J.A.; Hansen, P.; Paper presented at 46th Appita Annual General Conference held 30 March-3 April 1992 at Launceston, Tas, Australia, pp 33-40 [Parkville, Vic, Australia: Appita, 1992, 558pp], (1992), 9212 [in English].)

2017 PHYSICOCHEMICAL TREATMENT OF BLEACH PLANT FILTRATES AND FINAL EFFLUENTS FOR THE REDUCTION OF CHLORINATED ORGANIC COMPOUNDS [PIRA-10118344]

Three physico-chemical treatments are evaluated for their ability to remove chlorinated phenolic compounds and adsorbable organic halogens (AOX) from softwood bleach plant filtrates and final effluents from kraft mills. AOX removal efficiencies of 40-80% were obtained with these treatments. However, the results indicate that both alum and SorbPlus are ineffective at removing individual chlorinated phenolic compounds, but powdered activated carbon was found to be over 90%. All three treatments were able to decrease the colour levels of the effluents by 75% or more. (Barton, D.A.; Technical Bulletin No. 635, New York, NY, USA: NCASI, 1992, 39pp, (1992), 9212 [in English].)

2018 ULTRAFILTRATION OF COATING EFFLUENTS: CLEANING, RECYCLING COMPONENTS [PIRA-10118354]

The effluent from coating processes contains organic materials (binders, additives, pigments). It is difficult to treat because the quantities of these components vary considerably. This report describes a crossflow ultrafiltration method which was designed to recover the coating contaminants in the effluent so that they can be reused in the coating process. The cleaned water thus obtained can also be reused. The report describes industrial tests with this system and evaluates its economic viability. (Camatta, R.; vol. 46, no. 4, 1992, pp 121-127, (1992) Rev. ATIP, 9212 [in French]. 0750-7666)

2019 POLLUTION CONTROL OF COATING EFFLUENTS [PIRA-10118389]

A coated paper or board mill may lose 3 to 5% of its daily coating output with implications in terms of lost material and in effluent volume and content. The effluent contains 0.5 to 1% solids and biological oxygen demand (BOD) may be generated from organic chemicals and pigments. These compounds may be difficult to flocculate, and this plus the variable flows of coating effluent can upset the efficient running of wastewater treatment plant. Representatives of Cellier and Koch Membrane Systems Inc. describe cross flow ultrafiltration as a process with the potential to give a closed system in coated paper effluent treatment. The process gives a concentrate which is completely recyclable and a permeate which can be reused of wash water. Separation is achieved without the use of chemical additives and total separation is guaranteed of membranes with sufficiently fine pores are used. (Tardy, G.; Kulbok, J.; Woerner, D.; vol. 108, no. 5, May 1992, pp 30-31, (1992) Pap. Age, 9212 [in English]. 0031-1081)

2020 THE NEW TERRACE BAY [PIRA-10118392]

After a difficult period in the 1980s with both profitability and environmental protection standards, Kimberly-Clark Canada Inc. has invested about C$90m to improve its Terrace Bay, Ont., bleached kraft pulp mill. In 1987, closure of the mill had been likely if K_C had not complied with requirements to install C$32m worth of pollution control equipment. The mill is now described as being at the leading edge in environmental control and is in a position to be competitive at a time of recession. The environmental improvements were deemed necessary to reduce the flow of effluent chemicals (including dioxins and furans) into Terrace Bay and Lake Superior. The solutions included installation of a secondary treatment and aerated stabilisation basin and chlorine dioxide substitution for chlorine to up to 100% in the bleaching process. (Karl, W.; vol. 45, no. 4, May 1992, pp 12-15, (1992) Pulp Pap. J., 9212 [in English].)

2021 3RD CESIO INTERNATIONAL SURFACTANTS CONGRESS AND EXHIBITION - A WORLD MARKET HELD AT LONDON, UK, 1-5 JUNE 1992 [PIRA-10118398]

In this international surfactants congress and exhibition in London, June 1992, the papers and reports presented on surfactants are divided into the subject categories of economics, raw materials, syntheses, applications, environment and toxicology, relating to all areas of application including water and effluent treatment, life cycle analysis, and ecobalance in packaging. (Anon; Brussels, Belgium: CESIO, 1992, 4 vols, (1992), 9212 [in English].)

2022 MECHANISM AND CONDITIONS OF WASTEWATERS FERMENTATION. [AGRIS-PL9000419]
52 ref. (Polec, B., Instytut Przemyslu Cukrowniczego (Poland); Gazeta Cukrownicza (Poland), (1989), v. 97(8-12) p. 155-159 [in Polish]. ISSN 0016-5395)

2023 KINETIC OF WASTEWATERS TREATMENT BY A METHANE FERMENTATION METHOD. [AGRIS-PL9000420]
24 ref. (Polec, B, Instytut Przemyslu Cukrowniczego (Poland); Gazeta Cukrownicza (Poland), (1989), v. 97(8-12) p. 159-163 [in Polish]. ISSN 0016-5395)

2024 MICROFAUNA AND LOADING OF ACTIVATED SLUDGE. [AGRIS-PL9000673]
Studies were carried out in 5 aeration chambers with activated sludge in which average loading amounted to 0.76, 0.60, 0.52, 0.37, and 0.13 g $BOD_{(5)}$/g d.wt./d. Effectiveness of treatment amounted respectively to: 53, 80, 90, 91 and 96 percent reduction of $BOD_{(5)}$. 34 taxons were determined: Flagellata - 7, Rhizopoda - 4, Ciliata - 19, Rotatoria - 3 and Nematoda - 1. Species composition of the sludge was similar in all chambers, but there were differences as regards numbers and frequency of the taxons. 3 fig.; 2 tables; 18 ref. Summaries (English, Polish, Russian). (Hul, B., Akademia Rolniczo-Techniczna, Olsztyn (Poland), Katedra Biologii Wody i Sciekow; Szczerbowska, B., Osrodek Badan i Kontroli Srodowiska, Olsztyn (Poland); Acta Academiae Agriculturae ac Technicae Olstenensis. Protectio Aquarium et Piscatoria (Poland), (1989), (no. 16) p. 113-123 [in Polish]. ISSN 0860-2611)

2025 POSSIBILITIES OF FOOD INDUSTRY WASTE WATERS AND SLURRY UTILIZATION TO FERTILIZE FISH PONDS. [AGRIS-PL9001028]
1 fig.; 3 tables; 11 ref. (Lewkowicz, S., Zaklad Doswiadczalny PAN, Golysz (Poland); Polska Akademia Nauk, Warszawa (Poland), Wydzial Nauk Rolniczych i Lesnych; Scientific conference: efficient and wasteless methods of agricultural production, Poznan (Poland), 24-26 Sep 1985; Publisher: Panstwowe Wydawnictwo Naukowe (1989) Zeszyty Problemowe Postepow Nauk Rolniczych (Poland), p. 279-287 no. 380 [in Polish]. ISBN 83-01-09150, ISSN 0084-5477)

2026 ACCLIMATION OF AN ANAEROBIC BIOMASS TO HIGH SULPHUR CONTENT PULP MILL EFFLUENTS: FIXED BIOMASS REACTOR. [AGRIS-FR9100685]
Summaries (French, English) (Najean, H., Centre Technique du Papier, Grenoble (France); Pichon, M., Rouger, J., 4. Symposium International sur la Chimie du Bois et des Pates, Paris (France), Apr 1987; Revue des Sciences de l'Eau (France), (1990), v. 3(3) p. 293-301 [in French]. ISSN 0750-7186)

2027 MIXED-FUNCTION OXYGENASE ENZYME RESPONSES AND PHYSIOLOGICAL DISORDERS IN FISH EXPOSED TO KRAFT PULP-MILL EFFLUENTS: A HYPOTHETICAL MODEL. [AGRIS-SE9110198]
49 ref. Summary (English). (Lehtinen, K.J., Finnish Environmental Research Group, Vanda (Finland); Ambio (Sweden), (Aug 1990), v. 19(5) p. 259-265 [in English]. ISSN 0044-7447)

2028 THE BRUNEI BAY AS AN EFFLUENT RECEIVING WATERBODY: OBSERVATIONS DURING THE START-UP PERIOD OF A KRAFT PULP AND PAPER MILL. [AGRIS-MY9005213]
The water quality of Brunei Bay, Malaysia, subsequent to receiving effluent from a pulp and paper mill, was monitored. Conventional water quality parameters such as dissolved oxygen, suspended solids, and biochemical oxygen demand were used as indicators to compare the present status of the bay water quality with that of the baseline. Generally, data gathered during the first 16 months of the mill operation did not indicate marked changes in the bay water quality. Levels of suspended solids, total organic carbons, and 1, 1-dichlorodimethyl sulfone in the bay water were used as indicators in the determination of dispersion pattern of the effluent in the coastal areas of the bay. 4 ill.; 3 tables; 18 ref. Summary (English, Malay). (Murtedza, Mohamed, Chin, L.L., Lim, T.S., Kebangsaan Malaysia Univ., Kota Kinabalu, Sabah. Department of Chemistry; Pertanika (Malaysia), (Apr 1990), v. 13(1) p. 123-128 [in English]. ISSN 0126-6128)

2029 CHARACTERIZATION OF CHROME TANNERY WASTE WATER FROM GOAT SKIN PRODUCTION UNIT PAKISTAN. [AGRIS-PK9000895]
5 tables, 9 ref., Summary (English). (Qureshi, A.W., Rizvi, N., Iqbal, M., PCSIR Labs., Karachi (Pakistan), Leather Research Centre; Pakistan Journal of Scientific and Industrial Research (Pakistan), (Dec 1989), v. 32(12) p. 795-797 [in English]. ISSN 0030-9885)

2030 DISCHARGES TO WATER OF EUTROPHICATING SUBSTANCES IN 1987. MUNICIPAL WASTE WATER TREATMENT PLANTS, PULP AND PAPER INDUSTRY. [AGRIS-SE9110160]
Numerical data. Summary (English). (Statistiska Centralbyraan, Stockholm (Sweden); Publisher: SCB (21 Dec 1990) Statistiska Meddelanden. Serie Na, Naturresurser och Miljoe (Sweden), 38 p. no. 22.1 [in Swedish]. ISSN 0282-3500)

2031 EFFECTS OF TREATED AND UNTREATED SOFTWOOD PULP MILL EFFLUENTS ON BALTIC SEA ALGAE AND INVERTEBRATES IN MODEL ECOSYSTEMS. [AGRIS-SE9000411]
24 ref. Summary (English). (Rosemarin, A., Kungl. Vetenskapsakademien, Stockholm (Sweden); Lehtinen, K.J., Notini, M., Nordic Pulp and Paper Research Journal (Sweden), (Jun 1990), v. 5(2) p. 83-87, 103 [in English]. ISSN 0283-2631)

2032 ALGAL PRODUCTION FROM AGRO-INDUSTRIAL AND AGRICULTURAL WASTES IN MALAYSIA. [AGRIS-SE9110497]
28 ref. Summary (English). (Phang, S.M., Malaysia Univ., Kuala Lumpur (Malaysia), Inst. for Advanced Studies; Ambio (Sweden), (Dec 1990), v. 19(8) p. 415-418 [in English]. ISSN 0044-7447)

2033 ACIDOGENIC FERMENTATION OF DAIRY MANURE. [AGRIS-US9100401]
Paper presented at the 1988 Winter Meeting of the American Society of Agricultural Engineers. Available for purchase from: The American Society of Agricultural Engineers, Order Dept., 2950 Niles Road, St. Joseph, Michigan 49085. Telephone the Order Dept. at (616) 429-0300 for information and prices. Ill. ref. (Krones, M.J., Johnson, A.T., Hao, O.J., (1988) American Society of Agricultural Engineers (Microfiche collection) (USA), 12 p. no. fiche no. 88-6612 [in English].)

2034 THE EFFECTS OF FEED PRODUCED FROM WASTE WATER OF STARCH INDUSTRY ON MEAT PERFORMANCE OF BROILER CHICKENS. [AGRIS-CS9101087]
5 tables; 4 ref. Summaries (English, Russian, Slovak). (Chrappa, V., Slovenska Akademia Vied, Kosice (CSFR), Ustav Fyziologie Hospodarskych Zvierat; Polnohospodarstvo (CSFR), (Mar 1990), v. 36(3) p. 246-252 [in Slovak]. ISSN 0551-3677)

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2036 EFFLUENT MONITORING IN THE PULP AND PAPER INDUSTRY. [AGRIS-SE9110739]
(Kommitten foer Bottniska Viken. Arbetsgruppen foer Skogsindustriernas Vattenvaardsfraagor; ([nd]) Rapport - Naturvaardsverket (Sweden), 24 p. no. 3661 [in English]. ISBN 91-620-3611-4, ISSN 0282-7298)

2037 MONITORING IN WATERS OUTSIDE PULP AND PAPER INDUSTRIES. [AGRIS-SE9110740]
Also published in Swedish. (Kommitten foer Bottniska Viken. Arbetsgruppen foer Skogsindustriernas Vattenvaardsfraagor; (1989) Rapport - Naturvaardsverket (Sweden), 16 p. no. 3445 [in English]. ISBN 91-620-3445-6, ISSN 0282-7298)

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2043 ESTIMATION OF THE BIOCHEMICAL OXYGEN DEMAND FROM POLLUTION PARAMETERS IN A WASTE DISPOSAL SYSTEM FOR DAIRY PROCESSING WASTES. [AGRIS-US9105992]
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Ill. (Ferguson, K.H., Pulp and paper (USA), (Apr 1990), v. 64(4) p. 59-66 [in English]. ISSN 0033-4081)

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Palm oil mill effluent (POME) and empty fruit bunches (EFB) are waste products from the oil-palm industry. The effects of POME and EFB compared with chicken-dung (CD) on the yields of chilli, cabbage and tomato grown on sand-tailings were studied. POME application at 30 t/ha gave chilli yield comparable to chilli yield obtained from application of chemical fertilizer NPK at 3 000 kg/ha while cabbage and tomato yields were double that from NPK application at 2 000 kg/ha. POME + NPK and EFB + NPK did not give as high yields as CD + NPK. However the potential of POME and EFB as organic sources for vegetable cultivation on sand-tailing soils is clearly shown from the results obtained. 3 ill.; 8 ref. Summary (English, Malay). (Othman, Haji Abu Bakar, MARDI, Kundang, Rawang (Malaysia), Bahagian makmal Penyelidikan Pusat; Vimala, Purushothaman, Teknologi Sayur-sayuran (Malaysia), (1989), v. 5 p. 17-31 [in Malay]. ISSN 0127-7960)

2047 BIOLOGICAL TREATMENT OF MALTING AND BREWING EFFLUENTS. [AGRIS-US9116694]
Ill. ref. Literature review. (Vriens, L., Seghers Engineering, Leuven, Belgium; van Soest, H, Verachtert, H., Critical reviews in biotechnology (USA), (1990), v. 10(1) p. 1-46 [in English]. ISSN 0738-8551)

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2049 PULP INDUSTRY WATER POLLUTION. [AGRIS-SE9110756]
33 ref. Summaries (English, Swedish). (Winqvist, A.K., Publisher: Umeaa Univ. (1988) MHS (Sweden), 56 p. no. 1988:27 [in Swedish].)

2050 REPORT OF THE WORKSHOP SESSIONS ON ENVIRONMENTAL ISSUES. [AGRIS-US9117684]
A 1984 workshop addresed environmental concerns related to the US food industry. Five research needs areas are identified and discussed: (1) reduction of waste loads via reprocessing and food processing modifications;(2) development of methodologies to upgrade wastes to new value-added products and to enhance the incorporation of raw products into finished products; (3) development of new sanitizing/cleaning agents and sanitizing methods; (4) analytical identification of factors influencing the composition and properties of process water and wastewater; and (5) development of methods for converting wastes to energy and soil quality enhancers. (wz) (Cooper, J.L., Dostal, K., Carroad, P.A., Food technology (USA), (Jun 1985), v. 39(6) p. 33R-35R [in English]. ISSN 0015-6639)

2051 MANURE WITHOUT POLLUTION. [AGRIS-US9118935]
Ill. (Comis, D. (ARS), Agricultural research - U.S. Department of Agriculture, Agricultural Research Service (USA), (Oct 1989), v. 37(10) p. 10-12 [in English]. ISSN 0002-161X)

2052 ENVIRONMENTAL AUDIT CAN HELP MILLS ANALYZE WASTEWATER TREATMENT NEEDS. [AGRIS-US9120472]
First of a series. (Garner, J.W., Jaakko Poyry Inc., Raleigh, NC; Pulp and paper (USA), (Apr 1991), v. 65(4) p. 86-89 [in English]. ISSN 0033-4081)

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2071 TREATMENT OF PAPER INDUSTRY EFFLUENTS WITH EICHHORNIA CRASSIPES: FIRST RESULTS (TARTAS FACTORY, LANDES, FRANCE). [AGRIS-FR9102880]
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25 ref., Summaries (French, English). (Delachapelle, S., Societe 3M France, Rueil Malmaison (France); Renaud, M., Vignais, P.M., Revue des Sciences de l'Eau (France), (1990), v. 4(1) p. 83-99 [in French]. ISSN 0750-7186)

2073 POLLUTION DUE TO TANNERY EFFLUENTS IN THE KORANGI INDUSTRIAL AREA KARACHI PAKISTAN. [AGRIS-PK9100442]
5 tables, 10 ref., Summary (English). (Beg, M.A.A., Mahmood, S.N., Naeem, S., PCSIR Labs., Karachi (Pakistan); Pakistan Journal of Scientific and Industrial Research (Pakistan), (Oct 1990), v. 33(10) p. 431-435 [in English]. ISSN 0030-9885)

2074 NATIONAL PLAN FOR THE SWEDISH MARINE ENVIRONMENT. ANNEX A-K. MAPS, DESCRIPTIONS OF INDUSTRIAL AND MUNICIPAL PLANTS. [AGRIS-SE9120245]
Summary (English). Annex to: Rapport - Naturvaardsverket no. 3880. Also published in Swedish in: Rapport - Naturvaardsverket no. 3879. (Statens Naturvaardsverk, Solna (Sweden); (Jan 1991) Rapport - Naturvaardsverket (Sweden), 419 p. no. 3881 [in English]. ISBN 91-620-3881-8, ISSN 0282-7298)

2075 BARRIERS OF THE DEVELOPMENT OF FOOD ECONOMY. SPATIAL STRUCTURE OF THE COUNTRY. RURAL AND AGRICULTURAL INFRASTRUCTURE. FOOD PROCESSING INDUSTRY PERFORMANCE. [AGRIS-PL9100470]
3 fig.; 26 tables; 100 ref. (Machowski, E., Towarzystwo Rozwoju Oswiaty Rolniczej, Rzeszow (Poland); Publisher: Panstwowe Wydawnictwo Rolnicze i Lesne (1990), 162 p. [in Polish].)

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2077 MANAGING CREOSOTE WASTE STREAMS FOR THE WOOD TREATING INDUSTRY. [AGRIS-US9129413]
References. Paper presented as Colley Lecture of the meeting. (Ratcliff, S.A., Allied-Signal Inc., Morristown, NJ; Proceedings ... annual meeting - American Wood-Preservers' Association (USA), (1989), v. 85 p. 100-105 [in English]. ISSN 0066-1198)

2078 BIOFIRM WILL TREAT DAIRY WASTE. [AGRIS-US9130669]
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2079 THE ANAEROBIC-AEROBIC UNITANK SYSTEM FOR ADVANCED WASTEWATER TREATMENT: PILOT- AND FULL-SCALE EXPERIENCE ON BREWERY WASTEWATER. [AGRIS-BE9100788]
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2080 PROBLEMS WITH THE DETERMINATION OF LIGNIN DERIVATIVES IN EFFLUENTS FROM BLEACHED KRAFT PULPING. [AGRIS-SE9111436]
4 ref. Summaries (English, Swedish). (Starck, B., Saagfors, P.E., Finnish Pulp and Paper Research Inst., Esbo (Finland); Vatten (Sweden), (1991), v. 47(1) p. 5-7 [in English]. ISSN 0042-2886)

2081 DETERMINATION OF PHOSPHORUS IN PULP AND PAPER MILL EFFLUENTS. [AGRIS-SE9111439]
5 ref. Summaries (English, Swedish). (Starck, B., Jaervinen, R., Finnish Pulp and Paper Research Inst., Esbo (Finland); Vatten (Sweden), (1991), v. 47(2) p. 91-95 [in English]. ISSN 0042-2886)

2082 PAPERMILL WASTEWATER TREATMENT TOGETHER WITH MUNICIPAL WASTEWATERS - OBSTRUCTIONS BY NEW REQUIREMENTS AND PRESCRIPTIONS. [AGRIS-DE91T0526]
1 table; 15 ref. (Moebius, C.H., Wochenblatt fuer Papierfabrikation (Germany), (1991), v. 119(7) p. 294-298 [in German]. ISSN 0043-7131)

2083 UTILIZATION OF SOYA EFFLUENT (OBTAINED DURING PROCESSING OF SOYA GRITS INTO A CONCENTRATE) AS RAW MATERIAL FOR FEED PROTEIN PRODUCTION: FUNGAL PROTEINS AS FEED; TRICHOSPORON "CUTANEUM". [AGRIS-PL9100401]
Possibility of microbiological utilization of soya effluent was investigated. This effluent was obtained upon extraction of non-protein compounds from soya grits, in an amount of 5-6 cu. dm/kg of grits. It contained in 100 cu. cm an average of 6.3 g of dry matter comprising 81.5 per cent of organic substances. Thermal treatment of effluent afforded a protein coagulate (65 per cent of crude protein in dry matter) and a post - coagulation effluent containing 5.6 per cent of dry matter which comprised 10.2 per cent of soluble protein and 54.3 per cent of sugar. 15 ref. Summaries (English, Polish, Russian). (Stecka, K., Instytut Biotechnologii Przemyslu Rolno-Spozywczego, Warszawa (Poland); Badocha, E., Labedzinski, S., Prace Instytutow i Laboratoriow Badawczych Przemyslu Spozywczego (Poland), (1990), v. 41 p. 116-131 [in Polish].)

2084 PILOT EXPERIMENT ON THE BIOLOGICAL PURIFICATION OF WASTE WATER FROM BREWERIES USING THE HCR SYSTEM AT THE GILDE BREWERY IN HANNOVER. [AGRIS-DE91J0229]
7 ill. Summary (German, English, French). (Wildhagen, H., Schneider, F., Vogelpohl, A., Geissen, S., Weichgrebe, D., Brauwelt (Germany), (1991), v. 131(19-20) p. 806, 808-812 [in German]. ISSN 0724-696X)

2085 FERMENTATION INDUSTRY. [AGRIS-US9128988]
References. (Manning, J.F., Jr.; Argonne National Laboratory, Argonne, IL; Chiesa, S.C., Research journal of the Water Pollution Control Federation (USA), (Jun 1991), v. 63(4) p. 448-450 [in English]. ISSN 1047-7624)

2086 PULP AND PAPER EFFLUENT MANAGEMENT. [AGRIS-US9128992]
References. (Norton, S.C., National Council of the Paper Industry for Air and Stream Improvement, Inc; Research journal of the Water Pollution Control Federation (USA), (Jun 1991), v. 63(4) p. 462-472 [in English]. ISSN 1047-7624)

2087 DETERMINATION OF FAT IN WASTEWATER FROM FOOD PROCESSING INDUSTRIES. INFRARED SPECTROPHOTOMETRIC METHOD. [AGRIS-SE9111521]
1 ref. (Standardiseringskommissionen i Sverige, Stockholm (Sweden); Publisher: SIS (5 Jun 1991) Svensk Standard (Sweden), 7 p. no. 028103 [in Swedish].)

2088 KINETICS OF THE DECOMPOSITION IN SOIL OF ORGANIC CARBON FROM VEGETATION WATERS (IN TUSCANY). [AGRIS-IT9160586]
2 tables; 2 graphs; 12 ref. Summaries (German, English, Spanish, French, Italian). (Saviozzi, A., Levi Minzi, R., Riffaldi, R., Pisa Univ. (Italy), Istituto di Chimica Agraria; Agrochimica (Italy), (Jan-Apr 1990), v. 34(1-2) p. 157-164 [in Italian]. ISSN 0002-1857)

2089 GETTING RID OF VEGETATION WATER OF OIL PRESSES TO SEND TO HUSK FACTORY - EFFECTS ON THE HUSK AND ON OIL QUALITY. [AGRIS-IT9160947]
2 tables; 3 graphs. Summaries (English, Italian). (Bondioli, P., Lanzani, A., Fedeli, E., Stazione Sperimentale per le Industrie degli Oli e dei Grassi, Milan (Italy); Casarotto, L., Rivista Italiana delle Sostanze Grasse (Italy), (Nov 1989), v. 66(11) p. 623-626 [in Italian]. ISSN 0035-6808)

2090 REDUCTION OF WASTE WATER IN THE BOTTLING HALL. [AGRIS-DE91J0325]
8 ill., 7 tables; 15 ref. (Schumann, G., Brauwelt (Germany), (1991), v. 131(25) p. 1056-1063 [in German]. ISSN 0724-696X)

2091 WASTEWATER TREATMENT IN DAIRY INDUSTRY. [AGRIS-IT9160986]
2 tables; 8 graphs; 10 ref. Summaries (English, Italian). (Geissen, S., Latte (Italy), (Jul 1990), v. 15(7) p. 578-585 [in Italian]. ISSN 0392-6060)

2092 MERCURY CONTAMINATION IN AND AROUND A CHLORALKALI INDUSTRY IN INDIA (PROCEEDINGS). [AGRIS-BD9125106]
The paper reports the concentration levels of mercury in the effluent of a chloralkali industry and in the surrounding objects. Thus, in the effluent water the mercury was recorded as high as 1.5487 0.0816 mg/l and in brine muds at different sites of the Rushikulya river estuary it was up to 1108.33 64.24 mg/kg dry wt. The residual mercury levels in different fish species from the estuary were up to 50.05 mg/kg fresh wt. and in a grass, Cynodon dactylon, collected from the area of solid deposits around the industry the residual accumulation was up to 90.12 5.78 mg/kg dry wt. The mercury level, however, declined with distance and the lowest level was recorded in the monsoon at all sites. Summary only. (Panigrahi, A.K., Sahu, A., Shaw, B.P., Bangladesh

Botanical Society, Dhaka (Bangladesh); International Botanical Conference, Dhaka (Bangladesh), 10-12 Jun 1991; Publisher: BBS (1991), p. 20 [in English].)

2093 RECYCLING OF WASTEWATER AND SOLID WASTE AT THE SELENGINSK PULP AND PAPER PLANT. [AGRIS-FR9103556]
Summaries (English, French, Spanish). (Aldokhin, N.A., Selenginsk Pulp and Paper Plant, Kabansk District (USSR); Goncharov, A.I., Grachev, M.A., Suturun, A.N., Industry and Environment (France) , (Jul-Dec 1990), v. 13(3-4) p. 21-23 [in English]. ISSN 0378-9993)

2094 THE EFFECT OF IRRIGATION WITH STARCH FACTORY ON AGROCHEMICAL CHARACTERS OF SOIL. [AGRIS-CS9101748]
8 tables; 10 ref. Summaries (Czech, German, English, Russian). (Ledvina, R., Vysoka Skola Zemedelska, Ceske Budejovice (CSFR), Agronomicka Fakulta; Sbornik Agronomicke Fakulty VSZ v Ceskych Budejovicich. Fytotechnicka Rada (CSFR), (1990), v. 7(1) p. 75-85 [in Czech]. ISSN 0862-0377)

2095 INFLUENCE OF INOCULATION AND TEMPERATURE OF WASTE-WATER IN FERMENTER ON THE EFFECTIVENESS OF POLLUTION REMOVAL FROM SUGAR-FACTORY WASTE-WATER AND THE PRODUCTION OF BIOGAS. [AGRIS-PL9100997]
20 g dry matter/$dm^{(3)}$ is the minimum of the oxygen-free sediment, which makes possible to run the fermentation process without adaptation phase and with high efficiency. Besides appropriate inoculation of waste-water there must be secured the suitable temperature (33 °C). 4 fig.; 5 tables; 4 ref. (Polec, B., Gazeta Cukrownicza (Poland), (1991), (no. 1) p. 17-20 [in Polish]. ISSN 0016-5395)

2096 BIOLOGICAL TREATMENT OF A BLEACH PLANT EFFLUENT IN COMBINATION WITH ULTRAFILTRATION. [AGRIS-SE9111531]
11 ref. Summaries (English, Swedish). (Almemark, M., Bergstroem, R., Boman, B., Ekengren, Oe., Frostell, B., (Sep 1990) IVL Rapport. B (Sweden), 26 p. no. 998 [in Swedish]. ISSN 0283-877X)

2097 THE REPORT OF THE APPLICATION OF THE WASTE WATER FROM SUGAR MANUFACTURING INDUSTRY IN RICE FIELD. [AGRIS-CN9124262]
4 tables, Summaries (Chinese, English). (Zhang, Sheng, Jiang, Chen, Heilongjiang Provincial Station of Agro-Environmental Protection and Monitoring, Harbin (China); Agro-Environmental Protection (China), (Jun 1991), v. 10(3) p. 108-111, 145 [in Chinese]. ISSN 1000-0267)

2098 INDUSTRIAL WASTEWATER MONITORING AT A CANE SUGAR FACTORY SOUTH TRINIDAD, RIVER CIPERO. [AGRIS-FR9104704]
9 ref., 6 tables, Summaries (English, French, Spanish). (Millette, E.D., Consultative Association of Trinidad and Tobago, Port of Spain (Trinidad and Tobago); Industry and Environment (France), (Jan-Mar 1991), v. 14(1) p. 30-34 [in English]. ISSN 0378-9993)

2099 SUGAR-FACTORY WASTE-WATER TREATMENT PLANTS IN POLAND IN THE LIGHT OF THE INVESTIGATIONS CARRIED OUT BY THE SUGAR INDUSTRY INSTITUTE. PT. 1A. HIGHLY EFFICIENT WASTE-WATER TREATMENT PLANT IN WROCLAW. [AGRIS-PL9100998]
The authors described the most efficient waste-water treatment plant, which has been designed and built in Poland. The plant was put into service in 1986-87 and subsequently it was closely examined. On the basis of results of investigation in the years 1988-89 the waste-water treatment plant has been modified. 1 fig.; 4 tables. (Wolski, T., Polec, B., Instytut Przemyslu Cukrowniczego, Warszawa (Poland), Pracownia Gospodarki Woda i Ochrony Srodowiska; Gazeta Cukrownicza (Poland), (1991), (no. 2) p. 33-39 [in Polish]. ISSN 0016-5395)

2100 SUGAR-FACTORY WASTE-WATER TREATMENT PLANTS IN POLAND IN THE LIGHT OF THE INVESTIGATIONS CARRIED OUT BY SUGAR INDUSTRY INSTITUTE. PT. 1B. HIGHLY EFFICIENT WASTE-WATER TREATMENT PLANT IN WROCLAW. [AGRIS-PL9100999]
The authors described the results of four-year long investigations. The results suggested that waste-water treatment plant in Wroclaw is undoubtedly the most economical as far as space and energy consumption is concerned and that it allows to receive the highest degree of sugar-factory waste-water purification. 3 fig.; 4 tables; 12 ref. (Wolski, T., Polec, B., Instytut Przemyslu Cukrowniczego, Warszawa (Poland), Pracownia Gospodarki Woda i Ochrony Srodowiska; Gazeta Cukrownicza (Poland), (1991), (no. 3) p. 51-56 [in Polish]. ISSN 0016-5395)

2101 SUGAR-FACTORY WASTE-WATER TREATMENT PLANTS IN POLAND IN THE LIGHT OF THE INVESTIGATIONS CARRIED OUT BY THE SUGAR INDUSTRY INSTITUTE. PT. 2. BIOLOGICAL PURIFICATION SUGAR-FACTORY WASTE-WATER IN THE SUGAR-FACTORY IN MELNO. [AGRIS-PL9101000]
Biological waste-water treatment plant in Melno is a two-stage system: oxygen-free and oxygen with open fermenting reservoir and aeration chambers with activated sludge. The author indicates the manners which make possible obtainment of high effects of purification in shorter term and at lower expenditure of energy and costs. 2 tables; 4 ref. (Wolski, T., Instytut Przemyslu Cukrowniczego, Warszawa (Poland), Pracownia Gospodarki Woda i Ochrony Srodowiska; Gazeta Cukrownicza (Poland), (1991), (no. 4) p. 71-74 [in Polish]. ISSN 0016-5395)

2102 GRAULHET. LEATHER INDUSTRY TREATS ITS WATERS. [AGRIS-FR9104734]
Summaries (French, English). (Ladet, B., Regie Municipale des Eaux de Graulhet (France); Perchet, A., Jouaffre, P., Parpagiola, P., Techniques Sciences Methodes (France), (Jun 1991), v. 22(6) p. 323-326 [in French]. ISSN 0299-7258)

2103 GALACTOSYL: A BIOCATALYST FOR HYDROLYSIS OF WHEY LACTOSE. [AGRIS-US9136166]
A study has been made of the properties of immobilized fungal beta-galactosidase (the trademarked preparation Galactosyl). The pH optima at different temperatures, the temperature optimum for enzyme action, pH-stability, and thermostability were determined. Preparation kinetic constants were calculated. Effective biocatalyst activity was found to depend on degree of substrate hydrolysis. The Galactosyl preparation was shown to be a high-activity biocatalyst suitable for producing glucose-galactose syrup from dairy industry wastes. References. Translated from: Biotekhnologiya (3), 1989, p. 305-310. (TP248.2.B57). (Samoshina, N.M., All-Union Scientific Research Institute of Biotechnology; Lotmentseva, E.Yu., Nakhapetyan, L.A., Soviet biotechnology (USA), (1989), (no. 3) p. 41-46 [in English, Russian]. ISSN 0890-734X)

2104 CHARACTERIZATION OF RESIDUAL WATER OF THE YEAST INDUSTRY "PERUCHO FIGUEREDO" CUBA. [AGRIS-CU9100269]
2 tables; 13 ref. Summaries (English, Spanish). (Machado de Armas, J., Wong Chung, H., Las Villas Univ. Central, Villa Clara (Cuba), Facultad de Ciencias Agricolas; Centro Agricola (Cuba), (1990), v. 17(1) p. 37-41 [in Spanish]. ISSN 0253-5785)

2105 NITROUS OXIDE EMISSIONS FROM WASTEWATER TREATMENT SYSTEMS. [AGRIS-NZ9100352]
In New Zealand nitrous oxide is the third most important greenhouse gas after carbon dioxide and methane. Waste treatment technologies that promote cyclic aerobic and anaerobic environments have the potential to produce significant quantities of nitrous oxide. Land application of wastes and artificial wetlands are two treatment methods that can produce nitrous

oxide and these schemes are being actively promoted in New Zealand. The nitrogen content of the wastes from New Zealand's primary industries (dairy sheds, dairy factories and meat plants) and from sewage collectively amounts to 19,000 tonnes annually. Total emissions of nitrous oxide (as nitrogen) from combustion and agricultural sources are estimated as 29,000 tonnes annually. Data in this report show that waste treatment schemes (meat processing and dairy factory wastes) can significantly contribute to New Zealand's nitrous oxide emissions, current research is showing that amounts of nitrous oxide emitted to the atmosphere can be minimized by managing soil pH and reducing the amount of carbon in the irrigated effluent by suitable pre-treatment. Summary (English). (Russell, J.M., Cooper, R.N., Lindsey, S.B., Meat Industry Research Institute, Hamilton (New Zealand); Publisher: Meat Industry Research Institute of New Zealand (Apr 1991) MIRINZ Technical Report Series (New Zealand), 5 p. no. 867 [in English]. ISSN 0465-4390)

2106 EVALUATING TOTAL CHLORINATED ORGANIC COMPOUNDS IN KRAFT MILL PROCESS STREAMS: ROUTINE ANALYSIS AOX (ABSORBABLE ORGANIC HALOGEN). [AGRIS-FR9104705]
Summaries (English, French, Spanish). (Canada Centre of Inland Waters, Burlington (Canada), Wastewater Technology Centre; Industry and Environment (France), (Jan-Mar 1991), v. 14(1) p. 52-53 [in English]. ISSN 0378-9993)

2107 ENVIRONMENTAL ISSUES FOR THE POULTRY INDUSTRY: PROCESSING. [AGRIS-US9135548]
The water flow and waste loading patterns of a modern broiler processing plant (260,000 birds per day) were studied. The study was conducted in two phases. The first phase examined the water flow and waste-loading patterns during a 24-h period. The second phase studied flow and waste-loading patterns from five major process functions of the plant. The first phase study showed that 94 percent of the water flow of the plant was used for processing and the remaining 16 percent for plant sanitation. Based on received water, the plant used 5.08 gal (1 gal .379 L) per bird. Analysis of the waste stream from five process functions determined that 72 percent of the plant flow came from the evisceration operation. The feather flow operation and the offal truck contributed 83 percent of the NH3N discharged by the plant. Definition of flow and waste-loading patterns provides valuable information for enhancing water conservation and waste minimization. References. (Merka, W.C., University of Georgia, Athens, GA; Poultry science (USA), (May 1991), v. 70(5) p. 1118-1122 [in English]. ISSN 0032-5791)

2108 EFFECTS OF BUKIDNON SUGAR MILL WASTES IN PULANGI RIVER PHILIPPINES. [AGRIS-PH9010002]
The effects of the Bukidnon sugar mill wastes which are mainly organic wastes in Pulangi River [Bukidnon, Philipines] were studied with the following objectives; (1) to determine the phytoplankton counts and diversity index upstream and downstream of the BUSKO [Bukidnon Sugar Company] project; (2) to determine the coefficient of condition and percent protein on the test species; (3) to conduct a toxicity test of the sugar mill effluent on the test fish species; (4) to determine the quality of water in Pulangi River in its natural state; (5) to determine the effects of the activities by the sugar processing plants upon the quality of the river water; and (6) to determine the quality of the effluent discharge into the river using selected parameters. Pulangi River was not polluted by the wastes coming from the sugar mill. Data on water quality, phytoplankton counts and percent protein and coefficient of condition of caged tilapia from upstream and downstream waters did not differ significantly. Values on water quality parameters fell under the values set for non-polluted waters. The fast flow rate of Pulangi River which averaged to 1,519.05 cm/sec may have been the important factor in dispersing pollutant sources, facilitated gaseous exchange and controlled phytoplankton population. Phytoplankton counts were affected by current flow, total suspended solids, temperature, and transparency. The higher phytoplankton counts in the dry season were enhanced by higher temperature and transparency, and lower flow rate and suspended solids during the period. To preserve the suitability of Pulangi River for its intended use, close monitoring of water quality, industrial wastes, and activities of people using this river is imperative and if necessary, the implementation of effective anti-pollution control measures should be done. 1 map (scale: 1:50,000 cm); 7 tables; 13 ref. Summary (English). (Quimpang, V.T., Famador, E.B., Central Mindanao Univ., Musuan, Bukidnon (Philippines), Dept. of Biology; CMU Journal (Philippines), (Jan-Jun 1989), v. 2(1) p. 13-26 [in English]. ISSN 0116-7847)

2109 ENVIRONMENTAL PROJECT, 104: POLLUTION REDUCTION IN THE SHRIMP PEELING INDUSTRY. [AGRIS-DK9121035]
22 ill., 12 tables; Summary (Danish). (Miljoestyrelsen, Copenhagen (Denmark); Publisher: Miljoestyrelsen (1988), 92 p. [in Danish]. ISBN 87-503-7604-7)

2110 WATER MANAGEMENT IN THE FRENCH MALTING INDUSTRY. PRESENT STATUS. [AGRIS-FR9104733]
(Jolibert, F., Institut Francais des Boissons de la Brasserie Malterie, Vandoeuvre les Nancy (France); BIOS (France), (Jun-Jul 1991), v. 22(6-7) p. 101-106 [in French]. ISSN 0366-2284)

2111 THE EFFECT OF SYSTEMATIC APPLICATIONS OF EFFLUENTS DERIVED FROM "OSVALDO SANCHEZ" AGROINDUSTRIAL ENTERPRISE ON A HYDRATED RED FERRALITIC SOIL WITH SUGARCANE CULTIVATION. [AGRIS-CU9100471]
1 ill., 3 tables; 14 ref. Summaries (English, Spanish). (Gonzalez, P.J., Paneque, V.M., Martinez, M.A., Instituto Nacional de Ciencias Agricolas, La Habana (Cuba); Izquierdo, R., Instituto Superior de Ciencias Agropecuarias de La Habana (Cuba); Cultivos Tropicales (Cuba), (1989), v. 11(4) p. 43-51 [in Spanish]. ISSN 0258-5936)

2112 BIOACCUMULATION OF NONYLPHENOL IN CAGED MUSSELS IN AN INDUSTRIAL COASTAL AREA ON THE SWEDISH WEST COAST. [AGRIS-NL9109177]
12 refs.; Summary (English). (Granmo, A., National Swedish Environmental Protection Agency, Fiskebaeckskil (Sweden), Kristineberg Marine Biological Station; Kollberg, S., Berggren, M., Ekelund, R., Magnusson, K., Renberg, L., Wahlberg, C., Angeletti, G., Commission of the European Communities, Brussels (Belgium); Bjoerseth, A., Organic Micropollutants in the Aquatic Environment, Lisbon (Portugal), 22-24 May 1990; Publisher: Kluwer Academic Publishers (1990), p. 71-79 [in English]. ISBN 0-7923-1104-3)

2113 WASTEWATER IN TAPPING OFF ROOM. [AGRIS-FR9104907]
(Schumann, G., VLB, Berlin (Germany), Departement Technique des Eaux; BIOS (France), (Oct 1991), v. 22(10) p. 51-55 [in French]. ISSN 0366-2284)

2114 RECOVERY OF WATER AND AUXILIARY CHEMICALS FROM EFFLUENTS OF TEXTILE DYE HOUSES. [AGRIS-NL9108966]
7 refs.; Summary (English). (Gaeta, S.N., Separem s.p.a., Biella (Italy); Fedele, U., Desalination (Netherlands), (1991), v. 83(1) p. 183-194 [in English]. ISSN 0011-9164)

2115 MEMBRANE DISTILLATION IN THE TEXTILE WASTEWATER TREATMENT. [AGRIS-NL9108967]
10 refs.; Summary (English). (Calabro, V., Calabria Univ. (Italy), Dept. of Chemistry; Drioli, E., Matera, F., Desalination (Netherlands), (1991), v. 83(1) p. 209-224 [in English]. ISSN 0011-9164)

2116 CHANGES IN THE ORGANIC MATTER OF A RENDZINA SOIL CAUSED BY WASTEWATER SLUDGE DISPOSALS FROM DAIRY PROCESSING PLANTS. [AGRIS-BE9101206]
1 ill.; 8 tables; 34 ref.; Summary (English). (Guichet, J., Jambu, P., Universite de Poitiers (France), Lab. de Pedologie; Dinel, H., Pedologie (Belgium), (1991), v. 41(2) p. 149-162 [in English]. ISSN 0079-0419)

2117 STUDY OF THE PROCESS OF BIOOXIDATION OF THE CULTURE LIQUID OF GAPRIN PRODUCTION. [AGRIS-US9139517]
The process of biooxidation by a microbial biocenose of organic materials contained in the culture liquid of methane-oxidizing bacteria was studied on a laboratory device. It is shown that the process provides effective biooxidation of the bulk of organic materials. Empirical equations reflecting the

relation between the specific load, residual COD value in the effluent, specific rate of biomass growth, and oxidation rate were obtained. References. Translated from: Biotekhnologiya, (4), 1990, p. 61-63. (TP248.2.B57). (Paramonov, F.F., All-Union Scientific Research Institute of Biosynthesis of Protein Substances, Moscow; Stolbun, S.V., Soviet biotechnology (USA), (1990), (no. 4) p. 92-96 [in English, Russian]. ISSN 0890-734X)

2118 HEAT BALANCE AND MASS TRANSFER IN AERATION TANKS OF SINGLE-CELL PROTEIN PRODUCTION PLANTS. [AGRIS-US9139516]
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1 fig.; 2 tables. (Wolski, T., Gazeta Cukrownicza (Poland), (1991), (no.5) p. 87-90 [in Polish]. ISSN 0016-5395)

2124 SUGAR-FACTORY WASTE-WATER TREATMENT PLANTS IN POLAND IN THE LIGHT OF THE INVESTIGATIONS CARRIED OUT BY THE SUGAR INDUSTRY INSTITUTE. PT. 3B. THE LATEST TECHNICAL SOLUTIONS OF BASINS TO THE ANAEROBIC FERMENTATION OF SUGAR PLANTS WASTE WATER. [AGRIS-PL9101076]
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2127 TREATMENT TECHNOLOGIES EMERGING TO MEET ORGANOCHLORINE REMOVAL NEEDS. [AGRIS-US9148297]
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2128 SECONDARY WOOD-BASED RAW MATERIALS IN THE NUTRITION OF FARM ANIMALS. [AGRIS-CS9101926]
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2129 BIOLOGICAL PURIFICATION PLANT FOR THE SUGAR FACTORY WASTE WATERS, 4: CONCEPTION AND PROPOSAL PARAMETERS OF THE AEROBIC PURIFICATION PLANT. [AGRIS-CS9101920]
1 ill., 3 schemes, 1 table; 7 ref. Summaries (Czech, German, English). (Stuchl, I., Budicek, L., Kubin, M., Navratilova, I., Vyzkumny Ustav Cukrovarnicky, Prague (CSFR); Listy Cukrovarnicke (CSFR), (Feb 1991), v. 107(2) p. 34-40 [in Czech]. ISSN 0024-4449)

2130 PRINCIPLES AND POTENTIALS OF THE UPFLOW ANAEROBIC SLUDGE BED (UASB)- PROCESS (REPORT). [AGRIS-DE91Q2275]
Anaerobic wastewater treatment without doubt can be regarded as a grown-up technology, although this is still not completely accepted everywhere. The Upflow Anaerobic Sludge Bed (UASB)-system so far is the most widely applied reactor concept. It has found successful application for a vast number of very different industrial effluents. Undoubtedly various hybrid reactor types will be developed in the near future, while also modified UASB-reactors, e.g. Expanded Granular Sludge Bed (EGSB) reactors or Internal recirculation (IC-UUASB) will find their way. The anaerobic treatment process very likely will find increasingly application for treatment of wastewaters of chemical industries. 2 ill. 3 tables. 33 ref. (Lettinga, G., Wageningen Univ. (Netherlands), Dept. of Environmental Technology; Bremen Overseas Research and Development Association, Bremen (Germany); International Conference on Biogas. Technologies and Implementation Strategies, Pune (India), 10-15 Jan 1990; Publisher: GTZ (1990), p. 515-530 [in English].)

2131 BIOLOGICAL WASTE WATER TREATMENT PLANT SYSTEM ANBICO. [AGRIS-CS9102073]
3 schemes, 2 tables; 1 ref. Summaries (German, English). (Stuchl, I., Duffek, K., Vyzkumny Ustav Cukrovarnicky, Prague (CSFR); Prumysl Potravin (CSFR), (Aug 1991), v. 42(5) p. 224-228 [in Czech]. ISSN 0033-1988)

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3 ill.; 23 ref. (Schumann, G., Brauwelt international (Germany), (1991), (no.3) p. 224, 226-227 [in English]. ISSN 0934-9340)

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Graphs, numerical tables; 26 ref. Summaries (English, Spanish). (Beltran, F.J., Encinar, J.M., Garcia-Araya, J.F., Alonso, M.A., Extremadura Univ., Badajoz (Spain), Facultad de Ciencias; Anales de Quimica (Spain), (1991), v. 87(1) p. 76-87 [in Spanish]. ISSN 1130-2283)

2137 LISTERIA IN EFFLUENTS FROM THE FOOD-PROCESSING INDUSTRY. [AGRIS-FR9200333]
46 ref., Summaries (English, French, Spanish). (Schoenberg, A., Institute of Veterinary Medicine, Berlin (Germany; Gerigk, K., Revue Scientifique et Technique de l'OIE (France), (Sep 1991), v. 10(3) p. 787-797 [in English]. ISSN 0253-1933)

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The calculation method proposed here, which utilizes the authors' substrate-oriented biological purification model, makes it possible to determine biochemical reactor volume ratio and minimize total volume while simultaneously providing a specified degree of purification and level of biomass recirculation in each reactor. A program in the FORTRAN-IV language was tested for numerical solution of this problem. Our calculations established that the biomass recycle coefficient has a strong influence on reactor volume ratio. References. Translated from: Biotekhnologiia, (5), 1990, p. 61-63. (TP248.2.B57). (Tsygankov, S.P., Kiev Technological Institute of the Food Industry; Lobok, A.P., Novak, A.G., Zavarzina, O.A., Soviet biotechnology (USA), (1990), (no. 5) p. 80-84 [in English, Russian]. ISSN 0890-734X)

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2161 ANAEROBIC TREATMENT OF WASTEWATER FROM WASTEPAPER CONVERTING PAPER MILLS. [AGRIS-DE92T2096]

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2162 EVALUATION OF DAIRY FOOD PROCESSING WASH WATER SOLIDS AS A PROTEIN SOURCE. I. FORAGE INTAKE, ANIMAL PERFORMANCE, RUMINAL FERMENTATION, AND SITE OF DIGESTION IN HEIFERS FED MEDIUM-QUALITY HAY. [AGRIS-US9165287]

Twelve ruminally, duodenally, and ileally cannulated (average initial BW 313 +/- 20 kg) and 27 intact Hereford heifers (average initial BW 256 +/- 17 kg) were used in two experiments to evaluate dairy food wash water solids (WWS) as a protein source in medium-quality hay diets. Heifers received a basal diet of orchardgrass hay (7.4 percent CP) and were assigned to one of three supplement treatments: control (C;.9 percent CP), WWS (18.8 percent CP)-, and soybean meal (SBM 19.1 percent Cp)-based supplements (fed at 1.5 kg of DM/d). Supplements were formulated to have similar ME concentrations. Ruminal ammonia concentrations were greater (P .10) for WWS- and SBM-supplemented heifers than for C heifers at most sampling times. Moreover, WWS and SBM increased (P 0.10) total VFA (mM) and acetate (mol/100 mol) and lowered propionate (mol/100 mol) at several sampling times. Ruminal fluid volume (liters) was unchanged (P 0.10) by treatment; however, fluid dilution and flow rate (liters/h) were less (P 0.10) in C heifers than in heifers fed SBM or WWS supplements. Wash water solids and SBM supplementation increased (P 0.10) OM, NDF, and ADF digestibilities compared with C heifers. Feeding WWS and SBM supplements increased BW at 84 d (P 0.10) compared with C-supplemented heifers. Forage intake at 54 and 84 d by heifers supplemented with SBM or WWS was greater (P 0.10) than by C heifers. Control-supplemented heifers had the least, WWS intermediate, and SBM the greatest ADG at 84 d (P 0.10; 0.14 vs 0.35 vs 0.48 kg/d, respectively). These data indicate that WWS may be used as a protein source without serious adverse effects in heifers consuming medium-quality hay for 84 d. References. (Caton, J.S., North Dakota State Univ., Fargo; Williams, J.E., May, T., Beaver, E.E., Belyea, R.L., Journal of animal science (USA), (Aug 1991), v. 69(8) p. 3406-3415 [in English]. ISSN 0021-8812)

2163 EVALUATION OF DAIRY FOOD PROCESSING WASH WATER SOLIDS AS A PROTEIN SOURCE. II. MICROBIAL PROTEIN SYNTHESIS, DUODENAL NITROGEN FLOW, AND SMALL INTESTINAL AMINO ACID DISAPPEARANCE. [AGRIS-US9165288]

Twelve ruminally, duodenally, and ileally-cannulated Hereford heifers (average initial BW 313 +/- 20 kg) were used in a replicated experiment to evaluate dairy food processing wash water solids (WWS) as a protein source. Heifers were fed 2.8 kg of chopped (7.6 cm) hay and one of three supplements (1.5 kg/d, DM basis). Supplements were formulated to be similar in energy and contained 1.0 (control), 23.2 (WWS), and 21.6 percent (soybean meal; SBM) CP on an OM basis. Total N and nonammonia N entering the duodenum (g/d) were greater (P . 10) for heifers fed WWS and SBM supplements than for controls. Bacterial N flow (g/d) at the duodenum was less (P 0.10) for controls (43.9) than for WWS- (63.9) and SBM- (69.9) supplemented heifers. Feed escape N (g/d) was greater (P 0.10) for WWS-fed heifers than for those fed SBM (32.1 vs 20.7 g/d, respectively). Total tract N digestion (g/d) was greatest (P 0.10) for SBM, intermediate for WWS, and least for control heifers. Microbial protein synthesis (g/kg of OM intake) was enhanced (P 0.10) by WWS and SBM supplementation, but efficiency of synthesis (g/kg of OM fermented) did not differ among treatments. Essential amino acid (AA) disappearance in the small intestine (g/d) was less (P 0.10) for control than for the other two treatments. Nonessential AA disappearance was greatest (P 0.10) for the WWS and least (P 0.10) for the control treatment. Based on our short-term feeding data, WWS can be used as a protein source for ruminants, but N availability of WWS seems less than that of soybean meal. References. (Caton, J.S., North Dakota State Univ., Fargo; Williams, J.E., May, T., Belyea, R.L., Beaver, E.E., Tumbleson, M.E., Journal of animal science (USA), (Aug 1991), v. 69(8) p. 3416-3424 [in English]. ISSN 0021-8812)

2164 EVALUATION OF DAIRY FOOD PROCESSING WASH WATER SOLIDS AS A PROTEIN SOURCE. III. NITROGEN UTILIZATION BY HEIFERS FED MEDIUM-CONCENTRATE DIETS. [AGRIS-US9165289]
Eight multicannulated heifers (average BW 415 +/- 34 kg) were used in a replicated 4 X 4 Latin square to evaluate fluid milk processing wash water solids (WWS) as a dietary N source. Heifers were fed corn/cottonseed hull-based diets containing soybean meal (control, 0 percent WWS N) or WWS replacing soybean meal at 33, 67, or 100 percent of supplemental dietary N. Total tract and ruminal DM and OM digestibilities decreased linearly or cubically (P 0.05) as dietary WWS N increased. Total ruminal VFA concentration (P 0.05) and propionic acid molar proportion (P 0.10) were greater in heifers fed 0 vs 100 percent WWS N. Heifers fed 0 percent WWS N had the greatest (P 0.05) ruminal ammonia concentration at all sampling times. Dietary WWS did not affect (P 0.10) ruminal pH, fluid dilution rate, fluid flow, fluid volume, or turnover time. Total tract N digestibility decreased quadratically (P 0.10) with increasing WWS N in the diet. Supplemental WWS N did not affect (P 0.10) flow of duodenal ammonia N or bacterial N, or efficiency of microbial N synthesis. Diets containing WWS N resulted in a cubic increase (P 0.10) in duodenal flow of essential amino acids compared with 0 percent WWS N; however, there were no differences in small intestinal amino acid disappearance. Data indicate that WWS can replace 33 percent of the soybean meal N in a corn/cottonseed hull-based diet without decreasing ruminal fermentation, fluid digesta kinetics, microbial efficiency, or small intestinal amino acid utilization. References. (May, T., Univ. of Missouri, Columbia; Williams, J.E., Caton, J.S., Journal of animal science (USA), (Aug 1991), v. 69(8) p. 3425-3434 [in English]. ISSN 0021-8812)

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2167 ULTRAFILTRATION: A NEW ALTERNATIVE FOR THE MANAGEMENT OF REGENERANT WASTE STREAMS. [AGRIS-US9162463]
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Summary (French). (Gros, D., Agence de l'Eau Rhin-Meuse, Metz (France); Vasel, J.L., vander (eds) Borght, P., Traitement des effluents liquides industriels, Longwy (Belgium), 28-29 Mar 1991; Publisher: CEBEDOC (1991), p. 61-75 [in French]. ISBN 2-87080-020-7)

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In the production of ethanol from sugar cane molasses, large volumes of waste water containing very high concentrations of organics are generated. Both anaerobic and aerobic processes are available for treatment of this waste. Each process exhibits advantages and disadvantages. Anaerobic treatment has the advantage of low energy consumption and the production of biogas. The operation and performance of an upflow anaerobic sludge blanket reactor treating distillery waste under high loading rates is discussed. 2 ill., 1 table; 11 ref. Summary (English). (Butterfield, D.A., Thomas, S., West Indies Univ., St. Augustine (Trinidad and Tobago), Dept. of Chemical Engineering; 23. West Indies Sugar Technologists Conference, Bridgetown (Barbados), 18-22 Apr 1988; Publisher: Sugar Association of the Caribbean (1988), p. 207-211 [in English].)

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2180 DISTRIBUTIONS OF RESIDUAL SOIL PHOSPHORUS ALONG TRANSECTS FOR THREE DAIRIES IN OKEECHOBEE COUNTY, FLORIDA. [AGRIS-US9166786]
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2182 ANAEROBIC TOXICITY AND BIODEGRADATION OF SOME CHLORINATED AROMATIC COMPOUNDS IN INDUSTRIAL WASTEWATER (UPFLOW ANAEROBIC SLUDGE BLANKET (UASB) SYSTEM). [AGRIS-BE9200869]
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2190 COMPOSTING. [BIBL-TINF00636]
Composting is the aerobic biological degradation of organic waste matter, which can be used for reducing the bulk of household waste and slurries, with the advantage of producing a useful product and destroying many weeds and diseases. Succesful operation depends on many factors, including composition of the waste, moisture content, stacking, aeration and heating. Open heaps may be used, or closed systems of cell, drum or mutlifoor construction for a faster initial phase, followed by a maturing period in an open system. The method used depends on the type of waste to be treated, and additives may be necessary to adjust C/N ratio, dry matter content or porosity. Costs of capital investment, energy, labour and maintenance also depend on the system used. (A.M.M. Ansems; J. van Erkel; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 4-25 [in Dutch].)

2191 ELECTROLYTIC SEPARATION OF METALS. [BIBL-TINF00637]
Electrolytic separation can be used for the removal and concentration of metals, metalloids, and their compounds, from water, liquid waste and slurry waste. An electric current is passed through the waste material, causing electrochemical reactions at the electrodes. At the cathode, reduction of metal ions causes metallic deposition, with subsequent recovery of the metal possible. Reactor types include those with flat plate electrodes, those using electrodes with large specific surface used for low concentrations, and systems using ion exchange together with electrolysis, namely catiolysis and ionolysis apparatus. Main uses are in recovering metals from raw materials and in the surface treatment of metals, with some experiences of recycling metals from e.g. batteries, catalysts, and industrial wastes. (J. van Erkel; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 26-39 [in Dutch].)

2192 LEACHING WITH ACID, ALKALI, COMPLEXING AGENTS (DISSOLVING). [BIBL-TINF00638]
In this process impurities are transferred from solid to liquid phase by dissolving with water, acids, alkalis, complexing agents or oxidizing solvents. The impurity is then removed from the liquid by ion exchange, electrolysis, solvent extraction or precipitation. All inorganic, and some organic, components can be separated this way. Types of equipment include the percolation system using a column, the suspension system carried out in a stirred tank, and the pressure suspension system carried out in a stirred and heated autoclave. The effluent concentrations achievable depend on various factors, including concentration and reactivity of the reactant and availability of the impurity. The process is mainly used in the recovery of metals from ore, with examples also found in the treatment of waste from metal working industries and hydroxide sludge from purification installations. Leaching forms only one part of the whole waste treatment process. (H.J. Luggenhorst; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 40-62 [in Dutch].)

2193 SOLVENT EXTRACTION. [BIBL-TINF00639]
Solvent extraction is used for separating metals, metalloids and their compounds, and acids from water and liquid waste. An organic extractant is used to form a compound with the ion or metal-complex, which may be dissolved in an organic solvent. Acid, chelating, ionic or other dissolving extractant media may be used, depending on the type of reaction taking place. The extraction process involves extraction of the inorganic compound from the water into the organic phase, and the separation of the organic phase from water. This is followed by the regeneration of the used extractant and the separation of the regenerated organic phase from the regeneration fluid. Systems used are mixer-settler combinations, centrifugal extractors, and column extractors. Applications include extractions of metals such as copper or gold, and recovery of metals from industrial wastes, spent catalysts and batteries. (H.J. Luggenhorst; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 63-93 [in Dutch].)

2194 PRECIPITATION. [BIBL-TINF00640]
Precipitation is a method of separating and concentrating metals, metalloids and their compounds by chemical reaction with another substance to form an insoluble compound, which can then be removed by filtration or sedimentation. The process can involve either ionic or reduction precipitation. Areas of use include water purification installations, the treatment of waste water from metal and surface treatment industries, and the recovery of valuable components from waste. The process is straightforward to operate, with parameters and costs dependent on the techniques and substances involved. (H.J. Luggenhorst; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 94-120 [in Dutch].)

2195 IMMOBILISATION. [BIBL-TINF00641]
Immobilisation makes use of physical and chemical processes to solidify waste products to enable either dumping or reuse of the waste. Chemical stabilisation may be necessary to reduce the solubility of (heavy) metal ions, or to neutralize and/or reduce toxicity of other impurites. This is followed by physical confinement in crystalline, polymer or bituminous matrices. Soil, slurry and liquid waste, containing metals and metalloid compounds, and inorganic salts, acids and bases, with concentrations too low to be otherwise recovered, can thus be treated. In-drum, in-plant and in-situ processing may be used. A variety of applications are found in industry and water purification, with costs and additives varying according to the type of waste treated. Generally a low-complexity process. (E. Mulder; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 121-145 [in Dutch].)

2196 GRINDING/SIZE REDUCTION. [BIBL-TINF00642]
Reduction in the particle size of solid waste by grinding or crushing is generally carried out to enable further processing, or to lower transport costs by reducing the volume of waste. The choice of equipment depends on the type and dimensions of the material, and the final particle size required. Equipment may operate in any of four ways: crushing; bombardment with solid matter; grinding by free objects; and cutting. Wet or dry material may be used, and cryogrinding offers certain advantages, though at higher cost. The composition of the material is unchanged, but the process increases the potential for chemical and biological activity by increasing the surface area. Selective reduction is possible with cryogrinding. Applications are found in the treatment of solid waste from building and demolition, car breaking, plastics, household and hospital waste, packaging, wood and tires. (J.J.D. van der Steen; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 146-173 [in Dutch].)

2197 THERMAL TECHNIQUES FOR WASTE PROCESSING - PYROLYSIS. [BIBL-TINF00643]
Pyrolysis is the thermal treatment of organic waste, whereby as temperature is increased evaporation of water and organic matter takes place, and higher hydrocarbons are split into lower hydrocarbons. As the pyrolysis temperature rises different substances are released, and separated by filtering or condensation. The remaining pyrolysis gas can be used as fuel, or emitted, if necessary following purification. Four types of reactor are available: shaft reactor, rotary drum reactor and fluidized bed processes are continuous, while autoclaves are used in batch processes. The choice of reactor depends on the type and amount of waste to be treated. Applications are found in the treatment of organic components of household, industrial, agricultural and hospital waste, tires and plastics. (H. Bartelds; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 174-205 [in Dutch].)

* Source: Joziasse, J. and Wiering, A.C.F., "Monografieën Informatiesysteem Technieken Compartiment rep. Afvalstoffen, Water, Bodem en Lucht", RIVM, Bilthoven, The Netherlands

2198 THERMAL TECHNIQUES FOR WASTE PROCESSING (ROTARY DRUM KILNS). [BIBL-TINF00644]
Thermal processing in a rotary kiln is used for the treatment of polluted soil, sludge or slurry, and liquid waste, mainly from industrial sources, and containing toxic, harmful or unusable chemicals. As the temperature rises, evaporation of water and organic matter take place. Organic matter and solid carbon are burnt in the rotary kin and the post-combustion chamber. The non-combustible components (sand, ash, slag) remain in solid form. Any harmful components formed are treated, as is combustion gas if necessary. Other emissions are below acceptable limits. The operation and performance of this method are described, with reference to the AVR-Chemie installation at Rijnmond. (H. Bartelds; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 206-238 [in Dutch].)

2199 DRYING. [BIBL-TINF00645]
At present the only application for drying is in the treatment of paper and plastic foil recovered from household waste. A stream of air is heated, directly or indirectly, and passed through the material at a temperature of up to 400 °C in a convection dryer. The material may be moved in the dryer by various means and at various directions to the air current. The closed-wall drum is generally used for paper drying, while the belt dryer is most suitable for plastic waste. After drying, separation of smaller paper particles or dust may be necessary if paper recycling is desired. Dried material may be used as refuse-derived fuel. (J.C. Pisa; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 239-253 [in Dutch].)

2200 DISTILLATION. [BIBL-TINF00646]
Distillation is a process of separating liquids into various components according to their boiling points or volatility. It can be used for the separation, concentration and/or recovery of organic compounds from liquid waste and waste water. With the application of heat, the component with lowest boiling point is evaporated and the less volatile component is concentrated in the liquid phase. Two or more components can be thus separated, with the separation efficiency depending on the differences between their boiling points. Single trap systems are the simplest processing form, but multi-trap or rectifying systems can produce a purer product. Steam stripping is often used in the separation of low concentration liquid organic components from waste water. Additives are required only in extractive or azeotropic distillation. Uses in water treatment include the separation of halogenated hydrocarbons, non-chlorinated solvents, and oils. (H.J. Luggenhorst; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 254-276 [in Dutch].)

2201 SIEVING OF WASTE MATTER (DRY). [BIBL-TINF00647]
Sieving is a method of classifying waste by particle size in order to remove impurities, separate fractions for further processing, and reduce volume of waste. The waste must be solid and dry, some moisture content is permitted. Suitable material includes household, construction, shredder and industrial wastes, wood and combustion residue. The capacity and performance of the operation depends on the type of material, particle size, and type of equipment. Equipment types include drum, rod and flat sieves, and ballistic separators, with mesh sizes usually between 0.5 mm and 0.5 m. Particles are separated as they move across the mesh, the separation probability depending on the mesh size and particle diameter. Several sections with different mesh sizes may be used to separate different components from the waste. (F.G. Esmeijer; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101005, 1, 277-300 [in Dutch].)

2202 HYDROCYCLONES. [BIBL-TINF00648]
Hydroclones are used to separate suspended matter from a liquid by means of centrifugal force. As the liquid enters tangentially, heavier particles gravitate downwards while the liquid and finer particles move upwards. Types of equipment include conical and cyclindrical hydrocyclones, Linatex separator, Lakos separator, and air-sparges cyclone. Performance and costs depend on the desired separation diameter and capacity. Applications include sand extraction, clay working, uses in the processing and food industries, extractive purification, and processing of sewage sludge and dredged sludge. (H.J. van Veen; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101006, 2, 4-18 [in Dutch].)

2203 SIEVING OF SOIL. [BIBL-TINF00649]
Sieving is a physical separation process, whereby particles larger than the mesh diameter are removed from the input matter. The process may be carried out with wet or dry matter, wet sieving being more efficient. Reasons include the removal of large particles which cannot be processed, cause blockages, or require different treatment, the separation of strongly polluted particles such as oil-contaminated sand, and achieving desired product quality. Depending on particle size, grid, rod, drum or flat sieves may be used, often accompanied by vibration or oscillation. Fluid sieving of slurry, with a high solids concentration, is usually carried out in a curved sieve, with the relatively dry residue being removed by gravity as the grooved mesh is about 90° to slurry flow. (J.W. Assink; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101006, 2, 20-45 [in Dutch].)

2204 PROCESS-MODERATED EXTRACTIVE SOIL PURIFICATION. [BIBL-TINF00650]
In sandy soil, and sand containing loam or peat, impurities usually are more strongly absorbed in the fine and organic fraction. These particles are separated firstly by sieving with increasingly fine meshes until particle sizes of less than 10 mm diameter remain. This fraction is then thoroughly mixed with the extraction agent, usually water with added chemicals such as NaOH, soaps, or $FeCl_3$. Separation from the extraction agent of particles larger than 0.030 - 0.050 mm diameter takes place by sedimentation or hydrocylcone. The extraction agent can be purified and reused. Types of installation include the high-pressure water jet system, used for removing for example oil, heavy metals, organochloride compounds and cyanide; thermocoil installation for removing fuel oil from coastal sand; alkali and acid extraction processes. (M. Hinsenveld; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101006, 2, 46-78 [in Dutch].)

2205 FLOTATION OF CONTAMINATED SOIL. [BIBL-TINF00651]
Flotation is good method of separating particles according to surface properties, whereby certain particles are adsorbed by air bubbles, forming a foam which can then be removed. There are many types of flotation techniques, differing in the method of air-bubble formation, method of particle formation, and type of material used. The soil is mixed with water to form a slurry with 20-30% dry matter content. Chemicals are added to change surface properties so that the impurities are preferentially adsorbed by air. Air bubbles are passed through the mixture, which the polluted particles adhere to, forming a foam. Types of equipment include the Denver, Fagergren and Agiter flotation cells. Impurities removed include lead, copper, cyanide, certain aromatic compounds, polycyclic hydrocarbons, chlorinated hydrocarbons and oils. (M. Hinsveld; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101006, 2, 79111 [in Dutch].)

2206 THERMAL TREATMENT OF SOILS IN INCINERATORS. [BIBL-TINF00652]
Thermal treatment is used to remove complex cyanides, and organic components such as oils, aromatic hydrocarbons, polycyclic aromatic hydrocarbons, phenols and alkylised benzines from soil contaminated by spillage or waste. The soil is heated to 300-700 °C, causing the evaporation of these contaminants. The vapour is removed and treated in a post-combustion chamber, producing CO_2, and H_2O. HCl, SO_2 and other toxic gases may be produced, according to the composition of the contaminants. In the Netherlands, rotary drum kilns with direct, indirect or combined direct and indirect heating of the soil are used. A fluidised bed kiln is under test in pilot plant. Applications include the cleaning of soil from around gas works, petrol stations, chemicals and pharmaceutical industries, and pesticide-con-

taminated land. (M. Hinsveld; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101006, 2, 112-137 [in Dutch].)

2207 SECONDARY COMBUSTION OF FLUE GAS IN SOIL DECONTAMINATION. [BIBL-TINF00653]
Gas produced by the thermal treatment of contaminated soil often contains unacceptable levels of toxic substances such as aliphatic compounds, aromatic compounds, polycyclic hydrocarbons and chlorinated compounds. In principle, any substance that will react with oxygen at 700-1200 °C to produce CO_2 and H_2O and other harmless products can be treated in this way. The gas, fuel and air are mixed together in the combustion chamber, heated to ignition point, and combustion takes place at 700 °C for non-chlorinated substances, and 1200 °C or higher for less easily degradable compounds. If toxic substances such as SO_2, NO_x, HCl, etc. are produced they must be removed in a gas scrubber, enabling removal rates of 99.9999% to be achieved. (H. Bartelds; M. Hisenveld; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM) ; Publisher: TNO (July 1990), 736101006, 2, 138-164 [in Dutch].)

2208 STEAM STRIPPING. [BIBL-TINF00654]
Steam stripping of contaminated soil is as yet at the development stage. Steam is generated in a boiler to a temperature of 130 - 250 °C, and passed across the contaminated soil, either in-situ or ex-situ. Pollutants which are volatile at this temperature vaporise and are carried out with steam. This discharge is then condensed to separate the pollutants from the steam. The impurities are mainly organic, plus some inorganic substances with sufficiently high vapour pressure. Impurities can be present in soil as a separate liquid phase, adsorbed as solid particles, or dissolved in a liquid, usually water. Horizontal or vertical stripping techniques are possible. In tests, impurities including aromatic compounds, monobromium alkanes, benzine perchloroethylene and kerosine have bee n removed from soils with up to 99% efficiency. (J.W. Assink; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101006, 2, 165-191 [in Dutch].)

2209 SUPERCRITICAL OXIDATION. [BIBL-TINF00655]
Chemical waste water containing organic impurities is preheated to more than 400 °C in a heat exchanger before entering a high-pressure reactor. Air/oxygen and fuel are added, and oxidation takes place, the temperature rising to 500-700 °C through the heat of reaction. Some of the waste stream is returned to the heat exchanger. Organic impurities are oxidised to form H_2O, CO_2 and other substances. Inorganic salts and oxides are deposited as salts. Gas and water effluent are cooled and separated, and the water returned to the reactor. Supercritical oxidation is at present only at the pilot plant stage, with experiments carried out on waste containing PCBs, chlorinated hydrocarbons, aliphatic compounds, halogenated (aromatic) hydrocarbons, dioxins, nitrotoluene, etc. In principle all organic compounds can be oxidised. (G.J. van de Leur; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101006, 2, 192-206 [in Dutch].)

2210 FLUIDIZED BED INCINERATORS. [BIBL-TINF00656]
A fluidized bed is formed by passing air through a bed of solid particles such as soil or sand. The waste stream, comprising household waste, contaminated soil, or sludge, pretreated if necessary by sieving and removing unsuitable material such as metals, is fed into the incinerator and fluidized. Fuel (gas or oil) is added if required to raise the temperature to 700-900 °C, at which combustion of organic compounds to H_2O and CO_2takes place and volatile components are evaporated. The emitted gas is passed through a cyclone to remove solid matter, which may be returned to the bed. Gases are cooled, filtered and scrubbed to remove impurities before emission. Types of equipment include stationary, rotary, circulating and turbo fluidized beds, the latter comprising fluid bed and afterburner. Impurities are mainly organic, and emissions are within acceptable limits. (M. Hinsveld; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101006, 2, 207-224 [in Dutch].)

2211 PLASMA TECHNOLOGIES. [BIBL-TINF00657]
Plasma is generated in a plasma torch by causing a voltage arc in a carrier gas, usually hydrogen, oxygen or nitrogen. When the plasma comes into contact with cold material in the reaction chamber very high temperatures are generated. The plasma can be directed onto solid waste or mixed with gas or liquid waste via a venturi tube. The free plasma reaches 3000-5000 °C, and in the reactor temperatures of 1200-1659 °C are achieved. Organic waste compounds, mainly chlorinated, are broken down, and heavy metals can be immobilised in a matrix during pyrolysis. Applications include the treatment of liquid waste containing PCBs, and recovery of heavy metals from fly ash and iron works. The manufacture of refuse-derived fuel is a potential application. Various systems are available, including the plasmadust system from SKF, centrifugal reactor from Retech, and systems from Arc Technologies, Westinghouse Plasma Systems, and Resorption Canada Ltd. (M. Hinsveld; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101006, 2, 225-244 [in Dutch].)

2212 HYDROTHERMAL DECOMPOSITION. [BIBL-TINF00658]
Chlorinated organic compounds react with hydrogen at about 800 °C and 30-80 bar to form HCl and simple gases such as methane and ethane. Pure hydrogen, a mixture of hydrogen and inert gas, or syngas, may be used. The technique is still under development, and only liquids have been used. In theory, solid waste auch as soil and sludge can be processed using a fluidized bed process. If waste has a high content of organochloride components, the gases produced can be reused as fuel, and the HCl also recovered. The production of HCl can be prevented by the addition of calcium to the reactor. Removal rates of up to 99.999999% have been achieved. (M. Hinsenveld; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101006, 2, 245-254 [in Dutch].)

2213 PARTICLE SEPARATION TECHNOLOGIES. [BIBL-TINF00659]
Gravitative separation techniques can be used to remove particles with a high concentration of impurities, provided that a significant difference in density exists between contaminated and uncontaminated particles. The waste stream (soil or mineral) is brought into suspension with water and agitated using one of a variety of techniques — jig, shaking table, spiral, tilting frame, Vanner or Bartles-Mozley separation. Heavier particles sink and can be separated. If necessary, waste is pretreated to remove large particles by sieving, and the process can be combined with extraction or flotation. For soil treatment only the jig technique, combined with flotation, is used, other methods being used for separating minerals from ore. Impurities such as heavy metals and organic compounds can be removed. (E. Groenendijk; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101006, 2, 255-281 [in Dutch].)

2214 EXTRACTION WITH COMPLEXES. [BIBL-TINF00660]
Extraction with complexones can be used for separating heavy metals such as lead, cadmium, mercury, zinc, copper, nickel and arsenic, from soils and water beds, but is at present only at the development stage. The contaminated material is flushed through with the extraction agent, usually 5m% EDTA in water, in a heap leaching process or by vertical rinsing in a basin. The process continues until impurities are at an acceptable concentration. The extraction agent is purified by neutralization and electrolysis, and then reused. Fine particles (less then 0.050 mm) need pretreatment by coagulation and flocculation to form aggregated flakes. Removal rates of 50 - 80% are achieved, or higher in optimum situations. (M. Hinsveld; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101006, 2, 311-327 [in Dutch].)

2215 ELECTRO-RECLAMATION. [BIBL-TINF00661]
The process of electro-reclamation involves the transfer of charged particles in an electric field, by means of electro-osmosis, electro-phoresis or electrolysis. The electrokinetic installation consists of a series of electrodes, contained in casings together with a conditioned solution. The electrically

charged particles are transferred to this solution, which is removed and separated into a purified electrode fluid and residue. The electrode fluid is reconditioned and reused. This method can be used for in-situ treatment of soils, sand containing peat or sludge, and sludges, with possibilities also for the treatment of ground water and industrial wastes. Impurities must be electrically charged components, such as ions, ion complexes, colloidal particles, clay particles, etc. Separation of copper, lead, cadmium, nickel, zinc, etc., in the form of a metal hydroxide deposition has been successful. The separation of organic impurities eg. PCBs by dielectrophoresis is under investigation. (G.J. van de Leur; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research ; Publisher: TNO (July 1990), 2, 328-344 [in Dutch].)

2216 ACTIVATED CARBON ADSORPTION IN AIR PURIFICATION. [BIBL-TINF00662]

A polluted gas stream is passed through adsorbers with actived carbon grains in a fixed or moving bed, or fibres. The impurities are adsorbed by the activated carbon until a saturation point is reached, whereupon the carbon is either replaced, or regenerated. If regeneration is required, particularly if used for the recovery of volatile organic substances, desorption using steam, hot inert gas, or vacuum, is followed by condensation, drying and cooling. The main areas of use are in the removal of odorous components from chemicals, foodstuff and other industries, and the recovery of volatile organic substances from a variety of chemical processes. (H.J.G. Kok; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101007, 3, 19-43 [in Dutch].)

2217 FLUE GAS SCRUBBING. [BIBL-TINF00663]

Flue gases produced from incineration processes are, after cooling, passed through water, whereupon the impurities are absorbed to form a solution or suspension in the water. Chemicals such as $CaCO_3$ and CaO or $Ca(OH)_2$ may be added to neutralize the acid impurities. The main areas of use are in desulphurization of emissions from coal-fired power stations, and treatment of gases from household, chemical and industrial wastes installations. Impurities removed include acids, SO_2, HCl, HF and NO_x. In some processes, namely the Walther, Wellman-Lord and magnesium-oxide processes, the added chemicals can be regenerated and reused. The most widely used limestone or calcium process is not regenerable. (D. Schmal; A.C.P. Ligtvoet; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 763101007, 3, 44-62 [in Dutch].)

2218 GAS SCRUBBING. [BIBL-TINF00664]

Gas scrubbing is used in the removal of impurities such as organic substances, SO_2, NO_x, HCl, HF, NH_3, Cl_2 and H_2S from waste gases. It may be used as a pre-cleaning stage, removing impurities which cause problems in other methods. The impurity is dissolved or absorbed into a suitable fluid, which may be water or an organic liquid. If the impurity has limited solubility, chemicals are added either to improve solubility or to react with the impurity (chemical scrubbing). The contaminated scrubbing liquid is treated by thermal desorption, rectification, pressure reduction or stripping to separate the impurity, and can then be reused. Applications are found in the treatment of emissions from the chemical, mining, paper, fertilizer, food, leisure and metalworking industries, in laboratories and incinerators (incineration). (H.J.G. Kok; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101007, 3, 63-88 [in Dutch].)

2219 THERMAL AFTERBURNING. [BIBL-TINF00665]

Organic contaminants, H_2S, CO, NH_3, COS, CS_2, H_2, HCN and other gaseous components react with oxygen at high temperatures (600-2000 °C) to form CO_2, H_2O and other products. Waste gases from industrial processes enter the afterburner at less than 300 °C, are preheated in a heat exchanger to about 500 °C, then enter the combustion chamber where temperatures of 600-1200 °C are reached and oxidation of impurities take place. The flue gas is passed out via the heat exchanger to preheat incoming gas. Treatment of the flue gas is necessary before emission as excessive amounts of contaminants often still remain. Areas of use include the chemical and petrochemical industries, treatment of household and industrial wastes soil decontamination etc. (H.J.G. Kok; H. Bartelds; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101007, 3, 89-118 [in Dutch].)

2220 CATALYTIC AFTERBURNING. [BIBL-TINF00666]

Harmful components in waste gases are oxidised in a combustion chamber using a catalyst to improve efficiency. The gas is preheated in a heat exchanger before passing through a catalytic material at about 300-600 °C. The contaminants are adsorbed by the catalyst and oxidised, the catalyst surface then being available for further adsorption. Active catalysts components are metals from the platinum series and oxides of less inert metals, catalysts remaining active for about 2-5 years. The process is suitable for gases with low impurity concentrations, containing organic compounds, CO, H_2S, CS_2, and other harmful gases. Applications include the treatment of gases from solvent processing, chemical, food and leisure industries, sludge processing in purification plants, desulphurisation works, combustion engines and incinerators. (H.J.G Kok; H. Bartelds; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101007, 3, 119-137 [in Dutch].)

2221 FABRIC FILTRATION. [BIBL-TINF00667]

As gas is passed through a filter of woven or felt-like fabric, solid particles of diameter 0.01 μm become trapped due to the tendency of particles to adhere to the fabric or to other trapped particles. Envelope, cassette or tube-type filters are used. The particles are then removed from the filter using a shaker mechanism, reverse air cleaning or pulse/jet cleaning. In many cases the recovered material can be reused. For particles greater than 50 μm or concentrations greater than 50 g/m^3 mechanical pre-treatment in sediment chambers and/or gas cyclones is necessary. Filter materials include polypropylene, cotton,wool, polyamide, polyacrylonitrile, polyester, aramide, PTFE and fibreglass, the choice depending on the physical and chemical properties of the gas stream and the particles. Sticky, hygroscopic, strongly agglomerated or small particles may cause filter blockage. (H.J.G. Kok; J. de Koning; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101007, 3, 138-159 [in Dutch].)

2222 BIOFILTRATION. [BIBL-TINF00668]

Gas containing biodegradable components such as organic contaminants, H_2S, NH_2, CS_2 and odors, is passed through a filter consisting of biologically active material, e.g. compost or turf, sometimes mixed with a coarser, inert fraction such as bark, heather, plastics, lava etc. The naturally-occurring microorganisms in the filter material cause aerobic conversion of the impurities to (primarily) CO_2, H_2O and inorganic salts. In some cases additives may be necessary to start or maintain the process. A constant flow of gas must be maintained, together with a temperature between 10-40 °C. A biofilter usually consists of a pressure/distribution chamber topped by a layer of filter material usually 1 m high. Emissions rates vary widely according to the type of impurity, and filter design. (D.C. Heslinga; S.P.P. Ottengraf; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101007, 3, 160-176 [in Dutch].)

2223 BIOSCRUBBING. [BIBL-TINF00669]

Gases containing biodegradable impurities such as organic compounds, NH_3 and odour components, are passed through water in a scrubbing column. The impurities are broken down to non-polluting substances (primarily CO_2 and H_2O) by microorganisms contained either in the column (trickling filters) or in a separate reservoir (activated sludge installation). The microorganisms are added in sludge from an existing system or in specially bred cultures. Nutrient are added to the water, and sludge is produced by the process, some of which must be removed as a waste stream. Pre-treatment may be necessary to raise or lower the gas temperature to 10-40 °C, and to remove dry particles which can cause blockages. Development is at the pilot plant and laboratory stages, with application mainly in odour-producing industries. (D.C. Heslin-

ga; S.P.P. Ottengraf; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1992), 736101007, 3, 177-189 [in Dutch].)

2224 DRY FLUE GAS PURIFICATION BY MEANS OF CHEMICAL CONVERSION. [BIBL-TINF00670]

Acidic components in flue gases, such as SO_2, HCl, HF and NO_x, are neutralized in chemical reactions with basic additives, usually based on CaO, Al, Na, K, Mg, or NH_3, to form salts which are removed by particle separation techniques. The gas is passed through a reactor, which may be integrated into a combustion process, or treated as a secondary process in a separate reactor. For the selective catalytic reduction of NO_x with NH_3 to produce N_2 and H_2O, and oxidation of SO_2 to SO_3, the catalyst, usually an oxide of vanadium or tungsten, is mounted on a titanium carrier. Applications are found in fluidized bed combustion of coal, waste incineration, coal fired power stations, and glass, brick and aluminium works. (D. Schmal; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101007, 3, 190-207 [in Dutch].)

2225 ELECTROFILTRATION. [BIBL-TINF00671]

A voltage of 20-115 kV is created between negatively charged discharge electrodes and earthed collector electrodes. As gas is passed over the electrodes a negative charge is induced in solid and liquid particulate matter, which are drawn to earthed collectors and deposited. In dry filters this deposit must be regularly removed by rapping the collectors. Wet filters are used for separating liquid or moist particles. A variant is the two-stage electrofilter where the first stage discharge electrodes have a high positive charge, limiting ozone formation. The collector electrodes in the second stage are earthed and capture the positively charged particles. The technique is widely used in the treatment of industrial waste gases, in power stations for flue gas decontamination, and in air purification in workplaces. (H.J.G. Kok; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101007, 3, 208-225 [in Dutch].)

2226 SELECTIVE CATALYTIC REDUCTION (FOR NO_x CONTROL IN COMBUSTION PROCESSES). [BIBL-TINF00672]

Flue gas from combustion processes, particulary in power stations and waste incineration processes, contains a high level of nitrogen oxides (NO and NO_2). Unlike other reducing agents, ammonia reacts selectively with NO/NO_2, rather than with O_2, as follows: $4NO + 4NH_3 + O_2 -> 4N_2 + 6H_2O$; $6NO_2 + 8NH_3 -> 7N_2 + 12\,H_2O$. Using a metal oxide catalyst, e.g. vanadium pentoxide, tungsten trioxide, deposited in a thin (sometimes monomolecular) layer on a ceramic or titanium dioxide carrier, the reaction takes place at temperatures of 250-400 °C. The flue gas, with reagent (usually 25% solution of ammonia) is passed through the reactor, purified gas being emitted via a chimney. The catalyst may be positioned in the boilers before the E-filter (high-dust system), after the E-filter (low-dust system) or as the final component in the decontamination process (tail-end system). The process is widely used in power stations, with waste incineration plants in early stages of use. (M. Schipper-Zablotskaja; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101007, 3, 226-246 [in Dutch].)

2227 SOLID ION EXCHANGERS. [BIBL-TINF00673]

An ion exchanger consists of solid material (usually synthetic), able to combine more or less strongly with ions. Solid, charged groups are bonded to the base material, with the strong electrochemical bonding forces causing ions to be exchanged. After the ions from waste water have been exchanged with those from the ion exchanger, the process fluid is rinsed out with water, and the ion exchanger regenerated by rinsing with regeneration fluid. This is then removed. Anion exchangers are used for negatively charged, and cation exchangers for positively charged ions. A further type is the chelating ion exchanger. Ion exchangers vary according to acid/alkali behaviour, grain form, carrier material and capacity. Types of equipment include fluid bed, packed bed and moving bed systems. Applications are found in the removal and recovery of metallic and other ions in industrial processes, and the purification of industrial waste water. (W.F.J.M. Engelhard; TNO Environmental and Energy Research, National Institute of Public Health and Environmental Hygiene (RIVM); Publisher: TNO (July 1990), 736101008, 4, 4-20 [in Dutch].)

2228 SEDIMENTATION UNDER THE INFLUENCE OF GRAVITY. [BIBL-TINF00674]

Solid particles are separated from a liquid in a gravitional field, according to the difference in density or volumic mass between particles and liquid, or mutually between particles. Separation takes place in a clarifier, and particles may be concentrated in a thickener, performance depending on the type of impurity, hydrodynamics, fluid properties, and equipment design. Flocculants may be added to improve the sedimentation properties of smaller particles. Applications include the purification of household and industrial wastes (sometimes as a pre-treatment process), and various industrial processes, such as treatment of iron ore, potatoes waste, and the washing and classification of waste in the paper industry. (M. Hinsveld; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 21-42 [in Dutch].)

2229 ADSORPTION. [BIBL-TINF00675]

Organic (micro) impurities dissolved in waste water are adsorbed and concentrated on the surface of an adsorbant in granular or powder form. Some inorganic impurities and low concentration of emulsified matter can also be removed. Activated carbon is the most commonly used adsorbant, with resins used to a lesser extent. Regeneration of the adsorbant is often possible, by thermal, steam, chemicals or solvent means. Types of equipment vary according to the method of bringing the waste water into contact with the adsorbant. This may be mixing, or by passing through a packed bed, pulsed bed or fluidized bed adsorber. Applications include purification of waste-, drinking-, and ground-water. Resin adsorbers are used in the petrochemical industry, for recovering materials such as phenols from process and waste water. (G.J. Annokkee; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 43-67 [in Dutch].)

2230 ULTRAFILTRATION/MICROFILTRATION. [BIBL-TINF00676]

A waste water stream containing colloidal or suspended particles is passed across a semipermeable membrane, driven by a pressure difference of 0.1 - 10 bar. The stream is separated into a relatively small, highly concentrated stream, and a large purified stream. The purified water, and in some cases the concentrated components, may be reused. Membrane materials include various organic materials, also sintered metals, ceramics, glass and carbon, in tube, capillary and hollow fibre, flat or spiral-wound mebrane systems. Cross-flow filtration is the most usual operational design. The major problem is membrane fouling, which is influenced by concentration polarisation. Applications include purification of industrial waste water, used in the food, textiles, paper, electronics, pharmaceutical industry and other industries, the treatment of oil-contaminated water, separation of heavy metals, and electrophoretic deposition. (W.G.J.M. van Tongeren; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 68-93 [in Dutch].)

2231 REVERSE OSMOSIS. [BIBL-TINF00677]

Reverse osmosis is a filtration process whereby separation takes place across a semipermeable membrane which allows water to pass through while retaining dissolved components. Membrane materials include cellulose-acetate, polyamide and other polymers. A pressure of 20-100 bar across the membrane provides the driving force. Membrane fouling is the biggest problem, caused by deposits of impurities. This can be alleviated by pre-treatment to remove impurities, using high-cross flow speeds, or causing turbulence. Impurities such as heavy metals, salts, acids, bases and organic substances can be removed from waste water, often to be reused. Applications include desalination of drinking water, purification of wastewater from the food, metal finishing, paper, textiles, and petrochemical industries, and

the purification of percolation water from rubbish dumps. (W.G.J.M. van Tongeren; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 73610100, 4, 94-117 [in Dutch].)

2232 FLOTATION/FOAM SEPARATION. [BIBL-TINF00678]
Flotation is used for separating dissolved or suspended particles from waste water by passing air bubbles through the water. Particles which are surface-active, or modified to such by using additives, adhere preferentially to the air bubbles and rise to form a layer of foam on the surface. This is then removed. Depending on the type and size of impurities, methods include foam fractionation, foam flotation, ion flotation, molecular flotation, microflotation, and precipitation flotation. Additives such as collectors (to make impurities more hydrophobic), modifiers (to influence selectivity, speed, etc), and foam formers, may be necessary. Applications are found in many industries, including refining, food, metals, glass, paper, paint, chemicals, cosmetics, textiles and brewing, as well as in activated sludge processing. (J.W. Assink; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 118-149 [in Dutch].)

2233 CARVER-GREENFIELD DRYING PROCESS. [BIBL-TINF00679]
This is a multi-step vacuum evaporation process in which a carrier oil is added to the waste sludge suspension before the first evaporation stage, with a ratio of oil:dry matter of 5-10:1. This increases the viscosity so that continuous pumping and heat transfer is possible. When the drying process is complete, the oil is separated by centrifuge and steam stripping and may be recirculated. The final vapour is condensed, leaving an end product with dry content ca. 98%. Normally three or four evaporation steps are used, and energy consumption is significantly lower than conventional drying systems. Applications include processing of animal wastes, sewerage, and industrial sludge. In principle any type of non-volatile, thermally stable impurity may be concentrated. (F. van Voorneburg; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 150-172 [in Dutch].)

2234 PELLET REACTOR. [BIBL-TINF00680]
A cyclindrical vessel is half-filled with pelleted material such as sand. Waste water is passed through at a rate of 40-125 m/h, bringing the pellets into a fluidized state. Dissolved impurities in the water are crystallized onto the pellets, which sink as they increase in size, and are removed periodically. Purified water is discharged at the top. Chemicals may be added in solution at the bottom of the reactor to assist the precipitation process. In some cases the removed pellets can be regenerated by dissolving the precipitated crystals, and reused in the reactor. The most widely used application is in the softening of drinking water (crystallization of $CaCO_3$). Other uses include dephosphating of sewerage treatment waste water, and removal of heavy metals from industrial waste water. (W.G.J.M. van Tongeren; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 173-191 [in Dutch].)

2235 CHEMICAL OXIDATION. [BIBL-TINF00681]
Chemical oxidation takes place in a simple dosing and mixing operation. The waste water or gas is mixed with an oxidising agent, usually chlorine bleach, hydrogen peroxide (with iron catalyst), or ozone (with UV catalyst). Organic impurities are oxidized to H_2O, CO_2 and sometimes salts, cyanides to CO_2 and N_2, often in several steps. Dosing and mixing methods depend on whether waste streams and oxidation agents are in gaseous or liquid states. Oxidation with ozone (oxyphotolysis) requires in-situ production of ozone, either in an electric field or using UV. Available systems Fotozone and UVOX both use UV as a catalyst. Applications include purification of industrial waste water, e.g. removal of cyanides and phenols, and gas scrubbing to remove odour components. (H.J. van Veen; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 192-208 [in Dutch].)

2236 FREEZE CONCENTRATION. [BIBL-TINF00682]
Waste water containing dissolved impurities is cooled by direct or indirect methods so that ice crystals are formed. Crystallization takes place in stages in a number of sections, often in a counter current cascade system. The crystals in each section are removed to the previous section while the liquid is moved to a subsequent section. Separation of the crystals is carried out in a solid-liquid separation system, the wash column being particularly suitable. After separation the crystals are melted and emitted as pure water, leaving the concentrated waste stream. Relatively concentrated waste streams can be treated, provided that the concentration of dissolved matter is lower than that at the eutectic point. Various systems have been developed, but the technique is still at the pilot plant stage. Possible applications include the treatment of drinking water and industrial waste water. (G.J. Arkenbout; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 209-226 [in Dutch].)

2237 PERVAPORATION. [BIBL-TINF00683]
Pervaporation is a membrane separation technique suitable for the treatment of water containing relatively volatile impurities. The input side of the membrane is in the liquid phase, the permeate side in the vapour phase. Only a small amount of water passes through with the impurity, the driving force being caused by temperature difference, inert gas, or vacuum. The waste stream is separated into purified water and a concentrated waste, which can further be processed. Pretreatment of the waste water (filtration) may be necessary to remove suspended or colloidal particles which cause membrane fouling. The type of membrane used depends on the applications. The technique is still under development, separation of water from alcohols being the best developed application at present. Other possible uses include separation of organic liquid mixtures, and the separation of organic matter from water, as in water purification processes, or from gaseous waste. (J. Joziasse; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 227-256 [in Dutch].)

2238 ELECTRODIALYSIS. [BIBL-TINF00684]
Electrodialysis is a membrane process whereby ions are separated from a waste stream in an electric field. Between two electrodes a number of membranes are arranged, alternately cation-selective and anion-selective. 100-600 pairs of membranes, with 0.5-1 mm spacers form a unit, or stack, and several stacks may be connected in parallel or series. Membranes are usually copolymers of styrene and devinyl benzene, with charged groups such as sulphonates and quaternary ammonium compounds attached. Pretreatment of the waste stream may be necessary to remove particles which cause membrane fouling. Many systems operate with regular polarity reversal (EDR or Electrodialysis Reversal), which helps to prevent deposition on the membranes. The main uses of electrodialysis are in the production of salt from sea water, and the preparation of drinking water from brackish water. Others include the recovery of metals from waste water in the finishing industry, and uses in the food industry. (W.G.J.M. van Tongeren; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, p257-275 [in Dutch].)

2239 WET AIR OXIDATION. [BIBL-TINF00685]
A waste stream (water, soil, sludge or slurry) is passed, together with air, air enriched with oxygen, or pure oxygen, through a heat exchanger. The waste/gas mixture enters the reactor at ca. 240-340 °C and under high pressure. Organic substances are broken down by hydrolysis, pyrolysis and (partial) oxidation. Certain inorganic compounds e.g. cyanides, sulphides and ammonia may also be destroyed. Effluent is passed back through the heat exchanger, and treated by biological, physical and chemical means. Output gas is treated to remove volatile organic compounds and ammonia. Reactor types include above-ground bubble column, with or without packed catalyst bed, horizontal cascade reactor, underground and above ground pipe reactors, and internal ciculation reactor with static mixers. Applications include sewage sludge conditioning, oxidation of purification sludge and "night soil", activated carbon regeneration, oxidation of paper sludge, waste

water purification and chemical waste processing. (A. Rinzema; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 276-324 [in Dutch].)

2240 HIGH GRADIENT MAGNETIC SEPARATION. [BIBL-TINF00686]
Waste water or slurry containing magnetic particles, is passed through an inhomogenous magnetic field. Separation of ferromagnetic, ferrimagnetic or paramagnetic particles occurs if $F_m F_w + F_g$, where F_m = magnetic force; F_w = hydrodynamic friction; F_g = gravitational force. In an open-gradient system the gradient is generated by the magnetic field itself, while in a matrix-gradient system a filter matrix supplies the gradient. Non-magnetic or poorly magnetic particles may be separated if pretreatment is carried out by conversion into a magnetic compound, or by coagulation, flocculation or (co)precipitation e.g. with $Fe(OH)_3$. The process produces a purified watery effluent stream, and a magnetic sludge. Applications include kaolin processing to remove particles containing iron, removal of iron oxides during machine cleaning in the paper industry, separation of iron oxides and manganese oxides in the steel industry. At pilot plant scale, the dephosphating of household waste, tertiary purification of effluent, and drinking water purification are among interesting possibilities. (J. Joziasse; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 325-350 [in Dutch].)

2241 CENTRIFUGAL PARTICLE SEPARATION. [BIBL-TINF00687]
A waste stream of polluted water, sludge or slurry is passed into a centrifugal separator whereby particles are separated according to density, producing a more or less particle-free water stream, and a concentrated sludge. Efficiency can be improved by the use of coagulation or flocculation agents to increase particle density. Metals, metalloids and their compounds, salts and organic impurities can be separated, provided that they are present as suspended particles in the waste stream. The decanter centrifuge operates with horizontal rotation and continuous discharge of sludge, while the disc centrifuge rotates vertically and discharges waste discontinuously. Often both systems are used together, the disc centrifuge used as a secondary 'clarification' process. The main application is in the concentration of communal and industrial sludge. (F. van Voorneburg; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 351-364 [in Dutch].)

2242 FILTRATION. [BIBL-TINF00688]
Suspended particles such as metals and their compounds, salts and organic substances, are separated from a liquid, sludge or slurry waste stream and concentrated by passing through a filter bed or sieve. Dissolved, colloidal and emulsified particles may be separated if pretreated to bring them into suspension. Pretreatment with filter aids or flocculation agents can improve filtration properties. Pressure of 0.4-20 bar, depending on equipment, is required to ensure continuous flow. Filter types include fast and slow sand filters, sieve belt presses, filter presses and vacuum filters, with concentration limits and performance varying according to the type of equipment. Sieve belt presses, filter presses and vacuum filters are used for concentrating (dewatering) industrial and sewage sludge, while sand and multi-layer filters are used for effluent polishing and water purification. (F. van Voorneburg; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 365-383 [in Dutch].)

2243 EVAPORATION. [BIBL-TINF00689]
A solution of one or more non-volatile components in a volatile solvent (usually water), is heated to boiling point so that the solvent is evaporated. The vapour is separated and used for heating further influent, or condensed, leaving a more concentrated residue. Multi-stage flash evaporation, single- or multi-stage (vacuum) evaporation, and compression evaporation are the main types of systems. Any type of dissolved component, organic or inorganic can be concentrated, provided that it is less volatile than the solvent medium. The degree of concentration depends on the type of component, particularly its volatility. Applications include desalination, and concentration of impurities in waste, used in the food, textiles, metal finishing, chemicals, paper, yeast and alcohol and other industries. (F. van Voorneburg; National Institute of Public Health and Environmental Hygiene (RIVM), TNO Environmental and Energy Research; Publisher: TNO (July 1990), 736101008, 4, 384-399 [in Dutch].)

2244 MARINE POLLUTION FROM LAND-BASED SOURCES: FACTS AND FIGURES. [BIBL-TINF00620]
Estimates show that around three-quarters of marine pollution comes directly from land and the principal routes are: the air; rivers and other runoff; and from direct pipeline discharges. Each of these routes is briefly reviewed. All routes are shown to share one characteristic – they all cause most pollution at, or near, the coast. Types of marine pollution are briefly described. Chemicals discussed include tributyltin oxide (from anti-fouling paint) and mercury (which can be converted to more toxic organic forms). Structural abnormalities have been observed in a common fish species (dab) snd human health is also being affected. Regulatory efforts to contain these problems are reviewed and the role of UNEP in catalysing and organizing regional agreements on marine pollution is described. Substances whose inputs are to be reduced by 50% by 1995 against a base year of 1985 are listed. There are details of the UNEP Regional Seas Programme and the Montreal Guidelines on land-based pollution. (Anon.; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 3-6 [in English].)

2245 COASTAL DEVELOPMENT AND ENVIRONMENTAL PROTECTION IN CHINA. [BIBL-TINF00621]
The development of China's immense coastal zone in this century is traced and resulting environmental pollution is described. Details are given of projects aimed at increasing exploitation and improving protection and management of the coastal resources and environments. These include: nationwide surveys of tidal flats and the entire coastal zone of the mainland; setting up of 42 coastal experiment stations throughout China to study sea water cultivation, marine farming and other projects (reference marine technology); and establishment of a State Oceanic Administration (SQA), equivalant to NOAA in the USA. In 1982, legislation began and laws relating to coastal management established by the end of 1990 are listed and contain provisions for the management of coastal and ocean areas. 1 map. (Ying Wang; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992 , 1-2, 15, ps 7-10 [in English].)

2246 INDUSTRIAL POLLUTION OF LAND ORIGIN OF THE COASTAL ZONES IN THE FRENCH MEDITERRANEAN. [BIBL-TINF00622]
Land-based pollution of the French Mediterranean from river flow and drainage is discussed. A Rhone Action Plan has been initiated with the aim of quantifying the river's contribution to the marine environment and assessing the impact of attempts to de-pollute the river basin. In particular, micro-pollutants are studied and these include: heavy metals and metalloids; non-aromatic and polyaromatic hydrocarbons; chlorinated pesticides and PCBs; nitrogen herbicides and radionuclides. Pollution data are presented, including littoral pollution by mercury, cadmium, copper, lead, zinc, hydrocarbons, PCBs and chlorinated hydrocarbons. Legislation is described and applied to older and new factories in the 'Fos-Etang de Berre' region. Numerical data. (Rene Pontier; Philippe Clape; Patrick Philip; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 11-15 [in French].)

2247 INDUSTRY AND ENVIRONMENT IN THE MEDITERRANEAN. [BIBL-TINF00623]
A 'Blue Plan' is described which aims to put at the disposal of the responsible authorities and the planners in different parts of the Mediterranean region, information which will allow them to develop their own plans for assuring socio-economic development without causing environmental harm. Developments in industry which have taken place in the north, south and west of the Mediterranean basin are traced and their impact on the environment assessed. Globally, trends are likely to have a harmful effect on the natural countryside. The need for personal involvement in the fight against pollution by residents in the region is emphasised in considering future relationships between industry and the environment. Numerical data; map. (Jacques Giri; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 16-19 [in French].)

2248 LAND-BASED SOURCES OF COASTAL AND MARINE POLLUTION ION CARICOM COUNTRIES. [BIBL-TINF00624]
The Caribbean Community of CARICOM is a collection of most of the former British colonies including Jamaica; Trinidad and Tobago; Guyana and Barbados. Industry in this region is becoming increasingly diverse and polluting. Details are tabulated of industrial production, covering: agro-industry; fishery product processing; bauxite; cement; fertilizers; soap; asphalt; spirits (including metal products and paints); and energy (petroleum, gasoline, diesel, electric power and natural gas). The imapct of land-based sources of industrial pollution – petroleum wastes, pesticide and fertilizer residues, food products e.g. cane sugar and distillery wastes, power plants, heavy metals, air pollutants and solid wastes – are considered. Quantities of pollutants from some in dustries are tabulated. Remedial action measures are outlined. Assistance will be required from developed country and donor or lending agencies to implement these measures to restore and protect the coastal and marine eco-systems. Numerical data; map. (Arthur B. Archer; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 23-28 [in English].)

2249 DISPOSAL OF FISH IN ATLANTIC CANADA. [BIBL-TINF00625]
Details are given of the fish processing activities which take place in about 500 plants distributed in the Atlantic Provinces of Canada (New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland). Characteristics of effluents from these plants are tabulated. Liquid wastes are discharged in receiving water after physical and chemical treatment; they contain organic loads high in BOD, suspended solids, oils and pathogenic bacteria which may contaminate shellfish-growing areas. Problems associated with landfill disposal, ocean dumping or processing into fish meal, of solid fish wastes include unsightly accumulations and bad odour pollution. Progress with studies of ensiling and composting fish wastes is reviewed. The resulting products have good potential markets and could replace existing disposal practices with reduced environmental impact. The collaborative studies have been conducted by Agriculture Canada, the Department of Fisheries and Oceans, Environment Canada and various universities. Numerical data; map. (Shoukry N. Messieh; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 23-33 [in English].)

2250 TREATMENT OF FISH PROCESSING WASTES IN JAPAN. [BIBL-TINF00626]
Quality standards for waste water and sea water in Japan are tabulated. Characteristics of waste water from fish processing and methods of treatment are described; a flow-line of a typical fish waste processing plant is presented. Examples are cited of treatment methods applied at various factories in Japan and flow-lines are presented. Treatment of solid waste generated by waste water treatment is considered and treatment of other waste water related to fish processing (e.g. thawed water from fish freezing) is described. An example of waste water treatment at a commercial treatment facility is presented. Numerical data. (Akira Okumura; Kazumi Uetana; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 34-39 [in English].)

2251 RECEPTION AND TREATMENT FACILITIES FOR WASTE OILS AND OIL-POLLUTED WATERS FROM MARINE AND INDUSTRIAL ACTIVITIES IN GOTHENBURG, SWEDEN. [BIBL-TINF00627]
Details are given of the treatment by GRAAB-KEMI of oil (petroleum)-polluted water from marine and industrial sources in the Gothenburg area. The CICLEAN facilities and plant are described, which include: reception and storage; chemical flocculation using aluminium; sulphate; flotation; recovery of aluminium sulphate; filtering; and monitoring. Over 10 years of operation, the oil content in the effluent has gradually been lowered to a current mean value below 3 mg/litre (95% reduction). Oil and grease contents have been reduced to 13 mg/litre (80% reduction). Levels of aromatic compounds, oxygen-consuming organics, chlororganic compounds, phenolic compounds, PCBs and metals are reported. The Swedish Franchise Board currently permits CICLEAN to receive 700,000 m^2 per year of effluent. Local environmental concerns are considered. Latest plans include separate treatment of waste streams containing aromatic compounds and heavily polluted waters, activated carbon, and air stripping are being considered. Numerical data. (Kenneth Andersson; Sven-Ingvar Lexen; Mati Hell; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 40-44 [in English].)

2252 ENVIRONMENTAL CONSIDERATIONS FOR PORT OPERATIONS AND DEVELOPMENT. [BIBL-TINF00628]
The concept of sustainable development, as defined at the International Meeting of Experts on Land-based Sources of Marine Pollution, Nova Scotia, 1991, is a dynamic process designed to meet today's needs without compromising the ability of future generations to meet their own needs. A broad perspective is provided on what ports ought to do, and are currently doing, to provide sustainable development. Details are given of the American Association of Port Authorities' position on sediment clean-up and dredge material management. There should be an inventory of sediments, numerical sediment criteria and standards, a programme to monitor dredged material disposal sites and demonstration/clean-up of contaminated sediments. The benficial uses of dredged material, disposal practices and disposal of contaminated dredged material are considered. Waterside, wetlands and landside development are discussed. (Joseph J. Birgeles; David Berkovits; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 45-47 [in English].)

2253 THE RHINE RESEARCH PROJECT. [BIBL-TINF00629]
Progress with the Rhine Research Project (POR), begun in 1984 to attempt to clean up the upstream sources of pollution, is reviewed. The time horizon for POR is 2002, the year the Slufter will be full; dischargers will have to reduce each polluting substance by the same percentage as that by which the dredged sludge must be improved to permit dumping in the sea. Where such a reduction is met, the substance in question will be termed as Category I; provisions for Category II, III and IV substances are described. The question of environmental liability, as researched in co-operation with Erasmus University, is discussed. Agreements so far reached with potential discharges are examined and results obtained up to 1995 with regard to cadmium, chromium, copper, lead, zinc, nickel, mercury and AOX, are tabulated. Numerical data. (N.P. van den Berg; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 48-51 [in English].)

2254 CHOOSING PREVENTION IS WINNING: THE ORGANIZATION AND RESULTS OF THE DUTCH POLLUTION PREVENTION PROJECT PRISMA. [BIBL-TINF00630]
Details are given of the Netherlands' pollution prevention control project PRISMA. Techniques and methodology are described and presented in a flow diagram. The project combines studies, experiments within 10 Dutch companies and active communication of results; the system of operation is described in terms of method, stages plan and supervision and results are discussed. The second part of the paper deals with obstacles to the prevention of waste and emissions and ways in which they are being overcome. Recommendations are made for an effective government prevention policy. The third part describes the PRISMA multi-media approach, which is considered able to eliminate sources of coastal pollution. Numerical data. (Sybren de Hoo; Hans Dielman; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 56-62 [in English].)

2255 CLEAN TECHNOLOGY APPLICATIONS: THE PORT OF ALEXANDRIA, EGYPT. [BIBL-TINF00631]
The importance of long-term projects for clean technologies and their practical application in Alexandria is highlighted, with reference to the chemicals, textile finishing, food and poultry processing industries. Industrialization in Alexandria is described and specific environmental problems are outlined; distribution of pollutants in the industrial zones is shown schematically. Case studies are presented for various industries, in order to show approaches being adopted towards clean technology. The need is stressed for a strategy based on achievable and cost-effective practices in order to implement interim and long-range plans for control of industrial liquid and solid wastes. A regional environmental protection unit is to be set up within the local government. Map. (Ahmed Hamza; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 62-68 [in English].)

2256 EMERGENCY RESPONSE AT THE PORT OF GENOA. [BIBL-TINF00632]
After describing the organizational structure of a port's safety system in general terms, the response of the port of Genoa to the explosion of a sepertanker in 1991 is described. The tanker, Haven, was carrying 144,000 tons of crude petroleum when it exploded near the port. Organizational and operational aspects of the action taken by the port management are discussed. Significant aspects of the management of emergency response are examined and the importance of dissemination of information is stressed. The importance of legislation on the protection of the sea and the provision of suitable vessels to deal with emergencies are amongst measures advocated for the future. (Antonio Admiral Alati; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 69-72 [in English].)

2257 TECHNICAL PROGRESS, COMPETITIVENESS AND SUSTAINABLE DEVELOPMENT. [BIBL-TINF00633]
Close links between international competitiveness, technical progress and environmentally sustainable development are explored with reference to the Latin American and Caribbean regions. Details are given of the ecological package of Petroleos Mexicanos (PEMEX-Mexico) with regard to petroleum, diesel fuel, fuel oil and sulphur recovery. The environmental activities of Petroleos de Venezuela S.A. are also summarized. The relative positions of Latin America and the Caribbean are examined with respect to technology, competitiveness and natural resources and the energy production industry is studied as an example. The relationship between industrialization and sustainable development is considered, the market for goods and services for environmental protection is described and entrepreneurial strategies are outlined for sustainable development. Numerical data. (Jorge Beckel; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 73-79 [in English].)

2258 PREVENT THE RISK OF CLIMATE CHANGE BY TAXING FOSSIL FUELS. [BIBL-TINF00634]
Of all the greenhouse gases, emissions of carbon dioxide most urgently require reduction and the concentration in the atmosphere can only be stabilized if emissions are reduced by 60%. The need for a distribution of effort within each country are considered. A progressive tax restructuring through obligatory and continued direct levy is recommended. Impact of such a tax is considered to be less damaging than were the effects caused by the oil crisis. However, international difficulties in the implementation of the tax are described. In particular, the case of countries which export fossil fuels is considered. It is suggested that at least the tax option should improve the capacity of the richer countries to assist fossil fuel producers that are the least well off. (Yves Martin; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 80-84 [in English, French].)

2259 WASTEWATER MANAGEMENT IN KASTELA BAY, CROATIA. [BIBL-TINF00635]
The effect on the eco-system of Kastela Bay in Croatia, of discharge of untreated urban wastes and industrial wastes over a number of years, is assessed. Wastewater from a vinyl chloride and a chlor-alkali plant, discharging mercury until its closure in 1990, has caused the greatest problems. Problems also arise from metal plating plants discharging zinc, chromium and copper. The environmental impact of these effluents is described and planned protection measures are discussed. These include proposals for construction of a sewage system for waste water collection, transport, treatment and discharge into the open sea. None of the larger facilities have been completed due to lack of funding and existing industrial plants on the bay may need to be rebuilt. The need for a regional development policy to improve and protect water quality is considered. Map. (Stanislav Tedeschi; Bogdan Ivancic; Publisher: UNEP/IEPAC (Jan-Jun 1992) Industry and Environment, 1992, 1-2, 15, ps 20-22 [in English].)

Adsorbents

Adsorption

Aerated lagoon

Aeration

Aerator

Aerobic

Aerobiosis

Agglomeration

Agricultural wastes

Agriculture

Air

Air cleaning

Carbon steels

Cards

Caribbean region

Case-study

Cassiterite

Cast iron

Casting

Catalyse

Cathodes

Cathodic protection

Cation

Cation exchanging

Cattle

Cavitation

Cellulose

Cementation

Chemicophysical properties

Chemithermomechanical pulp

China

Chips

Chitin

Chlorate

Chloride

Chlorinated organic compounds

Chlorination

Chlorine

Chlorine compounds

Chlorine dioxide

Chlorine-free

Chloroform

Chlorolignin

Chromates

Chromating

Dewatering (separation process)

Die-casting

Diffuser

Digester

Digestibility

Digestive system

Dilution

Dimethyl disulphide

Dimethyl sulphide

Dioxin

Directory paper

Disc

Disease control

Disease transmission

Disinfectants

Disk filters

Dispersion

Disposal

Dissolution

Dissolved Solid

Distilled Water

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Dolomite

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Drainage

Drinking-water

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Electric-furnace steel-making

Electrification

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Electrodeposition

Electrodes

Electrodialysis

Electroforming

Electroless coating

Electroless nickel plating

Electroless plating

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Lakes

Lamella

Landfill

Lap joints

Latex

Latin America region

Layout

Leaching

Lead (metal)

Lead-base alloys

Lead ores

Leakage

Leather industry

Legislation

Life-cycle analysis

Lightweight

Nickel-base alloys

Nickel-chromium-molybdenum steels

Nickel plating

Niobium

Nitrate

Nitrogen

Nitrogen content

Nitrogen metabolism

Nitrogen oxides

Nitrous oxide

NMR spectroscopy

Noise control

Non-ferrous metals

Notch sensitivity

NSSC

Nucleation

Nutrients

Nutritive value

Nylons

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Reject

Reliability

Rendzinas

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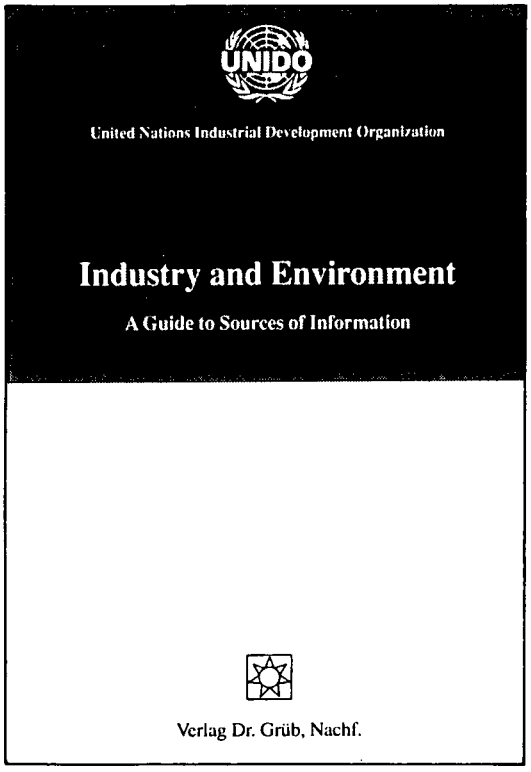

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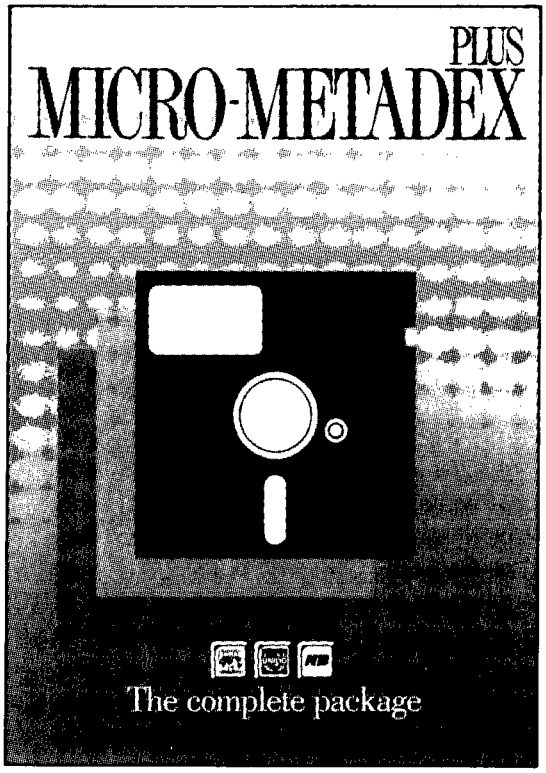

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