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ENERGY AND ENVIRONMENT
SERIES

Hazardous Waste Management in Industry

INTIB

Energy and Environment Series, No. 3

HAZARDOUS WASTE MANAGEMENT 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. 3: Hazardous Waste Management in Industry

PREFACE

Hazardous Waste Management in Industry is the third number in the Energy and Environment *Series* of the Industrial and Technological Information Bank (INTIB). The following page lists other titles in the *Series* as well as other, related titles.

The lead article admirably sets the scene for the subsequent abstracts. Although lengthier than such articles in previous numbers of the *Series*, it succinctly presents options for management, treatment and disposal of existing wastes, including criteria for site selection and the economic considerations involved.

A variety of information sources have been utilized to produce this volume, which covers ways to manage as well as to avoid environmental hazards resulting from a range of industrial sector activities. The reader will find related information in the previous titles dealing with industrial effluents and recycling. The main industrial sectors dealt with in this volume are metallurgy; plastics, ceramics and other composite materials including the business aspects of these materials; and chemicals and agro-chemicals, including solvents.

Due to the receipt of material from the organizers of the First International Symposium on Environmental Contamination in Central and Eastern Europe, there is a concentration on environmental engineering and waste/site remediation techniques for managing or reducing the impact of the results of previous bad management practices. Some of the topics covered in this section of the volume include: monitoring; legislation and regulations; waste recovery and recycling; risk assessment and management; soil remediation; waste disposal and conversion methods; water management and treatment. This section contains abstracts of a mixture of reports from the Eastern European region and proven technologies from other regions for analysing, controlling/monitoring and managing the problems which have been identified. There are over 270 abstracts of technical papers on the above subjects.

UNIDO also convened a meeting on the topic of hazardous wastes and the proceedings have been abstracted and included in this volume.

The *Industry and Environment Review*, prepared by the Industry and Environment Programme Activity Centre of the United Nations Environment Programme, as before, adds a valuable perspective to the *Series*. This time 3 issues of the *Review* are featured, each containing around ten articles on the subjects of solvents, technological accidents and computer tools for environmental management in industry.

As in previous volumes of this *Series*, Materials Information supplied half of the data, which were extracted from their Metals Abstracts, Materials Businees File and Engineered Materials Abstracts data bases. These abstracts are contained in the first part of the volume.

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[*]
No. 3: *Hazardous Waste Management in Industry*, 1994[*]

* 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, hazardous waste management in industry), followed by two sections containing abstracts of technical material.

The first section is entitled "Hazardous Waste Management" 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: UNIDO (United Nations Industrial Development Organization, Hazardous Waste Management Workshop, Vienna, 22-26 June); UNEP/IEPAC (the Industry and Environment Programme Activity Centre of the United Nations Environment Programme); BUDAPEST '92 (First International Symposium on Environmental Contamination in Central and Eastern Europe, 12-16 October 1992).

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: waste disposal; environment; industry.

The author and corporate author (which includes author affiliation) index entries include the name in alphabetical order followed by the sequential record number.

General points to note:

- In some cases, the titles of documents have been edited or translated;
- In the second section, the technical reports are mainly unedited, unpublished papers.

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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:

Hazardous waste management section (pages 39–81)

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CLEANTEC DATA—UNIDO

The cited papers appear in *Hazardous Waste Management, Selected papers from an International Expert Workshop convened by UNIDO in Vienna, 22—26 June 1987.*
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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.

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CONTROL OF
INDUSTRIAL POLLUTION
AND THE FINAL DISPOSAL OF
HAZARDOUS WASTES

EXPLANATORY NOTES

DRE	Dioxin removal efficiency
USEPA	United States Environmental Protection Agency
PCB	Polychlorinated biphenyl
PHOC	Principal hazardous organic constituent
POHC	Polyorganic hydrocarbon

Introduction

Unprecedented economic growth since the second World War has resulted in record production of industrial and consumer goods, including huge quantities of chemicals for various end uses. This has led to an increased output of the waste materials which cause air, soil and water pollution. The amounts of waste have become so large that new industries and specialist engineering expertise have to be developed to minimize waste generation and to establish acceptable disposal systems.

Air and surface water pollution are the most conspicuous types of pollution and therefore receive prime attention by the public. In contrast, soil and groundwater pollution are concealed from direct observation and become public issues only after massive ingestion has already taken place and/or hazardous conditions for human health have been confirmed by analytical evidence.

There are many sources of pollution, varying according to the particular country and location. Single polluting compounds are generated in gaseous, liquid or solid forms. Many of them are relatively inert to physico-chemical or biological degradation and thus pose no particular threat to the natural environment. However, others are highly reactive and must be treated and disposed of safely to minimize possible environmental impact.

Waste products, which cannot be further reduced and treated, end up in the form of solid waste on landfill sites and in underground repositories. Often these sites are a great nuisance because of their appearance and molestation by smoke, odour and windblown debris. More important is the potential danger posed by the unknown amounts of hazardous components frequently contained in household and industrial wastes. They may find their way as leachates into groundwater, thus violating one of the principal rules of safe waste disposal management, namely the prevention of water resource contamination.

Such contamination can only be avoided if waste products and potentially toxic leachates are safely contained within the boundaries of the repositories and no further contact occurs with the enclosing geologic environment. This condition should be fulfilled as far as possible for inert wastes, but it constitutes a mandatory provision if hazardous waste is deposited.

I. APPROACHES TO POLLUTION CONTROL

A. General

Pollution control forms an inherent part of the measures required to safeguard the environment, while at the same time permitting industrial and social development to proceed under safe, controlled conditions.

There are two types of environmental considerations associated with industrial activities:

(a) The safety of the internal working environment for the labour force;

(b) The impact of construction and subsequent operation of a plant and waste disposal on the external environment.

This report concerns (b), i.e. the effect of construction of industrial plants and their subsequent operation on the environment. It is an extremely wide ranging topic and includes the direct and indirect impact of construction, the effect of producing unavoidable quantities of industrial waste residues, solid, liquid or gaseous, the demands made on natural resources (e.g., water, fuel and power), induced changes to social structures and socio-economic effect. This report will confine itself to the control aspects of industrial pollution.

The severity of industrial pollution and the controls required to limit its effects to within acceptable limits depends not only on the products manufactured and the processes employed, but almost equally on the plant locations, including their proximity to population centres, as well as the absorptive capacities of local areas to accommodate waste residues. For example, liquid wastes may be more readily dispensable to acceptably low enough concentrations if the large quantities of water required are available at nearby locations to reduce toxicities through dilution or if benign reactions with co-disposed other wastes reduce or eliminate their hazardous nature.

Similarly, gaseous waste products can be controlled more readily if such gases can be removed away from population or agricultural centres by prevailing winds, e.g., through adequately high stacks. Solid wastes can be more readily disposed of when local areas contain candidate landfill sites which would not cause pollution to groundwater if containment soils have the required sorptive and hydrological characteristics. Because the specific sources and natures of wastes from each industry vary widely, the identification and quantification of wastes is essential, if a technically and economically reasonable, acceptable and effective control of pollution is to be achieved.

In mapping out an approach to pollution control, the following steps should be considered:

(a) Initial screening to identify main areas of present/or potential environmental sensitivity impacted on by existing plant or new plant design concept;

(b) Assessment of present or potential impact of current or proposed activity on environment. Identification and appraisal of linkage(s) between industry or plant and ecological and biological systems, over the short and long terms;

(c) Identification of the action required to abate adverse effects, e.g., legislative, regulational, educational, international and financial aspects;

(d) Analysis of the effects of the action taken, including economic, financial and technical viability of any innovative action(s) and

(e) Where external funding is required, the implications of such funding through bilateral or multilateral and international agencies on project viability.

B. Pollution control parameters

One method of designing pollution control measures is to reduce "end-of-pipe" waste products according to the type of industry involved. This method is particularly relevant to existing industrial plants. Where feasible, it could include the replacement of existing equipment and processes by less waste-

producing alternatives; it could also include improvements in efficiencies (e.g., technical innovations such as energy conversion processes and in plant training of personnel), application of recycling or reuse potentials, and waste management alternatives, the latter including emphasis on process alternatives minimizing waste generation.

In earlier attempts to establish guidelines for UNIDO officers in evaluating the environmental impact of industrial projects, * "prohibitive lists of materials" were prepared and recommended as being interdicted from dumping into waterways. These materials are evaluated on the basis of their toxicity, persistence and bioaccumulation and they include the following:

(a) Organohalogen compounds and substances;
(b) Organophosphorus compounds and substances;
(c) Organotin compounds and substances;
(d) Mercury and mercury compounds and substances;
(e) Cadmium and cadmium compounds and substances;
(f) Used lubricating oils;
(g) Persistent synthetic materials;
(h) Substances with proven carcinogenic, teragenic or mutagenic properties, ingested in or through the marine environment and
(i) Radioactive substances and their wastes when their discharges do not comply with the principles of radiation protection.

In addition, UNIDO prepared a table of waste types which it recommended should not be dumped into any inland waterway without the issue of a special permit from the national authorities having such licensing powers. The following substances, families and groups of substances and sources of pollution, are included, not listed in order to priority, and have been selected mainly on the basis of criteria used in the list of prohibited materials, while taking into account the fact that some of them are rendered harmless by natural processes and therefore with a less severe environmental impact.

(a) Elements and their compounds:

1. zinc	6. selenium	11. tin	16. vanadium
2. copper	7. arsenic	12. barium	17.cobalt
3. nickel	8. antimony	13. beryllium	18. thallium
4. chromium	9. beryllium	14. boron	19. tellerium
5. lead	10. titanium	15. uranium	10. silver

(b) Biocides and their derivatives other than those listed in the prohibited group;
(c) Organosilicon compounds and substances which may form such compounds in the marine environment, excluding those which are biologically harmless or are rapidly converted into biologically harmless substances;
(d) Crude oils and hydrocarbons of any origin;
(e) Cyanides and fluorides;
(f) Non-biodegradable detergents and other surface-active substances;
(g) Inorganic compounds of phosphorus and elemental phosphorus;
(h) Pathogenic micro-organisms;
(i) Thermal discharges;
(j) Substances having deleterious effects on the taste and/or smell of products for human consumption derived from the aquatic environment, and compounds liable to give rise to such substances in the marine environment;
(k) Substances which have, directly or indirectly, an adverse effect on the oxygen content of the marine environment, especially those which may cause eutrophication;
(l) Acid or alkaline compounds of such composition and in such quantity that they may impair the quality of sea water;
(m) Substances which, though of non-toxic nature, may become harmful to the marine environment or may interfere with any legitimate use of the sea due to the quantities in which they are discharged.

The products of the chemical industry and the waste residues resulting from their synthesis are a major component of materials requiring hazardous waste management. They form a group of materials that are highly heterogeneous in properties and conditions, many toxic to highly toxic, some biodegradable, while others do not lend themselves to treatment at all.

C. Treatment

An example of a group of chemicals, highly differentiated but toxic in nature and in extensive use, is polychlorinated biphenyls (PCB's); many of these present special waste disposal problems. Chlorinated wastes differ from each other by the way the chlorine is chemically present and the solid, liquid or gaseous phase in which the waste occurs. Wastes in this context refer not only to the primary wastes produced during the manufacturing process, but also to chemicals that are obsolescent, either because they are out of date or. because there is insufficient demand for them.

Toxic wastes from other industries include the important sector of electroplating, including sludges, liquid and solid wastes. The main hazardous waste streams are shown in figure I.

Waste streams from the electroplating industry need special treatment, as they contain potentially hazardous elements such as cyanides, chromium, nickel, cadmium and zinc, all of which are classified as toxic substances.

In a commonly employed treatment process, which is widely used in the industry, chromium complexes and cyanides are

* "First guide for UNIDO officers in evaluating the environmental impact of industrial projects", (UNIDO: PPD, 76; 8 April 1989; and E. Winter and others: "Proposal for clean technology digest", unpublished report, (UNIDO, November 1989).

Figure I. Simplified typical metal-finishing operations and hazardous wastes streams originating from each step. *

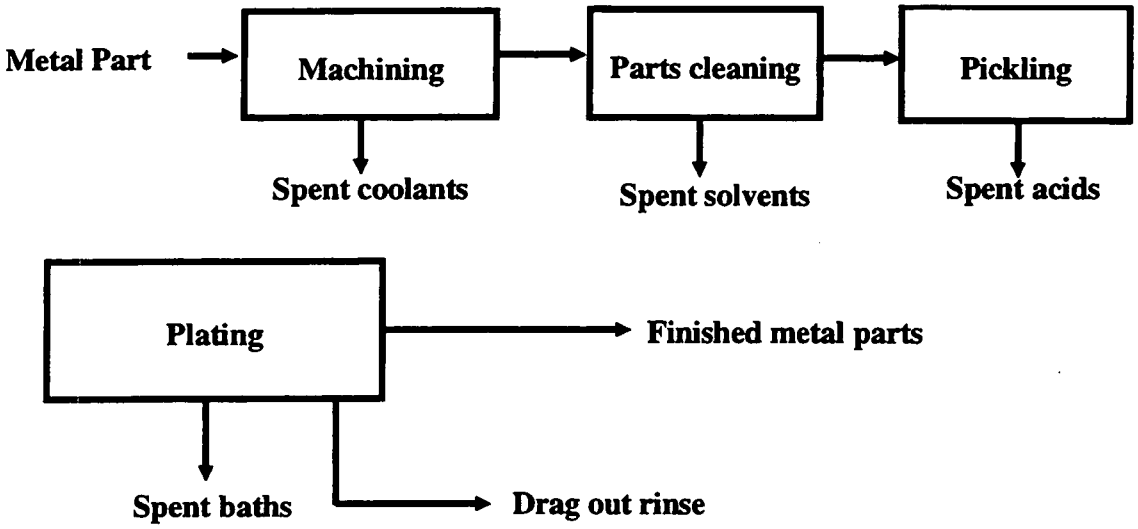
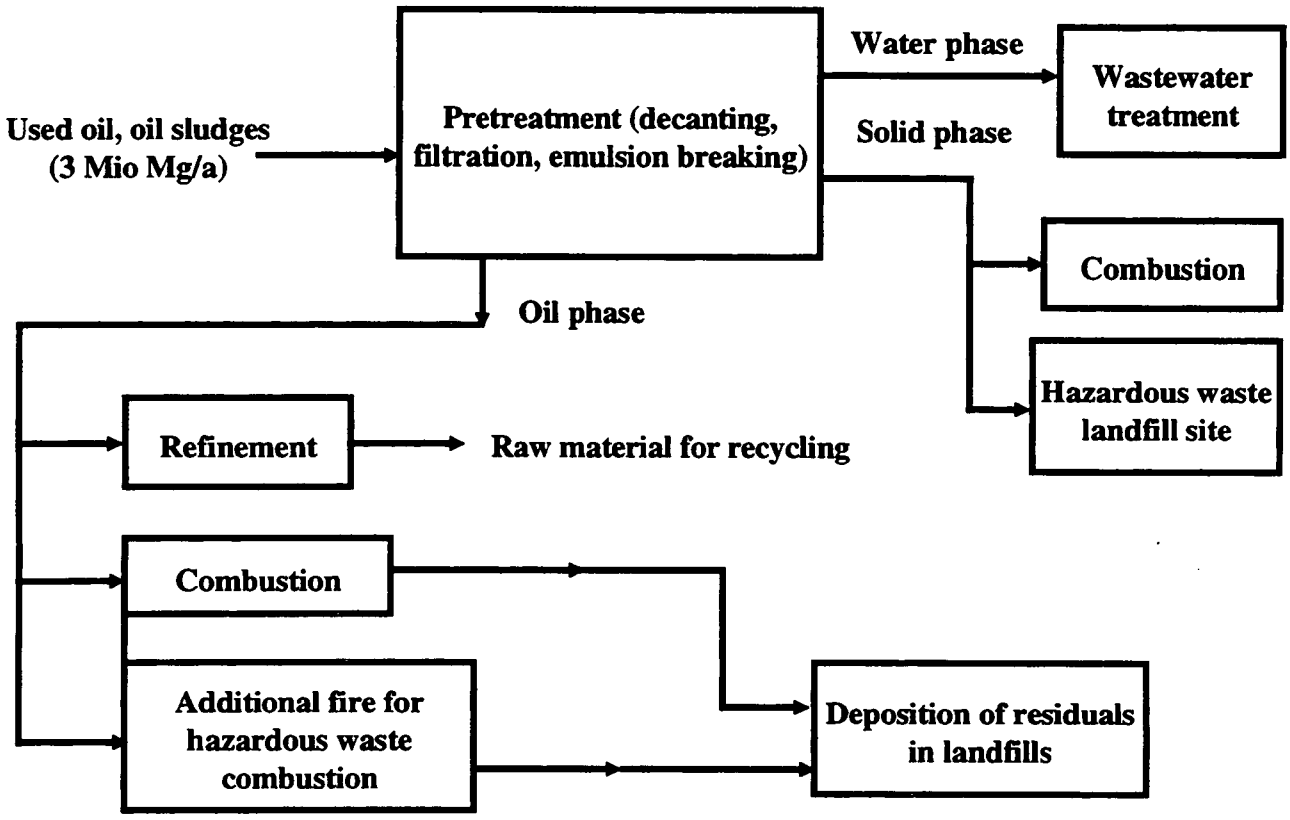


Figure II. Flowsheet of used oil and oil-sludge treatment



* From Sutter: "Review of hazardous waste management" (International expert workshop on hazardous waste management, UNIDO, 1987)

treated at first in separate processes, the hexavalent chromium being reduced to the less toxic trivalent chromium (usually by gaseous sulphur dioxide or sodium bisulphate) and then passed to a neutralization bath, while the cyanide wastes are at first treated separately to oxidize the highly toxic cyanide by chloride gas or sodium hypodilorite to a less toxic cyanide and ultimately to innocuous bicarbonates and nitrogen. The two treated waste streams are then jointly neutralized and heavy metals brought down during neutralization as insoluble hydroxides. This is followed by a gravity separation step to bring down the suspended solids. Sludges are deposited in a chemical landfill.

The electroplating industry is known to be one of the principal causes of contamination of both soils and groundwater. It was found that, in local areas surrounding such plants, there was severe deterioration in groundwater quality, caused mainly by spillage of chlorinated hydrocarbons, at times leading to such high anomalous concentrations that wells have had to be sealed. In other cases, the improper handling and disposal of spent plating solutions led to severe increases in Cr and Cd concentrations. Machining of parts requires the use of emulsion oils for cooling and lubrication; contaminants of these oils could include emulsifiers, biocides and special lubricating additives. The extent and nature of these contaminants will determine whether the oil can be reprocessed in a refinery or burnt in special incineration plants.

A flow sheet of the treatment of used oils and sludges is shown in figure II.

D. Water management

One of the characteristic features of developments in the recent past is the clearly broadening scope of water management. To the conventional tasks of protecting life and property against floods, droughts and erosion, ensuring drinking water supplies, satisfying the demand of industry and agriculture, and improving water quality, the task of maintaining and restoring the natural state of the water resources has been added. Responsible regulating authorities have become aware that respect for the prime characteristics and functions of water constitutes, especially in the long-term, the only rational basis for intervention in the hydraulic regime, whether it be regulation, drainage, abstraction or waste disposal.

Over the years, the tasks and concerns of public water management have been steadily expanding in response to the new requirements arising from socio-economic developments, increasing pressure on water resources and changing perceptions of their role and function. In the first two post-war decades, the attention of competent authorities was focused on the provision of quantitative supply. The aim was to satisfy, as far as possible, any demand for water and water-related services. Towards the end of the 1960s, when governments everywhere were beginning to consider the secondary and systematic consequences of excessive resource use and its ensuing social costs, the quality of water became an additional and, in many instances, the main concern of water management.

While protection of the prime quality, or natural state, of water was usually implicit, it is only now that water management is being expressly called upon also to ensure suitable conditions for the water-dependent ecosystems. During the 1980s, the concept of water as a resource in its own right, with prime quality and functions which should be maintained and restored, gained acceptance, thus promoting a new so-called ecosystems approach to water management. The underlying principle that aquatic ecosystems should be protected in their natural state is embedded in the many new water acts and other updated, consolidated water legislation of recent years which have been described; it is also apparent in current strivings for the development and implementation of integrated policies and strategies to deal with the complex and interrelated problems of the water management sector.

Integration of water management has been proceeding especially between developed countries at many different levels. With respect to administration, it would appear important everywhere to define an appropriate basic unit of management. A number of countries seem to have chosen the watershed for this purpose. A proper balance between centralization and decentralization of powers is another problem of integrated water management, the maintenance of necessary flexibility for adaptation to local conditions being an important issue. Many countries have opted for making water management a part of the government body responsible for general environmental protection policy, others are relying more heavily on a coordinated network of operative links throughout the administrative structure.

In the overall planning process, consideration is increasingly being given to the multi-purpose use of waters and the impact of various uses on other natural resources. The linkages between surface waters and groundwaters, as well as between quantity and quality of the water resources are recognized. Supply planning is to a great extent being complemented, if not yet replaced, by demand planning and appropriate measures to influence consumption and use. Great efforts are also being made to create integrated water supply and disposal systems. A very important feature of the current situation appears to be the emphasis placed on the coordination of land-use planning and water management in regional development. In this context, "water-use planning" is also being introduced, implying evaluation of present and future uses as well as potential conflict or compatibility of user interests in respect of specific water resources.

1. Preventing reduction in water quality

Whatever the eventual increase in demand for water will be for the rest of this century, the main concern is the deteriorating quality of available resources. Under the impact of policies to promote water saving and pollution control, the use of water in some economic sectors is changing. On balance, the impressive growth in water needs, which was forecast only some ten years ago, would not seem to materialize, and the efforts of the past decade to put a brake on, and eventually to stop, pollution at least from municipal and industrial point sources have had some effect. This does not preclude the existence of serious local, and even regional, pollution problems and qualitative protection of the water environment is emerging as a major issue in connection with the mounting impact of urban and industrial expansion on natural systems.

Even if remedial and preventive action can point at gratifying results, any appraisal of the present situation usually has some pessimistic undertones: restoring polluted water courses and water bodies to their natural state has been found to be a long and costly process; and there are a number of pollution problems calling for urgent attention, raising intricate questions of policy. Although the rate at which the pollution of surface waters was growing would seem to have been stemmed or halted, and in a few instances even reversed, the cleaning-up process is proving to be slow and costly everywhere.

High concentrations of organic pollutants, including phosphorous and nitrogeneous compounds which lead to eutrophication, cause damage to many surface water bodies. In a number of countries, measures have been taken to control phosphorus in municipal sewage discharges, but the lowering of loads is often slow to show effects. Untreated municipal sewage may be a pollution source of diminishing importance in a few countries; however, it is still far from having been eliminated and full control will require heavy investments in the years to come.

Chemical pollution, mostly from small-scale industries still dumping their wastes on land and water, and from farms using excessive amounts of fertilizers and pesticides, is a concern common to all countries. Toxic wastes in water bodies constitute a threat which can no longer be neglected, because the time needed to eliminate even present levels of toxic pollutants may be exceedingly long. Toxic contamination is likely to become a prime issue of water-management policy. At national levels, this problem does not seem yet to have been brought under adequate control anywhere. It involves large amounts of hazardous wastes from various sources and leakage from landfills and sludge deposits which often escape detection. Furthermore, many presently used waste removal and disposal methods are simply returning toxics to the environment. Another serious problem is that of airborne pollution, including acid precipitation containing sulphurous and nitrogenous compounds. These cause damage to water bodies with low buffering capacity, by destroying the basic conditions for any aquatic life.

A general issue of particular importance is the growing threat of contamination of ground water. Once groundwaters are polluted, it becomes very difficult and expensive to clean them or even to stop the spread of contaminants. As water in aquifers moves slowly, it may take decades before the pollution makes itself felt. Moreover, because of communication with surface waters, both sources of supply may eventually become polluted. Toxic contamination of groundwaters effectively renders them unavailable for generations. As groundwater is used to a great extent for the supply of drinking water, preventive action should be taken by drawing up vulnerability maps and establishing protected catchment areas. Few countries would seem as yet to have established systematic country wide monitoring of groundwater quality, but the cases of groundwater pollution reported to date suggest that long-term drinking water supply may in many instances be jeopardized unless appropriate measures are taken.

Water management authorities have recently been drawing attention to greater nitrate concentrations in surface as well as groundwaters, sometimes permanently exceeding permissible health standard levels. This problem is intimately linked to the broader and intricate question of so-called non-point source pollution which, in the near future, is likely to become one of the main issues of water management policy. Water pollution regulations have for a long time been mainly directed towards readily identifiable polluters, such as industrial plants and municipal waste-water treatment plants. However, for a large portion of polluting discharges to water bodies, the responsibility falls on dispersed area-wide sources such as farms, forests and urban surfaces which are much more difficult to control.

In this very important and highly topical field of pollution-control policy, research and experimental work is in progress in several countries with a view to designing effective strategies and policy instruments. In this context, it should be underlined that groundwater resources, which often are of critical importance for withdrawals to provide drinking water, are now becoming increasingly threatened. The threat to the groundwaters comes from a multitude of diffuse pollution sources, which are much more difficult to control than the point sources. Diffuse pollution is related, for instance, to agricultural techniques relying on heavy use of fertilizers and pesticides, run-off from urban and industrial areas, landfill repositories containing hazardous and toxic wastes, and outfall of air-borne pollutants. It is in this context that new water-management policies with broad linkages to policies in other compartments of national administration will be required.

In some countries, developments in this direction are already in progress. It is becoming increasingly necessary to have access not only to data of the conventional type but also to have a continuous flow of information on the state of the aquatic ecosystem. In the future, great emphasis will likely be placed on biological water testing. As a support for continuous adjustment to new situations, governments are organizing regular collection of basic water statistics to assist forward planning and research into significant relationships between socio-economic phenomena and water resources.

2. Cooperation in the field of transboundary waters

Such co-operation is highly important in a number of regions. For example, the Ministerial Conferences of the International Commission for the Protection of the Rhine against Pollution, which were held in autumn 1986 following a major pollution accident, have set up ecological objectives for the newly re-examined protection policy. The riparian countries of the Danube River, in their Declaration of 1985, agreed on objectives of the same character. Similar developments have been reported in respect of both bilateral and multilateral co-operation concerning other transboundary water bodies. A tendency has also been noticed to widen the scope of activities conferred on the joint bodies for the implementation of agreements.

There is concern over the increasingly disturbing effects of diffuse pollution, which is related to factors which are difficult to tame or control, e.g., agricultural technology relying on heavy application of fertilizers and pesticides; discharges from intensive livestock breeding; run-off from sealed urban and industrial surfaces; seepage from old and new landfills and sludge depos-

its; atmospheric fall-out and side-effects of expanded tourism and recreational activities.

Awareness is growing that this type of pollution constitutes a threat not only to surface waters, but also to groundwaters, which in many areas remain the only source permitting the supply of drinking water quality to the population. Groundwater contamination is often a long-term, accumulative process; thus, it is far more serious than surface-water pollution; rehabilitation requires extended periods of time and sometimes is not even possible. Particularly critical is the need to reduce, control and regulate the use of chemicals in such applications as agricultural fertilizers and pesticides, e.g., through the use of innovative techniques in farming. A very urgent question is the discharge of toxic wastes into water bodies. The problem of hazardous wastes is nowhere adequately controlled, though sizeable quantities of hazardous waste from various sources are involved.

Some presently used methods of waste removal and disposal imply direct or indirect discharge to water of such toxic materials as poisonous substances, including dioxin, polychlorinated biphenyls and chlorinated benzene, chemicals emitted by incinerators and other air-borne chemicals settling on food crops, drinking water, ingestion by fish and wildlife. In addition to the immediate threat to water bodies, the presence of toxic substances in sediments is likely to affect adversely aquatic ecosystems in the long-term. Transport of contaminated sediments may moreover create problems in downstream reaches of rivers and thus have eventually transboundary effects.

The increase in size and complexity of industrial plants and the rapidly growing volume and distances over which chemical products are transported contributes to the creation of environmental risks. Synthetic products are often highly toxic to the aquatic environment and, once released into water, they are non-degradable and bioaccumulative. It is anticipated that, in the next decade, accidental pollution of water resources will become of even greater concern. Although preventive measures could contribute to minimizing the risks of accidental spills of harmful substances, the probability of failure of the present sophisticated technological systems cannot be reduced to zero. Increased international co-operation would be essential to prevent accidental pollution of transboundary waters and mitigate the harmful effects of possible spillage of dangerous substances beyond national jurisdiction.

One of the most basic issues of the future is the design of practicable policies for the maintenance and restoration of prime water quality and functions. Such policies may require highly integrated management as they will have to rely on widespread recognition that water, being an indispensable economic resource, is first of all a vital life-supporting system which, as a sine qua non, must be protected so as to permit sustainable use. Rehabilitation of water bodies and their related aquatic ecosystems is in most cases a lengthy process, involving high costs. Often, as with aquifers, the restoration of contaminated water resources may even be technically impossible and natural purification may take decades.

It is concluded that the protection of water resources and the maintenance of water at drinking quality levels is becoming of increasing concern. Emphasis should be on preventive action rather than remedial and on international co-operation. Important issues in this respect are the following:

- Formulation of policies needed to deal with non-point source pollution;
- Prevention of further contamination of waters by toxic substances including wastes (e.g., waste deposition in sanitary landfills etc.);
- Prevention of accidental pollution;
- Maintenance of water-processing equipment;
- Increased consideration of the sustainable use concept of available water resources and
- Limitations in the use of pesticides and fertilizers for agricultural purposes.

II. HAZARDOUS WASTE MANAGEMENT

1. Prevention, treatment, disposal

Hazardous waste management includes prevention (waste minimization, recycling, clean technology), treatment (physical, chemical, biochemical) and disposal. It is the objective of treatment and disposal technologies to render wastes less hazardous and to dispose of them in such a manner that any negative impact on the environment is reduced to the lowest possible level. Pollutants and waste products affect land, water and air and become entrapped in these media by physical, chemical and biological reactions and mechanisms. The earth sciences are valuable tools in understanding these phenomena, because they involve the study of geological processes and materials. Their input is necessary and vital in order to produce a database in decision-making processes leading to the safe management of such wastes.

Categories of types of waste disposal methods are discussed later in this report. In order to arrive at an environmentally, economically and technically optimum selection of one of these under specific conditions, a thorough understanding of waste and site characteristics is a prerogative. Consideration should invariably be given to the feasibility of treating the wastes prior to disposal.

Such treatment could include any or all of the following:

(a) Detoxification of the wastes (e.g., by thermal, physical, chemical, biological processes);
(b) Separation and concentration of the hazardous constituents in a reduced volume;
(c) Stabilisation, solidification and encapsulation of the wastes to inhibit leaching.

A. Treatment of hazardous wastes prior to deposition

The wastes deposited in whatever environment is applicable and suitable, can be a mixture of organic and inorganic materials, hazardous and even nonhazardous wastes. They can be solids, liquids, sludges, or a combination of any or all of these. The major environmental risk at sites is from the leaching of chemicals and their mobility and transport to water resources. In many instances it makes sound economic and technical sense to pre-treat hazardous wastes before disposal. Ideally the treatment should be carried out before leaving the producer's site.

Illustrative of the effect of pretreatment on leaching rates is the plot of leaching rates before and after treatment in figure III. In some cases, pretreatment can lead to complete decomposition into harmless materials or to recycling and reuse of part of the wastes, in others to a reduction in volume, but in all cases a reduction in hazardous characteristics will make the waste safer during subsequent handling and transportation. Examples of pretreatment are given below.

Chemical treatment processes could include neutralization, oxidation, reduction, photolysis, precipitation, ion exchange, catalysis, calcination, and fixation.

Examples are:

- Destruction of cyanides by alkaline chlorination, using Na or Ca hypochlorite;
- Reduction in liquid content by settling, filtration, drying or centrifuging;
- Neutralization of strongly acidic or alkaline materials (sludges may form in the process and will require disposal);
- Oxidation or reduction to render wastes less hazardous by conversion, e.g., the reduction of hexavalent to trivalent chromium by ferrous sulphate oxidation;
- Encapsulation or solidification, e.g., by the proprietary SYNROC process, organic polymer coatings, encasement in concrete to reduce mobility in the landfill mass;
- Pretreatment by a combination of methods, e.g., sawdust, ferrous sulphate and lime.

Physical treatment could comprise distillation, evaporation, carbon, resin or mineral absorption, liquid-liquid or liquid-solid extraction, cryogenics, flotation and foam/liquid fractionation, sedimentation, flocculation, filtration, centrifugation, reverse osmosis, gas stripping, dialysis and electrodialysis. All these processes have been proven on an industrial scale and can be readily incorporated in plant operations.

Combinations of measures are sometimes applied, as illustrated in figure III, which shows the decrease in the leachability of copper, chromium and arsenic achieved by pre-treating timber treatment sludges with sawdust, ferrous sulphate and lime.

One of the simpler and relatively less expensive stages in the treatment is to carry out waste separation and concentration at an early stage of the waste treatment process. Even with a minimum amount of waste, it is possible to isolate the more hazardous and/or toxic waste streams from the remainder. Waste separation early in the process stream, as well as simple isolation of similar wastes into separate disposal containers, can reduce waste handling and disposal costs considerably. In addition, the recovery of some of the wastes, either physically (e.g., using pyrolysis) or in the form of energy (from incineration) can improve the cost factor.

Wastes should be treated wherever this is technologically and economically feasible, to convert them from hazardous to less hazardous or non-hazardous materials. Where treatment is not feasible, disposal in a specially isolated landfill repository, such as a chemical landfill repository, may be necessary. The residues generated in treatment processes require permanent disposal.

Waste disposal processing technology, sites, type and applicability depend, among others, on the particular situation, including the type of waste, quantity, phase, degree of toxicity. Possibly applicable technology fills into two main categories:

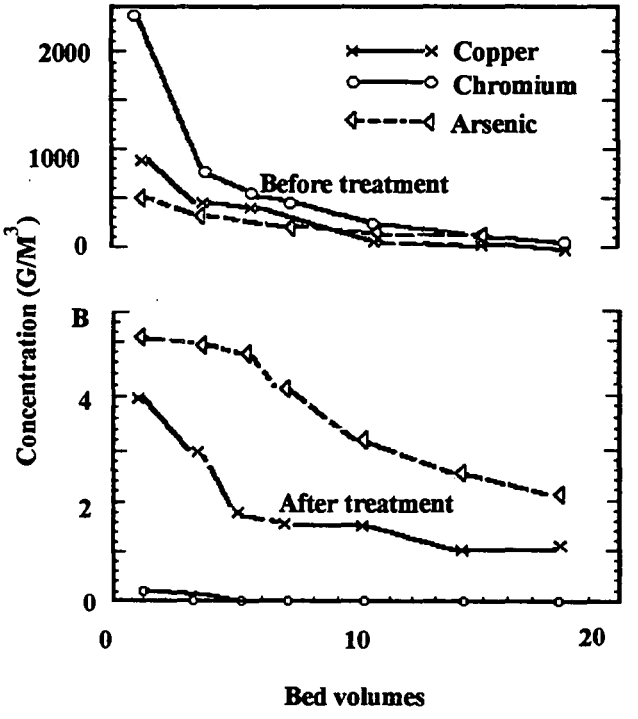
- Physico-chemical pretreatment to detoxify, neutralize, de-emulsify and dehydrate the waste and
- Thermal treatment (incineration, pyrolysis, oxidation, etc.) to reduce the bulk of the waste and the hazard it presents.

In general, where the technology is available, economics is the major determinant of whether or not wastes can be treated before disposal.

Thermal processes refer to methods of degrading hazardous wastes by the application of heat, either in the presence of oxygen (incineration) or in its absence (pyrolysis). A number of technologically more advanced thermal methods, such as plasma arcs and torches, high temperature fluid wall reactors, microwave systems, molten salt reactors, wet oxidation and supercritical water reactors, have been used in the destruction of hazardous wastes. Their application is generally restricted to those chemicals for which other treatment is either not available or too inefficient, as present costs of these methods considerably exceed those for incineration.

Incineration of wastes. With the imposition of increasingly severe restrictions on the direct disposal of hazardous wastes in sewers and landfills, greater usage is being made of incineration processes. When incinerators, equipped with the proper stack scrubbers and/or precipitators are operated properly at sufficiently high temperatures and residence times, they usually yield an acceptable gaseous product for emission to the atmos-

Figure III. Leaching behaviour of timber treatment wastes, before and after treatment to reduce leaching



phere and an inert, reduced volume of ash suitable for disposal in landfill repositories. Figure IV is a schematic flowsheet of an incineration system.

Knowledge of the characteristics of the particular waste to be burnt is a prerequisite to efficient and economic incineration, i.e.:

Organic wastes. Hydrocarbons containing only carbon and hydrogen (as well as small quantities of sulphur) are self-combustible. Burning with the correct quantity of air will yield CO_2, O_2, N_2 and water vapour. Heat in the gaseous products gas can be recovered through a boiler. The presence of sulphur dioxide, if produced, requires caustic scrubbing or other means of removing the gas to ensure clean, acceptable stack emission. For the incineration of [dioxinbearing] wastes, the incinerator must achieve a dioxin removal efficiency (DRE) of 99.9999 per cent for each designated principal hazardous organic constituent (POHC). This performance must be demonstrated on POHCs that are more difficult to incinerate than tetra, penta and hexachlorodibenzo-p-dioxins and dibenzofurans (EPA, 1985).

The DRE is calculated from the equation

$$DRE = \frac{(Win - Wout)}{Win}$$

where Win = mass feed rate of one POHC in the waste stream feeding the incinerator and

Wout = mass emission rate of the same POHC present in the exhaust emissions prior to release to the atmosphere.

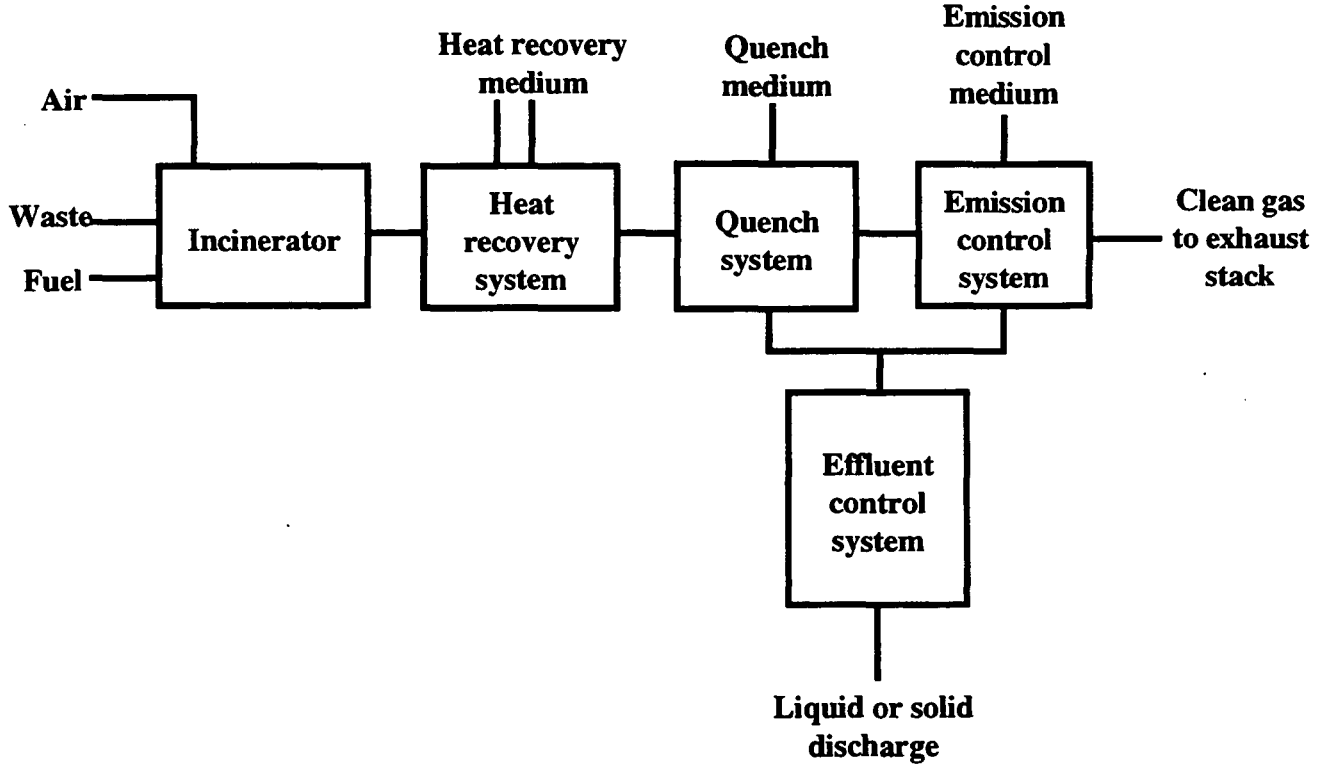
Halogenated wastes. Depending on the halogen content, these may require auxiliary fuel. Halogenated wastes include such chemicals as carbon tetrachloride, vynil chloride, methyl bromide.

Metallic wastes. Inorganic and organic salts such as sodium and potassium compounds are in this category. Upon oxidation, the combustion products will contain these salts in the molten state; the type of refractory material, the oxidation temperature and residence times are thus critically important parameters. Auxiliary fuel is required, because of a possible by-passing of the burner by the wastes, to ensure complete combustion.

Aqueous wastes. These are defined as containing at least 60 per cent water and are therefore not self-sustaining in the combustion process. They will require injection through atomized sprays "down-stream" of the flame zone.

Nitrogen-containing wastes. These include organic compounds having the nitrogen bonded directly to carbon, hydrogen or oxygen atoms within the chemical structure. The chemical bonds between the nitrogen atom and the remainder of the molecule are considerably weaker than the bond dissociation energy of nitrogen. During combustion therefore, these molecules can produce larger quantities of NO_x than is derived by the thermal fixation of N_2. The objective is to reduce the yield of NO_x, which can be done by a two-stage combustion scheme; a fuel-rich condition is first applied, to be followed by oxidising the unburnt hydrocarbons in a secondary combustion chamber,

Figure IV. Generalized process for waste incineration



an alternative is to employ a catalytic NO_x abatement system to reduce stack NO_x emissions to acceptable levels.

Incineration should be a technically planned, engineered process intended to destroy the hazardous nature of wastes. Its function is to apply heat directly or indirectly to destroy the chemical structure of the organic and other compounds and to reduce the volume and toxicity of the residuals. The basic objective is to bring about combustion to as complete a stage as possible and to produce an ash that can be deposited in landfills, at the same time ensuring that stack gases can be disposed of safely. A secondary objective is to carry out the incineration with minimal energy requirements and at minimal capital and operating costs. One of the most important components of an incinerator system is the primary combustor, the system is usually referred to by the type of combustor employed. Secondary combustors ("afterburners") are simply chambers designed to improve destruction efficiencies.

The requirements for an efficient incineration include: completion of the combustion process, facilities for recovering the heat and effective cleaning of flue gases, intimate mixing with sufficient oxygen (and support fuel gas) to ensure complete combustion and maintenance of operating temperatures long enough for oxidation to go to completion. Additional desirable features are the recovery of any valuable by-products and of the energy made available. Table 1 summarizes the applicability of the incinerator-type to each particular type of waste.

1. Incinerator types

A review of the characteristics of the three main incinerators used on hazardous wastes follows.

(a) **Liquid injection type**

Features. Simple, refractory-lined cylinders; applicable to pumpable liquids;

Advantages. No secondary combustion is needed if residence time in primary combustor is sufficient. It is capable of incinerating a wide range of liquid wastes. No continuous ash removal is required. Ther are virtually no moving parts and low maintenance costs;

Disadvantages. Only suitable for wastes which can be passed through a burner nozzle. Burners are susceptible to clogging;

(b) **Rotary kiln**

Features. Cylindrical refractory-lined shell slightly inclined; normally includes afterburners; usually equipped with auxiliary fuel firing system;

Advantages. High versatility, applicable to solids, slurries and contained wastes and liquids; continuous ash removal; retention or residence times can be controlled; can operate at temperatures up to 1400 °C; well suited for the destruction of toxic compounds;

Disadvantages. Needs secondary combustors; high capital costs; spherical or cylindrical items may roll through kiln, high particulate loadings; problems in maintaining seals; drying of aqueous sludge wastes can lead to clinker formation;

(c) **Hearth Incinerators**

Features. Basically a two-stage combustion process.

Advantages. Well suited for sludge disposal; capable of evaporating large quantities of waste-bound water. Versatility in fuel- type. For hearths with a multi-zone configuration, fuel efficiency is high and improves with number of hearths used: adjustable temperature profile (fuel burners);

Disadvantages. Needs a secondary combustor; solid wastes require preheating. Not well suited for wastes containing fusible ash, or wastes which require extremely high temperatures for the destruction of irregular bulky solids;

2. Dioxin wastes

Hazardous wastes grouped under the generic term of dioxins are wastes from the production of certain (chlorophenols and chlorophenoxy) pesticides, using tetra-, penta- and hexachlorobenzines, under alkaline conditions, as well as discarded unused formulations containing tri-, tetra- or pentachlor ophenol and their derivatives. The dioxin wastes are defined by the specific manufacturing processes (EPA, 1985b). Data on the quantities produced worldwide are not completely available, but estimates of the quantities existing in the United States and awaiting final disposal were 5,300 tonnes (in 1985). In the United States, incineration specifications for dioxin wastes must meet the requirements set forth in a series of directives by the Environmental Protection Agency (1985).

Several thermal as well as other processes have either been used for the treatment of dioxin wastes, tested on other chlorinated waste streams or are currently under investigation. These include the following:

(a) **The EPA mobile incineration system**

This is a mobile rotary kiln incinerator, intended to process wastes at the point of generation. The main steps of the process are:

- primary combustion;
- secondary combustion;
- quenching and
- scrubbing.

Trial burns with dioxin wastes indicated that Destructive Removal Efficiencies (DRE's) exceeded 99.9999 per cent for the PHOC's burned (Yezzi et al., 1984).

(b) **The Advanced Electric Reactor (AER)**

The AER (owned by the J.M. Huber Company, Borger, Texas) was specifically designed for on-site detoxification of soil.

The reactor employs a new technology for bringing materials up to temperatures between 2,200 and 2,800°C, using intense thermal radiation in the infrared region. The reactants, which can be either solid, liquid or gaseous, are insulated from the reactor walls by nitrogen gas flowing inward radially through porous graphic core walls. The reactor core is heated to incandescence via carbon electrodes, the heat transfer being effected by thermal radiative coupling from the core to the input of waste materials. Destruction is by pyrolysis rather than oxidation. After leaving the reactor, the gaseous and solid products pass through two post-reactor treatment zones. Solids

Table 1. Applicability of available incinerators to different waste types

Waste type	Rotary Kiln	Liquid Injection	Fluidized Bed	Fixed hearth (controlled air)
Solids				
Granular, homogeneous	*		*	*
Irregular, bulky (pellets etc.)	*			* a
High melting point (tars etc.)	*	* b	*	*
Organic compounds with fusible ash constituents				
Unprepared, large, bulky material		*		
Gases Organic, vapour-laden	* c	* c	* c	* c
Liquids				
High, organic strength aqueous wastes	* d	*	*	
Toxic organic liquids	* d	*	*	
Solids/Liquids				
Wastes containing halogenated aromatic compounds	*	* e		
Aqueous organic sludge	* f	*		

*/ Incinerator is suitable for the particular waste type.
a/ Handles large material on a limited basis.
b/ If material can be melted and pumped.
c/ If it can be properly fed into incinerator.
d/ If equipped with auxiliary injection nozzles.
e/ If liquid.
f/ Provided waste does not become sticky on drying.

exiting from these zones are collected and isolated from the atmosphere, while gases are cleaned of any fine particulate matter by cyclone treatment. Caustic scrubbing effects the removal of any chlorine: any residual organic and chlorine is removed by passing the gas through activated carbon.

The solids will require disposal, while the gas product (composed of almost entirely nitrogen), can be discharged into the atmosphere.

Several tests carried out in 1984 for the process with carbon tetrachloride over a wide range of operating conditions claimed a DRE of greater than six nines (more than 99.9999 per cent).

The potential advantages claimed for this process include its mobility, high treatment efficiencies, intrinsic safety features and detoxification in a pyrolytic atmosphere. The results obtained have led to certification by licensing authorities for destroying PCB-contaminated solids.

(c) **Newer technologies**

Among such technologies using chemical processes is the NaPEG method, developed by the Franklin Institute of Philadelphia, USA, for the destruction of certain classes of toxic chemicals, including PCB's. The process employs a liquid polymeric complex of modified sodium polyethylene glycolates which dechlorinates PCB's over a wide range of concentrations. The reaction can take place in liquids and solids (e.g., soils) to produce disposable water-soluble oxygenated compounds and common salts. Research has been under way with this method to dehalogenate and decontaminate chemical plant effluents, toxic waste spills, pesticide and herbicide residues, as well as for the destruction of selected phosphorus and chlorine-containing chemical warfare agents (United Nations Economic Commission for Europe, 1985).

(d) **Biological methods**

Biodegradation methods are being investigated to develop, identify and test microorganisms capable of degrading highly toxic and refractory organohalide pollutants, including 1,2,7,8-TCDD. However, the toxic constituents can inhibit microbial growth to the point where it is difficult to maintain an active population of microbes to metabolize the hazardous wastes at reasonably rapid rates of conversion. The treatment processes include

Table 2. Treatment processes for solvent wastes

Potential applicability		
Aqueous and mixed aqueous/organic solvents	**Organic solvents**	**Solvent sludges**
Phase separation	**Solid removal**	**Organic component separation**
Decanting/sedimentation	Sedimentation/filtration	Air or steam stripping
Filtration	Centrifugation	Evaporation
Flotation	Flotation/evaporation	Drying
Centrifugation		
pH adjustment		
Dissolved solids		
Precipitation		
Organic component separation	**Organic component separation**	**Organic chemical destruction**
Air or steam stripping	Fractional distillation	Incineration
Fractional distillation	Solvent extraction	Wet oxidation
Solvent extraction	Resin adsorption	
Carbon or resin absorbtion	Steam stripping	
	Air stripping	
Organic component transformation	**Organic component destruciton**	**Stabilization/solidification**
Biological degradation	Incineration	Cement base fixation
Chemical oxidation		Pozzalonic fixation
Incineration		Urea-formaldehyde polymerization
Wet oxidation		Thermoplastic encapsulation

activated sludge, composting, trickling filters and aerobic and anaerobic waste stabilization lagoons, generally referred to as land treatment.

With reference to 2,3,7,8-TCDD, research has not yet identified an organism capable of treating this pollutant. An organism known as white rot fungus (Phaenerochaete Chrysosporium) appears to be "very promising", although the work is still at bench-scale test stage. The fungus secretes a unique hydrogen peroxide-dependent oxidant capable of degrading lignin, but it is also effective in degrading organohalides such as lindane, DDT, 4,5,6-trichlorophenol and 2,4,6-trichlorophenol. Tests have been proposed and are being planned at several contaminated sites in the United States with the enzyme system (Bumpus et al., 1985; EPA, Office of Research and Development 1985).

3. Solvent wastes

These materials include halogenated and non-halogenated solvents, mostly toxic and some ignitable, and with sludges and still bottoms produced in their recovery. While hitherto their disposal was usually with the land disposal method, this practice has become restricted; of the 3.1 billion gallons of solvent wastes generated in the United States in 1981, 1.2 billion gallons were restricted. Without prior treatment, the low molecular weight of the organic constituents may favour reaction with synthetic liners used in landfills; in addition, their volatility may lead to emissions to the air at the disposal sites.

Modification to the land disposal method includes:

- Processing to remove toxic or flammable constituents;
- Destructive treatment, including oxidation and
- Recycle and re-use (including use as a fuel).

Alternatives to direct land disposal are generally applicable to all types of solvent wastes. The choice of which alternative to use will depend on the composition of the waste, the quantities involved and costs of the particular treatment.

Because they contain solids, solvent sludges require modifications in treatment. Possible applicable treatment processes include air and steam stripping, evaporation and drying (for organic component separation), organochemical destruction by incineration, wet oxidation and stabilization/solidification (to treat waste streams too toxic to be bio-degradable and too diluted for incineration). For the latter, cements, fly ash, lime, pozzolans and other materials are being investigated in the United States by the Environmental Protection Agency (Wiles, (N.D.)).

Recycling of those solvent wastes containing sufficiently high quantities of liquid organics for economic recovery is practiced widely; wastes with a sufficiently high BTU and low chlorine content can also be used as substitutes for fuel.

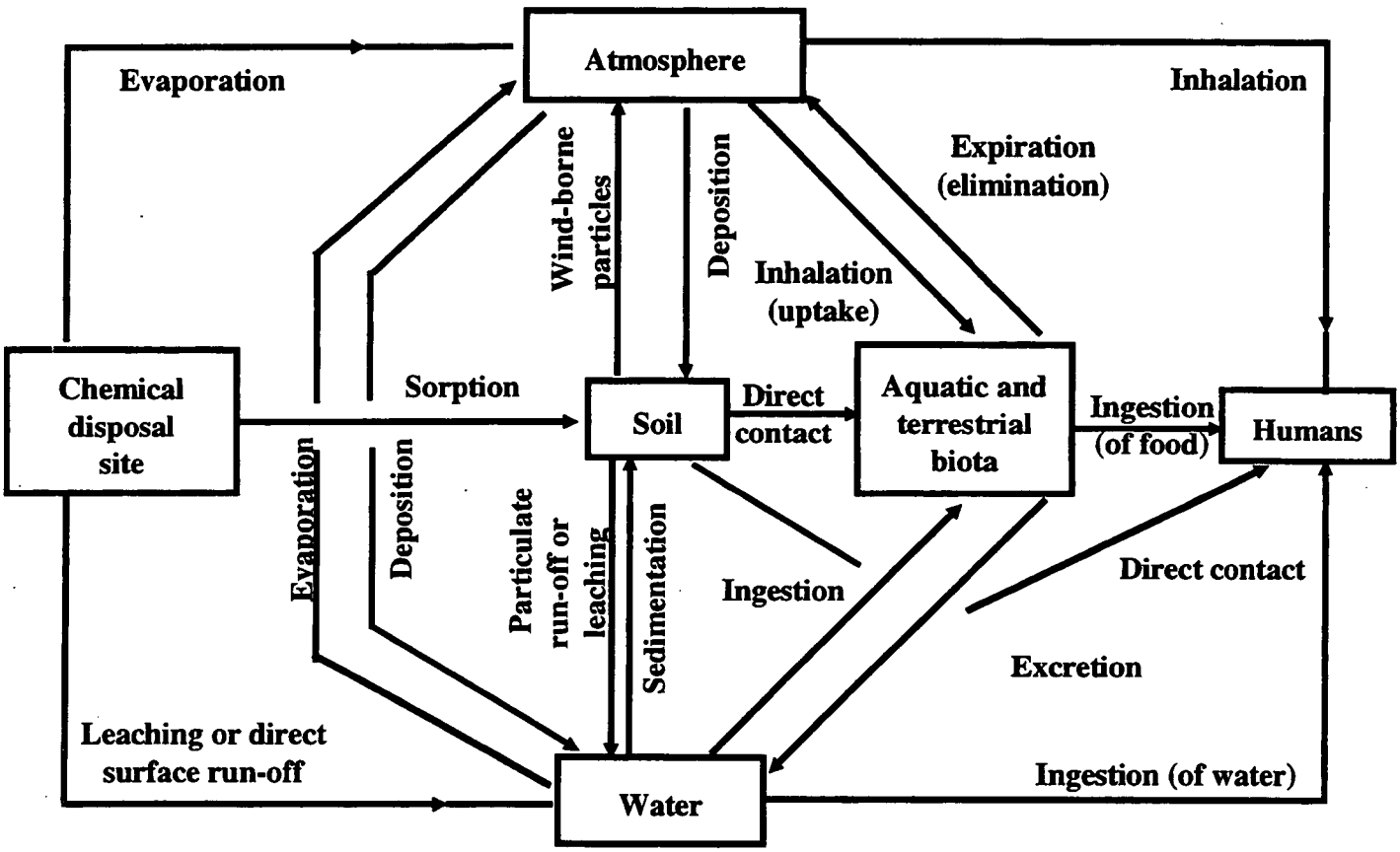
The series of waste treatment techniques by which solvents can either be recycled or prepared for environmentally acceptable deposition are shown in table 2.

B. The disposal of hazardous wastes

1. General

The term "hazardous wastes" covers a range of industrial and other wastes, the disposal of which calls for special procedures, either because of their hazardous nature or physical characteristics. However, as would be expected, such wastes necessitate special consideration at all stages of development. The

Figure V. Physical and biological routes of transport of hazardous substances, their release from disposal sites and potential for human exposure (adapted from van Hook, 1978)



characteristics of difficult wastes are wide ranging; therefore, each site must be judged on its merits and suitability for the types of waste it can receive and appropriate control procedures must be adopted; generally, more stringent measures are called for, compared to those employed for the disposal of household or similar wastes. Carefully planned management, maintenance and monitoring of repository sites, during the time they are operating as well as over the required periods of time after closure is essential to assure their effective isolation over the required period of time.

2. General environmental effects

The environmental effects of repositories containing difficult industrial wastes—that is, the effects on landscape, ecology and the local community is generally no different from those taking only household and similar wastes. Nevertheless, it must be acknowledged that repositories receiving industrial waste will be perceived as constituting a greater risk to health and safety in the locality concerned than those that do not. It is correspondingly even more important therefore, that operators of difficult waste repositories should take all possible steps to establish and maintain good relations with the local communities. There have been instances in the past when poor design and site selection and poor management have led to leakages of contaminants to groundwater and this has caused severe impact on water supply quality and a great deal of adverse publicity. In fact even today, industrial wastes as well as municipal refuse are being disposed of clandestinely or in an otherwise uncontrolled manner.

3. Categories of hazardous waste repositories

There are at least six distinct categories of hazardous waste disposal methods:

(a) Ocean disposal and other aqueous environments;
(b) Landfill repositories;
(c) Surface impoundments;
(d) Land treatment and
(e) Sub-surface disposal: deep burial deep well injection (for liquid wastes) disposal of contained liquid wastes via mine shafts to underground caverns.
(f) Ocean disposal.

The oceans and their near-shore shallow zones have long been used as disposal sites and for the dilution of liquid wastes. The wastes are usually piped to some release point or carried to sea by barges, where they are either dumped without prior treatment or they are incinerated before dumping.

The availability of the alternative of ocean dumping for disposal of last resort is being increasingly questioned, as it is causing concern over the likely tolerance of this resource. In fact, in some marine environmentalist oppo-

nents of this method of disposal allege that the limit has already been reached. The prospect of causing destruction to the environment and to the biosphere is real; concern has motivated investigations into the requirements for controlling disposal into the oceans. Systems that have been investigated include portside pretreatment processes, such as mixing, physical-chemical treatment, encapsulation and the use of concrete containers.

Research is required on the kinds and limitations of direct ocean assimilation. There is also a need to investigate the feasibility of using controlled ocean confinement systems. Examples of such proposals include the concept of injecting wastes, as liquids, sludges or even solids into sediments occurring in grabens along the edges of continental plates, particularly in such locations with subduction zones; others include the use of salt domes located in the oceans and of drilling injection wells. The latter technique could be somewhat similar to the use of deep injection wells on land, except that the injection point at sea would be an off-shore platform or ship. Clays located in deep ocean basins would form suitable host environments, because of their high ion-exchange coefficients and their impermeability.

Ocean dumping and incineration at sea is now regulated by international and national legislation, but a major drawback is the inadequate information that is available on the impact and relative lack of agreement by scientific experts of ocean dumping on the marine environment. The most relevant rules governing disposal at sea include the Oslo Convention for the Prevention of Marine Pollution Dumping from Ships and Aircraft (15 February 1972) and the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matters (September 1975). The latter restricts the sovereignty of states with regard to ocean dumping and prohibits the dumping of high level wastes. It requires that dumping is not permitted without the prior authorisation of competent national authorities, who must give careful consideration to possible environmental effects. The Convention encourages collective action through appropriate international bodies

4. Other aqueous environments

Aqueous wastes may be stored in ponds, lagoons and pits. They could be regarded as a type of long-term storage or as a means of enabling biodegradation to take place. For other wastes there are settling ponds to allow solids to settle prior to the discharge of effluents to surface waters.

Land disposal of hazardous wastes represents the permanent placement of solid, liquid, sludge, or contained gases in or on the land. It is expected that a portion or all of the wastes will be present at the site at closure. Unless the waste is totally and permanently contained, mobile contaminants could migrate from the location at which the waste was originally placed. It is the migration of (a) components of the original waste or (b) decomposition or reaction by-products, as run-off, leachates or gaseous emissions which must be controlled at a disposal site.

Careful evaluation of the relative risk associated with the land disposal of hazardous wastes is needed. Table 3 indicates which determinations are important when land disposal alternatives are being considered and evaluated.

Figure V illustrates some of the environmental parameters requiring consideration when selecting a land disposal site. As precipitation and surface water percolate through the disposal area, contaminants can be solubilized and carried to the water table where they are transported through the groundwater. The contaminated leachate will exist as a plume in the groundwater because of incomplete mixing and diffusion. Transport to and through the saturated zone can be slow. Clay soils retard such transport to a greater extent than sands or gravel, partly because of high adsorption in the clays. If drinking water or irrigation wells intercept the contaminated leachate or if the leachate enters surface waters, adverse environmental and public health impacts could occur. Surface waters could be contaminated by run-off from the disposal sites.

Other adverse environmental impacts could also take place. Contamination of the air may occur by loss of volatile waste components, by gases emitted from the surface or within the site and by wind-borne contaminated particles. In addition, vegetation growing on the site may be contaminated by waste that may adhere to leaves and by the uptake of constituents such as metals and other chemicals.

A hazardous-waste land disposal facility is designed and operated to avoid human health exposure and to minimize migration of contaminants from the site. Emphasis is placed on approaches that reduce the possibility of contaminating surface or ground waters, that control gaseous emissions and wind erosion and that prevent adverse food-chain impacts. These approaches involve one or more of the following:

(a) A Natural impermeable containment possibly reinforced by a man-made impervious liner;
(b) Diversion of off-site surface run-on, and control of any on-site run-off;
(c) Incorporation of the wastes in the soil;
(d) An impermeable cover for landfills and

Table 3. Determinations important in the evaluation of a candidate hazardous-waste land disposal site

- Analysis of the wastes to be applied;
- Identification of reactions or decomposition by-products expected to occur;
- Determination of soil, hydrogeological, seismic and surface characteristics;
- Assessment of the transport and fate of mobile waste constituents and byproducts;
- Assessment of the environmental and health impact of the mobile components if such constituents reach critical receptors (humans, animals, plants) in the ecosystem;
- Nature, type and extent of the environmental impact that could affect the nutrition chain, the biosphere and plant life-cycle.

(e) Avoidance of food chain vegetation on the surface of the site.

5. Landfills

Description Landfill repositories are disposal facilities where hazardous wastes are stored in sub-soil or rock and then covered. In order to prevent/minimize problems that could arise through improper siting, some of the more general procedures needed are listed in table 3.

6. Migration of contaminants

An important consideration when selecting the type of disposal facility is the characteristics and integrity of soils and rock as well as their capacities to absorb, retain or transmit waste materials, and their reaction products of known physical and chemical properties. Furthermore, it is essential to know the intensity, timing and transformation of wastes to less harmful constituents to estimate the timing required for their isolation.

Figure V shows diagrammatically the possible routes by which pollutants can migrate and are transported from waste deposits to the biosphere. Ground water movement is the main route by which hazardous wastes could migrate after penetrating beyond the near-term engineered barriers from the repository.

Investigations of the occurrence, distribution, volume flow of groundwater, its chemical characteristics and properties (pH, eH, redox potential etc.) are important components in the evaluation of a repository site.

The persistence of a hazardous organic chemical is a critical determinant of its environmental fate. Certain compounds can undergo chemical or biological degradation at repository sites, while others resist any transformation. The pattern of degradation is not only influenced by the characteristics and properties of the particular chemical, but also by the nature and conditions of the site. Degradation reactions could continue or be initiated during the transport of the chemical in the leachate and in the groundwater.

The major chemical processes associated with the degradation of organic contaminants are hydrolysis and oxidation; the latter is considered to be particularly important in the degradation of phenols and aromatic amines. Despite this qualitative assessment, the overall significance of chemical reactions in degrading toxic material at disposal sites is not entirely understood. The results of laboratory studies on chemical degradation cannot be fully applied in the field and it cannot be assumed that chemical degradation will occur to the same extent or even occur at all in different disposal sites.

A further possible hazard in a repository is that reactive chemicals can come into contact, possibly causing fires or explosions. Care must be taken to avoid the co-disposal of incompatible wastes. reactions between such wastes could include:

- Exothermic reactions, e.g., caused by alkali metals and strong oxidising agents, may result in fires or explosions;
- Production of toxic gases such as arsine, hydrogen sulphide and chlorine;
- Production of flammable gases such as hydrogen and acetylene.

Biological processes are a significant means of degrading contaminants at a disposal site. Microbial transformations could occur in the landfill itself (as well as in the groundwater), leading to the formation of harmless or less harmful products. Alternatively, these processes could lead to the synthesis of persistent and toxic compounds, for example vinyl chloride, which resist any further degradation. The degradation of many contaminants is favoured under aerobic conditions, a condition which usually prevails at the surface of a disposal site.

Anaerobic conditions predominating in landfill sites favour the bacterial reduction of sulphates, nitrates and carbohydrates. The reduction of sulphates leads to the generation of sulphides, nitrates are reduced to nitrites or ammonia. Where metals such as inorganic mercury are present, sulphides produced under anaerobic conditions could bring about a marked reduction in dissolved metals by precipitation of insoluble sulphides.

Gaseous components could also be produced through the bacterial activity, especially where domestic wastes are co-deposited with hazardous wastes. These gases are usually carbon dioxide and methane, to a lesser extent hydrogen sulphide. The main parameters influencing the production rates of the gases and their composition are temperature, moisture, waste density and pH. The decomposition rates of some organic wastes are so slow that significant quantities of methane may be generated years after the waste from which they are released has been deposited. "Landfill gas" can be the cause of serious fires and explosions at sites at a methane concentration range of 5-15 per cent. There must be a means of allowing the controlled release of gases.

Volatilization is a potential route of loss from landfill sites, particularly with certain organic compounds, such as chloroform, due to their high vapour pressure. The elevated temperatures encountered at many disposal sites result from bacterial activity and enhance the upward movement and dispersal of volatile organic matter.

7. Migration from landfill sites

The transport of waste oils from landfill sites was examined in several research projects (Mather & Day, (N.D.); Williams et al., 1984), when landfill sites containing mineral oils and refinery wastes were investigated. The movement of these pollutants through various geological strata was studied to examine the attenuation mechanisms and corresponding pollutant concentrations within saturated and unsaturated strata beneath the sites. Field tests and laboratory experiments showed that sorption processes are the most significant for retarding the movement of mineral oils migrating through solid waste and unsaturated strata. Oil wastes discharged to lagoons migrate considerable distances, both within a thin saturated glacial sand aquifer and a shale/sandstone succession. In both of these cases the oil migration occurred, because the landfill sites were overloaded with a far greater volume of oil than could be sorbed by the underlying solid waste and bedrock; co-disposal of oil wastes with certain industrial and domestic solid wastes is likely to prove effective, provided that the sorptive capacity of the solid wastes is not exceeded. where large volumes of oil or oil/water emulsion are discharged and exceed absorbent capacity of the

underlying strata and solid wastes, a much more severe deterioration of groundwater will result, since the immiscibility of oil and water inhibits dilution.

Another project (Williams et al., 1984) studied the dispersion pattern of liquid wastes containing heavy metals (such as Pb, Zn, Ba, Ni, Cu, Cr) and organic solvents into lagoons excavated beneath the water table in a shallow, unconsolidated sand aquifer, which had caused local groundwater pollution.

Williams found that the geometry of the pollution plume is controlled by the morphology of the aquifer, its permeability, its distribution and the head distribution in the vicinity of the lagoons. There was a transition from strongly reducing conditions near the lagoons and the base of the aquifer to oxidising conditions in the natural groundwater. Based on redox reactions, three geochemical zones were identified down the hydraulic gradient. It is found that heavy metals are attenuated within a short distance from the pollution site, probably as a result of precipitation as sulphides and carbonates. In contrast, organic wastes travel a considerable distance in solution, some in excess of 300 m from the site. It was found that biodegradation of the organic wastes is not significant, due to the relatively impervious till overlying the sand, which prevented the sand aquifer from being replenished with oxygen, a necessary ingredient in the biodegradation processes.

8. Factors requiring consideration in planning and operating a landfill repository

The primary consideration for the planners, builders and operators of landfill repositories is their isolation from the environment. The design and management of landfill repositories should be directed toward the objective of preventing leachate formation as much as possible-and to set up technical barriers in areas with favourable soil conditions to do so. The following aspects therefore require consideration:

- Avoidance of unrestrained liquids in or near the wastes (liquid wastes will require dewatering and/or solidification);
- Divergence of surface waters, including any likely meteoric waters, for example, from rain, snow, etc.;
- Use of relatively impermeable material in the temporary and final covers to reduce the infiltration of Waters and the migration of leachates as much as possible;
- Waste compaction;
- Isolation of different parts, using the multicell principle;
- Collection and treatment of any leachates;
- Degassing of repository under controlled conditions;
- The monitoring of groundwaters, through wells and surface waters;
- Evaluation and choice of suitable technical barriers and
- Decision for monodisposal or multidisposal operation (co-deposition of compatible wastes).

Landfill repositories are often made up of cells in which a discrete volume of the hazardous waste is kept isolated from adjacent cells and wastes by a suitable barrier. Barriers between cells commonly consist of a layer of natural soil (e.g., clays), which restricts downward or lateral escape of the hazardous waste constituents or leachates.

Figures VII and VIII show a cross-section of a hazardous waste landfill. The daily intermediate and final cover that represents proper operating conditions, the discrete cells of the landfilled material and the use of liners and a leachate collection system are portrayed. Liners, covers, operating conditions and closure and post-closure of landfills are discussed in subsequent sections.

Landfilling relies on containment rather than treatment or detoxification for control of hazardous wastes. Technologically, it is an unsophisticated method of containment. It is a common method of hazardous waste management for both untreated wastes and the residues from treatment processes.

Appropriate liners to protect the groundwater from contaminated leachate, run-on and run-off control, leachate collection and treatment, monitoring wells and appropriate final cover design are integral components of an environmentally sound hazardous waste landfill.

Although there have been instances of groundwater being contaminated by landfills, they remain a key hazardous waste management strategy barring of course their use in hydrogeologically completely unacceptable conditions. The majority (about 68 per cent) of hazardous wastes handled at North American facilities and about 47 per cent of such wastes handled at European facilities are disposed of by landfilling. In the United States alone, over 75,000 industrial landfill facilities were in operation in the early 1980s.

The primary concern is to prevent groundwater-contamination. Design and management attention emphasizes approaches to prevent formation of leachate and leachate migration. These approaches include:

(a) Elimination of free liquids (liquid wastes are dewatered or solidified before placement);
(b) Diversion of surface waters (run-on);
(c) Use of relatively impermeable daily and final covers to minimize infiltration of precipitation;
(d) Compaction of wastes;
(e) Use of cells throughout the landfill;
(f) Collection and treatment of leachate and
(g) Groundwater monitoring. Approaches to keep water out of landfills are noted in table 4.

Table 4. Measures needed for preventing water from penetrating hazardous waste landfills

- Correct siting, avoiding wetlands, flood plains and areas of high groundwater;
- Diversion of surface run-on;
- Minimization of exposed waste surfaces;
- Avoidance of ponding due to precipitation in the site area;
- Use of suitable intermediate cover material;
- Prompt covering and closing of inactive areas;
- Appropriate closure and post-closure management, including a well designed monitoring and maintenance

Ideally, landfill sites should be underlain by significantly thick layers of impermeable clay and should also be in a tectonically and seismically stable area. Whenever possible, they should not be located above aquifers.

Adequate records should be made and kept, for example the location and dimensions of each cell in the landfill should be recorded, as well as its contents, i.e. analyses, quantities of waste contained, types of containers and matrix and liner materials utilized.

Careful assessment of a site prior to selection and utilization is a prerequisite. Such assessments should include detailed knowledge of the type of soil covering the site, local availability and characteristics of clays and their sorption and desorption characteristics, location and distribution of groundwater and surface waters, tectonics and seismics, location and analysis of neighbouring wells, etc. This information is essential for the technically and economically sound operation of a landfill. It has already been indicated that for some types of wastes, pretreatment measures before disposal include:

- Detoxification;
- Separation and concentration of hazardous constituents in a reduced volume;
- Containment of the waste in barrels, capsules, concrete caissons or other types of technical barriers. In addition, the waste may be contained in an isolating matrix material before placement in the surrounding barrier material;
- Stabilization and solidification.

Regulations on how landfill facilities must be operated have not always been adhered to in the past, in some instances even in the most technically advanced countries. For example, in the United States, 70 per cent of such repositories are reported to have no lining, while 95 per cent have no groundwater monitoring system to detect toxic contamination. In a study of 50 industrial landfill sites in the United States, about 80 per cent containing specific types of hazardous materials were releasing "small fractions" of these pollutants into the ground. In the same country the extent of the problem remains yet to be fully evaluated. As long ago as 1979, the U.S. Environmental Protection Agency (EPA) estimated that there may be 1,200 to 2,000 disposal sites that may pose significant risks to human health. One of the more prominent examples of such a site is the notorious Love Canal at Niagara Falls, New York (Keller, 1985), where migrating contaminants presented serious health hazards to local residential areas.

Despite difficulties experienced in enforcing regulations on operating landfills in the past, it is expected that this method will continue to be utilized in the future. There is now a trend to apply engineering concepts more rigorously in new landfill facilities, including the collection of any leachate escaping from the immediate surroundings of the repository, followed by analysis and treatment and the monitoring of all underground and surface waters. Standards for monitoring include an observation period of at least 30 years after closure. In addition, provision is now made for a double liner under the waste material and a cover, which must include a venting arrangement for emanating gases, which must also be monitored.

9. The co-disposal variation of landfill repositories

Co-disposal pertains to the properly controlled joint deposition of selected hazardous wastes at a certain predetermined ratio and is designed to degrade and reduce organic contaminants or inorganic constituents to lower or even background levels, by physical, chemical or biological reactions between the different wastes deposited.

To do so safely and effectively, certain pre-conditions must be met; these include:

(a) The attenuation process within the landfill must be clearly identified;
(b) The chemical composition of the waste should be known (good record keeping, showing type and quantity);
(c) Leachability (determined by standard tests) should be known (USEPA, 1980, Young & Wilson, 1982);
(d) Pretreatment of wastes may be required before disposal;
(e) A study of compatibility must be carried out to ensure that the products of any reaction are significantly less noxious than either of the reactants.

The co-deposited material could be different types of hazardous wastes and even municipal refuse. Each type of waste is deposited up to a maximum "loading rate". The particular waste suitable for co-disposal is selected on the basis that it will interact with the co-deposited waste, leading to degradation of certain organic contaminants or the attenuation of inorganic toxic matter, ideally to background levels. Proponents of the co-disposal concept claim that this type of repository is less likely to cause future problems of contaminated sites rather than the alternative of disposal as segregated wastes, whose entombment could in effect be an open-ended storage requiring interminable monitoring and control. The practice of co-disposal is a method which does not require the complete isolation of the waste, but rather a controlled interaction. The method has been developed and applied in a number of countries, including the United Kingdom and New Zealand (Thom, N.G., 1986). Unfortunately, in some countries, controls over hazardous wastes are either recent or have not yet been enacted. As a result the uncontrolled disposal of such wastes on municipal or other landfill sites remains a widely used practice. The wastes encountered at landfill sites-can be a complex mixture of organic and inorganic hazardous chemicals in combination with other non-hazardous materials wastes can be solids, sludges, liquids or a combination thereof. The major environmental risk at the sites is from the leaching of chemicals and the resulting contamination of water sources.

A number of physical and chemical factors are important in determining the behaviour of chemicals in the environment; these can act in a complex. and interrelated series of reactions which may themselves be dependent on the geochemical properties of the host formation and adjoining geological formations. Generally, the higher the water-solubility of a chemical substance, the greater is its potential for leaching from the landfill site. Many hazardous organic compounds display low water solubilities, although water-soluble solvents, such as chloro-

Figure VI. contaminant transport from a land disposal site

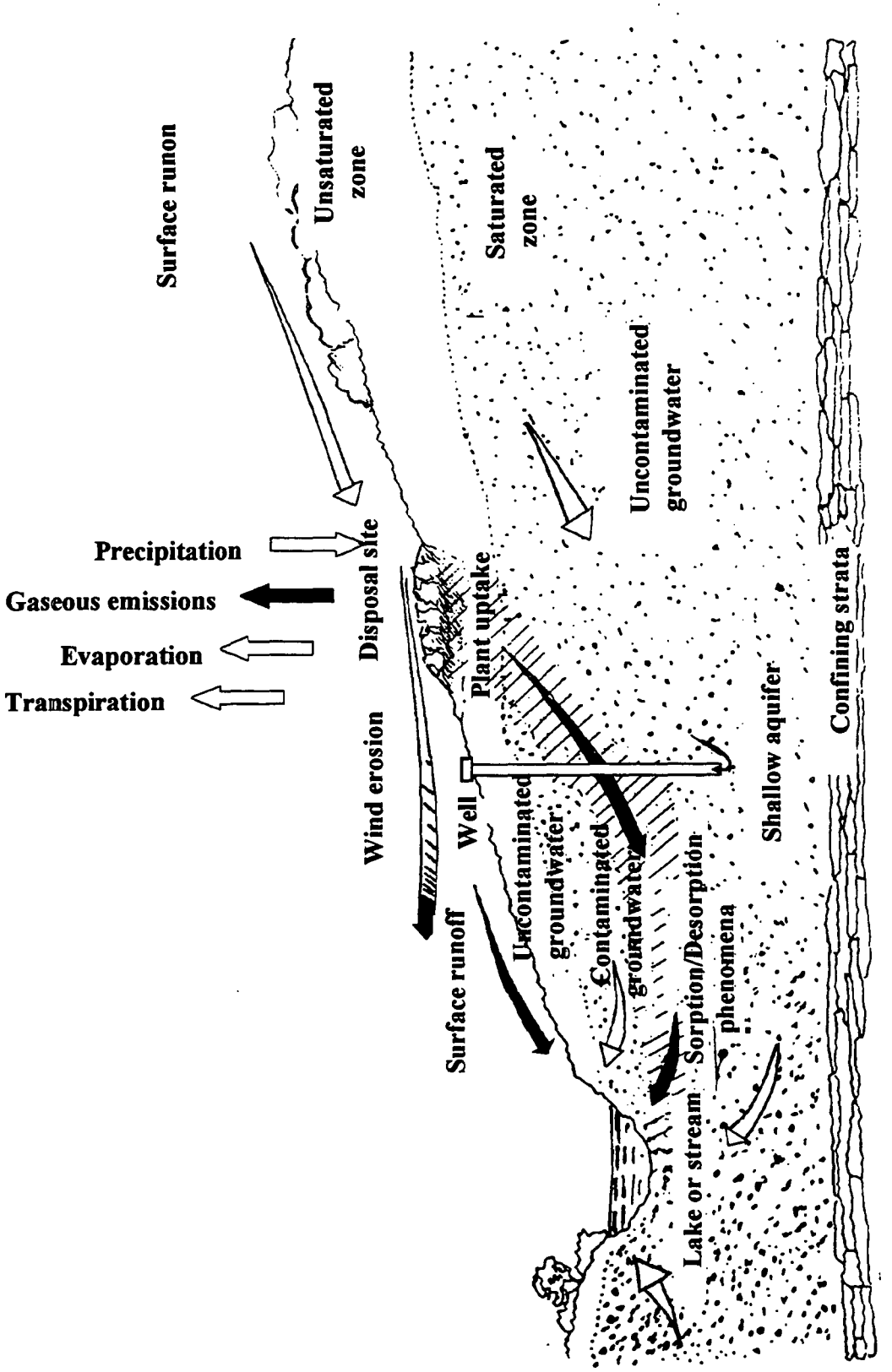


Figure VII. Schematic cross-section of a cellular landfill repository

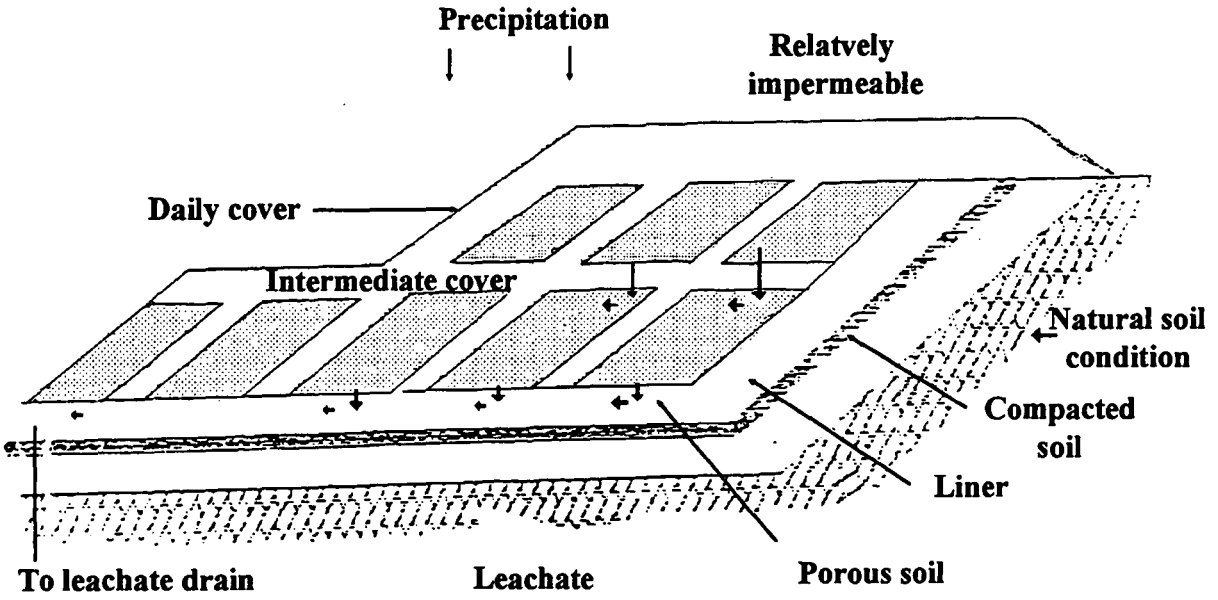
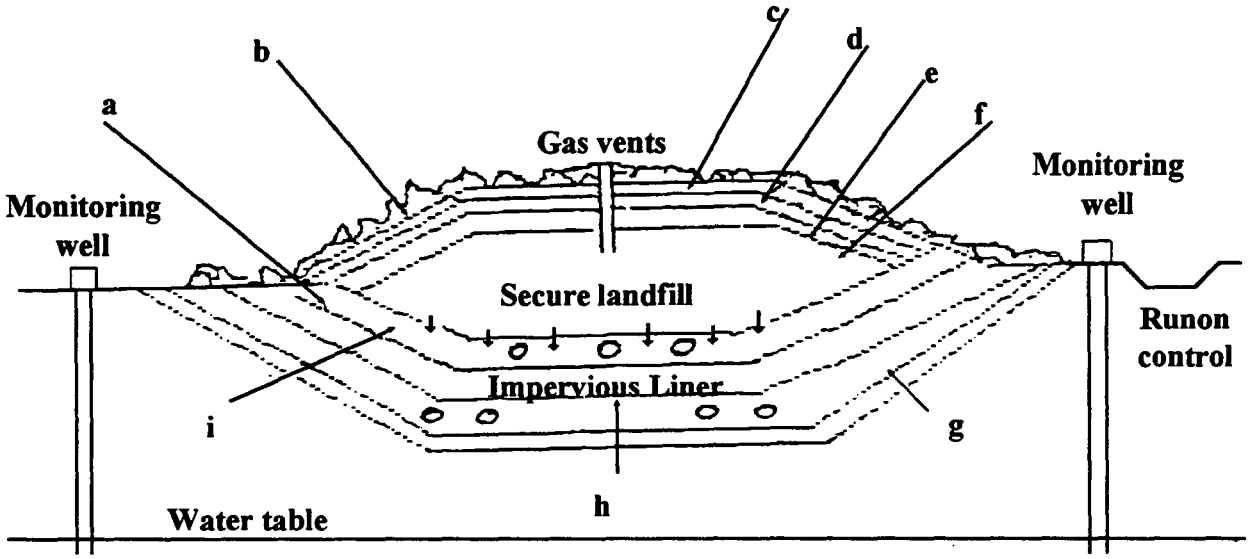


Figure VIII. Schematic cross-section of a secure landfill



a/ Pervious layer for liner protection and leachate colleciton for treatment;
b/ Slope stabilization (vegitation cover);
c/ Final landfill surface;
d/ Soil layer to establish vegitation;
e/ Sealing layer;
f/ Intermediate layer;
g/ Secondary liner;
h/ impervious liner;
i/ Leachate collection (pumped to wastewater treatement plant).

form, can enhance the leaching rate of organic compound in landfills (NUREG, 1981). A similar situation prevails when emulsions are produced

In many cases inorganic chemicals ionize on contact with water. Trace metals can form complexes with enhanced solubility. Cyanides may also solubilize trace metals by complex formation. Bacterial degradation of domestic waste producing fatty acids can lead to the formation of soluble complexes with metals.

Adsorption on soil particles or waste materials is a significant phenomenon, because it reduces the dispersion of inorganic and organic pollutants to the environment and can be an important process in inhibiting the migration of oil wastes. An organic compound with a low soil adsorption coefficient will generally tend to migrate away from the landfill site. An example of such a compound is phenol, which is not only highly water-soluble, but has a low adsorption coefficient and which migrates rapidly.

The vapour pressure parameter is also an important factor influencing migration rates for certain hazardous chemicals. Compounds with high vapour pressures, including chloroform, will migrate by volatilization at higher rates. In contrast, compounds with low vapour pressures and low soil adsorption coefficients will migrate more by the liquid leaching process from the repository site.

An understanding of the chemical, physical and biological reactions occurring in a waste repository is important when assessing their impact in the controlled deposition of wastes (monodisposal or codisposal) and in the attenuation of their hazardous characteristics.

The main processes occurring in a landfill are illustrated in figure IX, which shows the entry of water, the formation of leachate and the way in which materials may leave the landfill. Attenuation processes occur within the refuse, at the refuse/oil interface at the base of the landfill, in the unsaturated zone and in the final aquifer or receiving water.

10. Processes that can occur within a repository Formation of Primary leachate

Water diffuses through municipal refuse and comes into contact with the hazardous material. With perimeter drainage and good covering, the amount of leachate produced will be much less than the rainfall (approximately 20-30 per cent). This is due to evapo-transpiration and the fact that refuse has a significant capacity to absorb liquids.

(a) **Leaching of the contaminant from the hazardous waste**

Highly soluble inorganic salts such as sodium fluoride will be very mobile, whereas insoluble complex organic compounds such as polychlorinated biphenyls (PCBs) are substantially immobile. The influence of pH of the leachate on solubilities is the basis for standard leaching tests.

(b) **Biodegradation**

Some hazardous wastes will biodegrade within the refuse. Chlorinated phenols and cyanides, for example, will break down under the aerobic conditions that exist near the working face, and during the early decomposition stages Decomposition of a range of organics can also occur during the anaerobic stage.

(c) **Chemical reactions**

There is significant potential for chemical reactions to occur within the refuse site. A simple example is neutralization. Stabilized municipal refuse has a marked ability to neutralize acids.

It is also possible that chemically complex compounds will be formed, involving ligands from the organic material and acids (e.g., humic acid and fulvic acid). These compounds may have significantly different values in properties such as solubility. However, there should be a degree of caution e.g., while most metal complexes are largely insoluble, the presence of acetic acid may give rise to metal compounds such as lead acetate or zinc acetate, both of which are extremely soluble.

Metals may precipitate as hydroxides, carbonates or sulphides, and this is particularly effective in immobilising copper compounds. Oxidation-reduction reactions may also occur.

(d) **Volatilization**

By analogy with normal soil-atmosphere oxygen exchange, there is a basis to expect as much as a 25 per cent exchange of gases per day between the atmosphere and the top one metre of refuse. There is therefore significant potential for loss by volatilization. This could be a mechanism for the loss of low boiling point solvents if co-disposed; the rate of volatilization would be increased in aerobic areas, where temperatures significantly above ambient would exist.

(e) **Absorption**

The ability of refuse to absorb water and hence aqueous solutions has already been commented upon. Oils may also, within limits, be absorbed by solid wastes, and many metals in solution can be removed by sorption.

11. Processes occurring at the refuse/soil interface at the base

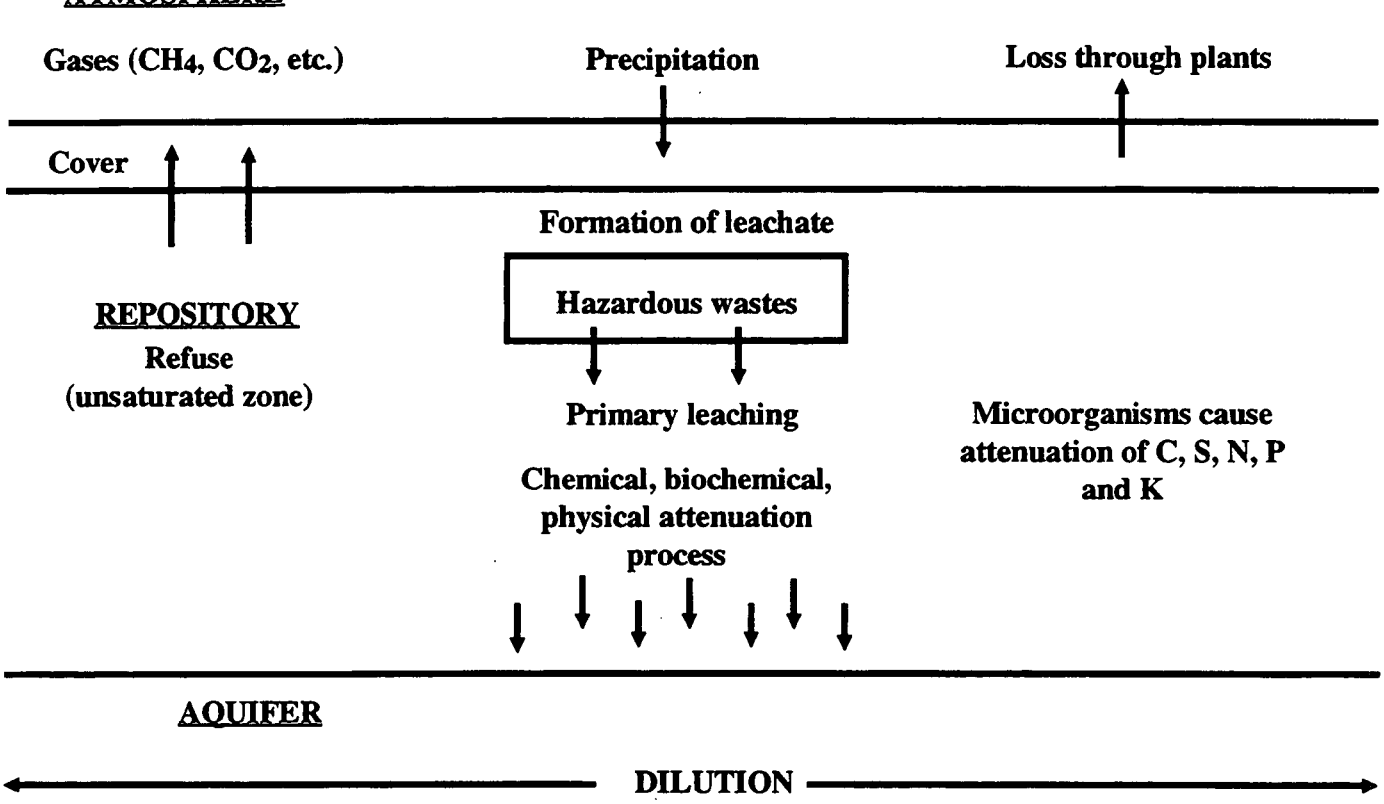
Biological, chemical, and physical processes will occur in the general zone between the base of the refuse and the underlying soil strata. These processes include further biodegradation, precipitation, sorption, filtration and dilution. The actual attenuation provided will be particularly influenced by the chemical nature of the waste and the characteristics of the underlying soils. Co-precipitation of metal ion species during the precipitation of ferric hydroxide in this zone can markedly reduce heavy metal concentrations in the leachate.

12. Processes occurring in the unsaturated zone below the landfill and above the underlying aquifer

A properly sited, attenuated and dispersed landfill should have an underlying unsaturated zone. The presence of this zone will provide further opportunity for leachate attenuation by physical, biochemical and geochemical processes.

Physical processes include dilution, dispersion and filtration. Where liquid flow is intergranular the presence of entrapped air will reduce permeability significantly, thus reducing the rate of

Figure IX. Main chemical and physical processes in a landfill repository



flow of leachate into the underlying aquifer. Biochemical processes in the unsaturated zone will further break down many organic compounds. Nutrient requirements for micro-organisms will cause attenuation of elements such as carbon, sulphur, nitrogen, phosphorus and potassium in the leachate.

There are many geochemical processes which can provide significant attenuation of hazardous components. Most rocks and soils, for example, have marked buffering capacities and can cause an increase in the pH of acidic leachate. This in turn would reduce the solubility of many metals. It was found for example that of the clay minerals, montmorillonite attenuates heavy metals more than illite, which in turn attenuates more than kaolinite.

Also in terms of relative affinity, for kaolinite at pH5

Mixed minerals such as sand with clay can also provide significant attenuation of some chemical species. For example, silt/clays and clay/loams act to immobilize arsenic.

13. Processes within the groundwater aquifer

$$Cr^{3}+ > Cu = Pb > Cd > Zn > Cr^{6}+ > Se.$$

Within the groundwater zone, all the processes referred to above will operate to an extent, but dispersion and dilution will predominate. Dilution may, however, be ineffective with hydrophobic materials such as oils. The depth of this zone, the speed of flow, and the mixing of the leachate with the groundwater will be the main factors.

14. Management of co-disposal landfills

The objective of co-disposal of various types of compatible wastes is to initiate or accelerate processes leading to a reduction in toxicity. The safe co-disposal of hazardous wastes relies heavily on informed management at the landfill site. Landfill operators should have adequate protective clothing and equipment immediately available and be trained in its proper use.

Consideration must be given to the compatibilities of various wastes as the mixing of some may cause fires or explosions, cause the formation of toxic gases or result in the mobilization of other hazardous components. This may appear to be a complex task but some guidelines are available. Chemical advice may be required to use these and the suppliers of raw materials should, if necessary, be able to provide information.

Care must be taken in determining the loading rate, i.e. the proportion of hazardous wastes to normal refuse. The loading rate will be site specific and should ensure that the longer-term land use of the landfill site is not unnecessarily restricted particularly by concentrations of material hazardous to plant or other life. The rate should not be such as to adversely affect biological degradation or to overload other attenuation processes. Again practical guidelines are available for a range of hazardous wastes, including those containing acids, arsenic, cyanides, heavy metals, oils, pesticides, phenolics solvents and tannery sludges.

Finally, a regular monitoring and analysis programme for incoming hazardous wastes and leachates from the landfill should be pursued. Analysis of incoming wastes is desirable on a random basis, as a check on the waste producer's description, thus ensuring the appropriateness of co-disposal management decisions and a safeguard for the health and safety of the landfill operators.

Leachate should be monitored with sufficient frequency to illustrate that the attenuation processes are operating as predicted. In this way public confidence in co-disposal practices will be encouraged.

15. Conclusion

Co-disposal of wastes, either with other types of hazardous wastes and/or with municipal refuse, can in certain cases lead to the formation of less hazardous or non-hazardous products and is a valid option for the management of many hazardous wastes. There are processes occurring during the normal degradation of refuse which may act to attenuate hazardous characteristics. It is essential that these processes be understood and management act to fully utilize co-disposal where the siting and operation of a municipal landfill make these practices appropriate.

(a) **Land treatment**

In the land-treatment concept, wastes are plowed into soil and allowed to react, using its natural, chemical physical and biological properties to degrade them to less hazardous materials, adsorption and precipitation reactions immobilize components, with some controlled migration of selected inorganic species such as nitrates and chloride. Originally, refinery sludges mixed with soil were disposed of with this method. This comprises mixing of the sludges into the top layers of soil, usually by ploughing.

Land treatment of oil sludges is intended to break down the contained organics. The land is not used for agricultural purposes, in contrast with the practice in some countries of using sewage and other biological treatment sludges in soil fertilization.

Periodic plowing is required to maintain a sufficiently high oxygen level for biological reactions to take place. The technique uses the assimilative capacity of soil as a means of degrading the hazardous wastes through chemical, biological, physical and photolytic reactions (the latter for only the top few centimeters of soil). The organic materials are degraded by microbes and photolysis, the inorganic components by oxidation/reduction reactions prior to fixation and adsorption onto the soil matrix.

The application of a land treatment process requires thorough and comprehensive understanding of the particular type of waste, the capabilities of the particular soil and evaluations of the assimilative capacity, the type of vegetation, topography, groundwater occurrence and location, the presence of population concentration centres. All these parameters must be evaluated to ensure a successful long-term operational life for the disposal site without causing adverse effects on the environment. Because of the different climatic conditions prevailing in southern Europe and the United States for example, the land treatment method is seemingly more applicable than for northern regions.

The assimilative capacity of the soil is the most critical factor in assessing the suitability of a site for the application of the method. The rate at which the wastes are degraded into less or non-hazardous forms and at which the heavy metals are immobilized by sorption depends on the type of soil. Use of the land treatment method is advantageous economically and technically because of the wide range of hazardous wastes amenable to treatment. Disadvantages include costs and the large area of land required, the problem of matching the assimilative capacity of the particular soil with the characteristics of the waste requiring treatment, the environmental monitoring programmes needed, special buffering zones and other aspects such as aesthetics, security and closure and post-closure maintenance.

A variation of this method is the composting of organic waste and the rapid biological decompositioning of the material under controlled conditions. While organic compounds are theoretically bio-degradable, the rate and extent depends on the nature (aliphatic or aromatic) of the material, e.g., the type and number of halogen substitutes and their positions on the chemical molecule.

Controls are necessary when the sludges contain heavy metals. In addition to oil-sludges, other wastes that have been successfully disposed of with this method are pesticides and herbicides like aldrin, dieldrin, parathion, malathion, 2 4-D, DDT, Kepone and piperonylic acid and other chemicals such as ethylbenzene, pentachlorophenol and pulp mill lignins.

(b) **Surface impoundments**

Aqueous Wastes may be treated in surface impoundments such as pits, ponds and lagoons. This may be regarded either as storage or as a form of wastewater treatment, allowing the settling of solids and perhaps some biological degradation prior to discharge of effluents to surface waters (refer to paper by Williams, G.M., 1984).

After treatment in surface impoundments, wastewater treatment or physical-chemical treatment facilities, the aqueous effluents are generally discharged to sewers or directly to surface waters. In most countries such effluents are not regarded as hazardous wastes. Exceptions include the United States, and also Sweden, where 12 per cent of all hazardous wastes are discharged to sewers.

(c) **Sub-surface disposal**

Because not all surface and landfill methods of waste disposal are suitable at all potential sites and because many are subject to breakdowns in isolation, there is an evident trend to sub-surface deposition of the more hazardous wastes.

Sub-surface disposal has a number of distinct advantages over landfill methods. Apart from the esthetically more pleasing "hidden" location, sub-surface disposal precludes the potential effects of weathering, e.g., through precipitation on repositories at the surface. Any seismic instabilities attenuate rapidly with depth below surface. On the other hand, there are a number of disadvantages, of which the cost-factor is not the-least. Geo-risks, including tectonics, land-mass instabilities, flooding can be analysed much more readily at the surface, whereas equivalent analyses below surface rely increasingly on indirect and therefore less accurate methods.

Sub-surface disposal techniques fall into three broad categories:

(1) **Deep-well injection;**

(2) **Disposal in cavities and mine shafts;**
(3) **Deep underground burial** in artificially created, mined openings in relatively homogeneous geological stratae.

The three categories are listed in rising order of costs.

(1) **Deep-well injection**

Deep-well injection of hazardous wastes has been largely employed in the United States. Some 30 million tonnes of aqueous wastes, 11 per cent of all hazardous wastes, were disposed of by this method annually during the early 1980's.

Deep well injection, the practice of pumping liquid of fluidized wastes down boreholes, has been a common practice in the oil industry; oil field brines are disposed of in this manner. Deep well disposal in petroleum-producing regions involves tens of millions of barrels of fluids annually. The disposal of other industrial liquids by this method, although on a much smaller scale by volume, has been increasing and covers a broad range of liquids, including hazardous and toxic fluids. However, under new regulations use of this method could be drastically curtailed, e.g., in the United States.

This type of disposal is mainly carried out within sedimentary basins. In order to do so safely, a thorough knowledge of the geological setting and other geotechnical parameters is necessary. Unfortunately, even in the technically developed countries this knowledge is fragmentary and inadequate. For example, while there is a reasonable general knowledge of most of the sedimentary basins in the United States, many important details are either not known or not available in the public domain. While the general lithology, distribution and structure pertaining to a potential sedimentary formation may be known, there is often little or no information available on petrophysics of that formation or on the composition of the contained fluids. Further information is often required on parameters such as mineral composition, porosity, permeability and density of the formation, which may be critical for the effective injection of fluids and their safe containment. Possible reactions between formation fluids and the waste fluids must also be known, as such reactions could lead to the precipitation of solids near the well bore, possibly sealing the formation to further liquid injection.

Waste injection at or near sites with active or inactive tectonically weak zones, such as major fault systems, could lead to negative consequences, as that which occurred in the United States, where liquid-waste injection lubricated and activated a fault system, causing earth tremors and minor earthquakes.

In summary, prior to deep well disposal, the following information is required in order to arrive at a better understanding of geological hydrological, geochemical and tectonic conditions:

- Interactions of the injection fluid, the host formation and contiguous formations and the contained formation fluids;
- Effect of injection pressure on the physical integrity of the host formation and adjoining strata;
- Tectonic stability and
- Long-term changes in the condition of the host formation, caused for example by gas evolution from the waste.

(2) **Disposal of liquid waste in shafts**

Disposal of liquid waste in mine shafts is practiced to a limited extent in the United Kingdom. The technique includes the re-injection of saturated brine and certain other liquid wastes into salt cavities. A major commercially available facility disposes of aqueous wastes contaminated with organic materials in a mine shaft which is claimed to be totally sealed. In Spain, a gypsum mine is used for the disposal of dewatered residues from chemical treatment.

(3) **Deep underground burial**

The main objective of hazardous, toxic waste disposal is to immobilize and isolate waste from man's environment for a period of time and in conditions such that any possible subsequent release of contaminants from a repository will not result in any unacceptable risks even in the long term. The goal is difficult to fulfill, since disposal systems cannot be tested over sufficiently long periods before being put into operation. The long-term behaviour of hazardous waste must therefore be evaluated on theoretical assessments carried out with models (Fedra).

The system of disposal approaching the isolation concept the nearest is deep underground burial in geological formations at depths ranging from 300 m downwards; generally, such depths do not exceed 2,000 m. The geological media first used for this purpose was salt formations, later other types of formations, including clays, granites and other plutonic rocks and shales were considered and investigated with this utilization in mind. Considerable experimental work has been carried out over the past two decades on this type of disposal for radioactive wastes and much of the experience gained is applicable to other hazardous and toxic wastes. In fact, some countries are currently considering the co-burial of radioactive wastes with such other hazardous wastes in common repositories but in separate cells, isolated by impervious man-made or natural materials.

In general, deep underground burial is restricted to hazardous wastes that cannot be recycled or treated to reduce their toxicity, as costs of constructing and operating waste repositories at depths of 300 m plus would be significantly higher than near-surface equivalents.

16. Innovative technologies

Despite the discouragingly high costs obtained, it is possible that cost differentials could be alleviated through recent developments in fields as wide apart as radioactive waste disposal and construction of underground bulk oil storage and which could be an indication that underground disposal costs may gradually approach those of current shallow landfill methods. One pro-

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Book

Book Chapter

Boron compounds

Boron steels

Borosilicate glasses

Brass foundries

Brasses

just a few kms from the copper mine of Recsk. In January of 1992, elderly people began complaining that their breathing was impaired indoors. In February of 1992, high radon concentrations were detected in these houses, exceeding 10 kBq/m3 in some rooms and 100 kBq/m^3 in a cellar. (Deak, F.; Marx, G.; Toth, E.; (June 1993), 371-372 [in English].)

2972 FACTORS ASSOCIATED WITH RISK PERCEPTION IN FLORIDA AND THE UNITED STATES: A GUIDE FOR EMERGING DEMOCRATIC STATES [BIB-BUDA00276]

The paper analyzes the bases of citizen evaluations concerning the health and environmental impacts of hazardous waste facilities and nuclear power plants. Of particular interest was the role played by capitalist values, environmental beliefs, and traditional religious ties in the acceptance or rejection of these technologies. Findings suggest that, after controlling for important background variables (such as gender and age), people who value equality over capitalism are much more likely to oppose hazardous waste facilities and nuclear power plants than those more favorably disposed towards the economic system. (Vittes, M.E.; Pollock, P.H.; Lilie, S.A.; (June 1993), 456-458 [in English].)

2973 GEMS - AN INTEGRATED INFORMATION SYSTEM SOLUTION FOR COMPLIANCE AND RISK MANAGEMENT [BIB-BUDA00277]

The Global Environmental Risk Management System (GEMS) is an integrated information management system specifically designed to provide the practicing environmental, health, and safety specialist with the information that is needed to reduce a company's risk and liability for violations of the many laws and regulations enacted to protect the environment. The GEM System integrates essential information about personnel, facilities and hazards (physical, chemical, biological) to produce required governmental (e.g., OSHA and EPA) reports, state reports, and organizational internal reports; to track hazardous materials and hazardous waste; to assist in the evaluation of risk; and to enhance the management of emergency operations. (Kirkpatrick, L.; (June 1993), 459-461 [in English].)

2974 TOXICOLOGICAL RISK ASSESSMENT IN THE APPLICATION OF HEALTH-BASED TARGET CONCENTRATIONS TO SITE REMEDIATION [BIB-BUDA00279]

It is important to establish clearly the magnitude and distribution of contamination at a site for evaluation of the associated environmental or human health risks, in order to determine whether and to what extent remediation is required. Target remedial concentrations for soils, ground water and surface water at contaminated sites historically have been established on the basis of local or regional ambient background, analytical detection limits, and site-specific human health considerations for current or projected exposures. Further, final remediation target concentrations typically are influenced significantly by engineering limitations and financial considerations. (Teaf, C.M.; Kuperberg, J.M.; Herndon, R.C.; Moerlins, J.E.; (June 1993), 461-464 [in English].)

2975 DETERMINING EFFECTIVE TECHNOLOGY TRANSFER MECHANISMS; A CASE STUDY IN THE RUSSIAN FEDERATION [BIB-BUDA00280]

In order to transfer technology efficiently, it is essential to define the context in which technologies reside and have been developed. Historically, Russia has experienced severe limitations in commercializing advances in laboratory research. Presently, there is a crisis in the scientific community regarding advances in laboratory research due to the withdrawal of government support for research. Assistance from foreign firms is welcome in order to preserve and commercialize the results of many years of high-level research. (Colangelo, R.V.; Edgar, D.; (June 1993), 404-406 [in English].)

2976 LASER REMOTE SENSOR FOR ORGANOPHOSPORUS WARFARE AGENTS AND AIR POLLUTANTS [BIB-BUDA00281]

A differential absorption LIDAR has been constructed for a contactless detection of warfare agents and atmospheric pollutants utilizing lasers radiation TEA CO_2 as a source. From the viewpoint of emitted radiation wavelengths, this source answers the requirements of both a minimal loss in a clean atmosphere and a strong absorption band of detected agents. In case of organophosporus warfare agents, wavelengths resembling emission spectrum lines of 9P were used for the lasers. In the course of testing the differential absorption LIDAR, sarin and soman, ethanol, dichlorethane and SF6 were detected as modal agents. (Kadlcak, J.; Dubina, P.; Safar, B.; Stein, B.; (June 1993), 508-509 [in English].)

2977 CENTER FOR HUNGARIAN/AMERICAN ENVIRONMENTAL RESEARCH, STUDIES AND EXCHANGES: A FLORIDA STATE UNIVERSITY/TECHNICAL UNIVERSITY OF BUDAPEST JOINT VENTURE [BIB-BUDA00282]

This presentation will provide an overview of the Center for Hungarian/American Environmental Research Studies and Exchanges (CHAERSE) at the Florida State University (FSU). This Center involves participation by the faculties of Florida State University, the Technical University of Budapest, the FAMU/FSU College of Engineering and other appropriate academic institutions. The CHAERSE conducts a wide range of research and related activities in the context of addressing common environmental problems that are facing the U.S. and Hungary. (Lick, D.W.; (June 1993), 1-3 [in English].)

2961 POTENTIAL APPLICATIONS OF REMOTE SENSING TECHNOLOGY IN MONITORING BIOREMEDIATION EFFORTS AT TOXIC AND HAZARDOUS WASTE SITES [BIB-BUDA00264]

There is currently a great deal of interest in utilizing bioremediation technologies at toxic and hazardous waste sites. The two general approaches are: 1) microbiological - in which contaminant-specific organisms are introduced to the site and 2) ecological - in which physical and chemical factors are adjusted to enhance naturally occurring microbial communities. although the two strategies differ in their methods, and limitations for specific sites, both require continued monitoring, not only of physical parameters to maintain optimum microbial activity, but also of site recovery processes (e.g. contaminant degradation, revegetation). (Smith, A.; (June 1993), 242-244 [in English].)

2962 HAZARDOUS WASTE MANAGEMENT IN THE UNITED STATES [BIB-BUDA00265]

The United States is facing important decisions concerning its hazardous wastes. A national program for the management of these materials has been ongoing for a number of years, under the two federal laws known by their acronyms as RCRA (directed at prevention) and CERCLA (directed at cleaning up existing waste sites). But there remains a growing public perception that these programs, in most states joint endeavors of the U.S. Environmental Protection Agency and the state environmental regulatory agency, cost too much and are taking too long to show significant results. Specific criticisms of these programs include 1) emphasis on clean-up, as opposed to prevention, (Hall, M.W.; (June 1993), 323-325 [in English].)

2963 GROUNDWATER PROTECTION FROM THE IMPACTS OF HUGE ASH DEPOSITORIES [BIB-BUDA00266]

Powerful thermal electric plants can adversely impact the environment. Most thermal power plants in Serbia use low-caloric coal and produce relatively large amounts of ash. The ash depositories are typically situated on alluvial sediments and can be affected by hydraulic ash transport. Therefore, special attention should be paid to the groundwater pollution by the ash depositories as well as appropriate protective measures. General principles of protection are given in the paper, as well as the results of field and numerical model investigations for groundwater protection in the vicinity of a particular large thermal- power plant. (Pokrajac, D.; Boreli, M.; (June 1993), 718-721 [in English].)

2964 ARCHITECTURAL IMPLICATIONS OF RADON CONTROL: DESIGN OF BUILDINGS - DESIGN OF RADON RESEARCH [BIB-BUDA00267]

Several years of radon research in the United States and Europe have yielded considerable knowledge about radon generation and transport in the soil. More recent work has focused on limiting radon entry into buildings, primarily by mechanical depressurization of the soil beneath the building. No method has yet been shown 100 percent effective or reliable, but with each failure comes the opportunity for new knowledge. This paper addresses the differences in building design and construction methods in the United States and Eastern Europe, and proposes a research strategy for avoiding the mistakes made in the U.S. while establishing radon-resistant construction standards for the modification of existing structures and design and construction of new buildings in Eastern Europe. (Pugh, T.D.; (June 1993), 358-360 [in English].)

2965 INVESTIGATION OF RADON ENTRY INTO CRAWLSPACE STRUCTURES [BIB-BUDA00268]

The deleterious health effects associated with prolonged exposure to elevated levels of radon have prompted research into building construction and operation techniques that minimize radon concentrations. This work presents results on characterization measurements that have been performed on a specially constructed research house, with a crawlspace foundation. The house is instrumented to measure radon concentration, temperatures, and humidity in the house, crawlspace and attic as well as pressure differentials across walls, floor and ceiling caused by local wind. Initial measurements performed on the house have centered on characterizing the ventilation of the superstructure, floor and crawlspace. (Dantin, E.; Telotte, J.; Pugh, T.; (June 1993), 361-363 [in English].)

2966 RELIABILITY ISSUES IN ENVIRONMENTAL PROTECTION [BIB-BUDA00269]

The operation of practically all technical systems, in either economic or social sectors, has a negative impact on the environment. The machines and other equipment contaminate air, water and earth, or they emit noise, vibrations or other electromagnetic radiation. Pollution control systems are designed to minimize these deleterious effects. As our knowledge of the long-term consequences of these diseconomies increases more and more legal requirements for environmental protection are being promulgated. The majority of these requirements are prescriptive by nature, setting the highest permissible level of various contaminants for different sources, which may contaminate the environment. (Todorovic, J.; Telotte, J.C.; (June 1993), 363-365 [in English].)

2967 DECISION MAKING ON INDOOR RADON REDUCTION TECHNIQUES [BIB-BUDA00270]

The paper provides a review of indoor radon concerns. Radon is a radioactive gas, which decays in a sequence of short-lived decay products. The techniques to reduce indoor radon concentrations are reviewed. The decision making in reducing indoor radon is considered, with particular emphasis on multicriteria decision making. (Oprikovic, S.; Dantin, E.; Telotte, J.; (June 1993), 366-368 [in English].)

2968 TOWARDS CONSTRUCTION OF LOW-RADON HOUSES [BIB-BUDA00271]

Radon is the major pollutant in indoor air for most European countries. For a country like the Netherlands, where radon concentrations are relatively low, radon is estimated to cause 500-1,000 deadly lung cancers per year among 15 million inhabitants, about half the annual number of people killed in car accidents. Since about 1980, the KVI has subsequently been involved in research to assess this problem via a survey and to construct sensitive instruments for measuring radon flux and time evolution of radon concentrations. Moreover, we developed a diagnostic method to quantify radon entry. (van de Graaf, E.R.; Koopmans, M.; de Meijer, R.J.; Put, L.W.; (June 1993), 368-370 [in English].)

2969 RISK MANAGEMENT UNDER UNCERTAINTY TO FOSTER CLEAN-UP EFFORTS [BIB-BUDA00273]

A risk management methodology is presented with application examples in order to help select cost- effective environmental clean-up alternatives. Ecological and health risk and cost assessments are often associated with very large uncertainties stemming from such factors as contaminant transport modeling and loss function assessment. If risk-cost analysis is conducted without considering these uncertainties, inappropriate management policies may result. On the other hand, considering these uncertainties may cause difficulties in decision making if they make management alternatives effectively indistinguishable. (Bogardi, I.; Duckstein, L.; Bardossy, A.; (June 1993), 426-428 [in English].)

2970 EFFECT OF AIR POLLUTANTS ON METAL CONCENTRATIONS IN THE HUMAN BLOOD [BIB-BUDA00274]

Aerosol and human blood samples were analyzed by ICP-AES to investigate the correlation between air pollution and the concentration of lead, nickel and cadmium in the blood. Aerosol samples were collected on a filter by a simple method. The filters were dissolved in 70 percent nitric acid, and then diluted with the same amount of water. The samples were taken from different districts of Budapest at different times in order to investigate the different pollution concentrations. The blood samples were chosen in such a way that they correspond to the aerosol samples. The whole blood was mixed with 70 nitric acid (the dilution was 1:3). (Rozlosnik, N.; Harka, L.; Horvath, Z.; Racz, Z.; (June 1993), 917-919 [in English].)

2971 HIGH RADON ACTIVITY IN NORTHEAST HUNGARY [BIB-BUDA00275]

A seismologically active geological overthrust zone runs across Hungary. The Matra mountains are the most active areas where eocenic volcanic andesite lies upon triassic limestone karst. From below the andesite, CO_2 emanates at different points through breaks. CO_2 containing wells and the occasionally detected CO_2 filled cellars have been also found in the village of Matraderecske,

recently by the U.S. Departments of Energy and Defense. Initial research focused on disinfection kinetics of bacteria. Our most recent experiments have focused on evaluating the effectiveness of electron beam irradiation in treating contaminated groundwaters. (Kurucz, C.N.; Waite, T.D.; Cooper, W.J.; Nickelsen, M.G.; (June 1993), 769-771 [in English].)

2951 SOIL AND VEGETATION POLLUTION STUDY: QUALITY CONTROL OF ANALYTICAL DATA [BIB-BUDA00254]

The systematic determination of soil and vegetation pollution demands an organized and coordinated approach to the problem. Soil and vegetation sampling, preparation of samples and analysis of selected organic and inorganic pollutants are the most important factors influencing data reliability. Designing and executing the analytical program in the study of soil pollution impact on certain plants in the Celje Municipality Region is presented in our work. (Hudnik, V.; Hodnik, A.; Lobnik, F.; (June 1993), 60-62 [in English].)

2952 THE RELATIONSHIP BETWEEN GEOGENIC AND TECHNICAL RADIOACTIVE EXPOSURE IN SAXONY AND THURINGIA [BIB-BUDA00255]

The areas of Saxony and Thuringia form part of the metallogenetic unit used for uranium extraction which is in Bohemia. The radiogeochemical characteristics of these areas show for many rocks a significant increase in uranium content and, on a local scale, a strong diversification of the uranium content. The uranium deposits in the entire geotectonical unit in the Bohemian area can be seen in this context. As a result of the intensive mining activities after World War II there exists in these areas contaminated abandoned mines, waste rock piles and tailings ponds. Obtaining an overview of all mining remnants which are contaminated by radioactive sources and assessing quantitatively their impacts are the basic activities for the planned decommissioning of these areas. (Viehweg, N.; Stoll, E.; (June 1993), 356-358 [in English].)

2953 THE RACKEVE - SOROKSAR DANUBE: INPUT WATER - SUDD - OUTPUT WATER SYSTEM [BIB-BUDA00256]

This paper will provide a summary of the paleohydrography of the Danube River as well as the development of the side channel near Csepel Island including: History of the present, river-canalised side channel; Hydraulic, channel morphological review, the hydraulical connection with the main channel, problems of the water alimentation; Review of the present situation of the water quality in the side channel; The water management situation in the side channel; The (Rackeve-Soroksar) - Danube, as a special mixture of recreation area and nature protection area, its mutual effects and problems; (Marton, B.; Szabolcs, T.; Mate, B.; (June 1993), 113-117 [in English].)

2954 JOINT DOE/EPA/IAEA/PRIVATE INDUSTRY DEMONSTRATION OF ENVIRONMENTAL CLEANUP TECHNOLOGIES IN EASTERN EUROPE / CIS [BIB-BUDA00257]

The objectives of this initiative are: to demonstrate specific cleanup technologies (soil and water) in Eastern Europe and the CIS that are contaminated with radioactive and hazardous constituents; to share these technologies with the engineering team concept for deployment in the host nations, in the United States, and in other countries; to catalyze private sector participation and open new markets for U.S. investment; and to form partnerships between EPA, DOE, and the international community. The demonstration will be conducted in a mutually agreed-upon location in Eastern Europe (e.g., Poland) and/or in the CIS (e.g., Ukraine). (Garcia-Frias, B.; Dyer, R.S.; (June 1993), 909-911 [in English].)

2955 DEWATERING SURFACE IMPOUNDMENTS USING FILTER PRESSES [BIB-BUDA00258]

Industrial surface impoundments have been a common method of sludge disposal in both Europe and the U.S. for many decades. Metal hydroxide sludges and petroleum refining wastes, as well as sludges from the pigment and dye stuff and wood preserving industries are but a few of the types of materials found in these lagoons. In the last decade, we have come to realize that many of these impoundments are potentially hazardous to the environment as they leach to the underlying aquifers and/or release volatile organics such as benzene to the atmosphere. Sound environmental practice calls on us to remove these sludges and close the lagoons. (Wachter, D.H.; Hamm, R.W.; Davis, M.L.; (June 1993), 676-678 [in English].)

2956 LEMNA, A NATURAL, STATE-OF-THE-ART AND COST-EFFECTIVE WASTE WATER TREATMENT TECHNOLOGY FOR CITIES AND INDUSTRIES [BIB-BUDA00259]

The Lemna technology is lagoon-based and uses aquaculture to treat waste water to achieve secondary, tertiary and advanced waste water treatment limits. The process uses little or no electricity, chemicals and requires no sludge management. Lemna facilities have no odor, mosquitoes and are algae-free. The Lemna technology is presently used in the United States and many parts of the world serving from small villages to large urban areas. It can cost as little as half in capital costs and one-third in operations and maintenance charges of the traditional mechanical/chemical systems. The harvested biomass is very rich in nitrogen and protein and can be used as fertilizer, protein supplement and animal feed. (Poole, W.; (June 1993), 92-94 [in English].)

2957 PROBLEMS OF COMPELLING RESTRICTIONS IN THE USE OF CHEMICALS IN AGRICULTURAL PRACTICES ARE TACKLED FOLLOWING A DIVERSIFIED APPROACH OF AGRICULTURAL RESEARCH ACTIVITIES [BIB-BUDA00260]

An overview will be given of Dutch research, following different entries that have been chosen for investigation: emissions - studying the damaging effects of excessive fertilizers and pesticides - with a view to establishing valid measuring instruments and criteria for legislators; and production - studying the economical and ecological impact of new production systems with a view to helping the farmer/producer change agricultural technology. With regard to the reduction of emissions there are four subject fields comprising groups of interrelated projects: (Eerkens, C.; (June 1993), 911-914 [in English].)

2958 BOUNDARY CONDITIONS FOR THE DESIGN AND OPERATION OF SINGLE SLUDGE BIOLOGICAL NUTRIENT REMOVAL FACILITIES [BIB-BUDA00261]

At fixed influent COD/P and COD/N ratios, the activated sludge process can be successfully operated between the following boundaries: minimum threshold aerobic Mean Cell Residence Time (MCRT) necessary for nitrification relative to the operating temperature; and maximum limiting MCRT below which the process is phosphorus loading limited and the phosphorus storage capability is not exceeded. Procedures are currently available to estimate the minimum threshold aerobic MCRT for nitrification with respect to temperature. Literature shows that enhanced biological phosphorus removal (EBPR) can be achieved at all reasonable temperatures provided the process is operated at MCRTs greater than two days. (Reddy, M.P.; (June 1993), 118-126 [in English].)

2959 A SYSTEMATIC APPROACH FOR THE DESIGN AND APPLICATION OF IN SITU BIOTREATMENT [BIB-BUDA00262]

A significant problem with applying in situ remediation technologies to the clean up of hazardous waste sites is the large number of site specific variables that warrant investigation. The resulting high costs, long time delays and difficulty in synthesizing the collected data encourages the misapplication of "favored" technologies. To address this problem, a holistic methodology has been developed that integrates field and laboratory investigations, technology selection, engineering design and post performance analysis of the applied technology. Key elements include the evaluation of site specific geological, chemical and biological characteristics. (Montemagno, C.D.; Leo, S.; Craig, J.; (June 1993), 632-634 [in English].)

2960 GROUNDWATER SAMPLING USING MONTEJUS SAMPLERS: THE DANISH AND POLISH EXPERIENCE [BIB-BUDA00263]

The large number of substances of anthropogenic origin represent not only a serious threat to groundwater resources, but also a challenge in the field of sampling techniques and laboratory methods. A short review of problems associated with collecting reliable groundwater samples is given. Five major problems are identified: a) change of conditions from aquifer environment to the sampling bottle, b) addition/removal of substances caused by sampling equipment, c) uncertainty with regard to aquifer level from which the sample originates, d) reliability of laboratory methods and e) the high cost involved in analyses of "exotic" parameters. (Gosk, E.; Usolnowicz, S.; (June 1993), 915-917 [in English].)

the feasibility of groundwater biorestoration technology in Italy, and is structured along the following research lines: state of the art of the groundwater biorestoration technology; evaluation of the Italian and EEC water quality legislation with regard to their influence on the development of biorestoration technologies, on the use and injection in groundwater of nutrients, electron acceptors and bacterial strain, and on the biorestoration objectives; (Caramuscio, P.; Imperiali, P.L.; Lupi, C.; (June 1993), 766-768 [in English].)

2942 HYDRODEHALOGENATION PROCESS IN POLYCHLORINATED BIPHENYLS DECONTAMINATION [BIB-BUDA00245]

Polychlorinated biphenyls (PCBs) are organic compounds which were used in the past in dielectric fluids for transformers and capacitors. Owing to their suspect carcinogenicity, PCBs were banned and their use were limited in closed systems which are easily checked and monitored. Since 1980, several countries have specified PCB limits in waste and oil (100ppm in Italy) to avoid environmental dispersions by disposal in landfill. PCB wastes destination in Italy depends on their degree of contamination: for PCBs range between 100-500ppm, oils are considered special wastes and can be disposed in chemical landfills; for higher levels (greater than 500ppm) they are considered hazardous wastes and the only available destruction method is incineration. (Quattroni, G.; Tundo, P.; (June 1993), 793-795 [in English].)

2943 RECYCLING OF DISCHARGED BATTERIES [BIB-BUDA00246]

The industrial activities of modern civilization require an increasing number of new energy sources with resultant increased concentrations of various substances in the human environment. One of the consequences of this situation is that certain heavy metals may accumulate to toxic levels. Discharged batteries are significant sources of heavy metal contaminants in soils and in waters. A procedure has been developed for the separation and recovery of chemical constituents of discharged batteries. This makes it possible to remove the toxic elements from waste water and industrial dusts and to recycle the main components of various batteries. (Sovago, I.; Papp, L.; Marton, A.F.; Kadas, M.; (June 1993), 745-747 [in English].)

2944 APPLICATION OF ISOTOPES AND OTHER TECHNIQUES IN GROUNDWATER POLLUTION [BIB-BUDA00247]

Faced with the increased concentration of several organochemical compounds into the groundwater designated for water supply in the southeastern (industrial) part of Skopje, a research program established to determine the possible sources and intensity of contamination, has been applied to the area of interest. Installation of several piesometric tubes on the site enables us to determine the hydrogeological conditions (characteristic) as well as to observe the hydraulic level and quality of the groundwater over time. By determination of d18O ratio and tritium concentration in the waters of interest (surface and underground), valuable information about the mechanism of recharge and mean residence time of local groundwater has been obtained. (Anovski, T.; Jovanovski, N.; Bozinovski, Z.; Popov, Z.; Minceva, B.; (June 1993), 57-59 [in English].)

2945 STUDY OF THE INFLUENCE OF AGROTECHNICAL MEASURES TO THE QUALITY OF GROUNDWATER IN RICE PRODUCTION [BIB-BUDA00248]

The location of the main water supply system (pumping of groundwater for meeting human and technological needs of the Kocani plain population) is almost completely surrounded with rice fields and the influence of most frequently applied pesticides (ordram, orizan and basagran with molinat, propanil and bentozane as active components, respectively) in rice production to the quality of local groundwater has been studied. Parallel to the definition of the hydrological relationship between surface (Bregalnica River) and local groundwater (under exploatation), determination of the propogation of the pesticides used throughout the observed aquifer has been performed. (Bozinovski, Z.; Popov, V.; Minceva, B.; Pop-Stefanija, B.; Jovanovski, N.L.; Anovski, T; (June 1993), 903-905 [in English].)

2946 CONCENTRATIONS OF $_{14}C$ AND $_{3}H$ IN TREE-RINGS FROM PLITVICE NATIONAL PARK REGION [BIB-BUDA00249]

For reconstruction of the isotope concentrations in the past in a clean-air area, tree-rings spanning the last three decades were collected from spruce tree grown in Plitvice, C. Croatia. Cellulose was prepared from separated tree-rings and then combusted for $_{14}C$ analysis. $_{14}C$ activity was measured by a proportional counter. The distribution of $_{14}C$ activity in tree-rings for the period 1963-1986 is compared with the published data on global-scale distribution of atmospheric $_{14}C$ and with data obtained from spruce trees grown in Matra, N. Hungary. A good correlation among all these activities has been observed. The exchangeable tritium was removed form cellulose samples used for tritium analysis. (Obelic, B.; Horvatincic, N.; Krajcar Bronic, I.; Kozak, K.; (June 1993), 605-607 [in English].)

2947 POSSIBILITIES OF APPLLYING THE POLARIMETRY METHOD BY INVESTIGATIONS OF INTERACTION OF THE MARINE TECHNOLOGY STRUCTURES WITH THE ENVIRONMENT [BIB-BUDA00250]

The interaction between industrial objects, energetics, marine technology structures and environment causes harmful consequences to the environment. It is important to know the change in concentration of trace elements, especially heavy metals. The method of polarographic analysis applied in the analysis of toxic metals in aqueous solution is described. This method has a large range of applications, particularly for the analysis of traces in aqueous solutions. Possibilities of these methods are in the field of toxic metal determination. Limits of detection are often extremely low. The measurements show that a very low concentration of toxic metals in sea water, meaning zinc, lead and cadmium, can be detected. (Dobrinic, J.; Crnic-Zalokar, V.; (June 1993), 906-908 [in English].)

2948 TRITIUM IN THE ATMOSPHERE OVER CROATIA AND SLOVENIA [BIB-BUDA00251]

Systematic measurements of integrated monthly precipitation samples started in 1976 at Zagreb, Croatia, and in 1981, at Ljubljana, Slovenia. Precipitation samples were also collected at Plitvice National Park, as a reference sampling point of "clean air" and at Rijeka, the North Adriatic. The yearly and seasonal variations of tritium concentration in precipitation at continental stations in Zagreb, Plitvice and Ljubljana generally follow the Mid-European pattern, while at Rijeka they are closely correlated with those at Genoa station. Tritium concentration in atmospheric air moisture at several sampling points in Zagreb has been also measured systematically since 1988. (Horvatincic, N.; Bronic, I.K.; Obelic, B.; (June 1993), 163-165 [in English].)

2949 IN SITU SOILS REMEDIATION OF VOC/SVC BY HOT AIR/STEAM STRIPPING [BIB-BUDA00252]

The remediation of soils containing volatile (VOC) and semi-volatile hydrocarbons (SVC) is most desirably accomplished in situ, i.e., without removal of the contaminated soils from the ground. This approach mitigates the environmental problem, i.e., does not transport it to another location, and, when properly applied, does not impact on the local environment during remediation. NOVATERRA has commercially demonstrated an in situ, hot air/stream stripping technology to remove VOC and SVC from soils both in the vadose and saturated zones. The technology has successfully removed various chlorinated aliphatics and aromatics, glycol ethers, phthalates, polyaromatic compounds, ketones, petroleum hydrocarbons and many other compound types from sandy to clay soils. (La Mori, P.N.; (June 1993), 630-632 [in English].)

2950 ELECTRON BEAM TREATMENT OF GROUND AND SURFACE WATERS [BIB-BUDA00253]

The Electron Beam Research Facility (EBRF) located in the Central District Waste water Treatment Plant in Miami, Florida houses a 1.5 MV, 50 mA electron accelerator. Extensive large scale (460 Lmin-1) research on the use of electron beams for the treatment of water and wastewater has been conducted over the last several years. These efforts have been funded primarily by the National Science Foundation, the U.S. Environmental Protection Agency, and more

2931 BULK PRECIPITATION DEPOSITION OF AIR POLLUTANTS AND THEIR INFLUENCE ON THE CHEMICAL QUALITY OF FOREST SPRING WATER IN THE SALEK VALLEY [BIB-BUDA00234]

Within the Ecological Research Cooperation programme extensive investigations have been initiated to quantify the emissions impact of precipitation on the chemical quality of forest sites in three different highland areas. The monitoring programme includes sampling of bulk precipitation deposition in the open area, seepage water in 50cm soil depth and spring water. The visible damage to the forest stands with continually increasing acidification of the forest floor is endangering the water quality of forested watersheds. Recent investigation results of the Ecological Research Cooperation progam show that this problem has already arisen. (Gros, M.S.; (June 1993), 160-162 [in English].)

2932 SOIL POLLUTION MONITORING IN SLOVENIA [BIB-BUDA00235]

In Slovenia, soil pollution monitoring has begun only recently. The soil is a sink which both receives fall-out from the atmosphere and absorbs or filters material from natural sources and waste water. The case study of soil pollution, which was done in Celje county in 1990 will serve as a base for soil pollution monitoring in Slovenia. The intent of the investigation was to obtain an approximation of the heavy metals in soil (As, Cd, Cu, Cr, Hg, Ni, Pb, Se, Ti, Zn), fluoride, and some organic substances (alachlor, metholachlor, aldrin, dieldrin, endrin, parathion derivatives, DDT, DDE, DDD, TDE, hexachlorobenzene, endosulfan, atrazine, simazine, silvex, bromacil, 2,4-D, 2,4,5-T, MCPA, MCPP, PCB). (Lobnik, F.; Turk, I.; Zupan, M.; Vrscaj, B.; Hudnik, V.; (June 1993), 532-534 [in English].)

2933 CONTROLLED STUDYING OF THE COMPOSTING PROCESS [BIB-BUDA00236]

A self-heating bioreactor of 810 L working volume was constructed and tested for use in studies simulating the biochemical and thermodynamic changes which occur during composting. A composting process is based on forced ventilation controlled by home made PC software. Basic parameters (conc. O_2, temperature) can vary so that a most favorable microbial environment is created. Large working volume and wall insulation minimize conductive heat loss, so that experimental results can be used directly to implement highly controlled industrial composting facilities which is necessary when composting hazardous wastes like sewage sludge or urban wastes. (Mihelic, R.; Kadunc, V.; Lobnik, F.; (June 1993), 710-712 [in English].)

2934 SATURATION OF EXPANDED VERMICULITE IN ANIMAL SLURRIES: NEW POSSIBILITIES OF USE [BIB-BUDA00237]

In this study, different parameters which influence the efficiency of saturating expanded vermiculite (Murmansk) in pig slurry, were investigated. After carrying out a number of procedures we chose an expanded fraction of 3-6 mm, which has a cation exchange capacity of 132 meq/100 g d.m. In saturation experiments with pig slurry we managed to bind to expanded vermiculite between 80 and 90 meq NH_4 + /100 g d.m., and between 20 and 90 meq K+/100 g d.m. This is how we were able to fill in a large part of cation spaces with these two nutrients. Two possible uses of this phenomenon are discussed in the study: (Kadunc, V.; Lobnik, F.; (June 1993), 712-714 [in English].)

2935 ALTERNATIVE SYSTEMS FOR MODELING THE GROUNDWATER REMEDIATION BY PUMPING AND/OR RECHARGE WELLS [BIB-BUDA00238]

This paper deals with the problem of groundwater quality remediation by pumping and/or recharge wells. The pollution, due to organic compounds (pharmaceutical products), concerned an unconfined aquifer in coarse to medium-grained alluvial deposits, surrounded by pre- quaternary rocky hilly relieves. The area is characterized by non-continuous surficial protecting layers, deep water-table, heterogeneity of the aquifer exploited by several drinking water wells and then by the lack of alternative water supply. In this situation the removal of groundwater contamination requires efficient systems planning in order to avoid damage of the hydrogeological balance. (Beretta, G.P.; Carabelli, G.; Colombo, F.; Francani, V.; Mariotti, C.; (June 1993), 673-675 [in English].)

2936 A SENSITIVE BIOMARKERS SET RESPONDING TO THE CHEMICAL EXPOSURE [BIB-BUDA00239]

The intent of this study was to establish the possible health risks of the contamination with environmental chemicals. The spectrum of the toxic effects induced by xenobiotics was evaluated from the serum and hepatic biochemical and morphological compartment in pesticides exposed rats. The time evolution (24, 48, 72 hours) of the serum and hepatic response induced by one dose pesticides exposure were compared with the cumulative effects obtained in short experiments (15 days) and in long-time (18 months) chronic experiments. (Codorean, E.; Filipescu, G.; Tanase, C.; Ciotaru, L.; Laky, D,; (June 1993), 898-900 [in English].)

2937 A REGIONAL NETWORK FOR THE INVESTIGATION OF ATMOSPHERIC TRITIUM [BIB-BUDA00240]

The relatively large amount of tritium which was released to the environment during the bomb test period in the early 1960's is decreasing but anthropogenic sources such as the use of nuclear fuel, fusion test experiments military and industrial uses of tritium may be offsetting this decrease. Tritium originating from natural and man-made sources is present in the atmosphere mainly in the form of tritiated water vapor (HTO), tritiated hydrogen gas (HT) and as hydrocarbons. The present background levels may be significantly altered on a regional and global scale especially if the form of released tritium is HT. (Urchrin, G.; Kozak, K.; Csaba, E.; (June 1993), 502-505 [in English].)

2938 TERATOGENIC PESTICIDE EFFECTS - A PROSPECTIVE STUDY [BIB-BUDA00241]

The potential toxic and teratogenic effects of chemicals upon the animals were investigated by administration of 3 pesticides in a long-time (18 months) chronic experiment in rat. The chemical chronic exposure induces a serum enzyme comportment expressing a various reactivity of the intracellular enzyme system including their susceptibility of the structural groups of xenobiotics. The study presents the results concerning the teratogenic effects induced by the fetal and prenatal pesticide exposure. The adverse teratogenic effects of the toxics with the probability of malformation risk is a problem of their chemical aggressivity, but also of their dose and time exposure and may be correlated with the bioenzymological serum, erythrocyte and tissue factors. (Filipescu, G.; Codorean, E.; Ciotaru, L.; Tanase, C.; (June 1993), 901-903 [in English].)

2939 DEVELOPMENT OF LANDFILL LINING SYSTEMS [BIB-BUDA00242]

The Federal Institute for Materials Research and Testing in Berlin is coordinating, on behalf of the Federal Ministry for Research and Technology of Germany, a national research project concerning the development of improvements in landfill lining technology. This major research project will cover many aspects of mineral layers and HDPE geomembranes for both basal and surface liners in landfill sites and slurry trench walls for abandoned hazardous waste sites. Twenty-eight universities and research establishments will take part in this program. (Meggyes, T.; Brune, M.; Muller, U.; (June 1993), 715-717 [in English].)

2940 EVANESCENT WAVE FIBEROPTIC IMMUNOSENSOR FOR THE DETECTION OF TRIAZINE HERBICIDES [BIB-BUDA00243]

Fiberoptic sensors based on excitation of luminescent chromophores by the evanescent field of the light- guiding fiber can be used as highly sensitive and selective biochemical affinity sensors. As an example, a sensor for the detection of the herbicide Atrazine, based on a competitive immunoassay will be presented. In this assay format, monoclonal atrazine antibody is immobilized on a multimode quartz optical fiber. A solution containing a known amount of Fluorescein-labeled Atrazine and an unknown concentration of non-labeled Atrazine is injected into the sample chamber surrounding the fiber. (Oroszlan, P.; Duveneck, G.L.; Ehrat, M.; Widmer, H.M.; (June 1993), 53-57 [in English].)

2941 DEVELOPMENT AND FEASIBILITY OF GROUNDWATER BIORESTORATION TECHNOLOGIES IN ITALY [BIB-BUDA00244]

ENEL (Italian National Electricity Board) - Brindisi Research Centre and ISMES initiated a research project focused on in situ groundwater biorestoration technologies. The project, to be accomplished in three years, aims at evaluating

organisms. (Odor, L.; Csalogovits, I.; Horvath, I.; Raincsak, G.; (June 1993), 51-53 [in English].)

2921 MULTICONIDIAL RESPIRATION TEST: A NEW STANDARDIZED METHOD FOR QUANTITATIVE BIO-MONITORING OF AIR POLLUTION [BIB-BUDA00224]

A rapid and reproducible bio-assay for the quantitative detection of environmental contamination is presented here. Toxic substances in ambient air can damage the conidia of Aspergillus niger to the degree that their potential for developing a new mycelium and new reproductive structures is impaired. The exposed conidia were incubated on nutrient agar and the growth of the mycelium and the formation of new conidia were evaluated by two measurements: growth zone of mycelium metrically and development of conidia by densitometry. In addition, the results were documented photographically. A supplementary metric and densitometric evaluation of the photographs is possible. (Bomar, M.; Bomar, M.T.; (June 1993), 500-502 [in English].)

2922 AEROSOL SAMPLING AND ANALYSIS BY PIXE IN THE INSTITUTE OF NUCLEAR RESEARCH, DEBRECEN [BIB-BUDA00225]

Aerosol samples were collected as thin layers on nucleopore filters in the Institute of Nuclear Research of the Hungarian Academy of Sciences during 1991-1992. In the laboratory - at the 5 MeV Van de Graaff accelerator - Particle Induced X-Ray Emission technique (PIXE) as a sensitive, nondestructive multielement method has been used for analysis of aerosols. About 20 minutes bombardment is sufficient to detect up to 20 elements: Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Br, Pb in these samples. Elemental concentration data were used for further statistical analysis and evaluation. (Koltay, E.; Borbely-Kiss, I.; Szabo, G.; (June 1993), 896-898 [in English].)

2923 FLUIDIZED-BED INCINERATION OF SOLID WASTES AND SLUDGES: A VIABLE TECHNOLOGY FOR ENERGY AND THE ENVIRONMENT [BIB-BUDA00226]

In this paper, the results of experimental combustion tests of different types of wastes (Municipal Solid Waste, refuse-derived fuel, agro-industrial wastes) carried out in a fluidized-bed pilot plant are presented. The reactor is an atmospheric bubbling fluidized bed, with a thermal capacity of around 1 MW and suitably instrumented for monitoring the operating conditions. The results are analyzed and discussed, in particular, as regards the environment and the potential of this technology for energy recovery. (Brunetti, N.; De Cecco, C.; Zuccotti, S.; (June 1993), 707-709 [in English].)

2924 REVIEW OF BUSINESS-RELATED LEGAL REFORMS IN CENTRAL AND EASTERN EUROPE [BIB-BUDA00227]

This paper will address the business-related legal developments that have occurred in Central and Eastern Europe within the past 2-3 years, focusing on steps to introduce a market economy and accompanying legal system. In particular, I would focus on laws governing foreign and private investment, tax structures of the various countries, a review of property rights, and the pace and mechanisms of privatization of industry. Specific issues would include repatriation of profits and investments, rules governing ownership and control of enterprises, intellectual property protection and the applicable laws and regulations governing environmental matters in the various countries. (La Belle, R.D.; (June 1993), 321-323 [in English].)

2925 INNOVATIVE TECHNOLOGIES FOR IN SITU REMEDIATION [BIB-BUDA00228]

The Lawrence Livermore National Laboratory is developing several innovative technologies for in situ remediation as long-term improvements to the current ex situ pump and treat approaches to cleaning up contaminated soils and ground water. These technologies include dynamic underground stripping, in situ microbial filters, and remediation using intense, penetrating bremmstrahlung, which are summarized below. (1) Dynamic Underground Stripping - LLNL is collaborating with UC Berkeley to develop and demonstrate a system of thermal remediation and underground imaging techniques for use in rapid cleanup of localized underground spills of organic contaminants. (Aines, R.; Knapp, R.; Mathews, S.; Ragaini, R.C.; (June 1993), 668-673 [in English].)

2926 INTERNATIONAL SCHOOL OF INNOVATIVE TECHNOLOGY FOR CLEANING THE ENVIRONMENT, ETTORE MAJORANA CENTER FOR SCIENTIFIC CULTURE, ERICE, SICILY, ITALY [BIB-BUDA00229]

As a first step in establishing an international training and research effort in the development of advanced technologies for improving the environment, the Majorana Center for Scientific Culture in Erice, Sicily, a branch of the World Laboratory, established a School of Innovative Technologies for Cleaning of the Environment in 1989. The goal of the School is to disseminate information concerning available approaches to assess the risks of environmental contamination and identify innovative physical, chemical, and biological technologies to remediate and restore the environment to a safe level. (Ragaini, R.C.; (June 1993), 398-400 [in English].)

2927 PRODUCTION UNITS IN THE SCOPE OF AQUISITION AUDITS OF ENVIRONMENTAL PROFILE ANALYSIS [BIB-BUDA00230]

In the scope of privatization, the assessment of the environmental status of industrial sites and production technology is an important issue. To solve this problem, the concept of environmental profile analysis is discussed using selected examples from metal-manufacturing industries in Hungary and Czech+Slovak Fed Rep. Input/output balances of chemicals used in a production process often show that hazardous chemicals are used to a large extent during production. Therefore, it is not surprising when these substances are found again in soil, ground water or uncontrolled waste disposal sites. While chemicals of environmental contamination seems to be relatively easy, problems often arise for the assessment of these sites with respect to the actual land use. (Simmleit, N.; Michaels, B.; Hempfling, R.; (June 1993), 593-597 [in English].)

2928 GEOPHYSICAL METHODS APPLIED FOR THE PROTECTION OF THE ENVIRONMENT AND GROUNDWATER RESOURCES [BIB-BUDA00231]

At the onset of geophysics as a science, the Earth was studied in whole as well as its physical - magnetic, gravity - fields. In a short time, basic methods of mineral row material prospecting developed from that. All these geophysical methods investigate changes in physical parameters (magnetic susceptibility, density, electric conductivity or resistivity, dielectric constant, propagation velocity of seismic waves, radioactivity, etc.) within the Earth's crust and in the rocks. Recently the uppermost layer which is simply called soil has also been investigated. Environmental damages have impacts, first, on the soil and the groundwater because they are easily polluted. (Schonviszky, L.; (June 1993), 597-599 [in English].)

2929 MICROELEMENT DETERMINATION IN THE UNDERGROUND WATER OF THE ROMANIAN SHORE [BIB-BUDA00232]

This study is a part of a comprehensive research programme on the Black Sea Romanian shore pollution. Microelement analyses have been performed on water samples, collected systematically from 26 points (bore holes, springs and surface sources) located in different hydrogeological conditions in the East Dobrogea. The instrumental neutron activation analysis (INAA) and the atomic absorption spectrometry (AAS) have been used for the trace element content determination. Two irradiations have been carried out: a short irradiation of 3 minutes in the rabbit system, in a flux of $2.1012 n/cm^2/s$. (Dinescu, L.; Catilina, R.; Dorcioman, D.; Orasanu, I.; (June 1993), 530-532 [in English].)

2930 SURFACE WATER CONTAMINATION IN THE NON-FERROUS METAL SECTOR [BIB-BUDA00233]

Waste waters assocatied with: the cleaning processes of waste gases contaminated with fly ash; washing of the electrolytic tubs; centrifugation; and filtering often contain Cu, Zn, Cd, Pb, Fe, and As as oxides, sulphates and other compounds. The techniques of precipitation of the metallic ions with calcium hydroxide, followed by a phase for acid removal results in good removal efficiencies, and the quality of the evacuated waters is reflected in the following constituent concentrations: Pb-max. 0.1 mg/l; Zn-max. 0.1 mg/l; Cu- max. 0.3 mg/l; and Cd-max. 0.2 mg/l, according to the existing Romanian Standards. (Zamfir, L.; Schneider, A.; (June 1993), 207-209 [in English].)

investigation performed to collect data for the evaluation and assessment of a 30-year old municipal landfill located in Northeastern Germany. (O'Shaughnessy, M.; Porsch, G.; Weiland, D.; (June 1993), 701-703 [in English].)

2911 ENVIROGEN'S NOVEL APPROACHES TO CONTROL AND REMEDIATE ENVIRONMENTAL CONTAMINATION [BIB-BUDA00214]

Envirogen is an innovative biotechnology company dedicated to the business of discovering, developing, and applying new and effective solutions to the task of degrading and transforming toxic and hazardous wastes. The traditional treatment of toxic vapor streams uses vapor scrubbing and adsorption. These methods do not destroy the toxic contaminant of interest, but merely transfer them to another media. Biological treatment of these compounds, on the other hand, can achieve not only higher removal rates, but also realize cost savings. Envirogen is currently working with toxic compounds such as trichloroethylene (TCE), styrene and methylene chloride. (Bordacs-Irwin, K.; (June 1993), 627-629 [in English].)

2912 THE VACUUM-VAPORIZER-WELL (UVB) METHOD FOR IN SITU GROUNDWATER REMEDIATION [BIB-BUDA00215]

The Vacuum-Vaporizer-Well (UVB) Method is a new, patented technology for in situ remediation of contaminated ground water. The principle of this method, namely how circular flow is created within an aquifer using the UVB Method, is briefly described, as well as how to determine the sphere of influence. In addition, some case studies will be presented. The UVB Method creates a circular flow pattern in the groundwater around a UVB well and thus causes mobilization of dissolved contaminants. These are subsequently drawn to the UVB well within which remediation units (e.g., stripping reactor, selective ionexchanger, or activated carbon filter), depending on the type of contaminants in the aquifer, are located. (Borchert, S.; Sick, M.; (June 1993), 790-792 [in English].)

2913 THE USE OF RAPID, SPECIFIC IMMUNOASSAY-BASED FIELD TESTS FOR ASSESSING SOIL AND WATER CONTAMINATION [BIB-BUDA00216]

The application of field analytical methods to site assessments can enhance the quality of the site assessment and result in substantial savings of time and expense relative to the conventional practice of collecting samples and submitting them for laboratory analysis. With the appropriate method and adequate quality assurance/quality control this can be accomplished without an accompanying decrease in the quality of the data necessary to support the decision making process based on the site assessment results. Field analytical testing can be used to substantial advantage for the "real-time" delineation of soil contamination and the extent of contaminant plume migration. (Carter, K.R.; (June 1993), 527-529 [in English].)

2914 DELINEATION OF A DENSE ORGANIC CONTAMINANT IN THE PHREATIC ZONES OF A COMPLEX SHALLOW KARST AQUIFER [BIB-BUDA00217]

In 1990, a train derailment in middle Tennessee resulted in the release of 15,443 gallons of chloroform from two tank cars. The spill occurred in an area underlain by horizontally bedded Middle Ordovician carbonate rocks, which exhibited significant karst features. The chloroform immediately entered the karst system and was detected 2200 feet away from the site within 24 hours of the release. After the initial emergency response, a detailed Phase I hydrogeologic investigation was conducted by Ogden Environmental and Energy Services (Ogden). This investigation included the drilling and installation of approximately 40 monitoring and recovery wells. Bi-weekly sampling of the wells and springs were conducted. (Shahmir, S.E.; Levy, M.J.; Caruthers, J.; (June 1993), 588-590 [in English].)

2915 BIODEGRADATION OF PAH IN AIRLIFT BIOREACTORS [BIB-BUDA00218]

Biodegradation of Polycyclic Aromatic Hydrocarbons (PAHs) is limited primarily by poor bioavailability of these substrates, caused by their extremely low solubility in water and strong adsorption to surfaces and organic matter. Because of low water transport rates, PAHs contaminated soil with high clay or silt content cannot be treated by conventional bioremediation techniques such as in-situ techniques, landfarming or composting processes. A biological soil decontamination process was developed as a technique complementary to soil washing processes. (Bryniok, D.; Brunner, W.; Eichler, B.; Kohler, A.; Knackmub, H.J.; (June 1993), 893-895 [in English].)

2916 AIR POLLUTION CONTROL STRATEGY FOR VOCS [BIB-BUDA00219]

A presentation on the Dutch KWS 2000 Program for the reduction of VOC-emissions will be outlined. The applicability of the program for Eastern European countries, especially Hungary will be discussed. The program deals with the following aspects: inventarisation, the most important sources of industrial air pollution of VOCs will be inventarized; reduction program, the feasibility of technical solutions for the emission reduction in different branches of industry will be studied and compared, latest developments in emission reduction technologies like biological and thermic, high energy recovery systems will be presented; implementation program. (Dragt, A.J.; Kovacs, L.; (June 1993), 89-92 [in English].)

2917 FROM REFUSE TO RE-USE: THE LADDER PRINCIPLE WASTE MANAGEMENT IN THE NETHERLANDS [BIB-BUDA00220]

In the Netherlands the policy for waste management is given in order of priority by: presentation; re-use; useful application; incineration; landfill. This policy leads to a number of reduction and prevention programs. In the presentation, an outline will be given of the main items of the program. Examples for different types of waste will be discussed, as well as the applicability of these principles in Central European countries. (Dragt, A.J.; (June 1993), 704-707 [in English].)

2918 ISOTOPE TECHNIQUES IN THE HYDROGEOLOGICAL ASSESSMENT OF POTENTIAL SITES FOR THE DISPOSAL OF CHEMICAL AND COMMUNAL WASTE IN EASTERN HUNGARY [BIB-BUDA00221]

Stable and radioactive isotopes of natural waters and dissolved substances provide information about the processes in the hydrosphere and often help to pin-point the source of pollution. The results of a five-year research program is presented in two fields: as a result of a comprehensive field investigation programme based on environmental isotope methods and hydrodynamical calculations we determined areas suitable for repositories of dangerous chemical waste in eastern Hungary; large waterworks, like near Debrecen, are modifying the ground water flow regime and, thus, groundwater flow from unprotected areas is expected in the future. (Hertelendi, E.; Miko, L.; Marton, L.; (June 1993), 590-592 [in English].)

2919 GEOCHEMISTRY OF A GREENHOUSE GAS - HUMAN INTERFERENCE IN THE NATURAL METHANE CYCLE IN HUNGARY [BIB-BUDA00222]

Methane is the third most important of the greenhouse gases. A part of atmospheric methane originates in the earth's crust through bacterial and thermal transformation of sedimentary organic matter. Sedimentary methane moves towards the atmosphere as free gas, as dissolved gas together with upward moving waters and by diffusion. A part of this methane flux is trapped in the sediments and in the hydrosphere in the form of gas fields, methane hydrate in the pore space of the sediments and dissolved gas in some tropical lakes. Another part is potentially oxidized and only a relatively small portion enters the atmosphere. (Veto, I.; (June 1993), 48-50 [in English].)

2920 THE RELATIONSHIP BETWEEN GEOLOGICAL SETTING AND TOXIC ELEMENT ENRICHMENTS OF NATURAL ORIGIN IN HUNGARY [BIB-BUDA00223]

It has been proven long ago by systematic geochemical investigations that the concentration of minor elements in rocks are different and at the same time characteristic for each rock type. The average abundance of elements for the main rock varieties can show great differences. In soils formed by weathering, the inherited minor element concentrations are similar to those found in the parent material. Certain cases of rock forming processes (e.g., the formation of black shales) result in unusually high concentrations of elements. By the influence of the so called ore forming processes (e.g., formation of ore deposits; post magmatic and post volcanic alterations affecting huge volumes of rocks and large areas) the toxic element content can reach values harmful to living

leaking from a toxic waste disposal unit into the Elbe River. (Tilly, J.; Braccio, R.; Dawson, G.; Beba, J.; (June 1993), 585-587 [in English].)

2901 HAZARDOUS WASTE MANAGEMENT PLANNING FOR THE SLOVAK REPUBLIC [BIB-BUDA00204]

This paper presents the results of a feasibility study for developing a hazardous waste management and remediation program for the Slovak Republic. This study was funded by the U.S. Trade and Development Program and conducted for the Slovak Ministry of Industry. The study compared proposed hazardous waste legislation and standards with corresponding European Community and U.S. standards and regulations; assessed the current hazardous waste generation, management, and treatment situation; and suggested appropriate treatment technologies. Finally, a practical, least-cost, environmentally sound hazardous waste management plan was provided. (Braccio, R.; Cheney, C.; Tilly, J.; Leontiev, O.; (June 1993), 742-744 [in English].)

2902 MODELING DENSE NON-AQUEOUS PHASE LIQUIDS CONTAMINATION IN GROUNDWATER AQUIFERS USING 3D GEOSCIENTIFIC INFORMATION SYSTEMS [BIB-BUDA00205]

Numerous cases of subsurface contamination and ground water pollution result from improper storage, use, and handling of organic compounds such as chlorinated solvents, creosotes and polychlorinated biphenyl (PCB) oils. These potentially carcinogenic compounds, which are classed in a general group called dense non- aqueous phase liquids (DNAPLs), are characterized by densities greater than water, and may be present as multiple phases in a contaminated aquifer. These characteristics make DNAPLs extremely difficult to model and analyze in the subsurface. Adequate sampling density is often impossible to obtain because excessive drilling to locate DNAPL source areas has the potential to worsen the extent of contamination through hydraulic disturbance of the system. (Fisher, T.R.; (June 1993), 270-271 [in English].)

2903 2- & 3-D GIS PLUS EEIS: A SOLUTION FOR ASSESSING AND MANAGING WASTE SITE INVESTIGATIONS AND REMEDIATION [BIB-BUDA00206]

A mistake commonly made during waste site investigation is the commencement of field activities without using available background information that could focus the investigation on the site's most critical problems and direct resources in those areas. The investigation is started with no defined scope or tools to manage information. The duplication of data acquisition represents a waste of valuable resources. Two- and Three-Dimensional Geographical Information Systems (3D GIS) are effective tools for spatial visualization of ground water and chemical contaminant movement, as well as modeling within the hydrologic flow regime. (Janssen, L.A.; (June 1993), 272-272 [in English].)

2904 REVIEW OF INNOVATIVE TECHNOLOGIES FOR EXTRACTION OF CONTAMINATED SOIL VAPORS AND GROUNDWATER FROM SANDSTONE AND ALLUVIUM [BIB-BUDA00207]

Contaminated soil vapors and ground water have been investigated at a former rocket motor production and testing facility in southern California, USA. The contaminants, volatile organic compounds, are present in alluvial soils and a low permeability cemented sandstone. While alluvial permeabilities are adequate to permit extraction, the very low permeability of the sandstone unit limits the ability to effectively extract contaminated vapors and groundwater using conventional methods. Vapor extraction well tests produced little or no vapor flow, and groundwater production rates are 1.9 liters/minute or less from test wells. An extensive study was undertaken to evaluate various technologies for vapor and water extraction. (Hamer, W.G.; (June 1993), 665-667 [in English].)

2905 APPROPRIATE TECHNOLOGY APPLICATION: AN AMERICAN/ROMANIAN WELL DRILLING PROGRAM TO PROVIDE POTABLE WATER SUPPLIES IN AREAS OF HIGH NITRATE GROUNDWATER IN WESTERN ROMANIA [BIB-BUDA00208]

In western Romania (Timisoara area), small, efficient drilling machines are being used to drill wells to access clean ground water supplies. The new wells access clean water that occurs below shallow contaminated water. The shallow groundwater in the area is contaminated with nitrates at concentrations as much as 5 times acceptable levels for potable water. Nitrate contamination in the region is known to have resulted in infant deaths. The drilling program is focused on drilling more than forty 100 meter deep wells to replace shallow hand dug wells in villages in the area. Two mud rotary drill rigs, submersible pumps, and well screens were imported to Romania as part of the program. (Hamer, W.G.; (June 1993), 319-320 [in English].)

2906 DATA MODELING AND MANAGEMENT FOR SUPPORT OF ENVIRONMENTAL SITE INVESTIGATION AND REMEDIATION [BIB-BUDA00209]

Site investigation and remediation efforts generate massive volumes of data. These data are the basis for conclusions concerning the nature and extent of contamination, evaluation of remediation alternatives, and provide a historical record to measure the success of the remediation effort. Data complexity and quantity make a coherent plan for data management imperative. Data management is complicated by activities driven by the associated dynamic regulatory and legal environment, and the support of changes in the underlying science. (Nunke, M.P.; (June 1993), 273-274 [in English].)

2907 MODELING ENVIRONMENTAL REMEDIATION COSTS FROM HYDROCARBON RELEASES [BIB-BUDA00210]

A computer model and data base were developed to estimate environmental remediation costs from hydrocarbon releases at retail gasoline stations and bulk storage facilities. Uses of the model include estimating clean-up costs for property transfer negotiations or budgetary purposes, identifying sites requiring additional field investigations, prioritizing environmental remediation actions, and developing optimum strategies for upgrading or closing facilities. The model, the Clean-up Cost Model (CCM), is a computer program that probabilistically describes the likelihood of potential product release volumes and soil and ground water remediation costs at terminals, depots, and service stations. (Gancarz, D.G.; (June 1993), 275-277 [in English].)

2908 DISCRETE INTERVAL GROUNDWATER SAMPLER [BIB-BUDA00211]

A discrete interval sampler designed for use in deep groundwater monitoring wells is a cost-effective method of obtaining high quality, representative groundwater samples. The sampler uses a well packer coupled to a remotely activated point-source bailer and a small diameter, stainless steel pump. The packer isolates the well screen from the water in the upper well casing. The pump purges water from the upper casing, lowering the phreatic surface; hydraulic pressure in the aquifer causes water to flow through the well screen, the packer and the bailer. The collected sample is representative of conditions in the aquifer because there is no mixing with the water in the upper well casing. (Koerner, C.E.; Rogalla, J.A.; Corbett, J.J.; Varnadore, D.J.; (June 1993), 566-568 [in English].)

2909 ADDRESSING LARGE-SCALE GROUNDWATER AND VADOSE ZONE CONTAMINATION USING SOIL VAPOR MEASUREMENT [BIB-BUDA00212]

Near-surface and downhole soil vapor measurement techniques were used to determine the best locations for ground water monitoring wells at a former propellant manufacturing facility in southern California. Historical aerial photography and a geophysical survey were used to identify potential contamination sources and initiate the vapor investigation. The soil vapor investigation, with sample analysis in a field laboratory, was a rapid, cost-effective method of accurately mapping the nature and extent of the two-mile long plume of halogenated volatile organic compounds. (Koerner, C.E.; Rogalla, J.A.; (June 1993), 764-766 [in English].)

2910 ASSESSING THE ENVIRONMENTAL IMPACTS OF UNCONTROLLED LANDFILLS [BIB-BUDA00213]

Many municipal, industrial, and hazardous waste landfills throughout Central and Eastern Europe are uncontrolled sources of contamination. These uncontrolled landfills are degrading air, soil, surface water, and ground water quality. Determining the nature and extent of contamination and its effects on the environment as well as developing corrective measures requires comprehensive study and evaluation. This paper includes a case study detailing a phased field

the United States Environmental Protection Agency for standard procedures, guidelines, or protocols that address site and soil contamination. (Cameron, R.E.; (June 1993), 580-582 [in English].)

2891 AGRO-ENVIRONMENTAL PROGRAM IN CENTRAL AND EASTERN EUROPE: WATER QUALITY [BIB-BUDA00194]

Environmental degradation of water quality (and soil) in Central and Eastern Europe has significantly affected potable water supplies and the productive capacity of its agriculture. Pilot projects are being initiated to determine the risk assessment of water supply, quality, usage, and remediation (including soils). Agricultural management practices in the use of pesticides and fertilizers, necessary protective measures and remediation of contaminated water supplies, especially those used for human consumption and agricultural production and irrigation, are being given primary consideration. (Cameron, R.E.; Vitorovic, S.L.; (June 1993), 204-206 [in English].)

2892 SOIL GAS TECHNOLOGY: INVESTIGATIVE APPLICATIONS [BIB-BUDA00195]

Shallow soil gas investigations can rapidly detect and delineate the real extent of ground water and soil contamination from volatile organic chemicals (VOCs). Detection of a volatile chemical in the shallow soil gas indicates the chemical is in the vadose zone near the soil gas sampling system or in the groundwater below. Soil gas technology is most effective in mapping low molecular weight, halogenated solvent chemicals and petroleum hydrocarbons possessing high vapor pressure and low aqueous solubility. These compounds readily partition out of the groundwater and into the soil gas as a result of their high gas/liquid partitioning coefficients. Soil gas contaminant mapping is accomplished by withdrawing soil vapor from a hollow steel probe inserted into the soil. (Thompson, G.M.; (June 1993), 560-563 [in English].)

2893 INITIATING THE CLEANUP OF THE ROCKY MOUNTAIN ARSENAL [BIB-BUDA00196]

The U.S. Army's Rocky Mountain Arsenal, located outside of Denver, Colorado, covers over 70 square kilometers and is one of the largest hazardous wastes sites in the United States. The facility was used from the 1940s to the 1980s as a chemical manufacturing facility: by the U.S. Army for the manufacture of various chemical munitions, including incendiaries and blister and nerve agents, and by several private companies for the manufacture of various chemicals, primarily herbicides and pesticides. (Gabel, D.D.; Lowrey, J.; Lytle, R.; Berry, E.; (June 1993), 46-48 [in English].)

2894 ON-SITE INCINERATION OF OILY WASTES [BIB-BUDA00197]

Oily wastes and oil contaminated soils and ground water are found worldwide and are frequently associated with the handling and mishandling of used oils and solvents. These wastes are frequently contaminated with polychlorinated biphenyls (PCBs), volatile organic compounds, and heavy metals. The remediation method most often selected for these sites is to incinerate the oily wastes and contaminated soils, to destroy the PCBs and other organics, and then to place the resultant ash in a landfill. An excellent example of this technology is the Bridgeport Rental and Oil Services (BROS) project in New Jersey, USA; one of the largest cleanup projects under the U.S. EPA's Superfund program. (Lytle, L.; Gabel, D.; Nelson, E.; (June 1993), 761-763 [in English].)

2895 COST-EFFECTIVE SITE CHARACTERIZATION TECHNIQUES [BIB-BUDA00198]

Characterizing the type and extent of soil and water contamination of large facilities can be very expensive, especially when standard drilling, sampling, and laboratory analysis techniques are used. However, innovative and cost-effective site characterization techniques can focus site characterization efforts and reduce the overall cost of the investigations. This presentation will demonstrate the benefits of several techniques used during the site characterization of the Rocky Mountain Arsenal, including: surface and aerial geophysics for detection of waste disposal sites and unexploded ordnance; surface and borehole geophysics for geologic characterization; (Gabel, D.D.; Lylte, R.; Cushing, D.; Sindelar, T.; Irons, L.; Blose, K.; (June 1993), 583-585 [in English].)

2896 INNOVATIVE VOLATILE ORGANIC PROCESSING SYSTEM (VOPS) FOR THE RECYCLING OF SITE REMEDIATION OF GASES [BIB-BUDA00199]

Soil vapor extraction of the unsaturated zone, air stripping of ground water and air sparging of the saturated zone are used extensively for cost-effective site remediation of volatile organic compounds. A consequence of each of these technologies is the transfer of VOCs into a gas phase, which must be treated prior to discharge to the atmosphere. A novel gas phase treatment system, (Volatile Organic Processing System; VOPS), for removal and subsequent recycling of gas-phase VOCs has been developed. Chlorinated and hydrocarbon VOCs in the concentration range from near saturation to low parts per million (ppm) are absorbed into various fluids. Removal efficiencies using a variety of gas-liquid contacting devices easily exceeds 99 percent. (Hoag, G.; Grasso, D.; Carlson, H.A.; (June 1993), 663-664 [in English].)

2897 SITE REMEDIATION: SOURCE CONTROL CURRICULUM DEVELOPMENT FOR CENTRAL AND EASTERN EUROPE [BIB-BUDA00200]

The United States Environmental Protection Agency (USEPA) has funded a major curriculum development project at The University of Connecticut (UCONN) entailing the design and structuring of a graduate level instructor's guide on site remediation specifically addressing source control issues. Topics covered include: regulatory frameworks, critical issues in technology selection, review of basic engineering principles, ground water issues, conventional technologies applicable to hazardous waste, soil vapor extraction, soil washing, solidification/stabilization, chemical destruction/extraction, bioremediation, thermal processes, and risk analysis. (Grasso, D.; Hoag, G.; (June 1993), 317-319 [in English].)

2898 FIELD APPLICATION OF ROBOTIC SYSTEMS IN HAZARDOUS WASTE SITE OPERATIONS [BIB-BUDA00201]

The cleanup of hazardous waste sites is a challenging and complex field which offers numerous opportunities for the application of robotic technology. The contamination problem, long in the making, will take scores of years to resolve. Our ingenuity in using robotic tools to assist in the cleanup will be a challenging endeavor. This paper addresses field applications of robotic systems at hazardous waste sites, as experienced by members of the U.S. Environmental Protection Agency. EPA must meet the challenge of finding solutions to clean up and/or remediate hazardous waste sites and at the same time reduce health risks and improve the safety of waste site field personnel. (Esposito, C.; Sullivan, D.; Frank, U.; Cibulkis, R.; (June 1993), 563-565 [in English].)

2899 HAZARDOUS WASTE INCINERATION AIR EMISSION CONTINUOUS MONITORING: THE OPERATOR'S VIEWPOINT [BIB-BUDA00202]

Most hazardous wastes can be eliminated by thermal combustion. This process reduces wastes amount and their hazardous, pollutant and toxic characteristics. Combustion converts wastes into ashes and fumes. These residues are further treated to allow their return to the environment. The continuous monitoring of air emissions can provide answers to various questions. It is compulsory for a few pollutants and allows for the control of gases and dusts in compliance with standards. Continuous monitoring provides the most reliable method of assessing plant safety and environmental impact. Operating an incineration plant with optimized air emissions control systems also requires continuous monitoring. (Sterin, M.; Chachuat, J.P.; Gourdon, A.; Valentis, G.; (June 1993), 498-500 [in English].)

2900 REMEDIATION PLANS FOR THE SPOLANA CHEMICAL WORKS FACILITY IN NERATOVICE, CZECHOSLOVAKIA [BIB-BUDA00203]

This paper presents the results of a feasibility study for cleaning up the Spolana Chemical Works facility in Neratovice, about 20 miles north of Prague. This study was funded by the U.S. Trade and Development Program and conducted for the Czech Ministry of Environment. There are three primary problems at this large chemical plant: (1) three dioxin-contaminated buildings that have been closed since 1966; (2) ground water contaminated with organic and inorganic chemicals threatening an adjacent nature preserve; and (3) hazardous chemicals

2881 A NEW ALTERNATIVE FOR INDUSTRIAL SOLVENT CONTROL: THE BRAYTON CYCLE SOLVENT RECOVERY HEAT PUMP [BIB-BUDA00184]

Emissions of VOCs, including solvents, are currently regulated in many countries with more stringent and broader regulations assured for the future. Regulations and increasing solvent costs will continue to place industries in critical situations, demanding that either solvent use be minimized or solvent alternatives be found. At the present, energy consuming control technology alternatives are in use by industry: carbon absorption and steam desorption, which allow for recovery, and thermal destruction, with no solvent recovery. In the future, solvent substitution and minimization will be additional alternatives. (Williams, J.H.; (June 1993), 739-741 [in English].)

2882 A NEW ALTERNATIVE FOR ENVIRONMENTALLY BENEFICIAL INDUSTRIAL POWER GENERATION: THE HIGH-PERFORMANCE STEAM SYSTEM [BIB-BUDA00185]

Industrial power generation has been and will continue to be a fundamental activity of industry world wide. However, the air pollution emissions from the combustion of fuels to generate industrial power will continue to come under more stringent regulation in the future. Regulations and increasing energy costs will continue to jeopardize the benefits that industries and nations can realize from industrial cogeneration (i.e. combined heat and power). The current technology options (e.g. "clean coal technologies", steam-injected gas turbines) available to industry are often operationally complex and expensive to purchase and operate. (Williams, J.H.; (June 1993), 155-157 [in English].)

2883 STRATEGY FOR ENIRONMENTAL CLEANUP UNDER TIGHT FUNDING CONSTRAINTS [BIB-BUDA00186]

This study proposes a strategy for planning and implementing an environmental restoration program in Central and Eastern Europe that borrows some features from the programs in the United States but also points out which features a Central or Eastern European country may wish to avoid. Careful thought and planning is essential to target those projects that will yield the maximum reduction in infant mortality, cancer deaths, and birth defects per thousand inhabitants as swiftly as possible. (Jump, R.I.; (June 1993), 314-316 [in English].)

2884 IN SITU TECHNOLOGIES FOR TREATMENT, STABILIZATION, AND REMOVAL OF HAZARDOUS WASTES [BIB-BUDA00187]

In situ treatment technologies are an attractive alternative to conventional excavation technologies, because they reduce exposure to contaminants, diminish health and safety concerns related to excavation, and decrease impacts to ongoing industrial facility operations. This paper will review the status of evolving in situ treatment, stabilization, or removal technologies for hazardous wastes. One of the most successful in situ treatment/removal technologies developed recently is soil vapor extraction. In this simple process, volatile organic contaminants are removed from subsurface soils by passing air through soil pore space. (Amdurer, M.; Gabel, D.; (June 1993), 787-789 [in English].)

2885 ASSESSMENT METHODS AND CLEANUP LEVEL DETERMINATION FOR HUMAN HEALTH THREATS POSED BY HAZARDOUS ENVIRONMENTAL CONTAMINANTS [BIB-BUDA00188]

Risk assessment, as conducted in the U.S.A. under the Superfund Program, consists of four basic steps: 1) contaminant identification, 2) exposure assessment, 3) toxicity assessment, and 4) risk characterization. Contaminant identification is performed through comparison of contaminant concentrations with background levels and risk-based concentrations. Exposure assessment identifies potential receptors, discusses land use scenarios, and estimates the type and magnitude of human exposures. Toxicity assessment weighs the available evidence regarding the potential for a substance to cause an adverse health effect. (DeAngeles, A.J.; Meadows, S.D.; Turnblom, S.M.; (June 1993), 424-425 [in English].)

2886 MONITORING AND REMEDIAL TECHNOLOGICAL DEVELOPMENT AT A U.S. DEPARTMENT OF ENERGY SUPERFUND SITE IN NORTHERN CALIFORNIA [BIB-BUDA00189]

Monitoring and remedial techniques are being developed and applied at the Lawrence Livermore National Laboratory (LLNL) Site 300 facility to assess and clean up soil and groundwater pollution. Site 300 is a 30km^2 high-explosives (HE) and materials testing site located in the highly faulted, rugged terrain of the Northern California Coast Ranges. At the site, multiple sources of volatile organic (VOCs), HE, and metallic compounds, as well as tritium and uranium occur. Testing has resulted in soil contamination, five discrete VOC plumes, a HE compound plume, and three discrete tritium plumes in groundwater. (Taffet, M.J.; (June 1993), 555-557 [in English].)

2887 FIBER OPTIC MONITORING OF NITRITE BIOREMEDIATION [BIB-BUDA00190]

Distal field fiber optic sensors have been demonstrated to be useful for monitoring nitrogen oxide concentrations in chemical and biological process vessels. We have utilized a commercially available extrinsic fiber optic probe and light sources to optically excite intracellular and extracellular biomolecules and metabolites in nitrite reducing fermentations of Pseudomonas denitrificans, and to monitor the resulting fluorescence emissions. Observed fermentation fluorescence emission is strongly modulated by the presence of nitrite in solution, due to the primary inner filter effect. In this investigation, the total luminescence spectrum was monitored over the course of several feeding cycles. (Stokes, E.B.; Stokes, R.W.; Uzgiris, E.E.; (June 1993), 558-560 [in English].)

2888 APPLICATION OF IMMUNOASSAY SCREENING TESTS FOR TRIAZINE HERBICIDES IN SURFACE AND GROUNDWATER SURVEYS IN EASTERN EUROPE [BIB-BUDA00191]

Monitoring the extent of environmental contamination associated with agricultural practices should be an integral part of determining an environmental protection strategy for countries in Central and Eastern Europe. Monitoring methods for nitrate are readily available, and inexpensive. However, analytical methods for pesticide monitoring are more complex and expensive. Recent advances in immunoassay screening tests for triazines and other classes of commonly used pesticides provide an accurate, inexpensive assessment tool. These screening technologies coupled with a systematic sampling framework for surface water and groundwater resources can provide valuable information for policy-makers at a relatively low cost. (Kross, B.C.; Herzog, D.; Colliss, J.; (June 1993), 525-527 [in English].)

2889 IDENTIFICATION AND ASSESSMENT OF AIR POLLUTION SOURCES IN THE REPUBLIC OF SLOVENIA [BIB-BUDA00192]

The Ministry of Environmental Protection and Physical Planning in the Republic of Slovenia is conducting Phase I of the Slovenia Environmental Project, which includes study elements addressing air pollution control, water pollution control, solid waste management, urban infrastructure, and environmental assessments. This presentation will provide an overview of the air pollution sources and justification for the priorities of air pollution abatement within the Republic of Slovenia. A review of existing air quality legislation, institutions, monitoring networks, and enforcement strategies will also be presented. (Kross, B.C.; Wallace, D.; Liegois, D.; (June 1993), 158-160 [in English].)

2890 HAZARDOUS WASTE SITE AND SOIL CHARACTERIZATION: METALS [BIB-BUDA00193]

A "knowledge book" of site and soil characteristics has been devised for an expert system guide to assist field personnel in the identification and interpretation of twenty-four parameters for hazardous waste sites (Cameron, 1991). Emphasis is given to metals and metalloid contamination, particularly heavy metals. For soils, the viewpoint of soil science is presented within the context of each knowledge frame. The "knowledge book" is designed to meet the needs of

load and quality variations of the inflowing waste waters. Based on experiments, it has been shown that substantial improvement is feasible through the application of dissolved air floatation (DAF) within the primary stage of the treatment. Results are described and discussed. Another application investigated was the use of DAF as a substitute for secondary sedimentation tanks after biological trickling filters. (Suschka, J.; Buczak, B.; (June 1993), 110-112 [in English].)

2871 THE USE OF CARBONIC-MUD IN AGRICULTURE AND ITS INFLUENCE ON SOIL AND PLANTS [BIB-BUDA00174]

When processing potassium-humate from lignite there remains a large amount of carbonic-mud as a by- product that contains several valuable materials. That is why the question of using it in agriculture has arisen. For studying the effects of carbonic-mud we started to make experiments in breeding pots with three types of soils and three indicator plants. We concluded that if carbonic-mud is mixed into the soil it increases the water-storage capacity of the soil, and, in this way, has a favorable effect on nutrient management. We have noticed a fall in drought sensitivity which is very important mainly in the case of sandy soils. (Fekete Agrartudomanyi, J.; Csicsor, J.; (June 1993), 624-627 [in English].)

2872 FAST ENVIRONMENTAL MONITORING WITH SURFACE ACOUSTIC WAVE GAS SENSORS [BIB-BUDA00175]

The high theoretical sensitivity of Surface Acoustic Wave (SAW) sensors, their fast response and their potential for versatility in the analyte to be detected make them suitable for the determination of gaseous compounds over the wide range of applications present in environmental monitoring. In addition, their output, which is a frequency signal, is unaffected by many electrical interferences. In many cases, the analyte must be detected in the midst of interfering substances which can be present in large excess. (Blom, N.; Amati, D.; Arn, D.; Ehrat, M.; Widmer, H.M.; (June 1993), 547-549 [in English].)

2873 SAMPLE COLLECTION DURING THE TESTING OF A SOIL REMEDIATION PILOT PLANT [BIB-BUDA00176]

The Office of Radiation Programs within the U.S. Environmental Protection Agency was charged to design, construct, test and demonstrate a pilot plant capable of on-site remediation of radiologically contaminated soils. The Phase I testing of this pilot plant was conducted at the U.S. EPA National Air and Radiation Environmental Laboratory. A sampling program was designed to verify the effectiveness of the soil remediation process and to monitor the operation of the equipment at each stage of operation. The effectiveness of the soil remediation process was verified by collecting grab samples of the input to and output from each piece of equipment in the plant as well as the end products of the remediation process. (Hay, S.; Richardson, W.S.; Gifford, M.W.; Pierce, P.E.; Cox, C; (June 1993), 523-524 [in English].)

2874 TREATMENT OF CREOSOTE-CONTAMINATED SOIL BY FLOTATION AND A SLURRY-PHASE BIOREACTOR [BIB-BUDA00177]

Creosote-contaminated soil and sediments were obtained from an abandoned wood impregnation site which adjoined and drained into a river. Concentration of polycyclic aromatic hydrocarbons (PAHs) approached 36,000 mg/kg. Respirometric studies showed that more than 90 percent degradation could be achieved in ca. 10 days when specially adapted cultures were added, and nutrient additions were optimized. The toxicity of the treated slurry, as measured by Microtox LC50, remained unchanged over the 28 day test, even though it was only the higher molecular weight (greater than 6 ring) PAHs that remained. This is in contrast to parallel studies with thermally treated, diesel-containing drill cuttings in which biological treatment reduced toxicity by a factor of three. (Berg, J.D.; Bennett, T.E.; Nesgard, B.S.; (June 1993), 782-784 [in English].)

2875 SIMPLE COMPOSTING SYSTEM FOR BIOTREATMENT OF PAH CONTAMINATED SOIL AND SEDIMENTS [BIB-BUDA00178]

Bio-remediation was evaluated as an alternative for a coke works facility site in northern Norway near the Arctic circle, which was characterized in 1989 as having significant contamination by polycyclic aromatic hydrocarbons (PAHs). About 20,000 tons of soil containing PAHs (ca. 500 mg/kg) were excavated. A pilot study was conducted in 1990, in which 1,000 m^3 of soil were treated in an enhanced composting system. The variables tested were: N&P, bark matrix and dispersant addition, temperature (4o-16 °C),moisture (10-40 percent), and aeration by blowers, H_2O_2 addition or pile turning. Composite soil samples from five sampling points from each pile were taken twice weekly for PAH analyses (GC-MS) and soil moisture. (Eikum, A.S.; Berg, J.D.; Selfors, H.; (June 1993), 785-787 [in English].)

2876 ENVIRONMENTAL EDUCATION AND RISK ASSESSMENT SOFTWARE [BIB-BUDA00179]

A series of seventeen environmental software applications have been developed. The programs use computer graphics and hypertext to provide information on a variety of environmental topics, primarily related to agriculture. The programs are in use around the world by a variety of audiences. A series of farmstead assessment worksheets are being converted into risk assessment and educational software. The assessment modules use a rule-based approach to provide a risk assessment of activities on farmsteads as related to ground water. The user provides information needed by each module through an interactive questioning component. (Engel, B.A.; Jones, D.D.; Strickland, R.M.; Bland, M.; Krause, A.; (June 1993), 421-423 [in English].)

2877 A PILOT MONITORING NETWORK SYSTEM FOR GROUNDWATER QUALITY AND QUANTITY IN THE UPPER-NOTEC CATCHMENT (POLAND) [BIB-BUDA00180]

A regional groundwater monitoring network system will be established in a typical agricultural catchment (4,000km2) in the Polish Lowlands. First, an analysis of the national and regional management objectives has been carried out. The guidelines given in the recently published National Environmental Monitoring Program (NEM), constitute the framework for the Ground Water Monitoring Network. The design of the networks (location, depth, frequencies and parameters of observation) will be based on Hydrological System Analysis, Geohydrological Units and Homogeneous Areas. The Ground Water Quantity Network will be based on the characteristics of the different geohydrological units. (Plenzler, W.; Uil, H.; (June 1993), 495-497 [in English].)

2878 GRUNDFOS GROUNDWATER SAMPLING PUMP [BIB-BUDA00181]

One major criteria of the "ideal" groundwater sampling device is that it be able to purge a monitoring well of stagnant water at a relatively high rate of flow (e.g., more than 10 liters per minute) and be able to sample groundwater at a low flow rate (e.g., 0.1-1 liter per minute) so as not to impact the integrity of the sample. Sampling devices for two-inch diameter wells generally have been able to deliver water at low flow rates, but have been relatively ineffective during the purging phase because their maximum flow rates are generally less than four to six liters per minute. (Heegaard, J; (June 1993), 550-552 [in English].)

2879 NEW DEVELOPMENTS IN ON-LINE TOXIC ORGANIC POLLUTANT MONITORING: AUTOMATIC DATA PROCESSING & POLLUTION CONTROL [BIB-BUDA00182]

In recent years, there have been dramatic changes in the equipment used and the methods used for monitoring environmental contamination in liquid effluent streams. Methods used to monitor organic pollutants in waste water streams, ground water and the monitoring of remediation techniques have changed dramatically in the last 24 months. This paper discusses the improvements in sensitivity and reliability of instrumentation for the measurement of total carbon, total organic carbon, total oxygen demand and chemical oxygen demand. It is essential that the best and most representative parameter be measured in every given situation. (Maley, L.E.; Hoek, F.B.; (June 1993), 553-555 [in English].)

2880 INTERNATIONAL ENVIRONMENTAL TECHNOLOGY TRANSFER FROM THE U.S. DEPARTMENT OF ENERGY'S R&D LABORATORIES [BIB-BUDA00183]

Technological innovation is vital to the environmental future of the United States and the world in dealing with environmental restoration and waste management. Fueled by research and development, such innovation has been the most important generator of productivity over the last 50 years, far surpassing the contributions of capital, labor, or economics of scale. Beginning in 1980, the U.S. Congress and the Reagan administration initiated a number of executive and legislative actions intended to stimulate the flow of laboratory technology to U.S. industry. The 1980 enactment of both the Stevenson-Wydler Act and the original Bayh-Dole Act started the movement towards a more interaction national laboratory system. (Mayfield, T.L.; (June 1993), 389-398 [in English].)

fying microorganisms which results in higher flexibility, improved detoxifying capacity of the microbiological system. (Szejtli, J.; (June 1993), 758-761 [in English].)

2860 NATIONAL RECORDING OF ENVIRONMENTAL INCIDENTS [BIB-BUDA00163]

One of the main problems in determining the environmental status of a territory is the common failure to accurately record the occurrence of environmental incidents. All too often, control of pollution is the responsibility of various independent central and local government departments without overall coordination and recording of incidents. If an efficient recording mechanism is not in place, determination of the number of environmental incidents that occur in a given period of time cannot be determined, the relation of connected incidents cannot be made, lessons cannot be learned and passed on to all those working in the pollution control field, and assessments of improved environmental standards cannot be achieved. (Forbes, G.I.; (June 1993), 310-312 [in English].)

2861 REMOTE SENSING OF HAZARDOUS MATERIALS [BIB-BUDA00164]

The instruments will be described that were developed at the Military Technical Institute of the Hungarian Army in collaboration with the Technical University of Budapest and Tungsram Laser Technology LTD. The goal of the development was to develop a remote-sensing infrared differential absorption lidar based on the coherent detection of backscattered CO_2 laser light. The lidar can be used for the detection of a wide range of molecular pollutants. Two types of instruments have been built: a deployable instrument and an onboard type of instrument. (Halasz, L.; Richter, P.; Gazdag, L.; (June 1993), 236-239 [in English].)

2862 ION MOBILITY SPECTROMETRY IN SITU SENSING OF HAZARDOUS MATERIALS [BIB-BUDA00165]

The Military Technical Institute of the Hungarian Army developed a family of ion mobility sensors. An IMS was elaborated to detect and make on-site analysis of hazardous vapors in air. The IMS measures the arrival times and current of ions were produced by the ionisation source from the pollutant molecule and from the air. The mobility spectrums are preprocessed, then stored in ROM. The programmed information may be used to select the appropriate windows within the spectrum, and peak measuring routines used to determine the magnitude of the peaks associated with material of interest. Stored calibration data are then used to generate a display output related to construction of material present. (Halasz, L.; Gruhala, P.; (June 1993), 44-45 [in English].)

2863 CONTINUOUS AUTOMATIC MONITORING OF AIR POLLUTION IN THE AREAS INFLUENCED BY THE MAJOR POWER-GENERATING PLANTS IN SLOVENIA [BIB-BUDA00166]

Three major power-generating plants in Slovenia: the coal-fired thermal power plants Sostanj and Trbovlje and the nuclear power plant Krsko are equipped with local, power-plant owned automatic air pollution monitoring networks. While the first two systems monitor gas pollution in the areas with very complex orography, the third one is designed for radiological monitoring and for diffusion modeling. All three systems are on-line integrated in the Slovenian Automatic Air Pollution Monitoring Network and run by a Hydrometeorological Institute of Slovenia. (Lesjak, M.; Mlakar, P.; Diallo, B.; Rupnik, Z.; Boznar, M.; (June 1993), 492-493 [in English].)

2864 A MODEL EDUCATION INFRASTRUCTURE FOR ENVIRONMENTAL REMEDIATION IN EASTERN EUROPE [BIB-BUDA00167]

During the last several decades, the centrally planned economies and economic-development policies of Eastern European countries have paralleled the environmental impact of certain business and industrial enterprises in market-driven economies in the West in terms of deterioration to the natural environment and to human health. In both cases, economic externalities were prioritized with subsequent environmental sacrifice. Environmental remediation in Eastern Europe will not occur merely through technological means; but must simultaneously occur within the political and educational spheres of influence. (Schultz, J.M.; (June 1993), 387-389 [in English].)

2865 MODELING OF GROUNDWATER CONTAMINATION FROM PESTICIDES POINT SOURCES [BIB-BUDA00168]

In 1986, a large area of Lombardy (Italy) was imported by pesticide contamination as a result of the widespread agricultural land-use practices (maize crop) and the underground dispersion from chemical industries. The study deals with a point-source atrazine contamination case of an alluvial aquifer bounded by a narrow valley formed by impermeable bedrock outcrops and situated in the area East of Bergamo. This case was so complicated that a three-dimensional transport model (MT3D) had to be implemented to describe the modality of the contamination movement, the influence of boundary conditions and the anthropic factors on the atrazine concentrations. (Avanzini, M.; Beretta, G.P.; Francani, V.; Pezzera, G.; (June 1993), 267-269 [in English].)

2866 AVOIDANCE OF RESIDUAL POLLUTION THROUGH CONTINUOUS MONITORING - AN INTEGRATED OPERATING AND INFORMATION SYSTEM FOR LANDFILL SITES [BIB-BUDA00169]

The landfilling of wastes will always remain a necessary task of waste management. The requirements for landfill space cannot even be appreciably reduced by increasing incinerator capacity. While a totally secure landfill will not exist for decades, timely recognition of ecological nuisance and environmental damage is required. Along with state-of-the-art technical installations, continuous collection of data describing operation and behaviour of landfills is a prerequisite. (Gossele, P.; (June 1993), 891-893 [in English].)

2867 HARMONIZATION OF COMMUNITY STATISTICS ON WASTE PROJECTS FOR THE COMMISION OF THE EUROPEAN COMMUNITIES [BIB-BUDA00170]

Recent developments in European policy relating to waste management, in particular the EC Directive 91/156/EEC on Waste, have emphasized the need for the compilation of accurate and compatible waste statistics. Regular collection of information and the elaboration of a statistical system on waste management are essential for the Member States who want to exercise control over waste management operations and adequately plan for the future. The objectives regarding waste management in the Member States which are laid out in this Directive can only be addressed, and any progress assessed, if accurate information on waste generation and waste management activities is quickly available upon request of potential users. (Krause, J.; (June 1993), 312-314 [in English].)

2868 GROUNDWATER MANAGEMENT IN DENMARK [BIB-BUDA00171]

The paper will present the overall organization of groundwater management and groundwater protection in Denmark, including the legislative framework. Special emphasis will be placed on setting up priorities for groundwater extraction for drinking water purposes, the retention of the environmental quality in lakes and streams, and for industrial and agricultural uses. Furthermore, the Danish National Monitoring system will be described. Approximately 99 percent of the drinking water in Denmark is extracted from the groundwater, and water supply management is highly decentralized. (Strobaek, N.; (June 1993), 202-204 [in English].)

2869 CONTAMINATION AND SPECIATION OF HEAVY METALS IN THE UPPER SILESIA REGION [BIB-BUDA00172]

The Upper Silesia, as one of the oldest industrial regions in the world, has contributed significantly to the soil and water pollution with heavy metals. Waste waters from non-ferrous ore mines and smelters have discharged metals to soil and surface waters for many years. Even if treated to some extent, pollution with metals exceeding the standards is manifested at large areas and along river stretches. Sediments deposited in river beds serve not only as a historical record, but also demonstrate a serious hazard for the future, keeping in mind the continuous changes within the environment. (Ryborz, S.; Suschka, J.; (June 1993), 660-662 [in English].)

2870 SPECIFIC APPLICATION OF DAF IN CONTAMINANTS REMOVAL AND UPGRADING THE EFFECTIVENESS OF CONVENTIONAL TREATMENT PLANTS [BIB-BUDA00173]

Although complex treatment processes are used, including chemical and biological methods, to treat coke coking phenolic effluents, the results are usually not satisfactory. Biological processes, e.g. activated sludge, are hindered by high

tion with Vituki Innosystem, Envimark, Vitukinvest and KGI to make an inventory of pollution sources. The one-year project, which forms part of the EEC/PHARE Program, is a major step towards protecting water supplies of 24 vulnerable aquifers. Of these aquifers, six are classified as high priority because they are at the limits of their development and cannot be replaced by other aquifers. (Langemeijer, D.; Botond, B.; (June 1993), 199-201 [in English].)

2850 HAZARDOUS AIR EMISSIONS POTENTIAL FROM WOOD-FIRED FURNACES [BIB-BUDA00153]

During the first week of April 1991, the Wisconsin Department of Natural Resources (WDNR) conducted a series of air emissions tests of a small industrial wood-fired boiler in northern Wisconsin. The boiler was firing a virgin hogged wood/wood waste fuel with a moisture content of about 35 percent. The pollutants measured were particulates, nitrogen oxides (NO_x), carbon monoxide (CO), total hydrocarbons (THC), benzene, formaldehyde (CHOH), polycyclic organic matter (POM; e.g., benzo(a)pyrene), aldehydes, and trace metals. Two other boilers were evaluated during March and May of 1991. One of these boilers is a utility-scale boiler (275 MMBTU/hr) which burns wood waste. (Hubbard, A.J.; (June 1993), 454-456 [in English].)

2851 ROCKY FLATS PLANT, USA DUCT REMEDIATION PROGRAM REMEDIATION OPERATIONS AND IMPLEMENTATION [BIB-BUDA00154]

The Duct Remediation Program was initiated to remove plutonium contaminants from process ductwork in buildings at the Rocky Flats Weapons Facility, U.S.A. Non-destructive assay measurements were used to identify areas of significant radionuclide holdup material accumulation. The U.S. Secretary of Energy defined the criteria for success " ... product would be remediated as low as practicable, but in no case greater than 400 grams of plutonium would remain in any single upward flowpath in a glovebox exhaust system ...". Process history indicated the likelihood of plutonium holdup, and the extent of material holdup was determined by non-destructive assay measurements. (Beckman, T.D.; Davis, M.M.; Karas, T.M.; Knutson, D.E.; (June 1993), 346-348 [in English].)

2852 ROCKY FLATS PLANT, USA DUCT REMEDIATION PROGRAM MATERIAL CHARACTERIZATION AND REMOVAL/HANDLING [BIB-BUDA00155]

The Duct Remediation Program was initiated to remove plutonium contaminants from process ductwork in buildings at the Rocky Flats Weapons Facility, U.S.A. Non-destructive assay measurements were used to identify areas of significant radionuclide hold up material accumulation. The U.S. Secretary of Energy defined the criteria for success " ... duct would be remediated as low as practicable, but in no case greater than 400 grams of plutonium would remain in any single upward flowpath in a glovebox exhaust system ...". The chemical composition of the hold up material was dependent on the process system serviced by that ductwork. Chemical reactions and physical mixing resulted from process exhaust systems meeting at a common header. (Beckman, T.D.; Davis, M.M.; Karas, T.M.; Knutson, D.E.; (June 1993), 348-350 [in English].)

2853 ROCKY FLATS PLANT, USA DUCT REMEDIATION PROGRAM CONSTRUCTION ACCESS RESEARCH AND ENGINEERING [BIB-BUDA00156]

The Duct Remediation Program was initiated to remove plutonium contaminants from process ductwork in buildings at the Rocky Flats Weapons Facility, U.S.A. Non-destructive assay measurements were used to identify areas of significant radionuclide accumulation. The U.S. Secretary of Energy defined the criteria for success" ... duct would be remediated as low as practicable, but in no case greater than 400 grams of plutonium would remain in any single upward flowpath in a glovebox exhaust system ...". The program relied on extensive research and engineering to accomplish the remediation goals. (Beckman, T.D.; Davis, M.M.; Karas, T.M.; Knutson, D.E.; (June 1993), 351-353 [in English].)

2854 ENVIRONMENTAL IMPACT OF HEAVY METAL LEACHING BY ACID RAIN IN KUWAIT [BIB-BUDA00157]

Crude oils contain usually some quantity of heavy metals and heterocyclic nitrogen compounds which can be toxic and mutagenic in nature and are harmful to human and other living creatures. The increased solubilities of these compounds in acidic solutions increase the potential of their acid washing. The possibility of partial leaching of these pollutants by acid rain and hence their transport into the aquatic environment is of great importance. Therefore, the leaching rate of the heavy metals by diluted aqueous solutions of H_2SO_4 and NHO_3 acids is currently investigated at ambient temperatures in this laboratory. (Jassem, F.; Bouhamara, W.; (June 1993), 145-155 [in English].)

2855 INVESTIGATION, ASSESSMENT AND REMEDIATION OF SOIL AND GROUNDWATER CONTAMINATION ON MILITARY AIRFIELDS [BIB-BUDA00158]

Experience with contaminated site characterization and hazardous material surveys on military airfield installations (MAI) indicates unique features which distinguish polluted MAI from other polluted sites. These include (1) often limited historic site information due to data confidentiality and high turn-over rate of military personnel, (2) a wide variety and large quantities of chemicals often improperly stored, handled, and utilized within various areas of the MAI by insufficiently trained personnel, (3) lack of precise book-keeping of utilized chemicals, (4) fuel and other chemical spills during vehicle and equipment maintenance, and (Goth, M.; Bollow, T.; Nazari, M.; (June 1993), 657-659 [in English].)

2856 GEOGRAPH - A WORLD-WIDE GEOGRAPHICAL DISPLAY SOFTWARE SYSTEM [BIB-BUDA00159]

GEOGRAPH combines a flexible display menu with a comprehensive world data base for country and regional boundaries to allow the user a convenient choice of 2 and 3 dimensional color graphical displays of Environmental Data Bases superimposed over Regional Maps. A unique feature of GEOGRAPH is the flexibility allowed the user in choice of single regions or combinations of regions through the use of special menus and forms for data entry. Specific applications include fallout migration following the Chernobyl accident, air pollution, episodes of smog, and terrestrial contamination from buried radioactive materials. (Broadway, J.A.; McCroan, K.; Sajo, L.; Ferrer, H.A.; (June 1993), 353-355 [in English].)

2857 PRESENT AND PROJECTED RADIOACTIVE CONTAMINATION OF THE BLACK SEA FROM THE CHERNOBYL REACTOR ACCIDENT [BIB-BUDA00160]

Approximately 2400 TBq (65 kCi) of Cs-137 and 1200 TBq of Cs-134 have been deposited into the Black Sea from the 1986 Chernobyl Nuclear Power Plant accident. The Cs-137 deposition, approximately 6.5 percent of that released into the atmosphere during the Chernobyl accident, has doubled the Cs-137 inventory in this water body. Near Sevastopol, radionuclide concentrations in surface waters peaked during 1986 at 840 mBq/L for Cs-137, 157 mBq/L for Sr-90, and 37 mBq/L for I-131. Approximately 1 percent of the Cs-137 associated with the Chernobyl accident was transported to Black Sea bottom sediments. (Egorov, V.N.; Polikarpov, G.G.; Broadway, J.A.; Curtis, W.; Livingston, H.D.; (June 1993), 353-355 [in English].)

2858 TESTING OF A PILOT PLANT FOR THE REMEDIATION OF RADIOACTIVE CONTAMINATED SOIL USING PARTICLE-SIZE SEPARATION TECHNOLOGY [BIB-BUDA00161]

The Office of Radiation Programs within the U.S. Environmental Protection Agency was charged to design, construct, test, and demonstrate a pilot plant capable of on-site remediation of radiologically contaminated soils. The Phase I testing of this pilot plant was conducted at the U.S. EPA National Air and Radiation Environmental Laboratory on soil contaminated with radium, thorium, and uranium. Using radium contamination as a measure of total radioactivity, the feed soil contained 0.36 Bq/g of Ra-226. The basic particle-size separation unit operations used in the plant were trommel screen, spiral classifiers, and hydrocyclones. (Cox. C; Eagle. M.; Hay. S.; Richardson. B.; Gifford. M.; (June 1993), 756-758 [in English].)

2859 CYCLODEXTRINS IN REDUCTION OF ENVIRONMENTAL POLLUTION [BIB-BUDA00162]

Depending on the type of the derivatization, Cyclodextrin (CD)-derivatives can either enhance, or reduce the solubility of various substances in water, facilitating extraction from multicomponent systems, or to remove them from solutions. Through their enzyme like catalytic activity, CDs can inactivate highly toxic substances like soman, sarin, etc. In biological detoxication of sewage, CDs reduce the effective free concentration of toxic substances protecting the detoxi-

2839 TECHNOLOGY RISK MANAGEMENT [BIB-BUDA00142]

A Technology Risk Reduction Management (TRRM) process was used in the aircraft industry to facilitate the infusion of new, and innovative high-risk technology into the development of advanced prototypes, such as the Lockheed Advanced Tactical Fighter (ATF). The process is a tailored version of the "Iso-Risk Contour" method and was used to calculate an overall Technology Risk Factor, or TRF. The TRF depends on two other factors: Probability of Failure and Consequence of Failure. This high-tech process has been modified by the authors to be used in the management of high risk technologies and their infusing into on-going remediation programs. (Brown, E.W.; Plumblee, H.E.; Whitehurst, C.A.; (June 1993), 443-445 [in English].)

2840 ASSESSING ENVIRONMENTAL TECHNOLOGY NEEDS [BIB-BUDA00143]

Much has been said and written about the EPA RI/FS process and the identification, assessment, selection, and implementation of remedial technologies. It has become apparent that innovative technologies must be introduced into the remediation plan if regulatory requirements and costs limitations are to be met. The Research and Applied Technology (R&AT) planning and assessment process described in this paper has been adapted form R & AT programs which supported the development of advanced aircraft. (Brown, E.W.; Plumblee, H.E.; Whitehurst, C.A.; (June 1993), 307-309 [in English].)

2841 FIELD SCREENING OF WATER AND SOIL SAMPLES FROM A CHEMICAL TRAIN DERAILMENT USING PORTABLE GAS CHROMATOGRAPHS [BIB-BUDA00144]

A chemical tank train derailment caused three railroad cars to leak chloroform and styrene onto the ground and adjacent drainage ditches. Site geology (Karst) contained numerous caves and underground streams, permitting rapid spread of contamination at a distance from the derailment site. Field analyses were developed to determine the extent of contamination in water and soil matrices. Two microchip Gas Chromatographs (GCs), Models M200 and P200 (Microsensor Technology, Inc., Fremont, CA, USA) were set up to analyze for chloroform and styrene. In addition, a portable dual trap concentrator was used to purge the volatile organics out of the water and soil samples and concentrate them onto a trap. (Wynnyk, R.E.; Kaelin, L.P.; Powell, G.N.; (June 1993), 232-232 [in English].)

2842 GEOPHYSICS IN BERLIN: INVESTIGATING CONTAMINATED SITES [BIB-BUDA00145]

Since the early 1980's geophysical methods have been applied in contaminated site investigations. The most commonly used tools are geomagnetics and geoelectrics. Geomagnetics are useful in locating metallic or metal containing objects (foundings, tanks, waste dumps, pipelines, etc.) in the subsurface. Measuring the vertical gradient instead of, or in addition to, the total intensity gives an increased resolution and less noise disturbed results, especially in urban areas. In detailed surveys, we measured up to 40,000 points/ha. An example from the western part of Berlin shows the investigation of a World War II anti-aircraft artillery site. (Lorenz, B.; Niederleithinger, E.; Wackerle, R.; (June 1993), 41-43 [in English].)

2843 RISK-BASED CONCENTRATIONS: A METHOD TO SCREEN ENVIRONMENTAL PROBLEMS USING LIMITED DATA [BIB-BUDA00146]

One of the most daunting tasks faced by regulatory agencies is choosing, on the basis of sketchy data, environmental problems on which to act. After selecting locations, officials must focus next on specific contaminant and media, to conserve time and resources. This paper proposes a quantitative method, using U.S. EPA toxicological constants, to prioritize locations, contaminants, and media according to risk to human health. U.S. EPA has developed carcinogenic potency slopes (upper bound lifetime cancer risk per mg/kg/d) or reference doses (mg/kg/d chronic dose without adverse systemic effect) for many contaminants. (Smith, R.L.; (June 1993), 445-453 [in English].)

2844 IDENTIFYING RESPONSIBLE PARTIES TO ASSIST IN FUNDING SITE CLEANUP [BIB-BUDA00147]

Experience in the United States has shown that the most significant obstacle to accomplishing site remediation is funding. Through the federal Superfund Program and similar programs in the individual states, the government has established a means by which to fund site cleanup through the contributions of various parties who participated in creation of the contamination. Although Central and Eastern European countries have had fewer private generators, it is argued here that the basic liability scheme can be adapted to meet the distinctive historic circumstances of individual countries, and improved to avoid some of the impediments to cost contribution and recovery faced in the United States. (Bookspan, S.; Cashier, R.; (June 1993), 655-657 [in English].)

2845 THE ENVIRONMENTAL SENSITIVITY MAP TECHNIQUE FOR REGIONAL IDENTIFICATION AND PREDICTION OF CONTAMINATION [BIB-BUDA00148]

Planning for remedial activities and contamination prevention requires a means for predicting where subsurface hazards may be found. A predictive model, adaptable to all regions, requires synthesis of information garnered from distinct fields: geology, hydrology, physical chemistry, and historic geography. Using a simple overlay mapping technique that superimposes historic and current chemical usage and waste disposal practices onto natural soils and drainage systems as well as engineered drainage systems, planners can see the interrelationships among operative factors and identify threatened or tainted areas. (Bookspan, S.; Cashier, R.; (June 1993), 263-265 [in English].)

2846 REMEDIAL ACTION OF HYDROCARBON-IMPACTED SANDY SOILS IN CENTRAL NEW MEXICO [BIB-BUDA00149]

IT Corporation recently installed and operated a full-scale vapor extraction system (VES) at a former gasoline service station in Albuquerque, New Mexico. The system was operated for 249 days from January 17 to September 20, 1991. The subsurface geologic environment is primarily dense sands and non-plastic clays. The system consisted of a vacuum pump connected to a 65-foot-deep extraction well located in the center of the backfilled former tank pit. Four observation wells, approximately 13 feet deep in the former tank pit, were used to estimate the effectiveness of the VES. (Raugust, J.S.; (June 1993), 884-890 [in English].)

2847 ADVANCED X-RAY FLUORESCENCE ANALYSIS FOR HAZARDOUS SITE SCREENING AND REMEDIATION [BIB-BUDA00150]

The process of screening and remediating a hazardous site requires the analysis of hundreds of soil samples. If these analyses can be performed rapidly on-site, the screening and remediation operations can be adjusted while they are in progress. When the distribution of contamination is not uniform, such flexibility can result in significant savings compared to the costs of pursuing a predetermined program. X-ray fluorescence (XRF) has suffered in past years from a variety of shortcomings including relatively delicate and bulky apparatus and rather severe analytical interferences from common soil forming elements. A number of recent advances in XRF technology have removed these difficulties. (Leland, D.; Little, S; (June 1993), 233-236 [in English].)

2848 CONSIDERATION OF GEOCHEMICAL BARRIERS IN THE DESIGN OF HAZARDOUS WASTE REPOSITORY FACILITIES [BIB-BUDA00151]

The primary function of waste repository sites is to isolate waste or waste-derived leachate from underlying soil and ground water. To attain isolation of waste from the environment, engineering designs consider installation of a synthetic or natural clay liner with a leachate collection system and a low- permeability cover. The engineering performance standards addressing isolation systems are mandated by regulations. However, regulations also recognize natural factors retarding or blocking the migration of contaminants away from a repository. In the United States, the owner of the repository can be exempted from stringent performance standards if the "attenuating capacity of the soil present between the landfill and groundwater is demonstrated." (Popielak, R.S.; Lewis-Russ, A.; (June 1993), 736-739 [in English].)

2849 INVENTORY OF GROUNDWATER POLLUTION SOURCES IN HUNGARY [BIB-BUDA00152]

The quality of shallow drinking water resources in Hungary is threatened by chemical contamination. The Ministry for Environment and Regional Policy has contracted Nethconsult, represented by BKH Consulting Engineers, in associa-

for aquatic and soil-forest ecosystems. (Mill, W.A.; Wojcik, A.R.; (June 1993), 39-40 [in English].)

2829 SENSITIVITY OF AQUATIC ECOSYSTEMS IN THE POLISH TATRA MOUNTAINS TO ACIDIC DEPOSITION [BIB-BUDA00132]

The acidification of surface waters is generally caused by inflow of strong acid anions, mainly sulphates and nitrates, which are deposited on the surface of the catchment area by precipitation and dry deposition. Critical load of acidogenic compounds transported from the air and introduced into individual environmental components is defined as the highest deposition of acidic compounds which does not result in any chemical transformations leading to long-term adverse effects upon the structure and functioning of the ecosystems. In Poland, the area of the Tatra mountains belongs to regions most sensitive to the acidic deposition. The Polis Tatra mountains are situated on the boundary between Poland and Czech+Slovak Fed Rep. (Rzychon, D.; Mill, W.; Henriksen, A,; Wathne, B.M.; Kot, K.; (June 1993), 197-199 [in English].)

2830 PACKAGE PLANT LEACHATE TREATMENT - THE APPLICATION OF AMMONIA STRIPPING [BIB-BUDA00133]

With the increased use of containment sites for the disposal of domestic and hazardous wastes the development of improved leachate treatment procedures to reliably meet effluent discharge standards is essential. Apart from the high and extremely variable organic strength of the leachate one of the unique problems facing the engineer is high ammonia levels. Whilst conventional aerobic biological treatments, such as aerated lagoons and extended aeration activated sludge, have successfully reduced organic levels their performance with respect to ammonia is unreliable - the high ammonia to BOD ratio that occurs in methanogenic leachate can give rise to treatment problems. (Fletcher, I.J.; Ashbee, E.; (June 1993), 105-109 [in English].)

2831 HYDROCARBON CONTAMINATION INVESTIGATION, RECOVERY AND TREATMENT STRATEGIES FOR GROUNDWATERS [BIB-BUDA00134]

In Europe, the investigation and remediation of hydrocarbon contamination problems is becoming of increasing interest following the progressive introduction of more stringent environmental regulations. Contaminations result from leakage of hydrocarbons from storage tanks, chemical refining complexes, spillage from chemical handling and particularly of note in Eastern Europe is the unregulated disposal of waste materials at military sites. In some instances many thousands of tonnes of hydrocarbons have leaked into the gound resulting in severe contamination not only of adjacent soils but also to water supply aquifers. (Tearney, K.W.; Fletcher, I.J.; Reece, M.; Campbell, K.; (June 1993), 752-756 [in English].)

2832 THE ENVIRONMENTAL QUALIFICATION SYSTEM FOR HUNGARIAN PRODUCTS [BIB-BUDA00135]

The "Environment-Friend" qualification system which pertains to domestically produced goods is well- known in certain highly developed industrial countries (e.g., Germany, Scandinavian States, and Canada). In particular, Hungary has followed with great intent the German "blau angel" system. The earlier Hungarian Ministry (Ministry of Environment and Water) took some steps toward adoption of such a system. The present Hungarian Ministry (Ministry for Environment and Regional Policy) assumed, with interest, the role of adopting such a system and improved the question of environment-friend qualification. (Karoly, B.; Agnes, G.B.; Szanto, P.; (June 1993), 303-304 [in English].)

2833 THE INTERNATIONAL ENVIRONMENTAL FELLOWS PROGRAM [BIB-BUDA00136]

The Environmental Fellows Program (EFP) is being managed through the New Mexico Waste Management Education and Research Consortium (WERC) and was co-funded by the U.S. Department of Energy and the U.S. Department of State. The mission of the EFP is to enhance the world's capability to address issues associated with management of hazardous, radioactive, and solid wastes by establishing a prestigious worldwide community of highly qualified administrators and scientists in the field of environmental engineering. The EFP will provide education, technology transfer, and personal interaction to quality personnel throughout the world who are associated with environmental engineering. (Otts, V.J.; (June 1993), 385-386 [in English].)

2834 A POLLUTION PREVENTION MODEL: ON-SITE TECHNICAL ASSISTANCE, TRAINING, AND TECHNOLOGY TRANSFER IN CENTRAL AND EASTERN EUROPE [BIB-BUDA00137]

Pollution and resultant contamination from various sources, including industries, can be significantly decreased using the expertise and services available in the faculties and staff of most technical universities. This paper proposes and describes an approach, which has been fully tested and realized in the U.S., that takes advantage of technical-university resources in a non-adversarial, very forthcoming manner. The methods, properly applied and given the appropriate perspective, result in industry, government, and the university working together in a partnership that solves many pollution problems in relatively easy and inexpensive ways. (Nemeth, J.C.; Paskaleva, K.; (June 1993), 304-307 [in English].)

2835 INTEGRATED RISK ASSESSMENT (IRA) [BIB-BUDA00138]

IRA is a simple management technique to assess and manage the risks posed from chemicals to both the indoor (workplace) and external (air/land/water) environments. A professional assessment of the complex health, safety and environmental matters can result in both financial savings and compliance with regulatory requirements. Such an environmental 'health check' can and often will show the industrial discharger how savings can be made on raw materials, wastage during manufacture, and waste disposal. IRA involves information retrieval on the chemicals used, synthesized, formulated and wasted, their chemistry and toxicology, leading to hazard and risk assessment and finally risk management. (Richardson, M.; (June 1993), 419-420 [in English].)

2836 EFFECTIVE CLEANUP OF SUBSURFACE CONTAMINATION USING VACUUM EXTRACTION [BIB-BUDA00139]

Volatile solvents and hydrocarbons are the most common forms of subsurface contamination impacting ground water quality. The most common solvents and fuel components contaminating groundwater supplies are tetrachloroethylene (PCE), trichloroethylene (TCE), methylene chloride, and benzene. All are known or suspected to cause cancer and can render groundwater unsafe for drinking. All sources of contamination must be removed to achieve cleanup of contaminated groundwater. Contaminated soils are a source of long-term groundwater pollution because of continuing leaching of contaminants. Contaminant levels in soils must be reduced to achieve groundwater cleanup. (Pineo, C.; Malot, J.; (June 1993), 653-655 [in English].)

2837 IN SITU ON-SITE BIOREMEDIATION OF WOOD TREATMENT SOILS CONTAINING CHLORINATED PHENOLS AND PAHS [BIB-BUDA00140]

Field research was conducted to evaluate the influence of a patent-pending soil amendment technology, and bacterial inoculation, on in situ and on-site bioremediation of wood-treatment soils containing chloricated phenols and polycyclic aromatic hydrocarbons (PAHs). Soil in twenty-one in situ plots, each covering an area of approximately 10m2, was treated to a depth of 0.6m. Treatment of excavated soil containing high concentrations of chlorinated phenols and PAHs was performed in a single on-site plot composed of a synthetic liner covered by a steel/polyethylene structure. (Seech, A.G.; Marvan, I.J.; (June 1993), 619-621 [in English].)

2838 REMEDIATION BY GROUNDWATER AND SOIL/AIR CIRCULATION IN SITU USING THE VACUUM-VAPORIZER-WELL (UVB) TECHNOLOGY [BIB-BUDA00141]

World-wide, not only in the industrialized countries, the number of known groundwater and soil air contaminations by hydrocarbons, BTX, pesticides, nitrates, etc. increases. Efficient remediation techniques at low costs are needed. A new method for the in-situ remediation of groundwater and soil air is the Vacuum- Vaporizer-Well (UVB) technology (German: Unterdruck-Verdampfer-Brunnen (UVB), Inventor: B. Bernhardt, Patents: IEG mbH, D-7410 Reutlingen). The well known disadvantages of groundwater remediation applying current pumping methods (groundwater lowering, limited yield, insufficient remediation) may be avoided if pumping and recharge take place in the same well. (Burmann, W.; Wagner, H.; (June 1993), 622-624 [in English].)

anionic organic food dye was mixed with a portion of soil and the rate of migration of the dye in an imposed electric field was monitored photographically. (Lindgren, E.R.; Mattson, E.D.; Kozak, M.W.; (June 1993), 614-616 [in English].)

2819 CONCEPTUAL MODEL DEVELOPMENT USING SOIL GAS SAMPLING RESULTS FROM EXISTING GROUNDWATER MONITORING WELLS [BIB-BUDA00122]

The U.S. EPA requires that groundwater monitoring wells at hazardous waste sites be screened across the water table for the detection of volatile organic carbon (VOC) releases. Due to the design of the monitoring wells, it is possible to use existing wells to extract soil gas samples at the groundwater/vadose zone interface. This paper describes an approach for using soil gas samples from such wells to assist in developing a defensible conceptual model of VOC transport through the thick vadose zone at a waste site in New Mexico. VOC transport from the source to the groundwater will be in one, or a combination, of the following phases: dissolved, liquid, or vapor. (Lindgren, E.R.; Mattson, E.D.; McCord, J.T.; Conrad, S.H.; Booher, W.F.; Ardito, C.P.; (June 1993), 545-547 [in English].)

2820 GROUND PENETRATING RADAR FOR HAZARDOUS WASTE SITE INVESTIGATIONS [BIB-BUDA00123]

Hazardous substances in the subsurface present a threat to human health and the environment. Investigators of hazardous waste sites require increasingly detailed subsurface data to make informed assessments on site conditions. Most shallow geophysical methods traditionally provide only highly averaged layered interpretations. Ground Penetrating Radar (GPR) is a geophysical technique which can provide images of the subsurface at scales that control ground water and contaminant movement as well as the detection of buried objects. In addition to producing high resolution continuous subsurface profiles non-destructively, GPR measurements are made rapidly and generate a real time profile record for immediate evaluation. (Fenner, T.J.; Vendl, M.A.; (June 1993), 575-577 [in English].)

2821 GROUNDWATER REMEDIATION - THE OLD AND THE NEW [BIB-BUDA00124]

In most cases, the remediation of contaminated sites involves the treatment of contaminated groundwater and/or leachate. Although in situ methods are preferred, they are effective in only a limited number of scenarios. As a result, most water treatment involves pump and treat technologies. In this case, the liquid must first be pumped to the surface then treated. This means that pump and treat also has a limited range of applicability but the range is much greater than that for in situ techniques. This paper will discuss some of the impediments to successful treatment of leachate and contaminated groundwater. It will then focus on a selection of available treatment technologies. (Whittaker, H.; (June 1993), 649-652 [in English].)

2822 CHLORIDE ION SENSOR FOR MONITORING DECOMPOSITION REACTION OF CHLORINE-BASED ORGANIC SOLVENTS [BIB-BUDA00125]

A new chloride ion sensitive field effect transistor to monitor decomposing trichloroethylene or tetrachloroethylene is reported. Chlorine-based organic solvents such as trichloroethylene and tetrachloroethylene are used in dry cleaning and degreasing, but they can cause cancer, also they enter waste water and pollute underground water, lakes and rivers. We carried out a project with the staff of Mie Industrial Research Institute at Tsu-city in Japan to develop a method to decompose chlorine-based organic solvents in waste water by ultraviolet irradiation or oxidation with ozone and we developed a chloride ion sensor to monitor the progress in the decomposing ones. (Morinaga, S.; Ito, N.; Kato, H.; Kojima, M.; Gatto, H; (June 1993), 879-883 [in English].)

2823 STAND-OFF DETECTION OF POLLUTANTS [BIB-BUDA00126]

The Centre d'Etudes du Bouchet initialized studies in the frame of CO_2 lasers technology for the conception of stand-off detection devices. These studies were focused on chemical pollution monitoring. First, experiments conducted through an exploratory development led to the vapor hazards characterization and to the construction of an experimental model named DETADIS. Second, efforts were made to measure the aerosol infrared backscattering coefficients of pollutants. These data show a specific backscattering signature on each product and will allow to develop special algorithms to detect and identify aerosol clouds (ALGO 3). A cooperative effort with the USA has resulted in field tests in Utah. (Cunin, P.; Adam, P.; (June 1993), 229-232 [in English].)

2824 PREDICTING BEHAVIOR OF CONTAMINANTS IN AQUIFERS USING APPARENT RELATIVE RETARDATION OF SURROGATES [BIB-BUDA00127]

Two-well recirculating tracer tests can be used not only to determine porosity and dispersivity of aquifers, but also to compare the in situ behavior of different solutes in aquifers, thus avoiding problems of transferring laboratory-scale results to the field scale. At special field sites for the testing and calibration of tracers under carefully controlled conditions, the behavior of certain hazardous target contaminants can be compared to that of harmless surrogate tracers, which, in turn, can be injected into other aquifers with minimal environmental risk and analyzed to determine how the hazardous substances would behave during normal ground water transit and during remediation. (Leap, D.I.; (June 1993), 578-580 [in English].)

2825 CHEMICAL, PHYSICAL, BIOLOGICAL PROPERTIES OF A SOIL AFTER REMEDIATION BY THE RUT LOW TEMPERATURE TREATMENT [BIB-BUDA00128]

To remediate, especially with organic pollutants contaminated sites, thermal treatment technologies are quite often used. By the thermal treatment of contaminated soils, high temperature (800-1200 °C) and low temperature (350-600 °C) technologies were used. In consequence of the thermal treatment of contaminated soils, chemical, physical and biological properties of the treated substrates are changed. In order to assess detailed information about the possibilities to recultivate soils which have been cleaned of toxic organic compounds (especailly PAHs) by a low temperature treatment (350-600 °C) a field experiment has been carried out. (Hiller, D.A.; Burghardt, W.; (June 1993), 780-782 [in English].)

2826 REMEDIATION OF CONTAMINATED SEDIMENTS IN THE NETHERLANDS [BIB-BUDA00129]

Contaminated sediment is a high-priority environmental problem in the Netherlands. It is mainly a problem associate with dredged material. Until a few years ago, all dredged material was removed to confined disposal facilities. Recently, treatment technologies have been applied to sediment remediation actions. Jointly, with these full-scale operations, a research program is being conducted. Since 1985, technology has been applied to reduce the volume of contaminated dredged sludge. This process combines two techniques: hydrocyclones and dewatering. Thus, a relatively clean fraction is separated from the dredged sludge, while the volume of the residual fraction is reduced as much as possible. (van Veen, H.J.; Bruggeman, W.A.; (June 1993), 616-619 [in English].)

2827 COMPARISON OF DIFFERENT LAB METHODS AND SCREENING TESTS FOR WATER QUALITY ASSESSMENT IN EAST GERMAN RIVERS [BIB-BUDA00130]

Water quality management procedures are commonly based on special measuring programs. In order to determine raw water quality data, different chemical measuring methods and techniques have been employed. In practice, the method selected depends on various criteria such as the number and kind of parameters and samples, conservation possibilities, lab capacity and the conditions of sampling. In this paper, manual and automated photometric lab methods and screening tests have been critically compared for their suitability in the application field of raw water surveillance. (Muller, A.; Arndt, K.; (June 1993), 34-38 [in English].)

2828 CRITICAL LOADS FOR ACIDIFICATION IN POLAND - AN ECE ASSESSMENT APPROACH [BIB-BUDA00131]

Poland, as a co-signatory of the Convention on Long-Range Transboundary Air Pollution, has undertaken a task consisting of the assessment and mapping of critical loads for airborne acid compounds. The major goal of this task was to determine the sensitivity of aquatic and forest ecosystems to acidic deposition from the air, and simultaneously, to provide a reliable basis for the development of a strategy aimed at the reduction of acidic compounds in atmospheric emissions. As a result of the first stage of the project which was accomplished in 1991, critical loads of acidity, sulfur and nitrogen were calculated and mapped

whereas particles pass through undisturbed. Automation of the laborious conventional technique increases its precision and offers the possibility to perform long-time measurements. Within this framework, ECN has developed so-called wet denuder systems in which trace gases are collected in a solution film on the walls of an annular rotating denuder (Keuken et al. 1988). The denuder is automatically emptied and refilled. (Wild, P.J.; Wyers, G.P.; Vermeulen, A.T.; Otjes, R.P.; Waijers, A.; Molsand, J.J.; Slanina, J.; (June 1993), 490-492 [in English].)

2809 CAUSES AND CONSEQUENCES OF GROUNDWATER AND SURFACE WATER POLLUTION IN THE SLOVAK REPUBLIC [BIB-BUDA00112]

Relevant information on water quantity and quality will be included in the paper, including questions on water use and water quality, the extent of pollution, and water quality monitoring systems. The strategic intentions of the ecological policy of the Slovak Commission for Environment will be presented including comments on the legislation, monitoring needs and economic considerations of this policy. (Gasperikova, I.E.; Matuska, M.; (June 1993), 439-442 [in English].)

2810 MONITORING FOR GENOTOXIC AND TOXIC SUBSTANCES IN SURFACE WATER [BIB-BUDA00113]

Health risk assessment based on data for single chemicals is limited by a number of chemicals that can be identified in water for which toxicity data are not available. Besides, prediction of biological effects of interactions between chemicals is difficult or impossible on the basis of data for single chemicals. Genotoxicity and toxicity of water samples taken from different chosen sites where pollution was expected was monitored. For the same samples physical, chemical and microbiological analysis were conducted according to the routine water quality control. (Filipic, M.; Lovincic, D.; Erjavec, M.; Glavic, D.; Sek, S.; Planina, P.; Klun, N.; Vrhovsek, M.; Kraigher, A.; Jan, J.; (June 1993), 520-522 [in English].)

2811 A GIS-INTEGRATION PROTOTYPE TO SOLVE ENVIRONMENTAL AND LANDUSE CONFLICTS [BIB-BUDA00114]

In the densely populated areas of middle Europe, the conflict concerning future land use for raw material extraction - agriculture - ground water protection - waste disposal and housing is growing. A geographical information system (GIS) offers the possibility to integrate knowledge on ground water conditions with the use and past and present landuse and to locate and evaluate conflict situations. In the study area, one problem is potential groundwater contamination by unauthorized landfills in former pits from sand and gravel extractions. It is difficult to identify these sites on the landscape today. Aerial photographs from the past are typically the only information available on the location of these sites. (Wolfbauer, J.; Hobenreich, L.; (June 1993), 258-262 [in English].)

2812 DISPOSAL OF PCB CONTAINING ELECTRIC CAPACITORS [BIB-BUDA00115]

Electric capacitors with PCB (polychlorinated-biphenyl) content are collected from all over the country and sent to a central decontamination site. During the decontamination process, after opening the capcitor bodies, the PCB-containing liquid is removed and the inside parts are removed using an organic solvent in a four-step counter-current flow extractor. In the final (fourth) extraction step, the capacitor bodies are washed with a solvent vapor which condenses onto the cool surfaces of the capacitors. Using this process, PCB concentrations of less than 50mg/kg (related to total mass of capacitor) are reached. (Kalman, J.; Ando, A.; Izsaki, Z.; Varga, T.A.; (June 1993), 734-736 [in English].)

2813 USING SEPARATION PROCESSES FROM THE MINERAL PROCESSING INDUSTRY AS AN ENABLING TECHNOLOGY FOR SOIL CLEAN-UP [BIB-BUDA00116]

A possible means of extending the range of contamination problems treatable by soil clean-up would be to separate complex contamination problems into simpler subunits, to enable their clean-up by existing processes. Technology developed for the mineral processing industry offers a route to achieve this separation. This paper discusses the interim results of a substantial two-year program investigating the application of mineral processing techniques for the separation of contamination problems and the treatment of the contaminant concentrates produced by this approach. (Bardos, R.P.; Dunn, R.M.; Lofthouse, A.; Martin, L.; Pearl, M.; Winter, D.G.; Wood, P.; (June 1993), 775-777 [in English].)

2814 NATURE OF HEAVY METAL STRESS TO CORN AND PEA PLANTS GROWING ON POLLUTED SOILS [BIB-BUDA00117]

Heavy metals such as cadmium, lead, and mercury are strong inhibitors of important life processes in mammalian and plant tissues. Despite the long history of research into their effects on the environment, we are still in the phase of discovery and hypothesis formation concerning the understanding and, if possible, predicting and counteracting ecological implications of heavy metal pollution. With the aim of taking into account the basic stress response of plants at the enzymatic level to exposure to heavy metals, a joint research project has been launched by the Plant Protection Institute of the Hungarian Academy of Science and the Institute of Plant Physiology of the University of Bern. (Komives, T.; Brunold, C.; (June 1993), 194-196 [in English].)

2815 THE QUALITY OF CONTAMINATED SOIL USING LANDFARMING TREATMENT [BIB-BUDA00118]

Biological soil treatment by landfarming is a relatively simple and inexpensive method of cleaning soil contaminated with different organic compounds. Depending on the properties of the polluted substance, soil characteristics and pollution age, 60 to almost 100 percent can be degraded by micro-organisms. The residual concentration can sometimes be acceptable. In other cases residual concentrations exceed the standards set by the national government. We assume that the residual concentration is not bio-available. Results will be presented about measures to increase the bio-availability of the residual concentration during the landfarming process. (Harmsen, J.; (June 1993), 778-780 [in English].)

2816 ENVIRONMENTAL IMPLEMENTATION PROGRAMMING: A REAL POSSIBILITY IN PRESENT CENTRAL AND EASTERN EUROPEAN CIRCUMSTANCES? [BIB-BUDA00119]

In this article, one of the many important techniques of implementation is dealt with: Implementation Programming. This management tool can be applied inside and outside the environmental field. Implementation programming is of particular use when "products" have to be produced in large quantities. This paper deals with the criteria that an Environmental Implementation Program has to meet in order to be effective. Requirements learned from Dutch practices will be presented.. The present situation in Central and Eastern Europe seems to pose no fundamental restrictions on the application of this tool. (Hutten Mansfeld, L.C.B.; (June 1993), 301-303 [in English].)

2817 REMEDIATION OF GROUNDWATER RESOURCES CONTAMINATED BY SEEPAGE FROM A HAZARDOUS WASTE SITE, BY EXTRACTION FROM WELLS, TREATMENT AND RECHARGE OF CLEAN WATER [BIB-BUDA00120]

In the past, the Ministry for Environment, Youth and Family installed at the largest waste disposal site in Austria, the Fischer-Deponia site, a system of extraction wells to prevent the seepage of the leachate from contaminating the aquifer. That was the first step taken to extract the 800,000m^2 of waste. The ground water at this site is contaminated to a great extent with chlorinated organic solvents but still provides water supply to about 500,000 people. To avoid further contamination, the effluent at the dump-site should be totally restrained by a line of extraction wells. (Urban, W.; Frischherz, H.; (June 1993), 647-649 [in English].)

2818 ELECTROKINETIC REMEDIATION OF ANIONIC CONTAMINANTS FROM UNSATURATED SOILS [BIB-BUDA00121]

Electrokinetic remediation is an in situ technique for removal of ionic contaminants from soil or ground water. In electrokinetic remediation, a small direct current is passed between electrodes implanted in the soil. This leads to a number of effects which can impart a movement of contaminant ions toward the electrodes. To date, most studies of this technique have only considered saturated soils. In this paper, the process is demonstrated for unsaturated sand (7 wt percent water) in experiments using a novel 2-D transport visualization technique. An

esses. (Been, K.; Goldsworthy, M.H.; Ernst, P.; (June 1993), 434-436 [in English].)

2798 STUDIES CONCERNING PESTICIDE LEVELS IN DRINKING AND SURFACE WATER [BIB-BUDA00101]

This paper presents the levels of organochlorinated insecticides (alpha, beta, gamma HCH, aldrin, dieldrin, DDE, DDE and DDT) in drinking water for the main towns of southern Romania and the Danube River. A liquid/liquid extraction procedure, followed by a GC-determination with a linearized electron capture detector, was used. The levels established are greater than the MAO values in 73 percent of the localities studied and these levels pose potential risks to human health. (Vasilescu, M.; (June 1993), 436-438 [in English].)

2799 REAL-TIME MONITORING OF HAZARDOUS WASTES [BIB-BUDA00102]

The requirement for immediate information during surveillance of hazardous waste sites is becoming more demanding today than in previous times. The demand for laboratory analysis of field samples brought in for identification and quantification is extensive. These demands will increase significantly as the Department of Energy, Department of Defense and other federal agencies are being characterized before environmental restoration can be initiated. The European Community, particularly Eastern Europe and the former Soviet Union, are also facing clean up problems at many sites similar to those within the United States. (Koutsandreas, J.D.; Thomas, J.W.; (June 1993), 484-487 [in English].)

2800 FIELD-SCREENING METHODS FOR TNT AND RDX IN SOIL [BIB-BUDA00103]

Field-screening methods have been developed for detecting TNT and RDX in munitions-contaminated soil. A 20g portion of soil is extracted by shaking with 100mL of acetone for three minutes. After the soil settles, the supernatant is filtered and divided into two aliquots. One aliquot is reacted with potassium hydroxide and sodium sulfite and forms the red-colored Janowsky complex when TNT is present. The second aliquot is passed through a strong anion exchange resin to remove nitrate and nitrite. The extract is then acidified and RDX is reduced with zinc to nitrous acid, which is reacted with a Griess reagent (NitriVer 3 powder pillow) to produce a highly colored azo dye. (Jenkins, T.F.; Walsh, M.E.; (June 1993), 222-224 [in English].)

2801 CHARACTERISTICS OF HAZARDOUS WASTES FROM HIGHWAY MAINTENANCE OPERATIONS [BIB-BUDA00104]

Highway maintenance waste consisting of road sweepings, vactor sludges, and ditch diggings were found to be contaminated with hazardous substances. Two indicators, the total petroleum hydrocarbon (TPH) and the Microtox solid waste toxicity test, were used to characterize the wastes. The geometric mean for the TPH content of road sweepings, vactor sludges, and ditch diggings were 1,054, 1,788 and 664mg TPH/kg, respectively. Road sweepings were categorized into three age groups. The recently collected sweepings had a higher TPH content than the stored sweepings. Several road sweeping samples were classified into three particle size groups. (Hindin, E.; (June 1993), 731-733 [in English].)

2802 ENVIRONMENTAL MONITORING TO ASSESS CONTAMINATION AT A NUCLEAR PRODUCTION SITE IN THE UNITED STATES [BIB-BUDA00105]

Environmental monitoring has been conducted at the U.S. Department of Energy's Hanford Site for almost 50 years. Resulting data are used to calculate the radiological dose to people and assess environmental effects. Concentrations of airborne radionuclides at the site perimeter and nonradiological water quality in the Columbia River are in compliance with applicable standards. Radionuclide levels in foodstuffs irrigated with river water taken downstream of the site, on-site wildlife samples, and soils and vegetation from both on- and off-site locations are generally attributable to worldwide fallout. The dose potentially received by an individual, using worst-case assumptions for all routes of exposure was 0.03mrem in 1990. (Gray, R.H.; (June 1993), 517-519 [in English].)

2803 A REMOTE CHARACTERIZATION SYSTEM FOR SUBSURFACE MAPPING OF BURIED WASTE SITES G.A. [BIB-BUDA00106]

Mapping of buried objects and regions of chemical and radiological contamination is required at U.S. Department of Energy (DOE) buried waste sites. The DOE's Office of Technology Development Robotics Integrated Program has initiated a project to develop and demonstrate a remotely controlled sensor and vehicle system, named The Remote Characterization System (RCS), to obtain highly precise and timely subsurface data to support characterization of waste sites. A significant component of the planned system is a low-signature vehicle. To minimize interference with sensitive instruments, the vehicle will be constructed predominantly of non-metallic materials. (Sandness, D.W.; (June 1993), 224-229 [in English].)

2804 CURRENT AIR QUALITY ISSUES IN THE USA [BIB-BUDA00107]

Growing public concern regarding air pollution resulted in a host of increasingly stringent air quality regulations in the USA. After more than a decade of public debate and legislative attempts, the enactment of the Clean Air Act Amendments (CAAA) in 1990 represented an environmental milestone. The CAAA significantly overhauled the previous Clean Air Act of 1977 and addressed three major areas of concern: ozone levels, air toxic emissions and acid rain. Provisions for attainment of the National Ambient Air Quality Standards (NAAQS) are described in Title I including area classification, new definitions of major sources and compliance deadlines. (Mester, Z.C.; (June 1993), 143-145 [in English].)

2805 IDENTIFYING DATA NEEDS AND DEVELOPING DATA QUALITY OBJECTIVES [BIB-BUDA00108]

This paper presents an overview of data needs identification and the development of data quality objectives (DQOs) for site specific restoration activities. Restoration activities are generally conducted in phases which include: Phase 1 -an investigation; Phase 2 -selection of restoration activity and feasibility study; Phase 3-restoration design; Phase 4 -restoration activity Identifying data needs and developing quality objectives are the first steps in the restoration process. (Rottero, T.E.; (June 1993), 487-489 [in English].)

2806 THE USE OF NATIVE BROWN COALS - SORBENTS IN CONTROLLING THE ENVIRONMENTAL IMPACT OF MINE WATERS CONTAINING HEAVY METALS [BIB-BUDA00109]

The possibility for qualitative evaluation of contaminated mine waters and technological solutions from various origins with the aim of sorption treatment with native brown coals has been tested. This case study deals with acid technological solutions obtained after hydrometallurgical treatment of low grade precious metals containing sulphides. The thiourea leaching option was chosen instead of cyanide because of low toxicity. After the two-stage sorption, the solutions could be safely disposed of into a lake under today's stringent environmental regulations. The ICPAES technique is used for simultaneous monitoring of the sorption kinetics. (Gaidarjiev, S.; (June 1993), 103-105 [in English].)

2807 DYNAMICS OF POLLUTANTS DURING INFILTRATION [BIB-BUDA00110]

The basic and determining factors of ground water quality are the natural conditions, the natural environment, where the ground waters are accumulated and where their natural regime is created. Water penetrates into the environment through he natural bankwell filtration in horizontal direction or through the soil cover filtration in vertical direction. A limiting factor in both cases is the original quality of raw infiltrating water. Chemical, physico-chemical, biochemical, microbiological and other processes in the environment are decisive for groundwater quality. In addition, the resulting groundwater quality, its genesis and formation of the chemism is expressively affected by human activity. (Lehocky, J.; (June 1993), 191-194 [in English].)

2808 AUTOMATED WET DENUDER SYSTEMS FOR ENVIRONMENTAL MONITORING OF ACIDIFYING AIR POLLUTANTS [BIB-BUDA00111]

Denuder systems are very suitable for measuring air concentrations of acidifying compounds. A denuder is a tube coated with a component-specific reagent. Diffusion gases can reach this wall-coating on which they become trapped

gas concentration can be enriched by landfill gas from 5 gas wells placed directly into the landfill. (Roth, R.J.; Kallo, J.D.; (June 1993), 700-701 [in English].)

2788 RISK ASSESSMENTS OF INCINERATOR STACK EMISSIONS [BIB-BUDA00091]

Cancer risks and chronic toxic threats can be calculated for incinerator stack emissions. Input data for these calculations are derived from an air dispersion model that uses contaminant feed rate, local weather data, stack dimensions, and emission rates. This model, the Industrial Source Complex Model Long Term (ISCLT) version, is used to identify the most exposed individual (MEI); the person exposed to the highest average annual concentration of stack releases. These average concentrations are used to calculate increased cancer risks for contaminants that are cancer threats and relative chronic health threats of noncancerous toxins. (Brunker, R.L.; (June 1993), 416-418 [in English].)

2789 EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER [BIB-BUDA00092]

The EPA method of risk assessment uses long-term or chronic exposure as a basis for determining the excess cancer risk at a Superfund site. Oftentimes, the risk from exposure to contaminated ground water is inappropriately calculated from the single highest confirmed concentration found in a groundwater well. This approach is mathematically and conceptually indefensible since a single measurement cannot represent the contamination in an entire plume at a Superfund site. Instead, a sufficient data base is required to effectively represent site risk during a lifetime of exposure. The larger database serves to reduce the uncertainty inherent in risk analysis, and a more scientifically sound evaluation of risk can be used to trigger a remedial decision. (Forman, D.L.; (June 1993), 429-431 [in English].)

2790 A SUCCESSFUL APPLICATION OF X-RAY FLUORESCENCE SPECTROSCOPY FOR FIELD SCREENING [BIB-BUDA00093]

A recent field investigation has demonstrated the successful use of x-ray fluorescence spectroscopy (XRF) screening analysis for elemental concentrations in soils and sediments at a mine tailings hazardous waste site in New Mexico, USA. Using minimal sample preparation and commercially available standards, approximately 300 samples were analyzed on location for seven elements including iron, copper, zinc, lead, arsenic, silver, and cadmium. Detection limits achieved were five to fifteen parts per million. Statistical and graphical methods of analysis were used to show a statistically significant correlation between XRF results and laboratory results using atomic absorption and inductively coupled plasma methods of analysis. (Sackman, A.R.; (June 1993), 219-221 [in English].)

2791 AIR POLLUTION ABATEMENT STRATEGY IN HUNGARY [BIB-BUDA00094]

Damages caused by air pollution emerge on local, regional/continental and global scale related to health, acidification and climate change issues. The main causes of air pollution are the following: inefficient use of energy in power generation, transport, industry, domestic use and services; rapidly growing car fleet of inadequate emission characteristics (excessive specific air pollution); lack of adequate strategies to control urban air quality; gaps in the implementation of legal, technical and economic measures. Abatement measures comprise complex action programs for the reduction of air pollution generated by urban traffic and major stationary sources. (Kovacs, E.; (June 1993), 81-83 [in English].)

2792 THE BOROVAC PROCESS HELPS TO ACHIEVE A CLEANER ENVIRONMENT AND A BETTER ECONOMY IN THE MINING AND POWER INDUSTRIES [BIB-BUDA00095]

Economic production and environmental protection are not easy to achieve when combusting low calorie coal for the power industry. Yugoslav electric power is mainly produced by combusting this type of coal- lignites with a high content of ash and moisture. BOROVAC C.E. has introduced an original coal cleaning process named "BOROVAC" primarily intended for the lignites where occurrence of the waste substance is mainly in the form of clay and sand. The BOROVAC process combined with our successful industrial solution of ash disposal technology makes it possible to mix the separated slurry from the coal cleaning process with fly ash from the power plants. (Grbovic, M.; (June 1993), 84-86 [in English].)

2793 GROUNDWATER IN SLOVENIA [BIB-BUDA00096]

On the territory of Slovenia there are 20 ground water fields (areas) with associated areas. In 1987, we started with the monitoring of the hole fields besides the drinking water monitoring and today the monitoring is spread to the biggest water fields. Twice annually, water is analysed for over 165 pollutants. In the first part of the paper are described the characteristics of the water fields and our approach taken for monitoring of the groundwater combined with the sanitary control of the drinking water. The second part of the paper addresses the growing problem of undergroundwater pollution caused by the environmental contaminants of physical and chemical characteristics derived from industry, agriculture and communal environment. (Lovincic, D.; (June 1993), 188-190 [in English].)

2794 PROTECTION AND SANIFICATION OF DRINKING WATER RESOURCES [BIB-BUDA00097]

Most drinking water resources and some potential water resources in Slovenia have water protection cones. Regulations pertaining to these protected cones are very strict with a description of the activities which can be allowed within each cone. The problem is that the most polluting facilities already are in this area for the very long time. These facilities can apply a new technology only if it is less harmful to water resources. The first part of the paper deals with the problem of old industry on drinking water protected areas and some areas from which protected resources can be affected. (Lovincic, D.; (June 1993), 431-433 [in English].)

2795 THE DEVELOPMENT OF AN INTERNALLY CONSISTENT AND CRITICALLY REVIEWED THERMODYNAMIC DATABASE FOR GEOCHEMICAL MODELING [BIB-BUDA00098]

The usefulness of geochemical modelling as a predictive tool for assessing contaminant behaviour in the environment depends crucially on the the quality of the underlying thermodynamic data base. Primary quality criteria include its internal consistency and the critical selection of data from the various sources available. In 1986, WS Atkins initiated the development of such a database in conjunction with partners from several EC member states. To date, well over 1000 aqueous and solid chemical species have been reviewed, concentrating on the actinide elements and major ground water components. (Falck, W.E.; Read, I.D.; (June 1993), 256-258 [in English].)

2796 ASPECTS REGARDING THE POLLUTANT EMISSIONS AT THE POWER PLANTS IN ROMANIA [BIB-BUDA00099]

The paper illustrates how the RENEL power plants supply electric and thermal energy to consumers, as well as the impacts of these plants on the environment. Information will be provided on the fuels used, the quantities annually consumed and the levels of pollutant emissions. Also provided will be information on RENEL's strategy regarding the management of these power plants regarding their impacts on the environment, in the context of measuring and continuous control of the pollutant emissions from these facilities. (Tutuianu, O.; Anghel, M.; (June 1993), 86-89 [in English].)

2797 RISK BASED DECISION ANALYSIS APPLIED TO URANIUM MINE DECOMMISSIONING [BIB-BUDA00100]

One of the major problems facing Central and Eastern Europe is how to allocate the limited financial resources available for environmental cleanup, so as to maximize the overall benefit to society. It is clear in this context that the cost of an acceptable cleanup at any given site must also be minimized, but still achieve acceptable results. Probabilistic methods, or risk based decision analyses, provide a rational approach to ensuring that the best possible decisions are made to protect the environment and human health, in the face of uncertainties about future events, what lies under the ground and contaminant transportation proc-

2778 REMEDIATION OF OIL CONTAMINATION AT FORMER GARRISONS OF SOVIET FORCES IN CZECHOSLOVAKIA: HYDROGEOLOGICAL ASPECTS [BIB-BUDA00081]

Hydrogeological surveys at the sites of former Soviet garrisons in Czech+Slovak Fed Rep were conducted in order to estimate remediation costs. These surveys were completed by June of 1991. The estimation for 100 sites fluctuate about 200 million USD expended mainly on oil remediation of soil and ground water. Preference for the oil remediation has been given to biodegradation procedures (BP) in the first place and to decontamination procedures in situ. Our companies initiated application of the BP of the oil products both by in situ and ex situ methods. In 1991, the company EKOL addressed the oil contamination at more than 120 localities including the sites of former Soviet garrisons. (Landa, I.; Mazac, O.; Vanek, J.; Mothejl, P.; (June 1993), 878-879 [in English].)

2779 LIQUID HOLDUP DETERMINATION IN PACKED COLUMNS FOR SULFUR DIOXIDE ABSORPTION [BIB-BUDA00082]

Since the early 1960s, atmospheric pollution with sulphur dioxide has become a major environmental problem in many developed countries in the world. Investigations are aimed for development regenerable processes enable sulfur dioxide removal from flue gases. Citrate solution process is recommended as it is found that sodium citrate meets the specific needs of reversible sulfur dioxide absorption to buffering range, buffer capacity, chemical and physical stability, intoxity, etc. In designing absorption processes, stripping processes utilizing equilibrium data on the efficiency of the equipment is very important, and depends on column the type, geometry and hydrodynamics. (Skrbic, B.; Cvejanov, J.; (June 1993), 77-81 [in English].)

2780 THE DEPOSITION AND ^{134}CS VERTICAL DISTRIBUTION IN VARIOUS SOIL TYPES IN THE REPUBLIC OF CROATIA [BIB-BUDA00083]

The deposition and vertical distribution of (exp 134) Cs in various soil types in the Republic of Croatia were measured by gamma-spectrometry. Four basic undisturbed soil types: flysch, terra rossa, loam-podzol and siltous soil were sampled during July of 1986. At each location, four soil intervals were sampled: surface 1.25cm, 5-6.25cm, 11.25-12.5cm and 25-26.25cm. The gamma-spectra of selected subsamples-soil intervals were recorded for 20,000-150,000s, and 134Cs activity calculated from the 795.8 keV-peak. The vertical change of cesium activity through the soil profile can be described by the general equation: y (A*exp(b*lnD+c*(lnD)2)-K. (Barisic, D.; Lazaric, K.; Lulic, S.; Vertacnik, A.; (June 1993), 179-181 [in English].)

2781 THE USE OF A COMBINED BEHAVIORAL AND NEUROTOXICOLOGICAL TEST BATTERY FOR THE INVESTIGATION OF CHRONIC LOW LEVEL EXPOSURE TO XENOBIOTICS [BIB-BUDA00084]

The continuously increasing environmental pollution consisting of toxic substances into the air, water and soil represents one of the most important challenges facing society. The effects of this pollution on organisms and also on humans are not well understood. Therefore, it is important to investigate how biological organisms and humans respond to long-term exposure to different hazardous and/or toxic compounds at different combinations and doses of xenobiotics which are present in the environment. We developed a test battery involving different tests and investigation parameters starting with observations of newborn animals and including data on the behavioral, neurophysiological and biochemical effects on developing and adult individuals. (Nagymajtenyi, L.; Schulz, H.; Desi, I.; (June 1993), 414-416 [in English].)

2782 ASSESSMENT OF THE SOIL/WATER CONTAMINATION IN OPERATING PETROCHEMICAL PLANTS: THE ITALIAN EXPERIENCE [BIB-BUDA00085]

Regional governments have been delegated by the Italian Ministry of the Environment to carry out both contaminated areas inventories and reclamations plans. One of the most important Italian experiences concerning the assessment of subsurface and ground water contamination refers to the AGIP oil refinery, in Rho, which is northwest of Milan. This plant occupies an area of 1.3km^2 and employs about 500 workers. Its use will be discontinued in 1994 due to relevant risk of accident, in a highly populated area. The survey was formerly planned as consisting of twenty sampling points (both drillings and piezometric wells), selected on the basis of a random net. (Ganapini, W.; Milani, A.; Tunesi-Lombardia Risorse, S.; (June 1993), 182-185 [in English].)

2783 ILLEGAL DUMPSITES IN SLOVENIA [BIB-BUDA00086]

Since 1985, a dumpsite inventory has been made by scouts and later by a private firm "Oikos" in 86 local communities in Slovenia (1,180km^2, which represents 6 percent of the country). This field survey provides for quantitative (geographical coordinates, estimate of area and volume) and qualitative data (nearest settlement, land use, vicinity of water, type of waste, suspected risks, etc.) about each site. Dumpsites are a significant problem in Slovenia. The average density in the referenced area is 1.7 sites per km^2, and 2.6m^3 of dumped waste per inhabitant. Prevailing types of waste are household and construction waste. (Stritih, J.; Sebenik, I.; (June 1993), 697-699 [in English].)

2784 ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA) SYSTEMS FOR ENVIRONMENTAL MONITORING [BIB-BUDA00087]

Although broadly applied in clinical and veterinary practice, immunoassays have gained importance in environmental chemistry and toxicology only recently. Utilizing the outstanding specificity of polyclonal or monoclonal antibodies towards certain target analytes (environmental pollutants), ELISA systems often are of prominent sensitivity and are more rapid and less costly than time- and labor-intensive traditional analytical methods. Our laboratories focus on the development of ELISA systems for the detection of low molecular weight chemicals of agricultural and/or public health importance (i.e.,pesticides and toxins). (Szekacs, A.; Hammock, B.D.; (June 1993), 482-484 [in English].)

2785 SURFACE WATER EUTROPHICATION SOURCES IN POLAND [BIB-BUDA00088]

Agriculture, municipal activities and industry are the sources of surface water eutrophication and contamination of under ground waters. The data on plant production, livestock populations and amounts of organic and artificial fertilizers was presented. Loss of nutrients in polish soils through leaching in lysimeter filtrate, drain water and catchment area was analyzed. The influence of soil conditions and utilization, climatic water balance, vegetation cover and type of fertilizer was presented. The load of biogenes introduced by agriculture into the surface waters was determined. (Ilnicki, P.; (June 1993), 186-188 [in English].)

2786 MERCURY CONTAMINATION FROM THE BVK FACILITY IN HUNGARY [BIB-BUDA00089]

In November of 1990, the Regional Environmental Center for Central and Eastern Europe in Budapest (REC) requested assistance from the United States Environmental Protection Agency (EPA) in the review and evaluation of contamination from the BVK Chemical complex in Kazincbarcika, Hungary. This paper is divided into three major sections: Section I describes the review by the EPA team of the mercury contamination at the BVK facility. It consists of an introduction, conclusions, and recommendations for future actions. It describes a plan for conducting a short-term health risk sampling assessment, a risk assessment based upon the limited data reviewed during the visit, and a plan for a more detailed site and risk assessment which is needed for the BVK facility. (Voltaggio, T.C.; Brunker, R.L.; Heston, G.T.; (June 1993), 140-142 [in English].)

2787 LANDFILL GAS COLLECTION AND DESTRUCTION AT BEMS/BIG HILL LANDFILL [BIB-BUDA00090]

A landfill gas collection system was constructed as part of an interim remedial action for the Big Hill Bems Landfill in Southampton, New Jersey. The remedial action was implemented to address public health hazards associated with migration of methane gas to a community adjacent to the landfill. The objective of the design, which consisted of 72 perimeter gas collection wells, was to provide a protective barrier between the landfill collection wells. The wells were connected to a header system of approximately 9,300 linear ft. HDPE pipe. The system is designed to operate at a vacuum of 10-20 inches of water. The methane

by the heavy metal content of the roots, while the compound effect of soil and air pollution was demonstrated by the element content of the leaves. (Kovacs, M.; Penksza, K.; (June 1993), 477-479 [in English].)

2768 FAST GC-MS ANALYSIS OF CONTAMINATED SOIL: ROUTINE FIELD SCREENING IN HAMBURG [BIB-BUDA00071]

After a five-year period of development, fast analytical on-site methods for organic soil contaminants based on a mobile GC-MS system, have become a standard component in Hamburg's routine residual analytics. With a focus on high sample throughput for volatile and semivolatile organics, the application of fast high- performance analytics to field screening within 5 min per sample has led to new site remediation strategies. For the analysis of volatiles, a fast soil headspace technique with quantification limits in the low ppb range is employed. Semivolatiles are ultrasonically acetone extracted and analyzed rendering limits of detection of some ppm. (Matz, G.; Schroder, W.; (June 1993), 214-216 [in English].)

2769 "SPRAY AND TRAP" FOR GC-MS ANALYSIS OF AQUEOUS ORGANICS [BIB-BUDA00072]

A new simple method for analyzing trace organics in water which is based on stripping of analytes is presented. The method is customized for field application with a mobile GC-MS. Time required to process a water sample is 5 min. Calibration is performed using internal standards. Linear dynamic range of calibration is up to 5 orders of magnitude (10 ppt-1 ppm for tetrachloroethylene). The method is capable of handling samples containing surfactants which cannot be "purge and trapped" without foam interference. The principle of operation is spraying the water sample together with the purge gas through a nozzle. (Matz, G.; Kesners, P.; (June 1993), 31-33 [in English].)

2770 SEVERE CONTAMINATION OF SOILS BY HEAVY METALS NEAR GYONGYOS, HUNGARY [BIB-BUDA00073]

Severe contamination of soils with heavy metals was detected alongside the Toka Brook, near the town of Gyongyos, and within the village of Gyongyosoroszi in Hungary. In some dried soil samples 160 ppm arsenic, 23ppm cadmium, 263ppm copper, 1,618ppm lead and 3,740ppm zinc was detected, respectively. Most of the vegetables and fruits cultivated on the affected area contain lower concentrations of heavy metals than allowed by the Hungarian standards. However, some vegetables with large leaf areas as well as root vegetables might accumulate dangerous amounts of some heavy metals. It is not known what chronic effects these elevated levels of heavy metals may have on human health if consumed over several years. (Turcsanyi, G.; Kovacs, M.; Buttner, S.; Penksza, K.; Guely, M.; Czinege, E.; (June 1993), 515-517 [in English].)

2771 INVESTIGATION OF DILUTION AND DECAY OF PETROCHEMICAL EFFLUENT IN THE RIVER [BIB-BUDA00074]

Knowledge of the distribution of pollutant concentrations discharged into the natural water receiver, as well as their decay rates, is essential for evaluation of the influence of existing outfall on water quality. An essential parameter in assessing the degree of pollution of surface waters is the rate of pollutant degradation. The numerical value of this parameter can be determined on the basis of radiotracer investigations by comparing measured distributions of radiotracer concentrations with the distribution of pollutant concentrations determined directly by taking samples of river water. These methods have been applied in field conditions on Vistula River near Plock, where the biggest refinery in Poland is being located. (Owczarczyk, A.; Szpilowski, S.; Wierzchnicki, R.; Strzelecki, M.; (June 1993), 868-870 [in English].)

2772 THE TASKS AND METHODS OF ENVIRONMENTAL CONTROL IN REGIONS OF EXPLOITATION OF GEOLOGIC DEPOSITS [BIB-BUDA00075]

The problems of complex environmental analysis in regions with intensive exploitation of geologic deposits, including mining, building and other activities are considered. The author notes the diversity of geophysical consequences of engineering activity, which are dangerous for the environment, in the context of the near-term and long-term contamination problems. The analysis is made using examples in some regions of the Russian Federation. On the basis of analysis, the author discusses the directions and principles of research of geophysical parameters in order to make a prognosis and estimate potential dangerous or adverse results of engineering activity and natural processes in regions of exploitation of geologic deposits. (Sofronov, V.V.; (June 1993), 870-872 [in English].)

2773 MONITORING OF ENVIRONMENTAL CONTAMINATION IN THE MANAGEMENT SYSTEMS [BIB-BUDA00076]

It is necessary to identify the types of environmental data that can be assessed for environmental control purposes. While considering the significance of information in the hierarchy of a control system, it is possible to define appropriate levels of the criteria for optimization and analysis of the effectiveness of the supply of data. At the level of monitoring, these indices make it possible to compare various technical decisions in the context of the precision and authenticity of the data obtained and on the basis of different versions of systems. (Sofronov, V.V.; (June 1993), 479-481 [in English].)

2774 ANAEROBIC DEGRADATION OF PHENOLIC COMPOUNDS IN UASB REACTORS [BIB-BUDA00077]

The objective of this study was to investigate the continuous anaerobic treatment of a synthetic wastewater containing guaiacol, and to compare the ability of two anaerobic mixed populations originating from different sources, namely a UASB reactor and an anaerobic cow manure digester, to mineralize this aromatic compound. The lab-scale UASB reactors were fed with a wastewater containing 1.5-3.0g COD/l volatile fatty acids and 0.5g COD/l of guaiacol. Guaiacol was found to be readily demethoxylated to catechol by both inocula. This intermediate was only partially degraded (approx. 30 percent) in the reactor seeded with granular sludge. (Sierra-Alvarez, R.; Bhattarai, M.; Alaerts, G.A.; (June 1993), 127-129 [in English].)

2775 APPLICATION OF A FREQUENCY AGILE CO_2 LASER-BASED DIFFERENTIAL ABSORPTION LIDAR SYSTEM TO ENVIRONMENTAL MONITORING [BIB-BUDA00078]

SRI International has designed, developed, and demonstrated an infrared differential absorption lidar (IR DIAL) system that can be used for environmental monitoring to detect, identify and measure concentrations of ambient or fugitive emissions of volatile organic compounds (VOCs) in the atmosphere. The IR DIAL system utilizes a single frequency-agile CO_2 TEA laser, a ten-inch receiver telescope in the Dall-Kirkham configuration, a liquid-nitrogen cooled HgCdTe photovoltaic detector, and a personal computer. The self-contained system is mounted in a small van and provides column-content measurements in ppm-m and displays time series plots of VOCs having significant spectral activity in the 9- to 11-micrometer region. (Carr, L.; Fletcher, L.; Leonelli, J.; (June 1993), 216-219 [in English].)

2776 COMPUTER CONTROLLED RADIOMETRIC PARTICULATE MONITOR [BIB-BUDA00079]

The principle of operation of this particulate monitor is based on the measurement of dust mass deposited on a fiber glass filter from a known volume of air forced through the filter. The mass of the dust is determined by absorption of Pm-147 beta radiation. The volume of the air is proportional to dust collection time, as the air flow rate is kept constant. A rotary source detector set enables the measurement of the same part of the filter before and after the dust is deposited. A reference mass sample is measured at the start and the end of measuring a cycle which enables compensation of errors resulting from pressure and temperature variations. (Machaj, B.; Urbanski, P.; Strzalkowski, J.; (June 1993), 872-875 [in English].)

2777 ENVIRONMENTAL GEOPHYSICS IN CZECHOSLOVAKIA: AN OUTLINE [BIB-BUDA00080]

Geophysical methods form one part of the integral survey used for solving environmental problems. The methods may be differentiated into two groups according to: a) the effects of the proper fields on the environment; and b) possibilities of how to use these investigative methods for quantitative or qualitative determination or estimation of such phenomena which are in a close relation to environment and its protection. The methods applied in the second group dominate because they are closely tied with abiotic as well as anthropogenic factors. (Mazac, O.; Landa, I.; Kelly, W.I.; Mares, S.; (June 1993), 875-877 [in English].)

esses accompanying the catalytic purification of tail gases were studied in an unsteady state pilot plant reactor of 80 dm^3. (Egyhazi, T.; Kovacs, J.; (June 1993), 851-853 [in English].)

2758 MODELING OF COLMATAGE OF FILTERS AND SOIL FILTER LAYERS [BIB-BUDA00061]

Colmatage is a clogging process of filters in industrial and native soil-filtration. The clogging process is caused by the floating and settling materials and precipitating products (by chemical and biological processes) on the surface area and/or in the cavities and pores. The chemical colmataging process, excluding the biological processes, was investigated. This was carried out by precipitating the salts resulting in the hardness of water with NaOH and using FeCl2-solution. Unsoluble ferri oxyhydroxide precipitate formed in the latter case. In the first case, a very quick outer colmatage was observed, while in the second case an inner colmatage was observed. (Kun-Szabo, T; (June 1993), 854-857 [in English].)

2759 CONTRIBUTION TO THE HEAVY METAL CONTAMINATION OF THE RESIDUAL SLUDGE WITH CHEMICALS USED IN WATER AND WASTE-WATER TREATMENT PROCESSES [BIB-BUDA00062]

Contribution to the heavy metal contamination of water and waste water treatment residuals with chemicals used in the processes is calculated and summarized in the paper. For assessing the contribution of different chemicals in different stages, average concentrations of raw waters and effluents were considered. Average sludge yields of Dutch water treatment practices, and average values of sludge yields of biological waste-water treatment from wide range surveys were used in the calculations of concentrations resulted by the addition of chemicals. (Karpati, A; (June 1993), 858-861 [in English].)

2760 ANALYSIS OF MANAGEMENT STRUCTURE WITHOUT RISK OF DANGEROUS AIR POLLUTION IN COMBINED NATURAL AND TECHNICAL SYSTEMS [BIB-BUDA00063]

Complex man-made technical systems (MS) impacting specific natural systems (NS) having many restrictions for permissible levels of impacts are considered as combined natural and man-made systems (NMS). The NMS are analyzed when making ecologically proven decisions for management of multiple components of MS. Systems structure analysis of the combined systems is performed considering the connections between the NS and NMS for alternative structures of MS and time to include components of their "life cycles" and setting risk factors of reaching critical levels of NS resources. Computer modeling enables one to determine optimal variants for a wide spectrum of alternative decisions. (Milyaev, V.B.; Kopp, L.Z.; (June 1993), 71-73 [in English].)

2761 TOOLS AND METHODS FOR SAFEGUARDING GROUNDWATER WITHDRAWALS IN HUNGARY [BIB-BUDA00064]

In Hungary, more than 80 percent of drinking water originates from subsurface water resources. Like in all industrialized countries, an increasing extent of pollution endangers groundwater resources. In order to know if or how groundwater withdrawals should be protected, knowledge is needed on the recharge areas and recharge rates, on the extent and type of pollution sources, and on the behavior of pollutants during transport to the withdrawl wells. A general framework for groundwater protection in Hungary is given and tools and methods are selected which are needed to address the problems of groundwater protection in Hungary. (Lennaerts, T.B.M.; Simonffy, Z.; (June 1993), 173-177 [in English].)

2762 DESIGN AND OPERATION OF MONITORING NETWORKS [BIB-BUDA00065]

Pragmatic and functional methods for the design and operation of two types of monitoring networks will be demonstrated: reference or primary monitoring network and a secondary monitoring network for safeguarding well fields. The primary network provides data of current ground water quality and may show long-term trends which can be used for assessment or readjustment of regulations to prevent ground water pollution. It can be designed by processing information on land use, soil type and hydrogeological conditions using remote-sensing techniques and a geographical information system. (Lennaerts, T.B.M.; Miunink, J.O.; (June 1993), 861-865 [in English].)

2763 INVESTIGATION OF THE ENVIRONMENTAL IMPACTS OF INDUSTRIAL WASTE IN THE GREATER BUDAPEST AREA [BIB-BUDA00066]

Budapest is the eighth most populated city of Europe. It is one of the prominent industrial centers of the continent because its industry employs half a million workers. The capital with over 2 million inhabitants is the most densely populated area. Twenty-four percent of the industrial workforce is employed at work sites in the capital. This concentration of industry and population is problematic because 20% of the inhabitants of the country live in the capital and the inhabitants of the city and its suburbs further tax the environment. (Hollosy, M.; Verraszto, Z.; (June 1993), 177-179 [in English].)

2764 SYNOPTIC INFORMATION SYSTEMS FOR ENVIRONMENTAL PROTECTION OF THE CENTRAL INDUSTRIAL AREA OF HUNGARY [BIB-BUDA00067]

Due to the unique geological conditions and historical occurrences in Hungary, more than 20 percent of the population lives in the capital city of Budapest. The Middle-Danube-Valley environment Authority is responsible for both the environmental conditions in the capital and the surrounding areas. It would not be possible to divide the two and handle them separately due to the fact that the activities influencing the environmental conditions are interconnected. The result is that one-third of the Hungarian population is living within one area of activity, and that 40 percent of the industrial activity in Hungary is located here, and as a result, half of the industrial and communal waste of the country is generated in this urban area. (Verraszto, Z.; Domokos, M.; (June 1993), 253-255 [in English].)

2765 EVALUATION OF CHANGES OF THE QUALITY OF GROUNDWATER SOURCES IN SLOVAKIA [BIB-BUDA00068]

Ground waters in the Slovak region are the most important sources of the drinking water. The overall quality of the ground water in Slovakia, however, is declining. The reason of this phenomenon is the influence of various natural and anthropogenic factors. This paper displays results of the investigation of the quality of 158 most important ground water sources located in the territory of Slovakia. The extent of analyses performed was based on Czechoslovak standards CSN 83 0612 "Operating surveillance of the quality of water in water treatment" and CSN 75 7111 "Drinking water" and included parameters such as inorganic anions, cations, heavy metals and (with special attention) organic pollutants. (Hucko, P.; Liska, I.; Tolgyessy, P.; (June 1993), 865-867 [in English].)

2766 DEVELOPMENT STRATEGIES OF THE HUNGARIAN ELECTRIC POWER INDUSTRY AND AIR QUALITY PROTECTION ISSUES [BIB-BUDA00069]

Regarding the discharge SO_2,NO_x, and solid particulates, the power plants of the Hungarian Electric Power System play an important role in the production of such emissions. Approximately 430 kt sulphur dioxide, 32 kt nitrogen oxide and 30 kt solid were emitted in 1991. The sulfur dioxide emission is unanimously determined by the amount of fuel used. Due to the low heating value, 6.5 to 10.5 MJ/kg and the average 2 to 3 percent sulphur content of our coals, and lignite, the SO_2 emissions from coal utilization represent more than 90 percent of the total sulfur dioxide emission of the power industry. The NO_x emission gives approximately 15 percent of the national emission. (Szorenyi, G.; Civin, V.; (June 1993), 74-77 [in English].)

2767 BIOLOGICAL INDICATION OF HEAVY METAL LOADING IN INDUSTRIAL AREAS [BIB-BUDA00070]

Biological indicators are used in monitoring networks in countries such as Germany, United States of America and Japan. Biological indication investigations were carried out in the vicinity of Ozd and Diosgyor in northern Hungary. This area is adversely affected by cadmium, chromium, nickel, lead and zinc pollution. Soil and specimens of Lolium perenne and Taraxacum officinale (recommended species for inclusion in an international Biomonitoring network) were collected for chemical analysis at 500 and 1000m from the emission sources in all four directions. The heavy metal pollution of the soil was indicated

specific site with regard to dredging and dumping problems. (Chiavarini, S.; Caricchia, A.M.; Cremisini, C.; Martini, F.; Morabito, R.; Pezza, I.; (June 1993), 540-542 [in English].)

2748 MONITORING PROGRAM FOR THE EVALUATION OF THE POLLUTION LEVEL OF THE ITALIAN HARBOUR SEDIMENTS: III. ORGANOTIN COMPOUNDS [BIB-BUDA00050]

Organotins contamination in harbor environment has been well documented and harbors can be considered as the main source of these compounds for the marine environment. These compounds, and principally tributyltin (TBT) and triphenyltin (TPhT), are widely employed as active components in antifouling paints, to reduce the deleterious effects of foulant organisms on the hulls of the boats and in cooling pipes. In water, TBT and TPhT are easily degraded to less toxic compounds down to inorganic tin. At the same time they are readily accumulated by feeding filter organisms and adsorbed onto sedimentable matter. Degradation phenomena occur in sediments as well as in water but, in this case, lower degradation rate and higher persistence time were observed. (Morabito, R.; Caricchia, A.M.; Chiavarini, S.; Cremisini, C.; Fantini, M.; Ubaldi, C.; (June 1993), 542-544 [in English].)

2749 REGIONAL MATERIAL BALANCES AS A TOOL FOR ENVIRONMENTAL MONITORING [BIB-BUDA00051]

This paper deals with the monitoring of chronic and longterm impacts on the environment due to anthropogenic activities. Contrary to the large and rapid impacts due to industrial accidents or the mismanagement of hazardous substances, small and slow releases of materials pose a different analytical problem. Their effect on the environment cannot be detected early enough by measuring concentrations in the soil, water or air. A new strategy for monitoring is introduced which is based on material balances of the regional anthroposphere and environment. The results of these balances are used to assess the longterm impact of urban regions on the "final sink" soil and the "conveyor belts" surface waters and air. (Brunner, P.H.; Daxbeck, H.; (June 1993), 474-476 [in English].)

2750 CONTROL OF COMBINING WASTE STREAMS FROM DIFFERING BATCH PROCESSES WITH EXTREME FLOW RATE VARIATIONS [BIB-BUDA00052]

The leather industry produces strong wastes that are high in biochemical oxygen demand, suspended solids, sulfides, and chromium. These batch discharges result in rapidly changing waste streams in flow rates and pH. In order to obtain a controlled steady flow at the desired pH, an automated system based on the interlocking of stream flow control with chemical addition, by an automated pH and liquid level instrumentation. The resulting waste stream can be adjusted to optimum conditions for coagulation and primary treatment. This cost-effective method has been used successfully in the leather industry and also for the treatment of metal finishing wastes for heavy metals removal. (Thorstensen, T.C.; (June 1993), 100-102 [in English].)

2751 MUNICIPAL SOLID WASTE DISPOSAL THREAT TO THE ENVIRONMENT [BIB-BUDA00053]

Municipal waste from the city of Krakow is disposed of at a landfill located next to the historical salt mine in Wieliczka. The nearest residential areas are located about 300 meters from the landfill. Key environmental problems are uncontrolled leachate permeating into high quality ground water aquifer, odor emissions and easy access to the site which threatens health and safety of the surrounding population. Surface water from the Mallnowka stream sampled has been clearly degraded by leachate. The municipal solid waste (MSW) currently disposed of is collected from residential and commercial generators. (Bajsarowicz, W.; Bajsarowicz, J.; (June 1993), 695-697 [in English].)

2752 EXTENT AND NATURE OF ENVIRONMENTAL CONTAMINATION BY LIGNITE-TAR PROCESSING PLANTS: A CASE STUDY OF A PLANT IN THURINGEN, GERMANY [BIB-BUDA00054]

The former lignite-tar processing plant was in operation for more than 70 years. Facilities include approximately 42 ha of processing plants, above and underground storage tanks, and offices and maintenance buildings. In addition, two solid waste landfills were investigated which were former lignite open pits, and which were refilled with tar-plant wastes, lignite ashes, and urban wastes. A third former lignite open pit has been continuously filled since 1932 with approximately 250,000m^3 of tar-processing wastes. Raw materials, endproducts and production processes were changed several times during operation of the plant. (Keller, G.; Keller, C.; (June 1993), 170-172 [in English].)

2753 RADIOACTIVE CONTAMINATION OF THE HUMAN FOOD CHAIN IN THE REPUBLIC OF CROATIA [BIB-BUDA00056]

The transfer of radionuclides from deposition on the soil to food, particularly to milk, has been studied for a number of areas of the Republic of Croatia since 1959. This paper provides the results of measurement of contamination of fallout and foods by 137Cs and 90Sr in the areas around the towns of Zagreb, Zadar and Osijek. In order to estimate the effective dose equivalents for the Croatian population, the cesium and strontium levels in diet were calculated and analyzed. The results showed that the risk to the population from 137Cs and 90Sr ingestion was highest during the 1960s and after the Chernobyl accident. In both cases, the effective dose equivalent was estimated to be approximately 100 mSv. (Lokobauer, N.; Maracic, M.; Franic, Z.; Bauman, A.; (June 1993), 848-850 [in English].)

2754 GEOTECHNIQUES TECHNIQUES FOR THE PROTECTION OF THE ENVIRONMENT [BIB-BUDA00057]

By drawing on a broad backgound experience gained worlwide, BACHY has developed a range of techniques which make a significant contribution to the care and improvement of the environment. These techniques include: containment by slurry trench, HPDE membrane and grounting; ground treatment by deep mixing and injection; drainage and venting. Special slurries have been developed in this respect. MICRON S, a high penetration mineral grount which is non-polluting and used to grout fine and silty sands. It can be utilized in slurry walls to produce extremely low permiability cut-offs. C3S, a high penetration bentonite cement grout for the sealing of finely-fissured or porous rock. "ANTI-ACID" Plastic Concrete, a non-cementitious formulation has been developed for very acidic environments. (Fichtner, K.; (June 1993), 851-851 [in English].)

2755 PROBLEMS AND CHALLENGES RELATED TO THE DECOMMISSIONING OF URANIUM MINES IN SAXONY AND THURINGIA, GERMANY [BIB-BUDA00058]

Uranium production by Wismut ceased on January 1, 1991. A total production of 220,000 tons of uranium by SDAG Wismut made the GDR rank third among the world's uranium producers. The heritage of contaminated plant areas, waste rock piles, tailings disposal sites, constitute long-term damaged sites. The decommissioning, remediation and final reclamation efforts cover a total surface of 32km^2 of former Wismut operations. The areas affected in the early years of uranium mining are indeed much greater including, among others, 16 suspect sites comprising 280 shafts and adits, 180 uranium ore loading sites, 15 tailings impoundments and more than 3,000 dumps and residual holes. (Hahne, K.; Daenecke, R.; (June 1993), 344-346 [in English].)

2756 THE ACOUSTIC TECHNIQUE FOR AQUATIC ENVIRONMENTAL MONITORING [BIB-BUDA00059]

The industrial revolution has left seriously polluted water and air which has resulted in reduced recreational areas, destroyed commercial and recreational fisheries, and endangered the existence of communities. A number of programs have been established in order to repair this damage. Usually the first step has been to "de-pollute" waters and secondly to enhance aquatic living resources. These programs have been applied successfully in the U.S. and later in some countries of Western Europe. In addition to accomplishing long term ecological improvements these programs have also enhanced the local economy by creating new jobs. To meet these demands, new technologies have been developed. (Burczynski, J.; (June 1993), 512-514 [in English].)

2757 MODELING OF AN UNSTEADY STATE CATALYTIC TAIL GAS REACTOR [BIB-BUDA00060]

Some physico-chemical processes take place more intensively under artificially established non-steady state circumstances than under the conventional mode of operation. If there exists an optimum of yield under the non-steady state then this yield is never lower than in a stationary state. At the alternating state flow of the direction of the reaction mixture, the catalytic bed of the adiabatic reactor acts both as a catalyst and as a heat exchanger simultaneously. Thermal proc-

Characteristic spectral regions have been considered for the retrieval of CO, NO, NO_2, HCl, N_2 0, SO_2, CH_4, H_2O, and CO_2 concentrations. (Schafer, K.; Haus, R.; Wehner, D.; Mosebach, H.; Bittner, H.; Neureither, N.; (June 1993), 843-845 [in English].)

2738 DOUBLE EXCITATION ELECTRON BEAM FLUE GAS TREATMENT [BIB-BUDA00040]

The air pollution in Middle Europe is particularly severe and there is a strong need for technology that can improve this situation. Conventional air pollution control technology (wet lime scrubbing and selective catalytic reduction (SCR)) has been developed to a state of art which do not allow significant cost reduction in the near future. The development of second generation technologies is necessary. Electron beam technology is one of these technologies. It is a dry process which allows simultaneous removal of SO_2 and NO_x and the final product can be used as a fertilizer. Additionally, high reduction of volatile organic compounds (VOC) can be acheived if they are present in purified off-gases. (Chmielewski, A.G.; Iller, E.; Zimek, Z.; Tyminski, B.; Licki, J.; (June 1993), 68-71 [in English].)

2739 MEASUREMENT OF THE CONTRIBUTION OF A SINGLE SOURCE OF AIR POLLUTION TO EMMISSION CONCENTRATIONS USING THE SF6-TRACER METHOD [BIB-BUDA00041]

For controlling the quality of air, there are many regional and local networks where the concentrations of pollutants are continuously monitored. However, the measured emission concentrations are usually the sum total of the contributions of a large number of air pollution sources, such as industrial facilities, road traffic, domestic heating and long-range transport of pollutants. The measured values of pollutant concentrations in air therefore give no information about the dispersion of individual plumes and their contributions to these values. Yet, for decisions concerning measures to improve air quality, well founded information is needed about the contributions of single sources of pollutants to the emission concentrations. (Rotzer, H.; Riesing, J.; (June 1993), 472-474 [in English].)

2740 UTILIZATION OF LIQUID WASTES CONTAINING AMMONIACAL NITROGEN [BIB-BUDA00042]

Utilization of waste waters, particularly effluents from anaerobic reactors containing ammoniacal nitrogen, wastewaters from the production plant of artificial fertilizers, etc. have been studied. Optimal conditions of precipitation of ammonia in the form of $MgNH_4PO_4$ were determined. Phosphoric acid of technical grade and magnesium oxide originating as a waste from thermal processing of magnesite were used. In the first step, the low-reacting waste magnesium oxide is transferred by reaction with H_3PO_4, in the presence of an activator, to low soluble $MgHPO_4$, which forms, by conversion with ammonia, the $MgNH_4PO_4$ salt. Optimum conditions of the conversion have been determined. (Kacetl, L.; Sakra, T.; (June 1993), 691-692 [in English].)

2741 SO_2 AND NO_X EMISSIONS IN CZECHOSLOVAKIA BETWEEN 1970-1990 [BIB-BUDA00043]

During the twenty-year period (1970-1990), the emissions of sulphur declined in Europe, while the emmisions of NO_x increased. Between 1980-1990, SO_2 fell by 6.5 million tons. In the Central European Region (Czechoslovakia, Eastern FRG, Poland and Hungary) only two countries decreased slightly the SO_2 emissions (Czechoslovakia and Hungary) and in Poland and in the Eastern part of FRG, the SO_2 emissions are still increasing. The emissions of NO_x increased by 1.5 million tons, between 1985-1990 in Europe. (Mejstrik, V.; (June 1993), 136-139 [in English].)

2742 STABLE ISOTOPIC COMPOSITION FOR THE CHARACTERIZATION AND TRACING OF ELEMENTS IN ENVIRONMENTAL STUDIES [BIB-BUDA00044]

Pollutant lead generally has its origins in lead ores and has different isotopic composition to naturally- occurring geochemical lead. Lead isotopic composition gives information on the origin of lead pollution and the movement, uptake by plants, entry into water courses and entry into the food chain of accumulated lead. Studies in Scotland are being made on the origin and movement of lead deposited over a long period from the atmosphere and accumulated in the surface, organic horizons of peaty soils. Data from different sites in Scotland show that the strontium isotopic composition in stream waters remains constant and appears to be almost independent of time and rainfall conditions. (Bacon, J.R.; Berrow, M.L.; Harthill, J.J.; (June 1993), 846-848 [in English].)

2743 HAZARDOUS WASTE MANAGEMENT IN NORTH-WEST HUNGARY [BIB-BUDA00045]

In Hungary, approximately five million tons of hazardous wastes are produced each year, including three million tons of red mud from bauxite processing. The paper describes a survey which has been carried out to identify the major generators of hazardous wastes as well as the types and quantities of wastes produced. Topics to be covered will include appropriate legislation, an estimate of the potential for the reduction in the quantity of waste produced in individual factories and recommendations for appropriate treatment/disposal routes. The latter could involve the strengthening of local treatment technologies and other approaches. (Parker, A.; (June 1993), 728-731 [in English].)

2744 MODELING AND OPTIMIZATION OF A HYDRO-GEOLOGICAL SYSTEM TO PREVENT GROUNDWATER POLLUTION FROM A LEAKY LANDFILL [BIB-BUDA00046]

Numerical simulations of the groundwater flow and contamination in a confined sandstone aquifer underlying a leaky landfill, have turned out very helpful in the choice of the prevention means to be taken. The geometry of a buried impervious wall and the scheme of the associated pumping system are optimized using a Finite Element code. The results of this study are illustrated, commented and analyzed with an eye to the further applications of this method to the other cases. This consistent way to make use of all the available data, provides, undoubtedly, a good tool to advise decision-makers facing these kinds of environmental problems. (Dassargues, A.; (June 1993), 250-252 [in English].)

2745 WASTE MANAGEMENT MONITORING IN POLAND [BIB-BUDA00047]

In Poland, waste management monitoring is regarded as a basic tool for the development of a waste management system. Such an assumption requires that monitoring take into account two aspects related to industrial wastes: environmental and economic aspects. Thus, waste monitoring has to determine, on the one hand, the types and amounts of wastes generated by a polluter, their displacement and treatment methods, and, on the other hand, the impacts of existing waste sites on air, water and soil pollution. The point of issue for the development of a data base on monitoring is information which is collected from various sources, division of information into files, grading of wastes into groups concerning their material properties, together with identification of wastes. (Mieczkowska, E.; (June 1993), 693-694 [in English].)

2746 MONITORING PROGRAM FOR THE EVALUATION OF THE POLLUTION LEVEL OF THE ITALIAN HARBOUR SEDIMENTS: I. ORGANOCHLORINES AND PCB CONGENERS [BIB-BUDA00048]

The emissions of hazardous substances into coastal waters is directly related to the increase of the human activities. Harbor sediments, that are a concentration site for micropollutants, have to be frequently dredged in order to maintain open shipping lanes for maritime transport. The conditions to be taken into account before the disposal of dredged material, have been drawn in international guidelines (starting from the London Dumping Convention, 1972). Characterization is necessary to determine if the dredged material can alter chemical and physical properties of the sediments at the proposed disposal site and cause environmental problems due to remobilization of contaminants. (Cremisini, C.; Bernabei, M.; Brondi, A.; Caricchia, A.M.; Chiavarini, S.; Morabito, R.; (June 1993), 537-539 [in English].)

2747 MONITORING PROGRAM FOR THE EVALUATION OF THE POLLUTION LEVEL OF THE ITALIAN HARBOUR SEDIMENTS: II. POLYCYCLIC AROMATIC HYDROCARBONS [BIB-BUDA00049]

Polycyclic aromatic hydrocarbons (PAHs) are a class of toxic organic compounds and some of them are well known carcinogens. They have been shown to be ubiquitous in the environment. The origin of these compounds is both natural and anthropogenic (forest fires and volcanic eruptions represent the main natural sources while domestic heating, industrial activities, vehicle engines and petroleum spills are the main anthropogenic sources). PAHs were quantified in sediment samples from 14 main Italian harbors in order to characterize the

solid and fluid phases. The fluid phase may include a floating or sinking layer of hydrocarbons where a spill has occurred. Each phase will contribute to the measurement signal depending on phase composition and its interaction with the detection method employed. (Brummer, C.H.; Olie, J.J.; (June 1993), 247-250 [in English].)

2728 CONVERTING FROM ANAEROBIC TO AEROBIC DECOMPOSITION IN OLD WASTE DEPOSITS FOR LOW-EMISSION WASTE TRANSPOSITION [BIB-BUDA00030]

As a result of urban expansion, many former suburban sanitary landfills now are situated in urban areas. Combustible and toxic gases, as well as ground water contamination, resulting from these deposits appear on a larger scale than what was assumed at the time when the building up of the areas was started. Only transportation of the wastes to sealed sites can be taken as a reliable rehabilitation. This method is practicable without endangering and exciting people in associated neighborhoods. Remediation can be effected by aeration and degasification of the waste, which will convert the anaerobic decomposition to an aerobic process, exhausting toxic gases through a filter. (Spillmann, P.; (June 1993), 686-688 [in English].)

2729 THE DETECTION OF AIR CONTAMINATION AND INDOOR ENVIRONMENTAL CONTROL USING A GAS SENSOR [BIB-BUDA00031]

The air purifier is a branch of air conditioning, which has been used to maintain comfortable indoor environmental quality (IEQ) in domestic dwellings. A tin oxide gas sensor is used to detect air tainted by smoke and polluted air. The sensor consists of n-type tin oxide and is widely used to detect leakage of inflammable gases. The sensor also has sensitivity to various gases, for example, carbon monoxide, hydrogen, smoke from cigarettes and the gases oozing from human bodies, etc. So the sensor is employed to detect the air pollution of indoor environments. In this study, the temperature and humidity are also monitored and controlled simultaneously using a pulse motor fan. (Oyabu, T.; Honda, M.; Katsube, T.; (June 1993), 535-537 [in English].)

2730 DISPOSAL OF RADIOACTIVE AND MIXED WASTE IN HUNGARY [BIB-BUDA00032]

Because over half of Hungary's electrical power needs are met with nuclear power, the nation must aggressively pursue development of a technically sound and publicly acceptable disposal option for low-level and intermediate-level radioactive wastes and mixed (hazardous and radioactive) waste. Deep geologic disposal of radioactive and hazardous wastes at the site of an existing uranium mine near Pecs appears to be a technically sound, economically feasible, and publicly acceptable option. Two Hungarian firms and one U.S. firm have teamed to examine the feasibility of utilizing the mine near Pecs as a waste repository. (Istenes, G.; Benkovics, I.; Raudenbush, M.H.; Pierce, G.D.; (June 1993), 688-690 [in English].)

2731 IDENTIFICATION AND ASSESSMENT OF REMEDIAL OPTIONS FOR THE CHABAROVICE WASTE DISPOSAL SITE [BIB-BUDA00033]

In 1991, CH2M HILL in association with AQUATEST studied remedial options for the Chabarovice waste disposal site near Usti nad Labem, CSFR. The study generally followed the remedial investigation/feasibility study (RI/FS) process proscribed by the U.S. EPA under Superfund. Beginning in the early 1970s, the site received chemical wastes, including hazardous liquids and sludges. Total volume of waste is estimated at 4 million cubic meters of which about 25 percent is chemical waste. The site is in the path of the advancing Chabarovice coal strip mine. Presence of the waste site will cause mine operation to be curtailed sooner than planned. (Fleissner, J.T.A; Beba, J.; (June 1993), 724-727 [in English].)

2732 THE EVOLVING ROLE OF MATERIAL/TECHNOLOGY EXCHANGES IN DEVELOPING ECONOMIES [BIB-BUDA00034]

A two-pronged problem faced by Central and Eastern European countries is building an economic infrastructure based on free-market principles to rejuvenate their plodding economies and simultaneously upgrading many of their practices in mining, agriculture, manufacturing, forestry, energy and transportation to reverse the rate of degradation of their natural environments. Economic development and growth require intrusion into the biosphere and consumption of its resources. At the same time the biosphere requires man's technology and management to insure it can provide the needed resources for a growing population and absorb the residues of his economic behavior. (Neace, M.B.; (June 1993), 383-385 [in English].)

2733 COOPERATIVE PROGRAM BETWEEN THE UNITED STATES AND EASTERN EUROPE "EFFECTS OF AIR POLLUTION AND CLIMATIC CHANGE ON FOREST ECOSYSTEMS" [BIB-BUDA00035]

Environmental pollution is thought to be responsible for forest decline in Europe and North America. In Eastern Europe air and soil pollution have caused severe damage to forests, leading to forest dieback in some locations. Stronger cooperation between east European and Western scientists is needed for better understanding of the effects of environmental stress and climatic change on forests throughout the world as well as for developing mitigation strategies. This international project will provide for the transfer of Western technology and equipment as well as for implementation of research involving the exchange of scientists. This effort is planned within the framework of a multi-year program which is being developed with the USDA Forest Service and the US EPA support. (Bytnerowicz, A.; Noble, R.; (June 1993), 134-136 [in English].)

2734 SYSTEM FOR PREDICTING THE VULNERABILITY OF SOILS TO ORGANIC CHEMICALS [BIB-BUDA00036]

Pollution of soils from air, rain, surface water, irrigation water and sludge application was described in the literature for a number of different sites and areas. For such areas, the risk of contamination by organic chemicals and the potential filter and buffer capacity should be known for landscape planning and municipal planning. Therefore, it is necessary to have a simple system to predict, for different site conditions, the behavior of pollutants in soil, the risk to reach ground water and their uptake by plants. A classification system which fulfills these requirements was developed using data from field experiments with 47 different organic chemicals, which were published in the literature. (Litz, N.; (June 1993), 835-843 [in English].)

2735 GROUNDWATER INVESTIGATION IN FRACTURED ROCKS IN CONNECTION WITH CONTAMINATED LAND [BIB-BUDA00037]

A new manual of ground water investigation in fractured rocks in connection with contaminated land has been elaborated and published. The manual lists a variety of possible testing procedures and evaluates the procedures with regard to their application, their meaningfulness and the costs. By means of this guide the official is able to select the various investigation procedures which can help to solve remaining problems with the assessment of the dangers. (Coldewey, W.G.; Bauer, H.J.; Krahn, L.; (June 1993), 574-574 [in English].)

2736 RISK ASSESSMENT METHODS IN GENETIC MONITORING OF HUMAN POPULATION [BIB-BUDA00038]

It has long been established that genetic risk of human population is associated with certain environmental hazards, such as exposure to ionizing radiation and different chemicals. These factors at certain doses are known to mutate previously normal cells which can, in some cases, cause different diseases. An elevation in mutation rate in germinal cells may result in an increase of genetically defective individuals in future generations, and the mutations in somatic cells may be the most possible causes of cancer. Health effects due to genetic susceptibility may decrease the fitness and lifespan of individuals, resulting in high cost to society. It is, therefore, important to reduce genetic risk with the research of new techniques in genetic monitoring and screening. (Gundy, S.; (June 1993), 412-413 [in English].)

2737 FOURIER-TRANSFORM-INFRARED-SPECTROSCOPY OF AIR POLLUTION BY A MOBILE SYSTEM [BIB-BUDA00039]

The high gas concentrations and the temperature of smoke stack effluents cause a sensible infrared radiation signal so that remote-sensing is possible. The spectral features of the gas to be searched are overlapped by other gases. Background and foreground radiation influence the plume radiation in an integral manner. A quantitative analysis of ground-based plume emission measurements demands a radiative transfer modeling. Gas transmittances are computed by a line by line algorithm including overlap of Voigt profiles.

chamber in which the rubber and fiber are washed from the steel belts and beads and emerge as a slurry of rubber/fiber material which can be pumped to combustors for the WTE (Waste To Energy) mode. The wire beads and belts are washed free of rubber and other material and are extracted in their original size and shape and are much more marketable because they are free of foreign materials. (Carpenter, R.K.; (June 1993), 681-683 [in English].)

2719 APPLICATION OF PETROGRAPHIC AND RADIOCHEMICAL ANALYSIS OF RADIOACTIVE SOIL FRACTIONS TO STAGES OF THE RI/FS PROCESS [BIB-BUDA00021]

The Office of Radiation Programs has developed a soil characterization protocol for radioactive soils that has application to (a) enhancement of the conceptual model of the sites, (b) improvement of baseline risk assessment, and (c) facilitate identification of potential remedial alternatives at radioactively contaminated Superfund sites. The protocol involves separation of the bulk samples into several size fractions with complete petrographic and radiochemical analysis of each size fractions. This procedure provides (1) identification of activity levels versus grain size, (2) identification of the mineral/material composition and physical properties of radioactive contaminants, and (3) differences between physical properties of contaminants and host materials. (Neiheisel, J.; (June 1993), 510-512 [in English].)

2720 CATALYTIC REDUCTION OF NITRIC OXIDE WITH PROPANE OVER PLATINUM ION-EXCHANGED P ZEOLITES [BIB-BUDA00022]

Catalytic reduction of nitric oxide with propane was studied over platinum ion included Pentasil-type zeolite (Pt/Na-P). The catalytic activity of Pt/Na-P was detectable at around 473K and increased with the increase in reaction temperature until about 623K where the NO conversion of 100 percent was attained. When the activity was given by the temperature at which a NO conversion of 10 percent was attained, the order of the activity was Pt/Na-P greater than Pt/H-P greater than H-P (H: proton ion) Na-P. The difference of the activity between Pt/Na-P and Pt/H-P would result from the reactivity between NO and reducing agents on the catalyst. (Sakamoto, E.; Arakawa, T.; Arai, H.; (June 1993), 831-834 [in English].)

2721 ADVACATE: LOW COST PROCESS FOR SO_2 CONTROL [BIB-BUDA00023]

The ADVAnced SiliCATE (ADVACATE) process development has been sponsored by the U.S. Environmental Protection Agency in response to the need for a low-cost sulphur dioxide (SO_2) control. Through research agreements and contracts, ADVACATE has evolved to a simple add-on technology easily retrofitted on existing utility boilers with minimal disruption to the existing facility. This paper discusses sorbent chemistry and process development of the ADVACATE process. The sorbent is produced by high temperature (normally 90 °C) slurrying of $Ca(OH)_2$ and fly ash, as a source of silica. Slurrying results in the formation of high surface area materials that are more reactive toward SO_2 than $Ca(OH)_2$. (Jozewicz, W.; Hall, B.; Singer, C.; Sedman, C.; Maxwell, M.; (June 1993), 65-68 [in English].)

2722 A STRATEGY FOR THE ECONOMICAL AND ECOLOGICAL RESTRUCTURING OF AN OLD INDUSTRIAL REGION [BIB-BUDA00024]

The Freiberg Region is one of the oldest mining districts in Germany and in Europe. For more than 800 years, metal mining and smelting had an important influence on the social and economical profile and structure of the region. The ecological situation of the region is especially influenced by heavy metals. The change of political and economical conditions led to an economic slow down. Plants were closed down and thousands lost their jobs. The regional authorities recognized the need to stop the negative development and started an initiative to develop new structures, to manage the ecological problems, and to create new jobs. The region needs new industrial perspectives. For the Freiberg region the best alternative would be to remediate the sites which have fallen into disuse. (Weingran, C.; (June 1993), 131-133 [in English].)

2723 APPLICATIONS OF IN SITU SOIL VAPOUR EXTRACTION AND AIR INJECTION [BIB-BUDA00025]

Soil vapour extraction has become a widely recognized technique for in situ treatment of contaminated soil in the unsaturated zone. Soil vapor extraction results in two treatment methods. First, volatile components are withdrawn from the soil. As a second effect, biodegredation is enhanced by the supply of oxygen in the soil vapor. In three cases, soil vapor extraction was performed as a method of in situ soil clean-up. In Case 1, contamination with toluene was removed from the soil mainly by volatilization of the contaminant. Toluene was removed to concentrations below the detection limit with in a year and a half. Case 2 is the in situ clean-up of a gasoline spill underneath a highway. (Pijls, C.G.J.M.; van Vree, H.B.R.J.; Urlings, L.G.C.M.; Spuij, F.; (June 1993), 607-611 [in English].)

2724 APPLICATION OF IN SITU BIOREMEDIATION TECHNIQUES CONCERNING PAH AT LABORATORY AND PILOT PLANT SCALE [BIB-BUDA00026]

The application of bioremediation techniques for polycyclic aromatic hydrocarbons (PAHs) has been restricted for sometime due to unfavorable technological and microbial reasons. In Case 1 a former gasworks site was heavily contaminated with PAHs and cyanide. The PAHs had spread in a vertical direction until encountering a clay layer 17m below ground surface. Six column experiments were carried out to determine if biodegradation and/or chemical extraction could be a useful option for in situ remediation. Large amounts of low molecular PAHs were biodegraded within six weeks. Biodegradation can take place without oxygen and nitrate can be used as an alternative electron acceptor. (van Vree, H.B.R.J.; Nijhof, A.G.; Urlings, L.G.C.M.; Spuij, F.; (June 1993), 643-646 [in English].)

2725 BIOPURR: AN INNOVATIVE BIOREACTOR FOR THE SIMULTANEOUS TREATMENT OF GROUNDWATER AND SOIL VAPOR CONTAMINATED WITH XENOBIOTIC COMPOUNDS [BIB-BUDA00027]

In many places in the Netherlands, the soil is contaminated with organic hydrocarbons, such as BTEX, mineral oil and naphthalene. In situ techniques are methods that can be used to remediate these contaminated sites. In situ remediation can take place by withdrawing ground water and soil vapor. Both of these streams can be treated in the BiopurR reactor. The BiopurR process is a patented, aerobic fixed film reactor filled with polyurethane as a carrier material for the biomass. Water and soil vapor flow concurrently through the bioreactor to prevent stripping. Bacteria attached to the polyurethane biodegrade the xenobiotica in the soil vapor and groundwater. (Marsman, E.H.; Bult, B.H.; Urlings, L.G.C.M.; (June 1993), 612-613 [in English].)

2726 CONTROL TECHNOLOGIES FOR THE PREVENTION OF ENVIRONMENTAL CONTAMINATION FROM THE LANDFILLING OF MUNICIPAL SOLID WASTE [BIB-BUDA00028]

This paper will describe the potential adverse environmental impacts that can arise from the landfilling of municipal solid waste, and the control technologies available to prevent environmental contamination. It will cover the use of environmental impact assessment as an aid in engineering design and control of landfill development, the measures to be taken to prevent pollution of surface and ground waters, and the control of landfill gas. These will be placed in the context of European regulatory standards and legislation. A major landfill development by Cornwall County Council in Southwest England will be used for illustration. (Ankers, B.; (June 1993), 683-685 [in English].)

2727 SYNLOG: A COMPUTER MODEL FOR SELECTION OF DETECTION METHODS IN THE DEVELOPMENT OF A HYDROCARBON PROBE [BIB-BUDA00029]

In order to develop a hydrocarbon probe, a model has been developed for selecting detection techniques to be built into a sounding device. This sounding device is intended to detect floating and sinking layers in the soil, caused by spills at the surface. The methods for detection are based on techniques stemming from petrophysical exploration and chemical analysis. The basis of the computer model is a complete description of the subsurface. The subsurface is divided into

many other separation techniques, the surface properties of the contaminants, rather than their particle size, govern the separation. The technique is capable of cleaning a large portion of the fine fraction as well, leading to very modest sludge production. (Hinsenveld, M.; (June 1993), 771-773 [in English].)

2709 INVESTIGATIONS ON CADMIUM LEVELS IN SOILS, PLANTS, TOBACCO, AND HUMAN BLOOD IN PEST COUNTY, HUNGARY [BIB-BUDA00011]

Soil investigations (n60) show the highest Cd-values in the surface layer of soils situated in industrial areas while these values exceeded the permissible limit only in some of these cases. Among the different plants (n46) studied, the highest Cd-level was found in carrots, but high Cd-values have been measured in green beans and other vegetables as well. Some Hungarian cigarettes (tobacco and smoke, n14) were analyzed as well, but more investigations are necessary for the determination of further details of the Cd-circle, and of the Cd transfer factors in Hungary. The results gained from the blood analysis from humans show that, among the different factors investigated, occupational exposure has the greatest influence on the Cd-levels of blood. (Vermes, L.; Petho, E,; Marth, P.; (June 1993), 409-411 [in English].)

2710 U.S. SUPERFUND SITE ASSESSMENT: APPLICATIONS FOR EAST EUROPEAN HAZARDOUS WASTE SITE PRIORITIZATION [BIB-BUDA00012]

This paper discusses the Superfund Hazardous Waste Site Assessment Program established by the U.S. Environmental Protection Agency. A key to this program is the Hazard Ranking System (HRS), a mathematical model that is used to compare the relative risk posed by potential hazardous waste sites. By using the HRS plus other environmental and social factors, EPA determines which sites pose the greatest threat to human health and the environment, and this assists the Agency to prioritize and allocate its cleanup funds. We explain how the HRS works in the U.S., and we draw upon actual Superfund site field experiences to discuss how to use the HRS to determine sample strategies at a variety of hazardous waste sites. (Courreye, P.L.; Nalipinski, M.; (June 1993), 380-382 [in English].)

2711 RECENT DEVELOPMENTS IN TECHNIQUES OF GROUND TREATMENT FOR THE SAFEGUARD AND REHABILITATION OF THE ENVIRONMENT [BIB-BUDA00013]

Underground water supplies are continually threatened by pollution, which can have origins of very different natures. These may include planned disposal or accidental releases - resulting from the presence of either industrial processes or domestic and industrial landfills. Each occurrence of pollution is a unique case and the protection of the natural environment and the rehabilitation of the contaminated areas requires mobilization of highly sophisticated techniques and expertise such as structural diaphragm walls or plastic slurry walls to achieve containment, venting trench for controlled emission and collection of gas, traditional grouting, jet grouting, compaction grouting, and deep mixing methods to produce an impermeable base layer, and waste encapsulation. (Esnault, A.; (June 1993), 749-752 [in English].)

2712 SOLUTION OF COAL-TAR CONSTITUENTS AND THEIR IMPACT ON GROUNDWATER QUALITY [BIB-BUDA00014]

Coal-tar contaminated industrial sites represent a widespread problem in Central and Eastern Europe. Many of the tar-constituents are toxic and/or carcinogenic and present substantial risk for groundwater quality. However, the main processes concerning the solution and transport of these compounds in ground water are still poorly understood. Coal-tar is a complex mixture containing phenols, aromatics and polycyclic aromatic hydrocarbons as main constituents. They vary in their environmentally relevant chemical and physical properties such as water-solubility and octanol-water partition coefficient (Kow) over several orders of magnitude. (Schuth, C.; Pynka, W.; (June 1993), 168-170 [in English].)

2713 PERSISTENCE OF CONTAMINANTS IN SOILS AND SEDIMENTS DUE TO DIFFUSION CONTROLLED DESORPTION [BIB-BUDA00015]

Subsurface contamination with organic compounds has proven to be unexpectedly persistent. In many cases, remediation could not be achieved even within a decade. In situ techniques such as soil-air-venting and pump-and-treat are typically employed under nonequilibrium conditions, and the decontamination of the solid phase proceeds much slower than the concentration decrease in the mobile phase (soil air or ground water) suggests. This nonequilibrium transport of the contaminants may be due to heterogeneities on a macro- or micro-scale. Macro-scale heterogeneities may be represented by zones on a field scale with different permeabilities or sorption capacities such as clay and peat lenses. (Grathwohl, P.; (June 1993), 604-606 [in English].)

2714 SOME EXPERIENCES WITH HAZARDOUS WASTE MANAGEMENT AT MARSHALL SPACE FLIGHT AND NASA CENTERS, USA [BIB-BUDA00016]

A large amount of hazardous waste is produced each year by various centers of research, development, testing and operations throughout by the National Aeronautics and Space Administration agency. Appropriate management and disposal of these wastes have become desirable and mandatory in order to avoid the shutdown of these facilities by the U.S. Environmental Protection Agency or the respective state governmental environmental agencies. Several laws and regulations govern the management and disposal of wastes at federal facilities. Efforts are in progress to appropriately manage the electroplating wastes at Marshall Space Flight Center, as well as the mercury spillage (April 1989) in the wind tunnel at the Lewis Research Centre. (Parate, N.S.; (June 1993), 721-723 [in English].)

2715 BIOLOGICAL TREATMENT ALTERNATIVES OF TRIFLURALIN PRODUCTION WASTEWATER [BIB-BUDA00017]

In the production of trifluralin ($C13H16N_2O_4F_3$) which is a dinitroaniline herbicide, wastewater streams containing 9000 mg/l COD, 1000 mg/l BOD5, 5000 mg/l TOC and 8600 mg/l Cl-1 are often encountered. In this study, anaerobic and aerobic treatment of this wastewater was investigated experimentally. Anaerobic treatability studies were carried out in two identical 71 upflow fixed bed filters which were acclimatized using acetic acid and propanil wastewaters. During acclimatization, the amount of trifluralin wastewater in the feed was increased gradually while the contents of acetic acid and propanil wastewater were decreased. It was found that the TOC removals were not satisfactory and decreased with the increased loadings. (Altinbas, U.; Timur, H.; Alper, E.; (June 1993), 95-97 [in English].)

2716 THE DIRECT REACTION BETWEEN NITRIC OXIDE AND THE SUPERCONDUCTOR $YBA_2CU_3O_7$ TO DELTA [BIB-BUDA00018]

We have studied the direct reaction between nitric oxide and the superconductor $YBa_2Cu_3O_7$ to delta in an attempt to provide the removal of nitrogen oxide. A large amount of NO was rapidly absorbed by the $YBa_2Cu_3O_{6.83}$ superconductor at around 573K. The maximum NO content so far achieved corresponded to x 2.5 if $YBa_2Cu_3O_{6.83}(NO)_x$ would be obtained by the direct reaction with nitrogen monoxide (NO) gas. Up to x 1.0 the absorption rate was fast, although in order to obtain a composition of x 2.5 several days were required. The implanted samples were not superconducting. NO incorporation was found to shift the crystal symmetry from orthorhombic to tetragonal. (Arakawa, T.; Sakamoto, E.; Adachi, G.; (June 1993), 827-830 [in English].)

2717 MAGNETIC TREATMENT: TODAY'S ALTERNATIVE [BIB-BUDA00019]

An excellent report for the magnetic treatment novice as well as the experienced technologist. A complete story is told and referenced to allow the reader to perform additional research if desired. This paper covers an extensive review of magnetic treatment theory and studies, a comprehensive discussion of the state of the art in theoretical and practical application of magnetic devices is covered. The requirements for proper application of magnetic treatment is discussed and an evaluation of several reports are included. Reports by MIT (Massachusetts Institute of Technology), South Dakota School of Mines, Purdue University, London University and Tulane University are evaluated for credibility by established criteria. (Carpenter, R.K.; (June 1993), 98-100 [in English].)

2718 TIRE REFINER [BIB-BUDA00020]

An approach to processing all tires including the aircraft and off-the-road varieties is called a "Tire Refiner". The "Tire Refiner," now in development by a Florida company, will begin with the old tires that are placed into a multi-stage

2699 AN OVERVIEW OF THE EVALUATION OF VARIOUS TECHNOLOGIES TO REMOVE ORGANIC CONTAMINANTS FROM SOIL [BIB-BUDA00001]

Over the past three years, the Emergencies Engineering Division (EED) of Environment Canada has investigated various ex situ methods for removing organic contaminants from soil. A description of three of these methods is presented and the removal and destruction efficiencies obtained using bench scale units are outlined. The first study evaluated readily available solvents for the removal of petroleum hydrocarbons from soil. The second study investigated a combination of solvent extraction and enhanced oxidation, whereby organic contaminants in soil are removed using a non-oxidizing solvent and the contaminant in the solvent is destroyed by enhanced oxidation. (Punt, M.; (June 1993), 601-604 [in English].)

2700 SCREENING FOR ENVIRONMENTAL CONTAMINATION VIA FIELD PORTABLE GAS CHROMATOGRAPHS [BIB-BUDA00002]

Field portable gas chromatographs (FPGCs) have been deployed for the on-site analysis of volatile organic compounds (VOCs) at Superfund sites across the United States of America. Four different FPGCs are routinely used for VOC analysis in air, soil and water matrices. Permanent gases (CO, CO_2, O_2, N_2) and methane can be determined using the Microsensor Technologies Inc., (Fremont, CA, USA) model P200, configured with dual packed columns and dual "microchip" thermal conductivity detectors (mTCDs). A P200 FPGC configured with dual capillary columns is used for VOCs ranging in volatility from vinyl chloride to styrene. (Kaelin, L.P.; Wynnyk, R.; Mickunas, D.; Humphrey, A.; Pritchett, T.; (June 1993), 211-213 [in English].)

2701 RAPID ASSESSMENT OF THE EXTENT OF ENVIRONMENTAL CONTAMINATION USING BOREHOLE TECHNIQUES AND PORTABLE INSTRUMENTATION [BIB-BUDA00003]

The U.S. EPA has used "borehole techniques" to collect the volatile organic vapors from the soil vadose zone at hazardous wastes sites across the U.S. and in other countries. These vadose zone vapor samples are called "soil gas" samples. Soil gas analysis can indicate the presence of volatile organic pollutants in the soil column or underlying ground water aquifers. The soil gas samples are collected in inert gas sampling bags using a vacuum box of simple design. The gas sample bags are analyzed using commercially available field portable instrumentation to determine the concentration and the identity of the volatile organic pollutants. (Kaelin, L.P.; Fekete, A.; Mickunas, D.; Wynnyk, R.; Humphrey, A.; Prince, G.; (June 1993), 240-242 [in English].)

2702 USING REGRESSION ANALYSIS IN SITE EVALUATION AND MONITORING AT A U.S. SUPERFUND SITE [BIB-BUDA00004]

Site evaluations and monitoring involve many different techniques and academic areas, including mathematics. The example given illustrates how regression analysis can help in evaluating a site. Problem: Suppose we have several storage tanks which either leak or give off gas. (Research has shown that nearly all underground storage tanks leak.) Gas measurements were collected at the enclosure boundaries and weather data were obtained at a nearby meteorological (met) station. Both sets of data were to be recorded each hour. Our problem was to relate the gas measurements to the weather data. (King, M.K.; Haller, S.A.; (June 1993), 469-471 [in English].)

2703 UNIDO'S ENERGY & ENVIRONMENT INFORMATION PROGRAM [BIB-BUDA00005]

This paper outlines UNIDO's energy and environment information program, which is a sub-system of the Industrial and Technological Information Bank (INTIB), including a brief introduction to the services of INTIB. CLEANTEC DATA, the concept under which the sub-system functions, is explained and the UNIDO approach to information sourcing, preparation of dissemination packages and the problems of developing countries in assessing relevant information are covered. The need to 'know-who' or 'know-where' to look for information is considered as important as the 'knowhow' part of the equation. For this reason, the utilization of existing sources of knowledge plays a large role in the program. (Pembleton, P.N.; (June 1993), 377-380 [in English].)

2704 FIELD METHODS FOR SITE CHARACTERIZATION OF CONTAMINANTS [BIB-BUDA00006]

Analytical equipment which is applicable for the characterization of contaminated sites provides great advantages as transportion time to laboratories is avoided and rapid decisions in relation to other investigation/preventive measures are possible. Moreover, this technique usually makes it possible to perform several analyses within a short period, thus making it possible on the spot to continuously implement an optimal strategy like determination of hot spots. Consequently, the investigations will become less costly and a significantly improved sampling strategy will be applied. (Kirkegaard, C.; Wille, E.; Hojslet, L.; Grove, A.; (June 1993), 571-573 [in English].)

2705 IN SITU AND ON-SITE GROUNDWATER REMEDIATION TECHNIQUES WITH VERTICAL CIRCULATION FLOWS IN THE AQUIFER [BIB-BUDA00007]

An in situ groundwater remediation technique is currently being used at numerous sites in Germany where the underground is contaminated by strippable substances, e.g. chlorinated hydrocarbons, BTEX. The groundwater is stripped by air in a below atmospheric pressure field in a so called "Vacuum Vaporizer Well" (German: Unterdruck-Verdampfer-Brunnen, abbreviation: UVB). Often the well is used for vapor extraction at the same time. The contaminated air is cleaned employing activated carbon or in case of suitable contaminants by using biofilters. For these remediation techniques special wells with two screen sections are employed, one at the aquifer bottom and one at the groundwater surface. (Herrling, B.; (June 1993), 637-639 [in English].)

2706 3D VERTICAL CIRCULATION FLOWS AROUND WELLS WITH TWO SCREEN SECTIONS FOR AQUIFER REMEDIATION: NUMERICAL RESULTS [BIB-BUDA00008]

Three-dimensional vertical circulation flows around wells with two screen sections in one aquifer are an important subject of numerical investigation. The circulation flow is initiated by vertical pumping measures within the well casing. The well system is used for physical or biological in situ remediation of aquifers. Moreover, partial discharge withdrawal or infiltration vs. the total discharge through the well casing with two screen sections has been investigated numerically. The paper will clarify the general concept of the numerical modelling of such a well system and will focus in detail on the resulting complex three-dimensional (3D) flow patterns by plotting results in plane and perspective views. (Herrling, B.; Stamm, J.; (June 1993), 640-642 [in English].)

2707 PROGRAM FOR PROVIDING ENGINEERING TECHNICAL ASSISTANCE IN SITE REMEDIATION [BIB-BUDA00009]

In 1989 the U.S. EPA established a branch in its Office of Research and Development to provide engineering technical assistance to its Regional offices in the remediation of about 4,000 contaminated industrial facilities, landfills, abandoned dumps and other sites. The program provides site-specific assistance and also develops technical resource documents, data bases and training courses to help a wide range of parties involved in site remediation. The Branch's small group of technical experts has been able to significantly assist in site cleanups, helping to assure that there is a strong technical basis for remediation technology selection and that the design and implementation of the chosen technology is properly done. (Blaney, B.L.; (June 1993), 297-300 [in English].)

2708 RECENT DEVELOPMENTS IN EXTRACTION AND FLOTATION TECHNIQUES FOR CONTAMINATED SOILS AND SEDIMENTS [BIB-BUDA00010]

Soil cleaning in present aqueous extraction installations is mainly a result of the removal of heavily contaminated fines. substantial sludge production is considered a problem. Since sediments consist mainly of fines, these extraction techniques are not successful for cleaning of sediments. Developments in application of various separation techniques will be reported. A technique, which largely circumvents the above mentioned problems, is flotation. As opposed to

* Source: *International Symposium on Environmental Contamination in Central and Eastern Europe, Budapest '92, Symposium Proceedings*, Florida State University-CHAERSE, Tallahassee, Florida, USA

occupational exposure limits for halogenated solvents in the United Kingdom are shown. Personal monitoring and biomonitoring techniques for solvents are discussed and some data are provided. Finally the ICI approach to safe use of solvents is outlined and future alternatives to CFC-113 are considered. (Hampson, C; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 4, 14, pp. 31-36 [in English]. 0378-9993)

2694 ELIMINATING ORGANIC SOLVENTS USE THROUGH THE SUBSTITUTION PROCESS [BIB-TINF00746]

Case studies from Danish plants are presented to indicate how dangerous chemicals have been substituted in Denmark. These include the use of alkaline degreasing in place of trichloroethylene in the metals industry and substitution of solvents (a mixture of soya bean oil and modified coconuts oil) for organic solvents in the offset printing industry. Other examples of substitution are provided for plants producing plastic mouldings and plastics waste pipes. Steps in substitution are examined; these are two approaches, one involving changing the substance used in a process, the other involving a change in the process itself. The social process of substitution is considered and the role of Occupational Health Centres in Denmark is discussed. Official approaches to initiating further substitution in plants are finally examined. (Goldschmidt;, G.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 4, 14, pp. 37-40 [in English]. 0378-9993)

2695 REDUCTION OF VOLATILE ORGANIC COMPOUNDS USE IN THE PRODUCTION OF FLEXIBLE PACKAGING [BIB-TINF00747]

Possibilities of reducing emissions of volatile organic compounds in manufacture of flexible packaging are considered. Although incineration is relatively easy to implement, other approaches are preferable from the standpoint of environmental and financial considerations. Changing to water-based inks is one possibility, and these are slowly becoming available. Another possibility is the recovery of solvents. Government regulations are considered in relation to implementing alternative approaches to incineration for reducing solvent emissions. (Verspoor, P.W.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 4, 14, pp. 40-42 [in English]. 0378-9993)

2696 REDUCTION OF CONSUMPTION OF CHLORINATED SOLVENTS: 70 TONNES PER YEAR. MOULINEX - AN EXEMPLARY CASE [BIB-TINF00748]

Details are provided of how Moulinex has reduced its consumption of a trichloroethylene solvent (Altene D6 produced by Societe Atochem) at its Cormelles-6 Royal plant for producing microwaves, ovens, rotisseries and dryers. Modification of the cleaning equipment and changes in cleaning procedures have allowed a 60% reduction in solvent consumption as well as a decrease in solvent emissions in the workplace. Work is continuing to reduce further air pollution and effluent contamination. (Dongueille, R.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 4, 14, pp. 43-44 [in English]. 0378-9993)

2697 CHLORINATED SOLVENTS: TIME FOR A GLOBAL BAN [BIB-TINF00749]

The Greenpeace view is presented, that a global phase-out of all chlorinated organic compounds is not only feasible, but is urgently necessary. It is shown that current national and international legislation is insufficient; the EC Project Group is urged to prepare an assessment and action plan for complete substitution use within the European Community. Clean production criteria are advocated as offering the best yardstick for evaluating products and processes, because they recommend production systems that are socially just and compatible with the ecosystem. Applying these criteria shows the need for a total phase-out of the entire chemicals group. To illustrate the toxic life cycle involved, a detailed discussion is presented of perchloroethylene and its use in the dry cleaning industry. (Thorpe, B.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 4, 14, pp. 44-47 [in English]. 0378-9993)

2698 PROTECTION OF THE ENVIRONMENT IN THE SUGAR CANE INDUSTRY [BIB-TINF00750]

World production and consumption of sugar is reviewed, by-products are described and the method of preparation is discussed briefly. The industry is of particular importance in developing countries and environmental problems associated with sugar cane production are examined. Pollution arises principally from atmospheric discharges, from by-products and from liquid effluents. Each of these causes is examined in turn in some detail and approaches to overcoming pollution are described. The most serious problem is stated to result from distillery slop. Current treatment techniques can ensure environmental protection and provide a profitable business opportunity. General recommendations are made to overcome pollution. (Chaux, D.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 4, 14, pp. 50-59 [in English]. 0378-9993)

forced-plastics pipe, a fire of lagging material caused oildripping on a hot steam pipe, a scaffolding fire attributable to leaking organics, the presence of live O in a supposedly isolated pipe section, a reactor sparger that dropped 1.5 m, a historical fatal boilers explosion, and a spray of hot condensate from a vent pipe on a blowdown header. (Dunford, N.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 32-36 [in English]. 0378-9993)

2686 RECOVERING METALS FROM HYDROXIDE FILTER CAKES AND SLUDGES [BIB-TINF00738]

The recovery of metals from electroplating and other process wastes is now a viable operation in Australia, and particularly in Victoria. The changed conditions involved are listed and details given of the recovery techniques. In general the wastes are now segregated on-site before collection by "middle man" concerns, which beneficiate them to a form acceptable by metal producers for processing in conjunction with their ores, etc. Systems for recovering Zn, Ni, Cu and Cr from treated sludges or filter cake are discussed in terms of costs as well as processes. New techniques emerging for concentrating metal hydroxide wastes include neutralization by $MgO/Mg(OH)_2$, use of Fe colloids in foam flotations, and separating the metals by ion-exchange and liquid membrane adsorption. (Reeve, D.J.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 36-39 [in English]. 0378-9993)

2687 IMPLEMENTING ENERGY-MANAGEMENT POLICIES AND STRATEGIES: THE IMPACT OF THESE ON ENVIRONMENTAL PROTECTION IN THE CASE OF CAMEROON [BIB-TINF00739]

Natural advantages and disadvantages of Cameroon are highlighted in extensive presentations of demographic, geographic, geomorphological, climate, ecology ecological, etc., data. Abpout 25 million hectares of forest constitute a potential energy source, the value of which is recognized by re-afforestation. The energy consumption in 1987-88 totalled 3.77 million TEP, 67.71% of which was used by the domestic sector and 64.63, 21.44 and 13.93% were supplied by the mainly wood/charcoal biomass, hydrocarbons, and electricity, respectively. Areas particularly susceptible to pollution by petroleum production and electricity generation are identified, together with occurrences since 1976. Reference is also made to a project aimed at developing the use and distribution of liquid petroleum gas to reduce the dependence on firewood and a degree of deforestation. (Ekello,, F.N.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 40-45 [in English]. 0378-9993)

2688 INTRODUCTION TO SOLVENTS: SOME FACTS AND FIGURES [BIB-TINF00740]

Solvents as a category present some of the greatest challenges to environmentalists and some background information on solvents is presented. Solvents are defined and are classified as halogenated or non-halogenated types. Uses of solvents, which can contribute to their release to the environment are considered and an indication of the quantities involved is given. Hazards to human health posed by exposure and the effects of solvents and solvent-bearing wastes on the environment are discussed. U.S. exposure limits and health hazards for common solvents are tabulated and processes and resulting solvent wastes are compared. U.S. statistics for chlorineated solvents in 1990 are presented and toxic effects of common pollutants in aquatic and terrestrial environments are tabulated. (Palmer;, K.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 3-6 [in English]. 0378-9993)

2689 PROGRESS TOWARDS PHASING OUT THE USE OF CFC-113 AND 1,1,1-TRICHLOROETHANE IN SOLVENT APPLICATIONS [BIB-TINF00741]

In order to eliminate the use of CFC-113 and 1,1,1-trichloroethane in solvent cleaning applications, a number of alternative chemicals and process have been commercialized and more are currently being developed. This article focuses on progress to date in phasing out these compounds, alternatives that are being developed and future activities to aid in the phase out of these controlled substances. The areas of activity considered include cleaning of printed circuit board assemblies, metals cleaning, precision cleaning, dry cleaning, adhesives, coatings and inks and aerosol products. A phase-out programme will require strong government-industry cooperation in the continued development and implementation of alternative chemicals and processes. (Anderson, S.O.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 7-10 [in English]. 0378-9993)

2690 SOLVENT CLEANING IN THE ASIAN ELECTRONICS INDUSTRY: THE SEARCH FOR ALTERNATIVES TO CFC-113 AND METHYL CHLOROFORM (1,1,1-TRICHLOROETHANE) [BIB-TINF00742]

An in-depth examination is presented of how the electronics industries in Hong Kong, Korea,Malaysia,Singapore, Taiwan and Thailand have responded to the demands of the Montreal Protocol to reduce use of CFCs and methyl chloroform. A policy framework for control of ozone-depleting substances is discussed and reduction strategies as incorporated in the practice of electronics firms are reviewed. Benefits and costs of substituting for these solvents are examined. Finally, lessons for other developing countries are considered. In the longer term, the direction of technological innovation will be towards -no-clean" processes, which is consistent with the goal of "zero emissions/zero waste". (O'Connor, D.C.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 12-23 [in English]. 0378-9993)

2691 MALAYSIAN CFC SOLVENT REDUCTION STRATEGIES [BIB-TINF00743]

Malaysia is seeking to eliminate CFCs through the formation of six working groups working in close partnership between government, industry and academic organizations, to look into reduction strategies for various CFC applications. This paper looks at the work of the solvent working group, which is divided into seven steps. Reduction strategies are shown schematically with their interrelationships. The first step aims to obtain accurate CFC consumption data for the past twelve months; the second is concerned with use of CFC solvent and its derivatives in various industries and the respective percentages. The third step identifies areas where immediate reduction of CFC-113 use is possible, and also looks at conservation. Step four deals with education and publicity for CFC reduction. In step five, efforts will be made to find alternatives to CFC in cooperation with industry. Step six concerns training and technology transfer and the final step is obtaining a measurable yearly goal against total elimination by 2000. (Kong Yoong, X.Hin; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 24-27 [in English]. 0378-9993)

2692 THE FORD ARBOR PLANT (BRAZIL) CFCS ELIMINATION PROGRAMME [BIB-TINF00744]

Since 1973, the Ford Electronics Assembly Plant at Arbor produced audio systems and electronics control for automobiles and used CFC-113 for cleaning operations. Details are given of the CFC elimination programme at the plant. Alternatives studies included: use of a fluxless soldering machine, terpine as solvent, aqueous cleaning, HCFC Solvents, Co_2 high pressure cleaning and no-clean flux. CFC usage has now been reduced to only the printed circuit board cleaning machines and the most innovative action has been the implentation of the no-clean flux programme. Details are given of product validation and in-process tests used to obtain an initial estimate of process potential. Future product development will involve a solder paste with non-clean flux used in a new technology, a top side surface mount device soldering process. (Lubraico, M.E.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 4, 14, pp. 28-30 [in English]. 0378-9993)

2693 HALOGENATED SOLVENTS: THEIR ROLE IN CLEANING [BIB-TINF00745]

Development of the use of halogenated solvents for cleaning industry is reviewed. Characteristics of individual solvents are presented (perchloroethylene, methyl chloroform, trichloroethylene, methylene chloride and CFC-113 and their applications summarized schematically. Functions of industrial cleaning methods are described (aqueous cleaning, emulsion cleaners, and solvent cleaning). Factors to be considered when selecting a cleaning process are outlined. Attention is paid to toxicological and environmental concerns of solvents and

assessment for process industries in terms of environmental and other considerations. The risks of economic and community damages are quantified by a model adopted from the Dow Chemical Company's "Fire and Explosion Index, Hazard Classification Guide", illustrated details that are presented. Data reuired for the package are listed, and an illustrative application of it to evaluating the risk from a 750-tonne butadiene storage tank hypothetically proposed for a petrochemicals plant expansion/diversification led to recommendations to relocate the tank and reduce its capacity to 400 tonnes. (Modak;, P.M.; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 34-38 [in English]. 0378-9993)

2679 PC PERSONAL COMPUTER APPLICATIONS FOR ENVIRONMENT MANAGEMENT IN INDUSTRY [BIB-TINF00730]

The PC applications reviewed are classified as computationally intensive, information-oriented, graphics-based, and interfaced with communications and/or controls for real-time use. The categories are individually illustrated and discussed, and worked examples given of applications within them include isopleth of long-term NH_3 concentrations computed by the Bombay-developed AIR programme, and dissolved-O surface downstream from an industrial outfall, produced from a two-dimensional water-quality model (STREAM-II). PC-based programmes developed by the US Environmental Protection Agency for air- and water-quality modelling are designated, and sample data-entry screens used to track information on industrial water-pollution potential are presented. Reference is made to PC systems for storing audit, etc., data on hazardous materials/substances, and to programmes available for the preparation, maintenance, updating, etc., of regulated chemicals. (Modak, P; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 2-5 [in English]. 0378-9993)

2680 ASSESSMENT AND EVALUATION OF FORMER INDUSTRIAL SITES WITH THE AID OF THE XUMA EXPERT SYSTEM [BIB-TINF00731]

Expert systems are defined, their advantages and risk assessment procedures considered, and functions of the case-oriented XUMA type under development in Germany (where XUMA is an acronym for expert system on environmental hazards of contaminated sites) are designed and reviewed. Features illustrated and discussed include the preparation of site-analysis plans and examples of the acquisition and assessment of the analytical results. An evaluation function yielding a risk factor, r_0, which can be used to compare the hazards of various contaminated locations is also reported, together with its objective to determine a numerical value for r_0 applicable to determining the degree of porosity for investigating and sanitizing the different sites. (Geiger, W.; Osterkamp, G.; Wiedemann, R.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 7-12 [in English]. 0378-9993)

2681 NEW MANAGEMENT METHODOLOGY FOR COMPUTER AIDED TOURISM PLANNING [BIB-TINF00733]

Details are given of a computer-aided urban management model collaboratively developed in Delfi for tourism planning. Basically the model can establish, for individual aspects of tourism, lower and upper limits representing the lowest and highest growths commensurate with a minimum profit and with a maximum expansion, termed the pollution point, where further growth would render the aspect so unmanageable as to become unprofitable owing to desertion by the tourists. A hypothetical scenario of this is presented for the assumed case of a small historic town and beach resort on the Mediterranean. Establishment of standard quality norms and an optimal decision-making system is also discussed. (Berkhout, E.E.; Abondano, C.V.N.; Deeleman, A.P.B.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 13-14 [in English]. 0378-9993)

2682 COMPUTER-AIDED MANAGEMENT OF EMERGENCY OPERATIONS CAMEO: A COMPUTER BASED PLANNING AND RESPONSE SYSTEM [BIB-TINF00734]

"Title III" provisions enacted in the US following the Bhopal disaster initiated information-management problems prompting the collaborative development of the CAMEO system. Initially this was worked on Apple Macintosh computers but is now also operable on IBM and compatible systems. Nomenclatures, properties and other characteristics of 3311 Chemicals are provided by "Codebreaker"and "Response" data sheets, illustrated examples of which are given for the case of C?. Facilities with any of the 360 hazardous substances identified by the US Environmental Protection Agency are used by emergency planning committies to conduct vulnerability analyses identifying special populations and institutions, such as schools and fire brigades, affectable by a release. Other features discussed include risk analyses, the ALOHA (Area Locations of Hazardous Atmospheres) air-dispersion model, and the APELL (Awareness and Preparedness for Emergencies at Local Level) programme. CAMEO has proved to be a flexible system adaptable to local requirements, and is used in ten different countries and at more than 2000 locations in the United States of America. (Jover;, Tony; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 15-20 [in English]. 0378-9993)

2683 THE USER'S GUIDE TO INFORMATION SYSTEMS USEFUL TO EMERGENCY PLANNERS RESPONDERS AVAILABLE IN OECD MEMBER COUNTRIES [BIB-TINF00735]

Designstions, locations and summarized costs, origins and other data are given for 29 information systems covered by the Guide, which is available free of charge in English and French editions on application to the Organization for Economic and Cooperation and Development. Most of the systems operate on personal computers, some entirely comprise a hazardous materials/substances data bank, and other contain such a bank as an integral component. (Visser, R.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 21-28 [in English]. 0378-9993)

2684 MODERN MATERIALS MANAGEMENT: MORE ENVIRONMENTAL, MORE COMPREHENSIVE, MORE INFLUENTIAL [BIB-TINF00736]

The need for environmental business management (EBM) is emphasized by reference to the environmental damage in, for instance, the European Community, and by that resulting from relatively minor lawful pollutions, which in aggregate could exceed the damage from spectacular disasters such as Bhopal. Benefits of EBM to individual businesses include enhancement and reduction of marketing opportunities and risks, successful examples of which are presented. Other aspects discussed include environmental approach to cost-effectiveness, risk management in terms of environmental offences and equation with cost management, an innovative role of materials management, and concept of the latter as a partner in product development. Opportunities linked with EBM are also exemplified by experiences of a large mail-order concern, a manufacturer of diamonds and cubic BN tools, and a Bavarian public authority. Reference is also made to the cooperative activitiesof academics and practitioners in the German Management Association (BAUM). (Winter, G.; Publisher: UNEP/IEPAC, Industry and Environment, (1991), 3, 14, pp. 28-32 [in English]. 0378-9993)

2685 A STRATEGY FOR PLANT MANAGEMENT TO PREVENT LOSS [BIB-TINF00737]

Failures of pipework and in-line equipment are analyzed in terms of direct and underlying causes and preventative mechanisms involved in 502 incidents in various countries. A three-dimensional matrix formulated from the data can be used by management to devise a plan to prevent such mishaps, and it is suggested that such an approach would theoretically have presented 44% of the failures reported. The preventive actions are classified and listed, and the underlying causes of the failures and preventive measures in this regard are similarly presented. Case studies described in an appendix, together with appropriate recommendations, comprise failure at a flange joint in a PVC-lined glass-rein-

2670 PREVENTION OF INDUSTRIAL ACCIDENTS IN THE NETHERLANDS [BIB-TINF00721]

The systematic policy of the Netherlands government as regards licensing and siting of hazardous industrial installations is reviewed in terms of its development from guidelines prepared by the United Nations Environmental Programme UNEP, and an independent advisory committee set up in the United Kingdom. Basically upper- and lower-limits representing maximum and negligible risks are established, and the area bounded by them is regarded as a region within which the risk requires reduction in line with the ALARM (As Low As Reasonably Achievable) principle. The approach is diagrammatically illustrated, together with individual and societal risk criteria. Applications to land-use planning and the transport of natural gas and liquid petroleum gases, etc., within the Netherlands are also discussed, together with the proven usefulness of the methods despite initial skepticism. (Kuijen, C.J.; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 2-7 [in English]. 0378-9993)

2671 IDENTIFYING AND EVALUATING RISKS [BIB-TINF00722]

A detailed survey of hazard-control principles and practices applied by ICI Holland BV includes different definitions of risks and hazards in the chemicals and other process industries, together with comparative presentations of risk and hazard analyses. The risks considered comprise those to which members of the public may be subject as a result of accidents involving hazardous substances. The company's approach to hazard identification in general is based on the concept that well-designed, well-built, well-operated, and well-maintained installations will not fail catastrophically if the design intentions are not exceeded. It is reported that further development of the QRA (Qualified Risk Analysis) approach will not yield a means of comparing computed results with risk-acceptability standards. View of the European Council of the Chemical Manufacturer's Federation on the quantitative assessment of risks from chemical industry installations are presented as an appendix. (Lans, H.J.D.; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 7-14 [in English]. 0378-9993)

2672 THE ROLE OF COMMUNITY ACTION GROUPS IN AVERTING AND COPING WITH INDUSTRIAL ACCIDENTS - LESSONS AND STRATEGIES FROM THE BHOPAL TRAGEDY. [BIB-TINF00723]

The International Coalition for Justice in Bhopal (ICJIB) and the United Nations Centre on Transnational Corporations (UNCTC) are presented as examples of groupings formed or activated by the magnitude of the Bhopal disaster, described as the world's worst industrial holocaust. The ICJIB is a coalition of seven citizens' groups protecting the interests of victims of the disaster, and the UNCTC has identified important issues arising from the manufacturing and other activities of the TCs. Aims, operations and recommendations of the organizations are listed and discussed, and the undue burdens imposed on the Third World populations and environments by the lack of controls of hazardous and toxic processes and shipments of their products are emphasized. A wide range of ideas for action to prevent future Bhopals is presented in an appendix. (Abraham, M.; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 14-17 [in English]. 0378-9993)

2673 THE LEGACY OF BHOPAL [BIB-TINF00724]

Primary and contributory causes of the Bhopal chemical-plant disaster in 1984 following the escape of 40 tonnes of methyl isocyanate (MIC) are critically reviewed and an in-depth consideration of environmental and other factors presented. At least 2,500 and 50,000 people were killed or seriously injured, and a further 200,000 were perhaps affected. Other features discussed include the legal aspects/position, inadequate warning by the company of potential hazards with MIC, reduction of supervisory staff, lapses by local safety authorities, absence of automated safety systems, and the decision to produce MIC at the Bhopal experience, problems still to be tackled, and signs of progress in these respects are also highlighted. (Lepkowski, W.; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 18-20 [in English]. 0378-9993)

2674 FIRE AT LIQUID PETROLEUM GAS (LPG) RECOVERY INSTALLATION OF A REFINERY [BIB-TINF00725]

The fire occorred in 1981, at a LPG-recovery plant commissioned in 1967 to recover up to 39 and 29 m 3 of butane and propane/h, respectively, from crude-oil-distribution and catalytic-reforming units. An illustrated case history of the event shows that the incident originated at a plug- and gate-valves assembly designed to drain off the caustic propane, which had been incorrectly re-assembled during a plant overhaul, Thus when at the time of the incident the operator thought he was opening the gate valve, he was actually closing it, and when no flow ensued he attempted to isolate the system by means of the plug valve. This opened rather than closed and released caustic soda in solution and a large amount of liquid butane, which together formed a dense vapour cloud which was ignited within 2-3 minutes, probably by a heater about 30m away from the butane-salt filter. The fire was under control within 50 minutes and was extinguished an hour later, without injury to the firemen or plant personnel. Improvements initiated in light of the incident are illustrated and described and recommendations for later implementation listed. (Unknown; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 21-23 [in English]. 0378-9993)

2675 THE NATIONAL STRATEGIES FOR THE PREVENTION AND RESPONSE OF INDUSTRIAL ACCIDENTS: AN OVERVIEW [BIB-TINF00726]

Scopes and implementations of national legislation and regulations concerning industrial health and saftey are informatively reviewed, both in general and with reference to particular enactments in various countries. These include the United Kingdom's Health and Safety at Work Act and the Control of Industrial Major Accidents Hazards Regulations, France's PPI and POI (Particular Emergency and International Operation Plans, respectively), Swedish responses via its National Rescue Services Board, and US Environment Protection Agency and other enactments covering state and local officials, police, fire, public health, transport, emergency planning, and the community "right to know". The aspects reviewed in general comprise safety analyses, land-use planning and licensing, and authorization systems with special reference to pollution prevention. Mention is also made of EEC directives and OECD analyses of major accidents involving hazardous substances within its member countries. (Galliot, F.; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 24-27 [in English]. 0378-9993)

2676 TRAINING NEEDS IN ACCIDENT MITIGATION AND CONTAINMENT [BIB-TINF00727]

Worldwide industrial disasters such as Bhopal have highlighted the need for adequate training to prepare for and prevent such incidents. Current courses are critically discussed and details given of the APELL (Awareness and Preparedness for Emergencies at the Lower Level) programme drawing on international experience. A complementary collaboratively produced audio-visual training programme also particularly described comprises four self-contained training modules covering prevention and preparedness, on- and off-site emergency responses, and planning operations and training, In this case each module comprises an approximately 20-minute video presentation and support notes designed for independent or group study or tuition. (Gajraj, A.M.; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 28-29 [in English]. 0378-9993)

2677 SAFE WAREHOUSING OF CHEMICALS [BIB-TINF00728]

The background to the CEFIC guide to safe warehousing of chemicals, prepared for the European chemical industry by the European Council of Chemical Manufacturers' Federation, is described and its contents list presented. The first part of the guide comprises four check-list sections covering warehouse premises and their management and protection, and the second part consists of 16 appendices dealing with personnel responsibilities, site layout, warehouse-construction materials, fire-detection equipment, control of ignition sources, and other key topics. The guide is now available in English, French and Dutch. (CEFIC European Council of Chemical Manufacturer's Federation; Publisher: UNEP/IEPAC, Industry and Environment, (1988), 3, 11, pp. 31-33 [in English]. 0378-9993)

2678 A COMPUTER-ASSISTED PACKAGE FOR MINIMUM RISK LAYOUT FOR PROCESS INDUSTRIES. [BIB-TINF00729]

Flow-chart and other data are given for an IBM personal-computer-based package developed in india to assist in the decision-making with regard to risk

2661 ENVIRONMENTAL ASPECTS OF HAZARDOUS WASTE MANAGEMENT FOR DEVELOPING COUNTRIES: PROBLEMS AND PROSPECTS [BIB-TINF00712]

A systems appraoch to hazardous wastes management is suggested, which includes minimum generation of hazardous wastes, reprocessing and re-use of wastes, separation from or transformation of hazardous wastes to non-hazardous types and disposal of wastes in a controlled landfill practice. The importance and details of education and training for hazardous wastes management are outlined. The potential role of UNIDO in such management including industrial safety in developing countries is emphasized. Who should provide training and guidelines of waste management, play major roles by reacting immediately to catastrophic accidents and establish a network of national and international organizations for transfer of information and technology. (Biswas, A.K.; (1989), 261-271 [in English]. 1-85148-027-7)

2662 HAZARDOUS WASTE MANAGEMENT IN ASEAN: WITH EMPHASIS ON SMALL AND MEDIUM INDUSTRIES [BIB-TINF00713]

Hazardous waste management under ASEAN Environment Programme is revised in terms of generation, storage, transport, use and disposal of wastes in various Asian countries which include: Singapore, Malaysia, Thailand, Indonesia, and Philippines. The case-studies of small- to medium-size electroplating plants are highlighted. Rapid industrialization in ASEAN during the last decade demands greater priority for management of hazardous wastes. Effective management can only be achieved when the essential data on sources, amounts, types and characteristics of the wastes are adequate and reliable. (Uriarte, F.A.; (1989), 272-285 [in English]. 1-85148-027-7)

2663 HAZARDOUS WASTE MANAGEMENT IN INDIA: POLICY ISSUES AND PROBLEMS [BIB-TINF00714]

The problems of hazardous waste management in India lie with the lack of information on wastes, inadequate coordination of different agencies, insufficient resources and incentives, and lack of specific legislation and standards for hazardous wastes. Policies on waste management are explained in terms of reduction at source and suitable treatment and disposal of wastes. New technologyies developed for handling hazardous wastes are highlighted. Waste disposal (Mahajam, S.P.; (1989), 286-292 [in English]. 1-85148-027-7)

2664 MANAGEMENT OF HAZARDOUS MATERIALS AND WASTES IN CHINA [BIB-TINF00715]

A rapid increase in the production and usage of chemicals in China resulted in the State Council promulgating regulations on safe management in the production, usage, storage, transportation and packaging of hazardous chemicals, and the punishment for violating the regulations. China produced 40 M tons a year of hazardous wastes, which are now being regulated via legislation formulated by the National Environmental Protection Agency. The standard levels of toxicity in waste liquor are highlighted along with the treatment, disposal and recovery of wastes containing heavy metals including chromium. (Qing, S.; (1989), 293-297 [in English]. 1-85148-027-7)

2665 HAZARDOUS WASTE MANAGEMENT IN SRI LANKA [BIB-TINF00716]

The problems from hazardous wastes in Sri Lanka are associated with surface- and ground water pollution and pesticides. legislations against health hazards and environmental pollution are highlighted. The problems of hazardous waste management in Sri Lanka are related to lack of trained personnel, insufficient resources to fund treatment of wastes and shortage of floor space within factories. Collective treatment of effluent appears to be economical with an introduction of industrial zoning to concentrate on treating wastes at one site. The steps taken to control environmental degradation in Sri Lanka include industrial zoning and detailed monitoring of effluents released into the sewerage system. (Alwis, D.P.; (1989), 298-301 [in English]. 1-85148-027-7)

2666 METHODOLOGY FOR RISK ASSESSMENT IN HANDLING PETROCHEMICAL PRODUCTS IN DEVELOPING COUNTRIES [BIB-TINF00717]

Risk assessment in handling petrochemical products in brazil is discussed, which stipulates the essential need to fulfill the legislative requirements of the Environmental Impact Assessment prescribed by the Brazilian Council. The classical methodologies of cause/effect analysis, failure modes and effect analysis (FMEA) and common mode failure are used as needed for risk management considered in terms of environmental assessment and risk identification. The various parameters involved in the evaluation of social and ecological risks are highlighted. (Almeida;, S.A.S.; (1989), 302-308 [in English]. 1-85148-027-7)

2667 MANAGEMENT OF HAZARDOUS MATERIALS IN CHEMICAL INDUSTRIES IN INDIA [BIB-TINF00718]

Three case studies on the management of hazardous materials in chemical industries in India are described, which include leakage of methylisocyanate at Union Carbide in Bhopal, release of oleum from Shriram Food and Fertilizers in Delhi and chlorine leakage at Bhadrachalam Paper Mills in Bhadrachalam. The actions and responsibilities of industrial guidelines are outlined along with those for the Central State and local government. UNIDO's possible role is described including involvement in classifying the processing of hazardous materials, offering guidelines on zoning and siting of plants and organizing training facilities to develop skills for the operational management of industrial installations. (Dave, J.M.; (1989), 309-314 [in English]. 1-85148-027-7)

2668 STRATEGIES FOR MAJOR ACCIDENT PREVENTION IN CHEMICAL INDUSTRY: THE CASE OF THAILAND [BIB-TINF00719]

The present status and profile of accident prevention in Thailand are detailed. The recommendations and proposed actions formulating strategies for prevention of major accidents in the chemical industry are described. These include establishment of a major hazard assessment system, accident prevention information system, disposal of dangerous substances, training of personnel and a public awareness campaign. Additional references: waste disposal; hazardous materials (Phantumvanit, D.; (1989), 315-324 [in English]. 1-85148-027-7)

2669 ENVIRONMENTAL CONTROL MEASURES FOR TOXIC AND HAZARDOUS WASTES OF EASTERN SEABOARD INDUSTRIAL COMPLEX IN THAILAND [BIB-TINF00720]

The measures taken for environmental pollution control and management of hazardous and toxic industrial wastes at the gas-fired Map Ta Phut heavy industrial complex are discussed. Washwater treatment plant for fertilizer, a petrochemicals plant and a tantalum plant of the complex are detailed. The management plan for handling hazardous industrial solid wastes includes disposal of wastes using sanitary landfills and special "gypsum pond" to store solid waste of phosphogypsum from the fertilizer plant. A future plan to open a polymer plant would mean that the Map Ta Phut complex should have two separate zones, one for organic and the other for inorganic industries in order to achieve effective management of waste water. Waste disposal (Chakrabarty, R.N.; (1989), 325-342 [in English]. 1-85148-027-7)

ing probabilities and hence inclination to take risks, is to have sufficient information. Any consideration of environmental problems and risk allocation from an economic perspective seems to suggest that the majority of the population supports the environmental protection policy and is willing to pay for it. It appears impossible to reach stable solutions in the allocation of risks without an incentive compatibility. (Abele, H.; (1989), 130-139 [in English]. 1-85148-027-7)

2651 COSTS AND BENEFITS OF RECYCLING [BIB-TINF00702]

The incentive to recycle secondary sources varies with the price of corresponding virgin resources and the strong urge recycle where prices are high. The introduction of recycling operation is affected by the diversified interests between the public and private sectors in free-enterprise societies and the extent to which these interests influence legislated policy which may promote or discourage such economic activity. The private decision to recycle is discussed in terms of main productive activity and in-plant management of residual wastes. The public decision for recycling would be more forthcoming when public benefits outweigh costs. (Maltezou, S.P.; (1989), 140-147 [in English]. 1-85148-027-7)

2652 COST-EFFECTIVE MANAGEMENT OF HAZARDOUS CHEMICALS [BIB-TINF00703]

A chemical management system SAFECHEM II for hazardous chemicals is developed as a cost-effective solution to the problem of obtaining the right chemical information in a timely manner. The system permits various analyses to be made and responds to questions about management of chemicals which include data directory, planning, and emergency reports, chemical reports, profile search and storage review. (Aadahl, J.; (1989), 148-152 [in English]. 1-85148-027-7)

2653 LEGISLATIVE MEASURES TO PREVENT AND RESPOND TO CHEMICAL ACCIDENTS [BIB-TINF00704]

An overview covers the general characteristics of the new legislations for assessment of risks from hazardous chemicals. Both the preventive and responsive regulatory approaches are described with suggestions of guidelines for legislations in the developing nations for their own benefit. The provision for the 1982 "SEVESO" Directive of the Council of the EC countries are detailed along with an example of implementation and proposed improvements in Germany. The work of UNIDO in promoting international initiatives to prevent chemical accidents and to respond to the treatment of hazardous materials is highlighted. (Irwin, W.A.; (1989), 153-174 [in English]. 1-85148-027-7)

2654 EFFECTS OF CHANGING REGULATIONS ON HAZARDOUS WASTES FLOW IN OHIO [BIB-TINF00705]

A study of industrial wastes generation in Ohio shows that 24% of the annual waste of 4M tons is shipped by the generator to commercial facilities for treatment and disposal, while the rest is treated by on-site management. The hazardous waste flow from industries indicates three types of disposition of the wastes, which include commercial management off-site both within and outside Ohio and management on-site. The net generation of hazardous wastes is affected by the economic growth within specific industries and the possibilities for waste reduction. The changes in the available capacity for waste management are influenced by the closure of existing waste management facilities, opening of new facilities and the regulatory changes in the management of wastes. Such changes along with the management of combustible wastes and spent solvents from the plastics industry are discussed. The need for analytical tool to predict the degree and location of changing the facility requirements is emphasized for forecasting the effects of regulatory changes on hazardous waste management. (Clapham, W.B.; (1989), 175-187 [in English]. 1-85148-027-7)

2655 HEALTH IMPLICATIONS OF HAZARDOUS WASTES DISPOSAL [BIB-TINF00706]

The health of people living in the vicinity of hazardous waste disposal sites require regular monitoring to correlate with detailed analysis of chemicals present at and escaping from the site, exploration of the transport routes of the chemicals, concentration in the environment and estimates of the uptake and absorption by the exposed population. The target organs which can be affected by the chemicals, and epidemiological studies for assessment of health associated with hazardous wastes are described. (Murti, C.R.K.; (1989), 188-199 [in English]. 1-85148-027-7)

2656 RISK MANAGEMENT IN NETHERLANDS: A QUANTITATIVE APPROACH [BIB-TINF00707]

The risk management strategy within an effective framework of environmental policy approved by the Dutch Parliament in 1985 is discussed. It deals with scientific uncertainty regarding essential toxicologyical and ecological relations in setting its quantitative environmental targets and allowing true public involvement. The process of risk management is described in terms of external safety policy, which involves sequential steps of risk identification and quantification, decisions about acceptability of risks, measures to reduce risk and control of risk by maintaining a situation of acceptable risk. Applications of risk strategy via analysis of risk criteria are outlined for liquified petroleum gas policy, natural gas pipelines, plastics industry and sites of Dutch State mines. (Kuijen, C.J.; (1989), 200-212 [in English]. 1-85148-027-7)

2657 RISK ASSESSMENT: DANISH PRACTICE AND EXPERIENCE [BIB-TINF00708]

The basic objective of Danish practice on risk assessment involves obligation of industries with certain levels of risk to provide document of their safety precautions to the governing authorities who would not interfere once a permit is approved. The concept of a common risk analysis is outlined which has not yet been widely followed by the industries for eventual risk assessment by the authorities. It is considered important to introduce a legislation framework giving higher priority to major rather than normal risk contributors. The implementation of risk analysis in several cases has demonstrated greater reliability of the system and thereby resulting in further improvement in industrial economy. (Vestergaard, N.K.; (1989), 213-217 [in English]. 1-85148-027-7)

2658 MODELLING OF UNCERTAINTY IN HAZARD ASSESSMENT [BIB-TINF00709]

Any dealing with uncertainty in hazard assessment can be optimized by considering Bayesian probability of correlating randomness and vagueness with indeterminacy. Risk analysis derived from assigned probabilities becomes credible only if it reflects expert consensus. The importance of risk analysis as a profession is emphasized along with an outline of standards for risk assessment (Lind, N.C.; (1989), 218-227 [in English]. 1-85148-027-7)

2659 FAULT TREE ANALYSIS AND ITS APPLICATION TO AN EXOTHERMAL REACTION [BIB-TINF00710]

The methodology of fault tree analysis is described, which establishes local connections between an undesired event in a technical system or component and operating failures resulting from it. Application of the analysis for the self-accelerating nitration process ("explosion") in a nitrator during the treatment of hexamine with nitric acid for the production of hexogen is detailed. Based on the failure rates of technical components and the probabilities of human failure, the annual rates of "explosion" in the nitrator for different initiating events are estimated by evaluating fault tree analysis using a computer programmes, which generates minimal cut sets via stimulation. An examination of the contribution of initiating events to the total estimated rates of "explosion" has indicated the areas of failure which on modification shows an improvement in performance by an order of magnitude. (Hauptmanns, U; (1989), 228-241 [in English]. 1-85148-027-7)

2660 COMPUTER-BASED INFORMATION AND DECISION SUPPORT SYSTEMS FOR MANAGEMENT OF HAZARDOUS SUBSTANCES AND INDUSTRIAL RISK [BIB-TINF00711]

The design and development of an integrated set of software tools are described along with the building of existing models and computer-assisted procedures for the management of industrial risk on the production and use of hazardous substances. Applications of the decision-oriented software for the management of substances are illustrated in terms of data bases (including geographical data, chemical database, and storage facilities, industrial production sites and waste streams database and chemicals process technology database) and simulation/optimization models (including process plant risk analysis and industrial process simulation). (Fedra, K.; (1989), 242-257 [in English]. 1-85148-027-7)

2640 REVIEW OF HAZARDOUS WASTE MANAGEMENT SYSTEMS AS APPLIED BY THE GOVERNMENT AND PRIVATE SECTORS [BIB-TINF00691]

A review covers the ecological and legal aspects of generating and handling hazardous wastes. The waste management technology is described in terms of low- and non-waste technologies applied to chemical and metal finishing industries, and the disposal technology of conversion of hazardous wastes into less- or non-hazardous materials by physicochemical pretreatment and incineration followed by modern landfill practice. The economics of waste management is highlighted which depends on the amount of wastes to be handled and the method of disposal. (Sutter, Hans; (1989), 3-23 [in English]. 1-85148-027-7)

2641 THE BAVARIAN SYSTEM FOR SPECIAL WASTE MANAGEMENT [BIB-TINF00692]

The disposal organizations and the collection-treatment stations for regulating safe disposal of hazardous wastes in the Federal Republic of Germany (FRG) first enacted by the Bavarian State, are detailed to include central treatment facilities of incineration, chemo-physical treatment and landfilling operations. Advanced techniques of treating highly contaminated leachate are adopted to reduce heavy metals content via precipitation and alteration of PH values. The control of hazardous wastes in FRG includes a "trip-ticket system", which involves a central task in each disposal system to ensure that the waste is directed along the right disposal route via transporter from the waste generator to a disposal facility for proper treatment. (Defregger, Franz; (1989), 24-34 [in English]. 1-85148-027-7)

2642 INCINERATION OF TOXIC AND HAZARDOUS WASTES [BIB-TINF00693]

An overview on different thermal oxidation systems for incineration of hazardous waste materials include rotary kilns, pyrolitic or "starved air" systems, multi-hearth furnaces, liquid injection systems and fluid bed combustors. The energy operating cost including that of plant installation can be reduced by introducing waste heat recovery systems using waste heat boilers, air preheaters or condensing heat exchangers. Both the type and method of handling of gaseous particulate and ash discharges from the incinerators are highlighted. (Brady;, J.D.; (1989), 35-46 [in English]. 1-85148-027-7)

2643 INCINERATION PROCESSES FOR THE DISPOSAL OF DIFFICULT HAZARDOUS WASTES [BIB-TINF00694]

An understanding of the characteristics of waste streams in terms of chemicals make-up or heat-content is essential for ensuring proper selection and design of an incineration system. The designing parameters of an incinerator include the incineration temperature, residence of time, amount of excess air needed and the type of vortex burner required. Information on the mixing aspects of an incinerator and the type of waste materials would also be required for satisfactory disposal of wastes. Chlorineated waste incinerator with facilities for steam generation and recovery of hydrochloric acid is described along with the details of a submerged combustion incinerator dealing with difficult wastes of fluorineated hydrocarbons or aqueous wastes containg inorganic salts and/or heavy metals. (Whiting, K.J.; (1989), 47-63 [in English]. 1-85148-027-7)

2644 HAZARDOUS SOLID WASTE DISPOSAL IN THE GEOLOGICAL ENVIRONMENT [BIB-TINF00695]

Waste products, especially toxic leachates, must be safely contained within the boundaries of the landfill site ensuring no further contact with the enclosing geological environment. The waste disposal sites are appraised in terms of geological, hydrogeological and geotechnical aspects of environment. Information on geomorphological, geological/lithological and hydrological features would be essential for an assessment of the geology-related suitability of waste disposal sites. (Egger, A.J.; (1989), 64-78 [in English]. 1-85148-027-7)

2645 THE MONITORING OF HAZARDOUS WASTE REPOSITORIES AND THE PREDICTION OF CONTAMINANT DISTRIBUTION [BIB-TINF00696]

The monitoring of hazardous waste repositories is described for both the repository operation and post sealing period. Monitoring in the operational stage should include determination of the limits of exposure of operating personnel, monitoring of effluents, environment and hydrogeological parameters, ground stability and rock mechanics parameters. The post-operational monitoring is discussed in terms of site conditions, public safety of closed down repository, the use of mathematical models such as ground water 3-D models, models on solute transport and migration, and interpretation of geological, meteorological and hydrological events. Reports on studies of physical and geochemical controls on migration, sorption and mobility of contaminants are highlighted. (Meyer, J.H.; (1989), 79-89 [in English]. 1-85148-027-7)

2646 DECHLORINATION OF PCBS, DIOXINES AND DIFURANES IN ORGANIC LIQUIDS [BIB-TINF00697]

A dechlorination system for organic liquids of PCB, PCDD, and PCDF as product lines is described in terms of catalytic hydrogenation of a recycling process of the chloroff method where the pretreated feed is dechlorinated and partially hydrogenated by a trickle phase mechanism in a high pressure reactor at 50-60 bar and 250-300 °C . An economic evaluation of the chloroff technique is highlighted along with the results of efficient conversion by the technique, which includes treatments of gasoil contaminated with chlorobenzene and PCB, lube oil contaminated with PCDD and PCDF, percolation oil from landfill deposit site and waste stream from pesticides production site. (Oosterkamp, P.F.; (1989), 90-103 [in English]. 1-85148-027-7)

2647 TREATMENT AND RECYCLING OF WASTE OILS AND SOLVENTS [BIB-TINF00698]

A catalytic dehydrogenation (hydroprocessing) process is developed to decontaminate and recover valuable hydrocarbons and chemicals of the waste oils. The process can be operated in a treatment plant with a typical capacity of 40 m 3/d at 65-454 °C under 14-70 bar pressure. The hydrogenated organic phase is suitable for re-use as a fuel oil. The advantages of the process include improved environment and safety, flexibility of treating hazardous materials in a cost-effective manner and re-use of a range of products. A pilot plant operation using contaminated oil is detailed, which shows reduction of PCB from 270 ppm to undetectable level, and the lead amount from 750 to 5.5 ppm. Desulphurization was achieved about 73% with an overall estimated ash reduction of more than 90%. (Youtsey;, K.J.; (1989), 104-113 [in English]. 1-85148-027-7)

2648 ELEMENTS OF A BALANCED APPROACH TOWARDS HAZARDOUS WASTE MANAGEMENT [BIB-TINF00699]

The various hazardous waste management alternatives other than the landfill practice would generate non-hazardous, less toxic or less leachable residue (ash or sludge), and include destruction via incineration, biodegradation and treatment, recovery and re-use of water, chemicals detoxification, adoption of low-waste generation technology and above-ground long-term storage. New effective technologies are highlighted as source control and migration control to address the environmental problems associated with the past landfilling practices. (Metry, A.A.; (1989), 117-119 [in English]. 1-85148-027-7)

2649 IS PREVENTION OF POLLUTION MORE ECONOMICAL? THE DUTCH SITUATION. [BIB-TINF00700]

The prevention of pollution is an attractive option for both environmental health and the economy. The development and application of clean technology ought to concentrate on preventing the generation of waste products. Environmental pollution from the industries mainly the chemicals and metals sectors in the Netherlands is discussed. The main features of a preventative approach should include in-process recycling of waste products, improvement in plant operations, replacement of raw materials with less harmful ones and redesigning of reformulation of end products. The relation between the characteristics of the Dutch industrial processes and the environmental pollution is outlined along with the opportunities available for prevention of generating hazardous waste. (Langeweg, F; (1989), 120-129 [in English]. 1-85148-027-7)

2650 RISK TAKING AND ENVIRONMENTAL ISSUES: A SURVEY OF ISSUES AND PROBLEMS FROM AN ECONOMIC PERSPECTIVE [BIB-TINF00701]

An overview on the state of the art in the analytical handling of risk management of environmental hazards is presented in terms of utility model to explain and describe decisions in uncertain environments. An essential ingredient for assess-

* Source: *Hazardous Waste Management, Selected papers from an International Expert Workshop convened by UNIDO in Vienna, 22-26 June 1987*, Tycooly, London

while returning almost all (95%) of the acid to the scale-removal units. According to firms supplying so-called spray roaster regeneration plants—the most popular variety in North America—gaseous and liquid effluents from the process are virtually acid-free and conform to the most stringent air- and water-quality standards. (Hess, G.W.; 9, (3), 18-21 [in English]. ISSN 0897-4365)

2633 THE ALUMINIUM INDUSTRY: ITS FUTURE UNDER THE ENVIRONMENTAL PROTECTION ACT. [BIB-199306-G4-0041]

The Environmental Protection Act, placed on the UK's books in April 1990, marks a significant beginning in changing the way in which industry is required to meet its responsibilities to the environment. Despite some initial discomfort in the increased public scrutiny, aluminum industry operators will examine their waste disposal and environmental management systems from an environmental viewpoint, then find ways of improving their operations to reduce waste and increase revenue. 'Pollution prevention pays,' could become more than a hackneyed phrase. (Jones, P.; (1011), 17-21 [in English]. ISSN 0955-2847)

2634 NEW WASTE TREATMENT TECHNOLOGY USES HOUSEHOLD BLEACH TO TREAT URANIUM. [BIB-199306-G4-0047]

Household bleach is the key ingredient in a new chemical process developed at Los Alamos National Laboratory, Los Alamos, New Mexico, USA to eliminate the potential fire hazard associated with long-term storage of uranium waste. The process converts depleted U into uranium oxide, a chemically stable powder, and traps it in concrete so that it cannot leach into the environment. (Banegas, D.; Publisher: LOS ALAMOS NATIONAL LABORATORY, Los Alamos, New Mexico 87545, (29 MARCH 1993), Pp 3 [in English].)

2635 NESTE STUDIES INCINERATION OF MIXED PLASTICS AND COAL. [BIB-199306-P1-0113]

As pressure to recycle postconsumer plastics mounts, Finland's Neste (Espoo) plans to carry out a year-long trial at its Porvoo site to study the incineration of mixed plastics and coal. The company, along with Outokumpu EcoEnergy and the Finnish Plastics Industries Federation, completed short tests last year using a 7-megawatt, fluidized-bed, low-pressure steam boiler at Porvoo. These tests concluded that for specific inorganic and organic substances, emissions were lower using mixed household plastics as a fuel than when using coal. Neste says that a fluidized-bed plant with efficient dust and carbon monoxide control meets the most stringent foreseeable regulations for polychlorinated dibenzodioxins and dibenzofurans (PCDDs and PCDFs). (Chynoweth, E.; 152, (17), 15 [in English]. ISSN 0009-272X)

2636 GERMANY'S WASTE POLICY DRAWS MORE COMPLAINTS. [BIB-199306-P1-0124]

The UK government, backed by France, Spain, and a number of other European Community (EC) members, has submitted a complaint to the European Commission regarding shipments of packaging wastes from Germany. Well-funded German wastes collectors are able to pay recycling firms up to $350.00/mt to take wastes or offer refuse at zero cost, depending on quality. According to the UK's Department of Trade and Industry, plastics wastes imports to the UK increased 450% between 1991 and 1992—most of the hike was in German shipments. Such increases, the DTI says, prevent the development of domestic waste recycling efforts in the UK. Other countries supporting the UK position include Denmark, the Netherlands, Italy, Ireland, and Luxembourg. (Chynoweth, E.; 152, (18), 24 [in English]. ISSN 0009-272X)

2637 DUALES SYSTEM FACES NEW ATTACKS. [BIB-199306-P1-0126]

The German organisation for collecting waste packaging, Duales System Deutschland is facing a new wave of criticism from a range of sources. The organisation is being investigated by the Federal Cartel Office, the Bundeskartellamt, to see whether it is entitled to collect commercial transport packaging in addition to consumer packaging which bears the green dot. It was awarded a monopoly to collect commercial packaging by the federal ministry for the environment at the request of the states which feared that such material would not be collected. However, this commercial packaging monopoly has been criticised by utility companies, such as VEW and RWE, which have recently moved into waste disposal and recycling. The two companies have indicated that they see this as an interesting area of business that they are being prevented from entering by law. ((187), 35-36 [in English].)

2638 EPA, USX INK FAIRLESS PACT: CLEANUP STUDY IS PLANNED. [BIB-199306-S4-0055]

The US Environmental Protection Agency and USX, Pittsburgh, Pennsylvania, USA, have signed an administrative consent order that requires USX to study and evaluate measures to clean up hazardous waste contamination of ground water, soil, surface water, and sediments at its Fairless Hills, Pennsylvania, facility and adjoining properties. During steelmaking operations, slags, air-scrubber wastes, and sludge from waste water treatment facilities were dumped in unlined pits. (Selland, K.J.; 101, (85), 8 [in English]. ISSN 0002-9998)

2639 MCLOUTH STEEL GETS $8.5M CASH INFUSION IN SURPLUS LAND SALE. [BIB-199306-S9-0292]

A long-sought deal between McLouth Steel, Trenton, Michigan, USA, and Waste Management, Oak Brook, Illinois, will give the financially ailing steelmaker approx $8.5M. McLouth sold the disposal company surplus land in Gibraltar, Michigan, USA, for use as a landfill. (Wrigley, A.; 101, (87), 12 [in English]. ISSN 0002-9998)

commodities be diverted for recycling. Incinerator operators would have to prove that materials to be burned could not be recycled practically, reused or reduced at the source, and that incinerators will not affect human health or the environment. The bill has been referred to the House Energy and Commerce Committee. (4, (50), 4 [in English]. ISSN 1042-802X)

2623 MEDICLEAN GRANULATOR DECONTAMINATES WASTE. [BIB-199303-P3-0097]

A new sister company to John Brown Inc. Plastics Recycling Systems has developed equipment to decontaminate infectious medical waste, allowing for cheaper disposal. Mediclean Technology Inc., of West Warwick, Rhode Island, USA, developed the equipment using granulator technology from Cumberland Engineering, headquartered in Providence, Rhode Island. Mediclean Technology built a prototype machine that has been tested at a Rhode Island hospital. The equipment grinds medical waste, including plastics, glass, tubing, sharps and paper, and douses and decontaminates the waste with chlorine dioxide. The waste then can be disposed of safely in a landfill and reportedly is unrecognizable as medical waste. John Brown, Mediclean Technology and Cumberland Engineering are units of Trafalgar House plc. (4, (50), 14 [in English]. ISSN 1042-802X)

2624 NEW PENNSYLVANIA WASTE RULES GET TWO THUMBS DOWN. [BIB-199303-S4-0023]

Two Pennsylvania, USA, metals recycling companies are displeased with the state's new hazardous-waste recycling regulations and believe the rules will drive up the cost of recycling industrial waste. Inmetco, an Inco subsidiary based in Ellwood City, Pennsylvania, USA, points to the fees for environmental consultants and legal advice as major factors in escalating costs. Horsehead Resource Development, which reclaims Zn and other metals from EAF dust, has scrapped plans to rebuild one of the oldest kilns at its Palmerton, Pennsylvania, facility and shifted that processing capacity to its plant in Calumet City, Illinois. The so-called PK-4 regulations, scheduled to take effect 16 February 1993, tighten requirements for hazardous-waste recycling and reclamation and sharply increase industry fees for hazardous-waste permits. The permit application fee for a commercial hazardous-waste landfill, will rise from $3500 to $125 000. (Marley, M.; 101, (19), 9 [in English]. ISSN 0002-9998)

2625 EXCESSIVE US ENVIRONMENTAL REGS SEEN HINDERING METALS' GROWTH. [BIB-199304-G4-0020]

Excessive US environmental regulations are stifling the growth of the metals industry and new international restrictions being considered could damage world trade. Excessive, expensive, and changing environmental regulations are affecting new Cu-smelters, existing ones, and the recycling of Cu. Special permits are needed for the movement of hazardous materials, treatment of waste water, and removal of particulates from the atmosphere, with licensing taking up to five years. (Goodwin, M.E.; 101, (35), 9 [in English]. ISSN 0002-9998)

2626 US ZINC EXECS WARNED ABOUT TOUGHER EPA—CLINTON AGENCY TO HAVE DIFFERENT STAND. [BIB-199304-G4-0026]

The Zn industry is likely to be placed in a more defensive position in its dealings with the US Environmental Protection Agency under the Clinton administration than it has been under past governments. Negative effects are anticipated from the reauthorization of major environmental laws scheduled to come before the 103rd Congress, including the Resource Conservation and Recovery Act under which a bill attempting to restrict interstate transport of waste is likely. (O'Sullivan, O.; 101, (37), 6 [in English]. ISSN 0002-9998)

2627 VDM WARNS AGAINST EXCESSIVE GOVERNMENT INTERVENTION IN SECONDARY METALS. (VDM WARNT VOR BUROKRATISCHER BEWIRTSCHAFTUNG VON ALTMETALLEN.) [BIB-199304-G8-0330]

Verein deutscher Metallhandler, Bonn, Germany, fears that the national and international waste laws for the European Community will produce fundamental structural changes in secondary metal trade that will hinder economic development in Germany and in the EC. Under the proposed laws, members of the EC countries will be forbidden to export secondary metal scrap to developing countries, and transport of secondary metal across borders of member states will involve time consuming bureaucratic processes. VdM feels that the current agreement of the Organization for Economic Cooperation and Development, signed by 50 states at the Basel Convention of 22 March 1989, and ratified on 19 May 1992, is a practicable policy for handling metal scrap. The current policies of categorizing metal-and metal-alloy wastes in metallic nondispersible form are reviewed and discussed in relation to the proposed changes. The handling of battery scrap, Al clipping, and zinc wastes are discussed in detail. (46, (12), 1264-1266, 1269 [in German]. ISSN 0026-0746)

2628 ALTERNATIVES TO INCINERATION BECKON IN SWITZERLAND. [BIB-199304-P1-0075]

The problem with post consumer plastics waste in Switzerland is that it burns too well, according to the Swiss Foundation for Plastics Reintegration. Why? Because plastics have a much higher calorific content than other forms of municipal solid waste, most of which is incinerated in Switzerland; and because they make up the largest fraction by weight (18%) as well as by volume in the incinerators. Searching for solutions, the foundation is investigating use of alternative energy-recycling technologies to incineration, such as pyrolysis, fluidized beds, and cement kilns. It is also broadening material recycling schemes devoted to high-purity streams such as polyethylene pallet wrap and polyethylene terephtalate bottles. (3 [in English]. ISSN 1044-9663)

2629 AUSTRIANS WRAP UP TIGHT PACKAGING WASTE LAW: PLASTICS TO BE CUT 80%. [BIB-199304-P1-0079]

The Austrian government has enacted laws that cut the current volume of plastics packaging waste that is landfilled and burned by almost 80% by 2000, a move that will force the country to drastically expand its recycling capacity. The Vienna-based Austrian Initiative for Valuable Plastic says that in 1991, 22 000 mt of plastics packaging waste were mechanically recycled in Austria and 220 000 mt were sent to landfills or incinerated. The statutes slash that level to 160 000 mt in 1994, to 103 000 mt in 1997, and to 47 000 mt at the century mark. The rest will have to be either chemically, mechanically or thermally recycled. Plastics packaging will have to be marked by material type after 1 October. Commodity thermoplastics—HDPE, LDPE, PET, PP, PS and PVC—will be stamped accordingly; all others, including composites, will receive an 'O'. (3 [in English]. ISSN 1044-9663)

2630 HIGH PERFORMANCE MATERIAL FOR CONTAINING NEUTRONS. [BIB-199304-P5-0031]

Nichias Corporation, Japan, with cooperation from Mitsubishi Heavy Industries Ltd, has developed a high performance neutron confining material for use in storing and transporting used nuclear fuel. It is intended to be used together with other materials that shut out other types of radiation. This material consists mainly of an epoxy resin which contains a high concentration of hydrogen atoms. It is formed by mixing bisphenol resin and polyamide resin liquids to which are added special fillers and boron hydrides. There is said to be virtually no loss in H atoms after one year. Moreover, heat resistance is three degrees higher than concrete-based neutron confining materials, with a maximum usable temperature of 180 °C . Also, high fluidity makes it easy to form complex shapes and fill narrow crevices. (7, (6), 10 [in English].)

2631 KAISER SUED FOR SITE CLEANUP—CALIFORNIA STEEL SEEKS $55 MILLION TO RIGHT FONTANA. [BIB-199304-S4-0031]

California Steel Industries, Sacramento, California, USA, filed a $55M claim against the estate of Kaiser Steel and its reorganized successor, Kaiser Steel Resources, for cleanup costs of a site formerly belonging to Kaiser. California Steel Industries is seeking to claim costs for the cleanup of the site of the former Kaiser mill in Fontana, California, now belonging to California Steel Industries. Kaiser operated the mill from 1943-1983. Kaiser maintains that its bankruptcy filing absolved the company of any responsibility for cleanup costs. (101, (36), 3 [in English]. ISSN 0002-9998)

2632 GETTING OUT OF A PICKLISH SITUATION. COLD-ROLLED STRIP OPERATORS FIND A CLEAN AND PROFITABLE SOLUTION TO THE DIRTY BUSINESS OF HANDLING SPENT PICKLING LIQUOR. [BIB-199304-S4-0036]

By treating used hydrochloric acid solutions from cold-rolled strip cleaning lines via sophisticated chemical processes to separate the HCl from diluting water and entrained iron oxides, operators can sell recovered oxides on the open market

2613 DIRECTING WASTE POLICY FROM BOARDROOM LEVEL. [BIB-199301-P4-0005]

Wavin, one of the world's largest producers of plastic pipe systems, has always used the best material, boasting that products made by the company would last—products even carried a long life guarantee. But it was this very claim that started to concern enlightened customers, the environmental lobby and the public —how long would the various materials last, especially if they were buried in land tips following the end of their useful life What damage would they do to the environment In 1988 Wavin began a searching appraisal of its environmental stance as well as examining its own responsibilities for its processes and the products they made. A look at how Wavin moved to fulfill its environmental responsibilities is presented. ((1463), 7 [in English]. ISSN 0032-1168)

2614 MODERN ALCHEMY RECOVERS METALS. [BIB-199302-G1-0042]

EA Technology, UK, is carrying out trials on the reclamation of metals from hazardous organic and toxic wastes using a fluidised test bed process called Modern Alchemy. The process was developed by KC Process was developed of Lichfield, UK. Applications such as recovering Ni from fat, Au from grease, and Pt from whale oil have all have been tested on the new facility, which aims to recover fine metal particles from a wide range of industrial processes. (73, (12), 21 [in English]. ISSN 0370-1859)

2615 INCINERATOR RECLAIMS METALS FROM HAZARDOUS WASTE. [BIB-199302-G4-0012]

EA Technology, UK, will begin testing a waste-treatment pilot plant, designed by KC Process, which will extract marketable Metals from hazardous wastes in December 1992. The Capenhurst, Chester, UK, facility will incinerate waste at 1200 °C using a fluidized bed of ceramic balls. Possible applications include processing of spent catalysts and extraction of Ni from fat left over from the production of margarine. (Wyman, V.; 275, (7124), 42 [in English]. ISSN 0013-7758)

2616 PROCESS RECOVERS REUSABLE MERCURY. [BIB-199302-G5-0016]

Japanese scientists have developed a wet system for recovery of mercury from dry cells and fluorescent lamps in municipal solid waste. In this process, mercuric chloride is extracted by washing exhaust gas with sodium hydroxide, after which stannous chloride is added, forming metallic Hg. Next, water is added, then cooled and condensed to separate water and metallic Hg. Besides recovery of reusable Hg, the proces can protect the environment and recycle harmful materials. Mercury contained in municipal solid waste incinerator combustion gas is inorganic, which has low toxicity, but inorganic Hg can be converted into organic Hg in the environment. Scientists in Japan also have developed a dry recovery system that presently is being tested in a pilot plant. This system employs a bag filter to remove Hg particles and compounds before the Hg absorbed with a carbon-based material. Recovery of nearly 100% of mercury will be possible by combining both systems in the municipal solid waste incinerator waste gas treatment process. (101, (2), 7 [in English]. ISSN 0002-9998)

2617 EPA NAMES LEAD AND CALCIUM SUBSTITUTES. [BIB-199302-C4-0001]

The US Environmental Protection Agency (EPA) announces a report that identifies Pb- and Cd-containing products that are disposed of in municipal solid waste and provides information regarding potential substitutes for the Pb- and/or Ca-containing components of these products. EPA will use the document to further voluntary efforts to reduce toxics in municipal solid waste. The analysis of substitutes does not, however, quantitatively assess economic factors that affect substitution or the effect of potential substitutes on end products. Report No. PB-92-162-551, "Preliminary Use and Substitutes Analysis for Lead and Cadmium in Products in Municipal Solid Waste", can be ordered from the National Technical Information Service, Springfield, Virginia. (72, (1), 49 [in English]. ISSN 0002-7812)

2618 EPA TO REGULATE STYRENE IN SOLID WASTE. [BIB-199302-D4-0002]

The US Environmental Protection Agency recently withdrew its proposed modifications to the Resource Conservation and Recovery Act (RCRA) Hazardous Waste Identification Rule (HWIR), citing criticism from environmental groups and states. The proposed changes to the HWIR would have meant that certain styrene-containing waste would have been classified as hazardous. The agency reported that the modifications will be re-issued within 12-24 months, and it is likely that styrene will still be regulated under any new proposal. Under the recently-withdrawn HWIR proposal, materials showing 10 mg/l of styrene in the TCLP solution were to be classified as toxic under RCRA, and would be handled and disposed of as hazardous waste. Preliminary testing has indicated that while fully-cured composites will not be classified as toxic, partially cured materials may leach more than the minimum amount of styrene. (Schweitzer, J.; 9 [in English].)

2619 US STATE LEGISLATURES MAY HOST BEVY OF ENVIRONMENTAL BILLS. [BIB-199302-P4-0010]

Solid waste legislation that could affect plaastics is expected to be introduced in at least 30 US states in 1993. The spotlight will be on bills aimed at increasing the demand for recycled materials. In 1992, lawmakers considered 500 bills affecting plastics, and approved 90. US industry representatives said they consider the passed laws to be realistic. States expected to be most active on solid waste legislation in 1993 include California, Florida, Maryland, Minnesota, New York, North Carolina, Oregon, Vermont, Washington and Wisconsin. (Gardner, J.; 4, (46), 11 [in English]. ISSN 1042-802X)

2620 EFFLUENT TREATMENT SYSTEM FOR ALCAN. [BIB-199303-G4-0016]

When Alcan was faced with the problem of treating effluent at its Al sheeting and semi-finished product manufacturing plant in Germany, Keramchemie (KCH) was called in to design, build and install an effluent treatment system, capable of handling a variety of harmful substances at fluctuating concentrations. The plant is operational 24 h/day, seven days/week and during the surface treatment of product, generates approx 40 m^3 of effluent/h. KCH designed a bespoke effluent treatment system with an operating and reserve capacity of 60 m^3/h. The effluent typically contains a variety of substances, including an assortment of Al compound, acid and tensides. The system initially neutralises the effluent with a lime suspension and then conveys it to a flocculation unit. From this tank, effluent flows into the KCH counter-clarifier, where the best possible separation of removable substances from water takes place. Clear water flows into the final inspection tank prior to expulsion to the sewerage system. Deposited sludge is conveyed to storage tanks for thickening and then to a filter-press where the sludge is further dewatered to create a disposable filtercake which can then be sent to landfill. (16, (11), 26 [in English]. ISSN 0309-3109)

2621 EPA INITIATES EFFORTS ON METALS RECOVERY, SOLID WASTE. [BIB-199303-G4-0018]

EPA has initiated several efforts aimed at developing a regulatory regime that encourages recycling/recovery of industrial materials, including Ni-containing wastes. In response to a legislative mandate, EPA is undertaking a study of the metals recovery industry. The study will examine the effect of existing regulations on efforts to recover metals from the nation's wastes, as well as how the materials should be regulated in order to protect human health and the environment and to effectuate the resource conservation and recovery goals of the Resource Conservation and Recovery Act. The study is due to be completed in April 1993. In addition, EPA staff are gathering information to lay the groundwork for recommendations to establish an appropriate definition of solid waste and possibly to develop a separate regime for regulating industrial recycling of hazardous materials, including Ni-bearing materials. Agency staff will be collecting information from interested parties through early 1993, with an emphasis on the cost impacts of overregulation. Then, presuming the Clinton Administration supports these efforts, EPA this spring will convene a meeting of interested parties and attempt to draft recommendations for implementing regulations. ((10), 7 [in English]. ISSN 1181-7208)

2622 HOUSE BILL WOULD BAN INCINERATOR BUILDING. [BIB-199303-P1-0054]

A US House of Representatives bill seeks to ban the construction of solid waste incinerators until 2000, and then would require towns sending waste to incinerators to divert for recycling 50% of plastics waste under a bill introduced in the House. The bill, sponsored by Rep. Edolphus Towns, D-New York, would amend the Solid Waste Disposal Act to require high percentages of six other

to accept boxes along with baled and briquetted scrap. (Marley, M.; 100, (166), 2, 8 [in English]. ISSN 0002-9998)

2603 PLASTICS RECYCLING INCHES AHEAD: EPA SEES 2.2% RATE. [BIB-199210-P1-0198]

The US plastics industry has poured tens of millions of dollars into polishing its environmental image. The payoff may be a long way off. The latest US Environmental Protection Agency (EPA) statistics show: plastics recycling is up only slightly, with bottle recycling making headway, plastics are an even larger part of the solid waste stream, more plastics are being consumed with plastics use forecast to grow through 2000. Plastics recycling increased to 2.2% in 1990, up from 1.9% in 1988, according to the EPA. Plastics is now 8.3 wt.% and 21.1 vol.% of the municipal solid waste stream (paper and paperboard were 32 vol.%), up from 8 and 19.9%, respectively, in 1988. (1, 5 [in English].)

2604 RECYCLING SYSTEM FOR LARGE-SIZED WASTE TO BE DEVELOPED. [BIB-199210-P1-0201]

Next fiscal year, the Ministry of International Trade and Industry, Tokyo, Japan, will begin developing a comprehensive recycling system which crushes large-sized waste such as home electrical appliances at low temperatures. MITI aims to begin making a prototype system in 1993, and practical application of the system is expected by fiscal 1995. The system will use the differences in the materials' embrittlement temperatures and low-temperature properties. For plastics, the system will separate polyolefins and vinyl chloride using the difference in embrittlement temperature. At the same time, the agency will promote research into the effective use of energy produced by the incineration of residues. (15 [in English]. ISSN 0265-3443)

2605 SOUTHERN COALITION SEEKS WASTE ANSWERS. [BIB-199210-P1-0206]

Sixteen US states and Puerto Rico have joined a new waste management coalition that will seek regional strategies for recycling, incineration and landfill garbage disposal. Among other goals, the Southern States Waste Management Coalition will try to build regional recycling markets to reduce the mounds of recyclable plastics and other materials building across the region, which stretches from Maryland to Texas and Missouri to Puerto Rico. The coalition also will seek to build cooperation among government, industry and public-interest groups when trying to solve regional waste-disposal problems. The group will be taking a cue from the Coalition of Northeastern Governors, which has been successful in working with industry and environmentalists in an effort to reduce packaging and toxic heavy metals in packaging. (Gardner, J.; 4, (28), 3 [in English]. ISSN 1042-802X)

2606 GLOBAL PVC FIRMS HOLD FIRST SUMMIT, ISSUE JOINT STATEMENT ON GREEN ISSUES. [BIB-199210-P4-0052]

Reflecting concern over the increasing number of attacks on the green merits of materials, representatives of the world vinyl industry held their first-ever multi-continental meeting in Washington, D.C., USA in September. The industry's first Tripartite Conference was organized to ascertain common interests and what to do about them. Some 50 firms were able to agree on a set of common environmental positions, including stances on recycling, incineration, and waste disposal. The companies represent members of the Japan PVC Assoc, the European Council of Vinyl Manufacturers and the Vinyl Institute, including members from both North and South America. Participants agreed on the need for ongoing information exchanges and to explore collaborative projects for the future. A second meeting has already been proposed, probably to be held in Europe in the spring of 1993. (7 [in English]. ISSN 1044-9663)

2607 MIXTURE AND DERIVED-FROM RULES TRY A COME-BACK. [BIB-199210-S4-0079]

The steel and recycling industries won a significant victory on the US Senate floor when they rebuffed attempts by environmental groups and the waste treatment and disposal industry to get lawmakers to reinstate two hazardous waste rules thrown out by a federal court earlier. The metals industry has criticized those rules as disincentives to recycling and has been working closely with the EPA to draft a new rule, called the hazardous waste identification rule. (Gannon, V.; 100, (180), 8 [in English]. ISSN 0002-9998)

2608 SCRAMBLE FOR EMISSION-FREE CAR TAKES NEW TWIST: CONCERN GROWS OVER NICKEL—CADMIUM CELL WASTE. [BIB-199212-G4-0075]

Nickel—cadmium batteries have the considerable advantage of extensive research and the fact that they are currently in wide use as small rechargeable batteries for household appliances and toys. But the environmental hazard and disposal problems posed by Cd are increasingly a factor in whether the batteries will be an acceptable option for carmakers in the future. Some US and European automakers are taking a serious look at a molten sodium—sulfur battery, which offers about the same acceleration time as Ni—Cd and has a shorter lifespan but gives a range of close to 160 miles. (Munford, C.; 100, (199), 4, 10 [in English]. ISSN 0002-9998)

2609 NEW PROCESS DEVELOPED FOR RECOVERING ALUMINUM. [BIB-199212-G5-0109]

A new method has been found to recover Al from dross while avoiding waste disposal problems posed by conventional processes. Invented by the BOC Group Technical Center, Murray Hill, New Jersey, USA, and patented in August 1992 the process uses a plasma furnace to recover Al and other salable products from the dross. A waste product generated by smelters, dross consists of approx 50% by weight of Al while the balance is mostly Al oxide. (100, (205), 9 [in English]. ISSN 0002-9998)

2610 ODOURLESS LAVATORY SYSTEM. [BIB-199212-D6-0273]

A simple lavatory system which burns human waste without odour by using advanced ceramics has been developed by Chiyoda Planning Co Ltd, Tokyo, Japan. Alumina reinforced with silicon nitride is used for the furnace wall as the refractory while a composite of magnesia, alumina, and activated carbon absorbs the smells. The system can treat the waste of approx 50 people/day and is intended for use in buses and trucks; it costs approx 1.2-1.3 million yen. (3 [in English]. ISSN 0268-9847)

2611 RECEPTACLES AND CONTAINERS FOR EVERY NEED. (BEHALTER UND CONTAINER FUR JEDEN BEDARFSFALL.) [BIB-199212-S3-0294]

Since an estimated 30% of production costs can generally be attributed to material flow, this constitutes a weak point in the logistics of plant operations and opens the door to innovative solutions of the problem. One of them is the need for more suitable or even tailor-made auxiliary installations or equipment that can help to improve storage, transfer and transport tasks in a plant, thus enhancing overall operating efficiency. Here, receptacles, containers, cassettes, barrels, boxes and similar storage and transport means play a key role. The market offers a huge choice in this respect. Described and illustrated are some novel concepts and products. An analysis is made with regard to their respective contribution, toward improved efficiency in plant operations. In addition to tailoring the items to the particular situation, such basic considerations as rolling vs. carrying, reducing transfer time, or modular construction of containers are discussed. Finally, the problems of receptacles for special scrap or toxic waste and their disposal are stressed. (Sterling, W. K.; 42, (7), 48-51 [in German]. ISSN 0343-3862)

2612 COPPER: A SAFE ALTERNATIVE FOR NUCLEAR WASTE DISPOSAL. [BIB-199301-G6-0019]

Following long term development work at Outokumpu Copper R&D, a feasibility study and construction of a Cu prototype canister for nuclear waste has been completed. Three alternative manufacturing routes for the canister are proposed, namely hot extrusion or hot rolling, bending and electron beam welding. The O_2-free Cu canisters are 4.5 m long, 80 cm in diameter and 50-60 mm thic. With the inner steel jacket (to provide mechanical support) and the fuel element, the structure will weigh approx 1400 kg. 1200 canisters will be needed for Finnish power stations to store accumulated waste to the year 2000. (29, (1), 26-27 [in English].)

as fuel. The booklet focuses on material recycling of plastics—the recovery and reprocessing of used plastics for use in new applications—but points out the realistic limit to this activity. The booklet, Plastics Recycling in Practice, forms part of an information package titled Plastics Recycling in Action . The package also includes a European Index of Key Plastics Recycling Schemes . (7 [in English]. ISSN 0264-7753)

2594 SOLID WASTE PROFESSIONALS PREDICT COMPOSTING WILL GROW FASTER THAN RECYCLING. [BIB-199208-P1-0161]

With recycling markets facing a dismal near-term future, source reduction and composting are gaining in popularity as solid waste management methods. A new survey by the Roper Organization, New York, New York, USA, shows 96% of solid waste professionals say composting will increase in the next five to ten years. Even more telling, 38% said composting would see the most growth of any method of handling solid waste. Another 37% cited recycling. Typically, plastics would be gleaned from the waste stream before composting. (6 [in English].)

2595 REFUSE HANDLING CONTAINERS: GLOBAL DEMAND TO SOAR. [BIB-199208-P6-0145]

As advanced methods for collecting trash are more widely adopted by the major industrialized nations, demand for polyethylene containers used in semi- or fully automated, recycle-friendly refuse-handling systems is expected to soar. The processors who stand to benefit from 12% annual global growth rates are molders of 40-90 gallon rollout carts, 300-400 gallon communal containers, 14-18 gallon recyclable bins, and commercial dumpster lids. About 15 rotational molders make 60% of carts used in the US, but they face a strong challenge from other types of molders. In Europe, solid growth continues, with automated systems being increasingly adopted in countries like Spain and the UK. (Leaversuch, R.D.; 69, (6), 107, 109 [in English]. ISSN 0026-8275)

2596 INDUSTRY GROUP REMAPS STAND ON SOLID WASTE. [BIB-199208-P7-0238]

A shift in the US plastics industry's response to its solid waste woes appear to have begun now that the chief executive officers of 27 corporations have joined forces to create the Partnership for Plastics Progress. A successor to SPI's defunct Council for Solid Waste Solutions, PPP includes 26 large, integrated resin suppliers companies as members. The 27th is giant national packager Procter & Gamble. The organization's new name, the involvment of company CEOs, and an expanded $50 million annual budget all suggest that the industry will change the ways in which it responds to its environmental critics. The new strategies vision is seen in PPP plans that include creation of an army of activists ready for instant mobilization to fight solid waste issue battles, as well as funding of a nationwide television advertising campaign to convince US citizens that plastics make positive contributions to protecting the environment. (Leaversuch, R.D.; 69, (7), 35 [in English]. ISSN 0026-8275)

2597 MITI EYES RECYCLING OF JUMBO WASTE. [BIB-199209-P1-0189]

Next fiscal year, Japan's Ministry of International Trade and Industry (MITI) will start developing a comprehensive recycling system that crushes bulky waste such as home electric appliances. MITI aims to start building a prototype system that will crush large-sized waste at low temperatures in 1993. Commercial application of the system is slated for fiscal year 1995. Waste will be cooled with liquefied natural gas and then crushed to separate and recover plastics, Cu, Fe and Al. In the case of plastics, the system will separate polyolefins and PVC using their respective differences in embrittlement temperature. At the same time, MITI will promote research into the effective utilization of energy produced by the incineration of residues. In Japan, approx 4.9 million mt/year of plastics waste are generated, of which only 27% is reused in some form. (4 [in English]. ISSN 1044-9663)

2598 LOBBYISTS GEAR UP FOR REVIEW OF SUPERFUND. [BIB-199209-P4-0043]

Plastics industry representatives in the US are preparing to make their mark on the next standing environmental law to face congressional overhaul, the 1980 act that created the Superfund toxic pollution cleanup program. Central to the plastics industry's efforts in the reauthorization of the Comprehensive Environmental Response, Compensation and Liability Act in 1993 will be changing the scheme for financing the cleanup of toxic waste pollution sites identified on a national priority list. Under the current law, the Environmental Protection Agency identifies one or several major contributors of waste at a Superfund site—called the "potentially responsible parties"—even though some never disposed of toxic waste there. Industry lobbyists argue that the existing system is heavyhanded because it can force processors who did not contribute to toxic waste disposal problems to pay for cleanup. (Gardner, J.; 4, (22), 3, 19 [in English]. ISSN 1042-802X)

2599 HAZARDOUS WASTE CAN HURT YOUR POCKET: FEDS GET TOUGH WITH PLASTICS FINISHER. [BIB-199211-P4-0064]

A court case focusing on plastics finishing and hazardous waste could go all the way to the US Supreme Court. Reason: Under the Resource Conservation & Recovery Act (RCRA) owner-operators of facilities that produce hazardous waste must assure the safe disposal of that waste and pay for any costs should a plant shut down. The key question: are plant owners (and even plant operators) personally liable? A US district court judge in Michigan thinks so, and if his order of 4 September 1992, to the owner of a now out-of-business plastics electroplating plant is not satisfied within 90 days, then the court is prepared to appoint a trustee to sell off property holdings, to pay for penalties and clean-up costs. The decision, which pits the US as plaintiff against Production Plated Plastics PPP and Michigan City Plastics MCP, part of the Detroit Plastics Molding group, and owner-operator Michael J. Ladney, is a first in the state of Michigan. (1, 3 [in English]. ISSN 1044-9663)

2600 LEAGUE OF WOMEN VOTERS PUBLISHING PLASTICS HANDBOOK. [BIB-199211-P7-0350]

Seeking objectivity in the debate about plastics' role in solid waste management, the League of Women Voters in the US, is publishing a plastics handbook intended to be distributed to local officials and activists. The Plastics Primer examines the possibilities and problems of plastics under various waste-management regimes, including recycling, incineration, and landfill disposal. The handbook is expected to be released this winter. The primer is an effort to provide balance in the often-politicized solid-waste rhetoric that has yielded bans on certain plastics products in municipalities across the country, without being incomprehensible to local officials. It is being underwritten partly by the Society of the Plastics Industry Inc.'s partnership for Plastics Progress. (Gardner, J.; 4, (32), 13 [in English]. ISSN 1042-802X)

2601 RECTICEL INDICTED ON TOXIC WASTE CHARGE. [BIB-199211-P7-0352]

A US federal grand jury has indicted the former Recticel Foam Corp., La Porte, Indiana, and six of the company's employees for illegally treating, storing and dumping toxic waste from the company's Morristown, Tennessee, plants. The indictments, announced 8 September in Greeneville, Tennessee, charge that the firm, a producer of flexible polyurethane foams, and employees conspired to violate federal environmental laws. This is the largest prosecution for environmental violations ever brought in the state of Tennessee. A 20 November trial has been set. Recticel Foam Corp. was the US subsidiary of Brussels-based Recticel NV/SA, itself a wholly owned unit of Societe Generale de Belgique. An October 1990 deal merged Recticel's North American operations with the Foamex division of Knoll International Holdings Inc. to create Foamex LP. (Gardner, J.; 4, (32), 3 [in English]. ISSN 1042-802X)

2602 SCRAP BOX SURCHARGE PLANNED BY COMALCO. [BIB-199210-G9-0326]

Rising disposal costs have prompted Comalco to impose a $5.00/box surcharge on all scrap metal delivered to the plant in cardboard boxes starting 1 September 1992. A letter announcing the new policy was sent out by Commonwealth Aluminum (Comalco) to 100 scrap metal dealers who supply the Lewisport, Kentucky, USA, mill. The letter noted that in the past Comalco had borne the full expense of disposing of the packaging material. The company will continue

bills such as the reauthorization of the Resource Conservation and Recovery Act (RCRA) and the government crackdown on package labeling keep waste management in the forefront. In 1991, 42 bills were introduced at the state level that would mandate recycled content for packaging, and two proposals were passed affecting plastics packaging. Nationwide, 104 bills were introduced requiring plastics to meet a recycling standard, and 12 of these proposals were enacted. (Block, D.G.; 38, (1), 84, 87, 89 [in English]. ISSN 0032-1257)

2585 LOS ANGELES DIE CASTERS MEET WASTE TREATMENT CHALLENGE. [BIB-199204-G4-0023]

As the California legislature passes increasingly restrictive environmental legislation, and the state's many regulatory agencies mandate ever-tighter controls and limits, Los Angeles-area die casters are controlling and treating their wastes to a greater degree than ever before. We came to the conclusion that we could no longer comply with local industrial waste sewer discharge regulations unless we upgraded our treatment systems, says executive VP and general manager of Lansco Die Casting, City of Industry, California, USA. Rangers Die Casting is a Lynwood, California-based company that faced a problem similar to that of Lansco, but devised a different solution. Hyatt Die Cast, Cypress, California, recently began treating its wastewater as a result of concerns over the company's liability in having its waste hauled away for off-site treatment. The three die casters' experiences with waste treatment form a good basis for a discussion of waste treatment technologies; and California's environmental regulatory climate, of which wastewater treatment is only the tip of the iceberg, which is proving increasingly challenging to industry. (Bralower, P.M.; 35, (4), 10-12 [in English]. ISSN 0012-253X)

2586 GREENPEACE MOVES TO RETURN WASTE TO SENDER. [BIB-199206-P4-0031]

Confusion over what constitutes good environmental intentions has sparked a confrontation between Greenpeace International and German chemical group Metallgesellschaft. At the centre of the conflict is a Danish-owned ship, the Cito, which moved a cargo of waste PE and PP car battery components from Germany to a cement factory in Egypt. Greenpeace argues that the cargo comprises a toxic waste shipment, and is now negotiating for the waste to be transported by barge back to its original source. The group says the case is an important example of the return-to-sender principle that it has been campaigning for. However, Metallgesellschaft subsidiary Blei-und-Silberhuette Braubach (BSB) denies the toxicity charge, emphasising the shipment had been sent for hand sorting for recycling and the residue would be destroyed using high-tech thermal destruction techniques at the cement factory. (57, (1518), 27 [in English]. ISSN 0014-2875)

2587 PLASTIC IMAGE IN THE US. [BIB-199206-P7-0179]

A Society of the Plastics Industry (SPI), Washington, survey shows that the US public attitude toward the plastics industry is becoming less favorable as worry about the environmental impact of solid waste disposal increases. In December 1991, 54% of 100 consumers expressed unfavorable attitudes toward the plastics industry, up from 34% in February 1990, while the number that view it favorably dropped from 62% to 39%. However, SPI says the public is finding incineration more acceptable than before and considers a 48% rate of recycling a major effort. (150, (19), 49 [in English]. ISSN 0009-272X)

2588 DUAL WASTE ECONOMY IN GERMANY—POSITION OF ALUMINUM PACKING MATERIAL. (DUALE ABFALLWIRTSCHAFT IN DEUTSCHLAND—POSITION DES PACKSTOFFS ALUMINIUM.) [BIB-199207-G4-0043]

In 1990 the German Federal Government issued an ordinance that waste management must protect the environment by either reusing the waste, or diminishing it or, best of all, avoiding it entirely. This directive had a significant bearing on the Al packaging and container business. A major requirement is the establishment of a collection and evaluation system with firm quotas for collection and assortment. Businesses concerned with the matter have organized a private organization called Duales System Deutschland GmbH or DSD, which since its inception in January 1991 has grown to a membership of approx 400. The organization handles the waste disposal problems and certifies compliance with environmental protection laws by so-called green dot marking. Member assessments provide funds for corrective action required by individual parties. The article describes this constantly evolving picture in detail and relates it to the situation encountered by Al as a packing, wrapping, canning, and container material. (Wirtz, A.H.; 67, (5), 412-413, 416-417 [in German]. ISSN 0002-6689)

2589 MARUZEN'S HDPE BURNS SAFELY. [BIB-199207-P1-0120]

With the plastics content of the municipal waste stream increasing—especially in Japan—the heat generated when refuse is incinerated is also rising. This poses a threat to antiquated incinerators that were not constructed to withstand the temperatures of burning plastics, not to mention the attendant environmental headaches. But Tokyo-based Maruzen Polymer Co is lessening that threat, thanks to its newly developed high-density polyethylene (HDPE) that burns safely. The company, a wholly owned subsidiary of Maruzen Petrochemical Co, says that the materials generates one-half the heat of conventional HDPE when incinerated. The product, tradenamed Pepra, produces less heat because it contains considerable amounts of calcium carbonate. Since the HDPE does not melt and drip while burning, it inflicts less damage to incinerator furnaces. Although the HDPE contains much calcium carbonate, the company says it displays the same strength as 100% HDPE. (5 [in English]. ISSN 1044-9663)

2590 SPI HOW-TO PROGRAM, MANUAL HELP COMPANIES CUT WASTE. [BIB-199207-P4-0032]

At a time when the US federal government has focused its efforts on preventing pollution, a Society of the Plastics Industry Inc. program and manual is offering a how-to guide for reducing waste. About two years in development, the manual and program are designed to give processors a management framework to reduce the amount of solid waste that either must be shipped to landfills or processed through the hazardous waste stream. The manual is not intended to be process-specific, but instead gives managers ideas on how to reduce waste ranging from office paper to waste oil or toxic byproducts of manufacturing processes. Source reduction, reuse and recycling are emphasized as methods of decreasing waste. (Gardner, J.; 4, (14), 10 [in English]. ISSN 1042-802X)

2591 THE STRUCTURE OF THE DUAL COLLECTION SYSTEM FOR THE REDUCTION AND AVOIDANCE OF PACKAGING WASTE—PANEL DISCUSSION ON STEEL RECYCLING. [BIB-199207-S1-0093]

The dual system of collection and recycling of packaging waste without a negative impact on sales outlets is described in terms of localised collection system with guarantees, organization and financing of collection. The legal background of waste disposal law and packaging regulations are highlighted. (Albrecht, H.K.; SYDNEY, AUSTRALIA, 7-10 OCT. 1990, Publisher: INTERNATIONAL IRON AND STEEL INSTITUTE, Rue Colonel Bourg 120, B-1140 Brussels, Belgium, (1990), 2417, Pp 5 [in English].)

2592 SECONDARY CONTAINMENT TRENCHES MADE OF ISOPOLYESTERS. [BIB-199208-D6-0201]

When US legislation requiring secondary containment of hazardous materials was initiated in 1985, Fiber-Trench Inc., Santa Ana, California, was ready with a three-fold plan: (1) design and build modular trench parts that can be assembled on site to follow virtually any pipeline path, (2) develop a bonding agent that could be applied in the field, and (3) fabricate trench parts from the same materials typically used for hazardous material transport pipes and storage tanks. All these—trench parts, gluing agent and primary pipes and tanks—were produced from glass fiber reinforced isopolyester resin systems based on Amoco Chemical Company's isophthalic acid. The state-of-the-art Fiber-Trench system was installed in 1987. Designers selected the system for its superior corrosion resistance. It will not rust like metal or crack like concrete, and is also lighter in weight and is easier to work with than either of these traditional materials. (16, (9), 2-3 [in English].)

2593 EUROPEAN MANUFACTURERS SPELL OUT THE OPTIONS. [BIB-199208-P1-0157]

The main options for sound waste management of plastics have been listed in a booklet published jointly by the Association of Plastics Manufacturers in Europe and the European Centre for Plastics in the Environment. These options are: prevention of waste at source, re-use and recovery by material recycling, recovery by chemical recycling, and thermal recovery of energy content by use

load/week from the stainless steel manufacturing process at the company's plant near Pittsburgh, Pennsylvania, USA. Representing a significant reduction in the costs and liabilities associated with disposal of this hazardous waste, the improvement was achieved in 1988 with a virtually closed-loop system called the Aquatech Systems Acid Recovery Process. In addition to saving the company $825 000/year from reduced disposal of acid and sludge, the system improved plant safety by minimizing acid handling, aided in recovering acid for recycling, and contributed to more consistent steel quality. (7, (8), 35 [in English]. ISSN 0897-4365)

2576 GERMANY'S DUAL WASTE DISPOSAL SYSTEM INAUGURATED. [BIB-199110-G1-0164]

On 14 November 1990 the German government issued a directive in respect of recyling used packaging. The directive obliges the retail trade to provide collection systems for all types of packaging either inside their stores or just outside their premises. The disposal of such collected materials must be carried out outside of the public waste stream and at no costs to the local authorities. To counteract the directive, the corresponding industries jointly agreed to set up a totally separate waste management system, the Duales System Deutschland (DSD), GmbH. Within schedules set up by government, DSD will build up collection and sorting systems. Quantities sorted must be recycled. Packaging which can be eliminated such as transport packaging may be replaced by multi-way systems and secondary packaging phased out. The existing infrastructure of collection systems will be integrated, emphasis being placed on collecting and sorting, glass, tinplate, Al, paper/cardboard, plastics, brick packs, laminates. (24 [in English]. ISSN 0955-8209)

2577 MANDATORY GLASS RECYCLING BILL INCLUDES REPORTING CULLET USE. [BIB-199110-C4-0001]

The Resource Conservation & Recovery Act Amendments of 1991, S.976, recently introduced in the US Senate, is designed to eliminate or reduce hazardous substances used in production activities. The bill contains a number of provisions to accomplish source reduction and strengthen waste management of toxic materials by improving disposal and waste treatment. Section 502 would mandate that within two years of the bill's enactment the EPA would have to promulgate specific recovery and utilization standards for glass. The standards would have to specify minimum recovery and utilization rates for individual glass products, product lines, product groups, or some other aggregated basis that EPA thought appropriate. Consequently, standards concerning the degree to which glass products could use toxic substances, and the degree that these products would have to be recoverable, would be set by EPA within two years of the statute's passage. (Calderwood, J.A.; 137, (3), 17 [in English]. ISSN 0009-0220)

2578 TRANSPORT EXEMPTION SOUGHT FOR PLASTICS. [BIB-199110-P1-0113]

A group of international waste management organizations has asked the Organization for Economic Cooperation and Development, Brussels, Belgium, to exempt recyclable materials such as plastics from controls on the international movement of wastes. Representatives of the Bureau International de la Recuperation told the OECD in June 1991 that regulations controlling the movement of wastes across national borders would be economically irresponsible as well as ecologically suicidal. The 1989 Basle Convention on waste transportation calls for a notification procedure that would apply to recyclable plastics. If an unconditional exclusion for recyclables is not available, BIR asked for an exemption for materials that pose no significant health or environment risk when they are transported, which the agency believes would include plastics. (News Brief). (3, (27), 8 [in English]. ISSN 1042-802X)

2579 AUTOMOTIVE FLUFF A GROWING PROBLEM. [BIB-199111-P1-0121]

Of the 130 million cars operating in the US, auto dismantlers and shredders currently recover approx 9-10 million vehicles/year—90-95% of the number scrapped. Almost all of the Fe and steel is recovered, representing approx 70-75% of total vehicle mass. But most of the increasing amount of plastic—which now composes 6-12% of total vehicle mass—is not being recovered. Shredder fluff has become a major problem in Europe because of skyrocketing land fill costs. Consequently, the focus in Europe is on minimizing their contribution to the waste stream. In addition, the recovered plastic is seen as an untapped—and valuable—resource for either virgin material or feedstock for recycled plastic products. (3, (31), 4 [in English]. ISSN 1042-802X)

2580 GUNDLE EXPECTS SURGE FOR LANDFILL LINERS. [BIB-199111-P6-0234]

The first US federal standards for municipal landfills will boost sales of plastic liner systems, according to the head of Gundle Environmental Systems Inc., which claims to be the largest US geosynthetic manufacturer. The regulations, announced 11 September 1991 by the US Environmental Protection Agency, require states without EPA-approved programs to use a synthetic liner covering a 2 ft clay liner under new and expanding landfills. Fewer than 10% of the nation's 6000 solid waste landfills currently follow those regulations. Although municipal landfills account for 60% of sales, Gundle serves other liner markets of mining, industry, utilities, hazardous waste landfills, and specialty applications such as canals. Gundle extrudes the flexible liners out of high density polyethylene and very low density polyethylene, then welds them together using heat and pressure. (Bregar, B.; 3, (32), 4 [in English]. ISSN 1042-802X)

2581 NEUTRON SHIELDING CERAMIC OFFERS TEN TIMES THE EFFICIENCY. [BIB-199112-C6-0091]

A neutron shielding ceramic called Krafton N Type has been developed in Japan by Sanoya Sangyo Co., Ltd, in association with the Ship Research Institute of the Ministry of Transport. The ceramic is made from boron and Cd based compounds, which are highly efficient thermal neutron capturers, and from a Ni—Mg based hydrogen storage alloy, saturated with H, which shields high energy neutrons efficiently. The material has a specific gravity of 2.8 A 15 cm thick shield of Krafton N Type shields 90% of the incident neutrons, while a 35 cm thick shield absorbs 99% of incident neutrons. The ceramic is ten times more efficient at capturing electrons than ductile steel and graphite shields. It is more durable than polyethylene, another material used as a neutron shield. The ceramic is fracture, water, and acid resistant and Sanoya and the Institute are currently studying the possibility of its use to make containers for shipping spent nuclear fuel. (News Brief). (8 [in English].)

2582 SHREDDER WASTE UNDER DISCUSSION—DISPOSAL BRINGS TROUBLES. [BIB-199112-S4-0085]

A summary of the discussions at the Workshop on the Disposal of Light Shredder Waste held in Duisburg by the Institut fur Umwelttechnologie und Umwelttechnik is followed by a description of the plant at the Entsorgungszentrum Duisburg conveived by Essener Thyssen Engineering for the simultaneous fludised-bed incineration of clear slurry and shredder waste. Advantages of the proecess include (i) compensation of the heat required for the slurry incineration by the excess heat from the shredder-waste incineration, (ii) restriction of combustion emission to within threshold limits, (iii) low noise emission and (iv) lower investment and operating costs than for other disposal methods. Auxiliary processes for reducing or destroying dioxines and furanes are planned. ((8-9), 14-15 [in German].)

2583 FAREWELL CSWS; NEW GROUP ENTERS SOLID WASTE FRAY. [BIB-199202-P1-0030]

The Council for Solid Waste Solutions (CSWS), which has led the US plastics industry's fight in the solid waste battle for the past three years, ceased to exist in January 1992. The group's work will be carried on by the Society of the Plastics Industry (SPI) and the new Partnership for Plastics Progress, which will operate as an SPI activity. Membership in the CSWS required a set fee, while the Partnership dues will be based on pounds of material processed. The group also will seek support from processors, end users, and machinery manufacturers. In early December, there were 27 companies enrolled, all resin producers. The CSWS received high marks for its lobbying work, but did not succeed in making a big dent in public opinions about plastics' role in solid waste. The organizational changes signal a desire to move solid-waste activities more clearly under the aegis of the SPI and to widen the base of support. (50, (2), 70 [in English]. ISSN 0032-1273)

2584 ALL EYES ON ENVIRONMENTAL ISSUES IN 1992. [BIB-199202-P1-0036]

In the US, with approx 500 bills proposed in 1991, solid-waste management is still the plastics industry's greatest regulatory concern. Although issues on clean air, clean water, and worker safety will also demand industry attention in 1992,

disposing of polychlorinated biphenyls (PCBs), which are known to cause cancer, and other toxic wastes at the Al smelting and fabricating plant. The misdemeanor violations occurred in 1989, when company employees evacuated 33 railroad cars full of PCB-contaminated soil and abandoned the soil for more than three months while preparing to install a drainage system. (Pollock, B.; 99, (133), 2, 7 [in English]. ISSN 0002-9998)

2567 SIC PRECURSOR FROM AGRICULTURAL WASTE. [BIB-199108-C5-0148]

Fukuoka Industrial Research Institute has produced a method of turning the byproduct chaff into a material for making silicon carbide. The chaff is a form of agricultural waste, readily available. The chaff is first crushed and then subjected to treatment with an alkali solution and boiling at a pressure of 30 atm. The treated chaff is then conditioned with enzymes (micro-organisms) so as to degrade cellulose. The remainder is burned, leaving an ash which contains Si and carbon, to which additions of Si and C can be made as needed. (News Brief). (2 [in English].)

2568 HAZARDOUS WASTE: THE TOXICITY CHARACTERISTIC. [BIB-199108-P4-0040]

On 29 March, 1990, EPA promulgated the Toxicity Characteristic (TC) greatly expanding the amount of waste considered hazardous. Regulatory levels were established for an additional 25 organic compounds, expanding the TC constituents list to 39 substances. The regulatory level for vinyl chloride was set at 0.2 mg/l, a sufficiently high level to assure that most PVC wastes will not be hazardous because of VCM. The history of this regulation and its effects on industry are discussed. PVC wastes continue to be at risk of becoming hazardous due to their heavy metal content. Those facilities managing wastewater on-site in surface impoundments should determine whether their wastewater contains any TC constituent at or above the regulatory level. If the source of the constituent cannot be controlled, the facility may need to submit a RCRA Part A. (Ledvina, J.C.; 13, (2), 101-103 [in English]. ISSN 0193-7197)

2569 EPA MAY CHANGE FURNACE DUST DISPOSAL CODES. [BIB-199108-S4-0051]

During 1991 the US Environmental Protection Agency is expected to come out with final regulations regarding the handling of hazardous waste classified as K061 under the Resource Conservation and Recovery Act (RCRA), which was originally enacted in 1976. Representatives of the mini-mills are concerned that the final regulations might require the mills to dispose of slag from treated arc furnace dust in hazardous waste landfills. The cost of disposal would increase operating expenses dramatically. The preferred method of handling arc furnace dust under RCRA is recycling rather than disposal. The proposed EPA regulations could force disposal of the slag rather than recycling, which would be ironic and inimical to the national interest, according to the Steel Manufacturers Association. The current industry practice is to put the dust generated by electric arc furnaces into a high-temperature metal recovery (HTMR) furnace to recover the valuable metals that remain. An alternative is to stabilize the dust by mixing it with concrete and shipping it to a landfill. (Connaughton, D.; 99, (98), (Suppl. Ferroalloys), 10A, 14A [in English]. ISSN 0002-9998)

2570 REYNOLDS SYSTEM GIVEN GREEN LIGHT. [BIB-199109-G4-0084]

The Environmental Protection Agency has given a conditional green light to Reynolds Metals Co. to proceed with plans for industrial-scale processing of spent potliner. The EPA conditionally removed spent potliner—for years a disposal headache for the US Al industry—from the hazardous waste list. This could make potliner eligible for disposal in landfills. Richmond, Virginia-based Reynolds Metals maintains that a thermal process it developed and worked through the pilot-plant phase can recycle the waste into a nonhazardous and potentially marketable product. (Abrahamson, P.; 99, (141), 1, 12 [in English]. ISSN 0002-9998)

2571 HAZARDOUS MATERIAL TRANSPORT REGULATION CHANGE FOR ALUMINUM WASTE. [BIB-199109-G4-0086]

On 25 April 1991, a new regulation (VO-E-70: Transport of Aluminum Waste) was passed. This regulation applies to the areas of rail and tractor trailer transport of Al waste and cancels a previous regulation in effect since 1 May 1990, which was under unanimous criticism from the nonferrous metal and transportation industries. Each year in the FDR, approx 40 000-50 000 tons of Al waste are produced. In contact with water, Al waste with a high surface to volume ratio can produce a flammable gas. Therefore, in the FDR, Al waste falls into Class 4.3 of the Hazardous Materials Transport Regulations. Depending on the rate of gas evolved, under the new regulation VO-E-70, Al waste can fall into one of three groups, with powdered Al falling under a separate regulation. Regulation VO-E-70 establishes guidelines for protection from water and moisture, materials leakage, registration of material with authorities and means of fire protection of the three groups of Al waste. (Eckert, M.; 67, (6), 515-517 [in German]. ISSN 0002-6689)

2572 EPA CITES THREAT OF LEAD IN RESIDUE AT SHREDDERS. [BIB-199109-G4-0089]

Lead contained in the residue from shredded autos and appliances might pose a greater environmental risk than either Cd or polychlorinated biphenyls (PCBs), according to a pilot study by the US Environmental Protection Agency. The study focused on seven US shredders; its findings appeared to suggest that the amount of Pb likely to leach from the residue into the environment is higher than the guidelines allow. Cadmium and PCBs, while still a threat, are believed to be within acceptable leaching levels. The study reaffirmed suspicions that the fluff, and not the metal output from the shredding, was where much of the PCBs were to be found. The PCB concentrations in fluff were 50 times greater than those found in nonferrous shredded metals and 200 times greater than the levels found in ferrous metals. (Goodwin, M.; 99, (137), 8 [in English]. ISSN 0002-9998)

2573 GREENPEACE TO RENEW ATTACK ON INCINERATION. [BIB-199109-P4-0045]

Just as European industry faces up to the many difficulties in recycling its waste, the environmentalist group, Greenpeace, has reaffirmed its opposition to the alternative solution of incineration. A Greenpeace report against incineration has been prepared and the campaign is to get fully under way in August. Greenpeace maintains that incineration does not destroy waste but creates dioxins and furans. Incineration aside, the group maintains its antipathy to PVC as a material, and also alleges that all of the UK's current tally of 34 incinerators are substandard in relation to forthcoming EC legislation on the matter. The Chemical Industries Association has responded that incineration is an essential, safe and practical means of waste disposal which offers the opportunity of using waste as an energy source. (News Brief). ((1390), 1 [in English]. ISSN 0032-1168)

2574 PROCESS REMOVES DIOXINS FROM SOLID WASTE. [BIB-199109-P4-0046]

In the past, there has been considerable controversy over PVC's presence in incinerated municipal solid waste and whether more dioxins are formed if PVC is present. Now, however, that whole discussion may be moot. Hitachi Zosen Corp. has developed an incineration system which drastically reduces dioxin emissions from incinerated garbage. In one company test, dioxin content decreased by 99.6%. With the Hitachi system, a mixture of air and water is blown from a nozzle fixed to the wall of the furnace at a speed close to the speed of sound. This causes more efficient mixing of the materials to be incinerated, thus more complete combustion that removes the dioxins from the exhaust gases. (News Brief). (4 [in English]. ISSN 1044-9663)

2575 CURING A SPENT PICKLING LIQUOR HANGOVER. [BIB-199109-S1-0047]

Leading specialty steel manufacturer, Washington Steel Corp., has reduced disposal of spent pickling liquor from nearly one truckload/day to just over one

particular have four major means of dealing with solid wastes: reduction, reuse, recycling, and disposal. One of the best ways for foundries to meet the solid-waste disposal challenge is through joint efforts, especially regional efforts. Issues confronting the foundry industry in dealing with mounting legislative and public pressure to handle solid wastes are discussed. (East, W.R.; 119, (5), 47-49 [in English]. ISSN 0360-8999)

2556 EDDY CURRENTS HELP SAVE OLD ALUMINIUM. [BIB-199107-G1-0103]

Modified equipment used in the metal reclamation business is being tested on refuse to salvage discarded Al. According to Eriez Magnetics, the Newport-based company which makes the eddy current machines, Oxfordshire council buries 2500 tonnes of Al each year because it cannot separate it from the other refuse. If the eddy current equipment is made use of, Oxfordshire stands to make nearly pounds sterling 1.5 million out of its rubbish. (272, (7043), 35 [in English]. ISSN 0013-7758)

2557 BARMET ALUMINUM INNOVATION ELIMINATES ENVIRONMENTAL PROBLEM. [BIB-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. (30, (2), 14 [in English]. ISSN 0026-055X)

2558 BIOLOGICAL FILTER REMOVES URANIUM POLLUTION. [BIB-199107-G4-0065]

Metal-eating microbes may provide a solution to the problem of how to clean up uranium pollution. Bacteria known as GS-15, found four years ago in the Potomac River, USA, were known to be able to live on Fe, and to decompose toluene and benzene. The US Geological Survey, looking for ways to remove U from polluted water near U mines and toxic waste from nuclear weapons plants, found that GS-15 is also partial to U. The microbes ingest the water-soluble U^{6+} ions and change them into insoluble U^{4+} ions. A filter chamber containing GS-15 could thus precipitate out U for collection and disposal. (News Brief). (11 [in English].)

2559 DEVELOPMENTAL RESOURCE RECOVERY TECHNIQUE GETS BOOST FROM DU PONT. [BIB-199107-P1-0073]

The Du Pont Company has agreed to participate in the development and marketing of a new resource recovery technology with application to both ends of the plastics life cycle—polymerization and ultimate disposal. The process, originally developed by Molten Metal Technology (MMT), Cambridge, Massachusetts, USA, involves use of a metal bath into which practically any type and form of waste material can be thrown—for separation, for sterilization if needed—and for ultimate recovery and reuse. Du Pont will fund the development of application of the technology to specific but yet unnamed waste streams. Examples of the general applicability of the MMT process to plastics include the reduction of auto "fluff", (the material that currently remains when recoverable metals have been extracted from scrapped automobiles) to its component molecules for reuse. Medical waste, which now contains twice the percentage of plastics and more PVC than is present in the municipal waste stream, would likewise be reduced to its elemental molecules, eliminating any problems with infectious matter along the way. (5 [in English]. ISSN 1044-9663)

2560 IMPETUS FOR SOPHISTICATED RECYLING TECHNOLOGIES FROM ITALY. MODEL TESTS IN CITIES FOR DISPOSAL AND RECOVERY OF USED PLASTICS PRODUCTS. [BIB-199107-P1-0088]

The latest Italian developements in plastics recycling machines, as exhibited at the Milan Plast '91, and stimulated by recent legislation, have resulted in recycling in Italy of 400 000 t of plastics: approx 10% of consumption. The household waste contains up to 11% of plastics, with 85 250 t of PET and 62 000 t of PVC being utilized in the packaging each year of approx 6.4 billion l of drinks. A typical model test in 31 Milan supermarkets permitted recovery of 7000 bottles/month corresponding to 4.2 t/year. The Italia Trade Centre in Dusseldorf also hosts frequent symposia on the subject. ((8), 12-14 [in German]. ISSN 0342-7099)

2561 PLASTICS WERE THE PACEMAKERS. THE "EUROPEAN WASTE STOCK EXCHANGE" CONTINUED TO FLOURISH IN 1990. [BIB-199107-P1-0090]

Plastics and other residues are clear leaders in the "European Waste Stock Exchange" set up in 1974, operated by the chambers of industry and trade and already serving non-European countries including Canada. The plastics business fell slightly in 1990, but offers for sale and for purhase still totalled 50.6 and 41.8% of the total waste transactions. Chemicals were next in succession with 14.8 and 18.3% respectively. ((9), 1-2 [in German]. ISSN 0342-7099)

2562 SOUND WAVES REDUCE SOOT EMISSION FROM BURNT POLYETHYLENE WASTE, SAYS EPA. [BIB-199107-P4-0036]

If loud rock music was able to drive Panama strongman Manuel Noriega out of his hiding place, can sound waves of 170 db clean up combustion gases in a municipal or hazardous waste incinerator, making them move faster, mix better with oxygen, and produce less stack emissions? That is the question the Office of Research and Development, US Environmental Protection Agency (EPA), is trying to answer while testing a prototype "pulse" combustor developed by Sonotech, Inc., Atlanta, Georgia. Approximately 75% less soot was emitted when the pulse combustor was used to burn polyethylene material-primarily HDPE milk jugs-than when a conventional (nonpulse) combustor was used. The pulse combustor reduces products of incomplete combustion such as soot, carbon monoxide, and organic chemicals, increasing "complete" combustion. (5 [in English]. ISSN 1044-9663)

2563 PRODUCE BORATED STAINLESS STEEL SQUARE PIPE AS SPACE-SAVING SPENT NUCLEAR FUEL STORAGE. [BIB-199107-S6-0096]

Since 1977, Nisshin Steel Co., Ltd., Tokyo, has manufactured stainless steel square pipe—UNS S 30400, Ni 8.00-10.50—for use as storage vessels for spent fuel from nuclear power plants. Boron, B^{10}, has a large thermal neutron absorption cross-section, and its addition to stainless steel increases the material's absorption capacity. In 1990, Nisshin's NSS 304 NFB 1 square pipe—width 154 mm, length 4300 mm—became the first borated stainless steel in Japan to be used in spent nuclear fuel storage vessels. (6, (4), 12 [in English].)

2564 EC TIGHTENS UP WASTE LANDFILL LEGISLATION. [BIB-199107-S7-0292]

A further directive on waste landfill was adopted by the EC in April 1991. This controls procedures for various kinds of landfill, dealings with existing difficult sites and similar matters. The question of the necessary fund raising has not been revealed. Present legislation does not differentiate between scrap and waste and the new directive is aimed at preventive action, defining those responsible for action. It also aims at being a European standard, acceptable to all. The new directive will include matters applying to metal type industries. ((7586), 21 [in English]. ISSN 0026-0533)

2565 ALCOA PLANNING $50M (ENVIRONMENTAL CLEANUP) PROJECT. [BIB-199108-G4-0071]

Aluminum Co. of America will spend $50 million at its Massena, New York, works for a remedial environmental cleanup project that is expected to take eight years. The remediation work will include the design and construction of a secure vault for the disposal of treated soils and sludges, landfill and lagoon closures as well as the restoration of stream and wetlands. Alcoa's Massena plant is a primary Al smelter with continuous casting capability and extrusion presses. (99, (119), 7 [in English]. ISSN 0002-9998)

2566 ALCOA HIT WITH $7.5M PCB FINES. [BIB-199108-G4-0072]

Aluminum Co. of America has pleaded guilty to four violations of New York State pollution laws at its Massena, New York, USA, plant and agreed to pay $7.5 million in fines. The Alcoa plant was charged with storing, shipping, and

and record-keeping violations. In addition to the stiff fine, the company has agreed to fund an independent audit of its waste-handling practices and plant records. (Lashinsky, A.; 3, (1), 22 [in English]. ISSN 1042-802X)

2545 EPA ACCUSES THREE STEEL FIRMS OF HAZARDOUS WASTE DISPOSAL. [BIB-199104-S4-0015]

Chaparral Steel Co., Midlothian, Texas, National Rolling Mills Inc., Paoli, Pennsylvania, USA, and Structural Metals Inc., Seguin, Texas, were among eight companies that the US Environmental Protection Agency has filed lawsuits against for alleged hazardous waste disposal violations with fines of up to $25 000/day/violation. The land disposal restrictions under the Resource Conservation and Recovery Act (RCRA) require treatment of most hazardous wastes, allowing only adequately treated wastes and residues to be disposed of on land. Through these laws, the EPA seeks to replace land disposal with advanced treatment, recycling, waste minimization and alternate hazardous waste control technologies. (Abrahamson, P.; 99, (37), 1, 16 [in English]. ISSN 0002-9998)

2546 SEARCHING FOR SOLID ANSWERS (TO SOLID WASTE DISPOSAL PROBLEM). [BIB-199104-S4-0020]

Steel and Al producers are faced today with solid waste problems that they didn't know they had until the implementation of the RCRA laws in 1976 that empowered the EPA to designate materials as hazardous wastes. Examples include PCB filled transformers, baghouse dusts, and coke oven gas drip legs. Each cite must be studied and an individual plan tailored for compliance. Electric furnace dust is the most pressing problem, along with scrap contamination with radioactive material. Several techniques have been developed to deal with furnace dust as well as techniques to reduce the amount of dust produced. (Brooks, R.; 29, (1), 22-25 [in English]. ISSN 0149-1210)

2547 POTENTIAL BENEFICIAL USES OF STEEL SLAG WASTES FOR CIVIL ENGINEERING PURPOSES. [BIB-199104-S4-0024]

Large tonnages of slag wastes are produced in the iron and steel industry and space for dumping them has become a problem. Any means of utilizing the slag would be welcome. Although blast furnace slags are known to be widely used in the manufacture of cement, the use of steel slags for civil engineering purposes has not been given much encouragement in the literature. This communication reports efforts to assist the Nigerian steel industry to ease the problem of waste disposal. An effort has been made to make their slag potentially useful in civil engineering with, hopefully, some revenue earned from the disposal of the now unwanted material. (Akinmusuru, J.O.; 5, (1), 73-80 [in English]. ISSN 0921-3449)

2548 GROUP EYES NEW SOLUTIONS TO OLD BATTERY PROBLEM. [BIB-199105-G1-0063]

Members of a Pb-acid battery advisory committee have agreed that landfilling batteries should be banned and instead some type of battery take-back system and more consumer awareness about recycling are needed. The group was formed in early February by the Environmental Protection Agency. Its aim is to try to come up with some consensus on how to attain as close to a 100% recycling rate for Pb-acid batteries as possible. The association has asked the agency to consider regulations that would: require a maximum content of recycled Pb in new batteries, limit the annual production of primary Pb, ban or restict the export of spent Pb-acid batteries; and ban or restrict the importation of new batteries, battery components and finished Pb in metallic form, and battery power sources. (Abrahamson, P.; 99, (55), 9, 11 [in English]. ISSN 0002-9998)

2549 RECYCLING ROUND UP. UK. [BIB-199105-P1-0056]

At present 0.1% of The 1.3 million tonnes of packaging consumed each year in Britain is reclaimed. the government is contributing pounds sterling 40 million to set up recycling schemes. By the end of the century, the UK intends to collect and recycle 50% of domestic waste (this compares with a figure of 85% in Germany by 1995). (10 [in English]. ISSN 0264-7753)

2550 (PLASTIC MODULES FOR HAZARDOUS WASTE.) [BIB-199105-P6-0095]

Unique composite plastic modules for managing hazardous waste have been developed by Environmental Protection Polymers, Inc., Hawthorne, California, USA, under a US Department of Energy SBIR program. Particulated toxic wastes are combined with polybutadiene resin and molded into cylindrical cores. The cores are then sealed by fusing high-density polyethylene (PE) pellets onto their surfaces, thereby encapsulating them in seam-free PE jackets. The resulting 48 gal modules approximate the shape of 55 gal drums. The process provides an attractive, cost-effective option for stabilization/solidification of toxic wastes. Pilot studies are underway. (News Brief). (7, (4), 11 [in English]. ISSN 0888-1227)

2551 MG GROUP TACKLES CLEANUP. [BIB-199106-G4-0050]

German metals and engineering company Metallgesellschaft AG is to head an international consortium aiming to clean up and modernize the massive VEB Mansfeld Al and Cu-producing complex, one of the largest and most polluted industrial zones in eastern Germany. The cost of the operation could eventually exceed 1 billion deutschemarks ($571.2 million). It teams Frankfurt-based Metallgesellschaft and private-sector partners from the US and Europe with Germany's state-run Treuhand privatization agency. The agreement calls for Metallgesellschaft to lead the group, which is to prepare a project feasibility study in the next three months. The next phase would focus on cleansing the soil around Mansfeld, modernizing its smelters, installing a new power plant and attracting new investors. (Regan, J.G.; 99, (88), 8 [in English]. ISSN 0002-9998)

2552 L'AIR LIQUIDE/MMT TO COMMERCIALIZE WASTE PROCESSING METHOD. [BIB-199106-P1-0062]

A resource recovery and waste processing technology with application to both ends of the plastics life cycle—polymerization and waste disposal—will be jointly marketed and developed by Molten Metal Technology (MMT) and L'Air Liquide, Paris, France. Over a period of four years, the firms will devote $30 million to a worldwide commercialization project for a process they call catalytic extraction processing (CEP), originally developed by MMT. The technology has at least two applications to plastics. First, it can be used to process finished materials such as plastics and rubber that may be part of a hazardous stream such as medical waste. In addition, the process can be applied to catalyst removal in monomerization and polymerization processes. (News Brief). (4 [in English]. ISSN 1044-9663)

2553 JAPAN ISN'T REUSING POST-CONSUMER PLASTIC. [BIB-199106-P1-0065]

Plastics recycling in Japan is overwhelmingly an industrial affair, while incineration outruns landfilling in a densely populated country that generates far less municipal solid waste/person than the US. According to new figures assembled by charles River Associates, the Japanese recycle very little post-consumer plastic waste, and of what they do incinerate—the disposal choice that accounts for 65% of plastics waste—most is converted to steam rather than electricity. Japanese plastics processors and users only now are beginning to form alliances to address solid waste issues, a process which should gather steam in coming months. Japan's primary plastics trade association, the Plastics Waste Management Institute of Japan, recently has begun working with the powerful Ministry of International Trade and Industry to coordinate plastics solid waste management. (Lashinsky, A.; 3, (10), 5 [in English]. ISSN 1042-802X)

2554 (US) SENATE TO HEAR PROPOSED RCRA REVISIONS. [BIB-199106-P1-0071]

A comprehensive waste-management bill introduced in the US Senate would set ambitious plastics recycling goals, mandate minimum recovery and recycled content rates for plastics and perhaps increase greatly the permitting burden that recyclers face. Those are just some of the measures contained in an opening bid by Sen. Max Baucus, D-Nevada, to rewrite the country's major statute governing waste, the Resource Conservation and Recovery Act. The bill is being viewed as the vehicle to begin the Resource Conservation and Recovery Act reauthorization process in the Senate. When completed, the bill could change the way the country produces, handles and disposes of all kinds of waste. (Lashinsky, A.; 3, (11), 5, 20 [in English]. ISSN 1042-802X)

2555 SOLID WASTE—NO PLACE TO GO. [BIB-199106-S4-0031]

Foundry waste may be the most innocuous nonhazardous industrial waste. Unfortunately, it is competing for dwindling landfill space with hundreds of millions of tons of other waste—both municipal and industrial—that are produced in the US each year. The US, in general and the foundry industry, in

them out of the landfills. A cosortium of molders for the automotive industry has used a pyrolysis system developed for disposal of automotive tires. It was found that shredding the CRP waste makes pyrolysis much more effective. Two-inch chip appears to be optimum. In pyrolyzing the GRP, the material is heated to high temperature in a vacuum chamber (eliminating oxygen), so no combustion actually occurs. Byproducts are gases, oil-like residues, and inorganic reinforcements/fillers which are relatively low in volume and hence easier to dispose of. (News Brief). (7, (3), 4 [in English]. ISSN 0888-1227)

2536 DATA AVAILABLE ON WASTE MANAGEMENT. [BIB-199103-P4-0015]

"A Competitive Analysis of Hazardous Waste Management", from Leading Edge Reports, Cleveland Heights, Ohio, USA, gives market size growth and forecast figures for the multibillion-dollar hazardous waste treatment and disposal market. The report covers competitive strategies, new legislation, new markets, industry trends and company profiles. Markets covered include the plastics, rubber, chemical and petroleum industries. Cost of the 160 page study is $1950. (News Brief). (2, (49), 10 [in English]. ISSN 1042-802X)

2537 MASSACHUSETTS FIRM TO MARKET MOLTEN METAL TECHNOLOGY. [BIB-199103-S4-0011]

A hazardous waste treatment process based on steel-making techniques is being brought to market by Molten Metal Technology, Inc., Cambridge, Massachusetts, USA. Wastes with a high metals content (0.5%) or a high halogen content (up to 15% by weight) can be handled by the technology. The system involves the injection of waste and oxygen into a bath of molten steel (with a temperature of 2900 °F (1593 °C)). The waste falls to the bottom and cycles its way up through the bath. As the high temperature causes the waste to break down to its elemental components, carbon is absorbed into the steel and then stripped by the O. An air pollution train can be employed to capture waste gases, such as hydrogen chloride, and in some cases, a low-Btu gas can be recovered. Inorganics are incorporated into a molten layer on top of the steel that can be tapped to produce a nonleachable glassy slag. Develoment work has focused on steel as the molten metal, but other metals could be employed for articular waste streams. An Fe bath may be suitable for wastes with a high Cr content as a means of producing stainless steel, and that a lower temperature bath is being developed for the recovery of Zn. (6, (2), 10 [in English].)

2538 DEALING WITH CHEMICAL WASTE. [BIB-199104-G4-0039]

Primary metal producers are being singled out as serious polluters of toxic waste and EPA prosecution is being upheld by the courts forcing manufacturers to impose expensive controls on their operations. Waste minimization and waste management are seen as the keys to meeting this crisis. Communication with the public is important to ensure that programs are understood. Once the toxic substance is identified, a program to take care of it can be initiated. In some cases, the waste can be processed into a useful product such as lime residue for agriculture or pickle liquor for wastewater treatment. PCB problems are a major concern, but hope for a biological treatment or a chemical/incineration method offer the greatest hope. The EPA still faces a struggle to find a middle ground between strict environmentalists and an industry plagued by increasing costs of environmental control. (Lavoie, F.J.; 29, (1), 26-28 [in English]. ISSN 0149-1210)

2539 ALCAN SET TO APPEAL TOXIC WASTE RULING. [BIB-199104-G4-0042]

Alcan Aluminum Corp., has elected to appeal a January 1991 federal court ruling that it must ante up approx $3.2 milion in connection with a Pollution Abatement Services (PAS) case involving a toxic waste site near its big Oswego, New York, USA, rolling mill. The former PAS property, once dubbed the seventh-worse toxic waste site in the US, has cost the federal government $13 million to clean up. Alcan Aluminum had been accused of dumping four million gallons of waste emulsion containing Cr, Pb and Zn there between 1970-1977. In 1987 approx 82 companies acknowledged responsibility for generating a toxic brew of arsenic, heavy metals and carcinogens and repaid the government a total of $9.1 million. Alcan demurred, maintaining that the wastes generated from rolling Al at Oswego were harmless. The EPA, which initially had concurred with Alcan's position, reversed itself on the basis of an in appropriate test precedure following Alcan's misreading of pertient EPA regulations. The result was a finding that a single sample was hazardous. Upon reverting to the correct procedure, the sample in question and all other samples passed EPA muster. (Regan, B.; 99, (33), 2, 7 [in English]. ISSN 0002-9998)

2540 WASTE WATER TREATMENT PLANT AT METALEUROP WESER BLEI GMBH AND METALEUROP WESER ZINK GMBH NORDENHAM—REDUCTION OF THE WASTE WATER VOLUME AND THE AMOUNT OF RESIDUES. [BIB-199104-G7-0132]

Waste water of the Pb smelter and the electrolytic plant are treated together. Domestic sewage waters flows to the municipal sewage purification plant. Weakly contaminated surface water is collected and used for cooling and as process water where the requirements are less strict. Contaminated waste water flows in a volume of 40-50 m^3/h — i.e. 2 m^3/t of metal prodction—to the three-stage waste water treatment plant. The toxic agents are precipitated by addition of Na_2S and NaOH in the first stage in an acid medium, an in the second stage in an alkaline medium. The third stage mainly works as a flocculation stage by adding lime, $FeClSO_4$ and caustic soda. The demand of the 39th. Administrative Regulation of article 7a of the Clean Water Act are reliably met. (Menge, R.; 44, (2), 75-80 [in German]. ISSN 0044-2658)

2541 HONG KONG FAULTED ON PLASTICS. [BIB-199104-P1-0041]

A recent study by Australia-based consultant Sira International, Canberra, found that Hong Kong still has a long way to go to bring its plastics waste management under control. The study suggests industry assumptions that recycling plastics waste is unprofitable are inaccurate. Export of plastics waste has doubled each year over the three years to 1989—when they totaled HK$200 million ($15 million)—with moderate growth to 1990. The report sees further growth potential in increasing demand from Japan, the US and Australia. Key growth areas are polyethylenes, polystyrene, and polyvinyl chloride. (News Brief). (148, (9), 34 [in English]. ISSN 0009-272X)

2542 21 MILLION TONNES OF PLASTICS WASTE BY YEAR 2000: SHELL. [BIB-199104-P1-0044]

A useful set of papers on plastics waste, produced originally for internal briefings, has been published by Shell International Petroleum, under the title Plastics: a Renewable Resource. Shell forcasts that the estimated 13 million tonnes of plastics waste produced in western Europe at present will increase to 16.5 million by 1995 and to 21 million tonnes by year 2000, and it makes some interesting projections. While, with the significant exception of vinyls, as plastics (including thermosets) will grow in the waste mountain, the major growth factor will be polypropylene, currently about 2.2 million tonnes of waste but forecast to rise to approx 6 million tonnes by 2000. (News Brief). (16, (1), 18 [in English]. ISSN 0309-4561)

2543 FORMOSA AGREES TO PAY RECORD EPA FINE. [BIB-199104-P4-0020]

Formosa Plastics Corp. has agreed to settle a dispute with the US Environmental Protection Agency over alleged violations of the federal hazardous and solid waste law. Without admitting or denying guilt, the Taiwan-based resin supplier's Point Comfort, Texas, plant will pay a $3.38 million penalty, the largest ever under the Resource Conservation and Recovery Act. The Point Comfort facility manufactures PVC powder and in the process produces crude ethylene dichloride, EPA lists waste from the EDC distillation process as well as waste from the purification of crude vinyl chloride monomer into PVC as hazardous. (News Brief). (3, (1), 2 [in English]. ISSN 1042-802X)

2544 EPA CRACKS DOWN ON REGULATION VIOLATORS. [BIB-199104-P4-0021]

Fulfilling its promise to punish violators of its hazardous waste laws, the US Environmental Protection Agency has announced a nationwide crackdown against 28 companies that have run afoul of the agency's record-keeping, treatment, storage and disposal regulations. A Du Pont Co. plastics-producing plant in Deepwater, New Jersey, led the list of alleged violators, and the company agreed to pay $1.85 million, one of the largest fines ever under the Resource Conservation and Recovery Act ban on hazardous waste land disposal. Regulators lodged five allegations against Du Pont for infractions including unlawful disposal of toxic solvent and liquid hazardous waste, inadequate waste analysis

of tools, proper elimination and santitation in the work area. Factors to be considered in developing a plan are described. (Guimond, M.; 2-3 [in English]. ISSN 0011-2199)

2526 PROCESSING PACKAGING PLASTICS. [BIB-199102-P1-0023]

The European Community generates 2 billon tonnes of potentially valuable waste every year. The latest report—Recycling Polymers From Scrap Products —from the Rubber and Plastics Research Association of Great Britain (RAPRA) estimates that the UK alone throws away recyclable material worth pounds sterling 750 million/year. About 7 millon of this waste is plastics most of which has been used in packaging applications, and it is the recycling of this particular post-consumer waste which is becoming one of the growth areas of the 1990s. However, all recyling schemes face two major hurdles: collection of the new material and finding a market for the recycled plastic. For these reasons BASF has said that it favours incineration with heat recovery as the best solution for plastic waste. Many other companies believe that recycling is the way forward and levels of investment in both R&D and new plant are at an all-time high. (Ottewell, S.; (485), 19-20 [in English]. ISSN 0302-0797)

2527 UPDATED STUDY CONSIDERS LEAD IN PLASTIC PRODUCTS. [BIB-199102-P4-0004]

SPI's Vinyl Institute has sponsored a study to supplement and revise a report on Pb in plastic products in municipal solid waste, which was originally published by the US Environmental Protection Agency (EPA) in 1989. The new study reanalyzes the sources of Pb in heat stabilizers in plastics, using more detailed information than previously was available. Results indicate that the estimates of total 1986 discards of Pb in plastics are 11% less than those contained in the original EPA report. Overall, discards of Pb in stabilizers in polyvinyl chloride are projected to be lower in the year 2000 than those projected in the 1989 report. Both studies were conducted by Franklin Associates, Ltd. (News Brief). (46, (12), 3 [in English]. ISSN 0091-9578)

2528 MANY SMALL LEGISLATIVE ISSUES COULD ADD UP TO MAJOR BURDEN. [BIB-199102-P4-0007]

The Society of the Plastics Industry and the Council for Solid Waste Solutions have pegged solid waste as the most significant area to watch for US governmental involvement in 1991. At the federal level, the issue is likely to focus on one major piece of legislation: reauthorization of the Resource Conservation and Recovery Act. Besides solid waste, a host of issues will affect the US plastics industry, including: the potential for the list of substances considered hazardous to be expanded; new environmental or energy taxes; and the possible lowering of the regulatory threshold for hazardous substances. One area that is sure to affect the industry is the Environmental Protection Agency's new stormwater regulation, released in mid-November, which will require every processor to obtain a permit of one form or another. (Lashinsky, A.; 2, (44), 13-14 [in English]. ISSN 1042-802X)

2529 J & L SPECIALTY STEEL USES DERECO SYSTEM TO MANAGE HAZARDOUS WASTE. [BIB-199102-S4-0007]

Hazardous electric furnace dust and other waste materials produced in J & L Specialty Steel's Midland, Pennsylvania, USA, stainless steel operation are processed in a briquetting facility that produces a recyclable electric furnace charge material. Cost savings are approx $10.00/liquid steel ton compared with dust disposal in a landfill. A future thermal separation plant will produce feedstock to a metal refiner for final resmelting from progressively Zn-enriched dust. (Marino, D.J.; White, J.F.; Deszo, R.L.; 67, (12), 47-50 [in English]. ISSN 0021-1559)

2530 WASTE CHARACTERIZATION AND ANALYSIS: NOW, IT PAYS TO KNOW YOUR WASTES. [BIB-199103-G4-0025]

The benefits of knowing all about plant waste materials and processes make possible intelligent decisions regarding waste management options such as: whether wastes are being disposed or handled according to regulations; the minimization or reuse of certain waste materials; and whether disposal or constructive use options can reduce costs and liability. A typical foundry can generate from 8-40 individual wastes. Idenitification of each generation point is important to avoid overlooking wastes generated infrequently or in small quantities. Points to consider in setting objectives, sampling, laboratory analysis and interpretation of results is discussed. (Streblow, S.; 81, (1), 30-31 [in English]. ISSN 0026-7562)

2531 ENVIRONMENTAL ASSESSMENTS AND AUDITS. [BIB-199103-G4-0031]

The single most important reason for conducting environmental assessments and audits is the effect of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). This law, better known as "Superfund", requires the cleanup of sites which pose a threat to human health or the environment. It is critical for a foundry seller or buyer to understand the purpose of the assessment or audit. There are many types serving different purposes. Generally, as used here, property reviews fall into two categories: assessments and audits. An assessment focuses on CERCLA or Superfund liability for past practices; the audit on present and future compliance issues. (Aldred, J.P.; Euvard, L.E.; 81, (2), 33-35 [in English]. ISSN 0026-7562)

2532 FOUNDRY WASTE RESEARCH: A MODEL FOR INDUSTRY. [BIB-199103-G4-0033]

Foundries constitute one industry group that has developed and maintained an extensive waste managment research effort since the early 1970s. Their research has not only earned the praise of EPA officials, but has also resulted in a series of important EPA decisions that have saved the industry many millions of dollars in waste disposal costs. A history of the research conducted by the American Foundrymen's Society over the past 20 years on waste disposal is given. (Smith, J.D.; 81, (2), 24-27 [in English]. ISSN 0026-7562)

2533 RCRA'S SOLID WASTE REGULATION AND ITS IMPACT ON RESOURCE RECOVERY IN THE MINERALS INDUSTRY. (REPORT). [BIB-199103-G4-0034]

The application and impact of the Resource Conservation and Recovery Act's (RCRA) regulations on the US minerals industry's efforts at resource recovery were analyzed, and some major regulatory conflicts, which hinder these efforts, discussed. One major conflict was the ambiguity in determining materials considered to be solid wastes under the Environmental Protection Agency's (EPA) jurisdiction. In addition, it was found that some rules have combined effectively to discourage reuse efforts and that EPA has provided only a few limited exclusions for recyclable materials. As a case study, Al industry's spent potliner was examined to demonstrate these adverse impacts. Prior to regulation, this material was being recycled for legitimate economic and resource recovery purposes to extract its energy and fluoride values through environmentally sound processes. However, virtually all efforts to reuse the material ceased after regulation, which has resulted in increased land disposal of mineral resources and increased costs to industry. Presently, the fully utilized reuse of this material could produce estimated avoidable costs and savings for industry of approx $24 million. However, this amount may greatly understate the potential savings as hazardous waste land disposal costs increase thorugh the anticipated imposition of increased state taxation. (Peterson, S.D.; Publisher: Bureau of Mines, US Department of the Interior, Washington, D.C., USA, (Sept. 1990), Pp 13 [in English].)

2534 COMPUTER MODEL FOR NUCLEAR WASTE CONTAINMENT USING GLASS. [BIB-199103-C3-0013]

Researchers at Lawrence Livermore National Lab, Livermore, California, USA, are developing a computer model of a proposed repository which could combine and safely store chemically resistant borosilicate glass with radioactive waste. The computer model calls for glass to be combined with Pu, Am, and Ne, housed in a double-walled metal container and placed in the US high-level waste repository at a proposed location of Yucca Mountain, Nevada. Research is focused on understanding the chemical reactions taking place when the glass contacts the groundwater and rocks present at the repository site. When the research is complete, the computer model will be a total performance assessment incorporating the computer simulations and predictions with graphics and three-dimensional images. This model will enable an optimal site and repository design to be selected. (News Brief). (70, (2), 204 [in English]. ISSN 0002-7812)

2535 PYROLYSIS FOR DISPOSAL OF WASTE GRP. [BIB-199103-D4-0002]

R&D studies by several organizations indicate the feasibility of high-temperature pyrolysis as the way to dispose of waste glass-reinforced plastics—to keep

storage of pellets away from areas subject to flooding. (46, (9), 5 [in English]. ISSN 0091-9578)

2515 RECYCLING WASTE, SAVING MONEY THROUGH IN-PLANT RECYCLING. [BIB-199010-S1-0058]

Bethlehem Steel Co. has embarked on an all encompassing recycling program. At Burns Harbor, there is a multi-phase program being instituted that will ultimately recycle nearly 100% of all reverts or wastes. The cost is estimated to be $14 million but could potentially save $10 million/year in transportation, landfill costs and reclaimed Fe and carbon. This plan includes equipment to remove contaminants from the environment, waste minimization, and everyday actions to recycle common material's such as wood and paper. The Bethlehem position is that recycling can be a low- or no-cost process. ((2), 4-6 [in English].)

2516 NEW RESEARCH CONSORTIUM TO TACKLE FOUNDRY WASTE PROBLEM IN ONTARIO. [BIB-199010-S4-0069]

Ten of Ontario's Fe foundries are combining forces with the Manufacturing Research Corporation of Ontario (MRCO) to investigate ways of recycling industry waste. The Foundry Group Consortium is focusing initially on the reclamation of moulding sand which becomes contaminated by chemicals used in the foundry casting process. Some foundries are having difficulty even finding sites capable of taking the thousands of tons of waste sand produced by the industry each year. One solution is a waste exchange program in conjunction with the Ontario Waste Management Corporation. This would involve providing the waste sand for use in the manufacture of other products, principally asphalt and other road construction materials. (32, (3), 10-11 [in English]. ISSN 0380-1969)

2517 GENEVA COMPLETES PHASE 1. [BIB-199010-S4-0070]

Geneva Steel has completed the first of four phases in its $226 million environmental modernization program. In this phase, Geneva constructed a $7.5 million biological wastewater treatment plant in a project that reduces the amount of ammonia in its coke flushing water. Activated mirco-organisms in reactors remove ammonia from wastewater by converting it into water, nitrogen and carbon dioxide. The plant also will eliminate the current practice of cooling blast furnace slag with coke oven wastewater. The slag now will be cooled with treated water, which will result in approx 85% reduction in particulate emissions from slag cooling. (98, (178), 3 [in English]. ISSN 0002-9998)

2518 NORWEGIAN GRANT TO SOVIET UNION TO CLEAR NICKEL POLLUTION. [BIB-199011-G4-0131]

The Norwegian government is to give the USSR approx US$50M to clean up pollution from the country's two Ni plants in the Kola Peninsula. The plants, at Monchegorsk and Pechenga, are thought to be responsible for sulphur gas emissions which are damaging vegetation in neighbouring Norway. The cash is to be allocated from the government budget pending parliamentary approval. It will be part of a joint Nordic environmental package, worth approx $164M and includes Sweden, Finland, Norway and the USSR. (News Brief). ((75), 5 [in English].)

2519 GLASS ENCAPSULATION OF HAZARDOUS WASTE. [BIB-199011-C6-0074]

Corning's Business Development Group in UK and France is assessing the potential of glass and glass ceramics as "ultimate" long term protective materials for hazardous waste storage. (News Brief). (7 [in English].)

2520 PLASTICS WASTE PROBLEM. [BIB-199012-P1-0170]

The production of plastics in Japan has exceeded 10 million tons annually since 1987 and, it is estimated that the used plastics waste may reach close to 5 million tons yearly. The recycling of the plastics waste is becoming an important problem for the industry. About 50-60% of the plastics waste is estimated to come from the house and city garbage. The remaining amount is considered as the waste by-produced in various, industrial circles. The plastics waste of the industrial circle is already recycled and reused and is handled by about 600 special firms. For example there is a joint venture between Mitsubishi Chemical Industries Co., Dainippon Ink and Chemical Co. and Nissei Plastics Industrial Co. called Nippon Palletech Co. The joint venture has been established for studying the recycling of beer bottle crates for Kirin Brewery Co. Kirin is using the recycled material of their crates for producing new crates. Recycling is gradually becoming a new type of business. But there are yet many problems to be solved for the handling and treating of the general city waste. (News Brief). (36, (10), 147-148 [in English]. ISSN 0032-1206)

2521 DOW EUROPE GEARS UP FOR INTENSE RECYCLING EFFORTS. [BIB-199012-P1-0172]

Dow Europe has signed a letter of intent with Germany's Otto Group to co-operate in the recycling of plastics from the consumer and commercial waste stream. Both parties are hopeful of an annual rate of approx 8-10 000 tonnes of recycled plastics once the scheme has been running 2-3 years in full production. Dow and Otto, which specialises in waste management systems, have already been working together for several months, and the project will continue at a development phase level for the next 12-18 months. (News Brief). ((1360), 3 [in English]. ISSN 0032-1168)

2522 B.U.S.-FINDING VALUE IN WASTE. [BIB-199012-S1-0070]

Berzelius Umwelt-Service emphasises the environmental impact of its services, which are centered on the disposal of all kinds of industrial residues and wastes. However, in terms of its metal activities, BUS is already a substantial recycler, which is looking to expand further into the US, the Far East and the Eastern Bloc countries. The company's activities in terms of metal recycling can be divided into three main categories—the treatment of Zn-and Pb-bearing residues from the Fe and steel industry, the treatment of Ni- and Cr-bearing residues from stainless steel mills and the recycling of Al salts. ((80), (Suppl. Scrap), 6, 8, 16, 20 [in English].)

2523 WASTE DISPOSAL: A SUMMARY OF THE FINAL RULES. [BIB-199101-G4-0002]

The Land Disposal Restrictions for Third Scheduled Wastes, or land ban regulations, will bring sweeping changes to the foundry industry. EPA identified in the regulations the best demonstrated available technology (BDAT) for a large number of wastes. The BDAT was demonstrated on a full-scale level, the results of which are currently available to generators. A constituent-specific maximum concentration to be allowed in the waste after treatment also was established for some waste types. Where treatment standards have been proposed, the generator has the option of applying the BDAT or an alternative treatment method that achieves the same treatment standard a summary of the regulations for corrosion, ignitable and reactive wastes and dilution prohibition is provided. (Bremer, J.; 80, (12), 38-39 [in English]. ISSN 0026-7562)

2524 RECYCLING: A VAST PROGRAMME. [BIB-199101-P1-0014]

Production scrap and that from treatment of plastic materials is often recycled where produced or sold to separate recyclers. More and more, the recycled scrap is used for new applications. The main industries involved include automobile, packing and agriculture. Joint schemes exist in France, involving manufacturers and also environmental organisations and increasing amounts of plastics are being recycled, particularly from domestic waste. The amounts and types recycled can vary between different localities, according to the populations and industries involved. In the UK, out of 20 million tonnes/year of domestic rubbish, 150 000 tonnes of plastics are recycled. For the future, attention will be necessary for the increasing amounts of plastics involved in scrapped cars and re-use in new ones. (News Brief). (Topuz, B.; 42, (9), 74-77 [in French]. ISSN 0032-1303)

2525 EMERGENCY RESPONSE: OSHA AND YOUR RESPONSIBILITIES. [BIB-199102-G4-0014]

One of the more overlooked and misunderstood standards in the OSHA regulations is 1910.120, Hazardous Waste Operations and Emergency Response. This federal regulation went into effect in March 1990, and has been a problem for both industry and OSHA enforcement personnel to fully understand how it applies to industry. This standard, therefore, affects those operations that generate, treat, store, or dispose of hazardous waste as defined by the EPA regulations. In addition, it also affects those companies who handle, store, or in any way use a hazardous substance. If your facility falls under these regulations, you will need to develop a very comprehensive written program on responding to any spills or releases, a study characterizing and analyzing any potential hazards resulting from the handling of this material, medical surveillance of employees, training of employees, engineering controls, monitoring, and decontamination

2503 TiO_2 PRODUCERS CLEAN UP. [BIB-199009-G4-0101]
Several of the major TiO_2 producers have announced substantial investment in acid waste recycling and waste minimisation. UK company SCM Chemicals Ltd is spending pounds sterling 14 million on technology to reduce waste from its 85 000 t/year chloride route plant at Stallingborough in South Humberside. New plant will convert the acid wastes into hydrochloric acid and metal oxides and reduce solids and dilute acid discharge. ((274), 19 [in English]. ISSN 0019-8544)

2504 GOVERNMENT CONFIRMS STAND ON LICENSING DESPITE PLEAS FOR THE SCRAP INDUSTRY. [BIB-199009-G7-0268]
In the House of Lords Committee stage of the Environmental Protection Bill, the Government reiterated its refusal to exempt the scrap industry from waste management licensing, but was willing to consult relevant organizations such as the British Secondary Metals Association in framing licensing guidelines. It added that possession of a Waste Management Industry Training Advisory Board qualification may be a requirement for holding a waste management license. (155, (26), 18-19 [in English]. ISSN 0025-5386)

2505 CERAMICS COULD LOSE IN CONTINUING PUSH FOR SOLID WASTE DISPOSAL LEGISLATION. [BIB-199009-C4-0002]
Legislative proposals concerning municipal solid waste disposal, which are pending, or about to be introduced, in approx 12 US states will significantly affect the ceramic industry if enacted. A New Jersey bill would effectively eliminate the sale and distribution of any glass or ceramic products with a Pb- or Cd-containing pigment, enamel or glaze in the state. The statute would cover such ceramic items as plumbing fixtures, tile, flat glass, stained glass, scientific ceramic items, and coffee mugs. Also introduced in New Jersey is the "Toxic Packaging Reduction Act", endorsed by the Coalition of Northeastern Governors. The Society of Glass & Ceramic Decorators (SGCD) is mobilizing various aspects to the industry to deal with the New Jersey situation. (Calderwood, J.A.; 134, (4), 22 [in English]. ISSN 0009-0220)

2506 MIXED PLASTICS PROCESS ON OFFER. [BIB-199009-P1-0133]
Austrian company CA Greiner und Sohne has developed technology for the recycling of mixed plastics from household waste. The system is up and running in Austria, with commerically viable recycled products on the market, and is now being offered under licence to processors worldwide. The Greiner process is claimed by the company to offer higher outputs and the possibiltiy of making from the reclaimed material a wider range of profile products than is possible with other mixed plastics processes. The technology involves reprocessing of mixed waste as received from collection without washing or sorting. (News Brief). ((1346), 6 [in English]. ISSN 0032-1168)

2507 PVC IS A GOOD BET TO SURVIVE ITS GLOBAL ENVIRONMENTAL TRAVAILS. [BIB-199009-P7-0114]
The PVC industry has mobilized on environmental issues, and most available data support its claims that PVC is more environmentally sound than alternative materials (as well as more versatile and less expensive). Among the points which are central to the PVC regulatory situation: Incineration and recycling will grow in importance, and efforts by vinyl suppliers to increase collection and sorting technologies for recycling, as well as clean waste-to-energy incineration systems, will help. Packaging is the first target, but other markets, including construction, have been named in some proposals. Regulations could affect PVC markets on a global basis. More proposals are being considered in Western Europe, but some US jurisdictions are attempting to limit PVC use. Alternative materials such as polypropylene grades that run on conventional PVC processing equipment have been introduced. (Kreisher, K.R.; 67, (6), 60-62, 64 [in English]. ISSN 0026-8275)

2508 ENVIRONMENTAL BENEFITS FROM CONTRACTING. [BIB-199009-S4-0066]
MultiServ International is the world's largest specialist contractor for steel industry waste materials handling and metal recovery. The company's environmentally positive procedures include pelletising waste, recovering metallics and the processing of EAF and AOD flue dust using plasma process technology. Unlike other technologies, MultiServ's solution to EAF dust disposal can be economically viable for a single customer mill. (218, (7), 358-359 [in English]. ISSN 0039-095X)

2509 METALS IN SOLID WASTE RISING. [BIB-199010-G1-0200]
The presence of metals in municipal solid waste will increase by approx 6%/year over the next five years, but the proportion of waste that it represents will decline, according to a recent report by the federal Environmental Protection Agency. Between 21-29% of thrown-away materials recovered for recycling in 1995—not counting industrial scrap—will be metals. By 1995, it is expected that municipal solid waste will total almost 200 million tons, and metals are expected to comprise approx 16.2 million tons of that total. By 1995 Al cans are expected to grow to approx 1.8 million tons while the steel beverage can portion is likely to hold still at 100 000 tons and 0.1% of the total. (Kuster, T.; 98, (161), 9 [in English]. ISSN 0002-9998)

2510 STATISTICS FOR LEGISLATORS. [BIB-199010-G4-0103]
Statistical data which can be used with US state legislators are tabulated. They include estimates of waste disposal costs, OSHA-EPA compliance costs and tons of waste disposed by ferrous and nonferrous foundries, for all states with ACMA members. These numbers were derived from ACMA's Foundry Industry Performance Study (FIPS). Data obtained as follows: column 1, 1986 County Business Patterns , US Department of Commerce; columns 2-4, average per plant based on responses to 1990 FIPS Survey. (21-22 [in English].)

2511 SURVIVING IN THE 21ST CENTURY (WITH ENVIRONMENTAL REGULATIONS). [BIB-199010-G4-0106]
Major changes in environmental laws have placed corporate executives in line for prosecution for violations of these laws. Emphasis on environmental clean-up has paid off, but today's industries must remain aware of their responsibilities. To stress this, the EPA has developed standards for waste management consistant in all ten regions. Violators can be subject to jail terms and fines up to $25 000/day of violation. Several pitfalls that a CEO faces are outlined to provide guidance for corporate survival while still keeping our environment clean. (Jacobs, J.; 35, (6), 15-18 [in English]. ISSN 0015-2358)

2512 AIR POLLUTION CONTROL SYSTEMS CLEAN FURNACE EXHAUST. [BIB-199010-G4-0111]
The new anode baking furnaces installed by Alcan Smelters and Chemical Ltd., Jonquire, Quebec, Canada, are near pollution free because of the air scrubbers that process the exhaust to remove condensable tars and HF. The total system consists of indirect gas coolers that circulate furnace gas around cooling tubes, electrostatic precipitators and dry scrubbers. The tars not condensed in the coolers are electrostatically precipitated into a heated hopper for pumping into trucks for disposal. The dry scrubber removes HF in a fluidized bed of Al_2O_3. The Al_2O_3 with adsorbed HF is collected in a baghouse for disposal. This system, which was designed by the Mikropul Environmental Systems Division of Hosokawa Micron International, allows only 2.5 mg to escape to the atmosphere for each 1250 mg of HF entering the system. (4, (7), 18-19 [in English].)

2513 JAPANESE SLOW TO ADOPT PLASTICS RECYCLING. [BIB-199010-P1-0141]
Compared to the US and Europe, Japan has been slow to adopt plastics recycling. Technology has not been a critical problem hampering recycling. Numerous curbside collection systems are in place, and the country also has a good network of incinerators. Nationwide, there are nearly 1900 incinerators, many of which are designed to prevent the emission of dangerous gases. Thus, the incinerators are able to burn most plastics safely. An estimated 70% of all plastic waste is burned. (Schreffler, R.; 2, (29), 22 [in English]. ISSN 1042-802X)

2514 SPI PRESIDENT URGES PROPER PELLET HANDLING. [BIB-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

million/year. This shows why Du Pont place great importance on waste. Previously discarded paint is sold for purposes other than that for which it was originally manufactured. Increased efforts are being made to increase recycling activities. Waste is recovered where possible from all Du Pont plants, including materials which are not plastics, e.g. electroplating sludges. Only the minimum of waste is destroyed. (84, (1), 2-4 [in English].)

2493 EUROPEAN ASSOCIATION TO PROMOTE RECYCLING PLANS. [BIB-199006-P1-0092]

The European Recovery and Recycling Association (ERRA) was launched in Brussels in March 1990. It is currently made up of 19 major international companies, including such names as CMB, Coca-Cola, Eastman Chemical and Solvay, and will be established in Brussels as a non-profit organisation to promote and accelerate the understanding and resolution of issues concerning solid waste management. The members have committed substanital funds to support, develop and implement projects demonstrating new techniques for the collection of a wide range of a wide of materials from household waste for recycling. ERRA will also sponsor scientific research and studies, seminars and conferences and will provide an information source. ((1328), 2 [in English]. ISSN 0032-1168)

2494 PLASTICS ONLY 11.8% IN JAPAN MUNICIPAL SOLID WASTE STREAM. [BIB-199007-P1-0103]

A survey on the composition of household wastes in Nishinomiya City by the Plastic Waste Management Institute of Japan shows that 37.3% is paper, 32.8% is garbage and 11.8% is plastics. The proportion of plastics in the municipal solid waste is 11.8% (by weight on a wet basis), but since approx 30% moisture, dirt and foreign substances stick to the plastics, the proportion, says the Institute, really becomes 8%, when such substances are eliminated. By resin, polyolefins account for the largest share, 65.4%. By type, films account for approx 50%. (6 [in English]. ISSN 1044-9663)

2495 PLASTIC BEADS FROM WASTE PLASTIC. [BIB-199007-P1-0114]

A waste plastic reprocessing plant has been developed by Taiyo Electric Industry Co. Ltd. This uses waste plastic at low cost. The enormous piles of waste plastic are causing trouble in disposal. This process eases this problem, and others at the same time. The plant is termed TK-8602 and uses a special washing technique using ultrasonic waves. In so doing it does not generate further pollution. Crushing, washing and dewatering processes take place, followed by drying, recovery and further use. One plant can regenerate 2000 t/year. (17, (12), 44 [in English]. ISSN 0385-6542)

2496 WASTE GROWTH WILL SLOW AFTER 1995. [BIB-199007-P1-0115]

A report from Helmut Kaiser (Germany) suggests that 23.9 million tonnes plastics were consumed in West Europe in 1989. West Germany took 27.5%, Italy and France over 14%, and UK 11.4%. Refuse of 9 million tonnes was produced, again with Germany leading. It is predicted that European plastics waste will grow at 11 million tonnes/year until 1995 but that environmental pressure will see decreasing acceptance of plastics after that. In 1989, 1.7 million tonnes Western European plastics were recycled; this should be 3.5 million tonnes by year 2000. (17, (5), 51 [in English]. ISSN 0306-3534)

2497 BIG CHANGES IN UK WASTE REGULATIONS: THE STEEL INDUSTRY'S NEW DUTY OF CARE. [BIB-199007-S4-0050]

Existing British regulations on waste disposal are being strengthened in the spring of 1990 by the Environmental Protection Bill. All waste producers will have a statutory duty of care to ensure that their wastes are disposed of responsibly. This will affect the entire steel industry, from integrated steelworks to small picklers or steel stockholders. It will relate to all type of waste, such as toxic waste and steel scrap. Even under current regulation steel companies should already be carrying out many basic checks, details of which are given. The local authority will, in future, have to compile a register of all carriers of waste (including scrap for recycling). The new legislation will have an effect on steel producers' costs. A pickling plant of even a medium sized company can credit an acid waste disposal cost of pounds sterling 20 000/year. Landfill costs could rise 30-60% in the next year. (Lausence, D.; 218, (3), 133, 139 [in English]. ISSN 0039-095X)

2498 THERMAL SAND RECLAMATION: A STRATEGY FOR WASTE MINIMIZATION. [BIB-199008-G4-0078]

With the rapid closing of existing landfill sites and the prohibition against opening new ones, the need to limit all types of industrial waste is imperative. The restriction and eventual ban on classified waste dumping has increased the need to find alternatives to waste foundry sand landfills. Based on economics alone, sand reclamation may be the only technology the foundry industry has to meet the requirements of the Resource Conservation and Recovery Act (RCRA). Combining waste separation with recovery strategies and thermal sand reclamation could reduce the spent waste sand stream by as much as 95%, and the associated disposal and handling costs decrease by a like percentage. New sand casts are also reduced. (Reier, G.J.; 80, (5), 37-39 [in English]. ISSN 0026-7562)

2499 FOUNDRIES FACE STRICTER AIR QUALITY, POLLUTION MONITORING. [BIB-199008-G4-0079]

For years, foundries, like other heavy industries, have worked to eliminate or minimize air pollution by utilizing dust collector systems, scrubbers, precipitators and other devices to capture a broad range of airborne contaminants. By and large, these efforts were successful, but now new air quality regulations have stiffened the requirements on effluents, exhaust gases, fumes, impurities and other waste materials. Methods for reducing these pollutants to bring foundries into compliance with these new regulations are suggested. (80, (5), 33-35 [in English]. ISSN 0026-7562)

2500 BASF OFFERS RECYCLING PROGRESS REPORT. [BIB-199008-P1-0120]

BASF, one of the world's three largest chemical companies, is spending DM10 million/year (approx $6 million) on recycling research. Planning is almost complete for a plastics-incineration plant designed to process 44 000-66 000 tons/year of waste. That size of plant would enable the handling of household and industrial plastic wastes from as many as 3 million people. BASF will be seeking a partner, such as an electricity-generating utility, that ultimately will take over management of the plant. The company is following a similar path with recycling, preferring to develop recycling methods that others will use. (Short, H.; 2, (19), 13 [in English].)

2501 DUTCH PVC INDUSTRY FACES POSSIBLE BANS. [BIB-199008-P1-0124]

The first of a series of talks that could decide the fate of PVC in the Netherlands took place 22 May 1990 between officials of the Dutch government and the Dutch Plastics Federation (NFK—Nederlandse Federatie voor Kunststoffen). Discussions centered on a position paper presented by NFK's steering group on PVC, which is designed to serve as a basis for negotiations on an environmental policy for PVC. There is agreement on the need for recycling, phasing out of Cd stabilizers and waste measurements for short-cycle materials, but not for long-cycle materials. The government plan—called National Plan Plus—is that waste streams should be stabilized at 1986 levels, meaning that landfilling will be reduced, and incineration and recycling will be increased. (Slis, N.; Short, H.; 2, (15), 7 [in English].)

2502 "PURGATORY" FOR SPECIAL WASTE (IN STEEL BATH). [BIB-199008-S4-0055]

A waste disposal process has been developed by Dornier GmbH, Friedrichshafer, FRG, which breaks down toxic wastes chemically in a bath of molten steel at temperatures 1600 °C . The chemical elements which are released during the high temperature incinerating process do not react to form toxic chemicals but rather, end up in a form which can be recovered or disposed of easily. Nickel, Cu, arsenic, as well as C and oxygen dissolve in the melt. Manganese, Cr and mineral rock components such as Si and Ca collect in the slag in an oxidized form. Heavy metals, which have a high vapour pressure at the bath temperature (Pb, Sn, Zn, Cd, Hg) excape as gas from the melt with the halogens, hydrogens, nitrogen, and carbon monoxide from "burned" carbon. The waste gas does contain a series of potential pollutants but they can easily be neutralized before being released into the atmosphere. (Steinert, H.; 6, (2), 9-10 [in English]. ISSN 0933-7814)

moval of PVC from the waste has no effect on dioxin formation under proper incineration conditions. (Short, H.; 1, (50), 5 [in English]. ISSN 1042-802X)

2481 EMISSION CONTROLS: NEWEST SYSTEMS MEET REGS, DELIVER EXTRA BENEFITS. [BIB-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 $m^3 s^{-1}$. 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.; 45, (12), 20-22, 24, 26, 28 [in English]. ISSN 0026-8127)

2482 "BACKYARD BOYS" TO COME UNDER REGULATORY YOKE. [BIB-199005-G4-0048]

At present, "conventional" Al secondary refiners in the UK are controlled by HM Inspectorate of Pollution using the Best Practicable Means guidelines published in 1981. Aluminium slags must be disposed of at a controlled dumping site, while bag filter dust must be bagged before disposal. Following the UK Environment Protection Bill (1989), pollution could be controlled more closely and fairly. (News Brief). (Cowhig, J.; (7468), 13 [in English]. ISSN 0026-0533)

2483 NGK METALS FINED FOR WASTE DUMPING. [BIB-199005-G4-0050]

NGK Metals Inc. was ordered to pay $300 000, including $20 000 to a local environmental group, after entering no-contest pleas to charges stemming from the illegal disposal of chemical wastes at its Muhlenberg, Pennsylvania, USA, facility. NGK manufactures a rare alloy, Be—Cu, for use in spark plugs and other components. The complaints also charged that NGK and a former employee attempted to conceal illegal discharges of waste by submitting falsified reports to the state. (Elson, J.; 98, (58), 5, 10 [in English]. ISSN 0002-9998)

2484 NORDENHAM LEAD SMELTER CLAMPS DOWN ON EMISSIONS. [BIB-199005-G4-0052]

Plants in West Germany are being forced increasingly to adopt better controls for emission pollution. Some Pb smelters have decided to adopt new technology, such as QSL. The Nordenham plant is, however, not changing from its present shaft furnace technology. The reason for this is that it is not felt that new techniques have yet been proved fully. Considerably improvements have already been achieved by Nordenham, sufficient to meet present requirements. There are some problems storing waste jarosite. (News Brief). (Anyadike, N.; (7467), 7 [in English]. ISSN 0026-0533)

2485 RHONE-POULENC PINJARRA RE (RARE EARTH) PLANT HALTED. [BIB-199005-G4-0058]

Plans by the French-based Phone—Poulenc (RP) company to build a 15 000 t/year monazite-processing facility at Pinjarra, in Western Australia, have been halted by continued governmental refusal to approve the second phase of the project. The problem concerns disposal of by-product NH_4NO_3 and radioactive Th and Ra, and the delay has prompted RP to withdraw from the project, which would have generated export earnings of A$100 million/year. The raw material would have been supplied by Associated Minerals Consolidated Ltd., which presently ships its entire Australian output of monazite to a RP plant in France. (News Brief). ((270), 19 [in English]. ISSN 0019-8544)

2486 MS TAKE PLASTICS WASTE TO THE CLEANERS. [BIB-199005-P4-0014]

Ms of all parties have been calling for better controls on plastics waste. One, Andrew Bennet, offered an amendment to a bill which would have placed greater pressure on the packing industry and its use of plastics. This would ensure the return of waste products for re-use but was defeated by a small majority. There has been united urging for biodegradable types of plastics to be pushed forward, to the extent of compulsory use for certain purposes in commerce. (Lunney, A.; (1326), 1-2 [in English]. ISSN 0032-1168)

2487 LICENSING OPPORTUNITIES: ALL-PLASTIC SEWAGE TREATMENT PLANT. (PAMPHLET). [BIB-199005-P9-0070]

Mechano-biological sewage treatment plants developed by Polytechna, Czechoslovakia, constructed from injection-molded thermoplastic structural foam parts (except for the shaft and electric motor) are resistant to chemicals and corrosion, they are light, and operate with an extremely low consumption of energy. Transport and installation is simple because of the low weight. They work automatically with a high purification efficiency under all climatic conditions. The units do not cause air or noise pollution and the service life is long. The main application is for hotels and campsites, residential buildings, agricultural and foodstuff plants involving 6-120 people. Over 600 plants have been installed in Czechoslovakia. Inexpensive material, simple processing technology, and modular design facilitate efficient production. An injection molding machine for structural foams with 30 kg capacity is required. (News Brief). (Publisher: Kiser Research, Inc., P.O. Box 33608, Washington, D.C. 20033, USA, (Jan. 1990), 5, (1), 4 [in English].)

2488 DISPOSAL OF FOUNDRY WASTE PRODUCTS—PROFESSIONAL ACTION. [BIB-199005-S4-0030]

The French ferrous foundry industry generates approx 2.4 million tons of waste, 2 million tons of which is used sand. The factors to be considered in the disposal of these waste products are defined. Subjects covered include original use of the sand, quantities, contained pollution and its elimination and protection of the environment. (Charbonnier, M.; Elary, M.; (91), 8-14 [in French]. ISSN 0249-3136)

2489 US LEAD INDUSTRY UNDER SIEGE FROM POWERFUL ENVIRONMENTAL LOBBY. [BIB-199006-G4-0061]

With effect from 8 May 1990 secondary Pb smelters in the US will be prohibited under the Resource Conservation and Reclamation Act (RCRA) from disposing of their untreated hazardous Pb waste in landfill sites. Under new RCRA regulations a limit of 0.51 mg/l of Pb in landfills has been set. Currently there is no set limit as to the content of Pb in landfills. The new limit will effectively stop secondary producers dumping their waste, as the technology necessary to render Pb waste "safe" is not available. The Secondary Lead Smelter Association has filed with the Environmental Protection Agency for a two-year administrative stay to be placed on the ruling, to enable the smelters to assess and advance their waste management technology. ((56), (Suppl.: Scrap), 10 [in English].)

2490 PLASTICS: CAN MORE BE MADE INTO LESS? [BIB-199006-P1-0071]

Although plastics constitute a relatively small portion of the weight of the solid waste stream, they are important in volume terms. According to DeWitt & Co., Houston, Texas, USA, plastics constitute 18% of the waste stream against 38% for paper and paperboard, 14% for metal, only 2% for glass, and 28% for other materials. To successfully solve the waste disposal problem, three actions are urged: source reduction for plastics materials needs to be implemented; recycling needs to move ahead faster; and the waste disposal industry needs to be encouraged to build new incinerators. (Wood, A.; 146, (17), 36, 38, 40 [in English]. ISSN 0009-272X)

2491 IS BURNING PVC A PROBLEM? [BIB-199006-P1-0084]

Ogden-Martin Systems Inc., a major US builder and operator of municipal waste-to-energy incinerators, was once a tough critic of vinyl's role in the solid waste stream. In 1984, in a submission to the US Food & Drug Administration, Ogden—Martin labeled PVC a contributor to acid rain. It had also pegged PVC a top cause of the corrosion often found in incinerator boilers. In its 1989 submissions to the FDA, however, Ogden-Martin has reversed those initial positions, citing new data that support the position that the disposal of vinyl in a modern incinerator is technically feasible and environmentally safe. (67, (4), (Suppl.: Waste Solutions), 72-73 [in English]. ISSN 0026-8275)

2492 SOLVING THE PROBLEM OF WASTE. [BIB-199006-P1-0085]

About 1 lb of dry waste is produced for every 10 lb of product made by Du Pont. In 1985, the figure was higher at 1.25 lb. This is a saving of approx $25

2470 TITANIUM SEEN PLAYING KEY ROLES IN "GREEN REVOLUTION". [BIB-199001-G6-0035]

A strong potential market envisaged for Ti is sewage treatment plants, in view of its corrosion resistance. Brown & Caldwell, a Phoenix-based builder of such plants, has been experimenting with Ti as well as painted and coated steels, plastics and stainless steel. Titanium shows promise of withstanding the corrosive gases normally encountered and should last the 20-30 years lifetime of the plant. (Stahl, D.; (7427), 25 [in English].)

2471 EPA GETS TOUGH WITH STEEL'S TOXIC CLEANUP. [BIB-199001-S4-0003]

Recent US Environmental Protection Agency (EPA) announcements regarding leaks from gasoline and other chemical storage tanks and emissions of leukemia-causing benzene from a host of sources—including metallurgical and foundry coke plants—are creating headaches for the industries involved, and new business opportunities for engineering companies that specialize in developing and implementing solutions to environmental problems. The federal agency has estimated that controlling benzene emissions at 36 active coke and coal-chemical plants could run up a tab of approx $74 million and hike the price of blast furnace and foundry coke 1% or more, or approx $1.20/ton. (Hess, G.W.; 5, (11), 29-31 [in English]. ISSN 0897-4365)

2472 LEAD AS A CONTAINMENT MATERIAL FOR NUCLEAR WASTE. [BIB-199002-G4-0016]

With a steady increase of 30 tonnes/annum from each of the world's expected 510 nuclear plants, the amount of high-level nuclear waste will soon reach a figure of 15 300 tonnes annually by the year 2000. Lead—even with its tendency toward grain growth, which results in decreased corrosion resistance and a need for structural support—is potentially the ideal material from which to manufacture high-level nuclear waste "coffins" for subterranean burial. The mechanical stability and corrosion behaviour of Pb are briefly reviewed. (Krysko, W.M.; 41, (12), 28-29 [in English]. ISSN 0148-6608)

2473 DEGRADABLE PLASTICS GET DEPLORABLE MARK. [BIB-199002-P1-0018]

Degradable plastics in products and packaging do not offer all the environmental or recycling benefits their promoters claim, according to a recent report by the Environmental Defense Fund and the Environmental Action Foundation. The groups called for a national boycott of degradable plastics in response to the questionable or false claims that these products are good for the environment. Other environmental organizations endorsing the report included the Coalition for Recyclable Waste and the Natural Resources Defense Council. (97, (247), 6 [in English]. ISSN 0002-9998)

2474 INCINERATORS TO BURN HIGH POLYMER WASTES. [BIB-199002-P1-0035]

A range of incinerators are offered with alumina cement walls, assuring high combustion efficiency and thermal insulation. Any polymer except PVC may be burned, the tertiary combustion chambers and cyclone separators producing only one tenth of the ash of conventional models. (News Brief). (6, (12), 12 [in English]. ISSN 0265-3443)

2475 RESIDUALS RECOVERY—SERVICE OF A METALLURGICAL CONCERN. [BIB-199003-G1-0054]

The firm Berzelius Umwelt-Service GmbH (B.U.S.), Frankfurt, FRG, has directed its service enterprise to deal with the recovery of nonferrous metal values in industrial waste and scrap metal accumulations, and the ensuing financial gains. This approach balances the burdensome obligation by the nonferrous metal industry to control effluents and wastes, limit impacts on the environment, and reduce contamination and pollution, as prescribed by law. In fact, the economic advantages may be such that the position of the particular metal producer or fabricator may be appreciably enhanced by domestic or foreign competitors. Several considerations are noteworthy when analyzing the pros and cons of a residuals recovery program. From the standpoint of plant economics, the program may provide cost savings and price cushioning from rising or strongly fluctuating raw material costs involving temporary dislocations or permanent declines in virgin metal supplies. From the broader aspect of the national economy, the program aids in preserving both raw material and energy resources. The program is also environmentally protective, as dumping of metallic wastes (which often are toxic) is reduced, and filling of increasingly scarce sites is eased. (Maczek, H.; 43, (9), 886-888 [in German]. ISSN 0026-0746)

2476 PROFESSIONAL DISPOSAL AS A FIRM STRATEGY. [BIB-199003-G6-0085]

The firm of Edlehoff has recently been involved with the manufacture of refuse vehicles and containers as well as air equipment. The "Multi-Service-Transport-System" (MSTS) is a noteable innovation in the logistics of disposal. With MSTS, collection and transporting of refuse is separate. The link between the two is an exchange container with which waste and secondary raw materials are collected separately, transported to central reloading points and reloading there by collecting and transport vehicles. This is suitable for use on road, rail and water. The material is sorted at the reloading points. Containers and essential components are made of Al. ((5), 50 [in German]. ISSN 0175-6273)

2477 DESIGN-INTEGRATED MANUFACTURING SOLVES SOLID-WASTE PROBLEM. [BIB-199003-P3-0081]

A joint computer-aided engineering project between Abbott Diagnostics Division, Irving, Texas and Nypro, Inc., Clinton, Massachusetts, USA, will remove 500 000 lb/year from the solid-waste stream by improving the design and processing of a disposable medical diagnostic product. Hospitals and laboratories will be able to cut incineration bills that can run as high as $1/lb without sacrificing product performance; and the molder is realizing a 40% productivity boost. Mold flow analysis and other software proved that the wall thickness of the relatively mature injection molded product could be successfully cut in half. Computer simulations facilitated use of a second technology—runnerless molding—that further reduced the shot-volume by one-third. (Kirkland, C.; 48, (2), 13-14 [in English]. ISSN 0032-1273)

2478 WASTE MINIMISATION IN THE METAL FINISHING INDUSTRY. [BIB-199003-S4-0012]

The first of the two underlying principles of the Australian government's industrial waste strategy is that effective management of industrial waste requires an integrated approach encompassing all aspects of waste generation, storage, treatment, transport and disposal. The second underlying principle is that waste minimisation is the preferred option for managing wastes. The implementation of clean technology waste minimisation projects at Gainsborough Hardware Industries, Stokes, Australasia, and Quality Heat Treatment Ltd. is described. (Reeves, F.; 21, (8), 16, 17 [in English]. ISSN 0047-6897)

2479 CONTROLLING NUCLEAR WASTE VIA CERAMIZATION. [BIB-199004-C6-0021]

At the FRG nuclear research center (Kerforschungszentrum, Institut fur Nukleare Entsorgungstechnik), the transformation of transuranic (TRU), and high-level liquid waste (HLLW) streams into a ceramic waste product has been found to be a reasonable alternative approach to conditioning nuclear waste, compared with conventional immobilization methods currently used. Well-defined mixtures of clay minerals and reactive corundum are used. These are then homogenized with the pretreated waste. A stable aluminum silicate ceramic product is generated after carrying out forming (extrusion and cord cutting), followed by heat treating at a maximum temperature of 1350 °C . This composition was selected as the host matrix both because of its stability against attack by aqueous salt solutions and radiation, and because of its fabrication from common, easily obtainable materials. (4, (11), 4-5 [in English]. ISSN 0887-1949)

2480 DANISH MAY CHANGE PLANS AND NOT BAN PVC. [BIB-199004-P4-0009]

In a country that incinerates approx 70% of its waste, the Danish Environmental Protection Agency estimated that dioxin emissions from municipal waste incineration were 1600-3200 g of dioxin equivalents/year. The estimates were based on a 1984 government study. A more recent EPA study conducted in 1986-1987 and made public in September 1989, indicates that 34 g of dioxin equivalents/year is a more accurate quantity. That figure is considered negligible under the fixed upper limits for ingestion of dioxin recommended in Denmark. Re-

affecting the industry were briefly reviewed. (Luce, Z.R.; Anaheim, California, USA, 9-12 Jan. 1989, Publisher: Society of Manufacturing Engineers, One SME Dr., P.O. Box 930, Dearborn, Michigan 48121, USA, (1989), EM89-102, Pp 7 [in English].)

2460 WEST GERMANS SET TO TAKE THE INCINERATION ROUTE. [BIB-198911-P1-0096]

A seminar at BASF was told that West Germany should soon give the go-ahead for construction of 10 or 12 high technology incinerators for industrial waste, with the aim of eliminating landfill disposal. Export of waste was described as unsatisfactory. BASF already treats all its own waste and is studying special treatment plants for plastics residue. Its Ludwigshafen plant produces 1.8 million tonnes of waste annually, of which one third is burnt for electricity generation. About 900 000 tonnes is recycled internally and externally. (News Brief). ((1304), 1, 32 [in English]. ISSN 0032-1168)

2461 A PLASTIC SOLUTION TO KITCHEN WASTE. [BIB-198911-P6-0217]

Ecoplastics of Toronto, Canada, Husky Injection Molding Systems of Bolton, Ontario, and Etablissement Pour Ecovert, a European investment company represented in Canada by Aitken Lees Capital Ltd., have formed Green Cone. The new company will manufacture and distribute the Ecolyzer digestor/composter, a backyard HDPE bin in which organic kitchen waste is turned into compost. Kitchen waste represents 30% of the waste stream, compared to approx 8% for plastics. Eco came up with the idea and is providing the technology for the venture, while Husky will produce the tooling necessary to manufacture the product. The digestor/composter is expected to be on the market by early 1990. (47, (7), 6-7 [in English]. ISSN 0008-4778)

2462 RECYCLING POSTCONSUMER PLASTICS. [BIB-198912-P1-0104]

The increasing resin prices stimulated a move to recycle the plastics confined to polyethylene terephthalate (PET) and high-density polyethylene (HDPE) containers. The waste plastics account 7% of the total weight of municipal solid waste in the USA, which in terms of volume is two to four times greater than the weight percent and is readily using up the landfills. Additives are available to upgrade scrap PET and HDPE so that they can be injection- or blow-molded to produce construction parts. Progress in plastics recycling may be hindered by the growing use of degradable plastics. (Garino, R.J.; 46, (5), 121-122, 124, 127-130 [in English]. ISSN 0036-9527)

2463 OLD PACKAGES NEVER DIE. [BIB-198912-P1-0105]

Packages are designed with fewer layers for easy recycling, which would otherwise account for approx 20% of the US' total volume of solid waste in landfills. Works are in progress for conversion of recycled paperboard into cartons, photodegradable plastic grocery sacks into industrial-packaging products and recycled polystyrene and other resins into fast-food trays and office accessories. Patented "compatibilizers, toughenens and additives" would enable reprocessing scrap into high-value engineering plastics. (Nelson-Horchler, J.; 238, (17), 88-90 [in English]. ISSN 0039-0895)

2464 CALIFORNIA GETS RECYCLING MANDATE. [BIB-198912-P4-0028]

Governor George Deukmejian of California, USA, has signed legislation requiring the state's local governments to initiate recycling programs designed to achieve a 25% reduction in buried solid waste by 1995 and a 50% reduction by the year 2000. This legislation will reportedly put California far ahead of other states in dealing with its waste management problems. Slated to take effect 1 January 1991, the bill replaces the nine part-time members of the existing Waste Management Board with an Integrated Waste Management Board comprised of six full-time appointees who will oversee implementation of local recycling/garbage disposal operations throughout California. The measure also creates a state agency to develop new markets for recycled materials. (News Brief). (Horne, J.; 1, (32), 2 [in English]. ISSN 1042-802X)

2465 CLEARING THROUGH THE CLOUDS OF ENVIRONMENTAL LAW. [BIB-199001-G4-0003]

The two principal US statutes of concern to scrap processors are the Resource Conservation and Recovery Act (RCRA), which regulates solid and hazardous wastes, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or Superfund, which controls the cleanup of hazardous spills. RCRA is important because it sets up a complex federal regulatory program that requires a lot of paperwork. CERCLA can be much more devastating because it establishes broad liability for the cleanup of sites contaminated in the past by actions which, at the time, may have been wholly legal. The legal background and the possible implications of these statutes are discussed. (Wolfe, J.T.; 46, (6), 82, 83, 85, 87 [in English]. ISSN 0036-9527)

2466 HANDLING METALLIC BY-PRODUCTS: EPA'S VIEW. [BIB-199001-G4-0004]

Solid waste is considered hazardous if it either is listed as such in EPA regulations or exhibits hazardous characteristics such as toxicity. Numerous metals, such as Pb, Cd, Ni, and Cr, fail the toxicity test even when present in only minute amounts. The only factor that precludes most scrap processors from being regulated as hazardous waste treatment, storage, and disposal facilities is a current provision in the EPA rules that exempts scrap metal processors and battery handlers from the comprehensive record-keeping and reporting requirements applicable to hazardous waste facilities. To add a layer of complexity, some by-products of scrap operations, such as slags and drosses, are regulated differently. By-products that are disposed of are clearly waste materials. Those that are reclaimed or sold for reclamation are exempt from regulation as solid wastes (and thus cannot be considered hazardous wastes) if certain criteria are met. The nine-part documentation that is required is outlined. (Wolfe, J.T.; 46, (6), 19, 21 [in English]. ISSN 0036-9527)

2467 JOINT VENTURE PLANNED TO BUILD FOUR METAL RECYCLING FACILITIES. [BIB-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. (4, (22), 167, 168 [in English].)

2468 COUPLED MEMBRANE SYSTEM DEVELOPED TO REMOVE METALS FROM WASTE. [BIB-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. (4, (20), 149, 150 [in English].)

2469 IMP RECEIVES STATE GRANT TO STUDY FOUNDRY SAND RECOVERY. [BIB-199001-G4-0009]

A $250 000 grant from the Michigan Department of Natural Resources Quality of Life Bond Program to develop a process for recycling cold set bonded foundry sand was received recently by the Institute of Materials Processing (IMP) at Michigan Technological University (MTU), Houghton, Michigan, USA. The US foundry industry annually produces approx 9 million tons of solid waste, which is primarily spent casting sand that must be disposed of in landfills. Foundry waste represents nearly 10% of the total volume of waste that is landfilled in Michigan. The present project's objectives are to understand the mechanisms involved in removing organic cold set binders by combustion, identify systems for effective removal and secondary-use binders, develop a separation method to reduce the amount of material that must be treated and design a complete system based on this information. (79, (12), 9 [in English]. ISSN 0026-7562)

particularly interested in the High Temperature Gasification process of Voest-Alpine with whom it has been working. The HTV process takes plastic waste as soils or slurry and combusts it as a reactor with other fuel to produce gas, usually carbon monoxide, and hydrogen. Non combustible residues emerge as liquid slag, useful as granulates. (News Brief). ((1291), 10 [in English]. ISSN 0032-1168)

2450 MEN AT THE SHARP END OF THE PROACTIVE RESPONSE. [BIB-198909-P1-0069]

The plastics industry is facing increasing problems arising from fears of spoiling the environment. This is causing many firms to appoint to senior positions staff to attend to such difficulties and these are experienced and articulate, and not always technical experts. One key item is the decision as to whether a company recycling scheme is worthwhile, feasible and viable. Higher attention to these problems is certainly needed, particularly with all aspects of collection. One main problem is the handling of PVC wastes. (News Brief). (Whitehead, J.; (1291), 12 [in English]. ISSN 0032-1168)

2451 DIFFICULTIES IN DIVERTING THE WASTE STREAM. [BIB-198909-P1-0070]

Local authorities should play a vital part in the recycling of plastics in the future. Industry may have a task in involving them in a commercially successful way. Collection is the first major problem to be solved and involves separate bins for different waste classes. An experimental scheme is in hand in Sheffield starting with bins and going on to bulk collection of recyclable material. Other major cities are waiting to see the best methods which they can employ. (News Brief). ((1291), 13 [in English]. ISSN 0032-1168)

2452 THE COMMUNITY'S RIGHT-TO-KNOW AND THE COMPOUNDER'S REQUIREMENT TO COMPLY. [BIB-198909-P4-0018]

Plastics compounders are being significantly affected by the requirements of the Emergency Planning and Community Right-to-Know Act (Title III), passed 17 October 1986, as part of the US Superfund Ammendments and Reauthorization Act of 1986 (SARA). Nearly every facility that produces, stores, uses, or ships certain hazardous substances is required under Title III to make available information about those substances to federal, state, and local officials—as well as the general public. Another provision of the law requires facilities to report the amounts of certain substances they released into the air, land, water, and waste-treatment facilities during the year. In addition to what are termed extremely hazardous substances, the substances regulated include many commonly used compounding additives, such as acrylic acid, antimony oxide, maleic anhydride, and heavy-metal-containing compounds found in pigment formulations. The requirements under each section of this law are analyzed. (Brewer, D.; 12, (4), 25-26, 28, 30 [in English]. ISSN 0148-9119)

2453 NEW JERSEY'S WARREN COUNTY SLATES AUTO BATTERY RECYCLING PLAN. [BIB-198910-G1-0170]

Faced with the problem of disposing of Pb-contaminated ash from a waste-to-energy incinerator, Warren County, New Jersey, USA, officials have announced a program to collect automotive batteries for recycling. Interstate Battery Co. has entered an agreement with the county's Pollution Control Financing Authority to pick up Pb-acid batteries at 15 service stations. Action was taken after the county incinerator produced some ash with high amounts of Pb and Cd. Disposal transportation costs rose because the ash could not be taken to regular landfill sites and had to be taken to hazardous waste facilities instead. (97, (175), 9 [in English]. ISSN 0002-9998)

2454 COMPOSITES POSE SERIOUS HAZARDS. [BIB-198910-D4-0007]

The disposal of composite materials including CFRP is potentially an environmental hazard, since they are non-flammable and do not decompose. Workers exposed to the dusts of composites complain of health problems and health officials fear the problems will grow. Management must be involved in the solution of these problems since capital investment and liaison with regulatory agencies are required. Finally, education of employees and the local communities is necessary. (Kuzela, L.; 238, (13), 64 [in English]. ISSN 0039-0895)

2455 GERMANS PROPOSE WASTE DISPOSAL PLAN. [BIB-198910-P1-0084]

The West German Association of Plastics Manufacturers (VKE) has presented disposal and recycling proposals to the West German minister of the environment. The VKE proposals state: generation of all waste must be minimized by the development of higher-performance plastics, better production methods and increased use of reusable packaging; material recycling must be implemented in all possible cases; although methods such as hydrogenation, hydrolysis and pyrolysis are not fully operational, VKE actively supports further development of these methods and first tests of their application; and energy recycling appears to be the most advantageous option for disposal of remaining plastic waste, particularly for mixed plastic waste because of the high calorific value of plastics and the fact that proven and environmentally friendly incineration technologies with continuous cleaning of flue gas are available already. (Short, H.; 1, (28), 1, 24 [in English]. ISSN 1042-802X)

2456 PETROCHEMICAL FIRMS FACE CHALLENGE AS COMMUNITIES TRY TO RECYCLE OR BAN PLASTICS. [BIB-198910-P1-0086]

The industry is now pushing the recycling of plastics to counter the growing crisis of waste disposal—a problem to which plastics are considered to be a major contributor. Plastics account for about 7.3 wt.% of the 140 million tons/year of solid wastes generated in the USA. Consumers believe biodegradability is the answer to reducing plastics waste, but some authorities doubt whether it works, and that in any case it is a squandered resource. Several companies have begun to recycle plastics, which appears to be economically attractive for producers as well as for communities, but is ominous for surplus production capacity in the 1990s. The industry can learn a lesson from the banning of CFCs. (Williams, B.; 87, (30), 13-15 [in English]. ISSN 0030-1388)

2457 NAVY HAS ITS TROUBLES MARAGING SOLID WASTE. [BIB-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. (66, (8), 17-18 [in English]. ISSN 0026-8275)

2458 PVC INDUSTRY COUNTERS DUTCH DIOXIN CHALLENGE. [BIB-198910-P4-0026]

A report by the Dutch RIVM committee suggested that the presence of PVC in incinerated waste in the Netherlands caused higher levels of harmful dioxins in emissions. The PVC industry has challenged this finding as the basis that the analysis was performed at the Rotterdam incineration unit, whose emission levels are greatly above typical European figures. Studies are cited which suggest that there is not a direct link between PVC and PCDD (dioxin) and PCDF (furan) formation. (News Brief). (Whitehead, J.; (1298), 1, 32 [in English]. ISSN 0032-1168)

2459 COMPOSITES AND THE INTEGRATED MANAGEMENT APPROACH TO ENVIRONMENTAL PROTECTION, HEALTH AND SAFETY. [BIB-198911-D4-0008]

Special problems presented by composite materials manufacturing in complying with environmental, health and safety regulations were addressed by the Society of Manufacturing Engineers at the Composites in Manufacturing 8 Conference, Anaheim, California, USA, in January 1989. A new, determined approach was recommended to keep composites from becoming overregulated. For example, an environmental, health and safety committee formed by the society to address the impact of composites on the environment was suggested. Major laws

process, called the HTV process, could provide a solution to polymer waste management. (16, (3), 16-17 [in English]. ISSN 0306-3534)

2437 EPA EYES TOXIC BAN. [BIB-198907-G4-0022]

The EPA is proposing a new strategy of "source reduction", which advocates preventing waste by minimizing its production, rather than manage waste after it has been produced. This proposed new focus on source reduction could mean trouble for the Pb business, since it can be a euphemistic way of saying "ban it"—which so far has been a last, rather than a first, choice. The perceived danger is that shrinkage in the battery-recycling industry might lead to an increase in the number of batteries going to landfills, with resultant health risks. (Schmitt, B.; 97, (88), (Suppl. Lead & Zinc), 10, 14 [in English]. ISSN 0002-9998)

2438 EFFECTIVE UTILIZATION OF WASTES. [BIB-198907-P1-0044]

A new method for the utilization of mixed and contaminated plastics wastes has been developed in Berlin at the GDR Construction Academy. The materials are processed in conventional extrusion machines to give foams with a density 0.29/cm^3 by mixing low-boiling solvents with the material before the extrusion process. The foams are of the closed cell, humidity resisting type. (News Brief). ((390), 4 [in German].)

2439 GERMAN PLASTICS INDUSTRY DEVELOPS WASTE CONCEPT. [BIB-198907-P1-0047]

West Germany's plastics manufacturers have developed a concept for thermal treatment of wastes which they plan to publicise at the K'89 plastics exhibition to be held in November 1989 in Dusseldorf. The concept is based on incineration of plastics wastes to produce heat, rather than recycling. The industry association VKE is in talks with West Germany's largest utility company, Rheinisch-Westfalisches-Elektrizitatswerk (RWE) about coordinating the energy supply. RWE's subsidiary UK Wesseling has also developed a process for thermal treatment a plastics wastes. (News Brief). ((1287), 1, 24 [in English]. ISSN 0032-1168)

2440 APME ACTS FAST ON WASTE MANAGEMENT. [BIB-198907-P4-0012]

A pan-European approach to the waste management of plastics has been adopted by the Association of Plastics Manufacturers in Europe (APME). It has formed an emergency sub-committee to put proposals to DG11 in Brussels prior to the publication of a directive early in 1990. To avoid the proliferation of national measures taken in isolation, the APME intends to coordinate all sections of the industry, local authorities and the public to establish an effective European consensus. (News Brief). (Sommer, G.; (1287), 1 [in English]. ISSN 0032-1168)

2441 THE PLASTICS DEGRADABILITY ISSUE. [BIB-198908-P1-0056]

Business Communications Company, USA, in drawing attention to the impact of degradable plastics on litter and solid waste, has stressed that neither photodegradation nor biodegradation will present a panacea to the growing plastic waste problem. Legislation will ensure that a feasible response is found to the developing crisis. Potential candidates for controlled degradation include refuse bags, merchandise bags, fast food containers and medical waste. (News Brief). (6, (8), 11-12 [in English]. ISSN 0264-7753)

2442 DOW PICKS UP WASTE CHALLENGE. [BIB-198908-P1-0057]

Dow Europe are formulating plans for managing and recovering plastics waste from cars. Plastics consumed by Europe's automobile industry are expected to increase by 3% per year, adding another 400 000 tonnes by 1995 to the existing 1.3 million tonnes in car body and interior parts. Incineration of the organic shredder fraction is not normally permitted and much of it is currently disposed of in landfill sites. Dow is examining state of the art incineration, and believes that over two trillion joules of energy could be recovered annually. (News Brief). ((1289), 1 [in English]. ISSN 0032-1168)

2443 WASTE RECLAMATION FOR ENERGY "MOST PRUDENT" AIM. [BIB-198908-P1-0059]

Waste-to-energy reclamation is "the most prudent approach" of the alternatives available to address the world waste problem. In a paper presented to the Fourth Annual ASM/ESD Advanced Composites Conference D.R. Barr of Mobay Corporation reported some of the benefits of waste-to-energy relamation. These include: development of a long term means of waste disposal, implementation of waste disposal systems, reducing the tipping of hazardous waste and reduction of landfill volume. (Dempster, D.; (1289), 7 [in English]. ISSN 0032-1168)

2444 PLASTICS IN SWITZERLAND DOMINATED BY IMPORTS. [BIB-198908-P4-0016]

The six million Swiss consume, per capita, about the same as their neighbours in Europe but only 20% of the products are made in house, about the same proportion as raw material. It is suggested that the position is unlikely to change because of the structure of government at all levels and their abiding concern with environmental protection. For example, PVC food packinging is to be elminated by the early 1990s while CFC propelled aerosols will be banned at the end of 1990 and permitted styrene levels have almost prohibited the manufacture of GRP laminates. (News Brief). (Sommer, G.; (1290), 8-9 [in English]. ISSN 0032-1168)

2445 AUSTRIAN GREENS PUT PVC UNDER STRONG PRESSURE. [BIB-198908-P4-0017]

The Austrian environment ministry is considering a total ban on PVC for packaging. Aiready the tonnage has fallen from 8000 t in 1983 to 6000 t in 1986, down 25%. For containers the figures are 3750 t, to 2500 t, 34% down. The main problem is in waste disposal. Over 90% is buried with only 6% burnt. There are some 200 landfill sites, 19 composition plants and just two incinerators. With the existence of a well developed glass container recycling system and pressure to eliminate PET for carbonated drinks containers, the prospects for the glass industry look good. There is also pressure from the Greens to phase out PVC in building on the grounds that it will eventually create a severe waste disposal problem. (News Brief). (Sommer, G.; (1290), 12 [in English]. ISSN 0032-1168)

2446 NEW LEAD CORROSION DATA FOR NUCLEAR WASTE USE. [BIB-198909-G5-0339]

Battelle Pacific Northwest Research Laboratories has been studying the corrosion resistance of Pb in environments simulating those expected in a repository located in a Yucca Mountain, Nevada, USA, site. The corrosion rates of three leads—corroding Pb, Pb—1.5Sb, and Pb—1.5Sn and Alloy 825, a Ni base superalloy—were determined over a six-month test duration in environments of humidified air at 100 and 150 °C , in water-saturated air at 100 °C , and in J-13 (tuff) ground water concentrated 25 times at 100 °C . (2 [in English].)

2447 PLASTIC RECYCLING. [BIB-198909-P1-0064]

The first plant for the processing of plastic wastes has gone into operation in Rodental. The plant cost 10.7 million DM and can process 4000 tons/year in two shifts, yeilding 3000 tons of granulate for new plastics production. (News Brief). ((393), 1 [in German].)

2448 WEIGHING UP THE PARTS IN THE WASTE EQUATION. [BIB-198909-P1-0065]

Increasing interest is being shown in the disposal of waste. Two well known methods are used in Western Europe, land infill and incineration, and others are also in use. Plastics waste accounts for 5-6 wt.% of domestic waste. These are, in Europe, 55% polyolefins, 15% PS, 10% PVC, 5% PET and 5% assorted. Recycling can dispose of many of these wastes and involves a fair amount of initial sorting. Chemical recycling requires more sophisticated technology and is in the development stage for plastics. Continuing research into waste disposal will be needed. (News Brief). ((1291), 8 [in English]. ISSN 0032-1168)

2449 DOW BACKS INCINERATION. [BIB-198909-P1-0068]

Dow Chemicals has turned its attention to ultimate disposal and, having looked at most systems of disposal, is backing incineration as the best one. They are

related to PVC and perceived environmental problems. The conclusion, PVC is an economical material which has outstanding properties and numerous uses. An analysis of its energy requirements, recycling possibilities and pollution potentials leads to the conclusion that the use of PVC has a positive effect on the environment. (Flury, M.; (9), 20-21 [in German]. ISSN 0023-5598)

2427 THE ENVIRONMENT TOPS THE AGENDA. [BIB-198904-P1-0027]

The group, Friends of the Earth, are again campaigning about disposal of waste plastics products, and other materials. Plastics cause much trouble in disposal, unlike metals, for example, and trends are generally towards more plastics. Difficulties are being experienced in finding enough landfill space for the non-biodegradable plastics. Attention is also being paid to over-packaging of many foodstuffs, so adding to disposal problems. It is felt that further examination is needed of disposal methods, including better forms of incineration. (News Brief). ((1274), 1, 28 [in English]. ISSN 0032-1168)

2428 APME TO BOOST ITS WASTE EFFORT. [BIB-198904-P1-0028]

In response to solid waste management problems, the Association of Plastic Manufacturers in Europe is increasing its resources, being very worried about at least three markets (in Europe). These are Denmark, Germany and Italy. Denmark operates a deposit scheme, preventing imports of drinks, but allowing global exports of Danish products. In Germany there is a compulsory deposit scheme on plastic drink bottles. In Italy responsibility is placed on both local authorities and industry, putting costs firmly on industry and trade. (News Brief). ((1274), 1 [in English]. ISSN 0032-1168)

2429 GERMAN BUND GROUP TARGETS DRINKS BOTTLES. [BIB-198904-P1-0029]

Germany's largest group protecting the environment is setting up a national campaign against the flood of plastic beverage bottles. Pressure is naturally being put on both retailers and consumers to boycott such products. At present, only a quarter of retailers will do without such bottles. There are roughly 2.7 billion bottles with a weight of 83 tonnes dumped in Germany per year. Of these, 750 million are of "environmentally dangerous" PVC, most originating in France and Belgium. Some companies are co-operating to lessen the problem, with limited success. (News Brief). ((1274), 1 [in English]. ISSN 0032-1168)

2430 MAKING PLASTICS THAT BIODEGRADE. [BIB-198904-P5-0093]

Development of degradable plastics for reduction of solid wastes is discussed. Growth of solid wastes, stability of normal plastics and legislation to restrict the use of plastics are described. Problems with current degradable products are discussed. Three categories of degradables are described. Technology and applications for biodegradables are discussed. Chemical and photodegradables are described. Current uncertain status of technology, specifications and needs are discussed. (Gibbons, A.; 92, (2), 69-73 [in English]. ISSN 0040-1692)

2431 IMS WINS CONTRACT TO PROCESS EAF DUST AT NUCOR-YAMATO. [BIB-198904-S4-0011]

In its second electric arc furnace contract, International Mill Service, Philadelphia, Pennsylvania, USA, has signed a long-term agreement with Nucor-Yamato Steel Co. to process EAF flue dust at its new Blytheville, Arkansas, mill. While IMS is negotiating several other long-term contracts for EAF dust on-site plants, it is constructing its first on-site EAF dust treatment facility at Florida Steel Corp.'s mini-mill in Jackson, Tennessee. Under the terms of the Nucor-Yamato contract, IMS will process 12 000 tons/year of EAF dust using the Tetronics Plasma Process. The processing technology is being licensed by IMS from the British research and development firm, Tetronics. (News Brief). (5, (2), 13 [in English]. ISSN 0897-4365)

2432 BATTELLE STUDYING CADMIUM PLATING TO REDUCE HEAVY METAL WASTES. [BIB-198904-S4-0012]

Cadmium-plating processes and alternative materials are being studied by Battelle Laboratories, Columbus, Ohio, USA, with the goal of reducing heavy metal wastes while allowing products to retain the required properties of Cd. Battelle researchers are trying to identify new or modified coating processes as well as substitute coatings and surface treatments that could lead to revised standards, practices and specifications for materials and end-use applications. The study involves six specific tasks: reviewing specifications; identifying alternative materials and specifications; comparing potential Cd replacement materials with end-use applications and requirements; determining possible waste generation reductions that could result from changes in the Cd-plating process; receiving comments from users regarding recommended changes; and submitting a final report to the Defense Construction Supply Center, which has commissioned the study. So far Battelle has identified 200 specifications using Cd plating as a degradation protection coating for fasteners and other metal parts. Pre-treatment, post-treatment and testing procedures required from the specifications will be documented and analyzed in relation to new or modified coatings. Project manager at Battelle Columbus is Russell Smith. (News Brief). (4, (3), 22 [in English].)

2433 HRD TO CONVERT TENNESSEE ROTARY KILN TO WAELZ PROCESSING OF EAF DUST. [BIB-198904-S4-0013]

Horsehead Resource Development Co., Inc., Palmerton, Pennsylvania, USA, has bought a rotary kiln in Rockwood, Tennessee, that will be converted to the treatment of electric arc furnace dust. The kiln had been used in preparing carbon material for the ferrosilicon industry and its configuration is suited to conversion to the Waelz process for recovering Zn from EAF dust. Initially, the kiln will service primarily electric arc steel producers in the Southeastern US. The 60 000 ton/year facility is expected to be fully operational by January 1990. HRD currently processes approx 350 000 tons/year of EAF dust at kilns in Chicago and Palmerton. The firm also owns the flame reactor technology for handling EAF dust and plans additional treatment facilities in the Southwest and on the West Coast in the near future. A flame reactor, which is less capital intensive than the kiln, is more economical when lower volumes of dust must be treated. The feasibility of a specialized operation to thermally process C steel EAF dusts containing low levels of Zn is under investigation by the company. A 19.9% interest in HRD, a subsidiary of Horsehead Industries, Inc., New York City, was acquired by Metallgesellschaft AG, Frankfurt, FRG, last year. (News Brief). (4, (3), 21 [in English].)

2434 NEW WASTE DISPOSAL REGULATION: CROSS FRONTIER TRANSPORT OF SCRAP AND RESIDUES CONTAINING NON-FERROUS METAL. [BIB-198906-G7-0163]

The monitoring procedures of the new waste regulations apply, amongst others, to all substances which are classified as dangerous by any EEC state—involved via transportation—independently of whether or not it is waste in accordance with German waste regulations. Residues (including scrap) containing non-ferrous metals are affected. In particular with regard to secondary materials, an explanation is given of when and, where necessary, how the new regulation is to be applied. (65, (3), 210, 212, 214-216 [in German]. ISSN 0002-6689)

2435 SCRAP DEPOSITION IS ANTICIPATED BY A MODEL SOLUTION. ENERGY RECYCLING OF SHREDDER RESIDUE IS PROMISING IN THE SHORT TERM. [BIB-198906-P1-0039]

The waste management of old cars is a troublesome problem. Debates on the composition of shredder rubbish result in precise listing, cost accounting, etc. Detailed programmes have been developed for optimising the treatment of this rubbish. Treatment of the organic fraction involves some material recycling followed by burning of residues as a source of energy. This appears to be promising in the short term. (Peters, I.; (388), 21-22 [in German].)

2436 THE NEED TO INDUSTRIALISE. [BIB-198906-P6-0143]

The success of plastics usage in automotive manufacture hinges on the acceptance of polymer substitution for metal in economic volumes and the creation of an acceptable method of waste disposal. Cannon's Compotec system is specifically designed for the development and potential production of high-volume large resin transfer moulded parts. Dow Europe, believing that the European automotive market will account for 20 000 t of material for RTM applications this year, is offering four basic families of resin for reaction injection moulding under the Spectrim tradename. Voest-Alpine's high temperature gasification

2417 INTERNATIONAL MILL SERVICE BUILDS FIRST EAF DUST FACILITY. [BIB-198901-S4-0003]

International Mill Service, Inc. (IMS) is engineering and building its first EAF dust processing facility. It will be located at Florida Steel's electric furnace mill in Jackson, Tennessee, USA, and have the capacity to process 7000 tons of EAF dust annually. IMS will own, operate and maintain the system on-site at the mill, and expects to begin plant operations next month. The facility will utilize the Tetronics plasma process, a thermal technology that recovers prime western grade Zn metal from EAF dust. IMS licensed the technology from Tetronics in the UK, and has exclusive rights to market the process to steel mills in North America and Europe. (15, (12), 8 [in English]. ISSN 0097-8388)

2418 W-P RAIL MILL CLEAN-UP STALLS BETHLEHEM BUY. [BIB-198901-S4-0004]

A delay in the sale of Wheeling-Pittsburgh Steel Corp.'s rail mill to Bethleham Steel Corp. centers on a dispute over environmental clean-up costs at the Monessen, Pennsylvania, USA, facility. The Bethlehem, Pennsylvania, steelmaker is seeking a Wheeling-Pittsburgh clean-up of stored waste at the site or a credit of at least $600 000 on the pre-established purchase price of the mill before it agrees to finalize the purchase. Bethlehem agreed in September to purchase the modern rail mill for $20 million but has balked at closing the deal. The delay has prompted attorneys for Wheeling, West Virginia-based Wheeling-Pittsburgh to consider seeking bankruptcy to court approval to sell the mill to another bidder or abandon it altogether if Bethlehem does not soon take possession of it. A status conference on the matter is slated for 14 December. At issue are hundreds of drums at the site containing what is believed to be non-hazardous material, such as waste oil, grease and lubricants. The drums are said to constitute disposed wastes because they have been in storage at the site for more than a year. Some 1000-1200 drums are at the site. It is believed, however, that only 30% contain waste material, which is starting to leak. (News Brief). (Balcerek, T.; 96, (236), 2 [in English]. ISSN 0002-9998)

2419 RECYCLING GROWS UP: A BIG FUTURE FOR RECYCLING PORTENDS GROWTH OF A NEW RAW MATERIALS STREAM AND NEW ROLES FOR PROCESSORS AND RESIN PRODUCERS. [BIB-198902-P1-0006]

The new shape of the reclaimed plastics supply/processing/marketing chain in the US is described. Topics of discussion include questions concerning whether large producers of virgin plastics for packaging become reclaimers and/or processors of recycled material or will they leave this field to the entrepreneurial firms that have already established their niches. One recent development which could challenge the current dominance of entrepreneurial firms over plastics recycling is the agreement between Dow Chemical, Midland, Michigan, and Domtar, Montreal, to form a joint venture to recycle and market materials derived from primarily PET soft-drink bottles. Separation technology developments are discussed. (Rogers, J.K.; 34, (13), 50-56 [in English]. ISSN 0032-1257)

2420 RISE IN PLASTIC WASTE ALARMS CAR SHREDDERS. [BIB-198902-P1-0011]

Consideration is given to the increasing problem of plastics waste resulting from the growing use of plastics in automobiles. Association of Plastics Manufacturers in Europe is monitoring car waste disposal and hoping to coordinate national industry efforts. Possible options are disposal in landfill sites or incineration. Another approach is labelling of different polymer components for easy identification and designing cars for systematic dismantling. This would make recycling easier. A levy could be charged on purchase to cover the eventual cost of plastics disposal. (News Brief). ((1266), 20 [in English]. ISSN 0032-1168)

2421 HORSEHEAD MAY BUILD SEVERAL REGIONAL FLAME REACTORS TO TREAT EAF DUST. [BIB-198902-S4-0006]

Following successful testing of its St. Joe flame reactor for recovering Zn and other metals from electric arc furnace dust, Horsehead Resource Development Co., USA, is considering construction of several reactors to handle EAF dust containing 15% Zn. No sites have been selected yet as the firm is discussing market needs with potential customers. Regional facilities with a capacity of at least 20 000 tons/year would be the most economical. Net processing costs for a 20 000 t/year facility, excluding transportation expenses, are estimated at approx $87/ton for EAF dusts containing 40% Zn, and $161/ton for dusts containing 5% Zn. For 40 000 t/year plants, the costs range from $54/ton for 50% Zn-dusts, to $128/ton for 5% Zn-dusts. (3, (25), 190 [in English].)

2422 STAINLESS STEEL IN WATER POLLUTION CONTROL. [BIB-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. (16, (94), 16 [in English]. ISSN 0306-2988)

2423 METALLGESELLSCHAFT BUYS 19.9% STAKE IN HORSEHEAD'S RECYCLING SUBSIDIARY. [BIB-198902-S9-0039]

The West German conglomerate Metallgesellschaft AG has bought a 19.9% stake in an industrial-waste recycling company owned by Horsehead Industries Inc. for an undisclosed sum. Horsehead Resource Development Co. Inc., based in Palmerton, Pennsylvania, USA, recycles inorganic hazardous wastes, primarily Zn-containing waste from the steel industry, extracting nonferrous metals for resale. In operation since 1980, the company uses high-temperature pyrometallurgical technology to process hazardous fumes collected from electric-arc furnaces used by mini-mills. The Horsehead acquisition is part of MG's strategy for its new subsidiary. Berzelius Umwelt-Service GmbH, through which MG bought its interest in Horsehead Resource. Berzelius currently processes approx 300 000 short tons of industrial residues containing nonferrous metals. Horsehead will account for an additional 200 000 tons. Within the next five years the MG subsidiary expects to be involved in processing 1 million tons of waste. In addition to Horsehead Resource, Berzelius has a stake in a Spanish company involved in recycling industrial waste, and plans to join forces with French and Italian companies in the future. The agreement between Horsehead Resource and MG's Berzelius calls for technical cooperation. The companies will also exchange technical know-how and cooperate on research and development projects to provide up-to-date, safe and cost-effective remedial services for the recycling of a variety of metal-containing industrial residues. Currently, Horsehead Resource has three processing plants, in Palmerton and Monaca, Pennsylvania, and Calumet, Illinois. The company plans to open additional facilities in the US South and West. (News Brief). (Tunney, J.; 96, (153), 2 [in English]. ISSN 0002-9998)

2424 RECYCLING OF PLASTICS SCRAP. [BIB-198903-P1-0014]

The focal point of a study by the South German Center for Plastics was plastic scrap recycling. The study showed that in many cases recycling is possible but that for some plastic waste, thermal recycling is the more sensible disposal method. The use of household waste for plastics production is economically and environmentally unacceptable because of the large variety of food products contaminating its surfaces. Plastics have a high heat content and incineration for energy production appears to be a sounder method for recycling. Results of the study were presented at a January 1988 seminar in Stuttgart. A report on the study and the discussions at the 1988 seminar are given. ((9), 26, 27 [in German]. ISSN 0023-5598)

2425 ARE SHIPBOARD PLASTICS (WASTE) ALL WASHED UP? [BIB-198903-P4-0002]

The amount of plastics discharged at sea is significant and is cause for concern. The US has signed an international treaty and enacted a new law—the Marine Plastics Pollution Research and Control Act— which bans plastic disposal at sea. Business will be lost because of these environmental concerns and the new laws, but recycling and incineration should probably create new commercial opportunities. (Smock, D.; 46, (9), 75-77, 79 [in English]. ISSN 0032-1273)

2426 THE PVC (ENVIRONMENTAL) THEME: PVC (NEEDS) CLEANING (UP). [BIB-198903-P4-0003]

There has been much media publicity in recent years about polyvinyl chloride. This has created the impression that PVC is a significant pollution source. Discussed are vinyl chloride, Cd, dioxin, HCl, dioctylphthalate and recycling as

softening or melting down to a saturation level. The melted plastic material is mixed with a given dose of a catalyst, e.g. calcium hydroxide, at a temperature of 220-300 °C . Then, a resultant mixture is shaped to a solid fuel product, or if saturated with the plastic material, to a predetermined form disposable in a landfill. (Matsuzaki, T.; [in English]., Patent no.: EP0475556 (European Patent) Convention date: 14 Feb. 1991)

2408 CONVERSION OF MUNICIPAL WASTE TO USEFUL OILS. [BIB-199301-D1-P-0086]

The invention is directed to a method for converting municipal waste containing plastics to a high quality synthetic crude oil which can be separated by fractionation into gasoline, diesel fuel and gas oils suitable as a feedstock to a catalytic cracker. The presence of cellulosic and proteinaceous waste materials in the municipal waste does not inhibit the process of the invention for converting the municipal waste into a synthetic crude oil. The process generally includes the steps of heating the municipal waste in a reaction gas of a mixture of H sulfide and hydrogen or H at moderate temperatures and pressures. (Stapp, P.R.; [in English]., Patent no.: US5158982 (USA) Convention date: 4 Oct. 1991)

2409 CONVERSION OF AUTOMOTIVE TIRE SCRAP TO USEFUL OILS. [BIB-199301-D1-P-0087]

The invention is directed to a process for the conversion of waste plastics and scrap rubber to a high quality synthetic crude oil which can be separated by fractionation into gasoline, diesel fuel and gas oils suitable as a feedstock to a catalytic cracker. The process generally includes the steps of heating the plastic scrap and scrap automotive tires in a hydrogen atmosphere at moderate temperatures and pressures. It has also been determined that the polymeric waste material must be present in combination with the scrap automotive tires to attain conversion of the scrap automotive tires to liquid hydrocarbon. (Stapp, P.R.; [in English]., Patent no.: US5158983 (USA) Convention date: 4 Oct. 1991)

2410 RADIATION-DISORDER AND APERIODICITY IN IRRADIATED CERAMICS. FINAL TECHNICAL REPORT, 22 JUNE 1989-21 JUNE 1992. [BIB-199302-A4-C-0018]

This research forms the latest part of an on-going program, begun at MIT in 1983 under DOE support, which has had as its objectives investigation of the responses in radiation environments of ceramics heavily-irradiated with electrons, neutrons and ions, with potential applications to fusion energy technology and high-level nuclear waste storage. Materials investigated have included SiO_2, $MgAl_2O_4$, $Al_{23}O_{27}N_5$, SiC, BeO, $LiAlO_2$, Li_2ZrO_3, $CaTiO_3KTaO_3$, and $Ca(Zr,Pu)Ti_2O_7$. The program initially proposed for 1980 had as its major objectives two main thrusts: research on defect aggregation in irradiated non-oxide ceramics; and research on irradiation-induced amorphization of network silicas and phosphates. (Hobbs, L.W.; Pp 79 [in English]. ISSN 0097-9007)

2411 LOW-TEMPERATURE ASHING OF HAZARDOUS PLASTIC WASTE. [BIB-199303-C4-P-0131]

A system and method for low temperature treatment of organic wastes containing potentially toxic concentrations of metals are described. The method comprises forming the waste material into pellets of preselected size, mixing the pellets with inert material, and incrementally heating the mixture in air from approx 200 to approx 600 °C to oxidize the pellets to the corresponding ash containing the metals, collecting the ash, and combining the ash with inert material and binder to form a solidified compact for disposal. (Wichner, R.P.; Spence, R.D.; Morgan, I.L.; Jermyn, H.W.; [in English]., Patent no.: US5167711 (USA) Convention date: 3 Jan. 1992)

2412 REDUCTION OF COST OF COMPOSITES IN USE THROUGH WASTE MINIMIZATION. [BIB-199303-D1-D-0388]

An environmental rationale is presented for using thermoplastic matrix composites (TPC) in place of thermoset composites (TSC). TPC offer advantages over TSC in waste reduction, safety, recycling, energy use, and processing. For most applications, performance properties are equivalent or higher for TPC, giving clear, cost-effective solutions to high performance material needs in production, use, and disposal. TPC are more stable than TSC, having long shelf life without need for refrigeration or disposal of unused, "out-of-date" materials. TPC's have essentially no volatile organic compounds (VOC) in processing or use. As opposed to TSC, they are non-hazardous and can be disposed as ordinary solid waste. Recycling of carbon fiber/PEEK composites is addressed. 12 ref. (Saunders, C.S.; SAN DIEGO, CALIFORNIA, USA, 21-23 MAY 1991, Publisher: SOCIETY FOR THE ADVANCEMENT OF MATERIAL AND PROCESS ENGINEERING, P.O. Box 2459, Covina, California 91722, USA, (1991), (Eng. Mat., 9303-G2-Z-0086), 463-476 [in English].)

2413 AN OVERVIEW OF ADDITIVES AND MODIFIERS FOR POLYMER BLENDS: FACTS, DEDUCTIONS, AND UNCERTAINTIES. [BIB-199303-D1-P-0484]

Polymer blends with enhanced properties and processability for specific applications are modified through the incorporation of a variety of additives. The performance of these additives is often difficult to predict from considerations of their known behavior in the separate blend constituents. This overview discusses additives and modifiers in terms of types and specific functions (e.g. impact modifiers, compatibilizers, flame retardants, stabilizers) and provides an analysis of the possible effects of their repartition in the constituent phases and at the interface. Graphs. 20 ref. (Mascia, L.; Xanthos, M.; MIAMI BEACH, FLORIDA, USA, FEB. 1992, 11, (4), 237-248 [in English]. ISSN 0730-6679)

2414 AN OVERVIEW OF THE REGULATIONS AND PROCEDURES FOR DISPOSAL OF EPOXY AND PHENOLIC HAZARDOUS WASTES. [BIB-199303-D1-Z-0548]

This paper focuses on the regulations and procedures in disposing of epoxy and phenolic wastes in the forms of prepregs, coatings and solvent rinsate. California Title 22 and Code of Federal Regulations (40 CFR) are the state and federal regulations that govern the identification and handling of these wastes. Identification, is the critical first step in properly disposing of waste. Incineration, supplementary fuels for incineration at a cement kiln, solvent recovery, and landfill disposal are the four most common commercially available methods of disposal. Each of these processes is touched on and the regulations that apply are discussed. 21 ref. (Ferrier, T.M.; San Diego, California, USA, 21-23 May 1991, Publisher: Society for the Advancement of Material and Process Engineering, P.O. Box 2459, Covina, California 91722, USA, (1991), (Eng. Mat., 9303-G2-Z-0086), 204-215 [in English].)

2415 A DISPOSAL/RECYCLING MODEL FOR COMPOSITE WASTE MATERIALS. [BIB-199303-D1-Z-0549]

An accurate and simple disposal/recycling model for composite waste materials will help to evaluate practical and cost effective disposal or recovery methods. First, the volume and composition of waste materials are analyzed. The base for all cost estimates is the current or projected, adjusted total cost of solid or hazardous waste disposal. Then, disposal and/or recycling options are identified and arranged for decision making. A level offers material disposal by waste exchange. Actual material recycling is considered with breakdowns for end products and process costs. Pyrolysis, reinforcement recovery, size reduction for reincorporation as fillers, reinforcement or foam, production of cast products and energy recycling are examined for site-specific practicality and cost effectiveness. Evaluations can be made after avoided disposal costs, estimated revenue, labor costs, and additional processing/material handling equipment expenses are integrated into a per kg material cost. The model compares each adjusted disposal method, allowing composite manufacturers to consider recycling in waste disposal practices. 5 ref. (Wood, J.J.; San Diego, California, USA, 21-23 May 1991, Publisher: Society for the Advancement of Material and Process Engineering, P.O. Box 2459, Covina, California 91722, USA, (1991), (Eng. Mat., 9303-G2-Z-0086), 384-392 [in English].)

2416 PLASTIC IN PUBLIC CONTROVERSY. (KUNSTSTOFFE IM OFFENTLICHEN MEINUNGSSTREIT.) [BIB-199303-G1-P-0013]

The public perception of plastics as a polluter, environmentally hazardous, is no longer true. A histogram shows that, from the recycling point of view, waste containing plastics weighs less, consumes less energy, has less volume when compressed, and costs less to recycle. (45, (8), 414 [in German]. ISSN 0176-1625)

discarded cars go directly from final owners to licensed recycling centers without being compacted for transportation. The Volkswagen pilot project at Leer addresses separation of components by disassembly. Presently, plastics are deposited in landfills. The Leer project is directed toward re-use of plastics in the same application as the original material rather than turning them into lower grade materials for applications such as park benches, flower pots, etc. (Brudgam, S.; Davos, Switzerland, 3-5 Apr. 1991, 4, (6), 408-420 [in English]. ISSN 0952-6900)

2398 BLEEDING OF PVC STABILIZERS CONTAINING HEAVY METALS. [BIB-199209-C4-P-0390]

Four PVC profiles containing different Pb, Cd and Ba stabilizers were examined for heavy metal bleeding and the potential effect on landfills. The four materials were subjected to leaching tests in three environments: acetic acid, alkaline with soda, and water with active carbon. Results indicate that under normal conditions, PVC molded part debris exhibit almost no bleeding of the heavy metal stabilizers. The conclusion is that these materials would have very little effect on percolating water in landfills. \In English p. 17-18\. 10 ref. (Griebenow, W.; 82, (1), 46-47 [in German]. ISSN 0723-0192)

2399 ECONOMICS AND CONSERVATION DRIVE RECYCLING. [BIB-199209-D1-P-2027]

Crellin Inc. produces spools and reels in sizes from 1 in. flange diameter for packaging solder to 30 in. reels capable of holding 1000 lb of wire products. The polymers used most often are polystyrene and ABS (acrylonitrile—butadiene—styrene). These thermoplastic resins are capable of being molded, ground back into a granular consistency, and remolded into spools, reels or other products. This process can be repeated many times, making it economical and environmentally advantageous. The recycle program started in 1972, when an unprecedented polymer shortage prevented Crellin from purchasing enough virgin polymer from suppliers. The economic advantages and elimination of disposal problems are the major driving force for the success of the program. Camden Wire uses the reel to package single end, concentric, and bunched Cu conductors. Camden reuses the reels until they are damaged, at which time they send them back to Crellin for the value of material in the reel and they are recycled. (Olsta, P.; 20, (1), 18-19 [in English]. ISSN 0898-9850)

2400 THE CHARACTERIZATION OF NUCLEAR WASTE GLASS. [BIB-199209-G1-C-0054]

The most relevant properties of vitrified high-level nuclear waste glasses are being determined, as part of the quality assurance/quality control verification action set up by NIRAS/ONDRAF (the Belgian Authority for Nuclear Waste Management). Verification includes the following properties: chemical and radiochemical composition, homogeneity, thermal stability and chemical stability. Existing but not standardized techniques were used. Photomicrographs. 22 ref. (Iseghem, P.; 21, (6), 179-183 [in English]. ISSN 0391-4259)

2401 FIBERGLASS-REINFORCED PLASTIC EQUIPMENT FOR WASTE INCINERATION GAS CLEANING. [BIB-199210-F1-D-0594]

During the past 15 years, fiberglass reinforced plastics (FRP) based on vinyl ester resin have been widely used in the highly corrosive wet glass cleaning process of incinerators. The waste incineration process is discussed. FRP based on vinyl ester resin has been a cost-competitive and reliable material for the construction of gas cleaning equipment for the highly corrosive wet cleaning process. Compared to bis A and chlorendic anhydride resins, FRP based on novolac vinyl ester resin provides improved resistance to thermal degradation, blistering, and delamination. Successful operation in hypochlorous acid (HOCl) has been achieved by lining an FRP caustic scrubbing tower with PVC. Improvements in thermal performance, hydrogen fluoride resistance, and fire resistance were obtained by using conductive filler, synthetic surface veil, and brominated vinyl ester resin containing Sb, respectively. Graphs. (Kelley, D.H.; 31, (5), 34-38 [in English]. ISSN 0094-1492)

2402 THERMOPLASTIC LININGS MECHANICALLY BONDED TO CONCRETE. [BIB-199210-F1-P-0633]

Mechanically bonded thermoplastic linings are a new generation of corrosion barriers that make concrete an effective and economical construction material for storing and treating of highly corrosive chemicals and chemical wastes. They offer many advantages over various bonded linings, including the following: optimum chemical resistance; resistance to external hydraulic pressure; interstitial leak detection systems; exterior waterproofing not required; can accommodate a positive air pressure behind the lining as a means of leak detection; satisfies many of the US Environmental Protection Agency mandates; availability in UV-resistant grades; eliminates need for surface preparation and expense of removal of blasting grit; reduction of moisture; elongation capabilities permit the lining to bridge small cracks. Lining materials discussed include PE, PPR, PVC and PVDF. Graphs. (Boova, A.A.; 31, (4), 34-37 [in English]. ISSN 0094-1492)

2403 GEOTEXTILES IN AGGRESSIVE SOILS. [BIB-199211-C5-P-0242]

Geotextiles are polymers used in ground engineering for purposes such as filtration, drainage and reinforcement, requiring durability over long lifetimes. In spite of concern with their chemical, biological and ultraviolet degradation, the principal damage identified so far is that generated during compaction of the surrounding soil. Tests have been performed using a variety of geotextiles and backfills to establish the extent of this damage, and to determine the reductions in strength and appropriate safety factors. The test method described will form the basis of a standard method of evaluating installation damage. HDPE, LDPE, PVC, polypropylenes and polyolefins are discussed. Photomicrographs, Graphs. 8 ref. (Greenwood, J.H.; 6, (1), 15-18 [in English]. ISSN 0950-0618)

2404 THE RECENT INVESTIGATION ON RECYCLING OF SMC(FRP) PRODUCTS. [BIB-199211-D1-D-2460]

In Japan, the production of plastics amounted to 12.26 million tons in 1990, and the amount of waste plastics (in subject) and wasted plastics are estimated as ten million and five million tons, respectively. The combustion method, the pulverizing method and the thermal decomposition method have been investigated. SMCAA in the USA and ERCOM in Europe have already started the activity, while the SMC makers are becoming a center of activity in Japan. Both the Reinforced Plastics Association and the Synthesized Resin Industries Association recently formed committees for investigation of recycling. Photomicrographs. 8 ref. (Shibata, K.; 44, (6), 15-28 [in Japanese]. ISSN 0386-3700)

2405 PYROLYSIS OF GLASS FIBER REINFORCED PLASTIC USING STEAM STREAM. [BIB-199212-D1-D-2630]

Application of steam stream in pyrolysis of fiber reinforced plastic (FRP) was effective in reduction of deposition of phthalic anhydride and charcoal-tar on furnace walls. The pyrolysis of FRP using a steam stream under atmospheric pressure was completed in 5 min at 500 °C ; the main compounds recovered were styrene and phthalic acid. The pyrolysis at 350 °C was not completed in 60 min, and produced 6% less decomposition oil components than the pyrolysis at 500 °C . The steam stream did not seem to participate in the decomposition of polystyrene of FRP. However, when steam was replaced with nitrogen gas, phthalic anhydride was produced by pyrolysis. The production of gas in the process using steam was not so much; approx 70% of it was carbon dioxide. Graphs. 13 ref. (Hamada, K.; 49, (8), 655-660 [in Japanese]. ISSN 0386-2186)

2406 RECYCLING POST-CONSUMER POLYMERS INTO CONSTRUCTION MATERIALS. [BIB-199212-D1-P-2697]

The construction industry is one of the major consumers of polymers and a significant potential customer for recycled plastics products. The growing problems with municipal solid waste (MSW) disposal space, the proliferation of polymer products, and public awareness of environmental issues makes it necessary for the construction industry to become actively involved in post-consumer polymer recycling efforts. Technical problems with utilisation of post-consumer polymers, potential recycled plastics products, and other related issues are covered to provide an understanding of the current status of plastics recycling technology as it relates to construction materials. PP, PVC, PS, polyolefins, nylons, PET, and polyethylene are discussed. Graphs. 35 ref. (Kibert, C.J.; 6, (2), 67-75 [in English]. ISSN 0950-0618)

2407 PLASTICS WASTE PROCESSING. [BIB-199212-D1-P-2725]

A waste plastic material, e.g. hard plastic waste of vinyl chloride, polyethylene, and foamed styrol, soft plastic waste, or other plastic waste containing metal fragments, is immersed into a vegetable or mineral oil heated to 110-180 °C for

2388 INDUSTRIAL WASTE DIVERSION PROGRAM: FINAL REPORTS NO. 9: EVALUATION AND RESEARCH REPORT ON THE USE OF A NEW BIODEGRADABLE RESIN. [BIB-199207-D1-P-1593]

A study was undertaken for Uthane Research Ltd. to identify potential markets and determine existing competition and prices for a new biodegradable resin developed by the company. The amount of waste generated by Ontario municipalities and their characteristics, the attitudes of the commercial—industrial sectors toward biodegradability, the ultimate usefulness of biodegradability in managing wastes, the problems with plastics, the acceptability of existing technologies and their end products, and potential markets for degradable polymers are summarized. (Irwin-Whylie, S.; MIC-92-00119/XAB, Pp 50 [in English]. ISSN 0097-9007)

2389 ENVIRONMENTALLY SAFE METHOD FOR THE REMOVAL OF RESIDUAL POLYETHERS FROM AQUEOUS WASTE STREAMS. [BIB-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 1-10min; (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 A, as determined by X-ray diffraction analysis; and (f) recycling the bentonite adsorbent for contact with additional aqueous waste stream containing polymers. (Ananthapadmanabhan, K.; 7, (2), 139 [in English]., Patent no.: EP0406846 (European Patent) Convention date: 4 July 1990)

2390 DIFFUSION OF CESIUM IN SODIUM BOROSILICATE GLASSES FOR NUCLEAR WASTE IMMOBILISATION, STUDIED BY LOW-ENERGY ION SCATTERING. [BIB-199208-A2-C-0394]

Low-energy ion scattering (LEIS) is shown to be a convenient technique for measuring the diffusion coefficient of Cs in sodium borosilicate glass. A 3 keV $^4He^+$ ion beam if first used to create an alkali depletion layer in the outermost 60 nm of the glass. After annealing, to remove the vacancies from the glass matrix, the return of Cs to the surface is monitored. Diffusion coefficients at 815 and 842K are determined. Both are found to agree, within experimental error, with the values from the concentration couple method. The latter analyzes the Cs profiles by SEM/EDS. The present technique, however, can be applied at lower temperatures, where the concentration couple method would require too long times. This gives the possibility to predict the diffusion coefficient of Cs at actual temperatures in nuclear waste glass cylinders. (Kessel, O.; Eindhoven, Netherlands, 1-5 July 1991, B64, (1-4), 593-595 [in English]. ISSN 0168-583X)

2391 COMPATIBILISERS AND POLYMER MODIFIERS FOR VIRGIN AND RECYCLED THERMOPLASTICS. [BIB-199208-C1-P-1805]

The inhomogeneous composition of non-segregated plastic waste presents challenges in recycling to produce materials that have useful mechanical properties. Blends of plastic waste may be modified with another compatible polymer, mixed with other multi-functional polymers to effect bonding or mixed with fillers or reinforcing coupling agents. Thermoplastics and thermoplastic elastomers which may be used as modifiers and compatibilisers are described in terms of their effects on impact strength and tensile strength. Graphs. 1 ref. (Fuzessery, S.; Davos, Switzerland, 3-5 Apr. 1991, 4, (6), 399-407 [in English]. ISSN 0952-6900)

2392 THE ACCELERATED BIODEGRADABILITY OF PLASTIC MATERIALS IN SIMULATED COMPOST AND LANDFILL ENVIRONMENTS. [BIB-199208-C4-P-0344]

Degradation of plastics such as PE, cellophane, PHBV, polycaprolactone, kraft paper, PVA, EVA, PET, chitosan blends and PHBV blends in an accelerated landfill simulator vessel is investigated. Percent weight loss of materials in simulators is plotted as a function of age. Graphs. 7 ref. (McCarthy, S.P.; Detroit, Michigan, USA, 3-7 May 1992, Publisher: Technomic Publishing Co., Inc., 851 New Holland Ave., P.O. Box 3535, Lancaster, Pennsylvania 17604, USA, (1992), (Eng. Mat., 9208-G2-Z-0230), 816-818 [in English].)

2393 OIL CONVERSION TECHNOLOGIES OF WASTE POLYOLEFIN PLASTICS. [BIB-199208-D1-P-1836]

The oil conversion technologies of waste plastics which were developed by Fuji Recycling Co. in cooperation with the Hokkaido Industrial Research Institute of the Science and Technology Agency of MITI and Mobil Oil Corp. are introduced. The features of the technologies are the use of zeolite catalyst, ZSM-5. About 1 l of oil is recovered from 1 kg of waste polyolefin plastics. It is estimated that approx 3 million kl of gasoline and kerosene can be recovered from waste polyolefin plastics, which amount to 3 million tons/year. The Fuji Recycling Co.'s pilot plant, with annual capacity of 500 tons, was constructed in 1988 and is in smooth operation. (43, (10), 34-36 [in Japanese]. ISSN 0386-3700)

2394 NEWLY DEVELOPED OIL CONVERSION APPARATUS OF WASTE PLASTICS. [BIB-199208-D1-P-1837]

Nippon Sangyo Co. started the operation of one ton capacity experimental plant based upon ZZZKURATA oil conversion process of waste plastics which was developed by Rikagaku Kenkyusho (Japan Research Institute for Physico-Chemistry), in June 1991. Main characteristics of the process are: low thermal decomposition temperature of 200-250 °C , the use of combined catalysts of special metals, and the use of special reaction accelerating reagent. About 1.2 l of oil (kerosene grade) can be produced from 1 kg waste plastics. Photomicrographs. (43, (10), 37-39 [in Japanese]. ISSN 0386-3700)

2395 GLOBAL ACTIVITIES IN INDUSTRIAL ENGINEERING RESINS AND POST CONSUMER PLASTIC WASTE RECYCLING. [BIB-199208-D1-P-1881]

The role of Du Pont as a world leader in the development of technical solutions and business approach to at-source waste reduction and recycling is described. The company has 12 reclamation centers in the US and Europe handling 100 000 tonnes of recycled material annually. Polyethylene terephthalate (PET) and high density polyethylene (HPDE) are major candidates for recycling. Alliances and joint ventures have been developed for recycling various types of plastics, resins and rubber. (Williams, V.; Davos, Switzerland, 3-5 Apr. 1991, 4, (6), 388-393 [in English]. ISSN 0952-6900)

2396 AUTOMOTIVE PLASTICS: RECYCLING AND APPLICATION-ORIENTED PRODUCT DEVELOPMENT. [BIB-199208-D1-P-1882]

An account of DSM Polymers and Hydrocarbons concerns and involvement in the prevention and recycling of automotive plastic waste is presented. Waste prevention is the primary responsibility of the automotive designer and manufacturer to use thinner wall construction through better materials, use of "environmentally friendly" materials, standardization of material grades and designing for recycling. Co-partnership of materials producers with an end user is essential. Recycling of some PP and PP-modified bumper scrap, for example, depends on whether the scrap is manufacturer-specific or material-specific. DSM encourages disassembly of automotive components to improve recycling potential. (Hansen, O.; Davos, Switzerland, 3-5 Apr. 1991, 4, (6), 394-398 [in English]. ISSN 0952-6900)

2397 RECYCLABILITY—A NECESSITY IN THE DESIGN OF AUTOMOBILES. [BIB-199208-D1-P-1883]

Volkswagen's plans for dealing with the problem of recycling scrap vehicles are discussed. State-of-the-art recycling of automobiles can only be ensured if

recycling of plastics is relatively new but showing signs of becoming an important means for reducing the amounts of plastics in SW. Plastics are unique among recoverable materials in that they require stabilizers for processing and fabrication and to withstand end-use conditions. Some information regarding the needs of plastics for stabilization is presented and some strategies for dealing with the stabilization needs of recovered plastics of unkown composition and history are proposed. Above all, it should be pointed out that much more must be learned about the stabilization of recovered plastics before routine practices for the purpose can be established. 6 ref. (Klemchuk, P.P.; Philadelphia, Pennsylvania, USA, 3-5 June 1991, 32, (2), 123-124 [in English]. ISSN 0032-3934)

2378 POST-CONSUMER PLASTIC RECYCLING: WADING THROUGH THE MYTHS, UNDERSTANDING THE COST OF COLLECTION. [BIB-199204-G1-P-0035]

The first myth discussed is that "plastics are bad because they do not degrade" has recently come under fire by its early promulgator, environmental groups. Within the last year critics who demanded all packaging plastics be degradable have criticized those bags which contained degradable additives. Myth two is "burning plastics causes toxic emissions". The corrollary is that "plastics production releases toxics". Both statements are so broad as to be useless. Myth three is "plastics are not recyclable". Thermoplastics are, of course, eminently recyclable as is demonstrated daily by regrind levels regularly in the 10-25+%. The grandest myth is "plastics are bulging our landfills and will bury us". This myth may have its basis in the confusion of litter, a human shortcoming, and solid waste. Numerous studies, including Rathje's eight national landfill field studies, show the plastics contribution to the landfill is approx 7 wt.%. (Cornell, D.; Detroit, Michigan, USA, 8-11 Oct. 1990, Publisher: ASM International, Materials Park, Ohio 44073-0002, USA, (1990), (Eng. Mat., 9204-G2-Z-0138), 265-269 [in English].)

2379 TOXIC POTENCY MEASUREMENT FOR FIRE HAZARD ANALYSIS. [BIB-199205-C4-P-0197]

A comprehensive methodology has been developed for obtaining and using smoke toxicity data for fire hazard analysis. This description of the methodology comprises: determination that the post-flashover fire is the proper focus of smoke inhalation deaths; criteria for a useful bench-scale toxic potency (LC_{50}) measurement method; a method which meets these criteria, especially validation against real-scale fires; a computational procedure for correcting the results for the carbon monoxide levels observed in real-scale post-flashover fires; procedures for reducing the usage of animals and broadening the applicability of data by interpreting gas measurement data using the N-Gas Model; and a procedure for identifying whether a product produces smoke within the ordinary range of toxic potency for post-flashover fires. Results using the methodology are discussed for materials which include polyethylene, ABS resins, PMMA, and rigid polyurethane foam. Graphs. 100 ref. (Babrauskas, V.; NIST SP-827, Pp 107 [in English].)

2380 SYNTHESIS OF THERMAL STABILITY AND WEAR RESISTANCE OF GLASS CERAMICS. [BIB-199205-D1-C-0933]

Previously abstracted from original as item 9106-D1-C-1030. The solid fuel industry generates large quantities of mineral wastes. The aim of this paper is to develop a means of using these coal-enriching solid effluents to produce glass crystalline material with useful properties. The experimental waste materials used (ex-Chumakov and Gorlovsk) have a constant composition (analytical data provided) and were subjected to glass making technology with additives to help stimulate crystallisation. The products were crystalline, being largely of a fine pyroxine structure, and possessed a good resistance to temperature, abrasion, and aggressive media. These glass-crystalline material find use in the coal, cement, chemical, and power industries as protection for or replacement of metals. The economic effects of introducing production of these materials were calculated and are very favourable. Graphs. (Goikhman, V.Yu.; 47, (5-6), 165-168 [in English]. ISSN 0361-7610)

2381 BLOW MOULDING AND RECYCLING. (BLOW MOULDING E RICICLO.) [BIB-199205-E1-P-0358]

The use of blow moulding in the recycling of plastic waste is described. The surface finish of the product is improved to an acceptable standard by co-extruding the recycled waste with inner and outer layers of virgin material. A suitable procedure for collection, sorting and washing, followed by the removal of foreign bodies and grinding, is used to prepare the recycled waste for co-extrusion. The extruded thick walled tube is used as a base material for the blow moulding of large bottles and other containers. Details are given of operating parameters, quality of product and future prospects for the process. Graphs. (Dohmen, W.; 39, (407), 58-59 [in Italian]. ISSN 0032-2768)

2382 TEST RESULTS HELP POLYETHYLENE MANUFACTURER SELECT EXPLOSION PROTECTION SYSTEM. [BIB-199205-G1-P-0041]

Fike Corp., Blue Springs, Missouri, USA, manufactures equipment to vent, suppress, and isolate processing explosions. Fike also operates a testing center to determine the explosion severity of various dusts. The test apparatus produces an explosion under controlled conditions. Test results have shown that polyethylene dust presents an explosion hazard. Details of the testing techniques, explosion criteria, and the design of an explosion protection system are provided. (5, (9), 52-55 [in English]. ISSN 0897-6627)

2383 COUNTERMEASURE OF REFUSE PLASTICS IN AUTOMOTIVE INDUSTRY. [BIB-199206-D1-P-1299]

Since January, 1991, CAFE has increased up to almost 40 mpg in 2001. Weight reduction pushes more use of plastics. A chart comparing steel, nonferrous alloys, and nonmetals used in the automotive industry is provided. Plastic use in cars is summarized. Junk car plastic recycling becomes important. Treatment methods for refuse plastics are discussed, along with their problems. Graphs. 2 ref. (11, (12), 44-54 [in Japanese]. ISSN 0286-4835)

2384 PRAVDA—AN ORGANIZATION ESTABLISHED BY THE GERMAN CAR INDUSTRY FOR REGENERATION. [BIB-199206-D1-P-1300]

The German car regeneration organization PRAVDA (Projektgruppe Autoverwertung des Deutschen Automobilindustrie) is an initiative associated with a VDA 1990 report on vehicle based waste and pollution reduction. New (1993) German laws are expected to require carmakers to provide a logical recuperation system with particular regard to plastics. Already VW, Audi, BMW, Mercedes, Opel, Ford, Du Pont, ICI and Dow have participated in the initiative, which covers, e.g. polypropylene, ABS, polyurethane, amide plastics and polymethyl methacrylate. (Edshammar, L.-E.; (11), 16-18 [in Swedish]. ISSN 0347-8262)

2385 STUDIES ON PVC/LLDPE BLENDS. [BIB-199207-C1-P-1592]

Methods of improving the mechanical properties of poly(vinyl chloride)/linear low density polyethylene (e.g. Ladene 218 W and Ladene 118 W) have been investigated as a means of reprocessing polymer wastes containing such mixtures. Chlorinated polyethylene was found to be a useful additive in such blends for improving their tensile strength and processing behaviour. Co-crosslinking of the blends by chemical means or by irradiation was also found to improve their strength and stiffness. Graphs. 19 ref. (Francis, J.; 24, (2), 151-166 [in English]. ISSN 0095-2443)

2386 EXPANDABLE POLYSTYRENE RECYCLING. [BIB-199207-D1-P-1591]

Plast-Ex Inc. has been operating a pilot expanded polystyrene (EPS) recycling project over the past four months, studying both post-industrial and post-commercial EPS waste. The findings are summarized, some preliminary conclusions on the economic efficacy of EPS recycling are drawn, and some future requirements that will enable a comprehensive program across Ontario are highlighted. (MIC-92-00158/XAB, Pp 30 [in English]. ISSN 0097-9007)

2387 INDUSTRIAL WASTE DIVERSION PROGRAM: RECYCLING OF FLEXIBLE PVC WASTE. [BIB-199207-D1-P-1592]

Canadian General Tower disposes of more than two million pounds of vinyl waste/year from their main product lines. Because of the increasing landfill cost, an investigation was undertaken on recycling of the waste. The sourcing and characterization of the waste, the possibility of reprocessing, an evaluation of the waste products, the design of a product, and the molding of the prototypes are described. (Law, F.; MIC-92-00122/XAB, Pp 88 [in English]. ISSN 0097-9007)

2370 LONG-TERM BEHAVIOUR OF TRU-WASTE-BEARING CERAMICS. TASK 3. CHARACTERIZATION OF RADIOACTIVE WASTE FORMS: A SERIES OF FINAL REPORTS, 1985-1989. NO. 16. [BIB-199201-C5-C-0004]

The aluminumsilicate ceramic matrix KAB 78, developed for the immobilization of TRU-wastes, has been doped with 20 wt.% of $Pu(238)O_2$, to irradiate the matrix by the same alpha -dose over a period of three years, as accumulated within a storage time of approx 100 years, when loaded with real TRU-waste. The Pu(238) doped ceramic KAB 78 was investigated, by means of ceramographic methods, while the accumulated alpha -dose increased up to 8,33 E 9 Gy (9,4 E 18 alpha -decays/g). Special attention was directed to the development of the microstructure, the crystalline state and the lattice constants of the matrix phases, and to stored energy, as a function of the accumulated alpha -dose. The lattice constants of the matrix phases corundum and mullite were found to be only slightly enlarged. Any sign of a beginning metamictization has not been detected. Changes in the microstructure have not occurred, and the amount of stored energy has been determined to be 11 J/g. To study the corrosion behaviour of the Pu(238) doped ceramic and ceramics loaded with real dissolver residues, leach tests were performed over a period of 214 days, using either Q-brine or DI-water of up to 200 °C . Leach rates, based on the total alpha -activity, were found to be slightly higher, when leaching the Pu(238) doped ceramics. Reaction zones of 150-600 mu m thickness were formed, with a significant decrease of Si, whereas the concentrations of Al and Pu remained unaffected. Graphs, Photomicrographs, Diffraction patterns. 12 ref. (Loida, A.; EUR Rep. 13602, Pp 53 [in English].)

2371 STAGED MOLD FOR ENCAPSULATING HAZARDOUS WASTES. [BIB-199201-F1-P-0068]

A staged mold for stabilizing hazardous wastes for final disposal by molding an agglomerate of the hazardous wastes and encapsulating the agglomerate is disclosed. Three stages are employed in the process. In the first stage, a first mold body is positioned on a first mold base, a mixture of the hazardous wastes and a thermosetting plastic is loaded into the mold, the mixture is mechanically compressed, heat is applied to cure the mixture to form a rigid agglomerate, and the first mold body is removed leaving the agglomerate sitting on the first mold base. In the second stage, a clamshell second mold body is positioned around the agglomerate and the first mold base, a powdered thermoplastic resin is poured on top of the agglomerate and in the gap between the sides of the agglomerate and the second mold body, the thermoplastic is compressed, heat is applied to melt the thermoplastic, and the plastic is cooled, jacketing the agglomerate on the top and sides. In the third stage, the mold with the jacketed agglomerate is inverted, the first mold base is removed, exposing the former bottom of the agglomerate, powdered thermoplastic is poured over the former bottom, the first mold base is replaced to compress the thermoplastic, heat is applied to melt the new thermoplastic and the top part of the jacket on the sides, and the plastic is cooled, jacketing the bottom and fusing with the jacketing on the sides to complete the seamless encapsulation of the agglomerate. (Unger, S.L.; [in English]., Patent no.: US4932853 (USA) Convention date: 8 July 1988)

2372 PROPERTIES AND BEHAVIOR OF THE PLATINUM GROUP METALS IN THE GLASS RESULTING FROM THE VITRIFICATION OF SIMULATED NUCLEAR FUEL REPROCESSING WASTE. [BIB-199202-C4-C-0044]

Two types of Pt group metal particles were found in borosilicate nuclear waste glasses: needle-shaped RuO_2 particles and spherical $PdRh_xTe_y$ alloys. They form a dense sediment of high electrical conductivity and relatively high viscosity at the bottom of the ceramic melting furnace. The sludge shows a non-Newtonian flow behavior. The viscosity and conductivity of the sludge depend not only on the Pt group metal content but also on the texture and morphology of the RuO_2 particles. RuO_2 forms long, needle-shaped crystals which are caused by alkalimolybdate salt melts that formed in the calcine layer. The salt melts oxidize the Ru present as small RuO_2 particles after calcination to higher oxidation states. Ruthenium (VI) compounds are formed, presumably, which are not stable with respect to RuO_2 under the melting conditions. RuO_2 precipitates and crystallizes into long, needle-like particles. Graphs, Photomicrographs. 16 ref. (Krause, Ch.; 6, (12), 2535-2546 [in English]. ISSN 0884-2914)

2373 ACTIVATION CHARACTERISTICS AND WASTE MANAGEMENT OPTIONS FOR SOME CANDIDATE TRITIUM BREEDERS. [BIB-199203-A4-C-0047]

Activation and transmutation characteristics are calculated for the candidate breeder compositions Li_2O, $LiAlO_2$, Li_2SiO_3, Li_2ZrO_3, $LiVO_3$and 17Li—83Pb. Irradiation conditions comprise a 2.5 y continuous exposure to the neutron flux appropriate to the outboard blanket zone of the EEF reference reactor with an assumed first wall neutron loading of 5 MW m^{-2}. Results are presented for specific activity, surface gamma -dose rate, ingestion and inhalation doses and compositional changes. Neglecting any retained tritium, activity is least for Li_2O and $LiVO_3$ and greatest for Li_2ZrO_3 and 17Li—83Pb. The silicate and aluminate are intermediate in level. Following reactor service, all the materials should be suitable, after appropriate conditioning, for geological disposal as intermediate level waste. Alternatively, they could be considered for recycling to reclaim the unused Li. In all cases, recycling is probably feasible within ten years of removal from service and should be easier for the oxide, silicate, and vanadate. Graphs. 20 ref. (Butterworth, G.J.; 184, (3), 197-211 [in English]. ISSN 0022-3115)

2374 THE DISPOSAL OF COMPOSITES. [BIB-199203-D1-D-0546]

There is an increasing need to conserve natural resources and protect the environment. It is important, therefore, that scrap materials are disposed of by acceptable routes and, wherever possible, "recycled". Composites are not easy to recycle as they are made of a mixture of different materials with different properties. Composites based upon thermosetting polymers are particularly difficult, as the polymer cannot be remoulded in the same way as thermoplastic. The problems of recycling and disposing of thermoset composites are described and some of the ways of addressing the problem are considered. Current developments in this area are reviewed. 9 ref. (Pickering, S.J.; The Hague, The Netherlands, 15-17 Oct. 1991, Publisher: The Plastics and Rubber Institute, 11 Hobart Place, London SW1W 0HL, UK, (1991), (Eng. Mat., 9203-G2-D-0084), 7.1-7.6 [in English].)

2375 INDUSTRIAL APPLICATIONS OF AUTOMOTIVE SHREDDER FLUFF. [BIB-199203-F1-Z-0225]

Automobile shredder residue was submitted to mild pyrolysis using a unique patented process based on twin screw extruder technology. The processing resulted in a coarse, granular solid fuel product of uniform consistency, substantially upgraded in heating value, storage, and handling characteristics. Ash produced from the combustion of this solid fuel product easily met federal standards for disposal in conventional landfills. Graphs. (Jones, F.L.; Detroit, Michigan, USA, 30 Sept.-3 Oct. 1991, Publisher: ASM International, Materials Park, Ohio 44073-0002, USA, (1991), (Eng. Mat., 9203-G2-D-0087), 601-609 [in English].)

2376 IDENTIFYING THE BARRIER ISSUES IN COMPOSITES APPLICATIONS. [BIB-199203-G1-D-0010]

Some of the questions that need to be answered and issues that must be addressed before composites can reach their full use potential are identified. These include design, environmental/safety issues, materials characterization and data standards, computer hardware and software, and education. Both current needs and future opportunities are explored. 54 ref. (Wilkins, D.J.; Publisher: US Department of Commerce, National Institute of Standards and Technology, Gaithersburg, Maryland 20899, USA, (1990), NIST GCR 90-577-1, (Eng. Mat., 9203-G2-D-0088), 163-181 [in English].)

2377 PERSPECTIVES ON THE STABILIZATION OF RECYCLED PLASTICS. [BIB-199203-G1-P-0016]

As concerns about the disposal of increasing quantities of municipal solid waste (MSW) have grown, several approaches to solid waste disposal are being investigated. Source reduction, recycling, composting, incineration, degradable plastics and sanitary landfills are all being considered for MSW disposal. Many states and municipalities have adopted recycling laws and have implemented recycling programs. Recycling is experiencing a "grass roots" upsurge of interest and, although much remains to be accomplished, especially to increase effectiveness of collection and reduce costs of recycled materials, recycling is likely to be a major means of resource recovery and MSW reduction. The

deposited in a container for loading into trucks for proper disposal. This equipment economically handles the small quantities of dust produced by small foundries and processes the powders into a manageable form. Graphs. (Fartini, W.; 4, (1), 92-93 [in English]. ISSN 0934-7348)

2368 ELECTROCHEMICAL ARRAY SENSORS FOR PLATING WASTE STREAM MONITORING. [BIB-199305-58-0543]

Electrochemical sensors are being developed to aid in waste reduction efforts for plating operations and in environmental remediation. An important feature of these sensor systems is solid-state multielement microelectrode arrays. The individual elements of these arrays will be selected so that a variety of chemical species can be detected using a single device. In addition, a compact electronics package, consisting of a potentiostat, signal generator, and microcomputer with user-friendly software is being developed to use in conjunction with the arrays. The selection process for array elements is discussed along with advantages of the use of microelectrodes, and application to the analysis of actual plating rinse tank systems. Graphs. 20 ref. (Glass, R.S.; Hong, K.C.; Estill, J.C.; Reibold, R.A.; Thompson, W.M.; O'Brien, D.W.; Ciarlo, D.R.; Granstaff, V.E.; ATLANTA, GEORGIA, USA, 22-25 JUNE 1992, Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992), (Met. A., 9305-72-0264), 83-102 [in English].)

2369 POLLUTION PREVENTION WITH ADVANCED TECHNOLOGIES: A SUCCESS STORY—WITH A PAYBACK. [BIB-199305-63-0263]

The principal sources of Cu waste are a small number of rinses and bath dumps, mainly etcher and microetch sources. About 75% of the sludge came from the alkaline etcher and microetch rinses and the microetch bath dumps. Therefore, it is recommended that ACT (Alternate Circuit Technology) look into wastewater treatment systems designed to minimize waste production. Ion exchange technology coupled with electrowinning is the cleanest solution available—it virtually eliminates water contaminants without producing hazardous sludge. Proposals were sought for ion exchange and electrowinning systems capable of producing acceptable water and of recovering the metal as metallic sheets suitable for recycle. (Greene, M.C.; ATLANTA, GEORGIA, USA, 22-25 JUNE 1992, Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992), (Met. A., 9305-72-0264), 483-490 [in English].)

reference (NASS-3) could be analyzed accurately by using these techniques. Graphs. 9 ref. (Pering, J.-Y.; Chen, S.-H.; (6), 103-108 [in English]. ISSN 1015-6070)

2359 GUIDES TO POLLUTION PREVENTION: METAL CASTING AND HEAT TREATING INDUSTRY. [BIB-199305-51-0790]

The guide provides an overview of the major waste generating process of metal casting and heat treating operations and presents options for reducing the waste through source reduction and recycling. Most waste generated by the metal casting, or foundry, industry is from melting operations, metal pouring, and disposal of spent molding materials. Most waste generated by the heat treating industry is from spent baths (e.g. cyanide solutions), spent quenchants, wastewater from parts cleaning, spent abrasive media, refractory material, and masking processes. To help companies in the metal casting and heat treating industry determine waste reduction opportunities, the guide provides a set of worksheets which take the user step by step through an analysis of the on-site waste generating operations and the possibilities for minimizing each waste. The guide is also intended to be instructive to consultants who serve the industry and government agencies who regulate it. (PB93-127793/XAB, Pp 78 [in English]. ISSN 0097-9007)

2360 WASTE MINIMIZATION ASSESSMENT FOR A MANUFACTURER OF PENNY BLANKS AND ZINC PRODUCTS. ENVIRONMENTAL RESEARCH BRIEF. [BIB-199305-51-0791]

The WMAC team at the University of Tennessee performed an assessment at a plant manufacturing penny blanks, dry cell battery cans, and other Zn products—approx 120 million lb/year. Zinc ingots and scrap Zn are melted in an electric furnace. The molten Zn is formed into coils of strip for further procesing or sale to industrial customers. The circular penny blanks are formed in a press, upset to form a rim on the edge, copper-plated, and visually inspected. Battery can blanks are pressed from the strip, drawn into can shape, cleaned, and dried. The team's report, detailing findings and recommendations, indicated that the most waste was generated as dross in melting the Zn and that the greatest savings could be obtained by reducing drag-out from the plating tanks to reduce downstream sludge formation and installing driers to dewater the sludge before shipment for disposal. (Jendrucko, R.J.; Magimn, J.C.; PB93-123107/XAB, Pp 6 [in English]. ISSN 0097-9007)

2361 THE WELDABILITY OF LOW ACTIVATION CR—W STEELS. [BIB-199305-55-0851]

A series of Cr—W ferritic steels patterned on the Cr—Mo alloys, 2.25Cr—1Mo, 9Cr—MoVNb, and 12Cr—1MoVW, were tested for weldability. These steels are being developed as candidates for the first wall and blanket structure of fusion reactors. Use of these materials will minimize the long-term radioactive hazards associated with disposal after service. In these low activation alloys, long half-life elements (Mo and Nb), which become activated during irradiation, are replaced. Autogenous bead-on-plate welds were performed using the gas tungsten arc welding process. Experimental results showed that all welds were free of cracks. Sounds welds were achieved in 2.25 and 5%Cr—W low activition steels while loss of ductility was observed in 9 and 12% Cr—W steels. This result suggests that post-weld heat treatment is necessary to restore toughness to the 9-12% Cr—W steels. Photomicrographs. 17 ref. (Wang, C.A.; Chin, B.A.; Klueh, R.L.; CLEARWATER, FLORIDA, USA, 17-22 NOV. 1991, 191-194, 831-835 [in English]. ISSN 0022-3115)

2362 MICROSTRUCTURAL AND MECHANICAL CHARACTERIZATION OF NEW LOW-ACTIVATION CR—MN AUSTENITIC STEELS. [BIB-199305-56-0705]

On the basis of alloy design considerations, and aiming at the disposal by shallow land burial of the waste of fusion tokamak reactors (to be achieved by limiting the long-lived radioactivity of the first wall through the optimization of the composition of the conventional Ci—Ni austenitic steels), a series of new low-activation austenitic steels are designed. The results of the last stage of the development, concerning the microstructure and the tensile properties of these steels, which have been subject of extensive experimental characterization work, are presented. Graphs, Photomicrographs. 15 ref. (Piatti, G.; Boeman, D.; Santos Marques, F.; CLEARWATER, FLORIDA, USA, 17-22 NOV. 1991, 191-194, 662-667 [in English]. ISSN 0022-3115)

2363 RECYCLING CHEMICALS ON THE ANODIZING LINE—COST SAVINGS AND QUALITY IMPROVEMENTS. [BIB-199305-57-0572]

Aluminum is anodized with simple water-based chemicals that can be treated easily. However, many plants now use recycling equipment to extend chemical life and reduce waste treatment costs. Etching and anodizing solutions are the ones most frequently recycled but technologies are available for other finishing solutions as well. As most recycling approaches involve some degree of purification, anodizers often find that quality improvements go hand in hand with chemical savings. The technologies available to anodizers and some recent developments that have helped to enhance the anodized surface finish are discussed. (Munns, K.; ATLANTA, GEORGIA, USA, 22-25 JUNE 1992, Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992), (Met. A., 9305-72-0264), 153-176 [in English].)

2364 IMPINGEMENT: THE KEY TO EFFECTIVE AQUEOUS CLEANING. [BIB-199305-57-0575]

The effective application of surface impingement in the aqueous cleaning process, coupled with the many innovative technologies discussed, are critical factors in efforts to successfully replace chlorinated solvent processes with environmentally friendly ones. (Rowny, M.J.; Temple, S.D.; ATLANTA, GEORGIA, USA, 22-25 JUNE 1992, Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992), (Met. A., 9305-72-0264), 413-422 [in English].)

2365 RECYCLING AND RECOVERY OF CLEANING SOLUTIONS. [BIB-199305-57-0576]

Aqueous and alkaline cleaners, both the concentrated solution and the rinse water, pose many handling problems not previously encountered with solvent cleaners. Aqueous cleaners require component rinsing following the clean cycle. Companies are finding that the new cleaning processes actually remove dirt and solid material, which the solvents never touched. The cleaners are relatively expensive, and the aqueous cleaners cause severe upsets when introduced into many waste treatment operations. An alternative to the discharge of the cleaners now exists. Most cleaners may be selectively filtered to produce a cleaner which is free of oil, grease, and other contaminates while allowing the wetting agents, additives, dispursants and cleaner components to pass through the membrane. This regeneration of the cleaner maintains a fresh cleaner, increases the operational life of the cleaner, reduces the amount of cleaner used in the operation and ensures continuous quality cleaning of the components. (Weaver, T.J.M.; ATLANTA, GEORGIA, USA, 22-25 JUNE 1992, Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992), (Met. A., 9305-72-0264), 431-438 [in English].)

2366 CLEANING—EMERGING TECHNOLOGIES. [BIB-199305-57-0577]

Mandated by the EPA in the early 1980s and later of their own initiative, the US metal finishing industry has been looking to replace chelated and solvent-based cleaners. The availability of specialty polymers and surfactants has led to the development of new liquid cleaners which often meet the above criteria, perform better, and last longer than the traditional powder cleaners. They are also easy to waste treat and can be safely fed through automated pumps. Such emerging technologies in cleaning, which will be increasingly used during the 1990s and beyond, are discussed. (Srinivasan, B.; ATLANTA, GEORGIA, USA, 22-25 JUNE 1992, Publisher: AMERICAN ELECTROPLATERS AND SURFACE FINISHERS SOCIETY, INC., 12644 Research Parkway, Orlando, Florida 32826-3298, USA, (1992), (Met. A., 9305-72-0264), 439-442 [in English].)

2367 TREATMENT AND DISPOSAL OF FILTERING POWDERS IN FOUNDRY CUPOLAS. [BIB-199305-57-0695]

The powders produced by cast iron foundries must be collected and disposed. This presents a problem for small to medium sized foundries because the quantities of powders they produce are not readily handled by conventional methods. A powder handling machine is proposed for just such applications. It consists of a small humidifier to moisten the powders, a mixing chamber to ensure complete wetting, and a discharge chute. The moistened powders are

METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), 389-392 [in English].)

2352 THE SPLIT PROCESS: ALUMINIUM PECHINEY METHOD FOR THE SAFE DISPOSAL OF SPENT POTLINING. [BIB-199305-42-0606]

Spent potlining (SPL) is a well known hazardous waste rich in soluble cyanides and fluorides. A full size industrial unit has been built and operated by Aluminium Pechiney for more than one year, on a test basis, using the SPLIT process (spent pot lining insolubilization technology) in order to detoxify SPL prior to disposal. Cyanides are thermally destroyed, fluorides are included in synthetic nonleachable minerals, so that the final product is compatible with regular landfilling, and meets the Environmental Protection Regulations in most of the World countries. Aluminium Pechiney is presently preparing the erection of several SPLIT plants attached to its smelters. (Bontron, J.-C.; Laronze, D.; Personnet, P.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), 393-397 [in English].)

2353 SPENT POTLINING: WATER SOLUBLE COMPONENTS, LANDFILL AND ALTERNATIVE SOLUTIONS. [BIB-199305-42-0607]

An overview is given about water soluble components of spent potlining. Fluorides and cyanides and their environmental impact are reviewed. Landfill problems are outlined and alternative solutions to reduce or eliminate the thermal insulation part of the potlining are discussed and recommendations are given. 72 ref. (Pawlek, R.P.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), 399-405 [in English].)

2354 PROCESS OPTIMIZATION FOR ELECTROWINNING OF CALCIUM. [BIB-199305-42-0620]

Fused salt electrolysis of a salt mix containing 10 wt.% calcium oxide in calcium chloride has been carried out in an electrolytic cell. The technology is aimed at resolving a contaminated waste disposal problem and improve the cost and process efficiency in Pu metal production where a similar salt mix is produced as a result of calciothermic reduction of plutonium oxide. A model has been developed based on the reaction rate theory to identify the influence of components on the cell-potential. On the basis of this model and extensive work done with various cell parameters, significant modification has been made to the cell to achieve the ability for elemental Ca recovery within the system. A porous ceramic sheath has been used around the anode to prevent the dissolution of electrowon Ca as oxide or carbonate and to prevent the contamination of salt by the anodic carbon. An ionic diffusion measurement has been made to understand the critical behavior of the ceramic diaphragm in terms of its porosity. Design and selection of electrodes has been performed to maintain a high rate of Ca deposition and to discourage back reactions. This work has been discussed with the objective to use the electrowon Ca for in situ reduction of a reactive metal oxide within the cell. Graphs. 10 ref. (Ferro, P.D.; Mishra, B.; Olson, D.L.; Averill, W.A.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), 1129-1136 [in English].)

2355 RECOVERY OF METALS FROM SLUDGES AND WASTEWATERS. [BIB-199305-43-0150]

The state-of-the-art of metals treatment and recovery technologies is presented to assist in identifying waste management options for metal-bearing sludges and wastewaters. Nine metal-waste producing industries are discussed: metal coatings, smelting and refining of nonferrous metals, paint and ink products, petroleum refining, iron and steel manufacturing, photographic industry, leather tanning, wood preserving, and battery manufacturing. These industries were selected because of the high metal concentrations associated with the sludges and wastewaters generated by plants within each of these industry segments. The techniques presented are also applicable to metal-bearing waste streams in all other industries. Graphs. 76 ref. (Krishnan, E.R.; Ultrecht, P.W.; Patkar, A.N.; Davis, J.S.; Pour, S.G.; Foerst, M.E.; Publisher: NOYES DATA CORPORATION, 120 Mill Rd., Park Ridge, New Jersey 07656, USA, (1993), (Met. A., 9305-72-0285), Pp 137 [in English].)

2356 RECOVERY OF CHROMIUM IN HIGH PURITY STATE FROM WASTE MATERIALS OF ETCHING OPERATIONS. [BIB-199305-43-0158]

The present invention is directed to a method for treating a sludge containing substantial amounts of chromium, aluminum, calcium, iron, and phosphorus. The method comprises forming a slurry of the sludge; reacting the slurry with an acid to dissolve substantially all the Al and Cr and provide a solids residue comprising mostly calcium sulfate; separating the Cr/Al-containing solution from the solids residue; raising the pH of the Cr/Al solution to precipitate Cr as chromium hydroxide; and separating the chromium hydroxide from the remaining Al-containing solution. The chromium hydroxide is then enriched with an alkali or earth alkali compound and calcined in an oxidizing atmosphere to convert the Cr to a chromate. The calcine is leached in an aqueous medium at a controlled pH to yield a high concentration, high purity chromate solution suitable for producing metallic Cr or a variety of Cr chemicals. (Crnojevich, R.; Case, A.B.; Rando, F.D.; Sweeney, J.D.; [in English]., Patent no.: US5171547 (USA) Convention date: 19 Sept. 1990)

2357 METHODS FOR PROCESSING BATTERY WASTE AND OTHER LEAD-CONTAMINATED MATERIALS. [BIB-199305-43-0161]

The present invention is directed to improved methods for processing battery wastes, batter casing debris and other Pb contaminated materials. The improved processes of the present invention provide less environmentally stressful methods for recovering Pb from such materials while at the same time producing scrap or recyclable ebonite and plastics having reduced and environmentally acceptable Pb and leachable Pb levels. Most of the Pb is first removed by trommel scrubbing. In another aspect of the present invention, ebonite and other hard surface materials to which are adhered Pb contaminants are mixed with water and abraded in a high energy scrubber to remove the adhered contaminants prior to separation of the cleaned ebonite from solution. This simple and environmentally preferred hydromechanical process provides clean scrap or recyclable ebonite. In another aspect of the present invention, plastic and other soft materials contaminated with Pb are mixed with a solution having a pH approx 7, preferably approx 1-5 wt.% alkali hydroxide solution, to dissolve Pb contaminants. Separation of particulates produces clean scrap or recyclable plastic while carbonation of the wash water permits recovery of lead carbonate. Finally, the present invention provides methods for controlling dust contamination prior to and during processing by spraying the fine, raw materials with an aqueous solution of a wetting agent, preferably approx 2 wt.% alkali carbonate, bicarbonate or sequicarbonate in water. (Montgomery, A.H.; Kube, W.H.; [in English]., Patent no.: US5173277 (USA) Convention date: 22 Feb. 1991)

2358 SEA WATER ANALYSIS BY ICP-AES GFAAS AND ICP-MS. [BIB-199305-45-0503]

The application of analytical technique to monitor trace heavy metals contaminants in such matrix samples has always received much attention owing to the high salt content in sea-water. Co-precipitation and ion-exchange methods have been most frequently used for sample pretreatment in seawater analysis. Pel's methods of separation and preconcentration were adopted in this study, and trace heavy metals of interest were concentrated 120-fold which is considered as a suitable concentration level for ICP-AES, GFAAS and ICP-MS analysis. Various pretreatments were necessarily made for the sake of minimizing contamination, and different precaution measurements were required to be taken during sample handling. Results obtained form ICP-AES, GFAAS and ICP-MS were compared. The application of each instrument to routine sea water analysis was also discussed. Both the coastal seawater reference (CASS-2) and open seawater

decreased exhaust gas emissions approx 90% compared with a conventional incinerator, with absence of NO_x and SO_2/SO_3 in the exhaust gas. (Kloters, W.; (4), 75-77 [in German]. ISSN 0941-0821)

2344 WASTE TREATMENT AND METAL REACTANT ALLOY COMPOSITION. [BIB-199305-34-0706]

An alloy composition of Al, Zn, Fe, Cu, and Ca when held molten at approx 800 °C by induction heating is capable of complete destruction of organic compounds that may be liquid or associated with sludges and at the same time is capable of reacting with metallic compounds in the sludges or liquid wastes to either dissolve or render the metals non-leachable. (Wagner, A.S.; [in English]., Patent no.: US5167919 (USA) Convention date: 15 Mar. 1990)

2345 USE OF ZINC COATED STEEL AS BUILDING PANELS AND ROOFING MATERIALS IN AGRICULTURAL APPLICATIONS. [BIB-199305-35-0875]

Since 1986, the International Lead Zinc Research Organization Inc (ILZRO) has sponsored North Carolina State University to investigate the corrosion behaviour of Zn coated steel (galvanized steel) in exposure to animal wastes and to provide quantitative Zn corrosion rates for design engineers. Zinc coated steel has proved its good corrosion resistance in an agricultural atmosphere. For the first experiment, several types of steel panels were exposed to animal wastes as encountered in agricultural environments, starting in March 1986. The types of exposure panels included bare steel (cold rolled 1020 steel), Galfan (commercial name of the Zn + 5% Al + mischmetal alloy coated steel) coated steels (GF-90, GF-60), epoxy coated steel, stainless steel, galvanized steel and drawing quality (DQ) galvanized steel (G-90). Four different environmental stations were tested for three animal types: swine, dairy cattle, and laying chickens. Each panel was weighed prior to exposure test. The sample panels have been removed, inspected and re-installed ten times since the first installation of March 1986. Batch galvanized and stainless steel test panels were found to provide superior corrosion resistance as compared to epoxy coated steel and other Zn coated steels in animal waste environments. Graphs. 2 ref. (Kim, M.M.; Safley, L.M.; BARCELONA, SPAIN, 2-7 JUNE 1991, Publisher: EUROPEAN GENERAL GALVANIZERS ASSOCIATION, London House, 68 Upper Richmond Rd., Putney, London SW15 2RP, UK, (1991), (Met. A., 9305-72-0296), GB2/1-GB2/6 [in English].)

2346 CORROSION STUDIES ON SELECTED PACKAGING MATERIALS FOR DISPOSAL OF HEAT-GENERATING RADIOACTIVE WASTES IN ROCK-SALT FORMATIONS. [BIB-199305-35-0892]

In previous corrosion studies, carbon steels and the alloy Ti99.8—Pd were identified as promising materials for heat-generating nuclear waste packagings that could act as a barrier in a rock-salt repository. To characterize the corrosion behaviour of these materials in more detail, a research programme including laboratory-scale and in situ corrosion studies has been undertaken jointly by KfK and ENRESA/INASMET. Besides C steels and Ti99.8—Pd, Hastelloy C4 and some Fe-base materials are being examined to complete the results available to date. (Smailos, E.; Schwarzkopf, W.; Gago, J.A.; Azkarate, I.; TIB/B92-03175/XAB, Pp 31 [in English]. ISSN 0097-9007)

2347 THE INFLUENCE OF RED MUD IMPOUNDMENTS ON THE ENVIRONMENT. [BIB-199305-41-0158]

As a result of the expanding metal consumption in the world and the increasing exploitation of low-grade ore deposits, mining tailings continue accumulating. Their disposal gives rise to ecological problems. Special problems occur with wastes that contain various noxious constituents (heavy metal ions, flotation reagents, acids, and others), which may seriously endanger the quality of surface and underground water. One such waste is red mud, which, besides great amounts of very fine particles and iron oxides, contains a significant quantity of extremely dangerous sodium oxides. The paper discusses the red mud disposal systems applied, in the areas of former Yugoslavia. Possible noxious environmental influences of these deposits and the protective measures are brought forth. 3 ref. (Salopek, B.; Strazisar, J.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), 41-44 [in English].)

2348 A NEW CONCEPT FOR TAILINGS DISPOSAL. [BIB-199305-41-0159]

Mineracao Rio Norte SA (MRN) started operations in 1979 with tailings from bauxite washing dumped into the nearby natural lake Batata, thereby upsetting its environment. From 1982 a series of studies, laboratory tests, and field trials were carried out seeking to characterize the tailings composed of clay and water at a 7-9% solids concentration. In 1986 reliable data were available making it possible to formulate alternatives for tailings disposal that would not entail silting of lakes or similar natural valleys. The most environmentally "clean" and economically viable alternative was based returning the tailings to mined-out areas. Besides characterizing the technical behavior of the tailings, it was also necessary to revise the mining geometry, drainage, and the operational modes required to physically accommodate the tailings. The present paper details the operational aspects of the new tailings disposal method, and mentions the evolution of the environmental rehabilitation of silted parts of lake Batata. Graphs. (Lapa, R.P.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9305-72-0288), 45-49 [in English].)

2349 ELECTROCHEMICAL STUDIES OF IRON SULPHIDES IN RELATION TO THEIR ATMOSPHERIC OXIDATION AND PREVENTION OF ACID DRAINAGE. II. [BIB-199305-42-0561]

Oxygen reduction of pyrite (FeS_2) and related redox reactions have been studied using RDE and RRDE. The mechanism of charge transfer and the role of the semi-conductor phase in the oxidation and dissolution of pyrite has been examined in light of the energy level diagrams. A mechanistic analysis indicates that O_2 is sequentially reduced to water via H_2O_2 route. H_2O_2 itself is reduced by the mechanism of hole injection in the valence band. The holes subsequently either recombine with e^-_{cb} or lead to other oxidation reactions. The problem of the "acid mine drainage" resulting from the atmospheric oxidation of the iron sulphides has also been examined. Methods of preventing the AMD by cathodic protection or by growing passive, iron oxide films on FeS_2 (on electrodes only) have been developed. Graphs, Spectra. 25 ref. (Ahmed, S.M.; Giziewicz, E.; ST. LOUIS, MISSOURI, USA, 17-22 MAY 1992, Publisher: THE ELECTROCHEMICAL SOCIETY, INC., 10 South Main St., Pennington, New Jersey 08534-2896, USA, (1992), PV-92-17, (Met. A., 9305-72-0280), 372-390 [in English].)

2350 A PROPOSAL FOR WASTE RECOVERY AND RECYCLING IN ELECTROPLATING. (PROPOSTA PERIL RICICLO E IL RECUPERO NEI PROCESSI GALVANOTECHICI.) [BIB-199305-42-0572]

A new concept based on a flexible modular construction of waste processing installations has as its central piece a completely sealed interchangeable cartridge with ion exchange resins. These units may be regenerated in a specially built plant with all the required facilities. A survey of the present situation in waste treatment in Italy is covered, analyzing the types and compositions of effluents (data are given). The proposed AFIG-FOESSEL method is technically described, emphasizing its advantages. Efforts to initiate the new project in Northern Italy (Emilia Romagna) are outlined. Iron, nickel, zinc, and chromium are recovered. (Bonapace, M.; Brambilla, G.; Frenquellucci, F.; 31, (6), 69-76 [in Italian]. ISSN 0041-1833)

2351 FURTHER DEVELOPMENT OF THE COMTOR PROCESS FOR SPL TREATMENT. [BIB-199305-42-0605]

Comalco Aluminium Limited (CAL) has developed the COMTOR process to treat spent potlining (SPL) and recover valuable constituents, at its Boyne Smelter. A feed preparation circuit supplying 10 000 t/year of crushed SPL to an expanded calcination facility has been constructed. Commissioning of the second of two production calciners, designed on the basis of prototype testwork, has coincided with that of the feed preparation circuit. Treatment of the calcine to recover chemical values has been demonstrated in a pilot plant and the design of a production facility is planned. The integration of the feed preparation, calcination and calcine treatment stages (the COMTOR process), provides aluminium smelters with an effective technology for the waste management of SPL. Graphs. 2 ref. (Kidd, I.L.; Rodda, D.P.; Gillett, G.D.; Nugent, K.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS,

keep the recirculating quantities low and to adjust correctly and then control the parameters of the process that uses the lubrication. Spent cooling lubricants need not necessarily be directly disposed of, but can under most circumstances be reprocessed to crude oil. To facilitate this approach—and delegate disposal to a second choice position—certain steps must be taken: any substitute ingredients should preferably be botanic in nature; dilution by mixing with harmful or toxic ingredients should be avoided, as should substances containing microoganisms that adversely affect stability; finally, nitrate contents must be closely monitored. Ways to diminish the quantity of recirculating fluids for simulataneous lubrication and cooling are discussed. (Wiese, H.A.; 98, (21), 28-30, 32, 34 [in German]. ISSN 0341-5775)

2337 RECYCLING STAINLESS STEEL PICKLE LIQUORS BY AN ELECTRODIALYTIC METATHESIS PROCESS. [BIB-199306-57-0705]

The stainless steel industry relies on nitric—hydrofluoric acid (HNO_3/HF) pickling solutions to remove surface contaminants and maintain the corrosion resistance of the steel. More stringent environmental guidelines are expected to be placed on the disposal of these solutions which could significantly increase processing costs. The US Bureau of Mines has been conducting research to develop a process for recycling depleted pickling solution, thus reducing the quantity of by-product acids generated. Research has shown that F^- can be liberated from the predominant iron fluoride species (FeF^+_2) by using oxalic acid in an electrodialysis cell. Ion selective membranes allow dissolved metals in the depleted solution to be replaced with hydronium ions by metathesis, thereby regenerating the HF. The regenerated HNO_3/HF is then retained in the pickling solution. This paper reports on the research effort at the US Bureau of Mines Rolla Research Center to apply electrodialytic recycling to HNO_3/HF pickling solutions. 10 ref. (Rivers, S.P.; Horter, G.L.; Schluter, R.B.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9306-72-0303), 1035-1046 [in English].)

2338 WATER CONSCIOUS—ALTERNATIVE METHODS FOR THE CLEANING AND PRETREATMENT OF METALLIC GOODS. (WASSERBEWUSST—ALTERNATIVE VERFAHREN ZUM REINIGEN UND VORBEHANDELN METALLISCHER GUTER.) [BIB-199306-57-0723]

Cleaning and preliminary handling of metallic goods comprises not only the intrinsic treatment process, but must also take into consideration washing purification and waste-water disposal compatible with the environment. Furthermore, for reasons of cost effectiveness, an optimal method must be initially selected from the water-managing viewpoint as well. Various types of cleansers are described. The present advanced technology for degassing installations and control of toxic metallic residues, nitrites, sulfates, and fats and oils is presented, and the processing of oil emulsions is described. Waste-water treatment with specific reagents, and a detailed discussion of the ultrafiltration-type physical and emulsion-splitting-type chemical-waste-water treatment processes now in operation in the most up-to-date plants is given. 1 ref. (Locke, F.-J.; 97, (38), 32-34, 36-37 [in German]. ISSN 0341-5775)

2339 MATERIALS DEVELOPMENT FOR ENVIRONMENT ENGINEERING. (WERKSTOFFENTWICKLUNG FUR DIE UMWELTTECHNIK.) [BIB-199306-61-0612]

One key aspect of Krupp VDM's materials development policy is to refine proven materials and to provide new materials for environmental engineering. Motor vehicle exhaust conversion, flue gas desulphurization, waste-water evaporation, cooling water recirculation and refuse thermal disposal investigations and resulting products, are reported. Graphs, Photomicrographs. 17 ref. (Heubner, U.; (4), 41-44, 47-48 [in German]. ISSN 0941-0821)

2340 DENTAL AMALGAM—ENVIRONMENTAL ASPECTS. [BIB-199306-61-0712]

Increasing knowledge about the risk of toxic effects caused by anthropogenic Hg accumulation in ecosystems has resulted in a growing pressure for reduction of the discharge of Hg waste. Consequently, the Hg waste problems of dental clinics have been given increased attention, and restrictions on handling and discharge of contaminated waste have been established in several countries. Major amalgam particles from trituration surplus of those produced during the carving and burnishing of new amalgam restorations are generally collected in coarse filters and sold for refinement. Minor amalgam particles released by production of new fillings or by removal of old restorations partly sediment in tubes and drains. The remaining particles are carried with the waste water stream to the local purifying plant. In Scandinavia, the industrial discharge of Hg-contaminated waste water has been reduced to a minimum. According to recent investigations, dental clinics appear to be responsible for the major amount of Hg collected in the sludge generated in purifying plants. If threshold values for heavy metal content, including Hg, are exceeded, the sludge is not allowed to be recycled as fertilizer. Installation of an approved amalgam-separating apparatus in dental clinics is now mandatory in several countries—for example, Switzerland, Germany, Sweden, and Denmark. Approval of amalgam separators is based on national testing programs, including clinical or laboratory tests demanding 95-99% separating efficiency. Graphs. 18 ref. (Arenholt-Bindslev, D.; BETHESDA, MARYLAND, USA, 26-28 AUG. 1991, 6, 125-130 [in English]. ISSN 0895-9374)

2341 DIRECT ELECTROPLATING OF PC BOARDS—EXPERIENCES OF THE USER. (DIREKTGALVANISIEREN VON LEITERPLATTEN—ERFAHRUNGEN BEIM ANWENDER.) [BIB-199306-63-0377]

Direct electroplating with copper of the walls of holes drilled through printed circuit boards is made possible by a permangante treatment of the polymer substrate exposed to convert it to an intrinsic conductor. The need is reduced for capital investment in waste disposal plant, less space is required for plant suitable for mass production, and replacement of electroless plating systems is relatively quick. Graphs, Photomicrographs, Spectra. 3 ref. (Beator, K.; Bressel, B.; Grapentin, H.J.; 46, (9), 384-389 [in German]. ISSN 0026-0797)

2342 THE POTENTIAL OF AIR-SPARGED HYDROCYCLONE FLOTATION IN ENVIRONMENTAL TECHNOLOGY. [BIB-199306-71-0186]

Air-sparged hydrocyclone (ASH) flotation is a high-capacity flotation technology originally developed in the Department of Metallurgical Engineering at the University of Utah for processing mineral resources. However, the technology has been found to be useful in industrial waste processing, in the recycle of secondary resources, and in remediation of environmental problems. For example, areas in which the ASH technology is expected to have potential application include cleaning of waste coal fines, air stripping to remove volatile organics from drinking and process water, water disinfection by ozone or chlorine sparging, dispersed oil removal from water, and contaminated soil remediation. Recently, the ASH has been studied extensively for deinking flotation in the wastepaper recycling industry and has been shown to have excellent efficiency/capacity. In fact, a $20M plant has been in operation since June 1992. The ASH technology can provide a specific capacity hundreds of times more than that which can be achieved with conventional flotation equipment and in certain instances is expected to provide superior separation efficiencies when compared to other technologies. The design and principles of ASH flotation are described. Experimental data for fine coal flotation, volatile organics stripping, and deinking flotation for paper recycle are presented and discussed. Finally, other potential areas of application for environmental technology are considered. Graphs. 17 ref. (Miller, J.D.; Yi, Y.; Hupka, J.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9306-72-0303), 123-135 [in English].)

2343 DISPOSAL OF CLARIFIED SLUDGE BY THE VERTECH DEEP SHAFT PROCESS. (AUFBEREITUNG VON KLARSCHLAMM MIT DEM VERTECH-TIEFSCHACHTVERFAHREN.) [BIB-199306-71-0190]

The VerTech wet oxidation process for environmentally friendly disposal of clarified sludge is described. This vertical technology, located underground, through addition of oxygen at approx 300 °C and 100 bar decomposes virtually all organic constituents into H_2O, CO_2, and solid residues. A 40 cm diameter VerTech reactor of up to 1500 m^3/day capacity, whose design is outlined,

mentioned above. There appears to be no other cleaning process capable of replacing chlorinated solvent-based methods, in terms of technical and economic performance. Aqueous systems are being installed for their environmental advantages. For such systems, recovery and/or disposal of the cleaning alkali is feasible and described. (Fallot, J.-F.; 83, (12), 4114-4118 [in German]. ISSN 0016-4232)

2329 THE DISPOSAL OF ARSENIC FROM METALLURGICAL PROCESSES: ITS STATUS REGARDING FERRIC ARSENATE. [BIB-199306-32-0318]

Much has been written over the past decade concerning the disposal of arsenic from metallurgical processes. In Canada, there are proposed regulations which would classify As in the primary group of 21 persistent, toxic pollutants to be banned or phased out. Since many nickel and cobalt ores, not to mention those of copper, gold, and uranium, contain significant amounts of As, it is pertinent to assess the current state-of-the-art of its disposal. The literature is reviewed, and it is demonstrated that from a purely chemical point of view, the family of ferric arsenates largely immobilize As. There is clear evidence from laboratory studies that both crystalline ferric arsenate (scorodite) and amorphous ferric arsenates in which the molar Fe:As ratio is at least three (Fe/As 3) have very low As solubility; plant data are given to support this. The debate over the long term stability of these compounds continues however; the evidence presented for long term stability and for compound breakdown is critically reviewed in the light of the recent structural studies, and the role of base metal in these compounds evaluated. Finally, conclusions are drawn as to the viability of a purely chemical process for the long term disposal of As from metallurgical processes. Graphs. 51 ref. (Harris, G.B.; Krause, E.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1993), (Met. A., 9306-72-0325), 1221-1237 [in English].)

2330 STEEL SHEET PILING FOR SAFEGUARDING AND RESTORATION OF INDUSTRIAL WASTE SITES. (STAHLSPUNDWAND ZUR SICHERUNG UND SANIERUNG VON ALTLASTEN.) [BIB-199306-35-0960]

Steel sheet piling provides excellent waste containment. Long-term investigations on soils and various test liquids show that the steel-wall thickness decrease though corrosion does not usually exceed the permissible limit values. The Hoesch sheet piling seal (DBP 27 22 978), as used in the Hamburg harbour flood protection scheme, illustrates the high capability of steel-sheet piling. Graphs. 2 ref. (Roth, S.; BERLIN, GERMANY, 26 MAR. 1992, (4), 59-63 [in German]. ISSN 0941-0821)

2331 MATERIALS PERFORMANCE IN HIGH-TEMPERATURE WASTE COMBUSTION SYSTEMS. [BIB-199306-35-1025]

Corrosion problems at high temperatures in the complex and variable environments in waste combustion systems create demanding challenges to designers and operators. The general scenario is reviewed including materials performance in the presence of various pollutant species, notably sulfurous gases, halogen vapors, molten metals, and glass. The range of available materials is noted with reference to recently developed alloys. Photomicrographs, Graphs. 10 ref. (Elliott, P.; 32, (2), 82-87 [in English]. ISSN 0094-1492)

2332 TREATMENT OF LEAD WASTES FROM LEAD—ACID BATTERY RECYCLING PLANTS. [BIB-199306-42-0706]

The US Bureau of Mines developed a method to treat Pb-contaminated soil and ebonite battery casing wastes to produce a nonhazardous material. The cleanup procedure involves wet screening to separate a —18-mesh soil fraction; removal of metallic Pb, rocks, wood, etc.; carbonation to change lead sulfate to acid-soluble lead carbonate; size reduction; acid leaching; and rinsing. The casing wastes undergo size reduction and washing to remove the lead sulfate sludge before carbonation. Similarly, the —18-mesh soil is carbonated, then acid leached and rinsed. In leaching, fluosilicic acid (H_2SiF_6) and hydrogen peroxide (H_2O_2) are used to dissolve Pb compounds. An electrowinning method is employed to strip Pb from the Pb-rich leachate. The acid content in the leachate is replenished with fresh H_2SiF_6 acid prior to recycling. Treated casing wastes and soils pass the toxicity characteristic leaching procedure (TCLP) test and can be reclassified as nonhazardous materials. Based on this process, a conceptual pilot plant has been designed which will be demonstrated on wastes from two Superfund sites. Graphs. 10 ref. (Lee, A.Y.; Wethington, A.M.; Gorman, M.G.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9306-72-0303), 927-942 [in English].)

2333 SALT SCRUB REDUCTION ALLOYS FOR ACTINIDE RECOVERY. [BIB-199306-42-0712]

Calcium and lithium gallides have been synthesized by powder metallurgy techniques in the stoichiometries that can be used as reduction alloys for the Rocky Flats Plant Salt-Scrub (SS) process. The SS process is performed to recover valuable metals from salts generated in the electrorefining and the molten salt extraction processes. Combustion synthesis has been optimized for variable heating rates up to the reaction ignition temperatures and for green densities of the powder compacts in terms of the ignition temperature and the exothermic heating of the product in an effort to develop LiGa and $CaGa_2$ alloys. The problems arising from the melting point and density differences of calcium, lithium and gallium have also been studied. The SS alloy compositions were produced by mixing, pressing and sintering the metal-powders. The efficiency of the intermetallic alloy, Ca—17 wt.% Ga, as a reductant and the effect of Ga on salt cleanup has been discussed. Measurement of actinide recovery has been studied with cerium as the surrogate for the actinide metal. The development of an alloy for SS reduces a major contaminated waste disposal problem besides recovering the valuable reactive metal. Graphs, Phase diagrams, Diffraction patterns. 17 ref. (Mishra, B.; Pritchett, S.; Moore, J.J.; Murray, A.M.; DENVER, COLORADO, USA, 21-25 FEB. 1993, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9306-72-0303), 1019-1034 [in English].)

2334 RECYCLING OF ALUMINUM, ALUMINUM SECONDARY ALLOY INGOT. [BIB-199306-43-0199]

Recently, more and more metals are being recycled. As far as aluminum alloys are concerned, the total weight of recycled alloys increases at a rate of approx 30 000 tons/year, with current level of approx 1.1 million tons. The recycling program has the following elements: (1) introduction of quality control, (2) pollution prevention, (3) establishment of Japanese Al alloy association, and (4) new Japanese industrial standards. A typical life cycle of an alloy includes several stages: (1) original alloy manufacturing, (2) component machining, (3) usage, (4) collection of used components, (5) remanufacturing, (6) new component machining, (7) new usage, etc. As an example, annual usage of Al soft drink cans is 160 000 tons. Approximately 43% of these cans are recycled. Before remanufacturing of the alloys, all collections are divided according to their Al contents. There exist many different kinds of prefabrication furnaces. There also exist several casting technologies. Quality of casted alloys is always tested before usage. Graphs. 7 ref. (Shimomura, Y.; 42, (8), 464-470 [in Japanese]. ISSN 0451-5994)

2335 THERMALLY RECLAIMING FURAN-BONDED SANDS. [BIB-199306-51-0880]

Foundries operating furan resin systems can mechanically reclaim 60-95% of sand, depending on the quality of the material being cast. The operation of these systems is governed by residual resin and catalyst buildup on the sand grains, which may be measured in terms of loss of ignition, acid demand value, residual sulfur, nitrogen, and dust level. Variations of these characteristics can create casting defects as well as environmental problems because of emissions during pouring. Thermal sand reclamation, using gas-fired, fluidized bed thermal reclaimers, allows the 100% reuse of sand for core sand molds, thus saving on new sand costs and greatly minimizing disposal costs and concerns. (Bailey, I.; 83, (1), 36-37 [in English]. ISSN 0026-7562)

2336 RECYCLING OR AVOIDING—ENVIRONMENT-COMPATIBLE TREATMENT AND REPROCESSING OF COOLING LUBRICANTS. (VERWERTEN ODER VERMEIDEN—UNWELTGERECHTES BEHANDELN UND AUFBEREITEN VON KULSCHMIERSTOFFEN.) [BIB-199306-52-0953]

Rapidly rising costs of scrap and toxic waste disposal measures compel industry to keep the accumulating amounts at a minimum. This general maxim applies also to cooling lubricants used in metal fabrication where it is of advantage to

satisfying the safe and environmentally acceptable disposal of gypsum. A proposal for engineering studies has already been submitted to a national agency for inclusion in its R&D program. 7 ref. (Bernard, L.M.; EDMONTON, ALBERTA, CANADA, 23-27 AUG. 1992, Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, (1992), (Met. A., 9304-72-0210), 343-348 [in English].)

2322 PHOTOCATALYTIC OXIDATION OF CYANIDE. [BIB-199304-42-0425]

Fresh cyanide solution was treated by near UV light with the assistance of photocatalysts. Cyanide was oxidized mainly to cyanate. Photochemical behavior of the anatase and rutile forms of TiO_2 was compared. It is found that anatase has a much higher activity than that of rutile. Bubbling of oxygen in the reactor showed no appreciable increase in cyanide oxidation, implying that the reaction is surface controlling. A very interesting finding in this study is that a natural mineral, ilmenite, can replace chemical titanium dioxide as the photocatalyst. Ilmenite without any treatment did not catalyze the oxidation of cyanide. But, after being roasted at high temperature with O, the oxidation was enhanced dramatically. The mechanisms of photooxidation of cyanide and the roasting of ilmenite are proposed. Graphs. 13 ref. (Zhang, J.; Hendrix, J.L.; Wadsworth, M.E.; NEW ORLEANS, LOUISIANA, USA, 17-21 FEB. 1991, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9304-72-0187), 665-676 [in English].)

2323 WASTE DISPOSAL FROM PLATING PLANTS. (DIE ENTSORGUNG VON GALVANIKBETRIEBEN.) [BIB-199304-42-0437]

Procurement of all the plants required to meet legislation on the disposal of plating effluents is financially beyond the means of an individual metal finishing business. This is especially true of the former East German territories where a major catching-up exercise is usually the order of the day. The solution proposed embodies procedures for waste avoidance or effluent recycling in such plating plants, and the establishment of a centralised facility for processing the remaining wastes and recovery of value where possible. The planning of such a facility is described. (Kimmerl, P.; Schade, H.; 83, (12), 4230-4239 [in German]. ISSN 0016-4232)

2324 PROCESSING OF EFFLUENT SALT FROM THE DIRECT OXIDE REDUCTION PROCESS. [BIB-199304-42-0480]

The production of reactive metals by direct oxide reduction DOR process using Ca in a molten calcium chloride salt system generates a significant amount of contaminated waste as calcium oxide saturated calcium chloride salt mix, with calcium oxide content of up to 15 wt.%. Fused salt electrolysis of a simulated salt mix $CaCl_2$ + 10 wt.% CaO has been carried out to electrowin Ca, which could be recycled to the DOR reactor along with the calcium chloride salt or may be used in situ in a combined DOR and electrowinning process. Many reactive metal oxides could thus be reduced in a one-step process without generating a significant amount of waste. The technology will resolve a major contaminated waste disposal problem, besides improving the cost and process efficiency in reactive metal production. The process has been optimized in terms of the Ca solubility, cell temperature, current density and the cell design to maximize the current efficiency. The solubility was found to depend on the use of graphite as the anode material as evidenced by the presence of calcium carbonate in the final salt. The rate of recovery for metallic Ca has to be enhanced to levels that overcome the back reactions in a system where quick removal of anodic gases is achieved. Calcium was determined by the hydrogen evolution technique and the amount of calcium oxide by titration with hydrochloric acid. A porous ceramic sheath was used in the cell to prevent the chemical reaction of electrowon Ca to produce oxide or carbonate and to prevent the contamination of salt by the anodic carbon. Cell design, temperature and current density were investigated to adopt proper methods for quickly removing the anodic gases and for maintaining a high rate of Ca deposition to discourage back reactions. Graphs. 15 ref. (Mishra, B.; Olson, D.L.; Averill, W.A.; EDMONTON, ALBERTA, CANADA, 23-27 AUG. 1992, Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, (1992), (Met. A., 9304-72-0210), 279-291 [in English].)

2325 A PYROMETALLURGICAL PROCESS FOR THE RECOVERY OF LEAD OXIDE FROM SPENT FIRE ASSAY CUPELS. [BIB-199304-42-0482]

Fire assaying of precious metals requires the use of Pb for the process of cupellation. Each cupel can absorb as much as 50 g of lead oxide. Some 10 million cupels/year are used in Canada alone. At the present time the used cupels are being disposed of in landfill sites or added to the charge of a smelter. These methods of disposal have several disadvantages, such as Pb leaching into the water table from the landfill site, increased Pb impurities in the smelter product, and Pb emission as fumes. In this work, a pyrometallurgical process was employed to recover the lead oxide from the cupel. The lead oxide was recovered at high temperatures and at low pressures. The effects of time, temperature and pressure on the removal of Pb from the cupel were investigated. The kinetics of the process and the diffusion rate of lead oxide through the cupel were studied. The optimum conditions for complete removal of the lead oxide were determined. Graphs, Photomicrographs, Diffraction patterns. 9 ref. (Lamontagne, M.P.; Pickles, C.A.; Toguri, J.M.; EDMONTON, ALBERTA, CANADA, 23-27 AUG. 1992, Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, (1992), (Met. A., 9304-72-0210), 307-328 [in English].)

2326 ZIRCONIUM—HAFNIUM PRODUCTION IN A ZERO LIQUID DISCHARGE PROCESS. [BIB-199304-43-0134]

A simple, low cost continuous process for separating and purifying Zr and Hf which eliminates liquid waste and facilitates the management of RCRA and LLW wastes is provided. An aqueous Zr and Hf-containing feed solution is prepared and fed to a continuously rotating annular chromatograph containing a bed of acid exchange resin. An acid eluant, such as hydrochloric acid, nitric acid, phosphoric acid or the like, is fed through the acid exchange bed while the chromatograph is rotating, which separates the feed into substantially pure Zr and Hf fractions and into RCRA and LLW waste fractions. The Zr and Hf are processed further into nuclear quality Zr and Hf metals. The acid eluant is recycled for reuse in the chromatograph, and the RCRA and LLW waste fractions are disposed of in solid form. (Snyder, T.S.; Lee, E.D.; [in English]., Patent no.: EP0490128 (European Patent) Convention date: 19 Nov. 1991)

2327 METHOD FOR TREATMENT OF ZINC-CONTAINING BY-PRODUCTS AND WASTE MATERIALS. [BIB-199304-43-0136]

A method is presented for the treatment of Zn-containing by-products and waste materials from the primary and second production of nonferrous metals, particularly Zn- and Pb-containing slags from the production of Pb. The by-products and the waste materials are supplied to a gastight closed electric smelting furnace in which the materials are melted and subjected to a selective metallothermic reduction to reduce and volatilise Zn and other volatile metals. Elemental sulphur and/or S compounds are added to the smelting furnace in an amount sufficient to form a sulphide phase containing one or more of the elements Cu, Ni, Pb, arsenic, bismuth, Sb, and Ag. An inert slag phase and the sulphide phase are tapped from the furnace, and Zn and other volatile metals are recovered from the off-gas from the furnace by condensation. (Aune, J.A.; [in English]., Patent no.: EP0489591 (European Patent) Convention date: 5 Dec. 1991)

2328 INDUSTRIAL CLEANING—A COMPARISON BETWEEN CHLORINATED HYDROCARBONS AND AQUEOUS-BASED METHODS. (INDUSTRIELLE REINIGUNG: VERGLEICH ZWISCHEN CKW- UND EINEM WASSRIGEN VERFAHREN.) [BIB-199304-57-0461]

In making the decision as to which process is best for a particular case, a number of criteria have to be taken into consideration. These include the extent of soiling of work to cleaned, and the degree of cleanliness required. Capital and operating costs including effluent disposal procedures and their cost have also to be considered. Comparable cleaning systems based on chlorocarbon solvent and aqueous solutions are compared with one another in terms of the criteria

In stagnant simulated cooling water (SCW), 500 ppm Na_2MoO_4 inhibits steel corrosion for a short period. Molybdate produces synergistic corrosion inhibition with sebacic and polymaleic acids. Mechanism of corrosion inhibition is discussed. Graphs. 10 ref. (Mustafa, C.M.; Farr, J.P.G.; 30, (8), 424-426 [in English]. ISSN 0019-5669)

2314 PREDICTION AND CONTROL OF SULFIDE INDUCED CORROSION IN CONCRETE SEWER INFRASTRUCTURE AND REHABILITATION TECHNIQUES. [BIB-199304-35-0669]

Most cities, counties, and sanitary districts have used concrete pipe for sewer construction during the past 100 years. Many of these pipelines under certain site conditions have been corroded by sulfuric acid formed from sulfide gas. Despite this track record, many design engineers are still selecting concrete pipe with some allowance for corrosion using the somewhat outdated sacrificial wall thickness method. There are numerous agencies which do not even include sulfide corrosion prediction and control as part of the sewer structure material selection process. Even when sulfide corrosion studies are undertaken, no engineering considerations are given for the potential of corrosion in structures such as wet wells, manholes, drop structures, and metering stations. Deteriorated concrete pipe in some cases is replaced with new concrete pipe with no provisions for corrosion and such practices will lead to premature failure of the sewer system and excessive rehabilitation budgets. The state-of-the-art of prediction is presented and control of sulfide corrosion in sewers and rehabilitation methods available for repairing such sewer systems are discussed. Steel and nodular iron are also discussed. 13 ref. (Jeyapalan, J.K.; SAN DIEGO, CALIFORNIA, USA, 3-4 NOV. 1991, Publisher: ASTM, 1916 Race St., Philadelphia, Pennsylvania 19103, USA, (1992), STP 1137, (Met. A., 9304-72-0206), 273-283 [in English].)

2315 LOCALIZATION IN THE CREVICE CORROSION OF TITANIUM. [BIB-199304-35-0720]

The impact of chloride concentration, temperature and O reduction on the depth and localization of crevice corrosion on Grade-2 Ti has been studied using a combination of electrochemical, metallographic, and image analysis techniques. Oxygen reduction was found to control the total amount of corrosion over a wide range of conditions. Depending on the temperature, the amount and depth of corrosion decreased with increasing chloride concentration. A decrease in temperature resulted in deeper penetration at fewer sites and a lower overall corrosion rate. Graphs. 17 ref. (Ikeda, B.M.; Bailey, M.G.; Quinn, M.J.; Shoesmith, D.W.; KYOTO, JAPAN, 29 JULY-2 AUG. 1991, Publisher: PERGAMON PRESS PLC, Headington Hill Hall, Oxford OX3 0BW, UK, (1992), (Met. A., 9304-72-0249), 619-625 [in English].)

2316 EFFECTS OF DISSOLVED OXYGEN CONTENT ON THE PROPAGATION OF LOCALIZED CORROSION OF CARBON STEEL IN SYNTHETIC SEA WATER. [BIB-199304-35-0721]

Effects of dissolved oxygen content on the propagation of localized corrosion of carbon steel have been investigated both by immersion type corrosion tests and electrochemical tests in synthetic sea water, which simulated the ground water environment in deep geological formations. Although the propagation rates of localized corrosion were reduced with the decrease of dissolved O content, slight localized corrosion was recognized even in deaerated condition by blowing pure N_2 gas. Graphs. (Sasaki, N.; Ishikawa, H.; Teshima, T.; Fujiwara, K.; KYOTO, JAPAN, 29 JULY-2 AUG. 1991, Publisher: PERGAMON PRESS PLC, Headington Hill Hall, Oxford OX3 0BW, UK, (1992), (Met. A., 9304-72-0249), 627-632 [in English].)

2317 CRONIFER III-TM AND NICROFER 45-TM: TWO NEW ALLOYS FOR WASTE INCINERATION PLANTS. (CRONIFER III-TM UND NICROFER 45-TM: ZWEI NEUE WERKSTOFFE FUR DEN EINSATZ IN MULLVERBRENNUNGSANLAGEN.) [BIB-199304-35-0754]

The two new alloys Cronifer III-TM (FeCr28NiSiCe) and Nicrofer 45-TM (NiCr28FeSiCe) exhibit, because of their high Cr (27-28%) and Si content (2.5-3.0%) as well as the addition of rare earth elements (0.05-0.15%), an excellent corrosion resistance in waste incineration environments. Weight loss of both alloys in a simulated waste incineration atmosphere with a high SO_2 - and HCl level did not exceed 0.125 g/m^2 h even at 850 °C .Optical microscopy shows a nonsignificant degradation of the microstructure 50 mu after 1000 h. Graphs, Photomicrographs. 10 ref. (Brill, U.; Klower, J.; LES EMBIEZ, FRANCE, 25-29 MAY 1992, 46, (9), 921-926 [in German]. ISSN 0026-0746)

2318 CHEMICAL MODELLING OF THE NEUTRALISATION PROCESS FOR ACID URANIUM MILL TAILINGS. [BIB-199304-41-0125]

Neutralisation of acid uranium mill tailings with lime or other alkaline materials is usually practised to reduce the dissolved concentration of heavy metals and radionuclides. Computer modeling of this process was carried out using the geochemical equilibrium code MINTEQA2. Computer dissolved metal and sulfate concentrations were compared with laboratory-based experimental data. It was found necessary to include the modelling of adsorption of trace metals (such as U and Pb) by the precipitated ferric hydroxide in order to obtain acceptable concentrations in the neutralised liquors. There were limitations of the modelling exercise due to important aspects which were not addressed or properly accounted for such as chemical reaction kinetics and the effect of high ionic strength. Graphs. 16 ref. (Khoe, G.H.; Sinclair, G.; NEW ORLEANS, LOUISIANA, USA, 17-21 FEB. 1991, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9304-72-0187), 117-136 [in English].)

2319 WATER TREATMENT AND ELIMINATION OF FINE ORE LOSSES AT QIT-FER ET TITANE INC. [BIB-199304-41-0133]

In 1986, QIT embarked on a program to effectively eliminate all solid losses in the water discharged from its ilmenite smelter in Sorel, Quebec. Construction of a $3 million water treatment plant is to start shortly. Fine ore tailings from the beneficiation plant constitute a major portion of the losses, amounting to approx 5% of the total ore processed. The paper describes the flowsheet for the facility and the various projects undertaken prior to definition and, in particular: identification of the source of ore fines generation and the scope for reduction by process optimization; environmental characterization of the ore fines for landfill disposal. Discussion is also made for work currently underway for further reduction or treatment of the ore fines: plant and process modifications for ilmenite beneficiation; recycling or conversion of the ore fines to a value added product. Graphs. (Guzman, S.; Marchesseault, A.; Domingos, J.; Cook, J.; EDMONTON, ALBERTA, CANADA, 23-27 AUG. 1992, Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, (1992), (Met. A., 9304-72-0210), 147-154 [in English].)

2320 DEWATERING BEHAVIOUR OF JAROSITE SLUDGE FROM THE ZINC INDUSTRY. [BIB-199304-41-0135]

Dewatering behaviour of jarosite sludge was studied using two high molecular weight flocculants with 23.6 and 62.7% cationicity. The lower cationicity flocculant increased settling rate by a factor of 70. Both flocculants decreased capillary suction time (CST); the lower cationic flocculant was more effective. The specific resistance to filtration (SRF) was only reduced by a factor of 1.6 at a pressure of 49 kPa. The cake moisture content was reduced with increasing pressure but at the same time the SRF increased. Graphs, Diffraction patterns. 8 ref. (Sengupta, D.K.; Hamza, H.A.; EDMONTON, ALBERTA, CANADA, 23-27 AUG. 1992, Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, (1992), (Met. A., 9304-72-0210), 331-342 [in English].)

2321 FROM STACK TO MINE: DEHYDRATED FLUE-GAS GYPSUM AS A CEMENTING AGENT IN UNDERGROUND MINE BACKFILL AND ENCAPSULATION OF ACID-GENERATING MILL TAILINGS. [BIB-199304-41-0136]

The 1990s will be a decade incorporating stringent new environmental regulations in Canada that will be driven by both world opinion and pressure from the USA to conform to their standards. The Free Trade Agreement may also come into play, putting pressure on Canadian smelters to produce metal under the same environmental conditions as the US smelters. Far northern Canadian smelters may be forced to fix sulfur dioxide as flue-gas gypsum, posing another environmental problem: how to dispose of this material. This paper suggests two applications requiring the use of dehydrated flue-gas gypsum, as a means of

Cu, and Pb are discussed. Graphs, Spectra, Photomicrographs. 10 ref. (Huang, C.-H.; 79, (4), 50-56 [in English]. ISSN 0360-3164)

2306 TRANSMUTATION OF HIGH-LEVEL FISSION PRODUCTS AND ACTINIDES IN A LASER-DRIVEN FUSION REACTOR. [BIB-199303-16-0098]

Incineration of ^{90}Sr and ^{137}Cs by thermal or fast neutrons is a very difficult problem. A 14-MeV neutron source based on inertial confinement fusion is a more appropriate choice. For the first time, the contribution of the (n,2N) reaction to incineration is revealed. The energy and nuclei balance for a system of several nuclear power plants and a fusion reactor for transmutation is analyzed. If the fusion reactor supports a sufficient number of nuclear power plants, it need not produce energy or tritium. Target and blanket material problems are considered. A laser fusion incinerator has the best prospects because of its fast neutron spectrum and high driver efficiency by target gain product. Graphs. 8 ref. (Basov, N.G.; Rozanov, V.B.; Belousov, N.I.; Grishunin, P.A.; Kharitonov, V.V.; Subbotin, V.I.; 22, (3), 350-355 [in English]. ISSN 0748-1896)

2307 THE APPLICATION OF NOVEL EXTRACTION CHROMATOGRAPHIC MATERIALS TO THE CHARACTERIZATION OF RADIOACTIVE WASTE SOLUTIONS. [BIB-199303-23-0178]

A simple method for the separation and preconcentration of radiostrontium from acidic nuclear waste solutions for subsequent determination is described. The method involves passage of the waste solution, acidified to at least 2M with nitric acid, through an extraction chromatographic column consisting of a 1M solution of bis-4,4'(5')(t-butyl)cyclohexano-18-crown-6 in 1-octanol sorbed on an inert polymeric substrate, which preferentially retains Sr. The Sr may then be stripped from the column with a small volume of either dilute ((Horwitz, E.Ph.; Dietz, M.L.; Chiarizia, R.; KONA, HAWAII, USA, 21-27 APR. 1992, 161, (2), 575-583 [in English]. ISSN 0236-5731)

2308 RISK, UNCERTAINTY IN RISK, AND THE EPA RELEASE LIMITS FOR RADIOACTIVE WASTE DISPOSAL. [BIB-199304-16-0160]

A conceptual model for the organization and execution of a performance assessment of a radioactive waste disposal site, including uncertainty and sensitivity analysis, is described. This model is based on a formal definition of risk as a collection of ordered triples, where the first element in each triple is a set of similar occurrences (i.e. a scenario), the second element is the probability or frequency of the first element, and the third element is a vector of consequences associated with the first element. This division of risk into its three constituent parts provides a useful model for the structure of a performance assessment for several reasons. First, it provides a clear distinction between the major parts of a performance assessment, which are determining what can happen, determining how likely things are to happen, and determining what the consequences of specific events are. Second, it provides a way to distinguish between different types of uncertainty, including completeness, aggregation, model selection, imprecisely known variables, and stochastic variation. Third, it leads naturally to the representation of stochastic variation with a complementary cumulative distribution function (CCDF) and the representation of state of knowledge uncertainty with a family or distribution of CCDFs. Fourth, it provides a context in which the US Environmental Protection Agency limits for radioactive releases to the accessible environment can be represented and calculated. Fifth, it facilitates relating the development of scenarios and their probabilities to the concepts used in formal probability theory. The preceding ideas are illustrated with results obtained in a preliminary performance assessment for the Waste Isolation Pilot Plant in southeastern New Mexico. Graphs. 49 ref. (Helton, J.C.; 101, (1), 18-39 [in English]. ISSN 0029-5450)

2309 A RADIOACTIVITY ASSAY METHOD USING COMPUTED TOMOGRAPHY. [BIB-199304-22-0267]

A nondestructive radioactivity assaying apparatus, especially suitable for miscellaneous waste drums, has been developed. The apparatus employs a simplified computed tomographic technique in the analytical process. The method uses 10 x 10 (horizontal) x 9 (vertical) density and radioactivity distribution information measured by NaI(Tl) detectors and an external source to compensate for photo-peak count rates from a Ge detector. Methods to compensate for the inhomogeneity of miscellaneous solid wastes are discussed. A detailed comparison of the proposed method with two other simplified methods, using 200 kinds of mockup wastes, showed an improvement in measurement precision for the proposed method over the conventional methods. The overall precision for measurements on the untreated miscellaneous waste was evaluated to be within 30.% when using the proposed method. Graphs. 7 ref. (Goto, T.; Kato, H.; 100, (3), 322-330 [in English]. ISSN 0029-5450)

2310 A KINETIC STUDY OF THE GENERATION OF HYDROGEN SULFIDE FROM AQUEOUS CALCIUM SULFIDE SLURRY WITH CARBON DIOXIDE. [BIB-199304-34-0527]

The experimental work is designed based on a three-step process—carbothermic reduction of solid waste to produce calcium sulfide; generation of hydrogen sulfide from calcium sulfide and oxidation of hydrogen sulfide to elemental sulfur. Recent work is focused on the kinetics of hydrogen sulfide generation from aqueous calcium sulfide slurry with carbon dioxide in a bubble column. The effects of process parameters (temperature, P_{CO2} and initial S/L ratio, etc.) on the overall kinetics have been studied. Graphs. 12 ref. (Jia, C.Q.; Lu, W.-K.; EDMONTON, ALBERTA, CANADA, 23-27 AUG. 1992, Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, (1992), (Met. A., 9304-72-0210), 215-227 [in English].)

2311 DYNAMIC AND EQUILIBRIUM SURFACE TENSIONS. I. SURFACTANT-POLYMER-FINES INTERACTIONS FROM OILSANDS PROCESSING STREAMS. [BIB-199304-34-0529]

Measured were the dynamic and equilibrium surface tensions of processed water containing varying quantities of the solids and surface active agents. The role of the solids and complexes is evaluated on the basis of their effects on the dynamic surface tensions and equilibrium surface tensions, comparatively. To investigate the mechanisms of interactions of the species, a model system consisting of humic acid as polymer, hexadecytrimethyl ammonium chloride (CTAC) was used as the surfactant and silica as the fines. Focus was placed on the differences between the equilibrium and the dynamic surface tension values obtained for adsorption isotherms and on the possible implications for real processes. Results show that equilibrium data do not give a true indication of the dynamic situation. Graphs. 8 ref. (Angle, C.W.; Xu, Y.; Hamza, H.A.; Hassan, T.A.; Altaweel, A.; EDMONTON, ALBERTA, CANADA, 23-27 AUG. 1992, Publisher: CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM, Xerox Tower, 1210-3400 de Maisonneuve Blvd. W., Montreal, Quebec H3Z 3B8, Canada, (1992), (Met. A., 9304-72-0210), 257-266 [in English].)

2312 MODIFIED LOG-ACTIVITY DIAGRAMS AS A TOOL FOR MODELLING CORROSION OF NUCLEAR WASTE CONTAINER MATERIALS, WITH PARTICULAR REFERENCE TO COPPER. [BIB-199304-35-0567]

Thermochemical data are used to construct a modified log-activity diagram for the system Cu—H—O—Cl—(CO_2). This diagram, restricted to standard state of pressure and temperature, serves as a complement to Pourbaix diagrams for the study of equilibria appropriate to solid phases and aqueous ionic species of Cu in chloride-bearing waters. Coordinate axes represent activities of chloride and aqueous Cu species; other thermodynamic variables are collapsed onto the diagram. Equilibria involving chlorination reactions, some of which cannot be displayed on a Pourbaix diagram, are presented. Also displayed are the various permissible geometric relationships of lines on Pourbaix diagram. Modified log-activity diagrams may be used to model localized corrosion of Cu and are potentially useful for the analysis and prediction of failure mechanisms in high level waste packages. Graphs. 19 ref. (Mohr, D.W.; McNeil, M.B.; 190, 329-342 [in English]. ISSN 0022-3115)

2313 A POTENTIODYNAMIC STUDY OF THE CORROSION INHIBITION OF MILD STEEL IN REALISTIC SITUATION BY MOLYBDATE AND ORGANIC COMPOUNDS CONTAINING —COOH AND/OR —OH GROUPS. [BIB-199304-35-0642]

An investigation was made to improve the corrosion inhibition behaviour of molybdate for mild steel in realistic situation by using organic compounds containing —COOH and/or —OH groups. Potentiodynamic experiments were used for the assessment. In the absence of inhibitor, aggressive anions are capable of removing most of the oxide layer from the steel surface within 1 h.

of cations by immersing into de-ionized water at room temperature and by a Soxhlet apparatus at 97 °C were found to be of the order of 10^{-10} and 10^{-7} g cm^{-2}/day^{-1}, respectively. X-ray powder diffraction analysis revealed that Ba, Cd and Sb cations were immobilized separately in the titania crystal lattice, which suffered some structural changes with the formation of different mineral phases. Graphs, Diffraction patterns. 25 ref. (Bhattacharyya, D.K.; Dutta, N.C.; 27, (21), 5948-5952 [in English]. ISSN 0022-2461)

2298 GOLD TAILING—A SUITABLE SILICEOUS WASTE FOR THE MANUFACTURE OF CALCIUM SILICATE BRICKS. [BIB-199302-41-0083]

Gold tailing, a waste material of Au ore beneficiation plants, is a fine siliceous material which at present has no use, but can be utilized for producing calcium silicate bricks. The laboratory results show that the bricks of compressive strength 100-150 kg/cm^2 can be produced by using 90% tailing and 10% lime, by shaping the bricks at 240 kg/cm^2 and autoclaving them at 14 kg/cm^2. The strength of bricks is further improved by replacing 10-30% tailing by sand. The formation of tobermorite (11 A type calcium silicate hydrate) in the autoclaved bricks has been identified, which possibly contributed to strength development. Graphs, Diffraction patterns. 14 ref. (Chandra, D.; Gupta, R.L.; Jain, S.K.; 30, (6), 285-292 [in English]. ISSN 0019-5669)

2299 CONTINUOUS FERROUS AND NON-FERROUS BATH SMELTING. [BIB-199302-42-0190]

The discovery in 1961, while with BHP, that fine lump ore could be continuously smelted in a slowly flowing stream of blast furnace hot metal which was sequentially lanced with oxygen, launched the author into bath smelting in both ferrous and non-ferrous metallurgy. Under the name WORCRA, zoned horizontal furnaces with both tuyeres and lances were evaluated. Problems and advantages of each are discussed, as is the subtle interplay of kinetics and thermodynamics in systems involving turbulent and quiescent zones and slag moving generally countercurrent to matte or metal. Metal was produced in the same furnace as smelting and slag cleaning were achieved continuously. With a change in top management, CRA discontinued the developments in the early 1990s, but aspects of WORCRA technology continue in other processes. Currently, WORCRA principles are used in the smelting of composites of steelworks dusts and a variety of carbonaceous wastes to produce a foundry type Fe, phosphorus-containing slag and zinc oxide in the off-gases. Graphs. 24 ref. (Worner, H.K.; MONTREAL, QUEBEC, CANADA, 18-22 OCT. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9302-72-0067), 83-101 [in English].)

2300 SIROSMELT—THE EMERGING ROLE OF NEW BATH SMELTING TECHNOLOGY IN NON-FERROUS METALS PRODUCTION. [BIB-199302-42-0191]

Ausmelt's development of top submerged lancing reactor systems over the last ten years has covered the spectrum of non-ferrous metal production from sulfide and oxidic resources. From laboratory studies, pilot plant trials and plant design and commissioning applications of this technology have been established for smelting ores, concentrates, residues, slags, fumes, drosses, and many other sources of base and precious metals. This technology represents more than just another bath smelting process; it also introduces opportunities for carrying out separations between elements in feed sources which have not been achievable in other systems. Top submerged lancing has been commercialised for many different purposes and there are many opportunities which have not yet been tapped. Some of these opportunities are outlined and Ausmelt's furnace system is compared with alternative approaches which have been or could be considered. Graphs. 28 ref. (Floyd, J.M.; MONTREAL, QUEBEC, CANADA, 18-22 OCT. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1992), (Met. A., 9302-72-0067), 103-123 [in English].)

2301 TRIMERCAPTO-S-TRIAZIN—A NON-TOXIC COLLECTOR FOR THE SEPARATION OF GOLD-CONTAINING SULPHIDE MINERALS BY FLOTATION. (TRIMERCAPTO-S-TRIAZIN—UMWELTFREUNDLICHER SAMMLER FUR DIE FLOTATIVE TRENNUNG VON GOLDHALTIGEN SULFIDMINERALEN.) [BIB-199302-42-0207]

By the flotation of sulphide ores, waste waters often pollute the environment because of high content of dissolved heavy metal ions. Despite any engineering progress made, problems are still encountered when disposing of such waste waters. Therefore, there is a reason to seek reagent regimes which are suitable for flotation and, at the same time, precipitate heavy metal ions from the waste water. In this connection, the reagent Trimercapto-s-triazine (TMT-15) represents a modern alternative for classical collectors used for separation of sulphides from silicates using flotation. The advantage of TMT-15 as a collector is that the dissolved heavy metal ions with valency 2 can be precipitated from the waste water far below the allowed concentration limit. Graphs. 12 ref. (Kinabo, C.; 45, (9), 464-467 [in German]. ISSN 0044-2658)

2302 FEASIBILITY OF RECOVERY OF ALUMINIUM FROM ALKALINE WASTE WATER BY ION EXCHANGE. [BIB-199302-43-0043]

The study of Al extraction from an alkaline liquid containing Al ion with anion exchange resin is reported. The breakthrough curve and exchange capacity have been investigated. The investigation was focused on 201 x 4 resin. The analysis of breakthrough curves and calculation of mass transfer parameters have been done with Doulah's and Jafar's method. On this basis, process kinetics is discussed. According to the analysis of transfer parameters and exchange capacity, it has been found that kinetics or thermodynamics of the process was not favourable. Thus it is concluded that it is uneconomical to recover Al from an alkaline liquid through ion exchange. Graphs. 2 ref. (Huang, S.Y.; Gong, B.F.; Zhang, Q.X.; 23, (4), 412-417 [in English]. ISSN 0253-4347)

2303 INCONEL FILLER METAL 622 (PITTING AND CREVICE CORROSION RESISTANT NICKEL-BASE FILLER METAL). [BIB-199302-46-0039]

Inconel filler metal 622 from Inco is a highly-alloyed product used for joining Inconel 622 and similar corrosion-resistant grades. In dissimilar welding, it can be used to prevent preferential weld metal attack. Inconel filler metal 622 is a versatile, corrosion resistant product for the chemical, power, petroleum, and marine industries. Applications include chemical processing, flue-gas desulfurization, hazardous waste incineration, bleaching systems in paper manufacture, and radioactive waste reprocessing. (Ni-414, Pp 2 [in English]. ISSN 0002-614X)

2304 SOLID ALUMINUM FLUXING ISSUES. II. [BIB-199302-51-0265]

A basic understanding of the science of fluxing, focusing on applications, handling and delivery, and the composition of solid fluxes was presented previously. The economics of drossing flux is covered, as are some concerns foundries should keep in mind when using flux, including safety, casting quality and legal disposal. 7 ref. (Crepeau, P.N.; Cochran, B.P.; Mulac, R.P.; 82, (8), 36-37 [in English]. ISSN 0026-7562)

2305 EFFECTIVE REMOVAL OF ORGANICS FROM NICKEL WASTEWATER BY MODIFIED CARBON ADSORPTION. [BIB-199302-58-0175]

An effective organic waste treatment for Watts Ni-plating wastewater was developed. With the addition of ion exchange (IX) or ion exchange membrane (IXM), the adsorbabilities of organic pollutants onto activated carbon (AC) were increased. Results indicated that IX and IXM behave as insoluble concentrated electrolyte for use in BOD treatment. This treatment is economically advantageous and could be conducted in other industrial wastewater operations. Iron,

provided that they contain near-neutral synthetic resin binders. They do, however, make the recycling of bentonites more difficult. Highly acid or alkaline core sands, especially when used in hot-box processing, are less likely to be recycled successfully. Graphs, Photomicrographs. 13 ref. (Boenisch, D.; 79, (11), 428-436 [in German]. ISSN 0016-9765)

2290 FOUNDRY WASTES IN MICHIGAN: INVENTORY AND MINIMIZATION POTENTIAL. [BIB-199301-51-0045]

A survey was prepared for the purpose of estimating material flow (primarily sand) and costs of the same within the foundry industry in the State of Michigan. The survey was sent to 128 foundries in which sand was used as a major component in molding and coremaking. Primary information received included amount and cost of sand purchased, amount of slag generated and landfilling costs of solid wastes. The return rate of the survey was 37.5%, with 48 foundries completing the survey. It was estimated that Michigan foundries generate 864 000 tons of waste sand and slag annually, which accounts for approx 7 wt.% of the waste material landfilled in Michigan. No Michigan foundries surveyed are thermally reclaiming sand, even though several are spending more than one million dollars annually on sand purchase and disposal. Ten foundries surveyed have mechanical reclamation units, eight of which are foundries using chemically bonded molding systems. The regional clustering of Michigan foundries seems to indicate that centralized sand reclamation, reuse and storage facilities may be an attractive approach to managing the state's foundry waste streams, although much additional research is necessary to determine the feasibility of the concept. Graphs. 19 ref. (Baillod, C.R.; Coduti, L.; Murto, S.L.; Rundman, K.B.; Talford, D.A.; BIRMINGHAM, ALABAMA, USA, 5-9 MAY 1991, Publisher: AMERICAN FOUNDRYMEN'S SOCIETY, INC., Des Plaines, Illinois 60016-8399, USA, (1991), (Met. A., 9301-72-0001), 673-680 [in English].)

2291 SURFACE TREATMENT AND CORROSION BEHAVIOR OF RUST AND ACID RESISTANT ALLOY STEELS. (OBERFLACHENBEHANDLUNG UND KORROSIONSVERHALTEN VON ROST- UND SAUREBESTANDIGEN EDELSTAHLEN.) [BIB-199301-57-0082]

Cr—Ni Steels, some with Mo additions, have been used since 1912 because of their demonstrated corrosion resistance. This resistance results from a passivated Cr layer between 2-4 nm thick, which forms on exposure to air within a few minutes. Localized corrosion occurs from stress or crevices in which Cl or chlorides are active. Surface etching to remove 5-10 mu m promotes passivation and provides enhanced corrosion protection. Modern etchants can be treated prior to disposal to prevent environmental pollution. Graphs, Photomicrographs. (Blaise, M.; Racky, W.; 21, (5), 118, 120, 123-124 [in German]. ISSN 0340-9961)

2292 TREATMENT OF CHROMATE RESIDUE BY DIRECT ELECTROLYSIS IN MOLTEN OXIDES. [BIB-199301-58-0050]

The viability of treating certain forms of hazardous waste by direct electrolysis in molten oxides is under investigation. Secondary residue or waste mud produced in the course of chromate chemical production is the focus of attention. The goal is to reduce the water soluble hexavalent Cr either to insoluble trivalent Cr or to Cr metal. Electrolysis tests have been conducted in a high temperature cell containing chromate sludge dissolved in an electrolyte composed of Al_2O_3, SiO_2, CaO, and MgO. Oxygen production on a carbon-free anode has been confirmed. 5 ref. (Sadoway, D.R.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0015), 469-473 [in English].)

2293 DECONTAMINATION OF SOLUTIONS CONTAINING HEXAVALENT CHROMIUM USING MODIFIED BARKS. [BIB-199301-58-0051]

Decontamination of synthetic $K_2Cr_2O_7$ solutions containing 10-1000 ppm of hexavalent Cr using chemically treated barks have been studied at a laboratory scale. Metal removal from solutions depends on the pH, the initial concentration and the bark species. The use of a pulp density of 2% in an agitated flask at the optimum pH for 2 h leads to a percentage Cr removal of approx 95% of the initial metallic ions content. Other trials conducted by column percolation permit the determination of the maximum retention capacity of the treated bark. Depending on the bark species, oak or pine, the rate of saturation is 110 and 215 mg of Cr/g of bark, respectively. The incineration of the metal charged barks gives recyclable ashes containing 36 and 54% and Cr metal for the oak and pine barks, respectively. Experiments of Cr^{6+} removal from industrial effluents containing up to 1800 ppm have been carried out on the semi-pilot plant scale. They have led to the elimination of approx 90% of hexavalent Cr from this industrial waste solution. Further studies are conducted to define the hexavalent Cr binding mechanisms on bark constituents. Graphs. 32 ref. (Goy, G.I.; Kilbertus, G.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0015), 475-487 [in English].)

2294 WASTE MINIMIZATION ACTIVITIES IN THE MATERIALS FABRICATION DIVISION AT LAWRENCE LIVERMORE NATIONAL LABORATORY. [BIB-199301-58-0052]

The mission of the Materials Fabrication Division (MFD) is to provide fabrication services and technology in support of all programs at Lawrence Livermore National Laboratory (LLNL). MFD involvement is called for when fabrication activity requires levels of expertise, technology, equipment, process development, hazardous processes, security, or scheduling that is typically not commercially available. Customers are encouraged to utilize private industry for fabrication activity requiring routine processing or for production applications. A waste minimization (WM) program has been directed at source reduction and recycling in concert with the working definition of waste minimization used by EPA. The principal focus of WM activities has been on hazardous wastes as defined by RCRA; however, all pollutant emissions into air, water and land are being considered as part of the program. The incentives include: economics, regulatory conformance, public image, and environmental concern. Waste minimization is discussed for metal finishing, degreasing, radioactive wastes and recycling water. Graphs. 8 ref. (Dini, J.W.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0015), 667-679 [in English].)

2295 PERFORMANCE OF GALVANIZED STEEL IN MUNICIPAL WASTEWATER TREATMENT PLANTS. [BIB-199301-58-0081]

Hot dip galvanized coatings provide excellent corrosion protection to structural steel under atmospheric exposure in wastewater treatment plants. Bare galvanized coatings provide only limited protection in immersion exposure. An exposure test program was conducted at 35 sites in three different plants on samples of pure Zn and hot dipped galvanized steel. Photomicrographs. 10 ref. (Belisle, S.; Dufresne, R.; 31, (6), 64-66 [in English]. ISSN 0094-1492)

2296 REJUVENATING ELECTROLESS SOLUTIONS: ELECTROLESS NICKEL BATH RECOVERY BY CATION EXCHANGE AND PRECIPITATION. [BIB-199301-58-0115]

An energy-efficient process for the rejuvenation and recycling of chemicals used in electroless Ni plating has been developed. The process eliminates the discharge of hazardous wastes normally associated with electroless plating, and it will improve plating quality and speed while significantly reducing costs. Undesirable by-products are removed from the plating process in forms that are environmentally safe so that they can be used as fertilizers or disposed of in sanitary landfills. In addition, the process recovers the Ni and other valuable chemicals from the plating solution and recycles them. It is estimated that hazardous wastes currently generated from the electroless Ni plating industry is 20 000 tons/year in the US alone. This new process is claimed to have the capability of reducing the total amount of waste to 10% of the current tonnage. Graphs. 3 ref. (Anderson, R.W.; Neff, W.A.; 79, (3), 18, 20, 22-24, 26 [in English]. ISSN 0360-3164)

2297 IMMOBILIZATION OF BARIUM, CADMIUM AND ANTIMONY OVER TITANIA. [BIB-199302-16-0045]

A simple method of immobilization of Ba, Cd and Sb cations in crystalline titania has been studied. High uptake was observed with ^{140}Ba, ^{115}Cd and ^{125}Sb; weighable quantities of these cations were separately precipitated together with titanium hydroxide and 69.02 wt.% Ba, 52.00 wt.% Cd and 46.05 wt.% Sb were found to be adsorbed. After calcination each of the mixed materials, the leaching

2281 ELECTROPLATING WITHOUT WASTE WATER: BLOCK HEATING POWER PLANT AS PART OF A WASTE DISPOSAL INSTALLATION. (ABWASSERFREIE GALVANIK: BLOCKHEIZKRAFTWERK ALS TEIL EINER ENTSORGUNGSANLAGE.) [BIB-199301-42-0080]

Tightened control over the discharge into sewers or natural waters of contaminated, toxic, waste water from electroplating plants has focussed attention on the economics of operating such plants without the discharge of waste water. Waste solutions from electrolytic and washing units may be processed by evaporation, condensation, filtering, and recycling of the water content into the system. Such a process is described, together with a recommendation for the installation of a gas or diesel fueled block heating power plant to provide for a more economical energy balance. Data are provided with regard to power units and the financial aspects of the proposals. Copper, Ni and Cr are discussed. (Schilling, R.; 46, (4), 171-176 [in German]. ISSN 0026-0797)

2282 CONTINUOUS DETERMINATION OF COPPER IN SULPHURIC ACID PICKLING SOLUTIONS—FUNDAMENTALS AND INDUSTRIAL APPLICATION OF CHAIN OF CONCENTRATION MEASUREMENTS. (KONTINUIERLICHES KUPFERBESTIMMEN IN SCHWEFELSAUREN BEIZLOSUNGEN—GRUNDLAGEN UND INDUSTRIELLE ANWENDUNG EINER KONZENTRATIONSMESSKETTE.) [BIB-199301-42-0081]

The concentration of Cu is measured in terms of the potential difference created when it is compared with a standard solution in an electrolytic concentration cell. The construction of the cell, and the corrections to be applied to compensate for changes in temperature, for diffusion potentials, and interference by other ions are explained in detail. The output from the cell is used to control the flow of pickling solution into an electrolyte where the Cu is removed before the solution is recycled. An example is given of a regeneration unit available to industry. Graphs. 3 ref. (Hein, K.; Schub, D.; Bombach, H.; Gawande, U.; 46, (4), 185-189 [in German]. ISSN 0026-0797)

2283 METHOD FOR UTILIZING THE COPPER—ARSENIC PRECIPITATE CREATED IN THE ELECTROLYTIC REFINING OF COPPER IN THE PRODUCTION OF ANTI-ROT AGENTS FOR WOOD. [BIB-199301-43-0008]

The invention relates to a method for producing wood anti-rot agent of the Cu—As precipitate created in the solution purification of Cu electrolysis, or of some other corresponding precipitate. (Virtanen, H.K.; Lindroos, L.E.; [in English]., Patent no.: US5141753 (USA) Convention date: 28 June 1991)

2284 COLLECTION OF DATA FOR THE ASSESSMENT OF QUALITY AND ECONOMY OF RECYCLING PROCESSES. (ERFASSEN VON DATEN FUR DAS ERMITTELN DER QUALITAT UND DER WIRTSHAFTLICHKEIT VON RECYCLINGVERFAHREN.) [BIB-199301-43-0017]

A system of data collection and evaluation for the purpose of determining the reycling value of old and new metal is presented. Data are collected on the average values of composition of the waste stream, economic values of the component materials, and costs of sorting, shredding, analysis, disposal of recycling process waste, converting old into new metal, smelting and other factors. An equation is given for determining recycling value as a function of the above cost parameters. A data collection diagram is also presented for establishing the value of byproducts from the recycling operation. (Danckwerts, H.; Schafer, M.; 46, (4), 385-387 [in German]. ISSN 0026-0746)

2285 EXTRACTING GOLD AND SILVER FROM THE SUBLIMATION DUST FROM CHLORINATING PYRITE RESIDUE. [BIB-199301-43-0027]

A method for recovering Au and Ag from the chlorination dust resulting from treating pyrite residue is introduced. The lead oxide powder has a strong capability of collecting Au and Ag in the dust under smelting condition. Thus, Au and Ag are completely concentrated into the collecting agent, and finally separated and extracted. As for the chlorination dust, this method is superior to the method of leaching and extracting. The recovery of Au is as high as 97% and Ag 95%. The method has obvious significance for comprehensive exploitation of pyrite residue and improvement of process economy. Graphs. 4 ref. (Lu, T.; 13, (2), 179-184 [in Chinese].)

2286 PLASMA AND FLAME REACTOR TREATMENT OF ELECTRIC ARC FURNACE DUST. [BIB-199301-45-0001]

Discussed is the application of the flame reactor flash smelting technology, and the plasma furnace treatment process to recover metal values from electric arc furnace (EAF) dust, an EPA-listed hazardous waste. Pending environmental regulations provide impetus to this application in that a considerable portion of EAF dust generated in North America is disposed of in hazardous waste landfills. The flame reactor process offers an alternative to land disposal, and a means of eliminating environmental liabilities associated with EAF dust. The process uses oxygen-enriched air and carbon-based fuels to fume and recover Zn and other volatile metal compounds from the dust, in the form of an oxidic product. Revenues generated from the sale of this product help reduce processing costs. Remaining dust constituents, principally iron-oxide and refractory metal oxides, are fused and recovered as a by-product slag. The slag is nonhazardous by current EPA standards and has potential application as a raw material in Fe-producing operations or as a high-Fe aggregate. The plasma furnace treatment process results in the reduction of zinc, lead and cadmium oxides in the feed to produce a furnace exhaust gas containing approx 20% Zn, PB and Cd vapor. The vapor is condensed in a Zn splash condenser as a commercial grade Zn, which can provide substantial credits to offset the processing costs. A major advantage of the system is the low flow rate of Ar required to stabilize the plasma arc. As a result, a high Zn vapor pressure is achieved, which is essential for the efficient operation of the Zn condenser. Zinc recoveries of approx 75% were attained during the development program. Graphs, Phase diagrams. 3 ref. (Svoboda, J.M.; BIRMINGHAM, ALABAMA, USA, 5-9 MAY 1991, Publisher: AMERICAN FOUNDRYMEN'S SOCIETY, INC., Des Plaines, Illinois 60016-8399, USA, (1991), (Met. A., 9301-72-0001), 405-409 [in English].)

2287 AN ENGINEERED CALCIUM CARBIDE DESULPHURIZER FOR LOWERING SLAG REACTIVITY. [BIB-199301-45-0036]

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

2288 OCCURRENCE OF SOLID AND LIQUID WASTES IN COKE OVEN PLANTS AND TREATMENT OF TARRY WASTES. [BIB-199301-45-0037]

Industrial wastes in individual coke oven plants are listed, and an analysis of waste and acid tars of Czechoslovak coke oven plants is presented. For economical treatment or liquidation of tarry wastes, the following methods may be considered: waste mixing with charge coal and treatment in the charge; reduction of solid and ash matter in wastes; and liquidation of wastes by combustion. Liquidation of toxic and dangerous acid tars by neutralization, followed by mixing with coal and dosing into the charge, is described in detail. According to the first survey at the NH Ostrava, the amount of treated wastes reaches approx 800 t/year. 11 ref. (Medricky, Z.; Drabina, J.; 47, (4), 1-5 [in Czech]. ISSN 0018-8069)

2289 RECYCLING USED CORE MATERIALS. II. CORE WASTE—A VERSATILE ITEM OF VALUE. (RECYCLING VON KERNALTSTOFFEN. II. KERNABFALL—EIN VIELSEITIGER WERTSTOFF.) [BIB-199301-45-0058]

Used core sands, as distinct from molding sands, are generally free of contaminants and are readily recyclable. They tend to improve bentonite mold sands,

one of the means by which the minerals industry can reduce the quantities of effluents and residues that are discharged to the environment. The wise use of available resources is not only an environmental necessity but also an economic benefit as natural mineral resources are depleted and/or become more complex. The technical and regulatory issues that will help shape the future of minerals recycling over the next ten years are reviewed. Research and development to address technical issues are discussed, with emphasis on the Bureau of Mines recycling research program (for Sc, Au, flake iron and pickling liquors). 13 ref. (Bhakta, P.N.H.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 499-506 [in English].)

2274 RECOVERY OF CALCIUM FROM THE EFFLUENT OF DIRECT OXIDE REDUCTION PROCESS. [BIB-199301-42-0039]

The direct oxide reduction (DOR) of plutonium oxide generates significant amounts of contaminated waste. This waste primarily consists of calcium oxide-saturated calcium chloride salt. This investigation explores the possibility of recycling the salt by the electroreduction of the calcium oxide. Fused salt electrolysis of a simulated salt mix ($CaCl_2$ + approx 10 wt.% CaO) is being carried out to electrowin Ca, and the process is being optimized in terms of the Ca solubility, cell temperature, current density and cell design to maximize the current efficiency. This work identifies the major concerns in the development of a process to electrowin Ca from this simulated salt mix. Graphs. 15 ref. (Ferro, P.D.; Mishra, B.; Moore, J.J.; Olson, D.L.; Averill, W.A.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 539-550 [in English].)

2275 EXPERIENCES IN PROCESSING OF CATHODE LINING FROM ALUMINIUM INDUSTRY. [BIB-199301-42-0040]

The Hall—Heroult process of reduction of alumina to Al has remained basically the same for 100 years, but the technology has been undergoing drastic changes with respect to selection of materials for cathode and anode and also energy consumption. The latest generation pots have a working life of approx 1800-2000 days normally. After the failure of the pots, the cathode lining is dug out and disposed of on land. Since the lining contains objectional materials causing pollution, various processes have been tried for re-processing of this waste. However, most of the processes have been unsuccessful from the techno-economic point of view. At Hindalco, a new chemical process for converting the fluorine values of the dug out material to cryolite was developed in 1988 and a one ton/day cryolite production plant has been operating since 1989. This process is especially applicable where the integrated alumina and smelter plants exist side by side. The experience in operating this plant is discussed in detail. (Venugopalan, T.A.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 555-558 [in English].)

2276 ELECTRIC ARC FURNACE PROCESSING OF SOLID WASTES. [BIB-199301-42-0041]

The results of "submerged arc" electric furnace processing of a variety of materials is discussed with respect to the process and products, including the characteristics of the products (e.g. TCLP or toxicity characteristics leaching procedure). The materials smelted include slags and wastes containing various metal oxides including Cu, Sn, Pb, Zn, Cr, Ni, and other associated elements. The findings of these tests are compared to those reported in the literature for other operations treating similar "wastes". 19 ref. (Cotchen, J.K.; Davis, H.F.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 559-572 [in English].)

2277 MF PROCESS FOR RECYCLING MATERIALS TREATMENT. [BIB-199301-42-0042]

MF is the semi-blast furnace which has been developed at Mitsui Miike Smelter in the 1960s to treat vertical retort residue. The MF has also been tested for treatment of various recycling materials and wastes. Now various secondaries and wastes (steel dust, Zn leaching residue, Cu—Ag sludge, spent catalyst and spent rubber, etc.) are mainly treated. Powder materials are briquetted with reductant before being fed to the furnace. Products are crude zinc oxide, matte, non-hazardous slag and steam. Zinc and Pb are recovered in oxide dust, and Cu and Ag are recovered in the matte. The MF furnace can be widely applied to many kinds of materials which contain such non-ferrous metal-valuables. In addition, the improvement in operation and technology has effectively made the unit capacity much larger. The MF furnace now has many advantages for these treatment processes. Graphs, Photomicrographs. (Murayama, Y.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 585-597 [in English].)

2278 RECOVERY OF ACID VALUES FROM METALLURGICAL ACID PLANT BLOWDOWN. [BIB-199301-42-0049]

In the treatment of gases from pyrometallurgical processes prior to acid manufacture, volatile components, sulfur trioxide and particulates are removed in wet gas cleaning systems. In the process a weak acid stream is generated, typically 10% H_2SO_4, contaminated with volatiles such as arsenic, fluoride and chloride, plus metallic particulates. This effluent stream has, in the past, been disposed of in a variety of different ways. As a result of changing environmental legislation, smelters are having to review alternative solutions for treating this effleunt stream. A process developed by Chemetics which treats this effluent stream, generating a small dry metal sulfate stream plus a clean acid stream which is suitable for recycling to the smelter acid plant is described. Graphs. 4 ref. (Trickett, A.A.; Evans, C.M.; Kozary, S.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 815-831 [in English].)

2279 BIOLOGY VS. HEAVY METALS—A BIOLOGICAL PROCESS FOR ELIMINATING HEAVY METALS FROM SEWAGE WATER. (MIT BIOLOGIE GEGEN SCHWERMETALLE—BIOLOGISCHES VERFAHREN ZUR SCHWERMETALLELIMINATION AUS ABWASSERN.) [BIB-199301-42-0078]

The removal of heavy metal (i.e. Ni, Cd, Cr, Zn, Ag, Au, vanadium) residues from waste water by precipitation of hydroxides, sulphides, or by ion-exchange does not always meet the stringent legal requirements. The Metex process based on anaerobic microbial action reduces a heavy metal content in two stages; a hydroxide precipitation is followed by microbial action within a sediment bed. The water passes vertically upward through the bed and a final filtration through a membrane filter removes any colloidal or retentive particles passing upward from sediment. A degree of feedback of water to the base of the column from the region before the filter extends the lifetime of the membrane. Sediment effectiveness is retained for up to 20 months. (Furst, P.; Morper, M.; 46, (4), 161-162 [in German]. ISSN 0026-0797)

2280 NEUTRALIZATION OF WASTE WATER WITH FLUE GAS—ENVIRONMENTAL-FRIENDLY, COST-SAVING NEUTRALIZING AND PRECIPITATION OF ALUMINUM IN ALUMINUM PICKLING PLANTS. (ABWASSER MIT RAUCHGAS NEUTRALISIEREN—UMWELTFREUNDLICHES, KOSTENSPARENDES NEUTRALISIEREN UND ALUMINIUMABSCHEIDEN IN ALUMINIUM-BEIZEREIEN.) [BIB-199301-42-0079]

The Al present as a complex hydroxide with Na in waste water from Al pickling plants is precipitated as a simple hydroxide when the pH of the solution is adjusted to within a very narrow range. The necessary close adjustment of pH by neutralization using sulphuric or hydrochloric acid is difficult and leaves unwanted sulphates or chlorides in the system. Neutralization with carbon dioxide is easily controlled and leaves only bicarbonate in solution. An industrial process based on this reaction uses the carbon dioxide present in flue gases from the Al plant to effectively and cheaply remove the Al residues from the waste water, which may be reused within the plant. Graphs. (Schwarzlmuller, A.; Nitzsche, T.; 46, (4), 163-166 [in German]. ISSN 0026-0797)

tightening all the time, so new processes must be developed to keep pace with these requirements. These processes generate more solid wastes, which must be utilized or at least processed into a harmless form landfilling. Municipal and hazardous wastes also contain valuable materials and energy, which must be used to minimize landfilling. Principles, examples, and some references of R&D work on processes for waste minimization are presented. Graphs, Diffraction patterns. 15 ref. (Tuovinen, H.; Metsarinta, M.-L.; Lilja, L.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 45-72 [in English].)

2267 ECONOMIC IMPACT OF TREATMENT OF RESIDUES AND EFFLUENTS ON INVESTMENT DECISIONS. [BIB-199301-42-0016]

Most metals are produced from minerals containing one or more of the desired metals, some contaminating metals, silicate, oxides, carbonates, and sulfides. Therefore, in the production of metals, there is generally a gaseous effluent in pyrometallurgical processes and a liquid effluent in hydrometallurgical processes. There are also solid residues such as waste ore, tailings, dust, and slag, created by the metal recovery processes. There are two important distinctions between the effluents and the residues. Effluents—gases and liquids—affect the neighboring environment for miles from the point of emission, while residues affect only the soil on which they are stored or dumped. The environmental and economic effects of effluents are known and felt essentially immediately. By contrast, the environmental effects of the residues may not be known for a long time. For these reasons, the economic impact and the potential corrective actions required are very different for effluents and residues. (Agarwal, J.C.; Katrak, F.E.; Loreth, M.J.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 73-80 [in English].)

2268 AMMONIUM CARBONATE LEACHING OF REDUCED ELECTRIC ARC FURNACE (EAF) DUST. [BIB-199301-42-0018]

One of the problems with ammoniacal—ammonium carbonate leaching of EAF carbon steelmaking flue dust is that Zn present in spinel phases is not leached. Results are presented of test work in which prior to leaching, EAF dust was reduced with carbon monoxide containing gas to decompose the spinels into zinc oxide and Fe bearing phases, mainly metallic Fe and wustite. From such reduction products, the amount of Zn leached increases but the Fe co-leached becomes extensive. The effect of various leaching parameters such as liquor concentration and redox potential on Zn and Fe dissolution has been investigated. Supplementary experiments utilizing pure zinc oxide and pure Fe phases were also carried out. Results show that the co-dissolution of Fe from severely reduced EAF dust cannot be prevented. This is because the wustite phase contains Zn which can only be leached when Fe also dissolves. Further, the Zn bearing wustite phase is not totally soluble so that the residue cannot be made Zn free. In the absence of air, dissolution of metallic Fe hardly occurred, though in leaching experiments of a long duration in transformation to a spinel structure was observed. Graphs, Diffraction patterns. 18 ref. (Nyirenda, R.L.; Peek, E.M.L.; Weert, G.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 163-177 [in English].)

2269 SIROSMELT TECHNOLOGY FOR SOLVING THE LEAD AND ZINC INDUSTRY WASTE PROBLEM. [BIB-199301-42-0027]

An outline is given of the problems facing the Pb and Zn industry from the viewpoint of the range of residues currently produced from electrolytic Zn, blast furnace and other processes. Smelting approaches available using top submerged lancing technology are discussed and analysed. Pilot plant results for a range of Pb and Zn-bearing materials are presented. Graphs. 4 ref. (Robilliard, K.R.; King, P.J.; Floyd, J.M.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 331-348 [in English].)

2270 THE ENVIRONMENTAL ASPECTS OF THE IN-PLANT COOLING OF ALUMINUM MELTING FURNACE DROSSES. [BIB-199301-42-0029]

The methods for the cooling of Al melting furnace dross and their impact on the environment are discussed. Also discussed is a case history of an AROS dross processor installation, which is designed to maximize the recovery of metal content of the dross in a manner which is not only environmentally cleaner, but which also prepares the output in such a way as to facilitate downstream processes. Handling of the discharged material is discussed in regard to the recycling of the preserved metal content and deposition of the unusable materials. (Roberts, R.P.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 367-376 [in English].)

2271 INTEGRATING JAROSITE RESIDUE PROCESSING IN HYDROMETALLURGICAL ZINC WINNING—COMPARISON OF FIVE POTENTIAL PROCESSES. [BIB-199301-42-0032]

Hydrometallurgical Zn winning processes are frequently based on Fe containing concentrates which yield a goethite, jarosite, or hematite residue. Jarosite or goethite are mostly stored in waste ponds which are lined with foil. Water percolating through the pond is withdrawn from the deposit and decontaminated before discharge. Despite these measures, more and more pressure is put upon Zn companies to treat their (historical) residues and to produce environmentally acceptable residues. The criterion which determines this acceptability is the potentiality of leaching out hazardous elements by natural processes. The comparison of five different process designs for integrated jarosite treatment in a hydrometallurgical Zn winning plant leading to environmentally acceptable residues is provided. The processes are designed for producing 200 ktons/year Zn and for treating 80 ktons/year historical jarosite. Mass and energy balances are used to determine parameters such as the energy use/ton waste treated and the amount and composition of final residues. The conclusion of the work is that pyrometallurgical jarosite treatment integrated in hydrometallurgical Zn winning is preferable to hydrometallurgical jarosite treatment. Integrated pyrometallurgical processes lead to a smaller quantity of remaining hazardous residues and require less energy. Graphs. 23 ref. (Elgersma, F.; Zegers, T.W.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 413-448 [in English].)

2272 HISTORY OF EFFLUENT AND RESIDUE TREATMENT AT TIN PROCESSING CORP., 1942-1946. [BIB-199301-42-0034]

One War Plant processed Bolivian concentrates as low as 17% Sn by the Arnhem process (pressure leach with HCL) and sent the waste acid down a ditch to Galveston Bay where the chlorides, mostly Fe, hydrolyzed. Oyster men, and Texas, demanded impoundment until a disposal process could be developed. A recycle process found by lab work was recommended, piloted, and a plant built. This involved cementation of arsenic—Sb, Cu, bismuth, and Ag on light moving scrap iron and of Sn and Pb on Al turnings (then not recyclable), evaporation and crystallization of hydrous $FeCl_2$, roasting crystals in a muffle furnace and absorbing HCl for reuse. The residue from leaching the low grade concentrates was floated to remove undissolved sulfides, classified and passed over sand and slimes tables to get a smeltable concentrate, a discardable sand tail and a slimes tail worth treating. After desliming at 2 mu m cassiterite, oxide flotation gave good lab results, but commercial equipment was not adequate then. Chloride volatilization, with or without smelting gave high recoveries of Sn as $SnCl_2$, whose marketing was questionable. This was heard to be finally fluxed and smelted. 5 ref. (Dasher, J.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0019), 461-467 [in English].)

2273 RECYCLING OF METALLURGICAL RESIDUES AND EFFLUENTS. [BIB-199301-42-0036]

The minerals industry is under political and economic pressure to reduce its processing wastes and minimize their impact on the environment. Recycling is

2260 COMPARISON OF EP TOXICITY AND TCLP TESTING OF FOUNDRY WASTE. [BIB-199301-23-0001]

The toxicity characteristic leaching procedure (TCLP) has replaced the extraction procedure (EP) toxicity test for determining whether or not wastes are hazardous by toxicity characteristics. The tests are compared, highlighting the significant differences and comparing the available results for foundries. A major difference between the tests is the inclusion of a much larger number of organic compounds in the TCLP. However, foundry wastes tested have not leached the listed organic constituents at concentrations above the hazardous waste criteria. Results for Pb and Cd are generally similar in the two tests, with Pb concentrations sometimes higher in the TCLP than in the EP toxicity test. Discussed are brass, gray iron and steel foundries. 3 ref. (Stanforth, R.R.; Turpin, P.D.; BIRMINGHAM, ALABAMA, USA, 5-9 MAY 1991, Publisher: AMERICAN FOUNDRYMEN'S SOCIETY, INC., Des Plaines, Illinois 60016-8399, USA, (1991), (Met. A., 9301-72-0001), 261-263 [in English].)

2261 REMOVAL OF ARSENIC FROM WASHING ACID BY THE SACHTLEBEN—LURGI PROCESS. [BIB-199301-34-0044]

Disposal of arsenic compounds from washing acid in metallurgical plants is becoming a severe problem when using lime neutralization. A further problem is the disposal of relatively large quantities of gypsum which is produced during this neutralization step and which is also contaminated with other toxic metal compounds. The Sachtleben—Lurgi process removes As and other metals from washing acid in the form of insoluble sulfides. The purified acid contains 0.5 ppm of As and can be used for standard sulfuric acid applications. The process has been demonstrated commercially at Sachtleben's acid plant for more than five years. (Klamp, G.; Wanner, D.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0015), 833-837 [in English].)

2262 STRATEGIES AND PRACTICES FOR HANDLING MINE WASTES AT THE SUDBURY OPERATIONS OF INCO LIMITED. [BIB-199301-41-0003]

Since the turn of the century, copper—nickel sulfide ores have been processed at the Sudbury, Ontario operations of Inco Limited, currently the largest integrated mining, milling, smelting, and refining complex in the free world. Through the years operation, economic, social, and legislative changes have dictated the need for research and development directed at mitigating the impact of existing operations on the surrounding natural environment and also the reclamation of areas affected by earlier mining activities. Approximately 100 years of mining history and the current annual processing of approx 12 million tons of ore presents significant challenges with respect to waste disposal, liquid effluent treatment, and land reclamation, particularly in light of rapidly evolving environmental regulations and controls within the Province of Ontario. (Hunt, C.E.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0015), 89-94 [in English].)

2263 TREATMENT OF RESIDUES AND EFFLUENTS IN REFRACTORY METAL INDUSTRY. [BIB-199301-41-0004]

Environmental protection and waste disposal are topics of ever-growing importance. These dynamic subject areas will become—if they are not already—driving forces for manufacturing industries worldwide. The refractory metals industry is seeking ways to comply with the increasingly stringent laws passed for environmental protection and the concomitant decrease in the availability of waste disposal areas. The Ta and Nb manufacturing process described complies with current regulations. For the most part, the amount of waste and effluent has been reduced without major change to all the processes described. The situation is the same for tungsten, Mo, and rhenium processes also. It is clear through that the historical imperatives used to design most of these processes were to achieve a high purity product and to minimize manufacturing costs. The driving forces of environmental protection and lowered availability of waste disposal sites can be expected to force reconsideration of both the raw materials used in the respective manufacturing processes and of the manufacturing process itself. Graphs. 3 ref. (Albrecht, W.W.; Gries, B.; Nadler, H.G.; Rockenbauer, W.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0015), 95-113 [in English].)

2264 BACTERIAL FLOCCULATION OF PHOSPHATE WASTES USING A HYDROPHOBIC BACTERIUM. [BIB-199301-41-0005]

A micro-organism will function as a mineral flocculant if it is to some degree hydrophobic and can attach itself in some manner, such as through electrostatic interaction, to the fine mineral particles to be flocculated. The use of a hydrophobic bacterium, Mycobacterium phlei, as flocculating agent for phosphate slimes is discussed. Experimental work on the flocculation of phosphate slimes and of dolomite and clay mineral suspensions was performed. It was found that M. phlei functions as an excellent flocculant for a dolomitic slime but does not function as well for mineral suspensions where large quantities of the solids are finer in size than the approx 1 mu m size of the bacterium. Graphs, Photomicrographs. 15 ref. (Smith, R.W.; Misra, M.; Dubel, J.; SAN DIEGO, CALIFORNIA, USA, 1-5 MAR. 1992, Publisher: THE MINERALS, METALS & MATERIALS SOCIETY, 420 Commonwealth Dr., Warrendale, Pennsylvania 15086, USA, (1991), (Met. A., 9301-72-0015), 747-756 [in English].)

2265 A STUDY OF POST-DEHYDRATION BONDING AND ION ADSORPTION IN A BAUXITE WASTE. [BIB-199301-41-0057]

Consideration of alternative methods for the disposal of bauxite waste by the Al industry has generated interest in the ability of bauxite waste solid constituents to attain a certain degree of physical integrity upon drying to yield a material of suitable strength properties. The development of physical integrity in bauxite waste was studied through elucidation of potentially operative bonding mechanisms in a selected Jamaican bauxite waste which is observed to dry to a material of relatively high post-dehydration strength properties. Interest in the ability of bauxite waste solids to attain a certain degree of physical integrity extends to an application, proposed in this study, involving the potential use of bauxite waste as a contaminant stabilization/solidification medium. Efforts at facilitating elucidation of potentially operative bonding mechanisms are accomplished by means of a comparative study involving a second bauxite waste derived from Guinea bauxite which, despite its similar mineralogy to the selected Jamaican bauxite waste, was observed to dry to a material of low post-dehydration strength properties. Results obtained revealed the apparently important role of hydroxylated oxide/hydrous oxide surfaces of high specific surface in governing the development of physical integrity. A parallel study concerned with the ion adsorption properties of Jamaican bauxite waste was conducted in efforts to further aid in establishing the potential for use of bauxite waste as a contaminant stabilization/solidification medium. Adsorption tests were conducted using four ions (Cl^-, SO_4^-, K^+, and Pb^{++}) selected on the basis of valency and sign of charge. The results indicated the marked ability of the bauxite waste solids to adsorb Pb both below and above the measured point of zero charge (PZC) of the bauxite waste solids. The results also indicated sulphate, contrary to chloride, was readily adsorbed provided it was added as its acid. When added as its salt (Na_2SO_4), no sulphate adsorption was observed even at pH values well below the PZC. The postulated chemisorption-type interaction of Pb and other heavy metals with hydroxylated oxide/hydrous oxide surfaces suggests that certain bauxite wastes, particularly those which exhibit high post-dehydration strength properties, may be well suited for use in contaminant stabilization/solidification applications. (DANN67698). (Ludwig, R.; 53, (3), Pp 233 [in English]. ISSN 0419-4217)

2266 DEVELOPMENT OF PROCESSES FOR MINIMIZING THE WASTES. [BIB-199301-42-0015]

The total utilization of raw materials and energy is the most important criterion when planning industrial processes. The main goal is clearly to use the raw materials and energy as effectively as possible to make the desired products directly in the primary process itself, or to recycle unused materials and energy either as such, or after cleaning back into the process. However, few industrial processes are so straightforward. Most processes generate by-streams of materials and energy, which cannot be recycled directly and it is these by-streams which tend to remain as wastes. These by-streams are slags, dusts, vaporized metals, liquids, slurries, sludges, gases, etc. Most base metal processes produce all these by-products. Waste water and gas emission controls and regulations are

Association of research institutions, universities, government organizations and private sector companies in the Pacific Basin countries, involved in hazardous waste research.

Packaging Council of Australia
P.O. Box 1469N
Melbourne Victoria 3001
Australia
Phone: 036984279, Fax: 036903514
Trade association for the packaging sector. Has expertise on environmental effects of packaging, in particular recycling, waste management and resources conservation.

Scandiaconsult International
P.O.Box 35
S-16493 Kista
Sweden
Phone: 4687032000, Telex: 17496 consults11023 SCCCINTS, Fax: 4687039250
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.

Servicio de Consulta a Bancos de Informacion
Cercuito Cultural Universitario
Edif A Planta Baja
CP 04515 Mexico D.F.
Mexico
Phone: NA, Telex: 017 74521
Provides access to national and international data bases and collects and disseminates information on information systems. Topics include: research on pollution (water, air, soil, solid wastes); clean technology; control techniques; elaboration of programmes related to waste management and pollution control; potable water; water treatment; wastes treatment; sludge treatment and management; legislation; laws; statistics; human health.

Simon-Carves Ltd.
Simon-Carves Ltd.
Sim-Chem House
P.O. Box 17
Cheadle Hulme
Cheadle
Cheshire SK8 5BR
United Kingdom
Phone: (061)4856131, Telex: 667844, Fax: (061)4861302
Commercial firm undertaking: liquid and solid waste disposal and treatment; vitrification of nuclear waste; pollution control; flue gas de-sulphurization; bulk material handling systems; chemicals and petrochemicals pollution; ores; fertilizers; glass raw materials; handling and transport of waste.

Svensk Avfallskonvertering AB
P.O. Box 904
S-692 29 Kumla
Sweden
Phone: 4619305100, Telex: 73139 SAKAB S, Fax: 461977207
Commercial firm responsible under a Swedish government mandate for hazardous waste management in Sweden. Also offers consulting services with training, process technology, and environmental effects of waste management.

Tuev Bayern Holding GmbH
Westernstrasse 199
D-8000 Muenchen 21
Germany
Phone: 0895791082 u. 1823, Fax: 08957912204
Independent inspection and consulting organization, acting as a technical inspection body for most sectors of society. Maintains laboratory and research centre and undertakes consulting work. Tuev Bayern has specialized competence in a number of environment sectors, co-ordinated under a "man and environment" department: air pollution; water pollution; soil pollution; noise pollution; waste management.

Air and Waste Management Association
P.O. Box 2861
Pittsburgh PA 15230
USA
Phone: 4122323444, Fax: 4122323450
Organization promoting research and technical information on pollution and waste management. Publishes the Air Pollution Control Association Journal, arranges meetings and seminars and conducts training courses.

Alberta Special Waste Management Corporation
610 10909 Jasper Ave
Edmonton
Alberta T5J 3L9
Canada
Phone: (403)422509, Fax: (403)4289627
Consulting firm with expertise in: hazardous waste management; location of industry; public participation; feasibility studys; technology assessment; legislation; solid waste management; recycling; incineration; landfill; waste management.

British Leather Confederation
Leather Trade House
Kings Park Road
Moulton Park
Northampton NN3 1JD
United Kingdom
Phone: (0604)494131/4, Telex: 317124 CORIUM G, Fax: (0604)648220
Professional association for the British leather industry. Among environmental concerns, with particular reference to leather industry waste, are: pollution control; recycling and recovery of materials; solid waste management; toxicity of metals. Maintains a data base on low- and non-waste technology (LNWT).

Clayton and Bostock Hill & Rigby Ltd.
288 Windsor Street
Birmingham
West Midlands B7 4DW
United Kingdom
Phone: 0213595951, Telex: 337273, Fax: 0213597606
Consulting firm specializing in environmental services, such as: water analysis and management; testing; environmental monitoring; water and waste water treatment; hazardous goods storage and handling; environmental impact assessment (EIA); environmental auditing; industrial safety surveys.

Clean Japan Center
No.2 Akiyama Bldg.
3-chome 6-2 Toranomon
Minato-ku
Tokyo 105
Japan
Phone: (03)4326301, Telex: CLEANJC J 32415, Fax: (03)4326319
Information centre promoting waste management and recycling. Conducts research and experiments to develop recycling techniques and collects related technical information. The centre manages a data bank on waste disposal and resource recycling and provides reference services.

ECON Pollution Control TVT.LTD.
25/Unique Industrial Estate
Veer Sabarkar Marg.
Prabhadevi
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Phone: 437 5363
Activities: environmental auditing; EIA studies; carring capacity studies of major regions and sub-regions; solid waste management; hazardous waste; management, waste disposal and impact assessment studies; design of waste water water treatment facilities; environmental management and planning; land use studies; development of social forestry; ambient air and stack emissions surveys; micro-meterological surveys; water and waste water analysis; soil analysis; traffic and noise monitoring; flora and fauna studies; setting up environmental laboratoryies; environmental research and development; software development in the field of environmental engineering; meteorlogical software; data base for air pollution and water pollution studies;

Federal Institute for Materials Research and Testing (Bundesanstalt für Materialforschung und -prüfung)
Unter den Eichen 87
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Federal research and test centre which carries out (mostly as contractual work) materials testing and research. Consists of a large number of departments and sub-departments with specialized competence in: metallurgy; building materials; plastics; textiles; leather; industrial safety engineering; wood technology; transport of hazardous goods; fire prevention; noise. Has a major publications programme, including seven journals.

General Association of Municipal Sanitarians and Technicians (Association Generale des Hygienistes et Techniciens Municipaux)
9 rue de Phalsbourg
75017 Paris
France.
Phone: (1) 42 27 38 98
Organizes annual and monthly conferences on water and waste management and maintains international relations in this field. Topics include: solid waste; municipal waste disposal; solid waste treatment; potable water treatment and supply; waste water treatment and purification; domestic refuse, its treatment and sorting; hydrology, hydraulics; urban design.

Institute for Waste Disposal (Stichting Verwijdering Afvalstoffen)
Postbus 184
Amersfoort
Netherlands
Phone: 033-12904
Conducts applied research on waste management policies and of waste impact on the environment. Provides advice on waste disposal to provincial and governmental authorities. Topics include: air and groundwater pollution problems; statistical analysis of quantities and composition of solid waste to be treated; optimum use of treatment facilities and refuse transport; mechanical separation of waste; pyrolysis and gasification; treatment of sewage and chemical wastes; cleaning of incinerator gases; separation of incinerator residue; labour physiology in collection systems; environmental considerations.

Israel Desalination Engineering
P.O. Box 591
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Israel
Phone: 52909777, Telex: 33590, Fax: 52909715
Consulting firm dealing with: industrial and domestic waste water and effluent treatment; recycling and reuse; biomass energy; bio-environmental engineering; computer modelling of bio-environmental processes; product recovery.

National Association of Solvent Recyclers
1333 New Hampshire Avenue NW
Suite 1100
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USA
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Trade association of companies involved in hazardous waste management.

Pacific Basin Consortium for Hazardous Waste Research
c/o East-West Center
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handling and storage expenses, plus US$ 21/m3 for cements and additives, totalling US$ 88/m3 of granulated waste. The total cost estimated does not include that of granulating the waste, which would be a sizable item. The total cost for the disposal of unpackaged wastes are bound to vary more than for waste in containers, because of the different types of processing required for each waste type. For cement-compatible waste it will probably be lower than others, because less waste processing is required.

The effect of varying design features on costs of underground disposal is the subject of several parametric studies undertaken by the CEC (1983) and several OECD countries (Waddel et al. 1982; Burton & Griffin, 1981; Hudson & Boden, 1982) as part of their research on the disposal of radioactive wastes. A sensitivity analysis was carried out, using a design-concept for a repository in a granitic host-rock. Table 7 shows the variation in the cost of a reference design and practical alternatives (OECD Nuclear Energy Agency and Commission of the European Communities, 1984).

Table 7. Sensitivity of costs to changes in design features of an underground repository

Alternative/variation	Variation in disposal cost relative to the reference case (1000 m) (percentage)
Shallower depth (500 m)	-3
Addition of 10 cm overpack on canisters	+16 to +25
Retrievability for 50 years	+10
Fewer containers (15000 instead of 30000)	-38
More containers (60000 instead of 30000)	+87

standable when it is known that the German landfilling costs may not allow for amortization of the initial capital investment and that subsequent investment costs are subsidized through interest-free loans (Defregger, 1987). A Canadian analysis on landfill costs (Faraday, (N.D.)), relying partly on United States studies is considered superior, because it defines the cost items included comprehensively and clearly and investigates a large number of options and designs using the same data base. An extract from this study is shown in Table 5.

Total operating costs, assuming a 20 per cent profit and a 30 per cent contingency over a twenty-year operating life-time, is calculated to be US$185 million, for a reference facility (58 trenches, 180 x 30 x 8 m deep, assuming a 50 per cent packing efficiency). Thus total cost per cubic meter of waste is calculated to be US$185.

Note that these costs do not include those incurred during closure of the repository, nor do they include costs of institutional maintenance and monitoring.

If these cost figures reflect construction costs in 1980, capital costs without including interest rates would have amounted to US$ 77.4 per tonne of waste; assuming an average inflation rate of 5 per cent per annum, by 1990 equivalent costs would amount to approximately US$ 126 per tonne, again without including interest rate, operating costs, insurance, etc.

1. Comparison of capital and operating costs using different disposal concepts in landfill

It is instructive to compare the total capital and operating costs incurred for a one million cubic meter capacity waste storage facility, using the alternative concept outlined in Table 6.

The high costs involved in developing and operating a disposal facility emphasizes the need for an optimized strategy for each repository and for planning on a regional basis.

The results of this study and others (Waddel et al. 1982) suggest the following:

(a) The cost of excavating, installing and operating a deep geological repository is relatively insensitive to likely local variations in mining costs in the various types of geological media. They are unlikely to be a major consideration in selecting a suitable design;

(b) The type and nature of waste containment (physical condition, type and dimensions of waste packaging) will be a major significant factor in disposal costs.

2. Costs of deposition and pretreatment alternatives

Thermal destruction of hazardous wastes, is one of the more widely used alternatives, covers a broad range in costs and very much depends on the nature and composition of the waste processed. For example, one source quotes the costs of burning chemicals to range from US$ 53 to US$ 800 per metric tonne (United Nations Economic Commission for Europe, 1985). This wide range reflects the technical simplicity of incinerating clean combustible liquids at one end of the range, compared with the capital-intensive process required for highly toxic, refractory solids and drummed wastes.

Where a waste is easily detoxified or its energy recovered, the unit costs for treatment can be lower than for land disposal, although more commonly they are comparable at the lower end of the range. Lower levels of confidence are assigned to the shallow land disposal method, mainly because of the "open-ended" nature of this method; in many instances there is doubt on the period of post-closure control required.

The technology required for the alternative processing treatment of toxic and hazardous wastes has advanced to the stage where many types of wastes can be thus processed, although costs remain high, in most cases still higher than for simple land disposal. There is need for providing economic incentives to waste generators to encourage them to invest in waste-processing to establish regional joint centres. There is an additional need for research into the development of economically more advantageous processing alternatives, including the feasibility of recycling at least a part of the wastes.

It is concluded that even though treatment and disposal technologies may be available, it is the parameter of economics that is often the major determinant of whether or not wastes are correctly processed and disposed.

The reasons for any current deficiencies in waste management include the following:

- Lack of consensus for a variety of reasons on what constitutes comparable levels of control across technology alternatives;
- Regulatory uncertainties; there are divergences on a national level on what the maximum permissible levels for a number of toxic materials should be. Uncertainties in cost information with reference to the application of a particular technology to a particular type of waste and what constitutes a hazardous waste. The changing, dynamic nature of costs, evolving technology and the increasing experience gained in responding to regulatory requirements.

3. Costs of deep disposal in geological formations

The costs of shallow landfill disposal are rising, partly because suitable sites are becoming more difficult to obtain due to opposition from an increasingly critical public and due to more stringent requirements and regulations by licensing authorities. Reports indicate that landfill costs are increasing at rates up to 40 per cent annually (Forsberg, 1984). Nevertheless, disposal in deep geological formations (300-2,000 m) remains much more costly. However, there are indications that the cost gaps are narrowing, in part because of relatively recent technical developments. For example, in the RUMOD process already referred to, it is proposed that granulized, solidified waste is mixed with cement "grout", to be pumped underground to disposal caverns. Much experience has lately been gained in the excavation of large underground caverns for oil storage, such as the Brofjrden project in Sweden, which required the excavation of four million cubic meters of granitic rock (Hinrichsen & Kayfetz, 1981). At this scale, the cost of opening up caverns decreases significantly, in fact, at Brofjrden it is claimed that the storage site is actually cheaper than would be the case if surface tanks were installed.

For the RUMOD study, cost estimates arrived at a surprisingly moderate excavation, pumping and waste-cement mixing cost of US$ 57/m3; to this is added US$ 10/m3 for solids

Table 6. Comparison of capital and operating costs estimated for various disposal concepts and different geometrical parameters

Concept	Outer dimensions (m)	Volume/Trench (m^3)	Loss from usable waste	Slope or wall vol. Vol a/	Number of trenches required	Cost difference (%) relative to reference trench (table 1) b/	Notes
Reference trench	180x30x8 (4/1 slope)	3340	34450	17225	58	0	ø
Trench in sand	180x30x8 (1/1 slope)	10870	26950	13475	74	0	ø
Small concrete trench	12.6x3.6x8.3 (concrete 0.3)	65	250	190	5290	+87	ø
Large concrete trench	130x30x8 (concrete .1)	2900	34900	20950	48	+10	No cell division
Thicker cover	130x30x8	As in reference trench					3m vs 1m
Layered disposal	130x30x8	As in reference trench					10% of waste layered
Intrusion barrier	130x30x8	As in reference trench					t = 5.5 bldrs. clay etc.

a/ Only capital and operating costs.
b/ Assumed packing efficiencies (volume utilized/volume theoretically available).

Note: A similar study relative to the cost of disposal in a newly mined cavity 550 m below surface arrived at a cost difference of +450 per cent.

that the two measures advocated (waste minimization and clean technologies) will become increasingly advantageous with time. The main factors influencing the cost of hazardous-waste management for the waste producer are the amount of waste produced, the pre-disposal treatment required and the ultimate disposal method chosen. There may even now be cases where costs of new or innovative process changes might well be justified by savings in raw materials and reductions in disposal costs. Waste separation (into types and degrees of toxicity) and concentration can also reduce costs.

Any comparative cost studies must consider all costs incurred from the time the waste is produced to the time when it is either processed, decays naturally to a harmless material or when it is effectively isolated from the biosphere. Costs should be compared on the basis of equivalent, environmentally acceptable methodologies, assuming full-scale industrial facilities. Landfill disposal has been the most widely used method, mainly because it has been found to be the cheapest, at any rate over the near term (In addition, it is found to be less sensitive to waste type and characteristics than other methods and treatment).

Underground or sub-surface disposal costs are inherently more costly. For one thing, shaft construction and underground openings are by their very nature expensive, for another, the dimensions of shafts and haulage ways superimpose a limit on the rate at which packaged, bulky wastes can be emplaced in underground caverns. On the other hand, the 30-year time period considered for monitoring and maintenance of landfill sites following closure and assumed in the cost-calculations, is considered by experts as far too short; cost estimates may therefore be too low. Even so, landfill costs are quoted at US$ 55 for "low-risk wastes", up to US$ 240 per metric tonne for more hazardous drummed waste (United Nations Economic Commission for Europe, 1985).

Cost figures must in most cases be treated with caution. Large discrepancies arrived at in different studies could partly be due to different costing ground rules and the inclusion of various options assumed. For example, a cost study carried out in the Federal Republic of Germany arrives at what appears to be unusually low, i.e. DM 75 to DM 190 per tonne (the latter for deposition in a concrete encasement). This becomes under-

Table 5. Summary of cost components included in calculating total capital costs for a reference disposal facility having a capacity of 1 million cubic metres

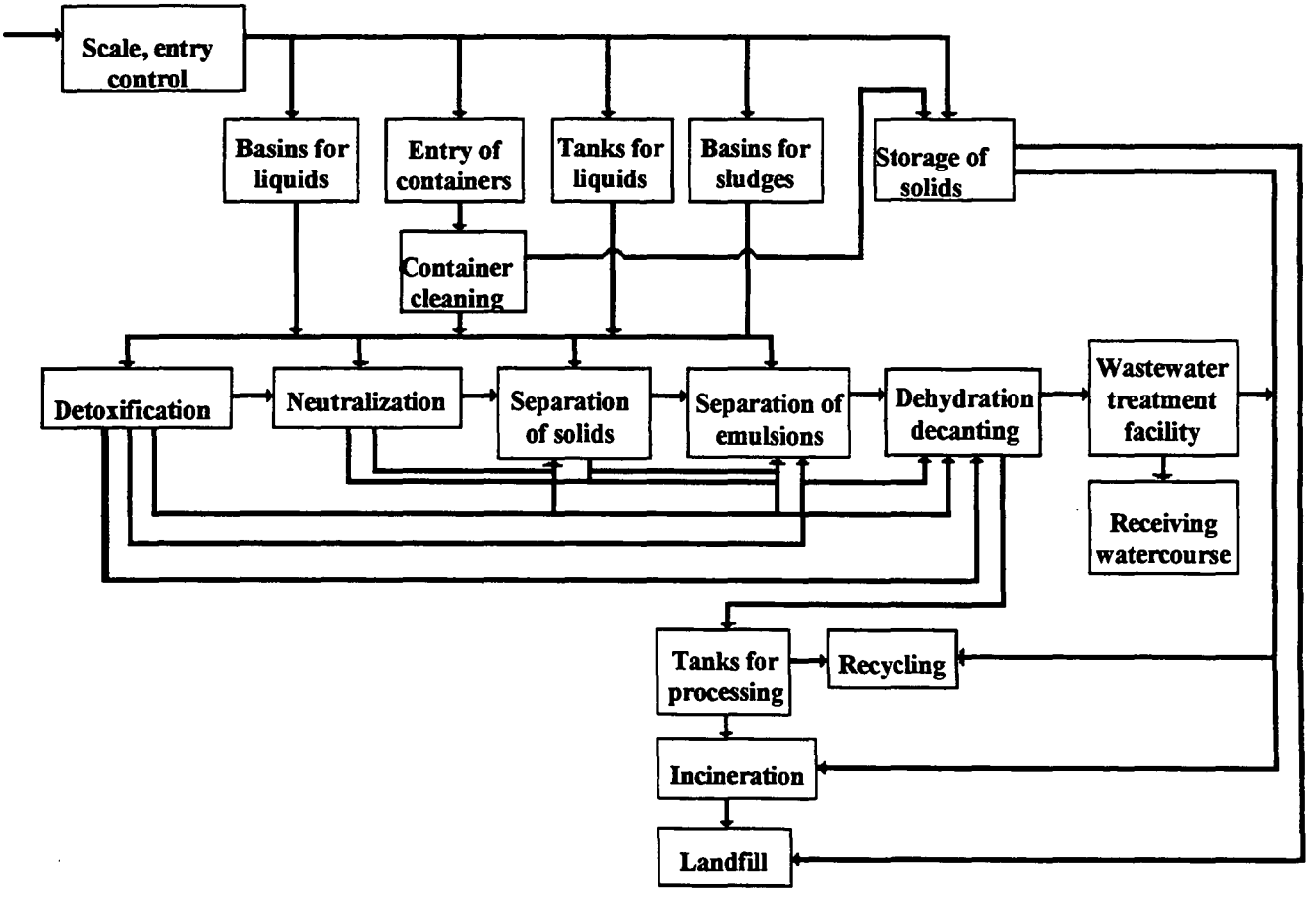
(1) Direct capital costs	1980 US$ (x 1000)
Site selection	500
Environmental impact studies	600
Licencing fees	325
Other licences and permits	250
Land acquisition (200 acres at $ 1200/acre)	240
Legal fees	1625
Corporate administration	1000
Road construction	200
Initial land preparation (40 acres at $1145/acre)	46
Office and other miscellaneous light equipment	400
Building construction utilities, supplies	1348
Peripheral services engineering and design	467
	7452

(2) Total capital costs	Percentage
Total capital costs were calculated on the following premise and with the following assumptions:	
Interest during construction	33
"Contingencies"	30
Other Costs	10
	73

Total capital costs =
direct costs x indirect costs x annual fixed charge x profit =
$7.452 \times 1.73 \times 0.25 \times 1.20 \times 10^6$ = US$ 77350000

Note: 1 acre = 0.405 hectare

Figure XI. Centralized waste treatment facility



versely, as well as parallel with groundwater flow is termed dispersion.

The rate at which any pollutants move through and are dispersed beyond a repository site depends not only on technical barriers but also on the nature and type of retention mechanisms by the underground geological material, e.g., the extent to which this material can retain pollutants and for low long. Sorption of pollutant radicals and desorption can both occur. Apart from sorption mechanisms, there are other parameters such as microfissures, diffusion, facies differences, grain-size, hydraulic conductivity and permeability which influence dispersion rates.

Depending on sorption reactions between pollutant matter and the containing geological material, dispersion will cause some of the dissolved substances to be transported slower or faster than average groundwater velocities. The techniques for measuring pollution dispersion parameters are described in a paper by the IAEA (1985); included are tracer and geochemical tests such as groundwater, pore-water, and mineral composition, geochemical history and groundwater-mineral equilibria.

In post-operational monitoring, the short-term concern is with the period when the facility is still under institutional control. Within this time frame (considered to be of the order of thirty years or so), primary reliance for isolation is on technical, engineered barriers. Monitoring will include the surveillance of these barriers, which must be easily accessible and repairable. Beyond the time of institutional control, there must be increasing reliance on the capability of the enclosing geological material to retain pollutants.

Where the hazardous materials are of such nature that they do not decay significantly within the period of forseeable institutional control, it may be mandatory to employ pre-depositional treatment of the wastes to less hazardous forms in order to safeguard the environment, in case failures of technical and natural barriers do occur.

In the United States, the control and disposal of certain hazardous wastes has been specified under Resource Conservation and Recovery Act (RCRA) and monitoring methodologies have been formulated, e.g., the levels of specific pollutants in groundwater below and around the sites are required not to exceed certain maximum values. To detect groundwater streaming, successive water samples are required to be taken from wells at different times to indicate which of the pollutants may be migrating into groundwater. RCRA prescribes a three-step approach:

(a) Detection monitoring, which looks for evidence of contamination, for example a change in the organic carbon level. Groundwater samples are taken twice a year. Where there is evidence of change, the operator has to analyse samples for specific chemicals. If these do not exceed the maximum permissible levels, the repository is permitted to operate, provided that any chemicals that have been detected are monitored on a prescribed basis;

(b) Compliance monitoring, which analyses samples at regular intervals from locations at which contamination has previously been detected;

(c) Corrective action, which seeks to eliminate contamination where maximum allowable levels have been exceeded, while continuous monitoring is done, to determine if contamination is actually being reduced.

Changes in the chemical composition of the leachate can indicate that changes in the general behaviour of the landfill are taking place. For example, it is possible that the system is being overloaded with a particular type of waste and that co-depositioning ratios must be adjusted.

Leachates will be formed in landfill operations even under ideal conditions and in moderate climates. Extensive data on leachates are particularly needed to ensure that the water quality is not being adversely affected. Even where the leachate is simply pumped to sewers, the volume and contents must be checked, measured and recorded regularly to satisfy the requirements of the local water authorities. Leachate monitoring should not be confined to the actual site, but should also be carried out beyond the boundaries of the site itself. The layout, periodicity of this groundwater monitoring programme should be drawn up at the pre-operational stage and measurements taken to ensure that background values are obtained prior to the commencement of waste-deposit operations. The periodicity of groundwater monitoring may have to be adjusted later on, if the reading taken indicates the necessity of doing so.

Fedra et al. has carried out a series of studies on risk analysis on the production, transportation of hazardous raw materials, feedstocks or interim products and waste disposal. A number of models were developed including: simulation/optimization of production systems, long-range atmospheric transport, river pollution, groundwater contamination, hazardous substances transportation and management (Fedra et al., 1985, 1987, 1989, etc.).

D. Economic considerations for disposal options

The cheapest method of waste disposal is a sanitary landfill without predisposal treatment; one of the most expensive options for a waste generator is a secure chemical landfill (refer to appropriate section on landfill repositories). It is essential to compare not short-term but long-term costs of the different alternative options. This obviously refers to the increasingly evident need to monitor and maintain repositories a considerable time beyond their final closure. The long periods of time which a particular waste may require to be isolated could impose a larger financial burden on the landfill option than other options not considered at first sight to be cost-effective.

The economy of scale, as in other industrial ventures, dictates the necessity for smaller enterprises to operate common, centralized waste-treatment facilities. Such a facility is schematically shown in figure XI.

The extent of the ultimate benefit derived from any possible waste minimization and use of clean technologies cannot now be assessed completely, but in view of increasingly more stringent requirements on maximum exposures to certain chemicals and compounds, stricter regulations on waste disposal by some countries, the considerably larger monitoring periods advocated (up to 500 years) for special landfill repositories, it is expected

amended waste regulations must be formulated to recognize this need.

Safety assessments relating to a disposal site utilize geological, hydrogeological, seismic, geochemical, geotechnical and other surveys, as outlined under the section "Site selection". These are carried out before and particularly during the final stages of selecting a disposal site and the results obtained are used for the design activities required once final selection has been made. However, such assessments are based on the initial characterization of a site and the results are invariably hedged by a degree of uncertainty, mainly due to the inevitable complexity in the hydrology at any site. This results in incomplete definition and understanding of the hydrological regime and often necessarily requires modifications and amendments in the design and the parameters of the repository operations. Environmental monitoring programmes are also used to refine and, if necessary, amend the future monitoring of the site after operations have ended. Monitoring activities include the use of monitoring wells to measure the effects of any changes in the ground water due to the presence of Wastes at the site. To do so, the wells must be located at optimum locations and depths and this requires detailed knowledge of the volumes and directions of groundwater streaming.

The following activities should all form part-of the monitoring activities during the operational phase of a disposal facility:

- Measuring and recording the limits of exposure of operating personnel to specific pollutants;
- Monitoring and recording of effluents emanating from the site;
- Measurements of hydrogeological parameters, e.g., groundwater flow, permeability, etc.

In one technique, usually employed at the pre-operating stage, tracer substances are added to boreholes for measuring flow processes in ground and surface waters. Parameters such as flowpaths, flow velocities, mean residence times and the extent of the dispersion process are determined (Behrens et al., 1977). A method has been evolved for the measurement of these parameters using only one borehole and thus significant savings in costs, time and hydrological integrity (Ullrich, 1986; Hacker, 1986).

Although in such investigations the attention is clearly focused on the groundwater system in the host-rock, an assessment of the necessary supporting data on regional and local surface-water systems is also required. For example, the relationship between recharge from surface-water sources and regional groundwater flow must be determined.

The denudation history of the region must be examined to ensure that relevant relationships between the present and past surface and groundwater can be incorporated in the safety assessment of a particular site, particularly with a view to a potential for flooding. Measurements for tritium and deuterium levels in surface and underground waters are sometimes carried out to calculate the age relationships of various water bodies locally present (Hacker, 1986).

Where boreholes are put down, the locations and off-sets of the boreholes and wells used for monitoring and the frequency of sampling these must be compatible with the velocity and quantity of groundwater and surface-water flow and any water-soil interactions. The holes must be aligned with the present or potential paths of pollution plumes arising through the migration of leachates possibly carrying such wastes and their products. The monitoring pattern must be flexible and reviewed in the light of newly obtained data and modified accordingly.

Sampling and measurements from monitoring wells and boreholes will provide one level of assurance that a hazardous waste facility is not releasing contaminants. In order to guard against any less than optimum siting of monitoring stations, it is advisable to carry out ground-borne geophysical surveys, such as conductivity-induced polarization, gravity and electromagnetic surveys, to identify any changes in groundwater distribution and flow patterns (Cook, 1986). If a geophysical survey is carried out during the first stage of a site investigation, i.e. before drilling, the results can be used to aid in the siting of monitoring wells at optimum locations. If the geophysical survey is repeated at some later date when the waste facility has been operating for some time, the follow-up survey is used to monitor any possible changes in groundwater distribution. Additional wells can be put down to investigate and corroborate such changes. The complexity and cost of analyses of samples taken are also important considerations affecting the siting of monitoring points and sampling procedures. The types and frequencies of analyses required must be related to the specific conditions prevailing at any particular site, but must be reduced as much as possible because of costs.

Air sampling in the area of a facility may have to be carried out to test for any airborne contamination arising in the course of waste emplacement operations and may have to be repeated later to detect and analyse any gaseous release from the repository.

The results of the monitoring programmes are recorded on maps, sections and in graphical form. If any trends in values recorded become evident and in particular if any anomalies in the values are obtained, this should be investigated immediately and the appropriate remedial action taken.

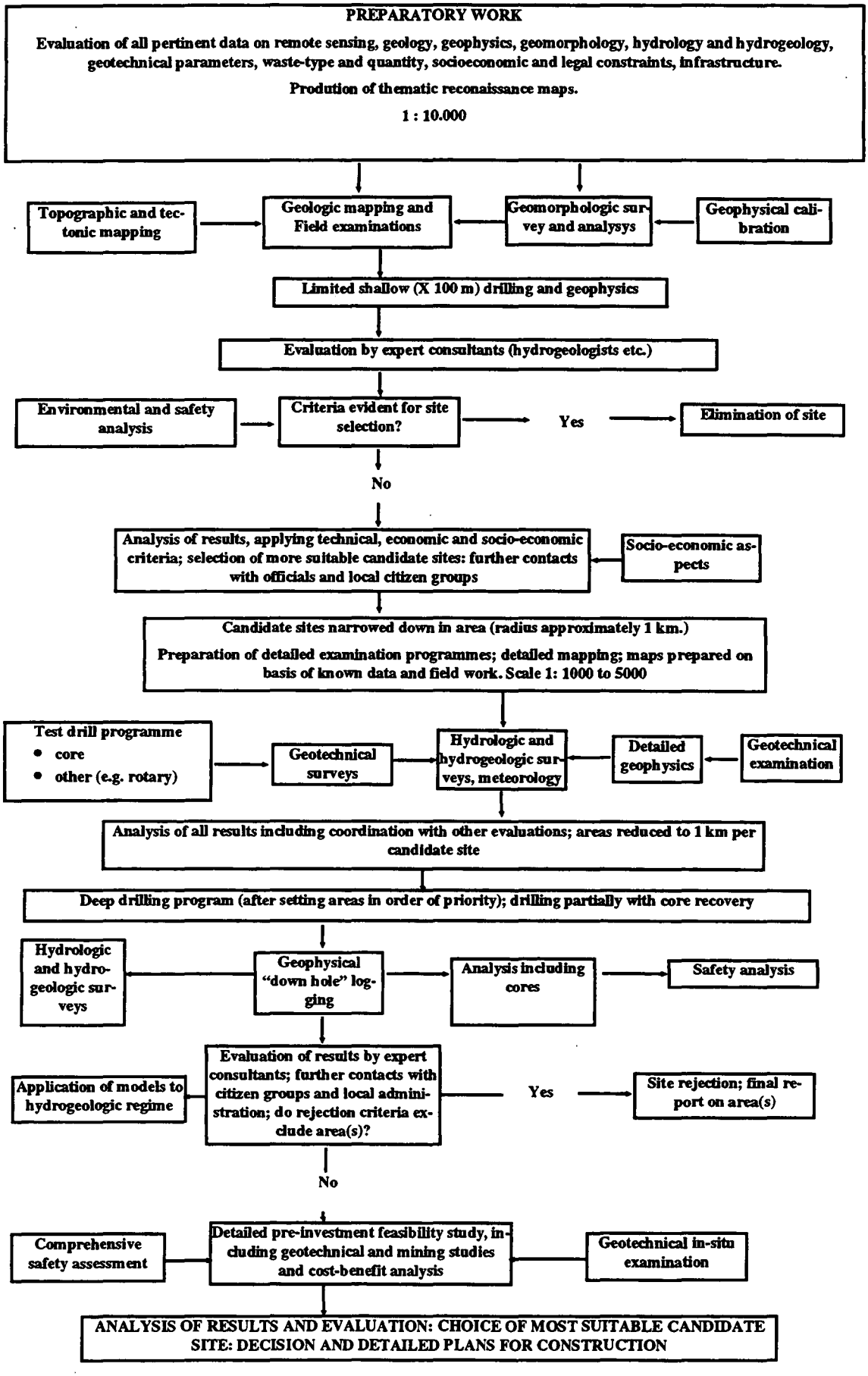
2. Post-operational monitoring

Once the repository has come to the end of its useful operational life, the impact of closure operations, including the emplacement of backfilling material, the sealing of access openings, cover and engineered barriers requires monitoring for leachate and groundwater quality. In addition, a postoperational monitoring programme requires setting up before the repository is sealed and closed.

By the end of the operating period, sufficient knowledge of the particular site (e.g., groundwater distribution and flow, geomorphology, tectonics, climatic conditions) should have been acquired to carry out post-operational surveillance effectively. At this stage monitoring sites should be emplaced at optimum locations.

A water-soluble substance transported with the groundwater in porous or fractured media will spread out both horizontally and vertically in time. This spreading, which takes place trans-

Figure X. Iterative site selection programme



- Topography;
- Climatology;
- Flooding potential;
- Waste—characteristics and volume;
- Natural resources;
- Satellite imagery interpretation;
- Sampling and selection for analysis;
- Tectonics (faults and fracture systems);
- Neotectonics (for example, active/inactive potential faults);
- Weathering processes;
- Geomorphology;
- Rock and soil mechanics;
- Nature and extent of formations underlying potential host formation;
- Erosion processes;
- Earthquake and micro-earthquake analyses and
- Availability of clay and other impervious liner-material (for landfills) and matrix materials (for contained wastes).

(e) **Environmental and social aspects**

- Protected areas;
- Planning provisions;
- Population density;
- Other utilization (industry, tourism);
- Cultural constraints and
- Risk-benefit analyses.

(f) **Ownership**

- Surface;
- Water and
- Minerals.

(g) **Investments: capital and operating**

- Site investigations and
- Interest.

A flow diagram, showing the sequence of the activities which may typically be required in a site selection programme is shown in figure X. The variables requiring evaluation, investigation and analyses are dependent on individual situations at each site. A cost-effective method of carrying out a selection process is to conduct it in a series of sequential stages; this procedure is described for example in a paper by Haji-Djafari et al. (1981). The method is to proceed from a broad, regional approach, eliminating or reducing in area candidate sites under consideration to select finally a site on the basis of having optimum characteristics. It is thus an iterative process. The primary controlling and limiting parameters must form part of the selection process from the very beginning. These will form the basis for decision-making. Failure to consider the limitations imposed by any of them could lead to costly changes later, either in the location and layout of a repository or even in the abandonment of the project.

The method is to proceed from the known to the unknown. During the first stage, much reliance is on known data and other information on candidate sites. Field work would be kept to a minimum. Where possible, any of the more expensive investigations, such as drilling, would be relegated to later stages, when some areas would have been eliminated and others reduced in size. Overlapping should be reduced as much as possible. A disposal site should provide a high degree of assurance that the reliable prediction of a sufficiently long-term safety performance can be achieved. This implies that the geological/hydrological system of the local area around the proposed site should be well understood and amenable to quantitative analysis (International Atomic Energy Agency IAEA, 1982).

Many of the modern waste repositories are designed on a multi-barrier principle. The more immediate barriers to the site are engineered barriers, i.e. containers, and container-matrix materials, fillers between containers, concrete walls and liners. These are known as near-field (engineered) barriers. In time, either through catastrophic events, such as earthquakes, or through gradual processes, such as erosion, flooding and chemical weathering, these barriers may fail. It is the function of the surrounding geological barriers to ultimately provide maximum isolation from the biosphere over the longer term. In the unforeseeable event of a catastrophic failure at some point in the future, pathways to the biosphere could be created, e.g., by rock fissures and faults, providing access to circulating waters. The properties of the containing rock should be to retain as much of the pollutants as possible by processes such as sorption.

Mechanisms for the possible transport of pollutants away from a disposal site are related to geological, tectonic, ecological and biological phenomena. Of the geological characteristics, it is the hydrogeological and geochemical properties which are the more important factors controlling the movement of pollutants, since water is the more likely natural medium for their off-site movement. Where these are less favourable than required, the engineered barriers are designed to supplement them.

Where the potential for reduction in the hazardous nature by interreaction between different wastes is inapplicable, the principle of mono-repositories, i.e. repositories containing only one type of hazardous waste, should be given priority; mono-repositories increase the possibility for re-use of the site as well as the predictability of anticipated chemical and physical reactions.

Isolation of waste can be limited in time if the waste decays or is converted in the course of time to harmless substances, i.e.:

- Organic compounds, which for example, could decay to CO_2 and H_2;
- The co-disposal of selected wastes leading to reactions which render these harmless, in which case the barriers should be designed so that there will be sufficient time for the reactions to occur without exposure to the biosphere.

1. Safety and monitoring requirements

Despite good management practices to reduce the quantities of wastes of all types produced, or to process and recycle part of the wastes will usually remain as residues and will require depositioning. As these residuals may only degrade very slowly, the long-term task of hazardous waste disposal is to prevent or inhibit possible migration into the biosphere, even beyond the time when control over the site is foreseeable. Apart from normal safety standards applicable to any construction programmes, additional safety requirements must be applied when dealing with wastes of toxic and hazardous nature. Existing and

posal has incorporated these and similar technological innovations and is referred to as the Regional Underground Monolith Disposal (RUMOD) system (Forsberg, 1984). Hazardous elemental wastes, which would be the principle wastes amenable to such treatment, would be processed into granular form, transported in bulk to a regional disposal site, mixed With special cement-based grouts and pumped as a wet waste-cement mixture into large underground caverns to 2,000 m below surface. The economic and engineering feasibility of this system is dependent on the following pre-conditions:

- Large, competent underground caverns (i.e. caverns which can be excavated) without failure of the roof, walls and the floor of the caverns);
- Bulk disposal of the waste-cement mixture (as a slurry) is feasible;
- Minimum handling and
- High volume throughput.

The major technologies required for the RUMOD system are in commercial use, but as far as it is known, they have not yet been combined for use in a waste disposal system

The question of whether such a system is economical would very much depend on finding a site with suitable geological and mining characteristics. Obviously, there must be secure isolation of the waste-cements from the environment and the host-rock must withstand folding and cutting without appreciable flow or internal shear.

The topic of waste isolation has been studied in projects concerned With intermediate and high-level radioactive waste disposal. Different types of geological formations have been investigated, including salt stocks, granites, plutons, shales and clays (U.S. Department of Energy, 1981). Such experience has included the disposal of liquid wastes, such as liquid radioactive wastes, as at the Oak Ridge National Laboratory in the United States, where a cement-based grout has been employed in a hydrofracture facility for the disposal of intermediate-level liquid wastes (U.S. Energy Research and Development Administration, Oak Ridge National Laboratory, 1977). The facility mixes these wastes with a cement-based, dry-solids blend and injects the mixture down a well into a shale bed 300 m below surface, penetrating along cleavage planes in the shale beds. On solidification, the wastes are permanently incorporated within a low leach-rate cement group sheet between water-impermeable shales.

To minimize construction costs, the opening-up of large caverns or galleries, of the order of 25 m width, 60 m height and several hundreds of meters in length must be feasible without resorting to expensive roof-support systems.

Evidently, the cost of disposal with this system is highly quantity-dependent and the economics of scale apply. To give some indication of the order of magnitude, it has been estimated that such a disposal site must process at least 100,000 tonnes of wastes annually to have acceptably low-disposal costs. It is also noteworthy that packaged wastes would have much higher costs because of higher transportation and underground handling costs and more difficult logistics due to the "bottleneck" of access passages such as shafts. Furthermore, it is found that it is not feasible to stack packaged wastes over heights of more than 10 m, because the weight of the packages would probably crush the container at the bottom of the pile and this would create difficulties for the operators and equipment in the stacking operation. As a footnote it should be added that Australian scientists have developed a similar waste-grouting system for radioactive wastes ("SYNROC").

In summary, the use of this cement-grouting technology in hazardous-waste management shows signs of promise and would have the following advantages:

- Liquid waste-cement mixtures can fill out underground caverns fully;
- The solidified strength of the concrete monoliths allows lower-cost underground layouts (closer spacing of caverns, as the cement provides support for the hanging wall);
- The physical nature of the solidified cement grout stops any egress to circulating groundwaters and hence any leaching of contaminants;
- Various types of wastes solidified by different processes may be compatible for deposition in the same facility.

Disadvantages include:

- Cooling will be required due to the heat generated during the curing-process of the cement;
- Adequate storage facilities will be required for the waste, cement and additives, with associated handling equipment and
- Uncertainty on costs of a full-scale operation.

C. Site selection procedures

The process of site selection is influenced by a series of technical as well as social, economic and logistical constraints. While the aspects requiring particular emphasis and importance in a programme depend on the characteristics of a particular site, a partial listing is shown below:

(a) **Geographical**

- Haulage routes and distances with reference to major waste-producing centres and
- Existing infrastructure, transportation facilities, requirements for servicing a waste-treatment and disposal facility.

(b) **Technical**

Types, nature and quantities of waste(s).

(c) **Costs**

- Ground preparation;
- Excavation;
- Barriers, sealing and matrix materials and
- Operational and post-operational monitoring-and maintenance.

(d) **Geoscientific and geotechnical**

- Hydrology;
- Hydrogeology and geology (extent and age of bedrock, aquifers and permeability, groundwater-streaming);
- Geochemistry;
- Seismology and seismicity;
- Morphological characteristics;

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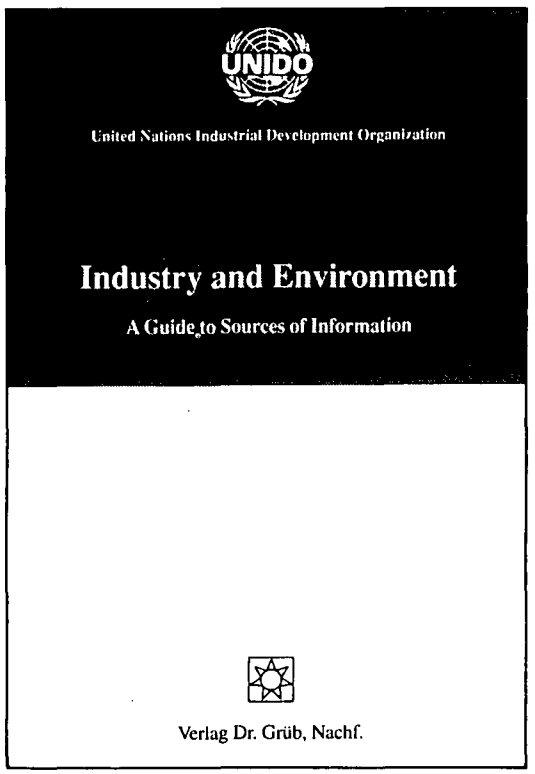

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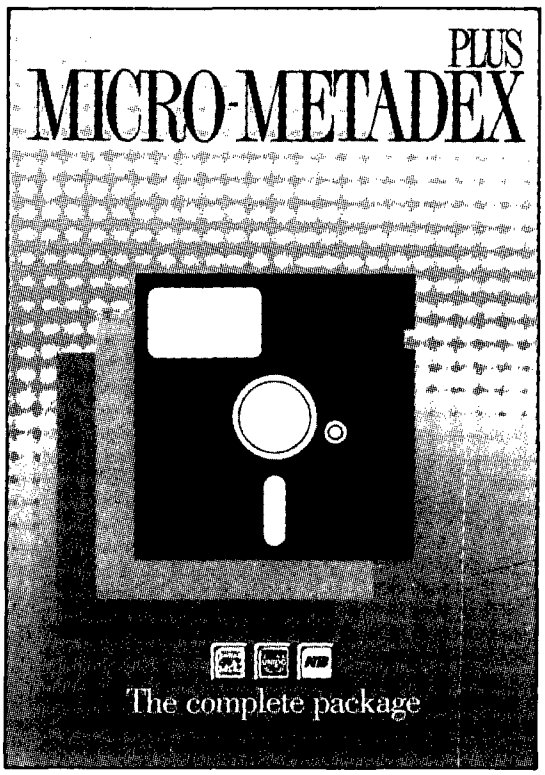

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