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EPA *Project Summary*

Emerging Technologies for the Control of Hazardous Wastes

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Investigations were conducted of new and emerging technologies for the disposal of hazardous wastes. These methods involve new technologies or a recent variation on an established one. In addition, a survey was made of potential users of hazardous waste information. The need for a data base for emerging hazardous waste technologies and/or a newsletter was evaluated. Information on the emerging technologies was acquired by computerized search, library searching, and personal contacts. The emerging technologies discussed include molten salt combustion, fluidized bed incineration, high energy electron treatment of trace organic compounds in aqueous solution, the catalyzed wet oxidation of toxic chemicals, dehalogenation of compounds by treatment with ultraviolet (UV) light and hydrogen, UV/ chlorinolysis of organics in aqueous solution, the catalytic hydrogenation-dechlorination of polychlorinated biphenyls (PCBs), and ultraviolet/ozone destruction. Theory, specific wastes treated, and economics are discussed.

The major technologies investigated in detail were molten salt combustion, fluidized bed incineration, and ultraviolet/ozone destruction.

Among the wastes treated by emerging technologies are PCBs, various Dioxins, pesticides and herbicides, chemical warfare agents, explosives and propellants, nitrobenzene, and hydrazine plus its derivatives.

This document encompasses a target audience ranging from laymen to natural scientists. The information presented here was derived solely for application to hazardous wastes. Readers requiring more specific information about theory and the economics of start-up plus operating and maintenance costs for technologies that may by applied to a specific hazardous waste not discussed in this report are referred to the literature cited in this report and to documents about state-of-the-art situations for a particular technology.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The material for the identification and evaluation of these technologies has

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been gathered through an intensive literature survey conducted over the course of a year. Although extensive use has been made of manual and computerized data bases, it was also necessary to monitor the recent literature and forthcoming conferences and symposia abstracts access material not yet in the literature. Personal communications were also used in the survey.

Major hazardous waste generators in the United States were surveyed for their hazardous waste information needs. Fifty-three of the 72 companies surveyed were identified by a Waste Disposal Site Survey Report from the House of Representatives Committee on Interstate and Foreign Commerce (Subcommittee on Oversight and Investigations) as the largest domestic generators of hazardous waste.

Conclusions

Molten salt combustion

Molten salt technology has existed for many years, but it has not been used for the disposal of hazardous wastes until recently. In the process, hazardous material is combusted at temperatures below its normal ignition point, either beneath or on the surface of a pool of molten salt. Individual alkali carbonate salts such as sodium carbonate, or mixtures of these salts, are usually used as the melt, but other salts can be employed based on the characteristics of the waste. Containers for the molten salts are made of ceramics, alumina, stainless steel, or iron. Ideally, during the molten salt process, organic substances are totally oxidized to carbon dioxide and water. Generally, the salt bath is stable, nonvolatile, nontoxic, and may be recycled for further use until the bath is no longer viable. The technology has progressed from bench-scale through the pilot plant stage to the construction of a demonstration-sized coal gasification unit. Portable units mounted on trucks have been tested.

Some of the advantages of molten salt combustion are as follows:

- Combustion is nearly complete.
- Non-polluting off-gases are generally emitted.
- Operating temperatures are lower than in normal incineration; thus, they are fuel efficient.
- The system is amenable to recycling generated heat.
- A wide variety of wastes can be combusted.
- Bulky wastes can be combusted after recycling.
- Many wastes can be combusted in compliance with EPA regulations.

Some of the problems of molten salt combustion are as follows:

- Particulate emissions from some wastes are high.
- The technology is not readily adaptable to aqueous wastes.
- Eventually waste salt and ash must be disposed of or the fluidity of the melt will be destroyed.
- A hazardous waste with greater than 20% ash cannot be combusted.
- Detailed economic information for a demonstration-sized system is not currently available for many wastes (1980).

Fluidized bed incineration

Fluidized bed systems have had many industrial uses since the technology was proposed by C.E. Robinson about a century ago, yet fluidized bed incineration of hazardous wastes is a relatively new technique. A hot fluidized bed is ideal for combustion. Air passage through the bed produces strong agitation of the bed particles, which promotes rapid and relatively uniform mixing of carbonaceous materials. The bed mass is large in relation to the injected waste, and bed temperatures, which usually range from 750°-1000°C, are usually uniform. Bed materials have included sand, sand mixtures, dolomite, and alumina.

Some advantages of fluidized bed incineration are as follows:

- The combustor design is simple and does not require moving

- parts after the initial feeding of fuel and waste.
- Fluidized bed incineration has a high combustion efficiency.
- Designs are more compact due to high volumetric rates.
- Comparatively low gas temperatures and excess air requirements minimize the formation of nitric oxide.
- In some cases, the bed itself neutralizes some of the hazardous products of combustion.
- A vertical induced draft incinerator was converted into a fluidized bed.
- The bed mass provides a large surface area for reaction.
- Temperatures throughout the bed are relatively uniform.
- Fluidized beds are able to process aqueous waste slurries.
- If the waste contains sufficient calorific value, the use of auxiliary fuel is unnecessary; moreover, the excess heat may be recycled in some cases.
- The bed can function as a heat sink; start-up after weekends may require little or no pre-heat time.

Disadvantages of fluidized bed combustion are as follows:

- Bed diameters and height are limited by design technology.
- Ash removal presents a potential problem.
- Systems requiring low temperatures may have carbon build-up in the bed due to increased residence time.
- Certain organic wastes will cause the bed to agglomerate
- Particulate emissions can be a major problem.

UV/ozone destruction

Ozone treatment is an established technology for the treatment of some hazardous wastes; the combination of UV light and ozonation recently has been found to be a more effective process for destroying hazardous waste than the use of ozonation alone. The addition of UV light to the ozonation process has greatly expanded the number of compounds that can be destroyed. PCBs are among the halogenated compounds destroyed. Compounds with shielded multi-bonded carbon atoms, sulfur compounds, and phosphorous compounds are less susceptible to UV/ozonation. Dioxins, nitrobenzene, and hydrazines have been destroyed by UV/ozonation.

Some advantages of UV/ozonation are as follows:

- Aqueous or gaseous waste streams can be treated.
- Capitol and operating costs are not excessive.
- Chemical carcinogens and mutagens can be treated.
- The system is readily adaptable to on-site treatment of the hazardous waste.
- It can be used as a final treatment to supplement partial treatment systems.
- It can be used as a preliminary treatment for certain hazardous wastes.
- It can be used to meet effluent discharge standards.
- Modern systems are usually automated, thereby reducing labor requirements.

Some disadvantages of UV/ozonation are as follows:

- Ozone is a non-selective oxidant; therefore, the waste stream should contain primarily the waste of interest.
- UV/ozone systems are generally restricted to 1% or lower levels of hazardous compounds. Frequently, hazardous substances are treated at ppm levels.
- Ozone decreases rapidly with increasing temperature; therefore excess heat must be rapidly removed.

Results of hazardous waste information survey.

Fifty-three major hazardous waste generators were surveyed for their hazardous waste information needs. Major information needs are:

- new technologies for hazardous waste disposal,
- state-of-the-art methods for hazardous waste disposal,
- best technologies available for destruction of specific wastes plus costs,
- updated federal and state regulations for waste generation, transportation, storage, and destruction of landfills,
- techniques to identify mixed waste streams,
- toxicity data on specific hazardous wastes,
- location of approved hazardous waste disposal sites and technology available at the site; identity of hauling contractors,
- waste exchange and recycling information.

Recommendations

The emerging technologies evaluated in this study can be considered as alternatives to landfill disposal of hazardous waste. It is presumed that the emerging technologies will destroy the waste or at least attenuate it to acceptable levels. The advantages and disadvantages of each emerging technology presented must be carefully considered when selecting the technology most suitable for the control of specific hazardous wastes is selected.

The information needs for major hazardous waste generators could best be met by the use of a hazardous waste data base supplemented by newsletters and telephone "hotlines."

Hazardous wastes destroyed by emerging technologies

A. Molten salt combustion:

Miscellaneous

PCB's
Chloroform
Perchloroethylene distillation bottoms
Trichloroethane
Tributyl Phosphate
Nitroethane
Monoethanolamine
Diphenylamine HCl
Rubber tire buffings
Para-Arsanilic Acid
Contaminated ion exchange resins (Dowex and Powdex)
High-Sulfur Waste Refinery Sludge
Acrylics Residue
Tannery wastes
Aluminum Chlorohydrate

Pesticides and herbicides

Chlordane
Weed B Gone
DDT powder
Malathion
Sevin
DDT powder with Malathion
2, 4-D Herbicide-Tar Mixed waste

Real and simulated pesticide containers

plastic, rubber, and a blend of these

Feasible pesticides and nitrile herbicides

Pesticides	Nitrile Herbicides
dieldrin	trifluralin
heptachlor	2, 4, 5-T dichlorobinil
aldrin	MCPA
toluidine	

B. *Fluidized bed incineration:*

Miscellaneous

HCl spent pickling liquor

Organotin in spent steel slag blasting abrasive

Organic dye slurries

red dye slurry (1-methylaminoanthraquinone and starch gum)

yellow dye slurry (dibenzpyrenequinone and benzanthrone)

Chlorinated hydrocarbons

PVC waste from a chemical plant

PVC mixed with coal

PVC insulation over copper wire

Chlorinated hydrocarbon waste with 90% chlorine

Munitions (slurry)

TNT

RDX (cyclotrimethylenetrinitramine)

Composition B

C. *UV/ozonation technology:*

Miscellaneous

PCB's

TCDD (2, 3, 7, 8-tetrachlorodibenzo-p-dioxin)

OCDD (octachlorodibenzo-p-dioxin)

Chlorodioxins (other dioxins are feasible)

Hydrazine

Monomethyl hydrazine

Dimethyl hydrazine (asymmetrical)

Copper process waste stream

Nitrobenzene

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The complete report, entitled "Emerging Technologies for the Control of Hazardous Wastes," (Order No. PB 82-236 993; Cost: $15.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
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