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Project Summary

Study of Codisposed Municipal and Treated/Untreated Industrial Wastes

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A study was undertaken to determine the long-term effects of codisposal of industrial waste (IW) and municipal solid wastes (MSW) under controlled, simulated landfill conditions. Three IW's (treated or untreated by solidification) were disposed with MSW in nine specially designed test cells at an approximate volume ratio of 1:4. The sealed test cells were leached with distilled water at a rate of 1.27 cm per week. Leachate was collected anaerobically and analyzed for 28 parameters monthly or quarterly over a 4-year period. The three IW's were an electroplating waste (EPW), a chlorine production brine (CPB), and a glass-electronics etching sludge (GES). Two processes were used for solidification of the wastes: one added cement plus a patented ingredient to waste, and the other mixed waste with lime and flyash.

In all cases, the codisposal of treated or untreated IW and MSW had significant effects on the nature of the leachate produced. All IW's increased the pH of the leachates from about 5.3 to 6.3, which alone could affect component solubilities and biological activities of the MSW. The GES inhibited biological activity in the MSW to the greatest extent, and the EPW inhibited it less. The CPB had little or no effect on the MSW biological activity. Both pretreatment systems greatly decreased the apparent effects of IW on the biological activity in the MSW.

Heavy metals in the untreated and treated IW's generally did not appear in the MSW leachates in appreciable amounts. However, heavy metal concentrations were generally increasing in the leachates during the last year of the study.

IW's containing soluble salts (CPB, for example) are not good candidates for disposal with MSW, even after pretreatment. Levels of salts from CPB test cells were high and consistent over the entire study period, even when the CPB was pretreated.

Interaction of leachates with a 31-cm layer of soil at the bottom of the test cells produced only minor modifications in leachate quality. However, interaction of soil and leachate can increase rather than reduce the pollution potential of the leachate.

This Project Summary was developed by EPA's Hazardous Waste Engineering 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

Disposal of industrial wastes (IW's) has become increasingly expensive and difficult because of heightened public awareness and regulatory restrictions. In the past, nearly all types of wastes were indiscriminantly disposed of at local dump sites. Increasing interest and progress in landfilling technology quickly followed U.S. Environmental Protection Agency (EPA) bans on burning at dumpsites. Landfilling is now the recommended and nearly universal method of disposal for municipal solid wastes (MSW), and IW's have been delegated to secure landfills or incineration.

Though disposing of hazardous IW along with MSW in dumps and landfills was a common U.S. practice until a few years ago, little information is available in this country on the environmental effects of this practice. Codisposal with MSW is the recommended practice for many hazardous wastes in Great Britain, where researchers claim that the scientifically determined disposal of hazardous wastes with MSW can be an acceptable and even preferred management alternative for many toxic substances.

This study addresses the effects of IW and MSW codisposal in a simulated MSW landfill environment. Eleven large (181-cm-diameter) test cells were filled with MSW only or with MSW plus one of three IW's—an electroplating waste (EPW), a chlorine production brine (CPB), and a glass-electronics etching sludge (GES). Two additional smaller cells were also filled with MSW only. All wastes were collected from actual industrial waste streams.

A secondary goal of the study was to investigate the possible use of chemical solidification/stabilization of the IW to reduce contaminant loss in the codisposed wastes. Two commercially available methods were used for this process.

This report describes the overall results of the leaching data from all three IW's, treated and untreated, for leachate samples collected above and below a 31-cm soil layer over the complete four-year (1510-day) study period.

Materials and Methods

The three IW's, treated or untreated, were codisposed with MSW in nine large (9.65 m^3 total volume), especially designed test cells. MSW and treated or untreated IW were loaded in the test cells in a ratio of approximately 4.1 by volume. The sealed test cells were leached with distilled water at a rate of 1.27 cm per week. The leachate was collected anaerobically and analyzed for 28 parameters monthly or quarterly over the four-year study period.

Four test cells loaded with MSW only were also included in the study as controls. Of these cells, two were smaller and had half the height and diameter (i.e., 1/8th the volume) of the large cells.

Selected Wastes

The three IW's included in this study (EPW, CPB, and GES) are largely inorganic, have high levels of toxic heavy metals and/or soluble inorganic salts, and are produced in large quantities in the United States. They are considered to be some of the most difficult to contain and are at the root of many environmental problems.

The MSW used in this study was provided by the Sanitation Department of the City of Vicksburg, Mississippi, and by two private haulers operating in Warren County, Mississippi. Residential collection routes were selected to exclude any commercial, industrial, or hospital wastes.

Test Cell Design

The test cells were designed to simulate a 1.83-m-diameter core through a typical landfill in which IW and MSW might be codisposed. The cells were designed so that deionzied leaching water of known composition and pH could be added in premeasured amounts through the top of the otherwise sealed cells and the resulting leachates could be sampled above and below a 31-cm soil layer. The test cells were free-standing, rolled steel cylinders housed in a large-scale facility that maintained a temperature of 25 ± 3°C year-around. All interior cell surfaces were coated with an acid-base resistant coal tar epoxy to protect the walls from corrosion or leaching. As mentioned, 11 of the units were large (1.83 m internal diameter by 3.66 m high), and two were small (0.91 m inside diameter by 1.93 m high). The small cells were filled with MSW only and were used to evaluate the effects of test cell size on leachate quality. All cells contained polyethylene beads in the leachate storage space on the bottom to provide support of the soil layer and pore space storage for leachate.

Test Cell Loading

Two large and two small cells were loaded with MSW only. The remaining nine cells were loaded with two layers of treated or untreated IW interspersed between three layers of MSW. The MSW was placed in 30.5-cm lifts that were compacted to 400 to 415 kg/m^3 wet density with a 2315-kg lead weight. Each layer of chemically treated IW was made up of four cylindrical, 61-cm-diameter cores of solidified/stabilized waste product. MSW was also packed around the treated IW cores and compacted to approximately the same wet density by use of a hand-held tamper. This loading yields an MSW-to-IW volume ratio of approximately 4 to 1, which is in the range recommended for codisposal.

Leachate Collection and Processing

Leachate samples were handled with care to preserve their anaerobic nature during sampling and before preservation. Quarterly leachate samples were drawn by suction from the test cells through Tygon* tubing into a 500-ml stoppered glass aspirator bottle mounted on the glovebox. Leachate was then forced inside the glovebox with He pressure. The glovebox had previously been purged with He for at least 5 minutes. The smaller monthly samples were prepared within the glovebox without contacting atmospheric air. They could be subsampled and preserved quickly enough to make the He atmosphere unnecessary. Parameters measured included the following:*

Specific conductance	B
Alkalinity	Be
Cl	Cd
TKN	Cr
TP	Cu
TOC	Hg
Ca	Ni
Fe	PB
K	Se
Mg	Zn
Mn	BOD_5
Na	COD
Al	TVA
As	pH
	F

*TKN = Total Kjeldahl Nitrogen; TP = Total Phosphate; TOC = Total Organic Compound; BOD_5 = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; TVA = Total Volatile Acids.

Conclusions

Leachates from Cells Containing MSW Only

Leachates from the test cells containing only MSW were typical of those re-

*Mention of tradenames or commercial products does not imply endorsement or recommendation for use.

ported in the literature. Initial leachates have very high organic loadings, slightly acidic pH (around 5.3), and significant ionic loadings. Early samples exceeded drinking water standards for all constituents with an established standard except Cu. Throughout the study, Fe and Mn concentrations averaged 1000 and 100 times the drinking water standard, respectively. As, Cr, Se, Zn, and Cl also exceeded these standards in their average concentrations in the leachate.

Levels of constituents varied greatly in the leachates from the four cells containing MSW only. This variability set the lower limit for detecting the effects of adding IW's to the MSW.

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The two small control cells, containing only 1/8 the volume of the larger ones, received twice the volume of leachate per kg of dry MSW. Comparison of these results with those of the larger control cells indicated that the loss of many metals and the oxygen demand were proportional to the amount of leachate produced and largely independent of the amount of waste or its configuration. However, losses of the highly soluble constituents such as Na and Cl were more nearly proportional to the amount of MSW loaded into the test cell than to the volume of the leachate produced.

Leachates from Cells Containing Codisposed IW and MSW

In all cases, the codisposal of treated or untreated IW with MSW had significant effects on the character of the leachates produced.

Organic Parameters

Untreated IW's Disposed with MSW

Inclusion of any of the untreated IW's increased leachate pH from about 5.3 to about 6.3, which alone would be expected to affect component solubilities and biological activities. The GES appeared to inhibit MSW biological activity to the greatest extent. Cells containing untreated GES had leachates with lower COD and BOD (both averaged only 28% of the values for MSW-only leachates), lower TOC (29% of MSW-only values), and lower TVA (34% of MSW-only values). The untreated EPW had a smaller inhibitory effect, on these parameters, averaging 50% to 75% of their values in the MSW-only leachates. The untreated CPB had little or no effect on these parameters; however, it did produce a small pH change. The inhibition appears to be the result of minor components such as toxic metals rather than high soluble salt levels or high pH.

Treated IW's Disposed with MSW

Test cells containing solidified IW's and MSW produced leachates with pH values and organic parameters similar to the MSW-only leachates. Thus, both processes appeared to overcome the inhibitory effects of the IW's on the microbiological processes in the MSW.

Heavy Metals

Heavy metals in the IW's were not readily leached out of the test cells. The EPW, for example, contained the highest levels of the heavy metals—6% Cr, 10% Cu, and 0.3% Ni. This untreated waste produced leachates with significantly increased levels of these metals, but the increases were very small compared with the total metals added to the cells. Test cells with MSW and treated EPW did produce significantly higher leachate levels of Ni but not of Cr or Cu. Test cells with MSW plus treated or untreated CPB or GES produced leachates without significantly higher or lower metal levels, since neither waste contained appreciable amounts of heavy metals.

The codisposal of MSW and IW's containing high levels of heavy metals in hydroxide sludges may be an environmentally acceptable option since the added metals were not found in large quantities in the MSW-IW leachates. Note, however, that the metal levels in these leachates were slowly increasing in the last year of the study, and their levels could increase appreciably over time. Also, the added IW appears to inhibit or modify the microbial activity in the MSW mass; thus long-term results cannot be predicted without knowledge of how metal ions affect MSW microbial stabilization.

Soluble Salts

Soluble salts in the IW's were immediately apparent in the leachates from those test cells. The cell containing MSW plus untreated CPB produced leachates with extremely high Na and Cl concentrations, even after four years. Solidification of the CPB did reduce the initial concentrations, but their losses were still high and consistent throughout the study. Na and Cl were also found at consistently higher levels in leachates from test cells containing both treated and untreated EPW and GES, but these concentrations were only two to three times those of MSW-only leachates. The codisposal of MSW and IW's with high levels of soluble salts, therefore, appears to be environmentally unsafe because of the rapid and large losses of salts to leaching waters even after pretreatment with solidification.

Calcium and Magnesium

The divalent cations Ca and Mg were prevalent in all leachates, including the controls. The presence of treated or untreated IW increased their concentrations by 100% to 200%. Ca was a major component in all the IW's and was found near its solubility limit in all IW leachates.

Iron

Fe levels in the leachates are probably indicators of the overall microbial activity in the waste mass. Addition of any of the untreated IW's to MSW consistently lowered the Fe concentration in the leachates produced, most likely because of inhibition of the microbial activity in the test cells.

Interaction of Leachates with the Soil Layer

Interaction of leachates from test cells with a 31-cm layer of a clayey-sandy soil produced only minor modifications in leachate quality. Most constituents were not affected by passage through this layer, but As and TP were significantly removed. Al, Cd, and Hg were added to the leachates from the soil in significant amounts. The interaction of MSW leachates with underlying soils requires more study. Apparently, the soil cannot simply be considered as an absorber of materials from the passing leachate. Leachates can interact with the soil and remove selected soil constituents, thereby increasing rather than reducing the overall pollution potential of the leachate.

The full report was submitted in fulfillment of Interagency Agreement No. D4-0569 by the U.S. Army Waterways Experiment Station under the sponsorship of the U.S. Environmental Protection Agency.

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The complete report, entitled "Study of Codisposed Municipal and Treated/ Untreated Industrial Wastes," (Order No. PB 85-235 588/AS; Cost: $20.50, subject to change) will be available only from:
National Technical Information Service
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