



Project Summary

Evaluation of the RCRA Extraction Procedure: Lysimeter Studies with Municipal/Industrial Wastes

A study was initiated to determine the accuracy with which the U.S. Environmental Protection Agency (EPA) extraction procedure (EP) simulates the leaching of an industrial waste when codisposed with municipal refuse in a nonsecure landfill. The EP is used in the regulations promulgated under the Resource Conservation and Recovery Act.

Simulated codisposal of industrial and municipal waste was initiated October 28, 1980. Cylindrical test cells 0.91 x 1.8 m were designed to simulate sanitary landfill environments. The five types of industrial wastes tested were oil reclaiming clay, petroleum refinery incinerator ash, paint manufacturing sludge, solvent refining sludge, and tannery waste. Fifteen test cells were loaded to provide triplicate samples of each industrial waste leachate. Each week, all cells received an 8.4-liter addition of deionized water, the equivalent of 1.27 cm of infiltrated rainfall. Leachate samples were collected from beneath the municipal waste and the municipal/industrial wastes each month. Seven inorganic parameters were measured during five sample periods for leachate collected below both wastes.

The metal concentration from the leachate collected below the municipal/industrial waste was compared with that produced in the EP extract. When the EP extract concentration of a specific metal exceeded the concentration criteria (100 times the National Interim Primary Drinking Water Standards), the test cells also showed a concentration that exceeded the criteria.

But EP concentrations were generally lower than those for the same wastes in the test cells, and very little quantitative relation was shown between the EP and the test cell results.

This Project Summary was developed by EPA's Municipal 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

Under the Resource Conservation and Recovery Act of 1976 (RCRA), the U.S. Environmental Protection Agency (EPA) was charged with promulgating regulations identifying hazardous waste characteristics and listing particular hazardous wastes. To determine whether a waste is hazardous, two mechanisms may be used: (1) identification by source or chemical name as a waste that is hazardous in all waste management scenarios (usually those wastes historically associated with hazard), and (2) description of properties that could result in harm to either human health or the environment. Such properties include the following:

1. Ignitability
2. Corrosivity
3. Reactivity
4. Toxicity of extraction procedure extract
5. Radioactivity
6. Infectiousness
7. Phytotoxicity
8. Teratogenicity and mutagenicity

To date, EPA has mainly relied on the first four characteristics because no validated test protocols exist for the others and because many radioactive wastes are separately regulated.

This study deals with the characteristic of EP extract toxicity. The characteristic was developed by EPA to identify those wastes that pose a threat to groundwater if placed in an unsecure landfill, especially those admixed with municipal solid waste. The EP measures the potential of waste constituents for migrating out of a landfill and contaminating the groundwater under poor management conditions. The procedure was designed to simulate the leaching action of the acidic leachate generated in municipal landfills. As published in the regulations, the EP involves the dilute acetic acid extraction of a waste sample at a specified pH and with constant agitation over a 24-hr period. The mixture is then filtered, and the resulting extract is analyzed. Currently, the extract is analyzed for eight heavy metals (Ag, As, Ba, Cd, Cr, Se, Hg, and Pb) and six organic compounds included on the list of National Interim Primary Drinking Water Standards (NIPDWS). Wastes generating an EP extract containing more than 100 times the limits established for the NIPDWS are hazardous. The factor of 100 provides for dilution and attenuation of the contaminants as they migrate to the point of water use.

Though EPA has expended considerable effort in developing and selecting the EP, no consensus exists as to its validity. Concern has been voiced that it does not address some significant factors in leachate generation, including redox potential, buffer capacity, complexation capacity, ionic strength, surface area, and contact time. The primary objective of this study was to determine how accurately the EP mimics landfill leaching of industrial waste. This objective was to be achieved by comparing potentially toxic constituents in the EP extract from the industrial wastes with those in the test cell leachates after contact with the industrial wastes. This comparison of the EP extract should duplicate the highest concentrations in the leachates from the test cells.

A secondary objective of this study was to obtain data on the landfill leachability of selected organic compounds in some of the industrial wastes. This objective was to be achieved by selectively analyzing various leachate samples collected before and after contact with the industrial wastes. The goal was to develop a test that better simulates the natural leaching of

potentially toxic organics in a landfill environment.

Methods and Procedures

Simulated codisposal of industrial and municipal waste began on October 28, 1980. Cylindrical test cells 0.91 x 1.8 m were designed to simulate sanitary landfill environments. The five representative industrial wastes selected for study were oil reclaiming clay, petroleum refinery incinerator ash, paint manufacturing sludge, solvent refining sludge, and tannery waste.

Industrial Wastes

All industrial wastes were acquired from a commercial waste disposal facility. A 208-liter drum of each of the five wastes was obtained, and bulk analyses were performed on the contents in duplicate to establish baseline data. Samples of the industrial wastes were subjected to the EP as described in the *Code of Federal Regulations* (40 CFR, Part 261, Appendix II). All EP tests were conducted in triplicate.

Municipal Wastes

Municipal wastes were gathered from waste collection routes in Vicksburg, Mississippi. Routes were screened to include only those containing residences and small businesses exclusively. Some 8.5 metric tons of waste were collected from the curbside and delivered to the laboratory within 2 hours.

Test Cells

Test cells were designed to contain industrial and municipal wastes in a simulated landfill situation. Five percent industrial waste (by weight) and 95 percent municipal waste were used in the test cells to simulate actual emplacement ratios and codisposal operations. The industrial wastes were placed so that they were in direct contact with the overlying municipal waste. The municipal waste was compacted to a density of about 475 kg/m³. Leachate samples were collected from both above and below the industrial waste layer. The sample collected above was representative of the leachate generated in the municipal wastes, and the sample collected below was representative of the municipal waste leachate after it had been in contact with the industrial waste.

Fifteen cylindrical test cells (0.91 x 1.8 m) were loaded to provide triplicate samples of each industrial waste leachate. A cross section of a completed test cell appears in Figure 1. As soon as all test

cells were loaded, each received 8.4 liters of deionized water (the equivalent of 1.27 cm of infiltrated rainfall). Thereafter, each cell received 8.4 liters of deionized water every 7th day until completion of the study. Field saturation of all test cells was reached after 137 days. An additional 54 days elapsed before enough leachate accumulated in the municipal waste leachate collectors for analysis.

Leachate samples for analysis were collected from the test cells during five sampling periods from May 6 to October 21, 1981.

Analytical Techniques

Methods of analysis and lowest reporting concentrations for parameters reported are summarized in Table 1. The same methods of analysis were used for the bulk analysis, EP extracts, and leachates. A quality assurance program was established to ensure the reliability and comparability of the analytical data. National Bureau of Standards and EPA standard reference samples were used to verify all analytical techniques.

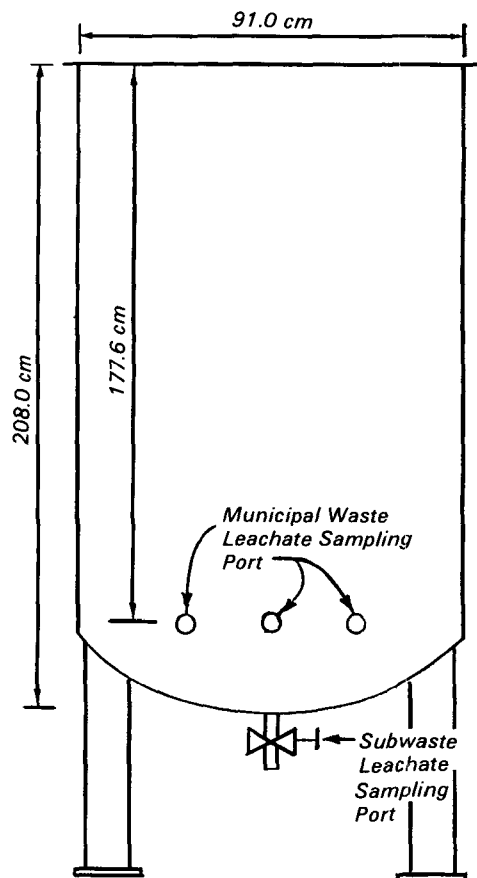


Figure 1. Exterior view of test cell showing positions of leachate sample collection ports.

Table 1. Methods of Analysis

Parameter	Procedures and/or Instrumentation	Lowest Reporting Concentration in Aqueous Solution (ppm)
As	Determined with a Perkin-Elmer* Atomic Absorption Unit with Hydride System	0.01
Ba	Determined with a Spectrametrics Argon Plasma Emission Spectrophotometer Model II	0.01
Cd	Determined with a Perkin-Elmer Heated Graphite Atomizer Atomic Absorption Unit	0.0001
Cr	Determined with a Perkin-Elmer Heated Graphite Atomizer Atomic Absorption Unit	0.001
Hg	Determined by standard cold vapor technique on Perkin-Elmer Atomic Absorption Unit	0.0002
Pb	Determined with a Perkin-Elmer Heated Graphite Atomizer Atomic Absorption Unit	0.001
pH	Electrometric	—
Toluene	Determined using purge and trap (Tenax) method and a HP gas chromatograph	0.1
Xylene	Determined using purge and trap (Tenax) method and a HP gas chromatograph	0.1
Cresols	Determined using Base Neutral Acidic Extraction procedure and a HP gas chromatograph	0.1

* Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

EPA procedures for priority pollutants, Federal Register, 3 Dec., 1979.

Results and Conclusions

This study highlighted several problems involved in the performance and interpretation of the EP testing. Industrial wastes containing significant amounts of oil or other immiscible components may not mix completely and may thus prevent intimate contact between the waste solids and the EP leaching solution. This lack of contact could limit the transfer of contaminants from the solids to the leaching solution. This problem was evident for the paint manufacturing sludge.

The metal concentrations in the EP extracts of the wastes studied were generally low. In fact, many concentrations were below the detection limit of the analytical methods used. Only two wastes had metal concentrations in the EP extracts above the maximum allowable concentrations and thus displayed EP extract toxicity—the petroleum refining incinerator ash and the paint manufacturing sludge.

Concentrations of As, Hg, and Se in test cell leachates were generally below detection limits. Other metal concentrations varied, depending on the industrial waste contained in the test cells. Metals found at significant levels in the industrial waste leachates tended to decrease in concentration over the sampling periods.

Only four of the five industrial wastes yielded test cell leachates with metal

concentrations above 10 percent of the EP extract toxicity threshold: The solvent refining sludge leached no metals at this level, the paint manufacturing sludge leached Cd, Cr, Hg, and Pb, the oil reclaiming clay leached Cr and Pb, and the petroleum refining incinerator ash and the tannery sludge leached Cr.

Only two wastes had metal concentrations in the test cell leachates above the EP thresholds—the petroleum refining incinerator ash (with an average Cr concentration of 136 mg/l) and the paint manufacturing sludge (with an average lead concentration of 604 mg/l).

When metal levels in the industrial waste test cell leachates were higher than 10 percent of the EP thresholds, they were generally much higher than those in the EP extracts (65 to 2000 times higher). The only exceptions were the Cr levels associated with tannery sludge and with petroleum refining incinerator ash, in which the respective concentrations were more nearly comparable.

Metals found at levels above the EP thresholds in test cell leachates (Cr from the petroleum refining incinerator ash and Pb from the paint manufacturing sludge) were also above the thresholds in the EP extracts. The EP thus made a correct qualitative prediction of the two industrial wastes in this study that would present a potential hazard by releasing metal contaminants at concentrations greater than 100 times the primary drinking waste standards.

Limited organic analyses for toluene, xylene, and cresol in the municipal and industrial waste leachates showed that their concentrations were very similar in the leachates collected both before and after contact with the industrial wastes. Evidently the toluene, xylene, and cresol (which were absent in the municipal solid waste) migrated by diffusion as vapor from the industrial waste into the overlying municipal waste and were absorbed by the leachate. As a result, no net contribution of these organic contaminants from the industrial wastes could be quantified. But the organics concentrations in the leachates from three of the industrial wastes were sufficiently high to pose a potential environmental hazard should they migrate into groundwater at a disposal site.

During the study, the municipal waste leachate samplers in the test cells did not collect enough leachate for analysis. This problem appears to have been caused by plugging of the samplers with partially deteriorated epoxy paint and biological growth and by diversion of the leachate flow with large pieces of refuse (primarily paper) above and around the sampler.

Though the EP made a correct qualitative prediction of the two industrial wastes studied that released metals at levels exceeding the EP criteria, the EP in general grossly underestimated the highest concentrations found in the industrial waste test cell leachates. Very little quantitative relation exists between the EP and test cell results.

Recommendations

Correlations between EP and test cell results should be expanded to include industrial wastes other than the five tested so that a broader data base can be developed.

Because of the problems encountered in collecting municipal waste leachate, the test cells should be modified if they are to be used in further studies. Changes should include replacing the perforated metal plates in the samplers to eliminate the need for the epoxy paint and shredding of the municipal waste to eliminate large pieces of refuse that could divert leachate flow. More extensive changes would be needed to eliminate the problems associated with migration of volatile organic contaminants.

The full report was submitted in fulfillment of Interagency Agreement IAG-AD-F-1-347 by U.S. Army Engineer Waterways Experiment Station under the sponsorship of the U.S. Environmental Protection Agency.

This Project Summary was prepared by staff of the U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180.

Robert E. Landreth is the EPA Project Officer (see below).

The complete report, entitled "Evaluation of the RCRA Extraction Procedure - Lysimeter Studies with Municipal/Industrial Wastes," (Order No. PB 84-143 114; Cost: \$8.50, subject to change) will be available only from:

*National Technical Information Service
5285 Port Royal Road
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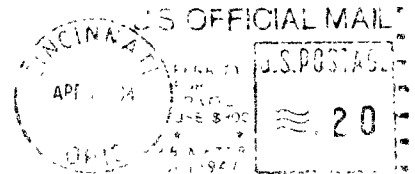
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