

LEACHATE TESTS FOR SOLIDIFIED HAZARDOUS WASTES

Leslie J. Blythe and Elio F. Arniella

AUTHORS: Leslie J. Blythe, President, B & G Environmental, 575 Franklin Road, Atlanta, GA 30342.

Elio F. Arniella, President, Envirosoft, P.O. Box 862188, Marietta, GA 30062-0001.

REFERENCE: *Proceedings of the 1991 Georgia Water Resources Conference*, held March 19 and 20, 1991, at The University of Georgia. Kathryn J. Hatcher, Editor, Institute of Natural Resources, The University of Georgia, Athens, Georgia, 1991.

ABSTRACT

Different criteria have been used to evaluate the effectiveness of solidified hazardous wastes. From a regulatory compliance perspective, leachate testing has been most frequently required to determine the adequacy of site cleanup and potential groundwater protection. Since no one leachate test has been consistently used or universally accepted, the major leachate tests and their corresponding applications are reviewed. Ranges for key variables of these tests are presented. Then different models for evaluating effectiveness are examined. Conclusions regarding ideal leachate testing are drawn.

AN OVERVIEW OF SOLIDIFICATION

Solidification typically denotes contaminant entrapment within a solid matrix of high structural integrity (a monolith). Stabilization, on the other hand, refers to contaminant entrapment through chemical reaction. Fixation is a term which includes both solidification and stabilization. Solidification/stabilization (S/S) is a treatment technology which applies to soils, sediments, sludges, and in some cases liquids. The primary objective of S/S is to decrease the exposed contaminant surface area, thereby decreasing solubility and leachate generation. By using absorbents, materials handling characteristics, such as free liquids removal from sludges, may be improved. Various S/S agents exist, but cement-based and pozzolan-based (i.e., lime, fly ash, and kiln dust) are by far the most commonly used in hazardous waste applications.

LEACHATE TESTS

Laboratory leachate tests are best used to compare the effectiveness of S/S processes as opposed to duplicating field conditions. The tests are standardized and therefore will have some limitations for a given site. In general, rapid leaching will result in low contaminant concentrations in leachate. Tests of this type replace leaching solution to obtain kinetic information and represent non-equilibrium

conditions. On the other hand, slow leaching results in maximum contaminant concentrations in leachate. In this case leaching solution is not replenished and equilibrium (i.e., static) conditions are simulated.

Two categories of leachate tests exist, batch and column. Batch tests may be conducted using a pulverized sample and agitation or a monolith and no agitation; the former usually gives maximum contaminant concentrations and does not incorporate replacement of leaching solution while the latter is often used to obtain rate data. Column tests are designed for a pulverized sample and specified leaching rate; they are more representative of actual field conditions but are not often used given data reproducibility problems and longer required test periods.

The major leachate tests summarized in Table 1 are all of the batch type.

Table 1. Summary of the Major Leachate Tests

Extraction Procedure Toxicity (EP TOX)
Toxicity Characteristic Leaching Procedure (TCLP)
Multiple Extraction Procedure (MEP)
California Waste Extraction Test (CAL WET)
American Society of Testing Materials (ASTM) A
American Nuclear Society (ANS) 16.1
MCC-1 Static Leach Test

Other tests have also been developed but have had fewer applications. A brief review of these major leachate tests follows.

The first four tests listed all use pulverized samples. EP TOX has traditionally been used by the Environmental Protection Agency (EPA) to characterize hazardous wastes. This test was intended to simulate landfill leaching and has been used to predict maximum contaminant concentrations. TCLP is now replacing EP TOX in many applications and has been used by EPA as the basis for promulgating some best demonstrated available technology (BDAT) treatment standards. Maximum concentrations in leachate have been

specified for selected hazardous constituents. Like the EP TOX test, TCLP also simulates maximum contaminant concentrations. Some laboratory comparison studies have shown the TCLP test to be slightly more precise than EP TOX. The MEP test essentially repeats the EP TOX test 9 times and is intended to simulate long-term landfill leaching from acid rain. Long-term in this case is on the order of 1,000 years. CAL WET has primarily been used by the State of California to characterize hazardous wastes in much the same way EPA has used the EP TOX test. However, the results may be more stringent than both EP TOX and TCLP for certain metals. Each of these four tests is considered to be very conservative given sample grinding and acidic leaching solutions.

The last three tests listed all use a monolith sample. The ANS 16.1 test originated in the nuclear industry for low level radioactive wastes. This method is used to derive leaching patterns over time, that is, it is a dynamic test. ASTM(A) was developed as a short-duration test for inorganics. Since water is used as the leaching solution on a monolith, it tends to be more representative of actual field conditions than are tests using pulverized samples and acidic leaching solutions. The MCC-1 static test originated in the nuclear industry for high level radioactive wastes. This method may simulate infiltration to a closed landfill, namely, one with a cap which has minimum infiltration. The MCC-1 test attempts to simulate maximum leachate concentrations under slow moving groundwater conditions.

Several of the key variables encountered in these major leachate tests are summarized in Table 2 along with the low to high range seen among these tests. Of the variables listed, extraction fluid, the number of extractions and liquid to solids ratio have been found to have the biggest impact on contaminant concentrations in the final leachate.

Table 2. Summary of Key Variables in the Major Leachate Tests

Variable	Range
Sample Size	50 - 350 g
Maximum Particle Size	2 mm - Monolith
Extraction Time	18 hours - Yearly
Extraction Fluid	Water (pH~7)-Acidic (pH~3)
Number of Extractions	1 - 9
Liquid : Solid Ratio	4:1 - 20:1

MODELS TO ESTIMATE EFFECTIVENESS

Once leachate test data are available, several models exist to interpret the results. Seven models to predict effectiveness are listed in Table 3.

Table 3. Models To Predict Effectiveness

Mobility Reduction
Mobility Rate
Mobility Index for Static Tests
Mobility Index for Dynamic/Column Tests
Waste Leachability
Cumulative Leachate Fractions
Long-term Cumulative Leachate Fraction

Mobility reduction is the simplest measure and is a standard contaminant reduction equation expressed in percent. Leachate concentrations from the untreated and treated wastes are the input concentrations utilized. Mobility rate is a measure of the mass leached for a given time period. Inputs are mobility rates and exposed surface areas in the field and test samples. Field parameters are estimated while test sample parameters are measured. Another possible measure is the mobility index for static leachate tests. This index compares the concentration of a given contaminant to its corresponding regulatory standard and ranks those where the measured concentration exceeds the standard. A separate mobility index has been developed for dynamic and column tests. This one examines the product of leaching rates for various contaminants. Leaching rates may be derived or expressed in terms of the diffusion coefficient. The waste leachability measure assesses the overall leachability based on the quantity leached after a specified number of days, the initial amount of contaminant present, and the ratio of the volume to surface area. The cumulative leach fraction is essentially a plot of leachability versus time. Lastly, the long-term cumulative leachate fraction expresses the cumulative leach fraction in terms of the effective diffusion coefficient. Depending on the site-specific application, one or more of these models may be used to estimate the effectiveness of contaminant immobilization.

CONCLUSIONS

Currently, no one leachate test meets all the objectives which an ideal test would possess. Therefore, provided that time and budget permit, it is desirable to conduct both a static and a dynamic test to incorporate as many parameters as possible.

LITERATURE CITED

Anderson, M. et. al. 1979. Test Factors Affecting the Release of Materials from Industrial Wastes in Leaching Tests. In Pojasek, R., ed. Toxic and Hazardous Waste Disposal. Vol 2. Ann Arbor Science Publishers Inc. Ann Arbor, Michigan.

Atkinson, A. K. Nelson, and T. Valentine. 1986. Leach Test Characterization of Cement-Based Nuclear Waste Forms. Nuclear and Chemical Waste Management. vol.6: 241-253.

Fisher, S. 1979. The Problems of Developing Consensus on Methodology for Predicting the Leaching Characteristic of Deposited Waste. In Pojasek, R. ed. Ibid.

EPA. 1988. Status of Solidification/Stabilization in the United States and Factors Affecting its Use. EPA/600/D-89/159. Second International TNO/BMFT Conference on Contaminated Soil. Hamburg Germany.

EPA. 1989. Stabilization/Solidification of CERCLA and RCRA Wastes Physical Tests, Chemical Testing Procedures, Technology Screening and Field Activities. EPA/625/6-89/022. Cincinnati.

Shively, W. et. al. Leaching Tests of Heavy Metals Stabilized with Portland Cement. Journal of the Water Pollution Control Federation. 58(3): 234-241.