Leaching Environmental Assessment Framework (LEAF)

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The USEPA is making a significant change in how leaching tests are used in decisions regarding waste disposal, beneficial reuse of materials in construction applications, and in assessing treatment effectiveness as presented in a 2010 background document[1]. Two of the test methods presented in this document are now part of USEPA SW-846 as:

- Method 1313. Liquid-solid partitioning as a function of extract pH for constituents in solid materials using a parallel batch extraction procedure.
- Method 1316. Liquid-solid partitioning as a function of liquid-solid ratio for constituents in solid materials using a parallel batch extraction procedure.

These methods incorporate a major change over previous SW-846 leaching test methods. The earlier methods (Method 1311 Toxicity Characteristic Leaching Procedure and Method 1312 Synthetic Precipitation Leaching Procedure) are based on single-point pH extractions. The tests were based on a single pH extraction fluid based on the pH of the material tested under the TCLP or based on the geography under the SPLP. Because pH plays a key role in controlling the leaching of solutes from solid materials for many inorganic analyses such as metals, Method 1313 tests the leachability of inorganic constituents under a broad range of pH conditions as follows:

FINAL EXTRACT pH TARGETS	
pH	**Target Rationale**
TBD	Natural pH at liquid to solid ratio (L/S) 10 mL/g-dry (no acid/base addition)
2.0 ± 0.5	Provides estimates of total or available constituent content
4.0 ± 0.5	Typical lower pH limit of most management scenario
5.5 ± 0.5	Typical lower range of industrial waste landfills
7.0 ± 0.5	Neutral pH region with typical high release of oxyanions
8.0 ± 0.5	Endpoint pH of carbonated alkaline materials
9.0 ± 0.5	Minimum of equilibrium partitioning curve for many cationic and amphoteric constituents
10.5 ± 0.5	Substitution sample if the natural pH sample falls within a mandatory target range
12.0 ± 0.5	Maximum in alkaline range for equilibrium partitioning curves of amphoteric constituents
13.0 ± 0.5	Upper bound of typical field conditions for amphoteric constituents

A "pre-test titration curve" or prior knowledge is used to guide the addition of inorganic acid or base to the test material to achieve the target pH ranges listed above. The nine or ten samples are tumbled together (i.e., a parallel batch) for a specified contact time that ranges from 24 to 72 hours a function of particle size (0.3 to 5.0 mm). Note that the method requires a greater degree of particle size reduction than the 9.5 mm criterion of the earlier test methods. After the tumbling is complete, the extraction fluids are filtered and measured for pH, electrical conductivity, and target analytes (oxidation-reduction potential is an optional measurement).

[1] USEPA. 2010. Background information for the leaching environmental assessment framework (LEAF) test methods. EPA/600/R-10/170, 187 pp.

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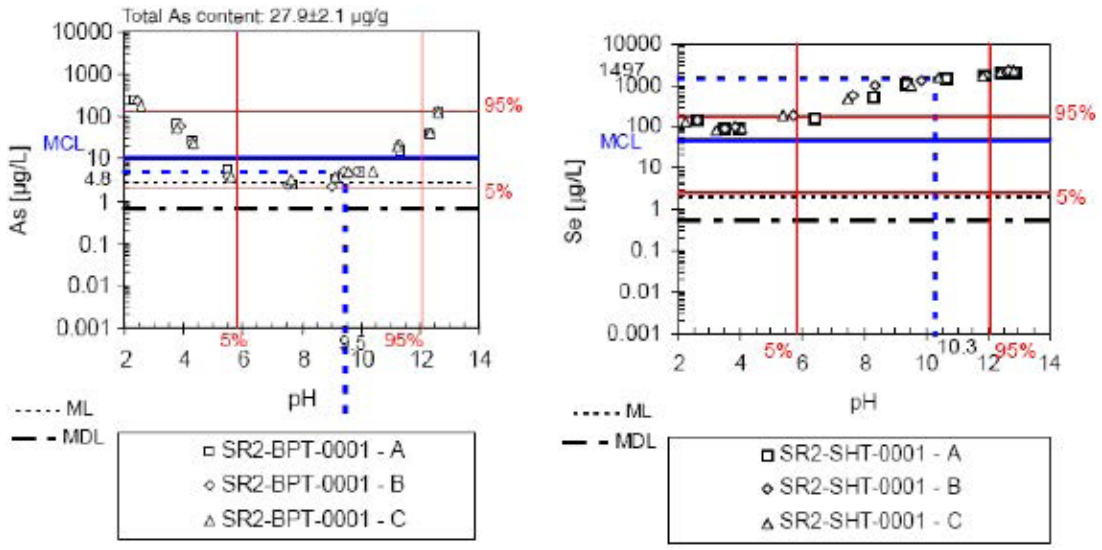
The results of the parallel extractions are then plotted to provide a liquid-solid partitioning curve as illustrated in SW-846 for coal fly ash samples:



The left-hand plot shows that at low and high pH arsenic solubility from the fly ash increases. If the pH remains near-neutral the arsenic concentrations are below the drinking water MCL of 10 µg/L. The right-hand plot show the selenium concentration increases with increasing pH to levels that are more than 20 times greater than the MCL. Barring any other stabilization reagent addition but acid or base addition for pH control, the data suggest that controlling the pH to approximately 4 to 5 will provide the minimum arsenic and selenium concentrations. However, it may be difficult to have both constituents below the MCL without the addition of other stabilization reagents.

Method 1316 evaluates how the liquid-solid ratio affects constituent leaching. In this test all parallel batches are run at the test material's natural pH and the liquid-solid ratio is varied in five steps between 0.5 to 10.0. Similar plots are produced with the liquid-solid ratios on the x-axis.

There are two other methods described in the LEAF document that are still under review by the USEPA for inclusion in SW-846. Method 1314 uses an up-flow percolation column procedure and Method 1315 uses monoliths or compacted granular materials in a semi-dynamic tank leaching procedure.

Contact us to learn more about the application of LEAF procedures on your project.

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