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Leaching Environmental Assessment Framework (LEAF)

Introduction

ALS is now NATA accredited for the Leaching and Environmental Framework (LEAF) methods 1315 and associated method 1310.

The Leaching Environmental Assessment Framework (LEAF) is a leaching evaluation system published by the US EPA and is designed to provide a consistent approach to estimating the release of constituents of potential concern (COPCs) from a wide range of solid materials through waterborne pathways. The LEAF consists of four leaching tests (USEPA Methods 1313, 1314, 1315 & 1316), the results of which provide the basis for estimating leaching rates under specified release conditions. It also provides tools for data collection and evaluation, and guidance on using data to support leaching assessments.

Leaching occurs when constituents within a material in the environment solubilise into contacting water. The leaching process is driven by the principles of mass transport. LEAF test methods consider the effect on leaching of important leaching factors, such as pH, liquid-to-solid ratio (L/S) and physical form of the material, that represent a range of plausible field conditions and management scenarios. Laboratory results can be used to generate evaluations ranging from generic screening assessments to more complex fate and transport modelling. LEAF test data may also be compared between materials before and after treatment to evaluate the efficacy of treatment options.

The types of solid materials covered include: wastes, treated wastes (e.g., solidified/stabilised soils and sediments), secondary materials (e.g., blast furnace slags), energy residuals (e.g., coal fly ash, air pollution control residues), industrial processing residuals (e.g., mining and mineral processing wastes) and contaminated soil or sediments.

Method 1313 – Liquid-Solid Partitioning as a function of pH

Consists of a series of parallel batch extractions of a solid material at up to nine target pH values (from pH 2 to 13) and at an L/S of 10 mL/g-dry. The pH of each extraction is controlled by additions of a known volume of dilute acid or base, derived from prior knowledge of the acid neutralisation capacity (ANC) of the solid material or from a pre-test titration procedure. The measured constituent concentrations can be plotted as a function of leachate pH.

Method 1314 – Constituent release as a function of cumulative L/S using an Up-Flow Percolation Column

Consists of a column packed with granular material. Eluent is introduced through pumping of deionised water up through the column (to minimise air entrainment and preferential flow). The eluent flowrate is slow so that the resulting COPC concentrations approximate liquid-solid equilibrium within the column. Samples of column eluate are collected over nine specified cumulative L/S intervals. Data from this method can be used to estimate pore water concentrations at low L/S and illustrate how leaching behaviour changes as the cumulative L/S ratio increases.

Method 1315 – Mass Transfer Rates in Monolithic and Compacted Granular Materials using a Tank Leaching Procedure

A semi-dynamic tank leaching procedure used to determine the rate of mass transport from either monolithic materials (e.g., concrete materials, bricks, tiles) or compacted granular materials (e.g., soils, sediments, fly ash) as a function of time, using deionised water as the leaching solution. The test sample is leached in a tank vessel with periodic renewal of the leaching solution at 9 specified intervals ranging from 23 hours to 23 days, for a total cumulative leaching time of 63 days. The volume of leachant used is based on a liquid-to-(exposed)surface area ratio (L/A) of 9:1. The preferred dimensions of the monolith are 38mm diameter x 70mm length, permitting a standard 1L leaching vessel to be used. The eluates at each interval are analysed for physical properties (e.g., pH, EC) and constituent concentrations. This data can be used to plot both interval flux and cumulative mass release as a function of cumulative leaching time.

Figure 1. Method 1315 monolith leaching setup. The holder facilitates ease of monolith transfer between tanks and maximises surface area exposed to the leaching solution

Method 1310 – Structural Integrity Procedure (SIP)

While not officially included in the LEAF framework, Method 1310 may be used in conjunction with Method 1315 to test the structural integrity of the monolith or compacted granular material. A hammer of specified weight is designed to free fall onto the sample material from a specified constant height a total of 15 times. This simulates the structural degradation that the sample material may undergo if disposed of in a sanitary landfill. The resulting material can then be leached to determine the leachable constituents in the physically degraded sample.

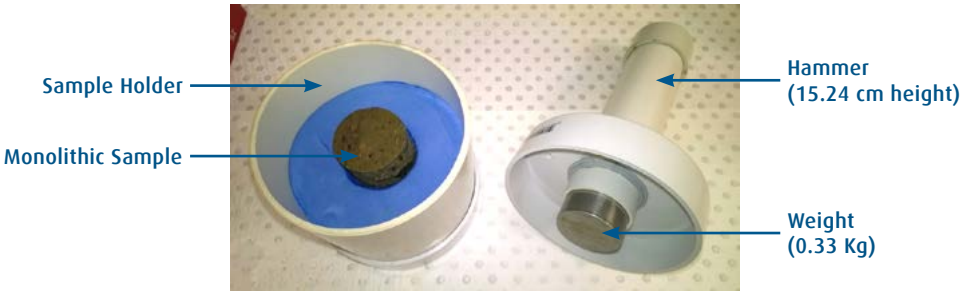

Figure 2. Opened Structural Integrity Tester with monolithic sample in position

Method 1316 – Liquid-Solid Partitioning as a Function of Liquid-to-Solid Ratio

Consists of five parallel batch extractions of a particle-size-reduced solid material in reagent water over a range of L/S values from 0.5 to 10 mL/g-dry material. Data from this method provides mass release information as a function of L/S similar to Method 1314. Typically Method 1316 eluate concentrations are higher than Method 1314, reflecting the nature of the batch test where constituents are not sequentially removed from the system at each L/S as with a flow-through percolating column. The batch method may be useful when characterising materials with physical properties not conducive to flow-through tests (e.g., low-permeability clays or materials with cementitious properties).

A useful summary of the methods is provided in the table below. Note, the number of leaching events and contact times/intervals as this will dictate minimum achievable turnaround times. Also note the required sample amounts (typically 1kg or more per sample).

Table 1. *Summary of the Leaching Environmental Assessment Framework (LEAF) Methods*

	Method 1313	Method 1314	Method 1315	Method 1316
ALS Method Code	EN58-2	EN58-3	EN58-1	EN58-4
NATA Accreditation Status	Pending	Pending	Accredited	Pending
Test Type	pH-Dependent	Vertical Percolation	Mass Transfer	Liquid-Solid ratio (L/S) Dependent
Test Description	Parallel batch extractions	Column test in up-flow mode	Tank test with periodic eluent renewal	Parallel batch extractions
Sample Type / Dimensions	Granular particle size of 85% by mass <0.3, <2.0 or <5.0 mm	Granular particle size of 85% by mass <2.0 mm, 100% <5.0 mm	Monolith or compacted granular (cylinder or tube) **with preferred dimensions 38 mm dia. X 70 mm length**	Granular particle size of 85% by mass <0.3, <2.0 or <5.0 mm
Leaching Duration	24, 48 or 72 hour extractions based on min. particle size	Continuous elution to L/S 10mL/g-dry, approximately 13 days for 0.75 L/S per day flowrate	Cumulative leaching time – 63 days (intervals ranging from 2 hours to 23 days)	24, 48 or 72 hour extractions based on min. particle size
Eluent Composition	Reagent water with pH adjustment using HNO3 or NaOH/KOH	Reagent water or 1mM CaCl2	Reagent water	Reagent water
pH range	Specified targets from pH 2 to 13	As controlled by material being tested	As controlled by material being tested	As controlled by material being tested
Amount of Solid Required	Min. 20g-dry per extract. Approx. 400g-dry. **Collect up to 1kg to include pre-test ANC.**	Min. 300g. Recommend. **Collect up 1kg per test column.**	**Monolith or compacted granular to meet dimension specifications above**	Min. 20g-dry per extract, up to 400g-dry. **Recommend collecting up 1kg per test column.**
No. of Analytical Solutions per Test	9 extractions (10 if natural pH is included), plus 5 pretest extractions for ANC if required	9 eluate fractions	9 interval solutions	5 extractions (L/S of 10, 5.0, 0.0, 1.0 and 0.5 mL/g-dry

REFERENCES

"How-To" Guide for the Leaching Environmental Assessment Framework