NEXT GENERATION LEACHING TESTS FOR EVALUATING LEACHING OF INORGANIC CONSTITUENTS

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The US EPA has completed the development and validation of leaching tests, referred to as the Leaching Environmental Assessment Framework (LEAF), that are used to r evaluate liquid-solid partitioning of inorganic constituents found in wastes and materials being considered for disposal or beneficial use. This paper provides an overview of the work completed to validate and implement the methods for a range of management options for a specific material or waste. Classifications of hazardous and nonhazardous material can be confusing, particularly when an industrial by-product may be found to be safely used in some or many applications as an alternative to extracted or virgin resources whereas otherwise the material would be regarded as hazardous. It can be difficult to assess the performance of a treatment technology unless the leaching tests reflect the environmental conditions under which the waste or material is managed. As a result, the next generation leaching tests were needed to help evaluate more effective and efficient strategies for management of industrial by-products while ensuring protection of human health and the environment.

The research described was conducted collaboratively by the U.S. EPA's Office or Research and Development and Office of Land and Emergency Management (formerly known as the Office of Solid Waste and Emergency Response), Vanderbilt University in Nashville, Tennessee, Hans van der Sloot Consultancy in the Netherlands, and the Energy Research Centre of the Netherlands. LEAF represents decades of research to develop standardized leaching tests that produce comparable data and can lead to more informed decisions regarding how best to manage industrial waste and other by-products.

In the U.S., as in other countries, there is increased interest in using industrial by-products as alternatives or secondary materials (i.e., not primary materials or virgin resources that are typically extracted from mines), helping to conserve virgin or raw materials. Within the U.S., beneficial use has been defined as the incorporation of an industrial material into a commercial product that provides (1) functional benefit, (2) meets relevant design specifications and performance standards for the proposed use, (3) replaces virgin or raw materials in a product already on the market and (4) is implemented in an environmentally acceptable manner. The LEAF and associated test methods are being used to develop a source term for leaching of any inorganic constituents of potential concern (COPC) in order to determine what is environmentally acceptable. A source term is an estimate of constituent release from a material or waste and is used in subsequent fate and transport modeling to evaluate r exposure for use in a risk assessment. The results from the risk assessments are used to inform decisions about levels that are protective of human health and the environment.

The LEAF tests have advantages over single-point pH tests, which when used do not typically reflect the conditions of how a waste is managed and therefore can result in an inaccurate estimate of the leaching source term. For example, aresenic was found to be leaching from a K088 disposal monofill at levels more than 100 times what a single-point test had estimated. As a result, the US EPA had to withdraw the delisting petition and instituted disposal restrictions for the waste. In another example, a waste from an aluminum company was evaluated for land disposal restrictions using the results of a single-point leaching. The US EPA was sued and the court found that models of the environment must bear a reasonable relationship to the situation that they are intended to represent. Whether one is concerned about the potential use of industrial by-products or the safe disposal and treatment of industrial by-products, more accurate source terms improve the ability to ensure protection of human health and the environment.

Rather than evaluate leaching under a single set of conditions to simulate field conditions, LEAF measures leaching characteristics of a solid material (e.g., waste, treated wastes such as by solidification/stabilization, secondary materials such as blast furnace slags, energy residuals such as coal fly ash, soil, sediments, mining and mineral processing wastes) over a range of conditions that influence leaching concentrations or rates. LEAF incorporates three factors that can affect leaching and that can vary under plausible use or disposal conditions: leachate pH, the liquid-to-solid ratio (L/S) of the test material and the leaching environment, and whether or not leaching is controlled by constituent aqueous-solid partitioning under chemical equilibrium or by the rate of mass transport through the material (e.g., the physical form of the material, diffusion from the solid). Important factors that may impact leaching but are not readily assessed in the laboratory (e.g., changing redox conditions, reaction with atmospheric carbon dioxide) can be evaluated using geochemical speciation and scenario-based reactive transport models.

The leaching test methods include batch equilibrium, percolation column and semi-dynamic mass transport tests for monolithic and compacted granular materials. By testing over a range of values for pH, liquid/solid ratio, and physical form of the material, this approach allows one data set to be used to evaluate a range of management scenarios for a material, representing different environmental conditions (e.g., disposal or beneficial use). The results from these tests may be interpreted individually or integrated to identify a solid material's characteristic leaching behavior. Furthermore the LEAF approach provides the ability to make meaningful comparisons of leaching between similar and dissimilar materials from national and international origins.

To assist in the implementation of LEAF, software (referred to as LeachXS-Lite) is available at no cost for data management, evaluation, and visualization. A user's guide to support implementation has been developed and is undergoing review prior to final release in 2016. This presentation will focus on the guidance for LEAF implementation summarizing a series of case studies illustrating how source terms are developed for a range of potential LEAF applications. In addition, future work to identify drivers for leaching of semi- and non-volatile organic constituents is ongoing with the goal to develop and validate methods for estimate leaching source terms for waste streams such as contaminated soils and sediments, including those that may have non-aqueous phase liquids (NAPLs) from manufacturing residues (e.g., manufactured gas sites), petroleum hydrocarbons (light- or LNAPLs) or chlorinated solvents (dense- or DNAPLs).

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