tities of leachate materials are allowed to escape due to cracks or diffusion through the clay liner, and FMLs have been shown to fail due to flaws in the FML or diffusion through the FML. The failure of these liner systems creates the potential for contamination of groundwater or adjacent soils.

The objective of this research is to evaluate the effectiveness of several alternative liner materials for use in landfills based on the material's ability to absorb selected organic compounds, availability, and expense with respect to large scale operations. These liner materials include peat moss, compost, activated carbon from cotton gin trash, lignite, and granular activated carbon for comparative purposes. Organic compounds were selected based on chemical characteristics and to represent a range of compounds potentially found in landfill leachate. These test compounds include acetone, 2,4-dichlorophenol, benzene, toluene, trichloroethylene, and tetrachloroethylene.

Isotherm experiments were used to evaluate partition coefficients for each test compound and selected mixtures with the liner materials. The isotherm experiments were also used to evaluate the effects of moisture content on liner material performance, quantify synergistic or antagonistic interactions between the compounds and their mixtures, and evaluate physical/chemical alterations to the liner materials as a function of exposure to the test compounds. Breakthrough experiments characterized dispersive and advective transport parameters, determined the effects of moisture on flow through a soil column, and finally determined liner materials with potential for value in landfill designs.

Feasibility of extracting lead, cadmium, mercury, copper and zinc from soil using anhydrous ammonia

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Abstract

An innovative anhydrous ammonia extraction process for removing toxic metals from contaminated soil is under investigation. Results to date indicate that cadmium, mercury, copper, and zinc can be extracted from contaminated soil using anhydrous ammonia alone. Lead can be removed using anhydrous

ammonia in conjunction with extraction-enhancing anionic ligands such as acetate and EDTA.

Extensive screening tests were performed at 43 °C and 250 psig (18.5 bar) using a pressurized stainless steel Soxhlet extractor to rapidly evaluate the anhydrous ammonia extraction concept. A typical test involved spiking and aging prior to Soxhlet extraction for 2-hours with 30 extraction/siphon cycles. When extracting soils that were soaked with metal nitrate solutions prior to drying and aging, the metal removals were 73% for copper and cadmium, 64% for zinc, and 26% for mercury when the metal-nitrate spiking concentrations ranged from 20,000 to 50,000 mg/kg. Only 8% lead removal was observed using ammonia under these conditions. Furthermore, poor extraction efficiency was uniformly observed for all metals when extracting soil samples with spiking concentration below 2,000 mg/kg.

When enhancing ligands were added prior to ammonia extraction, lead removals greatly improved. For example, 95% removal was achieved from $Pb(NO_3)_2$-spiked soil previously soaked in disodium EDTA solution and dried prior to extraction. When using dry-mixed enhancing ligands such as powdered sodium acetate or disodium EDTA, 75% to 87% lead removal was achieved on $PbSO_4$-, $PbCO_3$-, PbO- or Pb^0-spiked soil samples during ammonia extraction. Similar extraction results were obtained for lead-contaminated Superfund soil treated with solution-mixed or dry-mixed enhancing ligands prior to ammonia extraction.

A commercially available Supercritical Fluid Extraction (SCE) Screening System has been used under subcritical conditions (110 psig or 8.5 bar, 23 °C) to further evaluate the anhydrous ammonia extraction concept. The limited SCE experimental results obtained to date are confirming the Soxhlet extraction data for copper removal from $Cu(NO_3)_2$-spiked soil. Eventually the SCE will be modified to incorporate a mechanically-stirred extraction reactor in place of the fixed-bed extractor now in use. The modified SCE will more closely simulate the extraction mixing conditions in a full-scale soil extractor.

The feasibility of *in situ* treatment of soil to promote desorption of hazardous wastes, thus permitting capture and treatment

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Abstract

Hazardous wastes are frequently immobilized on soil particles by adsorp-