plished quickly and effectively in both HCl and HCl + NaCl solutions. Optimization of leaching conditions for effective detoxification and subsequent metal recovery can be achieved by controlling the pH of the lixiviant and the ratio of fly-ash to lixiviant. Significantly, Toxicity Characteristic Leaching Procedure (TCLP) tests have been conducted which show that residues can be produced which meet the toxicity limit for Pb and Cd. Furthermore, lead and cadmium can be recovered from the leaching solution by cementation with zinc dust. Experiments have been performed to determine the effects of pH, particle size of the zinc dust used, quantity of zinc added, and dissolved impurities on the cementation kinetics. The final solution obtained after leaching and cementation yields a dissolved zinc concentration of approximately 15 g/L or higher, a level suitable for direct electrowinning of zinc. Electrochemical experiments have been performed which are aimed at determining the critical parameters which affect the cementation and electrowinning steps.

A flexible process flowsheet incorporating the material and water balances has also been developed which runs on Lotus 1-2-3 or Quattro Pro spreadsheets. The program is based on the data generated from experiments and includes many adjustable parameters. The flowsheet/spreadsheet program is currently being used to develop an economic analysis of the overall process. Progress so far suggests that such an approach for simultaneous detoxification of the solid wastes and recovery of the metals value is both technically and economically feasible.

In situ treatment for cracked and contaminated clays and permeable soils

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Abstract

There is increasing concern over leaking deep clay aquicludes resulting in contamination of aquifers. Also failure of primary or secondary clay barriers in existing hazardous waste storage and disposal facilities has drawn much attention recently. But very little is known about repairing leaking clay barriers *in situ* to reduce seepage of contaminants. Improper modeling of local

defects such as desiccation cracks, fissures and fractures in laboratory clay specimens are totally or partly responsible for the discrepancies in the reported results. Since field tests are expensive, time-consuming and in many instances impractical, it is essential to develop reliable laboratory permeability tests where the field conditions are closely modelled. Effect of cracks on the hydraulic conductivity of clays and various treatment techniques to reduce the hydraulic conductivity of cracked clays and permeable soils (clay-sand mixture) have been investigated.

A field clay (obtained from Houston area) and kaolinite clay (commercially processed clay) were selected for this study with methanol and acetic acid as the organic permeants. In this laboratory study a reliable testing procedure for simulating cracked clays has been developed. The hydraulic conductivity of clays, compacted at optimum moisture content, ($<3\times10^{-8}$ cm/s) was increased above the EPA limit of 10^{-7} cm/s in a controlled manner using syringe needles of various sizes to simulate cracked clay specimens. Relationships between hydraulic conductivity of clays and crack parameters (crack length, size and density) have been developed. The interactive nature of cracks and hazardous organic permeants on the hydraulic conductivity of clays have also been evaluated. The hydraulic conductivity of the cracked clays ($>10^{-7}$ cm/s) and permeable soils ($>10^{-5}$ cm/s) were restored to that of the uncracked clays ($<3\times10^{-8}$ cm/s) using various colloidal solutions such as sodium silicate, cement, lime and bentonite or their mixtures thereof. These findings will improve the current repair practice for leaking clay barriers in waste disposal sites and deep acquifers. Preliminary results on treating contaminated soils are also very encouraging.

Investigation of equilibrium and kinetic parameters for air stripping of volatile and semi volatile organic contaminants from soil by dynamic experiments

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Abstract

An experimental technique has been developed for simultaneous measurement of adsorption equilibrium and rate parameters for air stripping of con-