1.3 In Situ Measurement of Volatile and Semi-Volatile Organic Compounds in the Subsurface

Technology Need

The projected costs for hazardous waste site assessment and cleanup in the United States are staggering. Environmental contaminants on DOE sites include radionuclides, toxic heavy metals (e.g., mercury), VOCs, semi-volatile organic compounds (SVOCs), and extractants such as tributylphosphate. Decisions concerning remediation require reliable information about the presence and extent of contamination at the facilities. The most cost-efficient means of obtaining this information is the use of minimally intrusive sampling techniques and on-site analysis (field analysis of samples). Cone penetrometer truck (CPTs) and in situ groundwater sampler provides a minimally intrusive, efficient, and cost-effective method of obtaining subsurface materials for analysis of contaminants. On-site analysis of samples has been shown to facilitate the characterization of sites by making real-time, interactive sampling decisions possible. Sampling techniques for VOCs in subsurface materials have been reported. These methods, although currently accepted, are cumbersome even when they are applied during on-site analyses. Consequently, there is a need to provide on-line, near real-time methods of analyses for VOCs and SVOCs in subsurface materials that maintain sample integrity and improve the accuracy of the analytical results by eliminating the manipulation of samples during collection, transportation, and storage.

Technology Description

The overall goal of this investigation is to develop methods and technology that will couple a CPT with field-deployable gas chromatography/mass spectrometry (GC/MS) instrumentation to transfer VOCs and SVOCs from subsurface material at depth to the analytical instrument in the field. Sampling, preconcentration, and analytical equipment will be directly coupled to a CPT to provide on-line, near-real-time analyses for VOCs (e.g., trichloroethylene, benzene) and SVOCs (e.g., polynuclear aromatic hydrocarbons, polychlorinated biphenyls) in subsurface materials. Preconcentration devices will be interfaced to GC/MS instrumentation and coupled to sampling devices housed in a CPT for in situ quantitative measurement of VOCs in soil gas and groundwater, and for screening of VOC and SVOC levels in the soil external to the penetrometer wall. The VOCs and SVOCs liberated from subsurface material will be carried to the surface by an inert, heated transfer line, preconcentrated, and analyzed by thermal desorption GC/MS.

Benefits

Real-time characterization of VOCs and SVOCs, in conjunction with the CPT, will dramatically improve the capabilities for Expedited Site Characterization. Time savings of real-time, depth-discrete analysis will yield rapid on-site decision-making and reduce the time required to characterize a site.

The in situ extraction of the VOCs and SVOCs reduces waste, not only in the generation of samples, which must ultimately be disposed of under applicable hazardous and/or radioactive waste disposal rules, but also in the elimination of the secondary waste generated in the laboratory with solvent extraction, column cleanup, etc.

Extensive cost savings should be realized with this approach. Substantial indirect cost savings will be realized by the rapid turn-around time of the information to those making site characterization decisions. In addition, there are quantifiable direct cost savings relative to the fixed-based laboratory analytical costs. A cost reduction exceeding 90 percent has been estimated for use of field analysis for organic characterization. Specifically, laboratory analyses using SW-846 cost $600 per sample, while field analysis can be accomplished for as little as $60 per sample, depending on the sample production per day. Based on DOE's estimate of 800,000 hazardous consituent analyses per year by 1994 and a typical cost of $600 per sample, DOE will be spending about $480 million per year for organics characterization or, over the stated life of the 30-year program, a total of $14.4 billion. If thermal desorption GC/MS can trim 90 percent from the per-sample cost for only 20 percent of the total samples, a conservative estimate of the savings is $87 million per year for an aggregate savings of $2.6 billion.

Collaboration/Technology Transfer

Tufts University is a key technical partner on this project. As part of the effort to make information about this technology and these results widely available to DOE site users, a follow-on demonstration of the technology at a contaminated site is planned. Commercialization plans will be developed with the commercial vendor to incorporate hardware and software changes into the instrument to make the methods available to users as catalog items and to market the whole package for use at DOE sites.

Accomplishments

- Established research partners through a subcontract to Tufts University
- Designed, built, and tested a laboratory prototype purge device and thermal extractor
- Evaluated transfer line materials
- Designed and fabricated transfer line
- Designed and built a prototype penetrometer purge device and thermal extractor
- Designed sampling fixture to laboratory test and evaluate analytical performance of the penetrometer purge device
- Laboratory tested the thermal extractor cone penetrometer
- Field tested the penetrometer purge device with the cone penetrometer truck

TTP Information

In Situ Measurement of Volatile and Semi-Volatile Organic Compounds in the Subsurface activities are funded under the following technical task plan (TTP):

TTP No. CH24C222 "In Situ Measurement of Volatile and Semi-Volatile Organic Compounds in the Subsurface: Development of Screening and Quantitative Field Methods Coupled to the Cone Penetrometer"

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Bibliography of Key Publications

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