P.20 In-Situ Stabilization Utilizing Reactive Fixation Chemistry

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Abstract

Introduction: The National Energy Technology Laboratory Industry Program is coordinating with the Subsurface Contaminant Focus Area and the Oak Ridge, Tennessee, Site to address technology needs to treat, remove or immobilize mercury in soil and sediment. Treatment of uranium and other radionuclides and heavy metals is also of interest. As one example, at the Oak Ridge Y-12 Plant, historic releases of mercury total an estimated two million pounds of mercury lost to soils and surface waters, creating a mercury management problem with numerous sumps and outfalls contaminated. DOE/NETL estimates that up to 300,000 cubic yards may be Resource Conservation and Recovery Act (RCRA)-characteristic due to the presence of mercury and other heavy metals such as cadmium and lead. Because of the toxicity and mobility of the mercury contamination, these sources are identified as principal threat wastes per EPA guidance.

Objective: The goal of this project is to demonstrate a treatment technology, in situ stabilization utilizing reactive fixation chemistry, that provides technical performance and cost benefits superior to current baseline treatments.

Approach: Phase One is bench-test treatment of contaminated soil with chemicals selected to react and fixate mercury such that the soil is rendered below RCRA-characteristic levels for mercury in TCLP leachate tests. Estimates are that 100 or more bench test runs will be required to refine and optimize treatment procedures. One or both of the following will be met:

1. Soil that meets requirements for less than the Toxicity Characteristic Level for mercury (0.2mg/l) in Toxicity Characteristic Level Procedure (TCLP) leachate;
2. Ten times the Universal Treatment Standard (0.25 mg/l) in TCLP leachate.

Phase Two is a field test in which a mercury-contaminated soil area within Oak Ridge National Laboratory approximately 30 feet by 30 feet will be treated by injection of these chemicals to a depth of approximately 20 feet. The quantities and reaction times for the chemicals used will be determined by data obtained from Phase One as well as the characteristics of the soil in the test plot.

Results: This technology will fixate both elemental mercury as well as ionic mercury in addition to other

heavy metals in-situ, preventing further leaching and groundwater contamination. This technology is applicable both in-situ and ex-situ. In heavily contaminated areas where excavation is practical, the soil could be removed, well mixed with the reactive and fixative chemicals, and them replaced or used a fill elsewhere. In areas where excavation is not practical, it presents a treatment option that could be used to react and fixate mercury that the treatment media comes in contact with by injection or diffusion through the soil as well as potentially providing a barrier for movement of mercury and other heavy metal ions into the ground water or water table.

Critical portions of this technology were demonstrated in 1997 and 1998 in CRADA No. Y1295-0356, AIn-Situ Soil and Water Remediation at Contaminated Sites Utilizing a New Form of Humic Matter,@ final report dated January 6, 1998, prepared by John F. McCarthy, Environmental Sciences Division, Oak Ridge National Laboratory.

Benefits: The key benefits of this technology are:

1. It does not require excavation of contaminated soil, for much of which access is impractical. Soil can be treated in-situ.
2. It will remediate mercury in fractured bedrock.
2. It is effective with other heavy metal contamination in addition to mercury, such as lead, cadmium and radionuclides.
3. The chemistry used has shown high effectiveness in treating PCB=s and related compounds in several earlier field tests for other applications.
4. The cost is significantly less than current base line technology, Low-Temperature Thermal Desorption (LTTD).
5. The ultimate disruption to the environment is trivial in comparison to LTTD

LTTD, also known as thermal stripping, involves excavating the contaminated soil and placing it in a sealed vessel, where it is heated under vacuum to physically separate the mercury contaminant from the soil. This technology is effective with volatile organic compounds and organic contaminants such as pesticides, PCBs and PAHs. While LTTD cannot be used for most metals, it does work with mercury because heating converts ionic mercury (Hg^{++}) to elemental mercury (Hg^0) which is volatile and can be collected on scrubbers. LTTD is not the best method for the Oak Ridge site because:

1. The relative high cost, estimated at $700 per cubic yard.
2. The ex-situ technology - contaminated soil must be excavated for treatment.
3. The large volume of contaminated soil, estimated to be 300,000 cubic yards.
4. The difficulty of access to much of the contaminated soil, e.g., underneath reactor buildings and within fractured bedrock.
5. The technology does not address non-volatile contaminants such as other metals.

Future activities: Once demonstrated as effective, opportunity for this technology is vast. Other DOE and DOD sites, industrial waste clean ups and contaminated sites around the world are hungry for an effective and economical in-situ solution as well as an alternate ex-situ method.