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ENVIRONMENTAL MANAGEMENT TECHNOLOGY DEMONSTRATION AND COMMERCIALIZATION

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Environmental Management Technology Demonstration and Commercialization

CONTRACT INFORMATION

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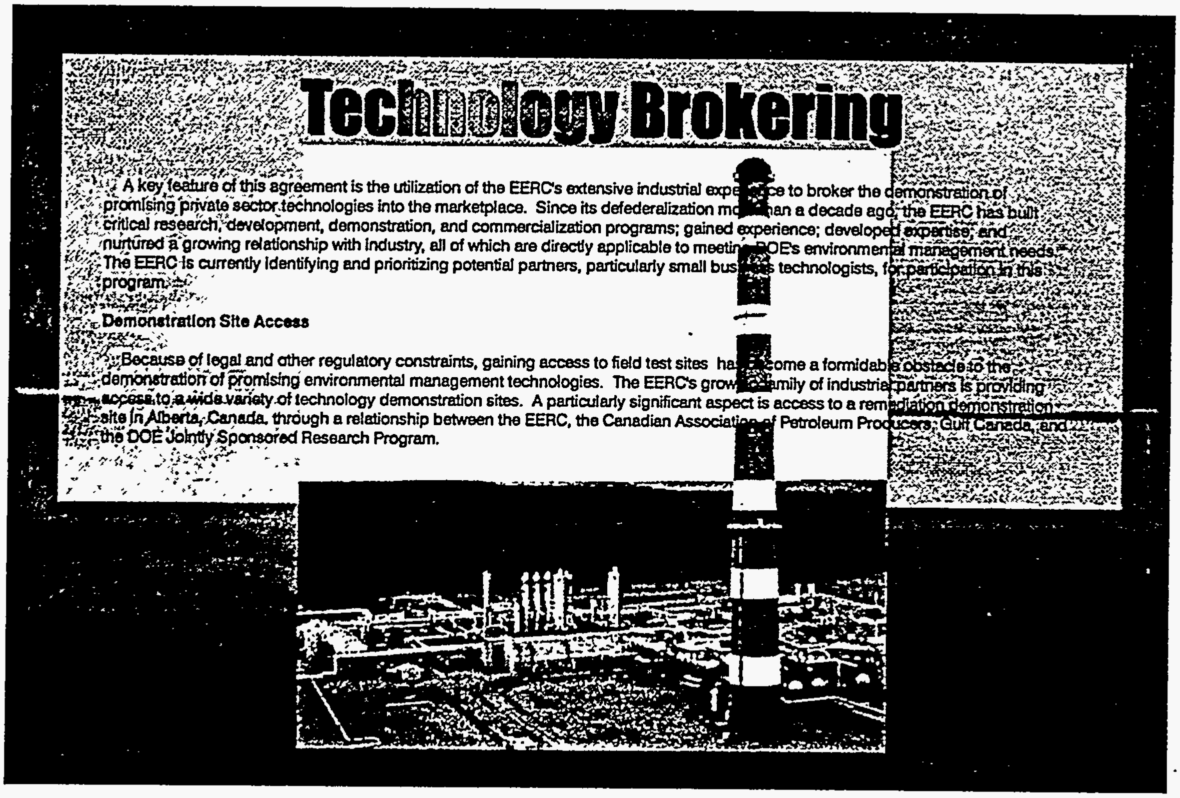
Period of Performance	9-30-94 to 9-29-95

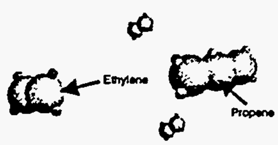


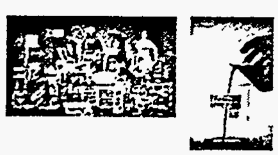
Technology Brokering

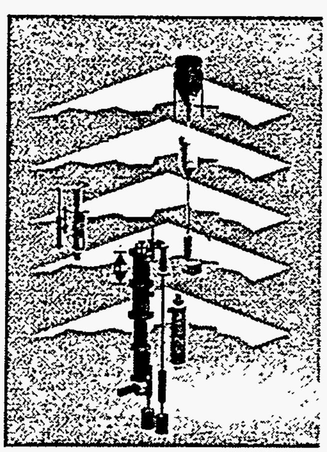
A key feature of this agreement is the utilization of the EERC's extensive industrial experience to broker the demonstration of promising private sector technologies into the marketplace. Since its defederalization more than a decade ago, the EERC has built critical research, development, demonstration, and commercialization programs; gained experience; developed expertise; and nurtured a growing relationship with industry, all of which are directly applicable to meeting DOE's environmental management needs. The EERC is currently identifying and prioritizing potential partners, particularly small business technologists, for participation in this program.

Demonstration Site Access

Because of legal and other regulatory constraints, gaining access to field test sites has become a formidable obstacle to the demonstration of promising environmental management technologies. The EERC's growing family of industrial partners is providing access to a wide variety of technology demonstration sites. A particularly significant aspect is access to a remediation demonstration site in Alberta, Canada, through a relationship between the EERC, the Canadian Association of Petroleum Producers, Gulf Canada, and the DOE Jointly Sponsored Research Program.







Pyrolysis of Plastic Waste

The chemically diverse nature of plastics has thwarted conventional chemical reprocessing of bulk waste plastic materials back to feedstock chemicals. The EERC is progressing rapidly toward a commercially viable plastics recycling process able to accommodate the wide variety of plastic materials found in commercial and military waste streams. It is anticipated that the technology will be adaptable for use on ships and other remote applications.

Objectives

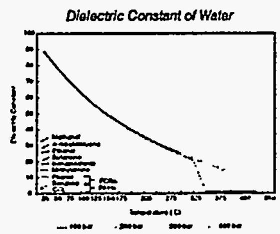
- Develop a commercial process to significantly reduce the volume oflowlevelradioactive contaminated mixed-plastics/paper/resin waste.
- Concentrate contaminants in a collectible form.
- Determine the distribution and form of contaminants after pyrolysis.

Approach

Actual contaminants and/or surrogates for radionuclides will be used in bench-scale testing using the EERC's 1–4-lb/hr continuous fluidized-bed reactor (CFBR) test unit. A tentative list of substances of interest includes chlorinated hydrocarbons (e.g., trichloroethylene, tetrachloroethylene, chloroform, carbon tetrachloride, chlorobenzene), radionuclides (thorium, uranium, plutonium, cobalt, cesium, strontium, tritium), metals (lead, zinc, copper, barium, mercury, chromium, arsenic), PCBs Aroclor®, and various ketones and organic acids. The range of temperatures practical for a thermal depolymerization process is approximately 475° to 600° C, depending on the composition of the feed material and assuming an inert (as opposed to catalytic) bed material. While different polymers have the potential to interact with contaminants, testing will begin with a single polymer and then proceed to other polymers later if the process shows potential.

Subcritical Water Extraction of Organic Pollutants and Extraction of Hazardous Metals from Mixed Solid Wastes by Chelation and Supercritical Fluid Extraction

Cost-effective analytical and remediation methods are critically needed to extract organic, inorganic, and radionuclide contaminants from earth materials. EERC research has shown that subcritical water extraction has great potential as a rapid, low-cost method for separating organic waste pollutants from earth materials. Materials to be treated by this method will typically be contaminated soils and sediments containing either polar or nonpolar organic contaminants that are not amenable to gas stripping. This includes soilds contaminated with mixed organic-metal wastes. While polar organics are the easiest to extract with water, even nonpolar organics such as PAHs and PCBs can be efficiently extracted in hot (250°C) Water because of the drop in the dielectric constant of water at those conditions.



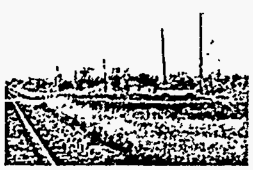
Objectives

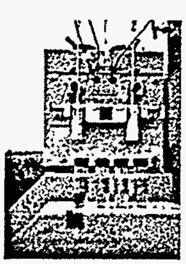
- Demonstrate the minimum temperature and pressure conditions necessary to remove polar and nonpolar organics from realworld samples to at least as low as the regulatory limits.
- Demonstrate the ability to selectively extract different classes of organic pollutants at different temperatures.
- Demonstrate extractant water recycle
- Demonstrate the use of supercritical CO_2 with chelating agents to extract hazardous metals from earth materials for analytical and commercial remediation applications.
- Demonstrate sequential extractions, of organic and hazardous metals from mixed wastes, with and without chelating agents.

Results

EERC has demonstrated quantitative removal of PAHs and PCBs from soils using water extraction at 250° C and pressures as low as 5 atm.

Extraction and Analysis of Pollutant Organics from Contaminated Solids Using Off-Line Supercritical Fluid Extraction and On-Line SFE/IR





One of the remediation industry's greatest challenges is obtaining cost-effective, accurate, and precise analyses for organic contaminants. The EERC is demonstrating and evaluating the use of supercritical fluid extraction (SFE) to extract organic contaminants rapidly and efficiently in the field.

Objectives

- Perform and evaluate off-line SFE on-site using conventional portable instrumentation (e.g., a portable gas chromatograph) for analysis of the extracts and to compare the results with conventional laboratory methods.
- Evaluate the use of on-line SFE with infrared (IR) detection (based on a fiber-optic interface) for an inexpensive (less than $20,000) and simple-to-operate field instrument. This will include determining the ability of this SFE/IR instrument to perform screening surveys at ppm-to-ppb detection levels.

Results

Results from initial SFE field survey of PAHs from a railroad bed:

- No support vehicle was needed.
- All SFE instrumentation performed well on 1200-W generator power.
- Total time from arrival on-site to beginning extractions was less than15 minutes.
- SFE recoveries of PAHs in the field were typically greater than 80% with a 10-minute field extraction compared to 14 hours of conventional sonication with chloroform.

In a total time of 5 hours and 15 minutes:

Three sampling sites were selected (including 50 miles of driving), all SFE instrumentation was assembled at each site, soil sampling was performed, 17 samples were extracted by SFE, and extracts were returned to the lab.

Stabilization of Vitrified Waste by Enhanced Crystallization and Development of a Protocol to Predict Long-Term Stability

Vitrification of materials containing hazardous inorganics is often advanced as a final remediation solution. However, simply vitrifying a material into a glassy slag does not necessarily produce an environmentally stable product. The stability of materials can be significantly enhanced through the production of stable crystalline phases.

Objectives

- Demonstrate the incorporation of toxic metals and radionuclides into engineered crystallized materials
- Predict the mass of leachable materials and the rate of leaching from a variety of engineered crystalline materials using EERC's synthetic groundwater leaching procedure (SGLP) and long-term leaching (LTL) procedure.

Approach

The chemical, mineralogical, and physical properties of selected chemical mixtures will be characterized. Both standard and advanced materials characterization techniques developed at the EERC will be employed to assess the concentration and mode of occurrence of hazardous materials in the chemical mixtures and mineral forms. This detailed information will be used to develop appropriate mix designs and take full advantage of the physical and chemical properties inherent in the chemical mixtures to produce stable crystalline products.

Detailed thermochemical equilibrium calculations will be performed to predict the interactions of toxic or radioactive elements with the benign elements in contaminated earth materials under simulated vitrification and crystallization conditions. The equilibrium calculations will predict whether the elements vaporize, at what conditions they condense, in what form they condense, and what crystalline and glassy products are produced during vitrification. These predictions will indirectly suggest the relative leachability of toxic elements from the vitrified product. This information will be used to select a combination of materials that will produce a highly crystalline matrix and the optimum process conditions for producing less leachable waste.

Plasma Remediation Technology

Current methods of remediating organically contaminated soils do not always provide permanent solutions, because many methods can produce undesirable by-products and/or require lengthy treatment to accomplish remediation. The EERC's patent-pending plasma remediation technology offers a permanent alternative solution to incineration, but with decreased production of harmful by-products. The process involves treatment with atomic oxygen generated by a high-frequency electrical field in a scalable reactor system.

Objectives

- Determine processing conditions required to remediate a specific site. Different soil and contaminant combinations require changes in processing parameters such as residence time, reactor pressure, and electron density within the plasma.

- Demonstrate the technology in the field.

Approach

This effort follows related ongoing EERC technology developments under separate funding. Both the determination of site-specific processing conditions and the field demonstration will be performed during Project Year 5.