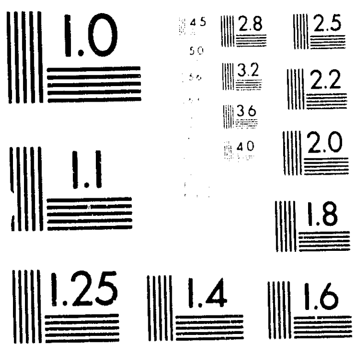
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INNOVATIVE ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT TECHNOLOGIES AT ARGONNE NATIONAL LABORATORY

by

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To be presented at:

Conference on Environmental Commerce
CONEC'93
Chattanooga, TN

October 17 - 20, 1993

*Work supported by the U.S. Department of Energy Office of Technology Development, under contract W-31-109-ENG38.

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Abstract

Cleanup of contaminated sites and management of wastes have become major efforts of the U.S. Department of Energy. Argonne National Laboratory (ANL) is developing several new technologies to meet the needs of this national effort. Some of these efforts are being done in collaboration with private sector firms. An overview of the ANL and private sector efforts will be presented. The following four specific technologies will be discussed in detail: (1) a minimum additive waste stabilization (MAWS) system for treating actinide-contaminated soil and groundwater; (2) a magnetic separation system, also for cleanup of actinide-contaminated soil and groundwater; (3) a mobile evaporator/concentrator system for processing aqueous radioactive and mixed waste; and (4) a continuous emission monitor for ensuring that waste incineration meets environmental goals.

Introduction

Radioactive, hazardous, and mixed-waste remediation is a major concern with the U.S. Department of Energy (DOE) complex at sites located across the country. Soils, waste sludges, surface water, groundwater, and other materials must all be treated so that they do not pose a threat to human health and the environment. Presently available remediation technology is not adequate to meet DOE's needs for remediating its contaminated sites and wastes. Argonne National Laboratory (ANL) is developing several new technologies for that purpose. In many cases, this development is being done in collaboration with private sector firms. The following activities are examples of work in progress.

Minimum Additive Waste Stabilization (MAWS) Technology

The MAWS system integrates, into a single process, three technologies that are usually employed separately for site remediation: vitrification, soil washing, and ion-exchange wastewater treatment. The MAWS system is centered on vitrification and incorporates all primary and secondary waste streams into a final, stabilized glass waste form. As a result, waste loading is increased, and the final waste volume, as well as the disposal cost, can be significantly reduced by optimizing the overall integrated system rather than a single step.

The MAWS system is currently being demonstrated at the Fernald Environmental Manageme:.. Project in Fernald, Ohio. At Fernald, 350,000 m^3 of residue from uranium ore processing was buried in waste pits. Pit sludge and the surrounding soil and groundwater are contaminated and require remediation. In the MAWS system, the soil washing and wastewater treatment will remediate the contaminated soil and groundwater, whereas the vitrification will incorporate the pit sludge and resulting contaminated soil concentrates and spent ion-exchange resins into a final, stabilized glass waste form.

Soils, primarily contaminated with uranium, will be washed with the TRUclean process to separate the waste into clean soils and soil concentrates. This will be accomplished by passing a slurry of the contaminated soils through a series of scrubbers, gravimetric separators, and hydrocyclone separators.

The water treatment system will handle contaminated wastewater from the vitrification and soil washing systems. Uranium and thorium contaminants will be stripped off by a traditional organic ion-exchange resin and redeposited onto a glass resin that can be fed to a vitrifier, allowing for conventional disposal of the spent organic resin.

The vitrification system (GTS Duratek Duramelter) uses high temperatures (typically between 1100 and 1600°C) to chemically incorporate the wastes into a glass matrix. At these elevated temperatures, glass becomes electrically conductive, and the current passing between the electrodes in the vitrifier causes the conductive glass to heat and maintains the glass in a molten state. Most inorganics oxidize and dissolve in the molten glass because the great majority of oxides are soluble in the silicate glass; organics rapidly oxidize at the high temperatures and form simple gases (mostly carbon dioxide and water vapor), which are collected and treated in an off-gas system.

Magnetic Separation Technology

In another effort, ANL is evaluating the performance and costs of the ACT*DE*CON^{SM} and MAG*SEP^{TM} processes for the treatment of contaminated soil and water. Both processes were developed by Bradtec-US, Inc., and are licensed through Rust Remedial Services. Initially, the problem of soils and sediments contaminated with plutonium at the Mound Laboratory near Miamisburg, Ohio, is being addressed.

The ACT*DE*CON^{SM} process, a chemical washing procedure, has been shown to be effective in removing plutonium from soils like those found at the Mound site. When used in conjunction with MAG*SEP^{TM}, it seems likely that an effective in situ soil remediation process can be developed. The four phases for the overall evaluation process for the Bradtec processes are as follows: (1) preliminary technology performance testing, (2) bench-scale performance tests, (3) pilot-scale performance tests, and (4) final process design, cost estimation, and full-scale field demonstration.

For the full-scale demonstration, the contaminated soil will be contained in a "cell" by means of a selected barrier technology. The purposes of this "cell" are to contain the canal soil and the ACT*DE*CON^{SM} solvents and to prevent plutonium migration, which could result in the further spread of contamination to areas not presently contaminated. The full-scale demonstration will include all aspects of the integrated treatment system, including the following:

- Isolation of the selected treatment area,
- Solvent distribution and contact with soil particles,
- Solvent recovery and reuse,
- Plutonium dissolution,
- Plutonium recovery by means of magnetic separation,
- Magnetic particle recovery and reuse, and
- Waste processing.

A quantitative objective is to achieve a decontamination factor of 10.

<u>Advanced Evaporator Technology</u>

In this research effort, a mobile evaporator/concentrator system is being developed for processing waste removed from the underground storage tanks at Hanford, Washington. Recovering waste from these tanks followed by cesium ion exchange requires the addition of a significant volume of water; a volume increase by a factor of three is anticipated. This additional water would cause problems for the envisioned process for organic/nitrate destruction. An evaporator/concentrator system could be used to remove and recover this water. The water could then be discharged or recycled to the process. A similar smaller-sized unit could also be useful for recovery of nitric acid in the regenerated solution from the cesium ion exchange column. LICON Inc. has developed a transportable evaporator system for processing commercial, nonradioactive waste solutions. Their evaporator, called TRANSVAP, is field deployable, automated, and capable of high decontamination factors.

Argonne and LICON have been working together since 1989 on developing this evaporator for processing high-level waste solutions. Design features being incorporated into this evaporator include criticality-safety-by-geometry, automated (and remote) operation, and remote maintenance capabilities. Specific tasks to be completed are:

- Develop design criteria (e.g., throughput, decontamination factors, anticipated feed concentrations and their variation over time, electric utility and ventilation requirements, and radiation shielding requirements),
- Evaluate effects of contaminate concentration on downstream processes,
- Test LICON's TRANSVAP with simulated feeds,
- Modify LICON's TRANSVAP based on test results, and
- Finalize design and fabricate full-scale unit.

Continuous Emission Monitor for Waste Incinerators

This task addresses the need, mandated by the Clean Air Act of 1990, to monitor air toxics emitted from hazardous waste incinerators. The objective is to develop a Fourier transform infrared (FTIR) spectrometer combined with a heated long-path cell as a continuous emission monitor for incinerators The instrumentation will continuously monitor organic products of incomplete combustion (PICs). To provide the required on-stream analysis, ANL is developing the FTIR technology.

The testing of stack gas from hazardous waste incinerators is required under the Resource Conservation and Recovery Act (RCRA) both during trial burns and in normal stack operation. During trial burns, the principal organic hazardous constituent (POHC) from the waste must be measured. Usually, either carbon tetrachloride or chloroform is selected as a POHC for monitoring because these components are difficult to incinerate. At ANL, we have demonstrated that through the use of a long pathlength cell, FTIR, and analytical software, POHCs can be rapidly identified and quantified in stack gas. The entire process can be automated and results obtained in minutes.

During FY 1992, two tasks were successfully completed. The first task was concerned with the laboratory development of the technology that will be required to field an FTIR continuous emission monitor for hazardous waste incinerators. The second task was concerned with engineering an FTIR system that can be transported to an incinerator for field testing.

During this past year, the field instrumentation was constructed. This equipment is now being tested for two weeks at the Toxic Substances Control Act Incinerator at the DOE K-25 Plant in Oak Ridge, Tennessee. It will be the first test of this system in the field. The FTIR spectrometer will be operational and data collection will be continuous 24 hours a day. Ruggedness of the instrument and stability of component materials will be evaluated.

Ultimately, this work will produce a validated Environmental Protection Agency (EPA) method for continuously monitoring an incinerator. Protocols for blanks, standards, matrix spikes, and duplicates will be developed. All quality assurance and control issues and methodology will be documented to initiate EPA certification.

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