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Monthly Research Progress

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Task 1 Support of Oak Ridge Site Closure

Characterization of Corrosion for Closure of Oak Ridge Research Reactor

Due to lack of funds for the 2007 federal fiscal year, the Oak Ridge collaborators were unable to provide the support required to enable deployment into the Oak Ridge Research Reactor (ORRR) pool.

Task 2 Support of Hanford Single Shell Tank Waste Disposition

In-tank/At-Tank Characterization for Closure of Hanford Waste Tanks

Stereovision. Progress on the stereovision effort was significantly slowed during September by the unexpected departure of the graduate student working on this effort. The retroactive recision of CA07 funds in May has prevented replacement of the graduate student. Lack of manpower significantly limits progress on this and other efforts.

Fourier Transform Profilometry. During September, the results of the ICET Fourier Transform Profilometry (FTP) Stage 1 effort to evaluate the performance of FTP under simulated Hanford waste tank conditions was reported at the 11th International Conference on Environmental Remediation and Radioactive Waste Management (ICEM'07) in Bruges, Belgium.

During September, the camera offset from the centerline of the probe was incorporated into the general correction algorithm. The stitching software was modified accordingly so that results are now reported in terms of tank coordinate system. Ways of reducing measurement error by reducing background fluctuations in flat areas were explored; preliminary testing is being performed using synthetic images.

Process Chemistry and Operations Planning for Hanford Waste Alternatives

Additional information was received from CH2M Hill Hanford on the development of a neural network for C-farm retrievals. It is anticipated that the emptying of the waste in C-farm will continue until 2015. BBI data was evaluated for charge reconciliation and then converted into molecular streams. The first retrieval that will be modeled involves sluicing of tank C-108 with the aqueous phase from the double-shell receipt tank AN-106. The flowsheet for this operation is under development. Work continues on automating the ESP software using the Perl scripting language. This is expected to allow for batch running and data processing enabling faster development of the neural networks.

Task 3 Disposition of Idaho HLW Calcine

Support of the CH2M-WG Idaho Calcine Disposition Project

The fifth pilot-scale run was designed to have about 10% less water in the batch and to mix for 30 minutes (as opposed to 20 minutes previously) in an attempt to increase the compressive strength.

Nine samples were taken, 3 at the beginning (1A, 1B, and 1C), 3 in the middle (2A, 2B, and 2C), and 3 at the end (3A, 3B, and 3C). Compressive strengths measured at 7, 25, and 39 days (see below) are still lower than desired.

7-days

Sample 1A:	213psi.
Sample 2A:	180psi
Sample 3A:	238psi

25-days

Sample 1B:	318psi.
Sample 2B:	387psi
Sample 3B:	374psi

39-days
Sample 1C: 425psi.
Sample 2C: 303psi
Sample 3C: 425psi

(These samples were taken at the beginning (1A-C), middle (2A-C), and end (3A-C) of the run.)

Task 4 Support of SRS Salt Disposition and Other SRS Alternatives

Modeling and Experimental Support for High-level SRS Waste Disposition

ESP simulation difficulties were encountered in mixing the aluminum-rich supernatant from the Batch 5 sludge with projected DDA fractions from tank 41H and the DWPF recycle stream. Specifically non-convergence issues were found when using the zeolite database which is directly associated with aluminosilicate chemistry. This database was originally developed for ESP version 6.5 for evaluation of cancrinite formation in the SRS evaporators. Some problems may arise from attempting to use the database with ESP version 7.0 where revised aluminum chemistry was incorporated. Efforts are in progress to ascertain specific reasons for the non-convergence.

Preparations were made to attend the 2007 SRS, Hanford, and Idaho workshop in Atlanta during early October.

Process Improvements for the Defense Waste Processing Facility (DWPF): On-line Analysis

It has been found that a laser energy above 60 mJ/pulse is needed to detect Cl and F in the simulated batch powder. This laser energy is much higher than what was used in previous pellet measurements (5-10 mJ/pulse is sufficient for all other elements of interest). This indicates the need to find a different to improve the sensitivity of Cl and F detection.

Double-pulse LIBS has been shown promising results in improving LIBS analytical figure of merit by many researchers. The next step will be the setup and testing of a dual-pulse broadband LIBS system for improving LIBS detection sensitivity. Double pulse laser systems available on the market have been compared. A laser system able to provide the proper pulse delay between the two laser pulses for dual-pulse LIBS has been selected. Work to order the dual-pulse laser is in progress.

Process Improvements for the Defense Waste Processing Facility (DWPF): Improvement of Waste Throughput

Preliminary experiments examining the thermal behavior of the various frit/waste simulant combinations using Differential Scanning Calorimetry (DSC) and Thermogravimetric and Differential Thermal Analysis (TGA/DTA) have been inconclusive. More experiments will be done next month to determine whether these analyses provide any useful information.

Process Improvements for the Defense Waste Processing Facility (DWPF): Melter Monitoring

Awaiting feedback from SRNL on the performance of delivered port adaptor and port window assembly during the CEF test runs.

Task 5 DOE Headquarters Support

DOE HQ Road Map

During the month of September 2007, a group of ICET researchers took part in Roadmapping activities. Drs. Jeff Lindner, Yi Su, and Charles Waggoner attended the Roadmapping Workshop for EM-21 in Salt Lake City, UT. ICET personnel also took part in biweekly conference calls of the different working groups. Information and insight gained in these meetings and discussions have been incorporated in the ICET proposed scope of work being developed for 2008.

In addition to taking part in the discussions referenced above, Charles Waggoner met with EM-21 personnel at DOE headquarters in Washington, DC. These meetings included discussion of the status of ICET projects under the 2007 scope of work and to provide briefings on the scope of work that will be included for 2008.

Workshop on Heavy Metal Phytoremediation

This workshop has been rescheduled tentatively for early summer 2008, we will report progress next year.

HEPA and Regenerable Filter Performance Assurance

Evaluation of large CeraMem ceramic membrane regenerable filters was continued during September. Filters were loaded in 1 in. w.c. increments and then backpulsed three times with 100 psi air. All data collected during the previous month's testing was critically analyzed. Based on the analysis, it was determined that the ability to recover filter ΔP from a partially loaded filter when employing air back-pulse cleaning methodology was only marginally successful. There are at least 3 possible reasons why

this may have been so: 1) the back-pulse cleaning system was not optimized for efficient cleaning; 2) the degree of filter loaded had not reached the point of equilibrium that is known to exist between mass captured and stabilized differential pressure following a back-pulse; and 3) the relative thickness of ceramic media essentially disperses the particle removing "shockwave" created by the air back-pulse, potentially requiring a higher back-pulse pressure than that used in our testing protocol.

Bio-availability Studies of Mercury and Other Heavy Metal Contaminants in Ecosystems of Selected DOE Sites

The extractability of mercury in mercury sulfide contaminated Oak Ridge soils with various reagents was compared. The reagents include 4 m nitric acids, 12 m nitric acids, oxalate solution, hydroxylamine hydrochloride, ammonia nitrate, hydrogen peroxide, and edta. Some mechanisms to trigger the solubility of mercury in the Oak Ridge soil were proposed.

A collaboration with New York City University for testing the application of newly developed mercury specific resin to remediate the mercury contaminated soils is planned to initiate.

Phytoremediation and Long-Term Monitoring of Selected Heavy Metal and Radionuclide Contaminants

Some of the samples and data from previous experiments were processed. Meanwhile, the preparation for the next round of phytoremediation experiments has been started.

Task 6 Technology Development

Development of New Technologies for DOE Site Applications

The UV pulsed wavemeter has not yet returned from the vendor. Therefore, the well-documented forbidden transitions in Hertzberg band I $A^3\Sigma_u^+ \leftarrow X\,^3\Sigma_g^-$ of O_2 are used to calibrate the mercury wavelength. Inconsistencies in the laser output necessitate obtaining spectral scans, as opposed to single wavelength measurements, which are intrinsically more time consuming. Experimental results indicate increased fluctuations with the presence of mercury samples placed under the ringdown cavity; however, as opposed to results obtained with the YAG pumped dye laser, there is an inconsistent correlation between mercury concentration and the observed change in ringdown time. Further studies are needed to accurately explain this phenomenon.

The portable ringdown optical bench has been assembled in August. An initial test on the methane (CH_4) has been conducted this month. Two testing schemes were used.

In the first testing scheme, the ambient atmosphere was introduced into the cavity at local atmospheric pressure 753 ± 5 Torr. The atmospheric methane concentration was measured to be 1.7 ± 0.08 ppm. The measuring time was approximately 50 -90 seconds with an average over 30 ringdown events (displaying one methane concentration every 50 -90 seconds). This sampling rate can meet the need of real-time on-site characterization. The second test plan was designed to evaluate the influence of water on the detection of methane. It was found that the measurement of methane was not interfered by the presence of water as long as the water concentration was not higher than 11000 – 15000 ppm. Water absorption will be overlapped with methane's absorption at the measuring wavelength if the water concentration is above this level.

Development of Fiber Optical Sensor Technologies for DOE Site Applications

DOE reduced the FY 07 funding from $5M to $4M dollars for the Institute for Clean Energy Technology. With the reduction in funding, MSU management had to make hard decisions as to which tasks to continue. After a thorough examination of several factors it was determined that Task 6.2 Optical Sensors would be removed from the scope of work. This information has been conveyed to DOE.

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