IN-TANK SUSPENDED SOLIDS PROBE AND SLURRY MONITORING SYSTEM

TECHNOLOGY DESCRIPTION

A collaborative program has been established among Florida International University's Hemispheric Center for Environmental Technology (FIU-HCET), the Savannah River Site (SRS), and Oak Ridge National Laboratory (ORNL) to develop the use of two Coriolis density monitors (called the Dual Coriolis System) for real-time in-tank monitoring of weight-percent suspended solids. Via this method, the slurry and filtered supernatant densities are monitored continuously and the wt% suspended solids calculated by the difference in the densities. In FY00, FIU-HCET took the lead to work with SRS to determine the function and design requirements (F&DR) for the SRS application and complete design drawings. Also in FY00, FIU-HCET conducted cold test loop studies to determine the precision and accuracy of this monitoring approach.

FIU-HCET organized and hosted a workshop on slurry monitoring needs and the capabilities of existing monitors. The workshop developed a scope and schedule to design an in-tank dual Coriolis monitoring system for deployment at Savannah River Site (SRS) in FY 2002. To support the acceptance of the dual Coriolis monitoring system, a laboratory test loop will be constructed to obtain performance data over a range of temperatures, densities, and solids loadings. To assure process control of the conversion and subsequent conveyance, the transport properties of the resultant slurry will be closely monitored. Density, viscosity, weight percent solids, and particle size range affect the ability and reliability of the transport operation. It is imperative that blockages of the waste flow do not occur. Monitoring of the transport properties and the hydraulic indicators (pressure, flow rate, temperature) assures that the conditions for solids settling and plugging are avoided. The dual Coriolis monitors will measure the slurry density and the carrier fluid density to their design accuracy of four significant digits. From these densities a weight percent solids will be calculated which should be accurate to less than one weight percent, well under the requirements of SRS.

Oak Ridge National Laboratory (ORNL) is deploying a larger but simpler dual Coriolis system outside a tank to support a cross-site transfer of waste. Scientists, engineers, and a statistician from ORNL will review the test loop design, help FIU-HCET finalize an experimental test plan for the loop, and review experimental data obtained from the test loop. Data from the ORNL deployment will be factored into the test plan.

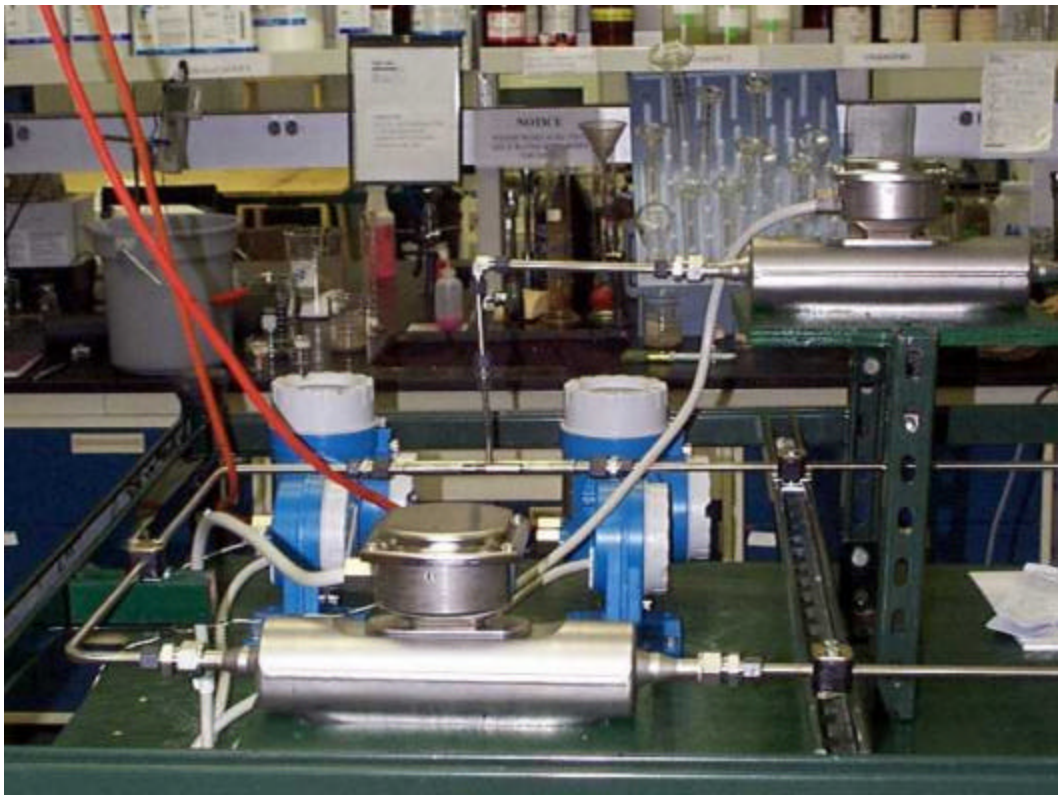
A meeting was held at Hanford with technology users and technology vendors during FY 2000 to better understand their slurry monitoring needs, to discuss performance data of existing monitors, initiate an ongoing dialog between technology users and developers, and to determine a path forward for getting a slurry monitoring system(s) deployed at Hanford.

TECHNOLOGY NEED

Millions of gallons of radioactive waste currently stored in underground tanks at Hanford, Savannah River, Oak Ridge, and Idaho will require processing. The waste typically consists of a mixture of liquid(s), sub-micron sludge, suspended colloids, fine solids, and solidified hardpan. Waste that is to be physically removed from the tanks will be transported through pipelines and processed into a final waste form. Employing a variety of procedures, the waste is converted to a multi-phase slurry prior to transport. Depending on the site, the slurries may have to be transported several miles. Pipeline plugging has occurred during transfers at most sites and can result in very costly delays and intensive efforts to mitigate the plugging. Because the wastes are highly radioactive, it is critical that the slurries be transferred without plugging the pipeline.

Due to the unreliability of many slurry monitors in measuring density, viscosity or weight percent solids, none are used during current retrieval operations. This situation results in grab samples being analyzed

(which takes many hours), exposes personnel and equipment to high levels of radioactivity, and yields an answer that is not representative of waste conditions. The waste settles during the time the mixer pump is turned off to collect sample and perform analysis. To prevent a waste transfer line from plugging and costing the site several million dollars in remediation and repairs, operators will transfer waste at less than optimal



Dual Coriolis Tank Slurry Monitoring Test Loop at the Florida International University Hemispheric Center for Environmental Technology. The horizontal cylinders are the Coriolis monitors. The two upright units behind the front cylinder contain the electronics. The monitors measure the density and weight percent of solids in the slurry flowing through the pipeline to prevent pipeline plugging.

waste loadings. This increases waste volume and waste treatment costs. The in-tank dual Coriolis slurry monitoring system will assure optimal waste loading during mixing and will lessen the mixing time required before retrieving.

Applicable Site Technology Coordination Group (STCG) needs are:

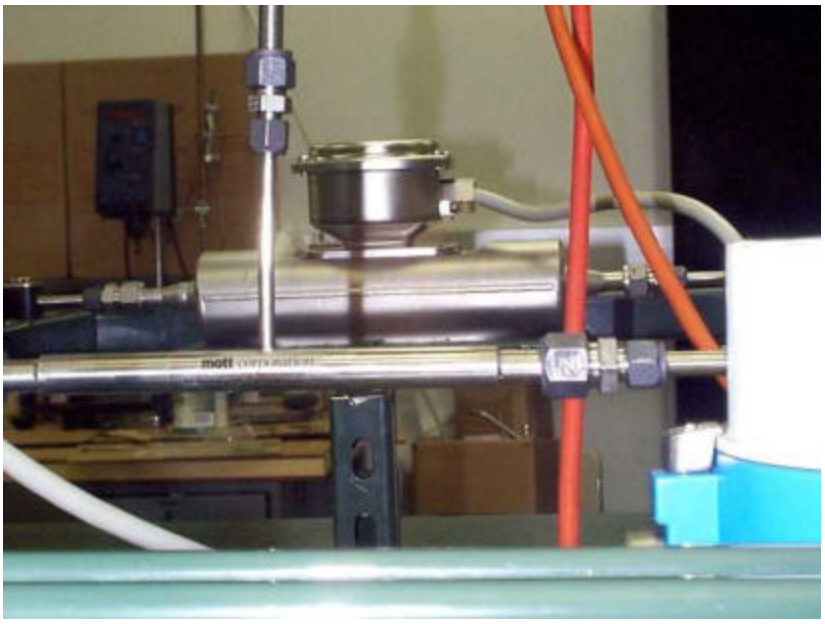
- ORTK-04 - Sludge Mixing and Slurry Transport
- ID-2.1.67B - High Level Waste Slurry Handling - Transport/Store Undissolved Solids
- SR00-2044A – *In Situ* Technology for Waste Characterization - Rheological Properties
- SR00-2037E - Tank Heel Removal/Closure Technology - Real-Time Data for Pumping
- RL-WT09 - Representative Sampling and Associated Analysis to Support Operations and Disposal
- RL-WT032-S - Monitoring of Key Waste Physical Properties During Retrieval and Transport
- RL-WT040-S - Mechanisms of Line Plugging

TECHNOLOGY BENEFITS

The primary benefits of this project are cost savings and reduced health and safety risk. Optimum control of slurry transfer will lower costs by minimizing or eliminating plugged transfer lines. If a plug occurs and conventional methods are not successful in dislodging it, the plugged portion of the pipeline will be replaced or a new pipeline built with remediation of the plugged portion performed later. This problem has in the past cost DOE four million dollars for a single plug. Blockage of transfer lines and inefficient transfer delay the completion of the retrieval operation. The inherent risk associated with the waste remaining in the tanks will be reduced as the transfer operation is expedited. The risk associated with the actual process of transfer and processing is also proportionately reduced. Finally, minimizing line blockage and other maintenance problems significantly decreases the inherent risk.

TECHNOLOGY CAPABILITIES/LIMITATIONS

Slurry monitors for high-level radioactive waste transport are needed for cross site transfers, transfers among tanks in the same tank farm, and for delivery of waste to a treatment facility such as the Defense Waste Processing Facility (DWPF) at SRS. The dual Coriolis in-tank system will be applicable to many DOE site slurry monitoring needs. Some sites will not require a complex, in-tank monitor, others may require less accurate, smaller instrumentation, and still others may require a second slurry monitor to be engineered together with a dual Coriolis monitor into a single deployment unit. The dual Coriolis monitor will accurately function over the entire range of mass loadings, temperatures, viscosities, and pressures for all slurry monitoring applications.



Liquid Phase Extractor. The small diameter vertical tube shown above is a transverse (cross-flow) filter used to extract a sample of the liquid phase of the slurry flowing through the horizontal pipe. The large stainless steel cylinder in the background is one of the two Coriolis monitors used in the test loop.

COLLABORATION/TECHNOLOGY TRANSFER

There is now a need to focus the development of tank slurry monitors on the determination of weight percent suspended solids. In addition, the deployment of slurry monitors must be expanded to Hanford, Idaho National Engineering and Environmental Laboratory (INEEL), and additional sites at SRS. These needs will be met by FIU-HCET experts in technology development working in collaboration with other slurry monitor developers and experts from across the United States. FIU-HCET will be used to obtain a better understanding of tank slurry transport phenomena and to prepare available slurry monitoring technologies for deployment.

SRS will initiate tasks to prepare for the deployment of a weight percent solids monitor at SRS. Of particular importance is the preliminary planning for the deployment of the dual Coriolis system at SRS that is scheduled to occur in FY 2002. In addition, ORNL will deploy a dual Coriolis monitor system at ORNL in FY 2000.

ACCOMPLISHMENTS AND ONGOING WORK

- A formulation for surrogate slurry was created and received concurrence by team members. Primary components are water, sucrose, and kaolin clay. A high shear mixer for preparation and conditioning of the clay is installed and working. The hot slurry is confirmed to be 95 percent within the range of 1 to 10 microns in particle size with 98 percent greater than 1 micron. The chosen surrogate components will allow the blending of combinations that closely emulate the mechanical properties of in-tank slurry.
- Slurry monitoring team conference calls were held periodically with participants from ORNL, Tanks Focus Area (TFA), SRS, Characterization, Monitoring, and Sensor Technology Crosscutting Program (CMST-CP), and FIU-HCET during which details of the design and the test plan, ongoing slurry monitoring activities, and the path forward were discussed. Future calls are expected every three-to-six weeks.
- Efforts to define the desired path forward are continuing. The technical approach is to construct and test the prototype in-tank slurry monitor in FY 2001 with hot implementation to occur in FY 2002.
- An original and revised experimental test and evaluation plan for the laboratory test loop and full-scale dual Coriolis monitoring system prototype was prepared and submitted to DOE.
- The conceptual design for the dual Coriolis monitoring system prototype was submitted to DOE on January 30, 2000. An updated conceptual design document is under review at SRS.
- The essence of the Function, Design, and Requirements (FD&R) has been assembled jointly by SRS and FIU-HCET. The formal document, in the form of a Plant Modification Traveler, was presented to FIU-HCET by SRS in January 2000 and the key elements were included within the conceptual design document. The Draft Conceptual Design for the prototype dual Coriolis monitoring system was submitted to DOE on January 31, 2000.
- A detailed project management sequence illustrated by a Gantt chart was developed for moving from conceptual design, through testing, to deployment of a slurry monitoring system in a real HLW tank at SRS in less than two years.
- The Slurry Monitoring Workshop was held December 14-15, 1999, in Atlanta, Georgia. FIU-HCET met to discuss solutions related to slurry transport integrity particularly related to SRS needs and plans for slurry monitoring instrumentation. A revision of this project occurred at the Slurry Monitoring Workshop, providing a path for moving from conceptual design, through testing, to deployment in a real HLW tank at SRS in less than two years.
- The initial phase of a project that assesses the current and projected future needs for high-level waste (HLW) slurry monitors (contained in STCG Need Statements), previous lessons learned (comparison testing done at ORNL over the past few years), and present applications (from discussions with site users) was completed in December 1999.

TECHNICAL TASK PLAN/TECHNICAL MANAGEMENT SYSTEM INFORMATION

- TTP No./Title: FT00C211 - Center of Expertise for Tank Slurry Monitoring
- Related Technical Task Plans supporting ORNL and SRS on the above-mentioned work are:
- TTP No./Title: OR17C231 - Comparative Testing of Pipeline Slurry Monitors
- Tech ID/Title: 2970 - Dual Coriolis Meters for In-Tank Slurry Monitoring

CONTACTS

David Roelant
Program Manager and Principal Investigator
Hemispheric Center for Environmental Technology
Florida International University
10555 W. Flagler St., Suite 2100
Miami, FL 33174
(305) 348-6625 fax: -1852
roelant@eng.fiu.edu

Troy Sikes
Amer Awwad
FIU-HCET Project Managers
Hemispheric Center for Environmental Technology
Florida International University
10555 W. Flagler St., Suite 2100
Miami, FL 33174
(305) 348-1816 fax: -1852
tsikes@eng.fiu.edu

Gary Johnson
Technology User (for deployments)
Westinghouse Savannah River Company
(803) 208-8026 fax: -0527
gary.johnson@srs.gov

Robert Schreiber
Technical Program Officer
National Energy and Technology Laboratory
3610 Collins Ferry Road
Morgantown, VA 26507
(304) 285-4127 fax: -4100
rschre@netl.doe.gov