COMPARATIVE TESTING OF PIPELINE SLURRY MONITORS

TECHNOLOGY DESCRIPTION

The goal of this project is to assess the capability of various types of in-line instrumentation to monitor slurry transport properties in real time. In FY 1997, nine pipeline and three in-tank instruments were evaluated with non-radioactive slurries for monitoring density, percent-solids concentration, viscosity, and particle size. In addition, the current and power requirements of the transfer pump were evaluated to determine whether these criteria could be used to provide an early indication of a potential problem with a plugged pipeline. In FY 1998, a Slurry Monitoring Test System (SMTS) for radioactive slurries was designed; the SMTS incorporated the most promising technologies from the FY 1997 testing and evaluation. The system was fabricated and included the following instruments for monitoring slurry transport properties: (1) Endress + Hauser Promass 63M Coriolis meter (for monitoring density), (2) Lasentec M600P (for monitoring particle-size distribution), and (3) a prototype ultrasonic solids concentration meter developed by Argonne National Laboratory (ANL). The Lasentec M600P, which was included with sponsorship of the Accelerated Site Technology Deployment Program, was not included in the FY 1997 testing and evaluation but was previously tested with non-radioactive slurries and evaluated by Pacific Northwest National Laboratory (PNNL). In addition, the SMTS contains an in-line-sampling device and instrumentation for monitoring the pipeline pressure, slurry temperature, and power consumption of the recirculation pump.

The SMTS was installed as part of a recirculation loop at the Gunite and Associated Tank (GAAT) project at Oak Ridge National Laboratory (ORNL). The objective of the GAAT project is to remediate and permanently close several inactive storage tanks that were originally constructed in the 1940s. The GAAT project removes the sludges from the various tanks by creating slurries and consolidating them into a single tank. Once the slurries are in the consolidation tank, they will be mixed to homogenize and suspend the solids in the liquid phase (i.e., to form slurries). The slurries in the consolidation tank will be recirculated to and from the SMTS. While the slurries are being recirculated, the various monitoring instruments will determine their transport properties. Samples will be collected and analyzed to verify the accuracy and precision of the data reported by the instruments. After the completion of a successful demonstration, the slurry monitoring instruments will be used to determine if and when the transport properties are acceptable. When the transport properties are deemed acceptable, the slurry flow will be diverted to the cross-site transfer pipeline.

TECHNOLOGY NEED

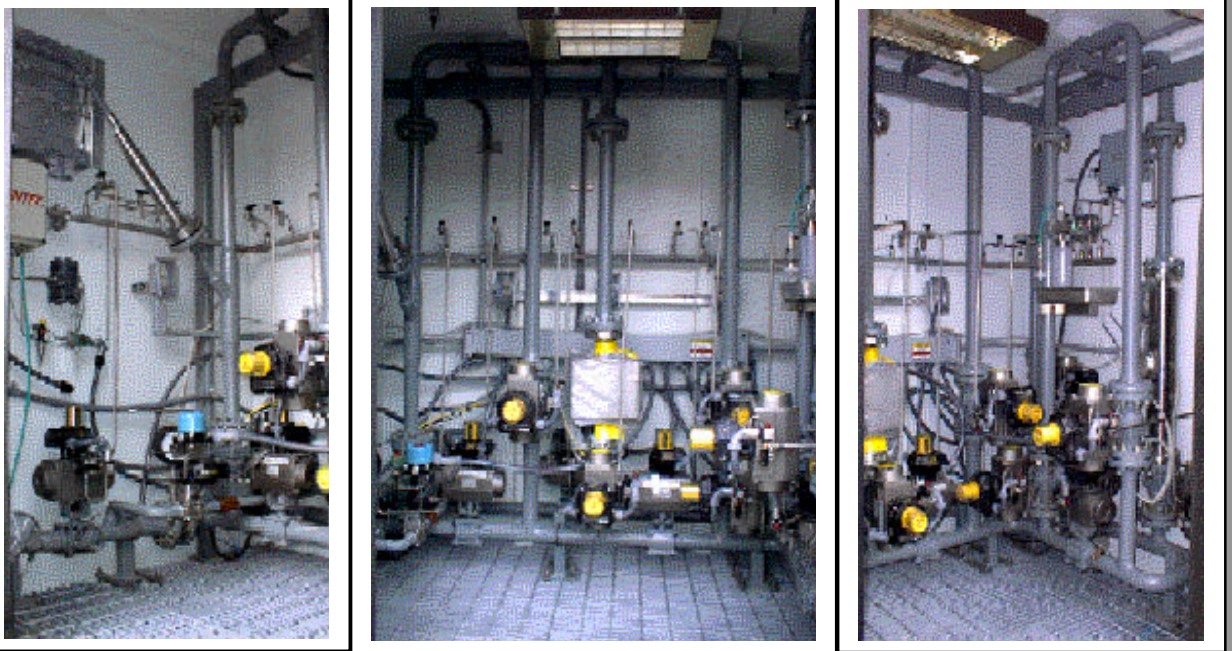
The U.S. Department of Energy (DOE) has millions of gallons of radioactive liquid and sludge wastes stored in underground tanks at sites such as Hanford, Savannah River, Idaho, and Oak Ridge. These wastes must be retrieved from the tanks and processed to a final waste form. For removal from the tanks, the sludge wastes will typically be mixed with the liquid wastes to create a slurry, which is then transferred to a treatment facility through pipelines. Depending on the site, the slurries may have to be transported several miles. Because the wastes are radioactive, it is critical that the slurries be transferred without plugging the pipeline. If a pipeline is plugged with radioactive waste and the plug is not removable by conventional methods (e.g., back-flushing the pipeline with water), the site must exercise one of two options: (1) locating, excising, and replacing the plugged section or (2) building a new pipeline and remediating the plugged line at a later date. Both of these options are expensive, cause delays in schedule, and pose significant risk of worker exposure to radiation.

To prevent plugging, the slurry transport properties (e.g., density, percent solids, particle size, and viscosity) should be determined and adjusted as needed prior to transport. These properties should also be monitored during transport to determine if they are changing. This is especially important for heterogeneous wastes such as those that have been stored. The technology is being demonstrated and deployed at ORNL, in support of the GAAT remediation project. Personnel associated with the Hanford

Tanks Initiative (HTI) are closely following the progress and results of the project because they intend to use in-line slurry monitors in their slurry transfer system.

The applicable Site Technology Coordination Group (STCG) Need Numbers and Titles are as follows:

ORTK-04 - Sludge Mixing and Slurry Transport
RL-WT032-S - Monitoring of Key Waste Physical Properties During Retrieval and Transport
RL-WT040-S - Mechanisms of Line Plugging



The left photograph shows the Lasentec M600P particle-size analyzer probe installed in the test system (mounted at a 45-degree angle). In the middle of the center photograph, the rectangular-shaped item is the suspended solids monitor that was provided to Oak Ridge National Laboratory for testing and evaluation by Argonne National Laboratory. The in-line sampling device (with attached sample bottle) is on the right side of the center photograph. The right photograph provides a more detailed view of the in-line sampling device. The Endress+Hauser Coriolis meter installed in the test system is the silver object, middle right.

TECHNOLOGY BENEFITS

In-line and real-time monitoring of the slurry transport properties provides the site users with the data that they need to make decisions regarding the transfer of slurries through pipelines. Because the slurry transport properties are continuously monitored, the users are provided data in real time. They can then determine if the transport properties are steady and acceptable for transport. This will result in a reduction of personnel exposure to radiation. The slurry monitoring instruments can also be used while transferring the slurries to determine if these properties remain steady during transport. Operators can respond quickly to prevent plugs in pipelines as the situation requires. This technology decreases costs by reducing the number of samples that need to be analyzed. Because the number of samples is reduced, personnel exposure to radiation is reduced (e.g., for the sampler and analyst). With in-line monitoring of slurry properties, the collection of fewer samples also results in the reduction of additional wastes.

The baseline technology for determining the transport properties of the slurries is sampling and analysis. The table below compares sampling and analysis with in-line slurry monitoring. The conclusion is that the latter is the preferred method.

Comparison of Methods for Determining Slurry Transport Properties

Sampling and Analysis	In-line Slurry Monitoring
Sample results represent the slurry transport properties at the time of sampling.	Slurry transport properties are provided continuously.
Sample results are not immediately available.	Results are available in real time.
Changes in the slurry transport properties are detected only when additional samples are collected.	Operators continuously monitor the slurry transport properties and respond with corrective actions as required.
Sampling and analytical personnel are exposed to radiation.	Personnel exposures to radiation are reduced.

If a plug occurs and conventional methods are not successful in dislodging it, the site user is left with the options of locating, excising, and replacing the plugged portion of the pipeline or building a new pipeline and remediating the plugged one at a later date. The benefits of implementing in-line slurry monitoring include the following:

- Avoiding major expenses (over $1M per plug).
- Reducing personnel exposure to radiation.
- Preventing schedule delays.

TECHNOLOGY CAPABILITIES/LIMITATIONS

The SMTS was designed for use with the ORNL cross-site transfer pipeline, which is limited to 300 psig. However, it is conceivable that a monitoring system could be designed for a higher-pressure situation.

COLLABORATION/TECHNOLOGY TRANSFER

As part of this project, ORNL has collaborated with ANL, PNNL, and Sandia National Laboratories (SNL). During FY 1997, these laboratories provided prototype instruments to ORNL for evaluation with non-radioactive surrogate slurries. PNNL also provided viscosity analyses (at high shear rate) for the non-radioactive slurries. In FY 1998, ANL supplied a prototype instrument for measuring the suspended solids concentration of radioactive slurries.

The Hanford Site (through the HTI project) has demonstrated interest in the project by following its progress. Fernald has also shown interest in the testing of the instruments, and a private company has inquired about the testing program for use in its non-radioactive operations.

A technical report that documents the testing and results from evaluation of the various slurry monitoring instruments using non-radioactive slurries has been published ([Hylton et al., Comparative Testing of Slurry Monitors, ORNL/TM-13587).

A paper entitled “In-Line Monitoring of Slurry Transport Properties” was presented at the April 1999 Waste Management Education & Research Consortium (WERC) Conference on the Environment.

ACCOMPLISHMENTS AND ONGOING WORK

FY 1997

- Twelve (12) slurry monitoring instruments (including commercially available and prototype instruments) were tested with non-radioactive slurries. The results from the instruments were compared with results obtained by sampling and analysis.

- A technical report that documented the testing and results from the evaluation of the various slurry monitoring instruments with non-radioactive slurries was published (Hylton et al., Comparative Testing of Slurry Monitors, ORNL/TM-13587). The results were used to select the most promising instruments for demonstration with radioactive slurries.

FY 1998

- A test plan was prepared to document the conditions by which the instruments would be evaluated with radioactive slurries.

- A test system for evaluating slurry monitoring instruments with radioactive slurries was designed, fabricated, and installed at ORNL.

FY 1999

- The selected slurry monitoring instruments were tested with radioactive slurries. The slurry monitoring instruments include the following: (1) Endress + Hauser Promass 63M Coriolis meter (for monitoring density), (2) Lasentec M600P (for monitoring particle size distribution), and (3) a prototype ultrasonic solids concentration meter developed by ANL.

- The results of the FY 1999 testing and evaluation with radioactive slurries will be published in a technical report.

TECHNICAL TASK PLAN (TTP) INFORMATION

This project has received funding under the following TTPs:

TTP No./Title: OR17C231 - Comparative Testing of Pipeline Slurry Monitors
TTP No./Title: OR16WT51 - LMES (Lockheed Martin Energy Systems) Retrieval and Closure (Subtask D)

The project has also interfaced with ANL, PNNL, and SNL in the testing of their prototype instruments for measuring slurry properties. Those laboratories were funded under separate TTPs, as indicated below:

Organization	TTP Number	TTP Title
ANL	CH26C217	Ultrasonic Sensors for *In Situ* Monitoring of Physical Properties
PNNL	RL36C214	*In Situ* Sensor Development — Ultrasonic Density Measurement Probe
SNL	AL26C213	*In Situ* Viscosity and Density Monitoring Using Quartz Resonators

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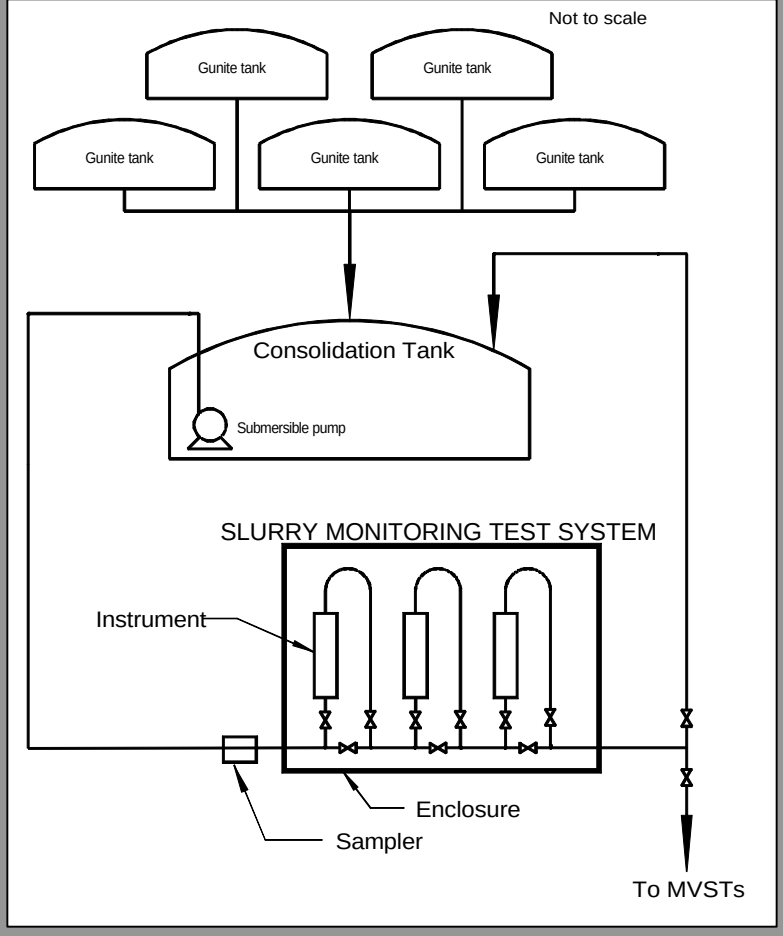

Conceptual diagram of the Slurry Monitoring Test System in the Gunite and Associated Tank (GAAT) Slurry Transport System.