2.2 Acoustic Characterization of Wastes in Double-Shelled Underground Storage Tanks

Technology Need

Information about material properties in underground storage tanks (USTs) is currently provided by intrusive methods such as core sampling, buoyancy-based density measurements, level tapes, and video cameras. None of these methods are effective in determining the distribution of waste types and submerged objects beneath the surface of the waste. In the planned effort to pump the waste out of double-shelled underground storage tanks (DSTs), vitrify it for permanent disposal, and then transfer single shell tank (SST) waste to the DSTs for interim storage, process monitoring will be very important. Critical data will include but will not be limited to, radius of cleaning from the mixer/transfer pump, locations of submerged objects, and density of waste mixtures. The absence of such data could compromise adequately designing a pump, predicting the effectiveness of transfer through lines without plugging, determining how completely a tank has been cleaned, and determining if obstructions or debris in the tank will interfere with pumping. An acoustic method, such as is being addressed in the current work, shows considerable promise of meeting these data needs, which cannot be met by known alternative remote sensing instruments.

Technology Description

This project is developing an acoustic monitoring array to locate and characterize wastes and submerged objects in high-level waste USTs. Two sensors are being developed to comprise a monitoring system: an echo sounder for locating interfaces and tank obstructions, and a density monitor for reporting changes in mixed fluid density during waste mobilization procedures. The array is designed to consist of multiple echo rangers and one or more density monitors mounted directly to the mixer pump. A possible alternative scheme would have sensors deployed through tank risers. Transducers produced for commercial and sport fishing use have been modified to tolerate the high pH, high temperature, and radiologically hot environment in DSTs at the Hanford site. A signal source for making the sonar measurement has been obtained commercially and has been modified to fit the smaller scale and more attenuative environment than as specified for sea water conditions. The density monitor is being developed using the adapted transducers with standard laboratory signal sources and data acquisition equipment. A density monitor and echo rangers have been delivered to the Hanford site and mounted on a mixer pump installed in DST-AN-107. Evaluation of the sensors to measure sludge layer depth, dispersion of the sludge under stirring, changes in supernatant density, effective cleaning radius, and location of

in-tank structures is in progress, and is scheduled to continue through FY96. The prototype monitoring system will be used by Hanford with Ames Laboratory support during the development period. A more automated monitoring system based on FY96 results is being considered for the test/demonstration of a functional test planned to occur in DST-AZ-101.

Benefits

Acoustic monitors will directly facilitate the remediation effort in USTs throughout the United States. The sensors promise to be applicable to any fluid-filled tanks, and as more systems are operated in actual tanks, further development of the data acquisition and control system will allow the technology to be fine-tuned for use in a range of waste types. These systems will, in addition to benefiting the remediation process by monitoring mixing and transfer, provide information to aid in designing the most effective transfer pumps. The sensors are installed as part of the mixer/transfer pump and are operated remotely, which minimizes worker exposure for obtaining monitoring data. Also, since the sensors are expected to survive the environment in the tanks, disposal costs are included in those for the pump at decommissioning. Another benefit is that the remote control of the technology could be extended to be operated through a central control station; for example, via Ethernet control of IEEE instruments, or by modem control using commercial remote control software. This would decrease the cost of monitoring by reducing the number of data acquisition control centers, which are currently expected to be one per tank.

Collaboration/Technology Transfer

Airmar Technology, Raytheon, and Westinghouse Hanford Company have collaborated extensively with Ames Laboratory and Iowa State University on the development of this technology. Westinghouse has cooperated in installing and providing engineering support for tests of the instruments in actual tanks. We estimate they have supplied 0.5 person-years of support in this effort, and have paid for the majority of the installation and safety assessment costs. Airmar has collaborated with Iowa State university researchers to redesign two of their off-the-shelf sensors, choosing robust housings and an appropriate array of piezoelectric elements for use in this application. This company is a small business, but produces a large share of the transducers currently used in hobby and commercial fishing for navigation and fish-finding. Airmar has expressed interest in manufacturing and marketing the finished device, and has the resources needed to handle the job. Raytheon manufactures the pulser used to drive the echo ranging transducers. Engineers at Raytheon have been very cooperative in helping modify the pulsers to be used in the tank environment and by providing engineering drawings and consultations. Raytheon is currently not interested in marketing the device, but is interested in supporting the work as it has in the past. Current planned tests

will initially benefit the development of the instruments and, in addition, will place instruments in tanks that will be used operationally to their full capability as soon as feasible.

Accomplishments

The sensors in AN-107 have successfully observed the tank wall, risers in the tank, a sludge supernatant interface, and small scale motion in the supernate. The direct density, phase shift, and sound speed data, which allow calculation of density changes with the density monitor, indicate that in-tank density changes will be observable. Sensors developed in collaboration with a manufacturer have been deployed in an actual waste tank for over two years, without failure. These sensors are the only acoustic sensors designed and field tested for tolerance to actual conditions in the high-level waste UST environment. Further tests of the echo ranging and density monitoring instruments in a DST are scheduled for early July 1996. Previous deployment of similar instruments in DST-SY-101 succeeded in demonstrating the survivability of the sensor, and the response of the density monitors to changes in tank density during pumping, but the echo rangers were not operated until after considerable tank mixing, and were not useful in interface detection.

TTP Information

Acoustic Characterization of Wastes in Double-Shelled Underground Storage Tanks technology development activities are funded under the following Technical Task Plan (TTP):

TTP No. CH14C212 "Acoustic Characterization of Wastes in Double-Shelled Underground Storage Tanks"

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Bibliography of Key Publications

Clark, M.A., and D.M. Martin, "Acoustic Properties of Underground Storage Tank Simulant Wastes," *Review of Progress in Quantitative Nondestructive Evaluation*, vol. 13, p. 1075, eds. D.O. Thompson and D.E. Chimenti, Plenum Press, New York (1994).