Ultrasonic Probes
Open UST Window

Under current experiments, the probe will be lowered into tanks filled with radioactive wastes. Charting the debris and sediment layers is a crucial first step toward correcting problems in tanks or pumping out old waste.

By Michael C. Purdy

It sounds like a mission to another planet.

Scientists are building a probe to map a place never completely explored. The probe will have to survive high-energy radiation, caustic chemicals, high temperatures and many other obstacles, some of which may be impossible to predict.

Instead of going to Venus or Mars, this probe will be lowered into underground storage tanks (USTs) that are filled with radioactive wastes. Charting the debris and sediment layers in these tanks is a crucial first step for engineers who want to correct problems in tanks or pump out old waste for newer, more effective treatment and storage.

Researchers believe that a relatively simple technology — ultrasonic probes similar to those used in commercial fish-finders — can be adapted to peer through the complex maze of chemicals, sediments, air bubbles, pumps, filters and discarded equipment in these tanks.

"The benefit of ultrasound is the potential for providing a global map of the contents of the entire tank," says Douglas Lemon, a technology manager at the Department of Energy's Pacific Northwest Laboratory. "Ultrasound promises to provide more complete information than can be obtained from other techniques like core samples and single-point measurements."

The environment in some tanks can provide formidable challenges, even for a technique as simple and effective as ultrasound. "Essentially, it's like trying to see through a foggy house of mirrors," says David Martin, Ames Laboratory senior scientist and professor of materials science and engineering at Iowa State University (ISU).

The steel walls of USTs can sometimes act like mirrors, explains Martin, reflecting ultrasonic signals to the point where reflections confuse and obscure data the probe gathers. The "fog" is created by bubbles, particles and layers of sludge-like materials found in some tanks. These obstacles scatter ultrasonic energy and make it difficult to obtain meaningful information about a tank's contents.

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Under Jim Corones, project manager and director of the Environmental Technology Development program at Ames Lab, Martin and Physicist Ronald Roberts are working to solve these difficulties. Roberts works for the Center for Non-Destructive Evaluation on the ISU campus.

An expert on three-dimensional imaging, Roberts is working on new approaches to interpreting the data gathered by probes that should help cut down on problems caused by reflections from tank walls.

Martin and his co-workers are studying sludge and liquid problems in laboratory simulations of tank environments. They are working to develop techniques to see through the sludge, such as reducing the frequency of the ultrasonic signal.

“We’re also measuring the properties of sludges and liquids, how they attenuate the sound,” Roberts says. “This will help us narrow in on what’s happening in the tanks.”

In addition to mapping out the contents of underground storage tanks, ultrasound may help pinpoint potential problems in the tanks.

Stephen Agnew, a technician member at Los Alamos National Laboratory in New Mexico, uses ultrasound to detect the presence of a few liquid tanks. Some of the tanks contain certain components that are producing flammable gases. The gas forms a thin bubble or bubbly layer. Eventually, the gas layer becomes so saturated with moisture that it is lighter than the fuel above and suddenly bursts, blowing the top of the tank off.

Scientists are concerned about the sudden release of such a large amount of flammable gas. “If the fuel were to ignite, the tank would blow and could be severely damaged and cause a large explosion,” Agnew says.

In one case, Agnew found that a solution to put the fuel out and stop the fire was to inject a high frequency ultrasound signal into the tank. The high frequency waves penetrate the bubble layer, and the tank pressure decreases. The fuel then is able to mix with oxygen and will not ignite.

Agnew notes that the high frequency waves may be safer and more reliable according to Agnew. We’ve been using Dave’s expertise to help us explore the benefits and pitfalls of that solution,” he says. “Dave has given us a lot of insight into the use of ultrasonics to disperse sherry and sediments.

For more information, contact Ames Laboratory’s Office of Public Affairs and Information, (515) 294-1866.

-By Michael O’Rourke
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ulate sound, how they scatter it, and the speed of sound as it passes through various materials," says Martin. "We're studying how these properties change with temperature and chemical composition so we know the range of things to expect in these tanks."

Another set of environmental challenges is created by the chemical properties of the waste. "This stuff is very caustic," says Martin. "It is also very radiologically hot and thermally hot, and all of these factors can damage and contaminate our equipment."

Contamination will probably make it necessary to leave any transducers inside the tank after it is mapped. To cope with the problems of heat and corrosion, Martin is testing a variety of materials in the solutions he and others have designed to simulate conditions in the tanks. One recent test subject was a transducer made of bronze. Bronze is noted for resisting the corrosive properties of seawater, but it proved vulnerable to corrosive agents at high temperatures.

The biggest challenges are things in the tanks that are impossible to anticipate. Martin says that many of the complicated chemical reactions and processes are poorly understood. "The lists of chemicals in these tanks are very long, and the tanks themselves are very big," Martin says. "We can duplicate some of the chemistry that's going on in these tanks, but just being able to duplicate it doesn't mean we can understand it."

"We're trying to do sonar in a very hot, corrosive ocean," he says. "We don't really know enough details of what's in the ocean to accurately predict what kind of troubles we're going to encounter, but we're taking a look at all the factors we can anticipate."

Beyond the problem of radioactive waste tanks, Martin points out, the new technology also may be helpful for mapping large underground tanks used for chemical storage or agricultural purposes.

"This technology will probably prove to be helpful for any liquid-storage tank, like a petroleum tank or a tank for agricultural settling processes, where something may crystallize in the liquid or settle out of it," Martin says.

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