Technology Demonstration Fact Sheet

Ultrasonic Liquid-Level Detection Technology

SUMMARY

The Ultrasonic Liquid-Level Detection system uses ultrasonic/acoustic wave transmission through solids and liquids to measure the relative time of flight of the transmitted energy. A *pulse-echo* technique is used that employs a single sensor to determine liquid level. As such, liquid-level information in tanks or equipment can be obtained for use in planning decommissioning activities.

The 221-U Facility contains numerous vessels and equipment that need to be assayed to determine whether liquid is present. The Ultrasonic Liquid Level Detection system was demonstrated to test whether it is a viable technology for use in the 221-U Facility. This demonstration was conducted in support of the Canyon Disposition Initiative (CDI) Project. The CDI Project is analyzing alternatives for the final disposition of the five large chemical processing facilities (canyons) at the Hanford Site. The 221-U Facility serves as the pilot facility for the CDI Project.

INNOVATIVE TECHNOLOGY DESCRIPTION

The liquid detection system uses ultrasonic transducer (UT), pulse-echo-based instruments with custom electronics designed for the manual detection of freestanding liquid in drums, tanks, and pipes. These instruments provide the capability for real-time, simple "Yes/No" electronic detection/ determination of the liquid level. The ultrasonic sensor is a piezoelectric crystal that, when excited by a voltage, deforms the crystal, generating a pressure wave that can be coupled off the face of the crystal.

The ability for water (i.e., liquids) to couple and support acoustic waves is the principle used to find liquid levels. A gel is used to couple the acoustic wave from the piezoelectric-based sensor into the wall of the vessel to be tested. The metal wall has similar acoustic impedance to the gel, along with low attenuation, and will conduct the wave to the other side of the wall. If the tank has water or a liquid with similar acoustic impedance, the inner wall wave will be transmitted at the interface and coupled into the liquid. The liquid will support the wave transmission across the tank diameter to the far side where some of the wave will be reflected back across the liquid. This reflected wave is coupled back into the near wall where it is detected as an "echo" by the same sensor that launched the wave.

In a scanning mode, the sensor is physically moved along an inspection axis, and the point at which the liquid level transitions to air is when the return echo disappears. This location is the fill-level line. The instrument will denote this point by lighting the "no liquid detected" light-emitting diode (LED) and turning off the "liquid detected" LED. Solids, such as sludges, are very attenuative and produce the same apparent result as air; therefore, this instrument is restricted to items that contain liquids.

The barrel/tank tester model uses a 1-MHz transducer and is operable on single-walled steel vessels of diameter range of at least 0.3 to 3 m (1 to 10 ft). The pipe tester uses a 5-MHz transducer and is used on pipe diameter of 10 to 25 cm (4 to 10 in.). Both units use a high-voltage (385-V) excitation pulse source to launch the ultrasonic pulse. The width of the high-voltage pulse is tailored to the transducer frequency. The units are powered by a separate 12-V battery pack and will operate for 4 hours or more. An accompanying AC charger allows overnight recharging of the battery pack.

BASELINE DESCRIPTION

Visual inspection, boroscopic visual inspection, and dipsticks are the baseline technologies for

determining the presence or absence of freestanding liquids in facility equipment. Liquid detection in pipes is accomplished by finding low points and tapping the pipe for insertion of sampling parts.

DEMONSTRATION DESCRIPTION

The Ultrasonic Liquid Level Detection System was demonstrated on three stainless steel tanks at the 336 Building in the 300 Area at the Hanford Site. Tank 1 had an apron beneath the bottom of the tank with approximately 0.5 m (1.5 ft) of water within the tank. Tank 2 had approximately 0.3 m (1 ft) of water, and Tank 3 had no water. The technology was able to determine whether liquid was present in Tank 2, which is similar to applications required at the 221-U Facility. However, it was noted that training is required for correct interpretation of the instrument output.

DETAILS OF BENEFITS

The Ultrasonic Liquid Level Detection System was selected for subsequent deployment at the 221-U Facility in fiscal year 2000.

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