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Abstract for

LINEAR SCARIFYING END-EFFECTOR FOR WALL CLEANING IN UNDERGROUND STORAGE TANKS

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The U.S. Department of Energy (DOE) is responsible for cleaning up and closing 273 large, aging, underground tanks that have been used to store tens of millions of gallons of high- and low-level radioactive and mixed waste. The waste's radioactivity precludes humans from working in the tanks.

At the Oak Ridge Reservation this problem has been addressed by integrating and deploying a suite of remotely controlled technologies—consisting of a long-reach manipulator, a vehicle and a high-pressure sluicing system—to remove the waste from the tanks. This integrated suite has been implemented in the Gunite and Associated Tanks (GAAT) Remediation Project at Oak Ridge and used successfully to clean two 25-foot and four 50-foot tanks. However, methods for improving the efficiency of waste retrieval operations continue to be sought and a number of special end-effectors have been developed to fill gaps in the existing retrieval technologies.

Remediation of the gunite tanks includes scouring the tank walls with water after the bulk sludge has been removed from the bottom of the tanks. During the cold test phase of the GAAT project, the long-reach manipulator was selected as the most suitable deployment platform for wall-cleaning operations. Scarifying the walls produced a dense mist that made it extremely difficult for the teleoperated vehicle to maneuver around the tank while maintaining a constant standoff distance with the scarifying end-effector. The long-reach manipulator, on the other hand, could have the cleaning paths preprogrammed and then essentially operate under instrument control while executing the required wall-cleaning operations. This method worked well on the 25-foot diameter tanks where the arm could be used to scarify the circumference of the tank from a centrally located riser. However, once remediation of the 50-foot diameter tanks was initiated, it became necessary to move the long-reach arm to a riser in each quadrant of the tank in order to complete scarification of the walls. Each move resulted in several weeks of delay in resuming waste retrieval operations. At this point, the vehicle was reconsidered as a deployment platform for scarifying operations since its tether, with a nominal length of 150 feet, made it possible for the vehicle to reach all areas of the tank when deployed from a single riser location.

A new tool, the Linear Scarifying End-Effector (LSEE), was designed and fabricated to compensate for the vehicle's limitations in scarifying operations. The design had to address the following requirements. 1) Extend the effective reach of the remotely operated vehicle to allow cleaning the 10-foot high walls. 2) Follow an autonomous scarifying path such that the vehicle only has to reposition the end-effector at the end of each pass after the mist clears. 3) Be capable of deployment though an existing containment system. And 4) use pneumatic, hydraulic and electrical interfaces already available at the site.

The LSEE uses two nozzles positioned approximately one foot from the wall surface and traveling on a ten-foot long vertical beam to clean a one-foot wide section of the tank wall. The LSEE was designed to operate at pressures up to 20,000 psig although initial operations were administratively limited to 7,000 psig. The nominal flow provided by a high-pressure pump at this pressure was 10 gpm. The two nozzles are mounted on a rotating ACME screw turned by a

small pneumatic motor. The nozzles move in opposite directions to help balance reaction forces transmitted to the vehicle arm. To accomplish this, half of the ACME screw has right-hand threads and the other half has left-hand threads. The motor air-supply contains an electrical valve that can alternate the airflow between ports on the pneumatic motor to change the rotational direction of the motor. Limit switches connected to the electrical valve are placed at the end of the travel route of the nozzles to trigger a directional change on the motor rotation. The end-effector weighs approximately 80 lbs and the electrical valve and limit switches are powered by 110 volt AC electrical power.

This paper will describe the LSEE system design, as well as the operations performed in tanks W-8 and W-9 at the Oak Ridge National Laboratory's South Tank Farm. A β-γ survey was performed before and after wall cleaning to determine effectiveness for removing contamination from the tank walls.