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Mercury Detection and Sampling of Waste Processing Tanks at the Savannah River Site.

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INTRODUCTION

The Defense Waste Processing Facility (DWPF) was investigating the removal and recovery of mercury from process tanks within their Chemical Process Cell (CPC). As a part of this investigation, DWPF engineering wanted to determine how much if any, mercury had collected in the bottom of any of the process tanks. Specifically, the tanks that needed to be checked were the Sludge Receipt Adjustment Tank (SRAT), Mercury Water Wash Tank (MWWT), Slurry Mix Evaporator Condensate Tank (SMECT) and Slurry Mix Evaporator (SME) Tank. This was the first step in investigating where the mercury is accumulating and then determining the amount and composition of the mercury that was collecting at the bottom of the tanks. Savannah River National Lab (SRNL) was tasked with the development of a device which could detect the level of mercury within the process tanks and also a sampler which could grab a sample for further testing of the mercury's composition.

DEVELOPMENT OF THE DETECTION PROBE & SAMPLER.

Detection Probe Lab Scale Testing and Design.

The first lab tests of the probe system were of a basic conductivity design. As the probe would be lowered thru the slurry in the tank the electrical resistance of the fluid would change and a remote readout would enable the operator to read the resistance value. If the probe hit a mercury layer the value of the resistance would then change to zero ohms value on the readout. Markings on the mast of the probe and a laser measurement meter attached to the upper mast would then be used to determine the distance the probe traveled into the tank. Lab scale testing showed that this design would not work with the thick slurry waste which would be inside the process tanks. During lab tests the slurry coated the outer surface and the probe would not detect the mercury layer on the bottom of the sludge. Multiple conductivity designs were tested with the same results.

The second round of lab tests was with a proximity sensor design which could detect the presence of non-ferrous metals. Multiple sensor designs with various detection ranges were successfully tested in the lab environment. The final sensor design was able to detect the mercury level to within 1/16" with repeatable results.

The final design for the probe was based on the successful testing of the proximity sensor. A 17 foot hollow mast was fabricated with the sensor mounted and sealed to the bottom. A control box was mounted to the top of the mast and housed a LED light to confirm mercury detection, distance readout from the attached laser of how far the mast was in the tank and a lithium ion battery pack to power the system. Figure 1 shows the probe system lowered thru the condenser port in a cutaway of a process tank. It also shows, on the right, how the probe may rest if it came loose of the crane hook.

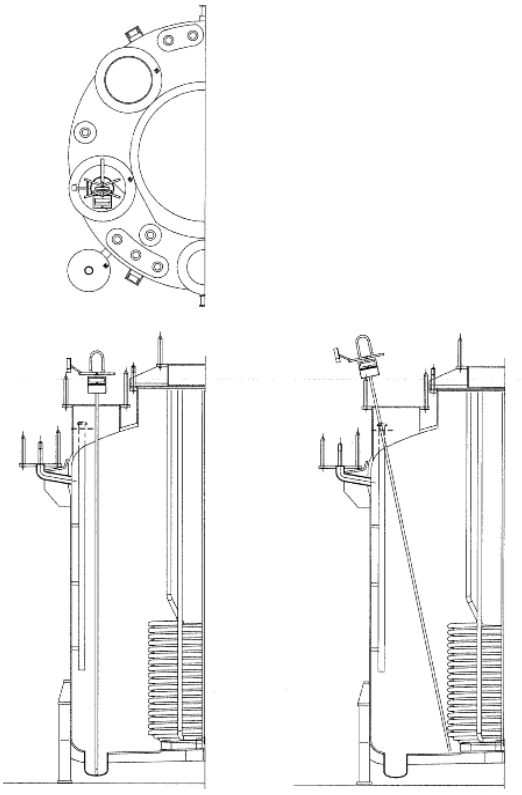

Fig. 1, Probe design within tank.

Mercury Sampling Lab Scale Testing and Design.

The mercury sampler was needed to grab a sample of the slurry at the bottom of the tank which would then be used to confirm the presence and composition of mercury. Initially other designs were considered but it was determined that grabbing a sample from the bottom would give us the best chance of getting a mercury sample. The sampler design is shown in figure 2.

Fig. 2, Sampler design.

The sampler is attached to a 17 foot mast with a crane hook attached to the top. As the system is lowered into the process tank and hits the tank bottom, the plunger on the bottom of the sampler is pushed upward and a sample of the sludge is pulled into the sample chamber due to the release of air thru the top ports on the sampler. When the system is lifted a spring forces the plunger shut and the sampler sealed by an O-ring seal. The system design needed to be completely operated by the actions of the crane due to no electrical power or pneumatic systems available for use in the process room.

After sampling the system was then taken to the extraction rig which was setup next to the cell windows. The rig is shown in figure 3.

Fig. 3, Extraction Rig

Using the cell crane the sampler was lowered with the help of the manipulator onto the cross members inside the funnel, this retracts the plunger and dispenses 310 ml of sample into the transport container shown below the funnel. Video is taken as the material was dispensed into the container and used to determine if any mercury is visible.

RESULTS OF FACILITY IMPLEMEMTATION

The probe and sampler were first tested with the Sludge Receipt Adjustment Tank (SRAT), Slurry Mix Evaporator Condensate Tank (SMECT) and Mercury Water Wash Tank (MWWT). The probe detected a level of mercury in the SRAT but did not detect any mercury layer in the SMECT or MWWT. Sampling of three tanks produced visual evidence of mercury in all three of the samples as viewed thru the cell windows.

Later the Slurry Mix Evaporator (SME) tank was detected to have a mercury layer but failed to attain any sample from the sampler. Assumptions are that a heavy sediment layer on the bottom of the tank prohibited the sampler from sucking in any mercury sample which may have been present.

The facility will ship the samples to SRNL for further composition analysis to determine what form of mercury is present in the sample.