Measurement of the DWPF Canistered Wasteform Weight and Free Volume

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The Defense Waste Processing Facility (DWPF) produced a total of fifty-five canistered wasteforms during four campaigns for the Waste Qualification Program prior to Radioactive Operations. These canistered wasteforms contained borosilicate glasses, which were non-radioactive simulants of the predicted DWPF radioactive glass compositions. Testing of these canisters has been performed as part of a continuing effort to demonstrate compliance with the Waste Acceptance Product Specifications (WAPS)\(^1\).

One part of the testing included the measurement of the weights, glass fill heights and free volume of the canistered wasteforms. The criteria for these tests are based on a maximum weight and a minimum glass fill height equivalency. The canistered wasteforms must weigh less than 2,500 kilograms. All canistered wasteforms met the weight acceptance criterion. All canisters processed in the DWPF are to be filled with glass to a height equivalent of at least 80 percent by volume of the empty canister. Glass in the canister occupying 80 percent by volume would correspond to a height of 218 cm in the canister. All canisters that were measured for fill height during the waste qualification runs, with the exception of two, met the acceptance criterion. These two canisters were partially filled and intentionally moved to the next processing step instead of opting for the completion of the pour.

The final weight of the wasteform was measured by DWPF on the pour turn table (PTT) while still under the melter bellows at the
completion of pouring and at the testing facility using a calibrated overhead crane scale. The glass weight for each canister was determined by subtracting the weight of the empty canister determined at DWPF prior to glass filling and any closure plugs from the final weight of the wasteform measured at the testing facility. These weights were compared to confirm the accuracy of the weights measured on the DWPF PTT. Figure 1 shows the glass weight as determined using the weight measurements from DWPF and the Savannah River Technology Center (SRTC) pilot plant testing facility. The DWPF glass weight was determined using the canistered waste form weights measured on the DWPF PTT before and after filling. The SRTC weight was determined using the crane scale and the empty canister weights measured at DWPF prior to glass filling.

![Graph of Calculated Glass Weights from DWPF and SRTC](image)

Figure 1

Using the measured density of the glass and the volume for an empty canister, a prediction was made of the glass fill height. During testing, discrepancies were noted between the actual and the expected fill level. Further investigation revealed the formation of voids of various sizes in the simulated waste glass. Upon cutting into the wasteform, voids were revealed. The typical
void was approximately two liters and determined to be formed by the shrinkage of the glass during cooling. These shrinkage voids were found in the radial center of the canister several centimeters below the glass fill heights corresponding to pour stoppages.

Several canisters had large differences, up to almost seventeen centimeters, between the measured and predicted fill heights. Cutting of these canisters revealed large voids on the side walls of the canisters. The cause of the larger side voids has not been completely determined, though there does appear to be a dependence on glass viscosity and pour rate. The calculated and measured fill heights are shown in Figure 2.

Free volumes of selected canistered wasteforms were measured. These canisters were specially fabricated with a tap to allow connection to a free volume measurement system. To perform these tests, the free space in the canister was evacuated, then connected to a known volume at a known initial pressure. The free
volume of the canister was calculated after the pressure between the canister and calibrated volume equilibrated.

Results of the weight, fill height and free volume testing show that all canisters tested during the waste qualification runs met the requirements for an acceptable wasteform. Although some discrepancies were noted during fill height testing, the formation of shrinkage voids in the glass is expected and is inherent to the cooling process of the glass. This should not present a problem during radioactive operations because of the use of the infrared detection system in conjunction with the weight measurements to monitor canister filling.

References