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Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Melt Rate Improvement for High-Level Waste Glass

Josef Matyáš
Pavel Hrma
Dong-Sang Kim

August 2002

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

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Summary

An efficient waste-glass melter should have a sustained, high-volume glass throughput. A more efficient operation at higher capacities would result in a smaller vitrification facility, a shorter lifecycle, and glass with a higher concentration of waste, all of which would reduce costs significantly. These benefits would enhance the vitrification of waste at several current and future U.S. Department of Energy sites, including Savannah River, Hanford, and Idaho.

This research is based on a workable hypothesis to control the rate of melting in a high-level waste melter. Its objective is to develop methods for increasing the melting rate, to quantitatively describe the phenomena underlying melt-rate problems, and to propose the ways to solve or mitigate them.

This report summarizes results of research accomplished during the first year of the 3-year project. The data presented in this report have been gathered to support work on the mathematical modeling of waste-glass melters. At this stage, only a qualitative description and interpretation of the observed phenomena has been attempted.

Two Savannah River feeds were used for the study. These feeds were subjected to thermal gravimetric analysis, differential thermal analysis, differential scanning calorimetry, evolved gas analysis with volume-expansion monitoring, modified reboil test, quantitative X-ray diffraction, scanning electron microscopy with energy dispersive spectroscopy, wet chemical analysis, and Mössbauer spectroscopy. Glass viscosity was also measured. Finally, it was recommended to use melt-rate furnace test data to measure thermal diffusivity of the feed.

Though both feed were reduced to prevent oxygen evolution from the melt, oxygen evolved form one of the melts and CO_x evolved from both. Hence, foam is likely to form under the cold cap even when the feed is reduced. An important difference between the feeds was in the melt viscosity at the temperature at which the melt interfaces the cold cap. It was suggested that low viscosity destabilizes foam under the cold cap, thus enhancing the rate of melting.

Acronyms

DOE	U.S. Department of Energy
DSC	differential scanning calorimetry
DTA	differential thermal analysis
DWPF	Defense Waste Processing Facility
EGA	evolved gas analysis
GC-MS	gas chromatography-mass spectrometry
HLW	high-level waste
LAW	low-activity waste
PNNL	Pacific Northwest National Laboratory
RSM	research-scale melter
RT	room temperature
SEM EDS	scanning electron microscopy with energy-dispersive spectroscopy
SRTC	Savannah River Technology Center
TGA	thermo-gravimetric analysis
UV-VIS-NIR	ultraviolet visible near infrared
WTP	Waste Treatment Plant
XRD	x-ray diffraction

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Contents

Figures

Tables