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Melt Rate Improvement for High-Level Waste Glass

Josef Matyáš
Pavel Hrna
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 from 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

Summary	iii
Acronyms	v
Acknowledgments	vii
1.0 Introduction	1.1
1.1 Objective	1.2
1.2 Prior Research	1.2
2.0 Approach	2.1
2.1 Feed Selection and Heat-Treatment Schedule	2.1
2.2 Process Characterization	2.1
2.3 Heat-Transfer Control	2.3
2.4 Mathematical Modeling	2.4
2.5 Research-Scale Melter Tests	2.5
3.0 Experimental Procedures	3.1
3.1 Thermal Gravimetric Analysis, Differential Thermal Analysis, and Differential Scanning Calorimetry	3.1
3.2 Evolved Gas Analysis with Volume-Expansion Monitoring	3.1
3.3 Modified Reboil Test and Bubble Analysis	3.1
3.4 Quantitative X-Ray Diffraction	3.2
3.5 Scanning Electron Microscopy and Energy Dispersive Spectroscopy	3.2
3.6 Wet Chemical Analysis and Mössbauer Spectroscopy	3.2
3.7 Viscosity	3.3
3.8 Thermal Diffusivity (using melt-rate furnace test data)	3.3
4.0 Description of Feeds	4.1
5.0 Results and Discussion	5.1
5.1 Thermal Gravimetric Analysis, Differential Thermal Analysis, and Differential Scanning Calorimetry	5.1

5.2	Analysis of Evolved Gas with Volume-Expansion Monitoring.....	5.6
5.3	Modified Reboil Test	5.9
5.4	Quantitative X-Ray Diffraction.....	5.13
5.5	Scanning Electron Microscopy and Energy Dispersive Spectroscopy.....	5.16
5.6	Mössbauer Spectroscopy and Wet Chemical Analysis	5.17
5.7	Viscosity.....	5.18
6.0	Conclusions and Recommendations	6.1
7.0	References.....	7.1

Figures

1.1.	Schematic Cross-Section of a Glass Melter.....	1.4
2.1.	Photograph of Research-Scale Melter.....	2.6
5.1.	TGA Mass Loss of DWPF Macrobatches 3 Feeds Versus Temperature	5.1
5.2.	TGA Mass Loss Rate of DWPF Macrobatches 3 Feeds Versus Temperature.....	5.2
5.3.	DTA Traces (Temperature Difference Versus Temperature) for DWPF Macrobatches 3 Feeds	5.3
5.4.	$\Delta T/\Delta T$ Versus Temperature for DWPF Macrobatches 3 Feeds	5.3
5.5.	DSC Conversion Heat Rate versus Temperature for DWPF Macrobatches 3 Feeds.....	5.4
5.6.	Comparison of TGA and DTA data for Feed I.....	5.5
5.7.	Comparison of TGA and DTA data for Feed II.....	5.5
5.8.	The Rate of Gas Evolution and Relative Volume Expansion of 10-g Feed I.....	5.7
5.9.	The Rate of Gas Evolution and Relative Volume Expansion of 10-g Feed II.....	5.7
5.10.	The Rate of Gas Evolution from 48.6-mg Feed I.....	5.8
5.11.	The Rate of Gas Evolution of 48.6-mg Feed II.....	5.9
5.12.	Evolved Gas Composition of 10-g Feed I (GS-MS data)	5.10
5.13.	Evolved Gas Composition of 10-g Feed II (GS-MS data).....	5.10
5.14.	Evolved Gas Composition of 10-g Feed I (MS data).....	5.11

5.15. Evolved Gas Composition of 10-g Feed II (MS data)	5.11
5.16. Fractions of Feed Minerals Versus Temperature in Feed I.....	5.14
5.17. Fractions of Feed Minerals Versus Temperature in Feed II	5.14
5.18. Mass Fractions of Intermediate Crystalline Phases in Feed I	5.15
5.19. Mass Fractions of Intermediate Crystalline Phases in Feed II.....	5.15
5.20. RT Mössbauer Spectrum of Glass I (MB3 with Frit 200) Quenched from 900°C	5.17
5.21. Wet Colorimetry and Mössbauer Spectroscopy Fe(II)/Fe(III) Values for Glasses I, II.....	5.18
5.22. Viscosity of Glasses I and II	5.19
5.23. Viscosity of Glasses I and II, Arrhenius Plot.....	5.19

Tables

4.1. Composition of Baseline Macrobatch 3(a)	4.1
4.2. Nominal Composition of Frits in Mass%	4.1
4.3. DWPF Glass Compositions in Mass Fractions	4.2
5.1. Total Mass Losses (in mass%) of DWPF Macrobatch 3 Feeds	5.2
5.2. Mass Losses of DWPF Macrobatch 3 Feeds.....	5.6
5.3. Maximum Volume Expansion (in vol%) and Total Volume of Batch Gases (in mL/g glass) Evolved from 10-g DWPF Macrobatch 3 Feeds.....	5.8
5.4. Volumes of Reboil Gases (in mL/kg glass) Evolved during the Heat Treatment of DWPF Macrobatch 3 Feeds.....	5.12
5.5. Wet Chemistry Analysis of Fe(II) and Fe(III) in Glasses I and II	5.18