Test and Evaluate HLW Vitrification System Improvements – Phase I

Contract Number: DE-AC27-06RV14790

Wing K. Kot, Hao Gan, Keith S. Matlack, Ian L. Pegg
Vitreous State Laboratory

Innocent Joseph, Bradley W. Bowan, II
Energy*Solutions*

Albert A. Kruger
Office of River Protection

Environmental Management
safety ❖ performance ❖ cleanup ❖ closure

www.em.doe.gov

Presentation Outline

- **Project Description**
- **Technical Strategy/Approach**
- **Technical Results and Status**
- **Impact on High Risk/Cost Reduction or Avoidance**

Project Description

Develop high waste loading glasses to treat Hanford HLW

- Hanford HLW spans a wide range of compositions.
- HLW studied under the Bechtel contract are mostly high iron compositions.
- High waste loading glass formulations were developed for HLW with high Bi, Cr, Al and Al+Na concentrations.
- Increased waste loading reduces the number of HLW canisters to be produced. This reduces both operating and disposal costs, and mission duration.
- Through glass formulation optimization, substantial increases in waste loadings are possible.
- Higher aluminum loadings in HLW glass has the potential to reduce the amount of sodium to be added in pretreatment.

Project Description – Technical Strategy/Approach

- Define HLW compositions of interest.
- Develop high waste loading glass formulations.
- Prepare and characterize crucible glass melts.
  - *PCT, $T_{1\%}$ (temperature at which crystal content = 1 vol%), viscosity, electrical conductivity, K-3 refractory corrosion.*
- Based on crucible test results, select fully compliant glass compositions for melter tests.
- Through melter tests, determine feed processing characteristics, including glass production rate.

Technical Status and Results

- Fully compliant glass formulations with high waste loadings were developed for all four of the HLW compositions specified by ORP.

- High-Bi glass has a Bi_2O_3 concentration of 6.7 wt% versus WTP contract minimum of 2.0 wt%.
  - Processing rate: 830 kg/m^2/day at 1150°C and 1200 kg/m^2/day at 1175°C.
  - Identified risk of glass foaming on canister centerline cooling heat treatment.

- High-Cr glass has a Cr_2O_3 concentration of 1.1 wt% versus WTP contract minimum of 0.5 wt%.
  - Processing rate: 1150 kg/m^2/day at 1150°C and 1300 kg/m^2/day at 1175°C.
  - Spinel formation was not the waste loading limiting factor.
  - Since this HLW contained sulfur, chromate/sulfate salt formation limited waste loading.

Technical Status and Results (continued)

- High-Al glass has a Al_2O_3 concentration of 24 wt% versus WTP contract minimum of 11 wt%.
  - Processing rate: 550 kg/m^2/day at both 1150°C and 1175°C.
  - Waste loading limited by spinel formation, and nepheline formation on canister centerline cooling heat treatment.

- High-Al+Na glass has a Al_2O_3 concentration of 21.3 wt% versus WTP contract minimum of 11 wt%.
  - Processing rate: 400 kg/m^2/day at 1150°C and 900 kg/m^2/day at 1175°C.
  - Waste loading limited by spinel formation, and nepheline formation on canister centerline cooling heat treatment.

- Identified the risk of low throughputs with high aluminum WTP feeds. This risk was addressed during the next phase of this work.

Project Impact

- Potential for substantial waste loading improvements in Hanford HLW was demonstrated.
- The demonstrated increases in waste loadings would result in potential reduction in HLW canister count by ~5000 – 6000.
- Assuming one million dollars per canister each for production and disposal, this translates to potential saving of >10 billion dollars.
- High-Al glass work is applicable to waste processing at SRS. However, testing with frit as glass former additive rather than chemicals is needed to assess the impact of waste processing using these types of formulations at the DWPF.
- Better information on waste loadings in HLW glasses allows DOE to more accurately estimate cost and schedule for the missions at Hanford and SRS.