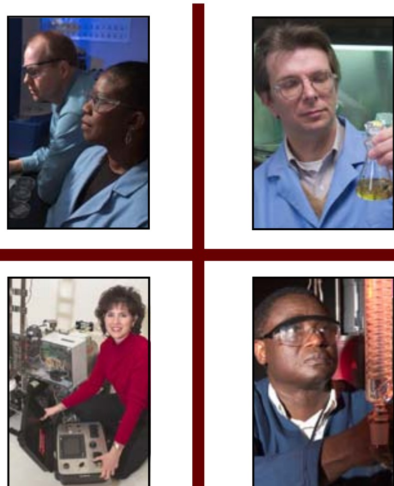
# Impact of Alkali Source on Vitrification of SRS High Level Waste



SRNL™
SAVANNAH RIVER NATIONAL LABORATORY

**We Put Science To Work**


M. E. Stone, D. P. Lambert, D. H. Miller, D. K. Peeler, M. E. Smith
Immobilization Technology Section
Savannah River National Laboratory


November 2005

# Overview

- Introduction
- Objectives
- Experimental Methods
- Results
- Conclusions
- Questions

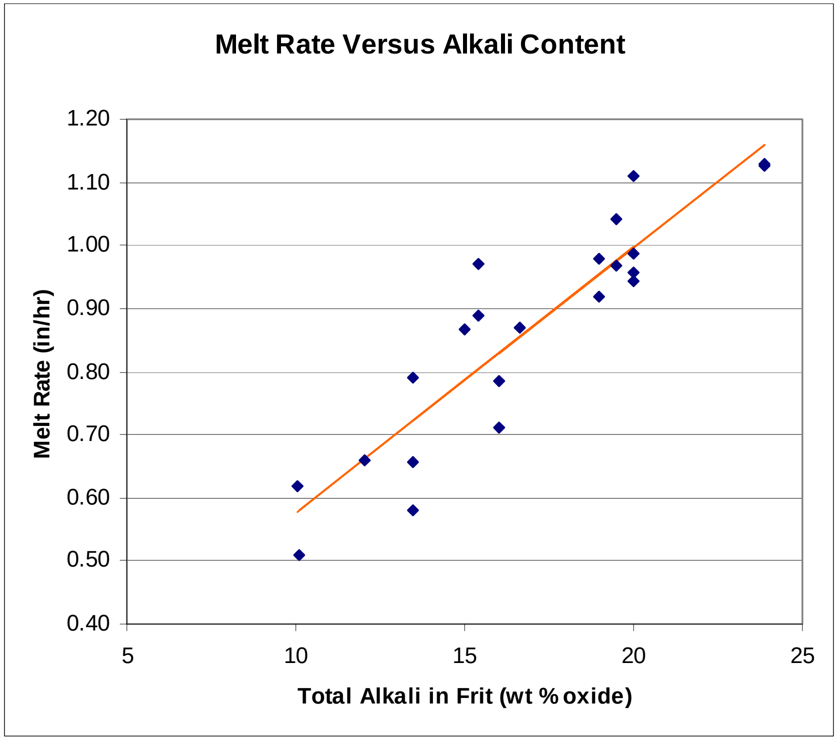
SRNL™

# Introduction

- The Savannah River Site (SRS) is currently immobilizing high level radioactive waste slurries from Cold War operations at the Defense Waste Processing Facility (DWPF)
  - Insoluble species are metal oxides/hydroxides
    - Fe, Al, Mn, U, Ni, Ca, Mg
  - Soluble species are primarily sodium salts
    - Nitrite, nitrate, hydroxide, carbonate
  - Vitrification used to stabilize waste
- Production rate improvement for DWPF decreases costs and speeds stabilization

SRNL

# Introduction: Alkali Impacts on Vitrification Plant




- Alkali content is a major factor in the operation of DWPF
  - Vitrification Impacts
    - Melt Rate
    - Offgas Quantity and Composition
  - Glass Quality Impacts
    - Durability
    - Glass pool viscosity
  - Pretreatment Impacts
    - Acid addition amount to acidify sludge
    - Rheological properties of process slurries
    - Offgas Quantity and Composition

# Introduction

- Waste alkali
  - Sodium and potassium salts
  - Sludge washing strategy adjustable
    - Sludge is washed in “sludge batches”
    - Each batch represents 2 to 3 years of DWPF processing
    - SB3 washed to ~ 1M soluble sodium
- Frit alkali
  - Sodium and lithium oxides
  - Frit composition adjustable to reach “optimal” composition for a given sludge batch
- Emphasis during source of alkali testing was on sodium content

SRNL

# Objective

- Evaluate how the source of alkali (waste versus frit) impacts the pretreatment and vitrification processes of the Defense Waste Processing Facility.

SRNL™

# Experimental Methods

- Non-radioactive simulants used during testing
- Five simulants prepared to simulate varying the sludge washing
  - Sludge Batch 3 used as midpoint
  - Simulants named for amount of sodium in corresponding frit
    - 0% is least washed, 16% is most washed
- Five frits prepared to match the five simulants
  - Frit 418 used for midpoint (8% Na)
  - Frits named for amount of sodium in frit
- Melter feeds prepared targeting the same final glass composition
  - Waste loading adjusted as required to maintain constant final glass composition

SRNL

# Experimental Methods: Pretreatment


- Small-scale (2.5 liter) tests conducted to replicate the first stage of pretreatment (SRAT cycle)
  – Frit addition not performed (SME cycle)
  – Acid addition factor was set to 155% for all runs
  – Offgas composition measured with an on-line gas chromatograph
  – Samples taken for composition and physical property measurements
- Larger scale (15L) runs performed to provide feed for slurry-fed melt rate testing
  – SRAT/SME cycle performed

# Experimental Methods: Melt Rate

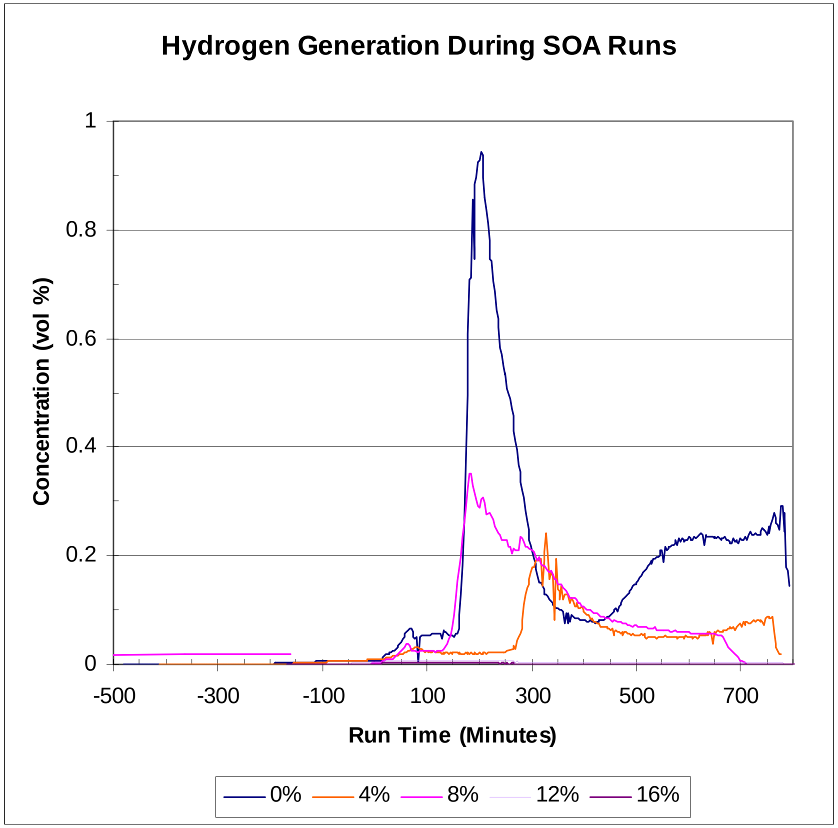
SB3: Frit 200

SB3: Frit 320

- Dry-Fed Melt Rate Furnace (MRF)
  - 4” diameter beaker
  - Dried feed added to beaker
  - Beaker sides/insulated
  - Beaker placed in top loading furnace for ~ 50 minutes
  - Beaker pulled and sectioned
  - Glass amount measured
- Slurry-Fed Melt Rate Furnace (SMRF)
  - 8” diameter test vessel
  - Slurry-fed in increments of ~ 90 ml
  - Each increment added when vapor space reaches setpoint
  - Continuous overflow glass pouring
  - Melt rate determined from glass pour rate

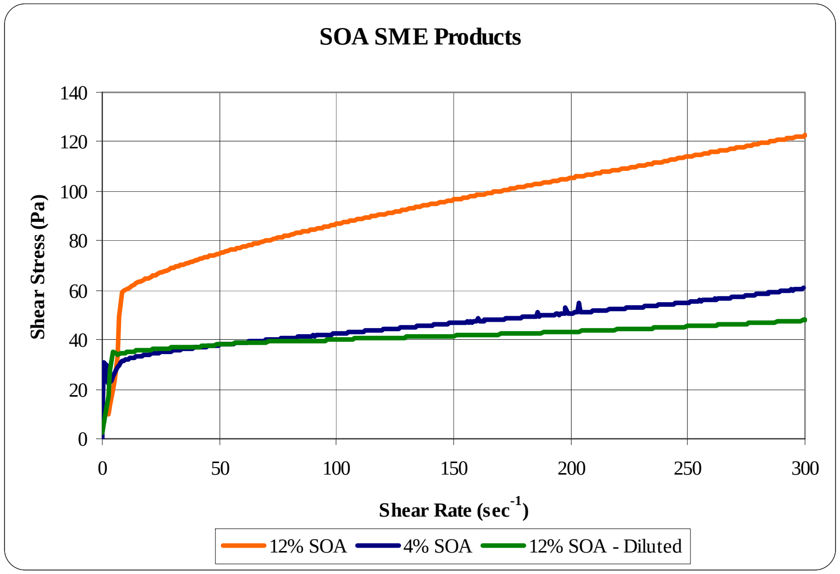
SRNL

# Results: Pretreatment Offgas Composition



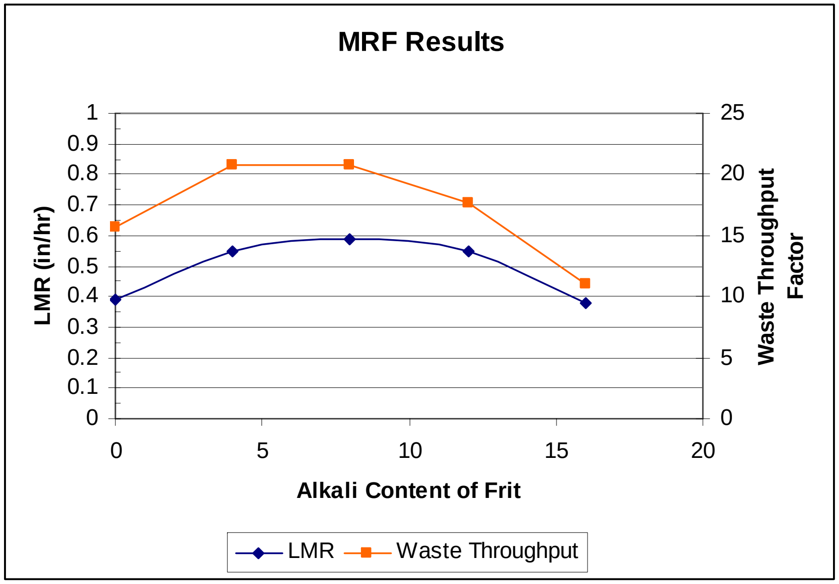

- Higher levels of offgas generation noted in less washed feed
  - Some soluble species (nitrite, carbonate, etc) generate gases
  - Larger acid demand adds more formic acid to generate hydrogen
  - Hydrogen generation significantly greater for less washed feeds

# Results: Rheology of Melter Feed




- Melter feed rheology impacted by amount of sodium in sludge feed
  - Same targeted solids (50% total solids) results in higher insoluble solids for more washed feed
  - Adjusting more washed feed to same insoluble solids concentration as less washed feed yields similar yield stress values

# Results: Melt Rate




- MRF results indicated a broad optimal region
  - Melt rate maximum centered on SB3 baseline
    - 21% Na in sludge (oxide basis)
    - 8% Na in frit (8% Li also)
  - Waste throughput factor optimal to the less washed side of SB3 baseline
  - Refractory frit or waste on either side of optimal point likely hindered melt rate
- SMRF results confirmed results of MRF testing
  - More washed melter feeds required dilution prior to testing

SRNL

# Conclusions

- Broad optimal region for sodium content in the waste in terms of melt rate impacts
- Less washed waste requires more acid during pretreatment
- Less washed waste generates more offgas (including hydrogen) during pretreatment and vitrification
- Less washed waste is less viscous at same total solids content due to higher soluble solids content

SRNL™

# Questions