SRNL Work to Support the Removal of Slurries from Waste Tanks, the Transport of Slurries in Pipelines, and the Separation of Solids from Liquids at SRS

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SAVANNAH RIVER NATIONAL LABORATORY
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Michael R. Poirier

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Introduction

- Savannah River Site (SRS) liquid waste contains slurries composed of solid particles and salt solution
- Effective processing of these slurries important to Tank Farm and DWPF operation
- Slurry processes include mixing, retrieval, transport, and solid-liquid separations
- Talk will discuss SRNL experience in testing and recommending processing methods for these slurries

Slurry Mixing (Tank Farm Processes)

- Occurs in waste tanks (~1 million gallons) and process tanks (1,000 – 30,000 gallons)
- Waste tanks generally mixed with slurry pumps (jets), spargers
- Process tanks generally mixed with agitators, spargers

Approaches to Recommending Mixing Equipment and Operating Parameters

- Tank Farm Experience
  - Limited data
  - Anecdotal
- SRNL Testing
  - Simulant rather than actual waste
- Computational Fluid Dynamics (CFD)
- Other DOE Site Testing
- Technical Literature

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SRNL Testing

- Evaluated mixing of Bingham plastic slurries in a 85 ft diameter tank
  - Developed model of effective cleaning radius
- Testing to evaluate resuspension of sludge/MST slurries after sitting for 6 weeks at elevated temperature
  - Able to resuspend high yield strength slurries even though cavern model predicted they would not be resuspended
  - Fraction resuspended was a function of time
  - Yield stress was a function of setting time
- Measure rheology (yield stress) of SRS slurries

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Waste Retrieval

- Bulk sludge removal
  - Mix sludge with 1 – 4 slurry pumps and transfer to downstream process
- Sludge Heel Removal
  - Remove sludge heels from waste tanks prior to closure
    - Slurry pumps
    - Flygt mixers
    - Chemical Cleaning (oxalic acid dissolution)
    - “New Technologies”
- Salt Removal
  - Add “water”, dissolve salt with or without agitation, and transfer to downstream tank

Waste Retrieval Testing and Demonstrations

- Flygt mixers to remove heels in sludge tanks
  - Testing performed at 4 scales
  - 1.5 ft, 6 ft, 18 ft, and 85 ft diameter
  - Different scaling for sludge and zeolite
- Waste Tank Salt Removal Demonstration
- Chemical Cleaning Demonstration
  - Laboratory-scale testing of sludge heel dissolution using oxalic acid
  - Actual waste and simulant

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Slurry Transport

- Need to pump slurries between waste tanks, process tanks, and facilities
- Concentrated sludge slurries
  - 12 – 18 wt % solids
- Dilute slurries
  - < 5 wt % solids

Slurry Transport Testing

- 1980s
- Georgia Iron Works (Chris Randall, Dave Lewis)
- TNX (John Fazio)
  - 500 foot, 3 inch stainless steel pipe
- Feed concentrated slurry (Bingham plastic)
- Measured pressure drop as a function of flow rate and rheological properties
  - Compared with Hanks model – good agreement
- Resuspension Tests
  - Allowed to sit for 7 days
  - Flow immediately established when pump started
- Flushing Tests
  - 2 – 3 line volumes needed to flush transfer line

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Slurry Transport Calculations

- Fast-settling or slow settling
- Fast-settling slurries
  - Use correlations by Durand, Wasp, Turian, Walton, others to calculate minimum transport velocity
- Slow settling slurries
  - If Bingham plastic, use Hanks model
- Calculate needed flow rate, pump discharge pressure by both approaches

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Solid-Liquid Separation

- Needed for many processes
  - Salt Waste Processing Facility
  - Actinide Removal Process
  - Enhanced Processes for Radionuclide Removal
  - Small Column Ion Exchange
  - Effluent Treatment Facility
  - Sludge Washing
- Impacts process throughput
- Technologies investigated include filtration, centrifugation, flocculation, settling-decanting

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Solid-Liquid Separation Technology Assessments

- Alternative Filters for ETF (Georgeton and Poirier)
  - Pilot-scale
  - Rotary filter, tubular ultrafilter, and ceramic microfilter performed best
- Solid-Liquid Separation Technologies for DOE Applications (McCabe)
  - Paper study
  - Tubular crossflow filter recommended technology
  - Testing needed
  - Baseline in many SRS processes
- Solid-Liquid Separation Technologies for SRS Salt Processing (Poirier and Fink)
  - Paper study, bench-scale testing, pilot-scale testing
  - Identified rotary filter as plausible technology
- Evaluation of Alternative Filter Membrane media (with INL)
  - Bench-scale Testing
  - Ceramic membranes produced higher flux than stainless steel membranes

Filter Testing

- Tubular crossflow filter
  - Bench-scale with simulant
  - Bench-scale with actual waste (SRS and Hanford)
  - Pilot-scale with simulant
  - Obtained design data
  - Evaluated alternative filter media
- Rotary microfilter
  - Bench-scale with actual waste
  - Pilot-scale with simulant
  - Full-scale with simulant
  - Evaluating new technology

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Lessons Learned

- Pore size dependent on manufacturer
- Filter flux
  - Polymer > ceramic > stainless steel
- Need to test to select best pore size
- Many commercially available flocculants not suitable for high pH, high ionic strength material in SRS Tank Farm
- Centrifuge not effective at separating particles typical of SRS waste
- Flocculation + settling-decanting could remove fraction of the solids, but would need polishing filter

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