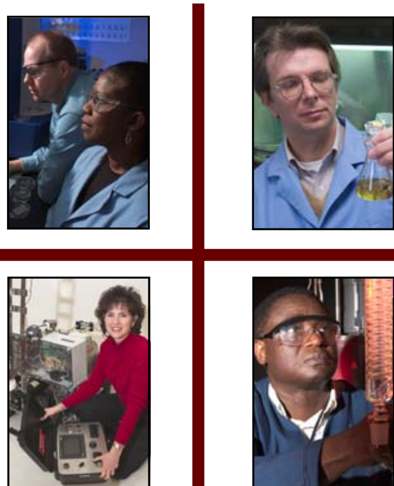
SRNL WTP Pilot Testing



SAVANNAH RIVER NATIONAL LABORATORY

We Put Science To Work

Dan Burns
Process Engineering Development Group Manager
Savannah River National Laboratory
December 4, 2007

SRNL Pilot Testing Experience in the PEDL

The Process Engineering Development Laboratory (PEDL) has conducted extensive Chemical/Waste Processing Pilot Testing for the last 10 years. These test programs have supported both WSRC Operations/Programs and the Hanford WTP.

PEDL pilot-testing activities have ranged in scale from a few gallons of material processed to over 10,000 gallons.

This discussion will examine the Best Practices and Lessons Learned that have been generated over the last several years of testing in the PEDL.

SRNL

Pilot Testing Programs Reviewed

- Small-Scale Ion Exchange (IX) Testing (2001 - 2003)
  - Multi-Year Program; Chemical & Hydraulic Performance
  - 1" to 12" ID IX Columns
  - 10 – 100s gallons processed
- Large-Scale Ion Exchange (IX) Demonstration (2003 - 2004)
  - 24" ID IX Column
  - 10Ks gallons processed
  - 24 hour operation
- Semi-Integrated Pilot Plant (SIPP) Testing (2003 - 2004)
  - Tested an integrated Evaporation, Filtration, and IX WTP flowsheet
  - 10s – 100s gallons processed
- PJM Mixing / Gas Release Testing Program (2003 - 2007)

SRNL™

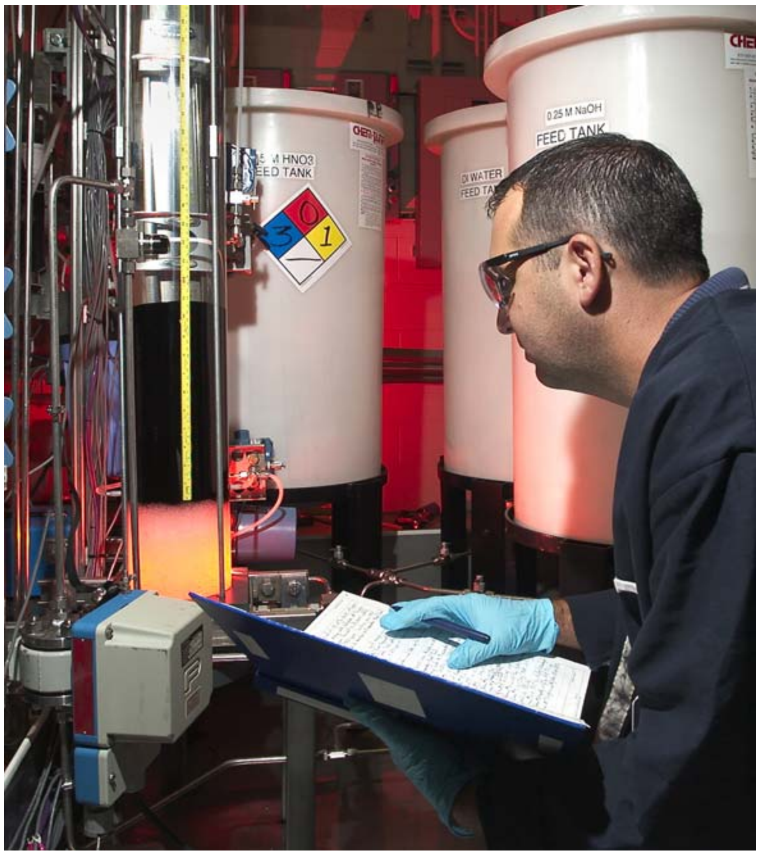
Small Scale IX Testing - Background

- Objective
  - Provide chemical and hydraulic performance data to permit scale-up of bench-scale real-waste testing

- Facility Description
  - Initial concept was a 1”ID x full height (90”).
  - System was fully automated to allow 24/7, unattended operation.
  - Subsequent testing was conducted in 2”, 4”, and 6” columns with aspect ratios from 4.6 (design) to 2.0.
  - All testing with non-rad chemical simulants (AN105)

SRNL

Small Scale IX Testing - Design



- IX System Designs
  - Used clear PVC or acrylic
  - Easily Modified
  - Heavily Instrumented
    - Flow, Pressure, pH, Temp, Conductivity
  - Early Designs Automated / Later Designs Manual Operation
  - Used Computer DAS w/ flow and pressure control
  - 1-2 Man Operation

Small Scale IX Testing - Background

- Multi-Year testing program for IX resin testing was developed and initiated.
- Startup of the system was delayed 6-8 weeks due to numerous problems with automated controls.
- Initial testing revealed an unexpected pressure excursion during operation in the full-height, 1” column.
- Numerous attempts to find “work-around” for hydraulic performance issue were unsuccessful, resulting in significant negative schedule and budget variance.

SRNL

Small Scale IX Testing – Lessons Learned

- Programmatic
  - Insufficient resources were budgeted and scheduled
    - Baseline budget/schedule developed prior to definition of scope
    - Utilized "success-based" planning with no contingencies
  - Researchers tended to accommodate Customer requests without communicating impact to task budget/schedule
  - Transmittal of preliminary/unreviewed data caused problems (quick turnaround vs. reviewed/accurate)
  - Personnel changes resulted in disconnect between plan and work

SRNL

Small Scale IX Testing – Lessons Learned

- Design/Construct/Checkout
  - System was designed for unattended, 24/7 operation. Significant delays resulted from numerous control valve failures, problems with automatic sampler operation, and LabView software/hardware issues.
  - Heavily instrumented system does provide useful information in system troubleshooting; however, significant resources are required to setup and maintain accurate instrumentation.
  - Highly automated systems minimize system flexibility.

SRNL

Small Scale IX Testing – Lessons Learned

- Testing
  - Unattended operation introduces numerous risk, including loss of data, aborted runs, etc.
  - The severity/complexity of the hydraulic issue was not initially recognized.
  - Attempts to minimize variance by finding "quick fix" resulted in:
    - Lack of consensus on path forward
    - Decision to conduct diagnostic testing without written plan
    - Significant scope, schedule, and budget variance
  - Program restored by significant effort to develop detailed technical program plan with Independent Consultant review and consensus on scope, budget, and schedule.

SRNL

Large Scale IX Testing - Background

- Objective
  - Demonstrate acceptable resin hydraulic performance

- Facility Description
  - Acrylic and stainless steel 24” OD IX column, heavily instrumented
  - System tanks and piping primarily polyethylene and CPVC.
  - All testing with non-rad chemical simulant (AN105 and AP101). Simulant recycling used (4-5X per run [3500 gal]).
  - 24/5 operation for 12 runs (5 weeks)
  - Rotating 12 hr shifts / Minimum of 3 operations personnel

SRNL

Large Scale IX Testing - Background

SRNL

Small to Large Scale IX Columns

Large Scale IX Testing – Best Practices

- Simulant
  - Use of simplified simulant recipes (major salt constituents, no hazardous metals or organics) had a significant cost benefit.
  - Great care/planning must be taken when recycling simulant.
    - Cost benefit (materials and disposal)
    - Critical parameters must be monitored (SG, viscosity)
    - Precipitated solids can be a problem (stability, makeup)
    - AN105 was problematic. AP101 was much better.
    - Verify with testing that recycling is viable.
  - Allow time/materials for replacement simulant.

SRNL

Large Scale IX Testing – Best Practices

- Programmatic
  - A thorough "Readiness Assessment" was a very effective tool in confirming all Safety, Conduct of Operations, Facility Support, and Technical Issues were addressed prior to testing.
  - An independent Process Hazards Review was useful in identifying all hazards.
  - A "Technical What If" assessment provided valuable insight into potential problems and documented appropriate responses. All "key players/decision makers" need to participate and "Buy In".
  - The Test Program was designed/set-up to provide flexibility to adapt to emergent problems.

SRNL

Large Scale IX Testing – Lessons Learned

- Design/Construct/Checkout
  - Inadequate time was scheduled for thorough equipment checkout.
  - Back-up personnel need to be trained and available to cover test extension or loss of personnel (e.g. sickness, emergency, etc.), especially critical for 24 hour operation.
  - Detailed/thorough water runs will minimize problems encountered during testing.

SRNL

Large Scale IX Testing – Best Practices

- Testing
  - Use of overlapping shifts provided good continuity to operations.
  - Active Customer support and involvement (presence) during testing allowed quick response to emergent issues.
  - The compiling/transfer of daily summary data (e-mail) was effective in providing test status and disseminating accurate information.
  - The level of authority (decision making power) for Customer, Operations, and Technical Staff must be clearly defined (especially important at 2:00 am).
  - Sufficient resources should be allocated for rapid data processing. Expectations for data (frequency and quantity) must be defined.
  - Need to recognize all the impacts of 24 hour operation on a normal "days-only" workforce.

SRNL

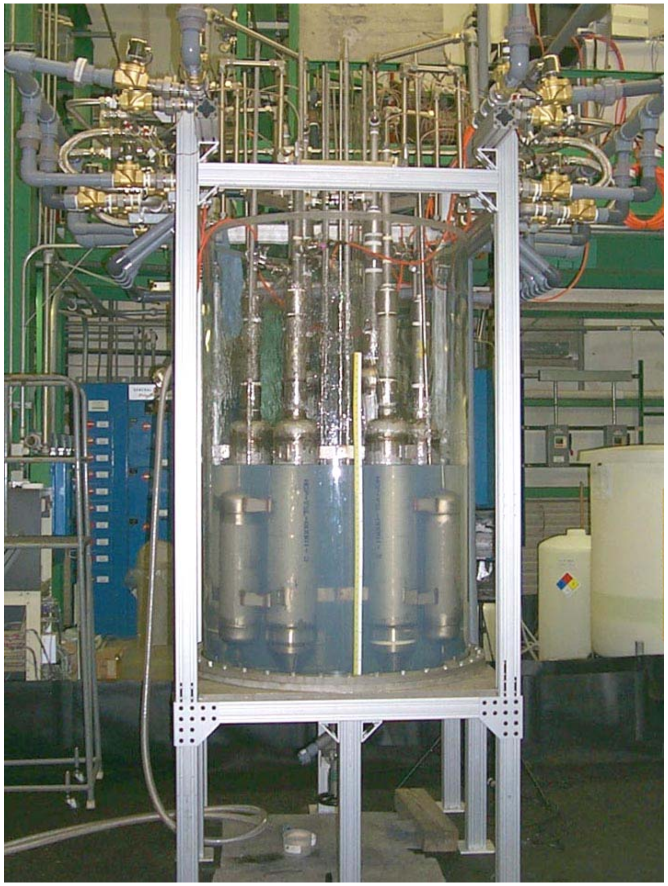
Mixing & Gas Release Testing - Background

- Objective
  - Measure gas retention/release rates and mixing effectiveness of several simulants under varying mixing conditions and configurations.
- Facility Description
  - Acrylic tanks with ID of 7”, 14”, and 42” equipped with various mixers (mechanical, pulse jet, and bubblers)
  - Gravimetric, colormetric, laser, and capacitance level instrumentation
  - All testing with non-rad chemical simulants (clay, laponite, AZ101)
  - Multi-year program

SRNL

Mixing & Gas Release Testing - Facilities

1/4 Scale Mixing Tank
42” ID



1/9 Scale Mixing Tank
14” ID

SRNL™

Mixing & Gas Release Testing – Best Practices

- Simulant
  - Simulants with suspended solids require special care when handling/mixing, particularly if transfer between tanks/containers.
  - Consider biocides to prevent algae growth
  - When scaling up simulant preparation, the recipe developer should be involved, do not rely on a procedure/report.
  - Scale-up of simulants with suspended solids can be problematic
  - If contracting a vendor to scale-up/manufacture simulant, thorough review and oversight of their equipment, practices, and procedures is strongly recommended

SRNL™

Mixing & Gas Release Testing – Best Practices

- Programmatic
  - Communication between Customer and Performing Organization are critical. Weekly meetings and calls should be a minimum. Also, **publishing the minutes** is very important to avoid miscommunication.
  - Always question the need every test, no matter what we say/think, they all consume schedule and budget.
  - Cost control is best achieved by holding a firm end date.
  - When working with computational modelers, get the modelers to review and approve the test plan/matrix.

SRNL™

Mixing & Gas Release Testing – Lessons Learned

- Design/Construct/Checkout
  - When planning to use new/untried instrumentation technology, allow time proof-of-principal testing, calibration procedures, etc.
  - When working with large volumes of compressed gases, noise will likely be a significant hazard
  - Laser liquid level measurement is a good technology. It is inexpensive, non-contact with process solution, very accurate, and easy to calibrate. 3rd party software much better than vendor-supplied.

SRNL

Mixing & Gas Release Testing – Lessons Learned

- Testing
  - Hold a firm test end date
  - Researchers (and Customers) will often find a reason to add another test
  - Level measurements in small vessels are affected by evaporation and accumulation on all wetted surfaces
  - Simulants (especially complex chemical mixtures with solids) can change properties over time and with use (or storage)
    - Rheology can change with shear and time
    - Solids can fracture or grow
    - Precipitation can occur
    - Foaming tendency can change

SRNL

Semi Integrated Pilot Plant (SIPP) - Background

- Objective
  - Operate pilot facilities to demonstrate an integrated WTP pretreatment process flowsheet. Testing must include recycle streams (both internal and from vitrification).

- Facility Description
  - SIPP testing included the following operations; Waste Feed Evaporation Process (FEP), Ultrafiltration Process (UFP), Cesium Ion Exchange (CIX), Treated LAW Evaporation Process (TLP)
  - All testing with non-rad chemical simulant (AY102/C106)
  - 150 gallons of TLP concentrate produced for vitrification

SRNL

Semi Integrated Pilot Plant - Facilities

Ion Exchange

Evaporation

Ultrafiltration

SRNL

Semi Integrated Pilot Plant– Best Practices

- Simulant
  - Verify critical parameters of simulants. Do not rely solely on following simulant manufacture procedures.
  - High solids-loading slurries need special equipment for handling, transport, and mixing.

Semi Integrated Pilot Plant – Best Practices

- Programmatic
  - Complex integrated test programs require very detailed plans and sufficient resources allocated for this critical role throughout the program.
  - Label, Label, Label; Prelabel all containers and samples with a rigorous numbering system. Complex test have many distractions and can have 100s-1000s of samples and containers. Be prepared to manage this with appropriate containers, storage, sampling plans and labeling system.

SRNL

Semi Integrated Pilot Plant – Best Practices

- Design/Construct/Checkout
  - Use of existing, operational test facilities minimizes equipment/facility operational problems.

SRNL™

Semi Integrated Pilot Plant – Best Practices

- Testing
  - A **Status Board** is a very useful tool. This posting allowed tracking activities as they were completed. Information posted included:
    - Needed Calculations or analytical results
    - Volumes (or mass) of chemicals to be added (or removed)
    - Indicate specific protective equipment requirements
    - Schedule for activities and when they were completed
    - Experiment status and preliminary results
  - Do not rely on stated/published analytical uncertainties for critical analyses. Cesium in high molar sodium solutions has been a problem at desired low detection levels. Run matrix standards and blanks to verify acceptable analytical detection levels.

SRNL