Near Tank Cesium Removal

Project Number
745964

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Environmental Management
safety ❖ performance ❖ cleanup ❖ closure

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NTCR Presentation Outline

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

NTCR Project Description

Describe technology need/requirement(s)

- Deployment of the NTCR process will:
  - Accelerate the start of WTP LAW Vitrification Facility up to 6 years freeing up DST space to accept SST retrieval waste
  - Supply feed to supplemental treatment (Bulk Vitrification)
- The NTCR process is an efficient, simple process:
  - Regenerable resins with an extended life
  - Readily deployable and mobile
  - Fixed lead/lag column configuration
  - In-situ spent resin destruction
- The NTCR process is based on extensive actual waste testing and deployment of proven technologies
- Full-Scale deployment does not require additional actual waste testing

NTCR Project Description

Relate to High-Impact Risk / Cost Issue

- Fixed lead-lag column configuration
  - Simplifies piping and valve configuration to aid in deployment
- Employs the new spherical Resorcinol-Formaldehyde resin
- Low temperature elution to extend resin lifetime
- Eliminates the handling of spent resin through the in-situ resin digestion process
  - Resin dissolution in column using mild conditions
  - TOC destruction in a separate vessel with more aggressive oxidizing conditions

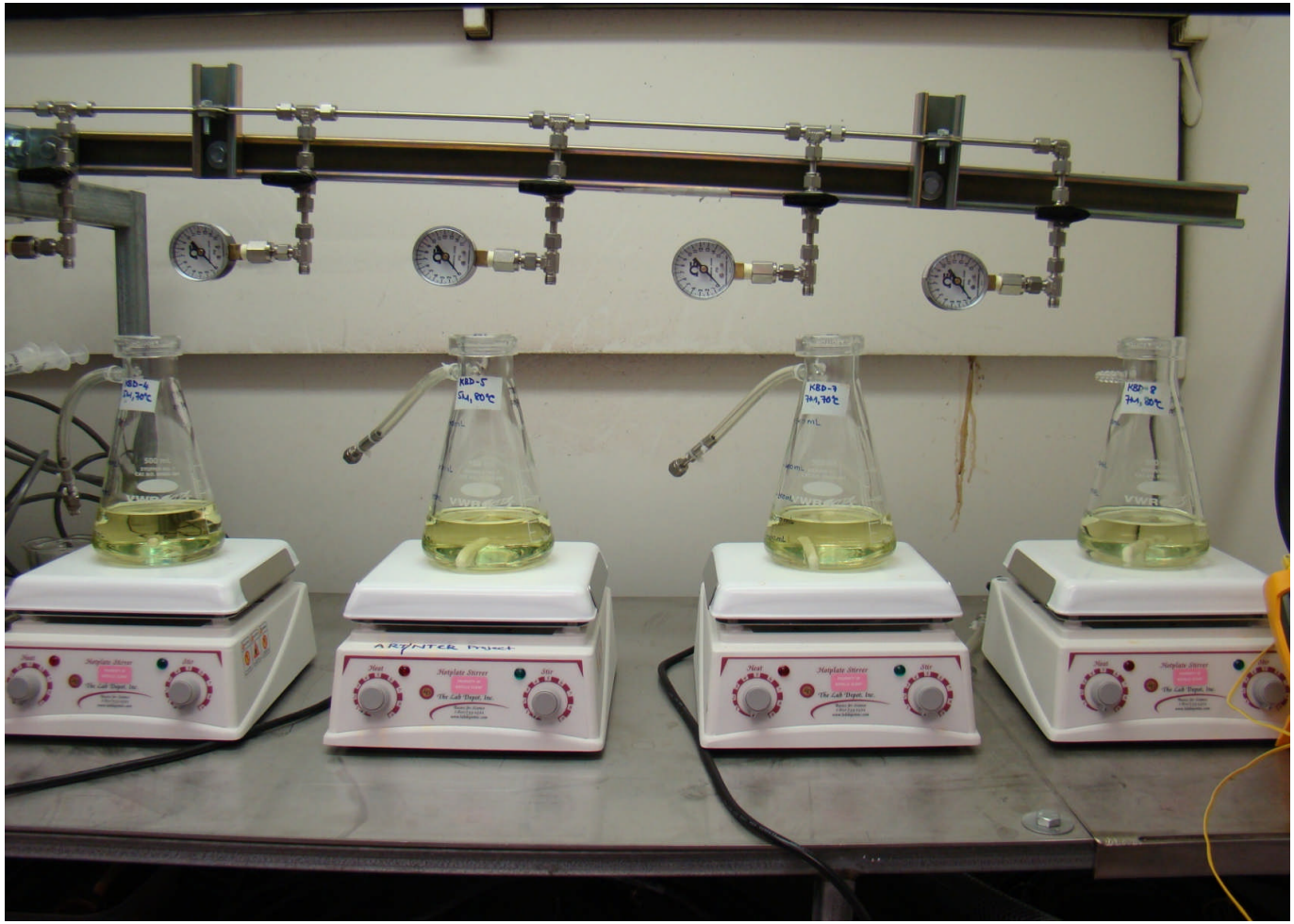
NTCR Phase II Task 1: Technical Strategy/Approach

- Batch Resin Dissolution/Destruction
- Small Column Resin Dissolution
- Small Column Ion Exchange Tests

Batch Resin Dissolution/Destruction: Technical Strategy/Approach

- Determine the optimum process conditions for the small-column resin destruction process testing
  - Small-scale studies of resin dissolution kinetics
  - Minimum condition tests for dissolution of resin from column
- Provide initial characterization of the aqueous nitric acid resin destruction residues
  - TOC analyses
  - SVOC analyses for selected liquid samples
  - Nitric acid consumption

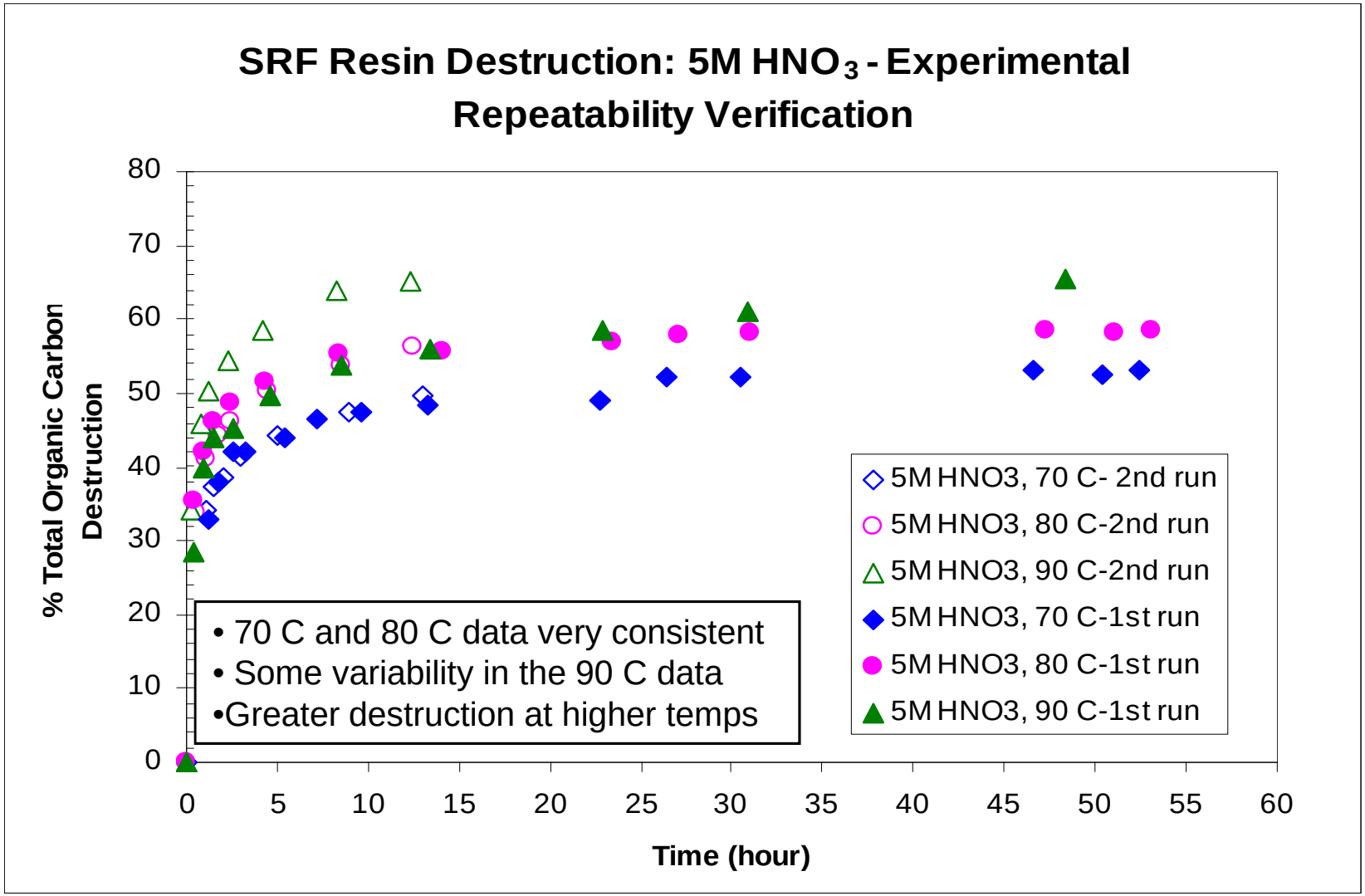
Batch Resin Dissolution/Destruction: Test Equipment



Batch Resin Dissolution/Destruction: Kinetics Tests

- Initial nitric acid concentrations: 3, 5, 7 M
- Nitric acid quantity: 24–35 times the minimum theoretical quantity needed for resin destruction
  - large excess of acid to isolate impact of [TOC]
- Heat acid to test temperature (70, 80, 90 ^{o}C); add resin beads
- First sample immediately after complete bead dissolution; subsequent periodic sampling

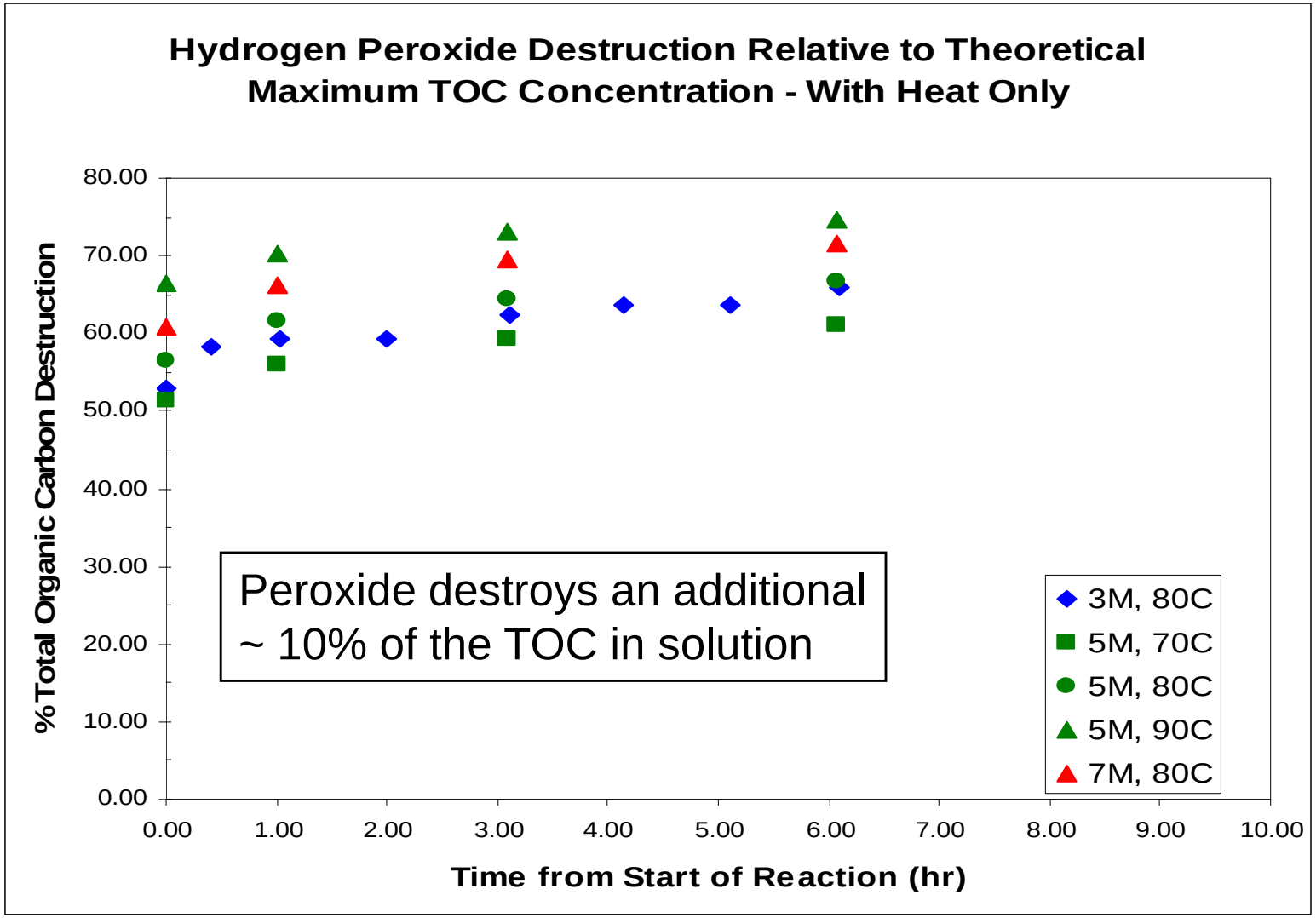
Batch Resin Dissolution/Destruction: Kinetics Test Results



Batch Resin Dissolution/Destruction: Hydrogen Peroxide Tests

- Hydrogen peroxide solution concentration: 31.5%
- Temperature: 40°C
- Reaction time with heat: 6 hours
- Hydrogen peroxide quantity: 1-2 times the minimum theoretical quantity needed for remaining TOC destruction

Batch Resin Dissolution/Destruction: Hydrogen Peroxide Tests



Batch Resin Dissolution/Destruction: SVOC Analyses

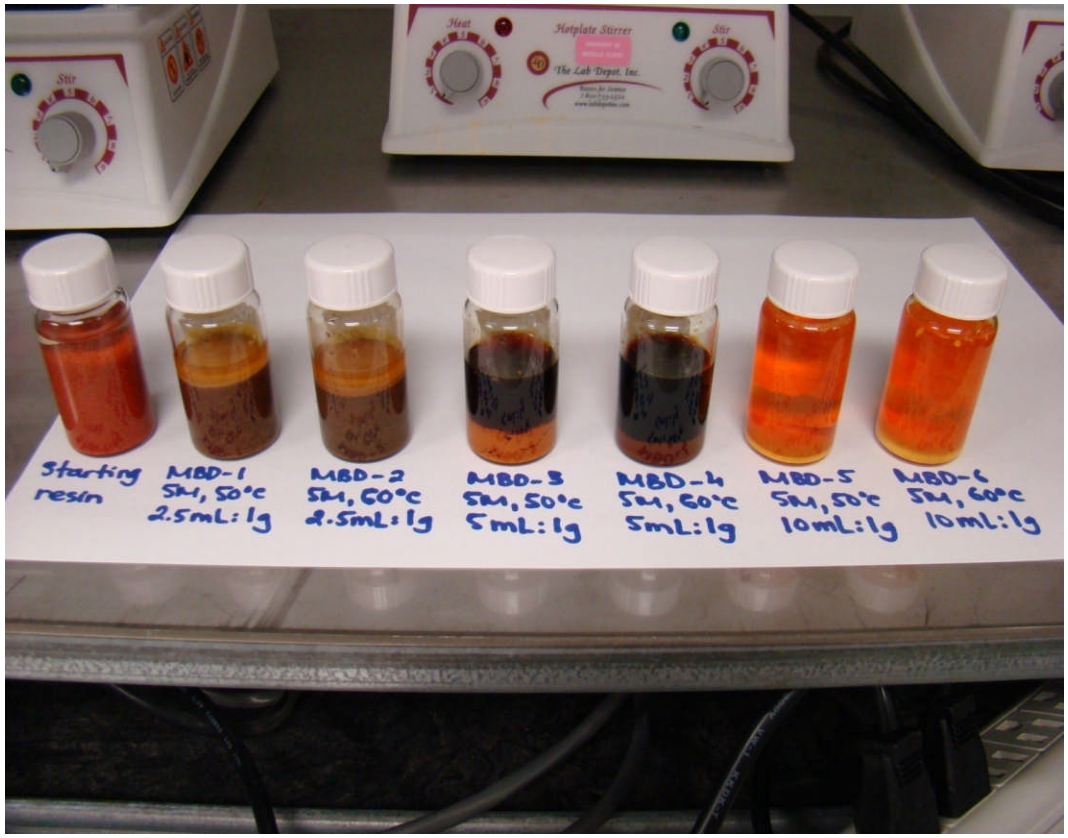
- Five liquid samples from kinetics batch destruction tests and five from peroxide destruction tests analyzed for semi-volatile organic compounds (SVOC)
  - EPA Method 8270C
  - 73 target compounds; all tentatively identified compounds (TICs) also requested
- Three of the peroxide samples analyzed to date
  - None of the 73 compounds found
  - Small amounts of acetone and fluorinated nitrophenols tentatively identified.

Batch Resin Dissolution/Destruction: Minimum Dissolution Conditions

Acid Conc (M)	Acid Vol per 1 g Resin (mL:g)	Temp (°C)	Observations	Solid Residue (~ Vol% of Original)
5M	2.7 mL : 1 g	50	Very vigorous boiling; Most resin beads didn't dissolve	80%
5M	2.7 mL : 1 g	60	Very vigorous boiling; Most resin beads didn't dissolve	80%
5M	5.3 mL: 1 g	50	Very vigorous boiling; Fine powder residue	35%
5M	5.3 mL : 1 g	60	Very vigorous boiling; Fine powder residue	30%
5M	10.6 mL : 1 g	50	Slow boiling; Fine powder residue	10%
5M	10.6 mL : 1 g	60	Very vigorous boiling; Fine powder residue	10%
5M	10.6 mL : 1 g	40	No boiling; Fine powder residue	40%
5M	10.6 mL : 1 g	45	No boiling; Fine powder residue	30%
3M	10.6 mL : 1 g	60	Slow boiling; Fine powder residue	15%
3M	10.6 mL : 1 g	70	Vigorous boiling; Fine powder residue	10%
3M	14.5 mL : 1 g	60	Slow boiling; Fine powder residue	10%
3M	14.5 mL : 1 g	70	Slow boiling; Fine powder residue	5%

Green text indicates viable conditions

Batch Resin Dissolution/Destruction: Minimum Dissolution Condition Final Solutions



Resin Dissolution/Destruction: Successfully Demonstrated

- Minimum condition tests successfully dissolve resin beads
- Most (> 50%) of remaining solution TOC destroyed
- No hazardous SVOCs identified in liquids (still in-progress)
- Results support a two phase resin dissolution process
  - Low temperature and acid concentration to remove resin from column
  - Higher temp and acid concentration to destroy TOC in separate vessel
- All complete except SVOC and report

Small Column Resin Dissolution: Technical Strategy/Approach

- Determine optimum process conditions for safe execution of the NTCR demonstration unit resin destruction process tests
- Provide initial characterization of off-gases for an initial assessment of off-gas treatment needs
  - VOC
  - NO_x

Small Column Resin Dissolution: Technical Strategy/Approach

- Equipment
  - Small column (1 cm – 2.5 cm dia)
  - Small tank (1 liter – 1 gallon)
  - Pump
  - Off-gas sampling system for VOA and NOx
- Method
  - Resin bed L/D ≈ 1
  - Circulate HNO_3, warmed to dissolution temp, through bed
    - Circulation needed to meet required acid: resin ratio
  - Complete digestion in tank, at higher temp and/or acid as required

Small Column Resin Dissolution: Status

- Equipment assembled
- Shakedown testing in-progress
- Test completion planned this fiscal year
- Report may be delayed to first quarter of FY09

(This activity is currently behind schedule due to delay in full funding)

Small Column IX Tests: Technical Strategy/Approach

- Assess impact of proposed process conditions on Cs IX performance
  - Abbreviated LAW displacement
  - Short upflow elution
  - Upflow resin conversion to Na form with high density solution
- Evaluate impact of feed variability on resin performance
- Evaluate low temperature Cs elution
  - Extends resin lifetime

Small Column Ion Exchange Tests: Method

- Small columns (10 mL resin beds) to minimize waste generation
- Three simulants that bracket compositions of the likely first four double shell tank supernates, and one simulant for a dissolved saltcake
  - Target 6 M Na in feed; some reduced to 5 M Na based on initial set of tests
  - Bracket Cs and K concentrations
  - Simple compositions, but include components that test for efficiency of feed displacement and resin conversion: $Al(OH)^-_4$, NO_2^-, CO_3^{-2}

Small Column IX Tests: DST Simulants

	Tank Compositions (M)				Target Simulant Compositions (M)		
Species	AP-108	AP-104	AN-101	AN-104	DST-1	DST-2	DST-3
Na	6	6	6	6	6	6	6
K	0.08	0.05	0.06	0.13	0.13	0.13	0.05
Total [Cs] (X 10-5)	5.3	5.8	4.3	11.7	12	6	6
Al	0.5	0.8	0.5	0.6	0.3	0.3	0.3
nitrite	1.5	1.6	1.6	1.2	1.6	1.6	1.6
nitrate	1.8	1.9	1.6	1.6	2	2	2
free OH	1.3	1.4	1.0	1.7	1.5	1.5	1.5
TIC--C	0.09	0.08	0.03	0.07	0.1	0.1	0.1

- **Tank compositions from TWINS data, adjusted to 6 M Na**
- **DST-1 and DST-3 conc's reduced to 5 M Na for Wave 2**

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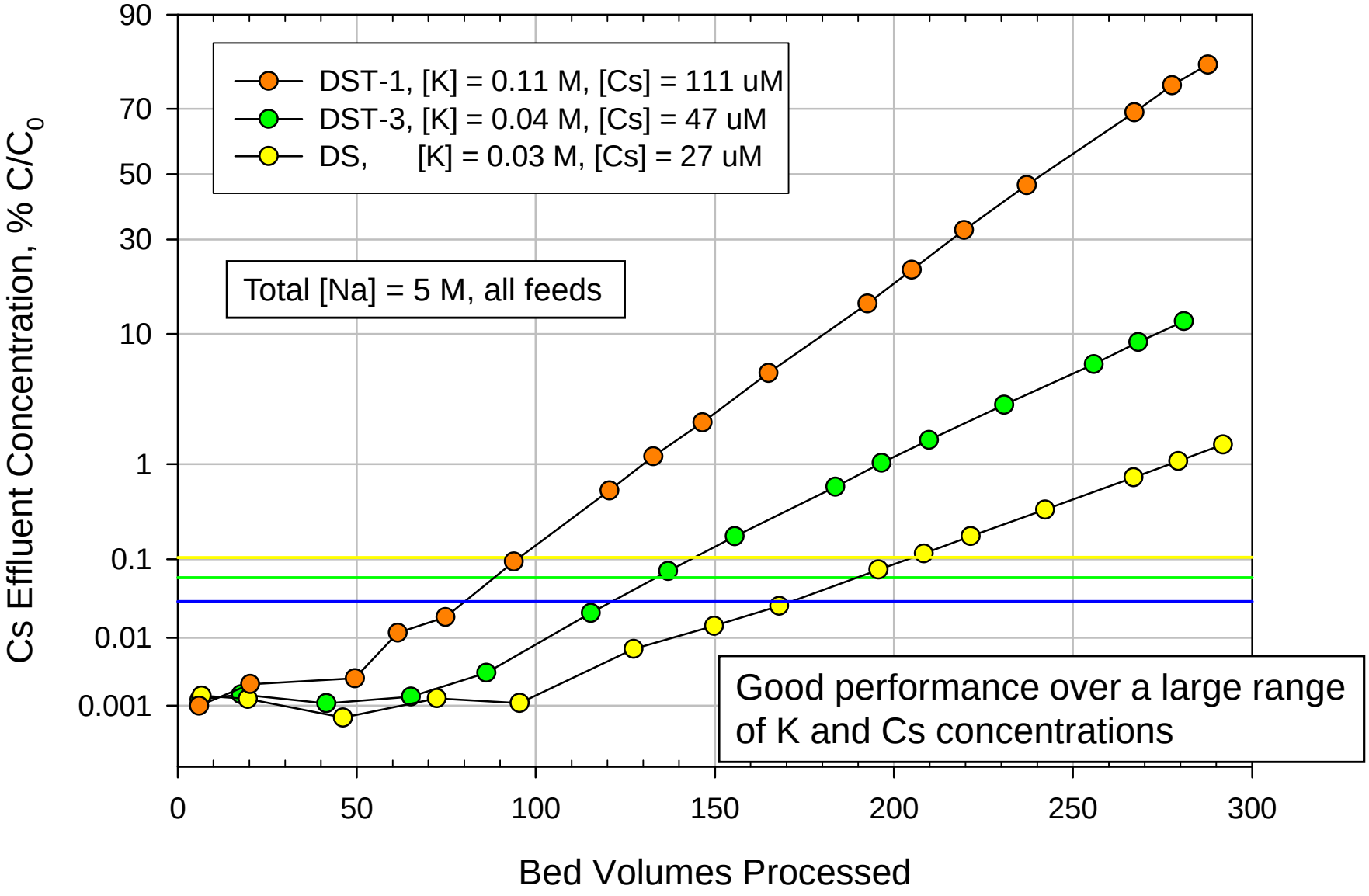
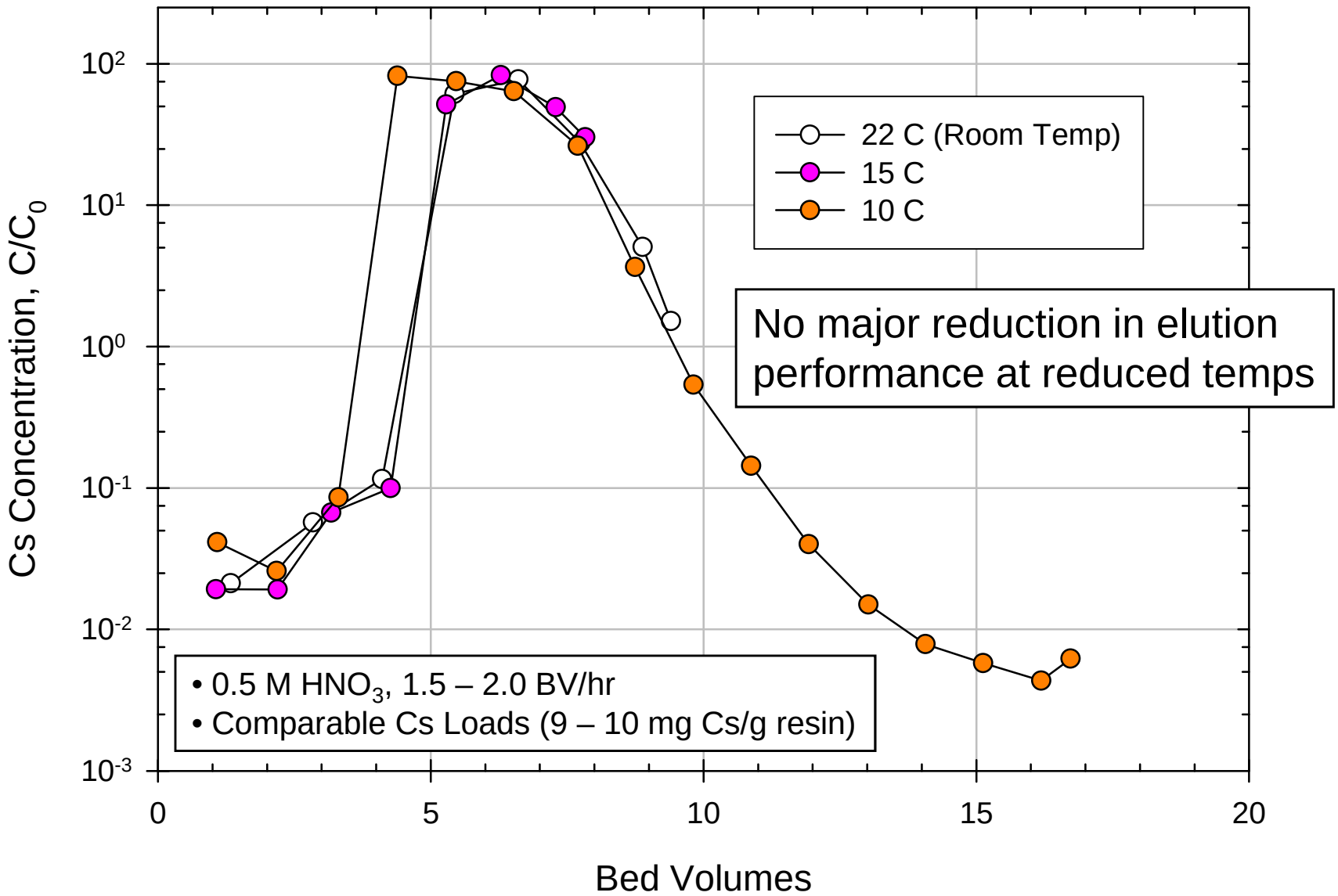
Small Column IX Test Results: Affect of Feed Variability



Small Column Ion Exchange Tests: Affect of Temperature on Elution



Small Column IX Tests: Results and Status

- Successfully demonstrated abbreviated process conditions
- Assessed impact of feed variability – good performance for all target feeds
- Successfully demonstrated reduced temperature elution
- All complete except report
- Results available to support design of the demonstration unit

NTCR Overall Technical Status and Results

- Two critical activities needed for NTCR, batch resin dissolution/destruction and small column IX tests, were successfully demonstrated
- Third critical activity, small column resin dissolution, is in progress; success of batch tests suggests no significant obstacles
- Completion date is currently 30 October 2008

NTCR Overall Technical Recommendations

- Complete FY08 scope
  - Batch Resin Dissolution/Destruction and Small Column IX Tests reports
  - Small Column Resin Dissolution testing and reporting
- Initiate Remaining Tasks of Phase II
  - Design, procure, fabricate and test demonstration unit
  - Deployment Engineering Conceptual design and ROM cost estimate

NTCR Project Impact

- The NTCR process is based on extensive experimental data and the deployment of proven technologies
- Deployment of the NTCR process could accelerate the start of WTP LAW Vitrification Facility up to 6 years
- Deployment of the NTCR process will supply feed to supplemental treatment (bulk vitrification
- Processing of this tank waste early will:
  - Free up DST space which will allow additional SST retrieval to proceed
  - Demonstrate progress on tank waste treatment, independent of the schedule for the WTP Pretreatment Facility completion date
  - Accelerate Tank Farm Closure
- Full-Scale deployment does not require additional actual waste testing