GSI-191 Chemical Effects Status Report

February 8, 2007

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Outline

- Chemical Effects Test Plans
- Test Results and Observations
- Bench top Experiments
- Refined Testing Planned
  - Integrated Testing
  - Autoclave Testing

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Chemical Effects Test Plans

- Overview of Tests Performed
  - WCAP Based – Vertical Loop Tests
    - 2 Plants – Unacceptable Results
    - Fiber bed thicknesses thin-bed to 2”
  - WCAP Based – Array Tank Tests
    - 1 Plant – Acceptable Results (Low-no debris bed/bare screen)
      - Latent fiber/Microtherm bed thickness (equivalent) = 0.13”
    - 3 Plants Upcoming
      - Low-no debris bed/bare screen (2 plant)
      - 2” Nukon Debris Bed (1 plant)

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Key Observations from Tests

- No acceptable head losses produced using the vertical loop unless chemical precipitate load is insignificant
- Precipitates will pass through bare screen (minimum required area not established)
- pH increased during precipitate additions (7.8 to 8.1)

Copies of Test Protocol/Procedures can be made available.

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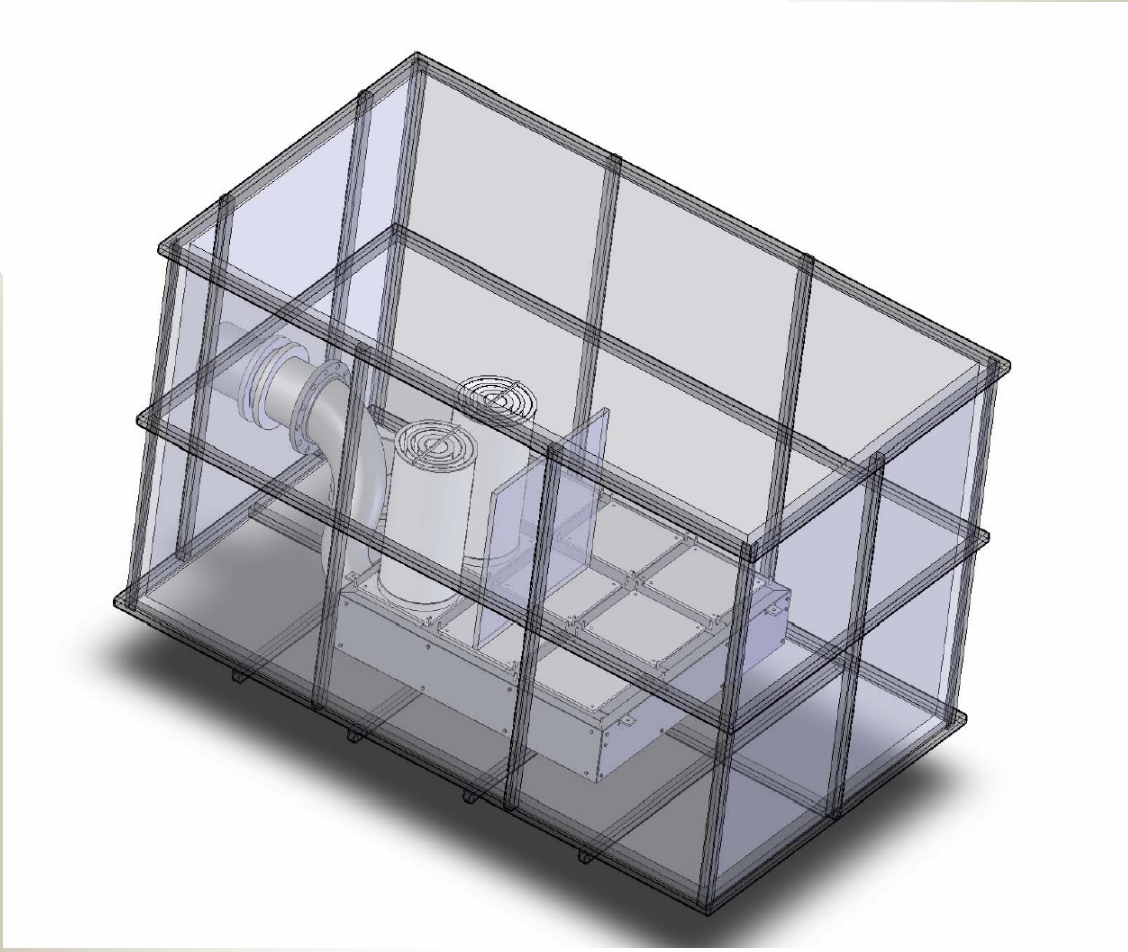
Test Setup - Prototype



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Test Inputs - Prototype

Scaled Debris	cu-ft	lbs	grams
Microtherm, lb	0.28	4.42	2004.40
Total Paint Surrogate		33.58	15233.84
Latent Dirt/Dust Particulate		7.21	3269.89
Latent Fibers	0.60	1.44	653.44
Thermolag surrogate	0.13	20.68	9378.33
Sodium Aluminum Silicate		0.51	233.32
Aluminum Oxyhydroxide		0.49	220.43
Calcium phosphate		0.13	59.44

Debris Bed Thickness	0.13	in

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Test Protocol – Debris Add

	$NaAlSi_3O_8$	AlOOH	$Ca_3(PO_4)_2$	Representative Curve Time
Addition	Percentage (lbs)	Percentage (lbs)	Percentage (lbs)	hours
1st	42 (0.37)	0	0	3.5
2nd	27 (0.23)	0	0	41.7
3rd	31 (0.27)	40 (0.10)	100 (0.017)	360
4th	0	60 (0.15)	0	720

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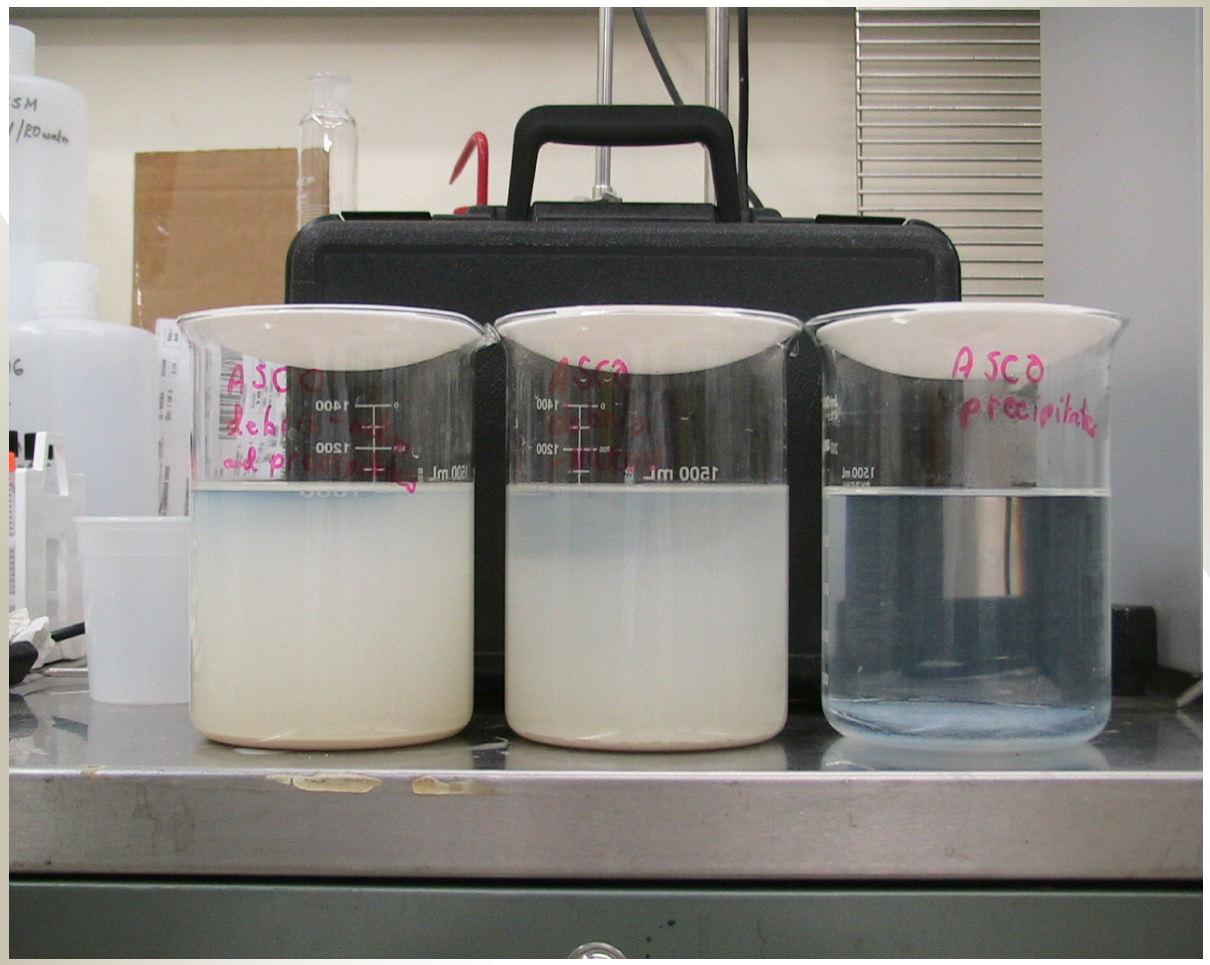
Sample Precipitate - WCAP



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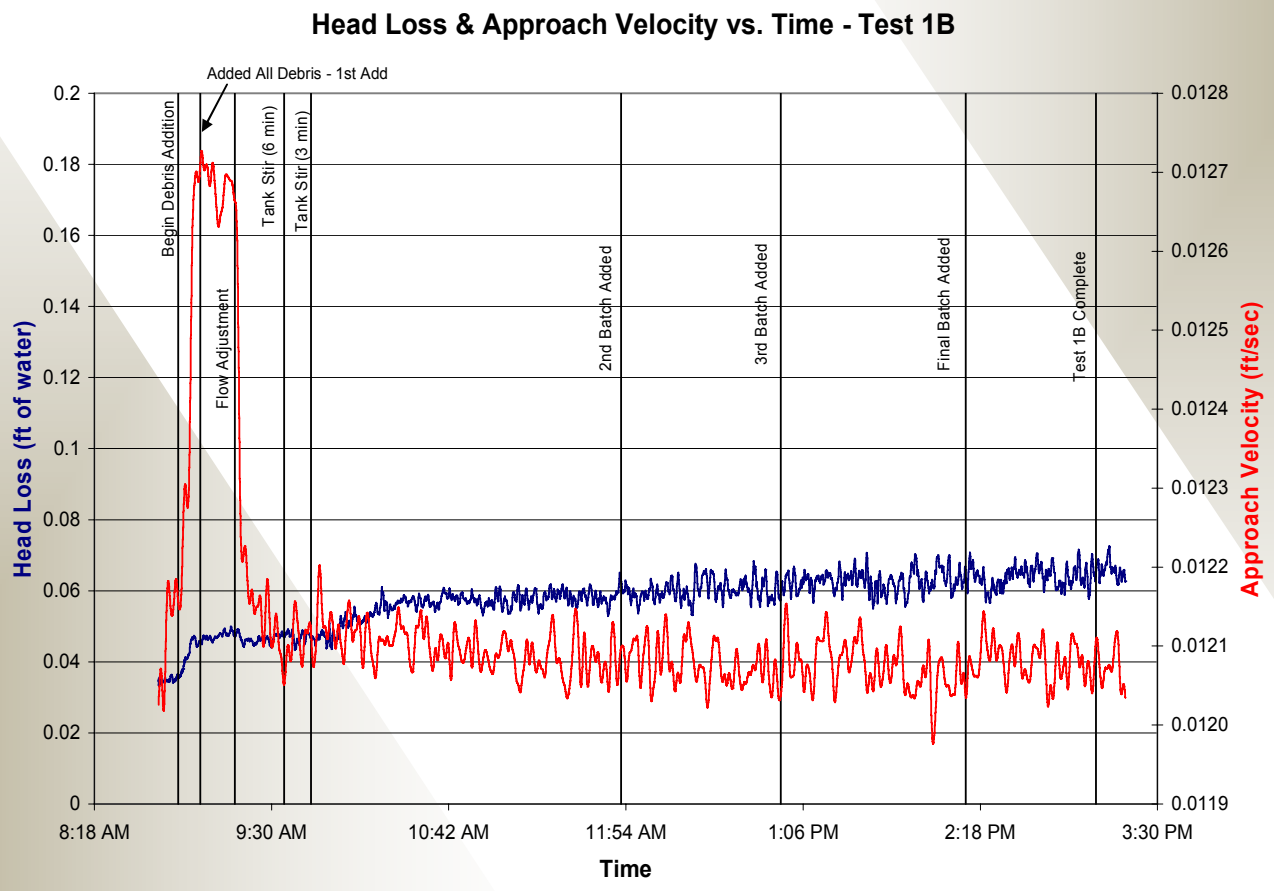
Test Results



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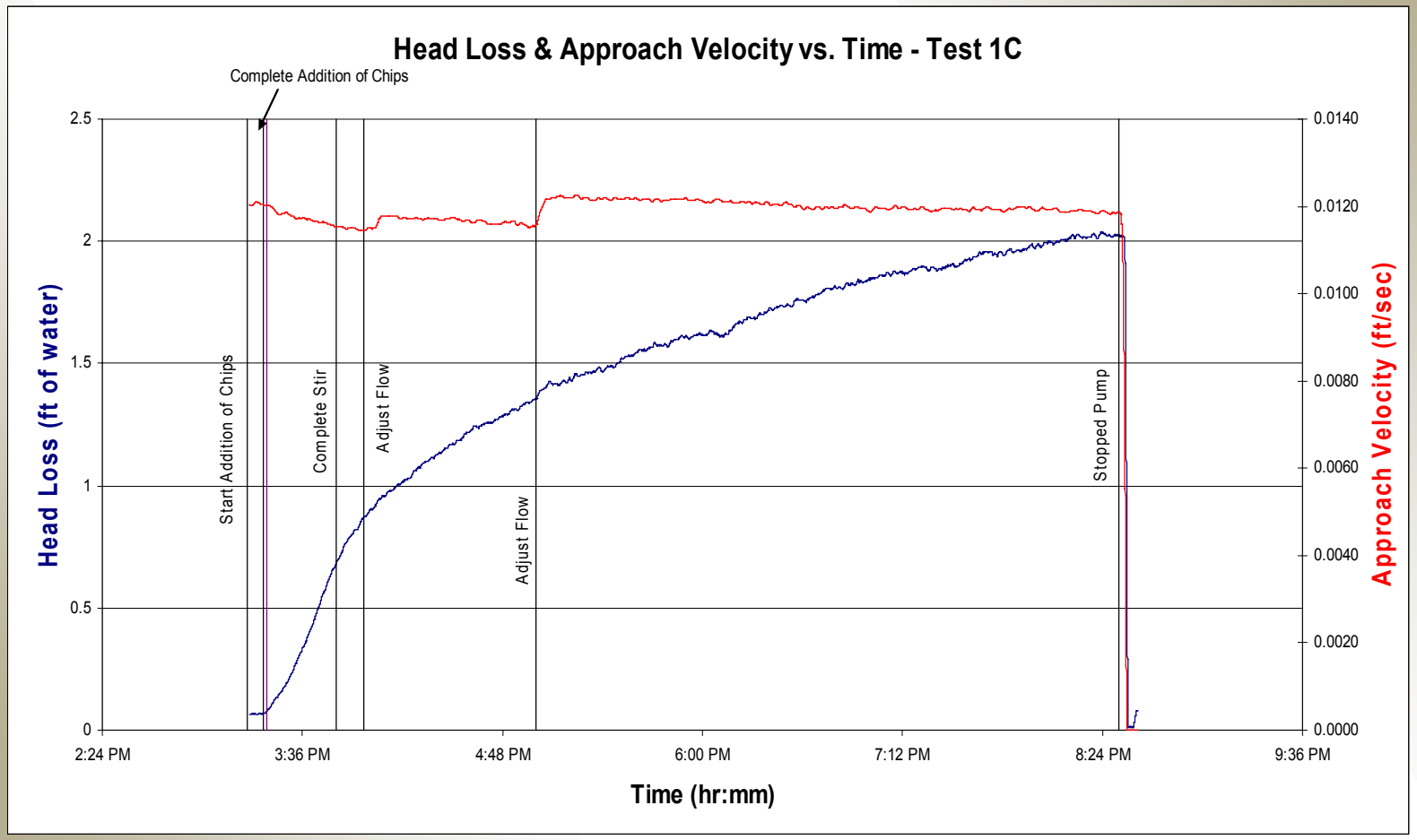

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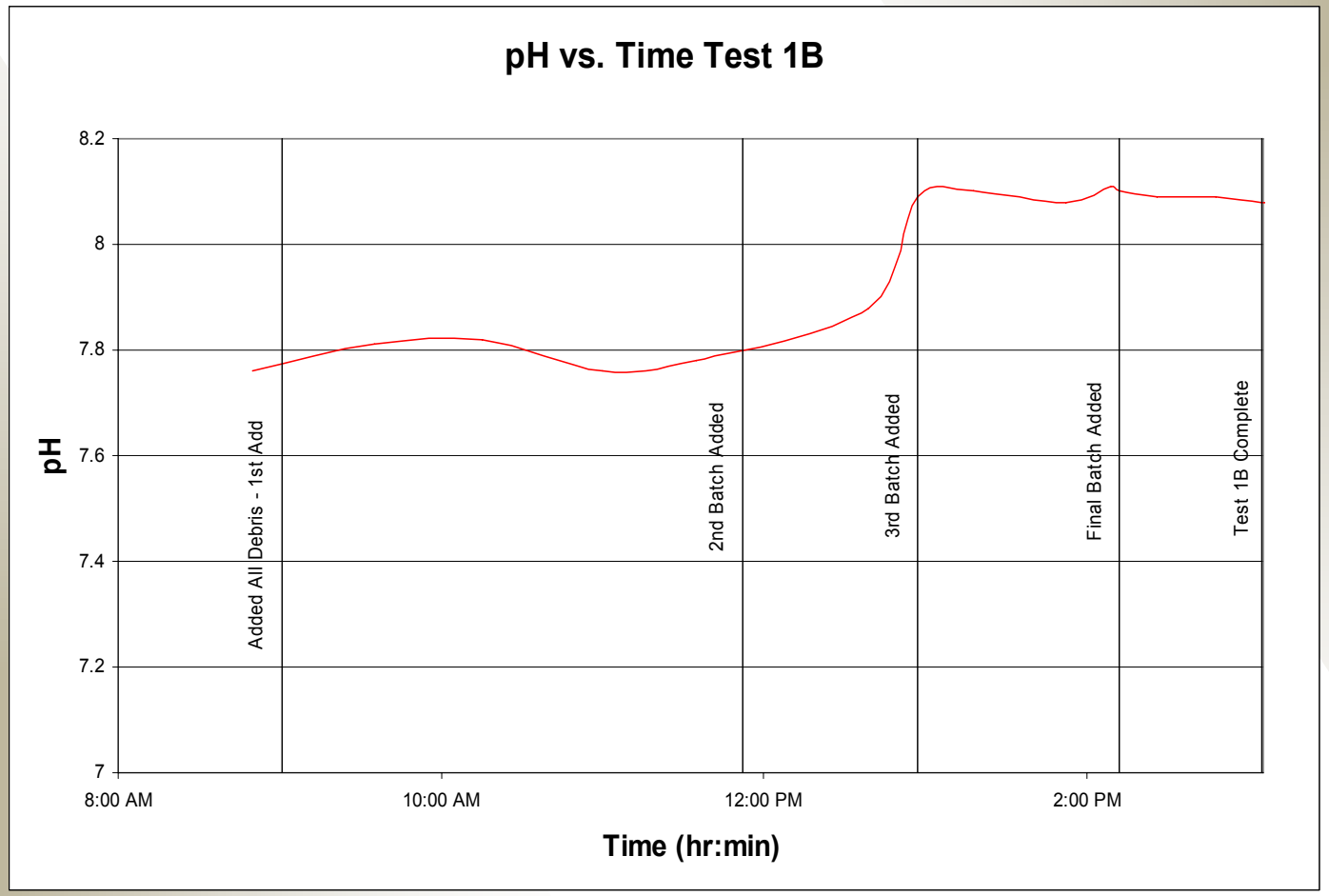

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Test Observations

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Bench Top Experiments

Investigate plants with TSP and NUKON/ Mineral Wool

Bench-top experiments

Test 1: TSP+Al

Test 5: TSP+Al+NUKON

Test 6: TSP+Al+Zn+NUKON

Same experiments underway for Mineral Wool

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Bench Top Experiments

Purpose of bench top experiments is to gain insight into mixed environment corrosion of Aluminum, Zinc and NUKON in TSP buffered solution

- Confirm inhibition of Aluminum from phosphates
- Investigate dissolution/degradation of fiberglass (Si)
- Confirm formation of precipitates and location

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Bench Top Experiments

- 100ml and 300ml beakers
- 2800 ppm Boron plus 0.7 ppm Li
- 264 ppm Phosphorus to achieve ph 7.3
- 200 deg F for 7 hours decreased to 140 deg F for 30 days
- Zinc and Aluminum surface area iaw WCAP-16530
- NUKON fibers
- ICP, SEM, EDS, SIMS measurements

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Bench Top Experiments

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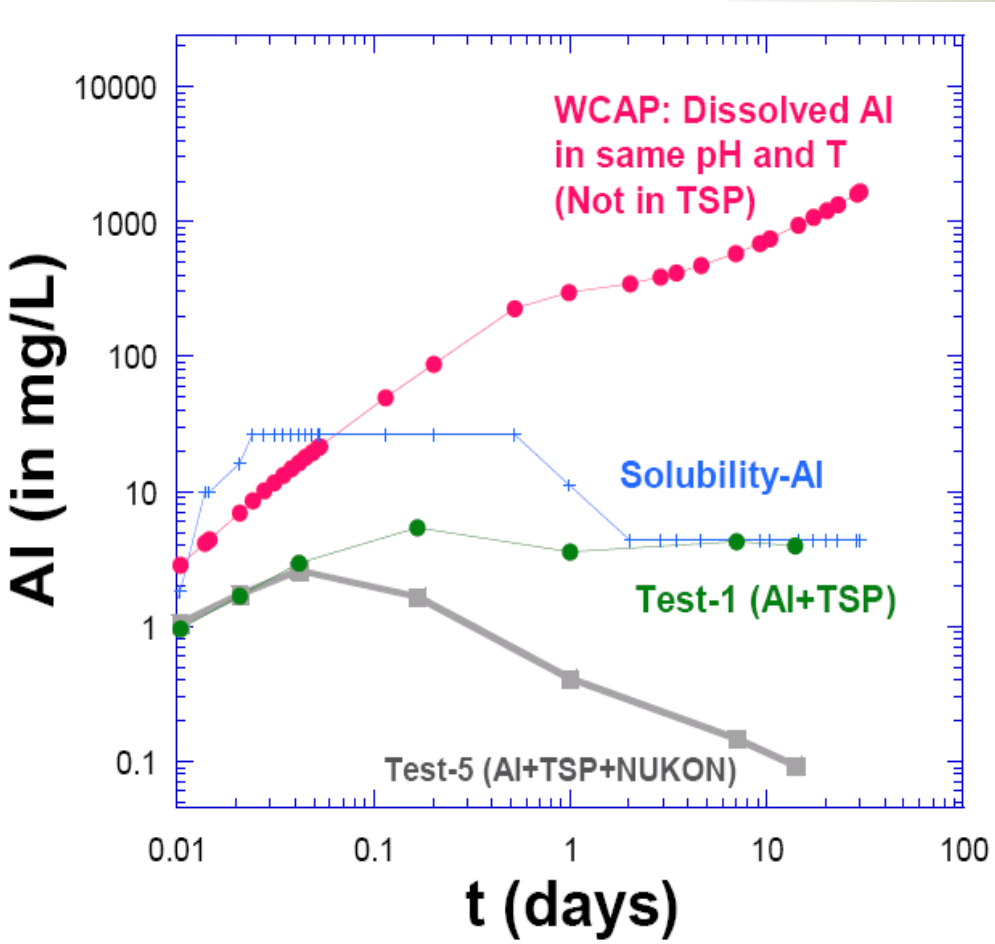
Bench Top Results



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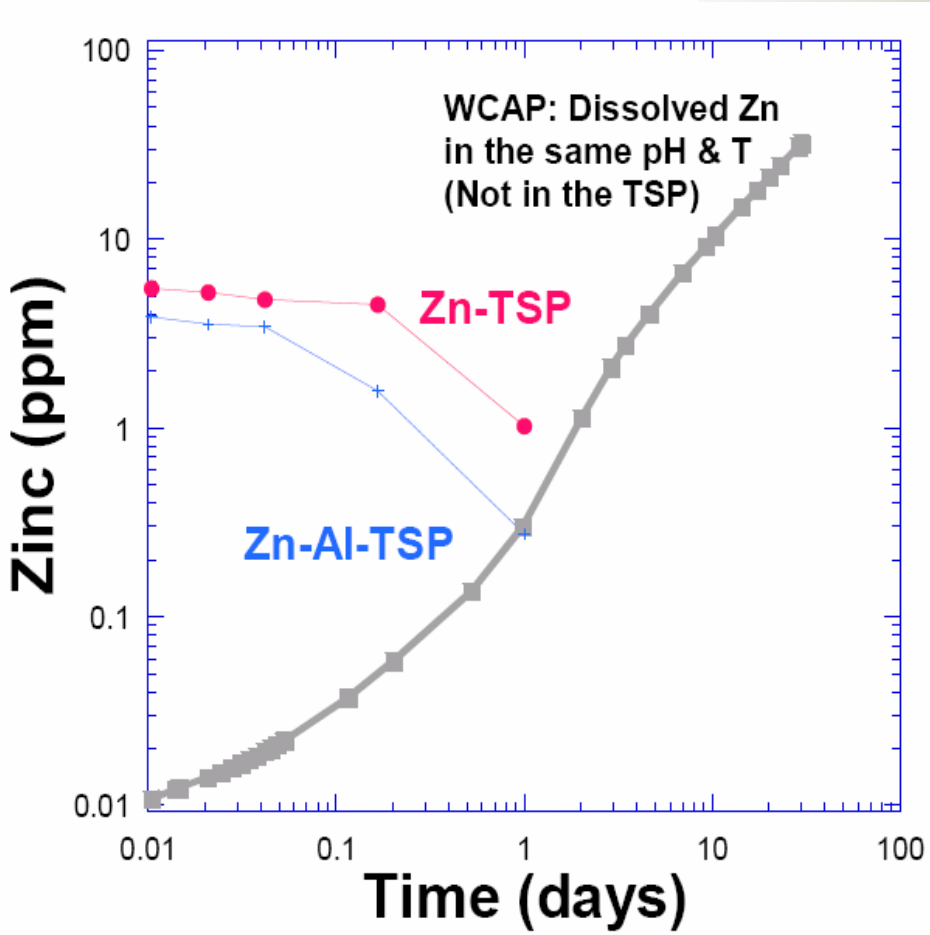
Bench Top Results



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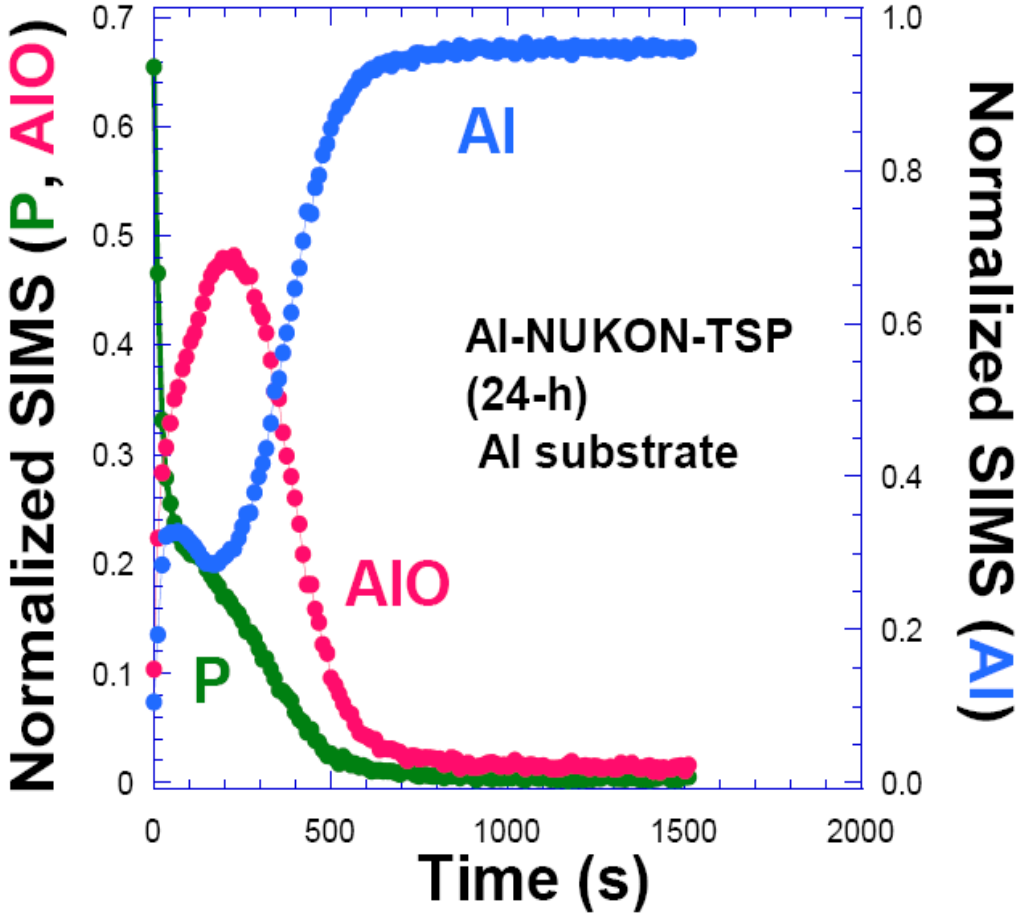
Bench Top Results



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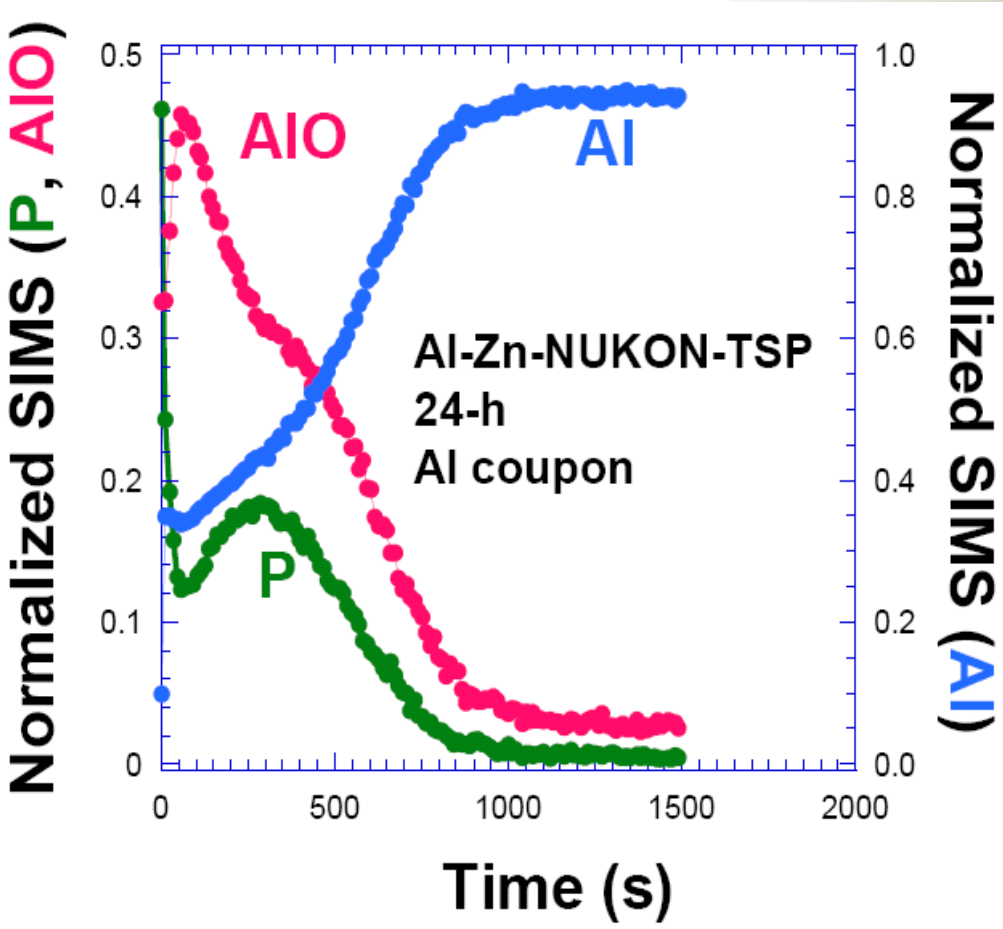

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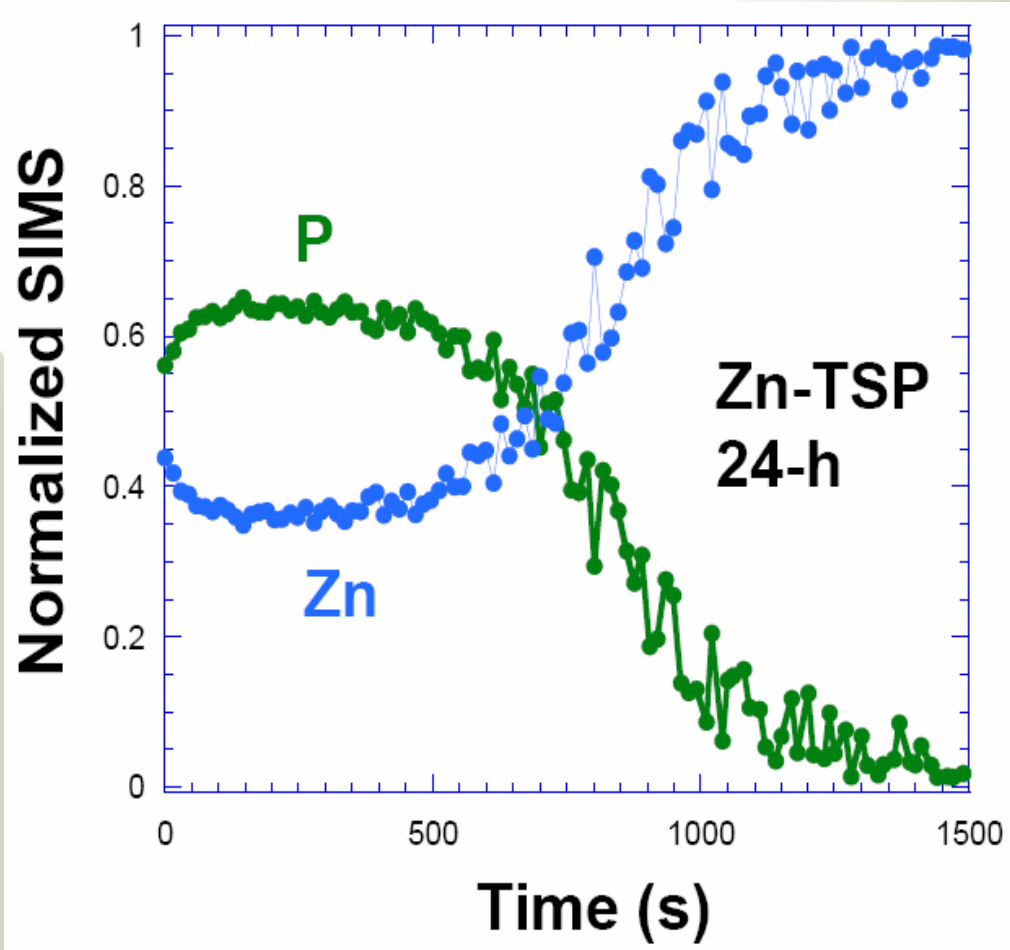
Bench Top Results



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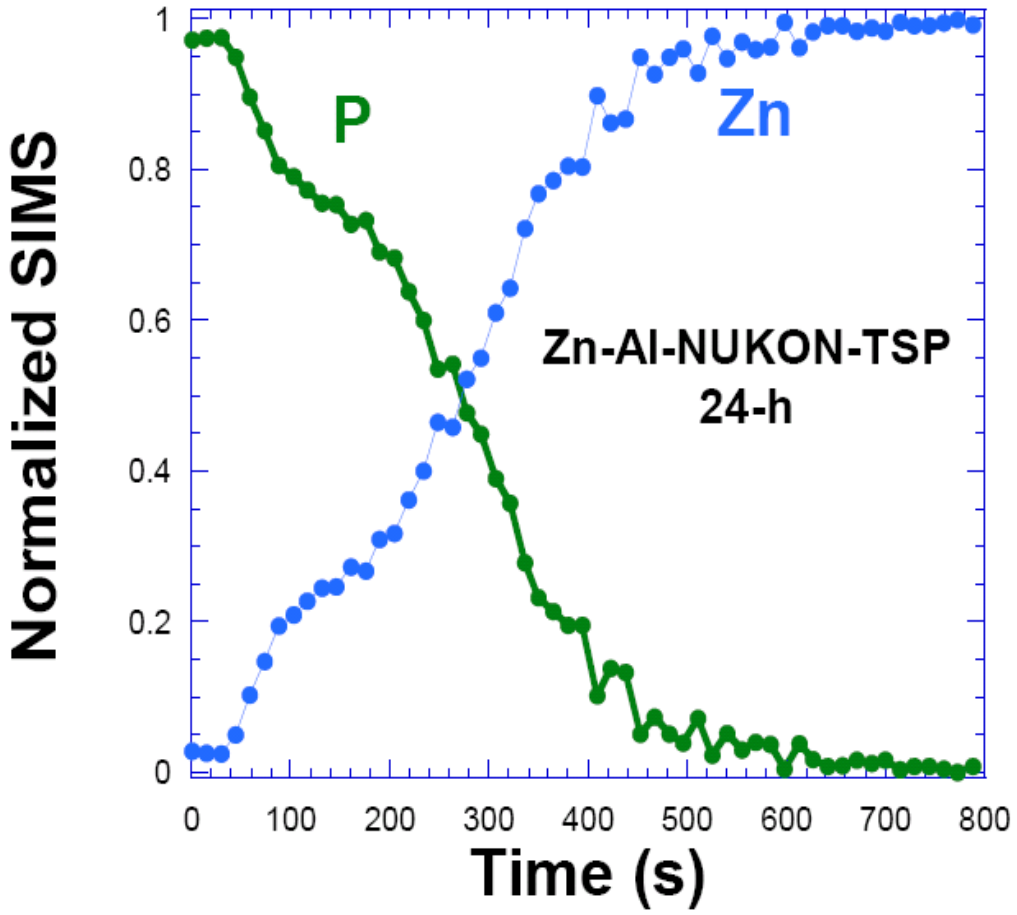

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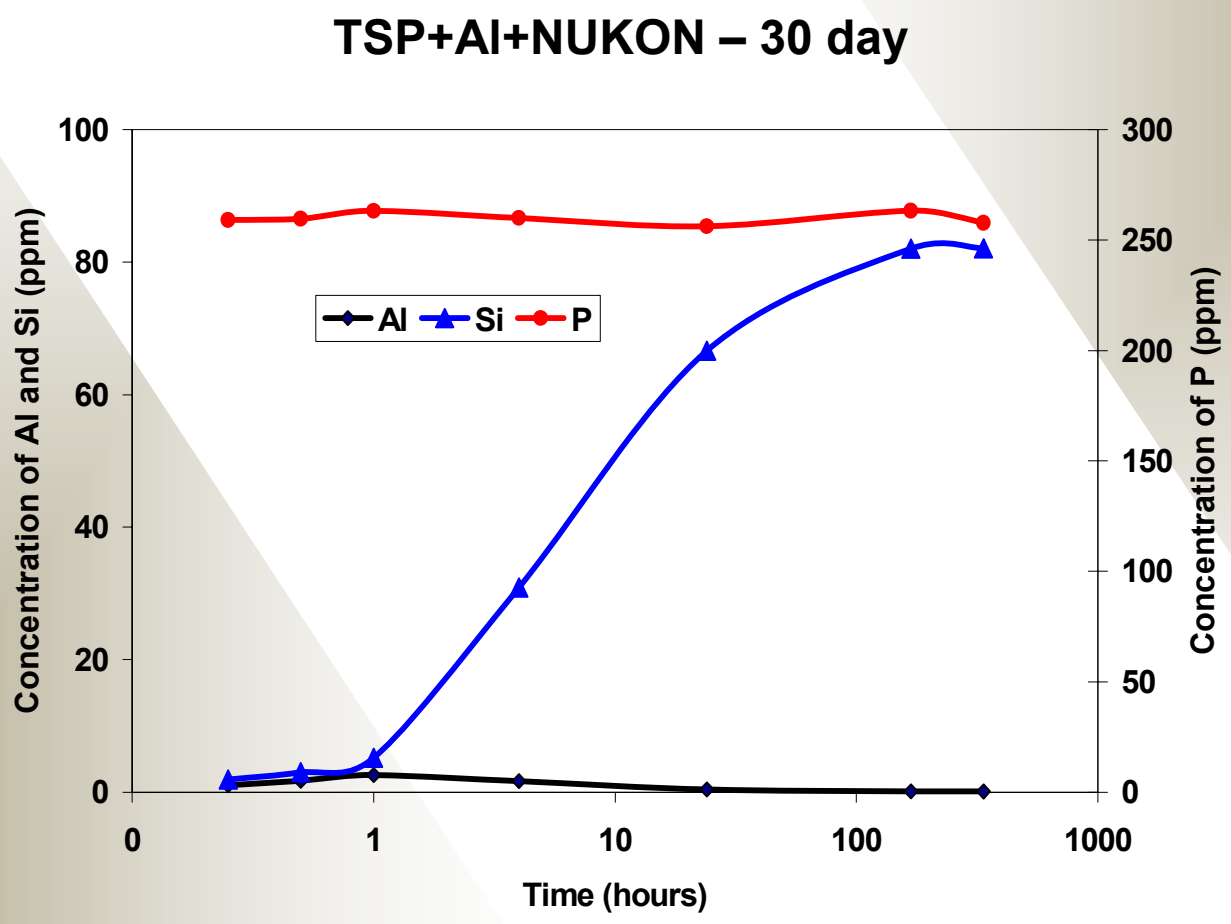
Bench Top Results



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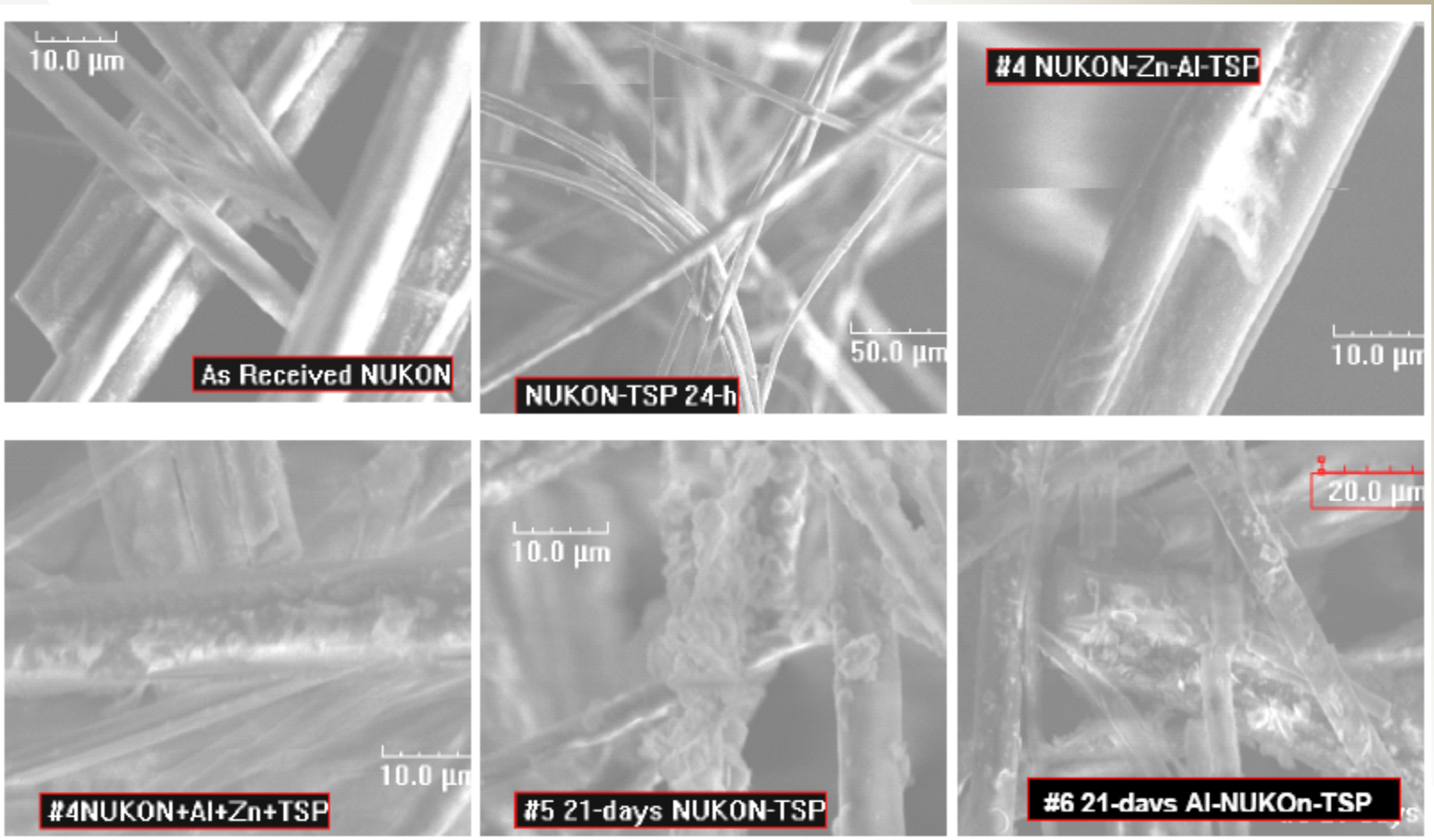
SEM Images of Fibers



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Conclusions

1. Aluminum and Zinc corrosion is inhibited in presence of Phosphate and Silicates.
2. Silicate concentration is increasing over time through the dissolution of NUKON fibers
3. Aluminum surfaces exposed to TSP do not form Al(OH)3
4. NUKON fibers are dissolving and forming aluminum silicate precipitation within the bed which will impact the bed morphology/structure.

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Refined Testing Planned

Assess the impact of the chemical environment on the debris head loss.

1. Corrosion/leaching of materials in coolant solution
   - Temperature, pH, time
2. Subsequent precipitation
   - Solubility
3. Affect on bed morphology (characteristics) - dP

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Integrated Testing

- Perform a refined test to integrate the three (3) concerns (corrosion, precipitation and head loss)
  - Replicate post-accident environment with scaled volume and chemistry of coolant and materials in recirculation loop
  - Control flow and temperature time history (200 deg to 120 deg)
  - Measure head loss through debris bed t = 0 through t = 30 days.

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Facilities

- Large Scale Chemical Reactor (500 liter) –
  - Recirculation Pool and Spray
  - Temperature Range (ambient to 195 deg F)
  - Screen Area
- Small Scale Chemical Reactor (55 liter) –
  - Recirculation Pool only, no spray
  - Temperature Range (ambient to 195 deg F)
  - Screen Area
  - Quantity 6 side by side (parallel experiments)

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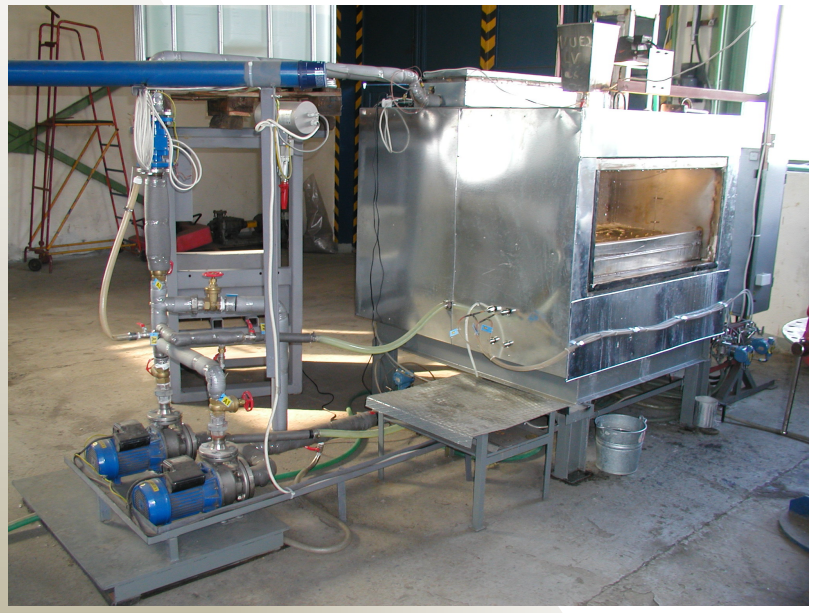
Large Loop



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Small Loops

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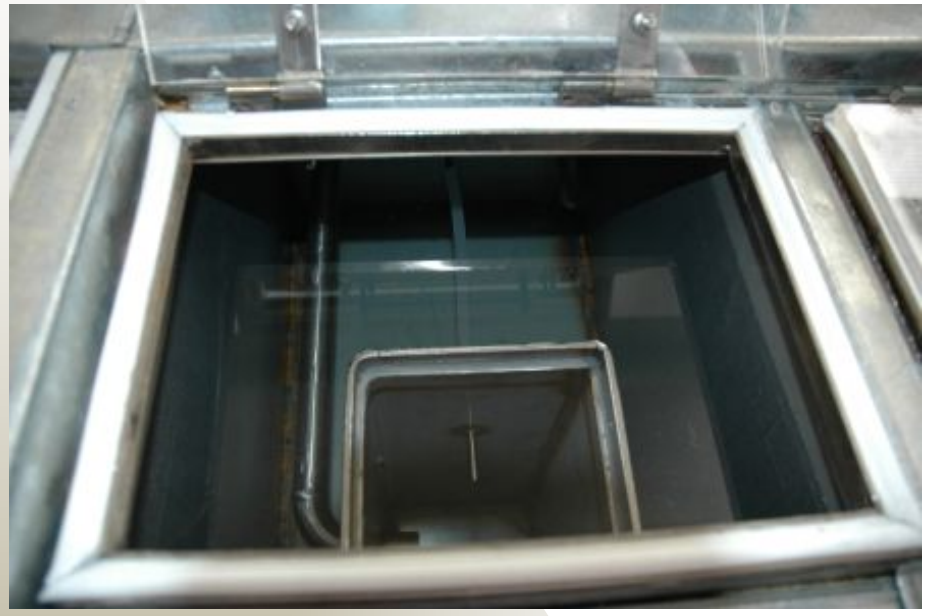
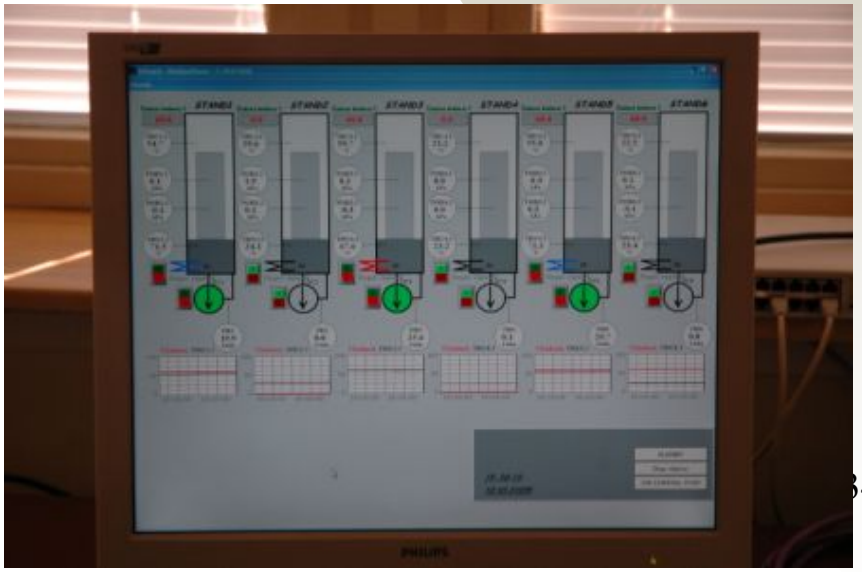
Small Loops



Upper part of the Small Loop



Special software for test control and monitoring

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Test Matrix - sample

Test No	1	2	3	4	5	6
	Loop 1	Loop 2	Loop 3	Loop 4	Loop 5	Loop 6
Debris	Fiberglass	Fiberglass	Fiberglass	Mineral Wool	Mineral Wool	Mineral Wool
Buffer	TSP	NaTB	NaMB	TSP	NaTB	NaMB
Time	30 days	30 days	30 days	30 days	30 days	30 days
Temp	Profile	Profile	Profile	Profile	Profile	Profile

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Issues to be Addressed

- Scale
- Materials in Debris Bed/Surrogates
- Application of results to existing head loss testing

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Autoclave Testing

Develop approach for chemical testing of arrays

- Corrosion/leaching in an integrated environment to determine type and quantity of precipitates
- Using refined corrosion rates, reduce quantity of WCAP precipitants and conduct array testing.
- Replicate environment (elemental concentration) within large scale tank with array.

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Autoclave Testing

- Corrosion/Leaching experiments performed in autoclave modified for spray and corrosion monitoring real-time over 30 day mission period
  - Plant specific materials and buffer
  - Plant specific temperature profile
- ICP, SEM, EDS, SIMS measurements taken
- Mass measurements taken
- Determine corrosion rates and fluid chemistry

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