FIU PROJECT 1: CHEMICAL PROCESS ALTERNATIVES FOR RADIOACTIVE WASTE

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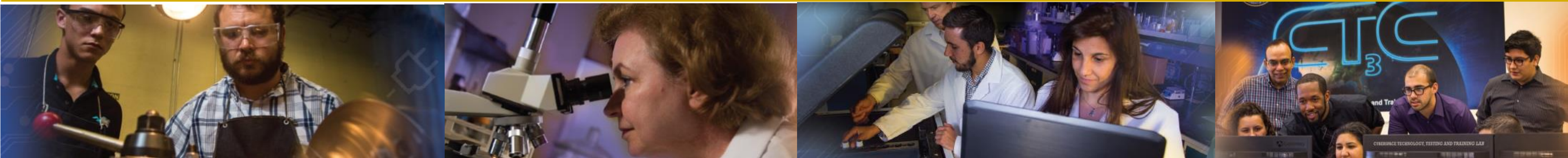

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Project Tasks and Scope

Task 17 Advanced Topics for Mixing Processes

- Investigate formation of sediment beds and pipeline flushing operations via FIU test loop

Task 18 Technology Development and Instrumentation Evaluation

- Development of inspection tools for waste transfer lines and DST primary tanks
- Investigate approaches/coatings to protect the walls in the exhaust channel at H-Canyon (NEW)

Task 19 Pipeline Integrity and Analysis

- Pipeline corrosion and erosion detection
- Nonmetallic materials evaluation

Task 20 Technology Evaluations using DST Mockup

- Evaluate the viability of inspection tools, robotic systems and sensors using FIU's DST sectional mockup.

Task 17 - Advanced Topics for Mixing Processes

17.3 - Evaluation of Pipeline Flushing Requirements for HLW at Hanford and Savannah River

Site Needs:

- According to the Defense Nuclear Facilities Safety Board, a number of issues still exist regarding the slurry transport and flushing strategies at Hanford.
- A series of flushing tests can address a variety of technical gaps associated with flushing techniques and would be beneficial to both Hanford and Savannah River.

Objectives:

- Conduct a series of experimental tests to bridge technical gaps associated with the flushing of HLW within the transfer systems at Hanford and Savannah River.
- Tests will be conducted using the loop that were developed in Year 9.
- The loop can be expanded to multiple of its lengths ranging from 165 ft to 825 ft for scale up analysis (study of length effect on flush operation efficiency).

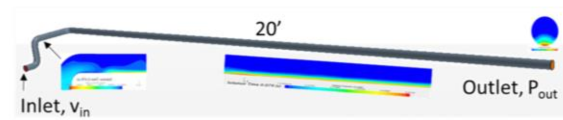
Supernatant Dried on Nozzle 18 in AP Valve Pit.

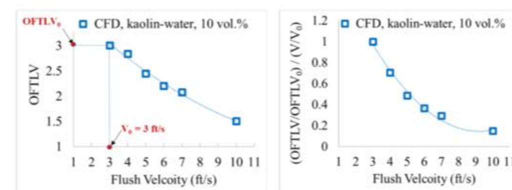
Task 17 - Advanced Topics for Mixing Processes

17.3 - Evaluation of Pipeline Flushing Requirements for HLW at Hanford and Savannah River

Accomplishments Year 9:

- Modified loop design to fit in provided space from FIU. Completed the construction of the loop design.
- Preliminary tests – conducted leak tests, pump control automation with VFD software.
- Rheology testing of simulant – kaolin water mixtures 9-22% by volume.
- Ultrasonic testing for fully developed and drained initial conditions.
- Conducted CFD of flushing operation in a 20 ft pipe.





Task 17 - Advanced Topics for Mixing Processes

17.3 Evaluation of pipeline flushing requirements for HLW at Hanford and Savannah River

Proposed Scope for Performance Year 10

- Conduct initial tests on the loop completed in Year 9
  - Removal of air from the system
  - Incorporation of Optimass 1000 Coriolis meter into the loop
  - Accurate density/mass flow rate measurements via the Coriolis meter
- Create repeatable initial conditions (fully-flooded and gravity-drained)
  - Accurate characterization of initial conditions (sediment bed height, solids concentration, and rheology)
- Advance computational investigations that were performed in Year 9 using the Star-CCM+ to full-scale simulations
  - Compliment experimental

Task 18 - Technology Development and Instrumentation Evaluation

18.2 - Development of Inspection Tools for DST Primary Tanks

Site Needs:

In 2012, tank waste was found in the annulus of AY-102. In addition, thinning (up to 70%) of the secondary liner in the annulus region has also been observed in other double shell tanks (DSTs). Understanding of the structural integrity of all DSTs at Hanford is of paramount importance - thus, the significant need for development of tools/sensors that can provide information regarding the health of the tanks.

Year 9 Objectives:

- Develop cost effective inspection tools that can travel through the refractory pad air channels underneath the primary liner and the drain line channels underneath the secondary liner.
- Develop cost effective tools that can travel through the air supply line (3 and 4 inch diameter lines) and the drain lines (6 inches).

Present Tasks:

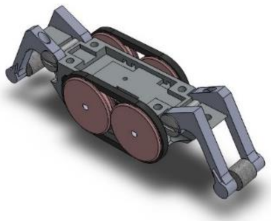
- Continue to develop our miniature rover by adding UT capabilities and improving its ability to make difficult 90 degree turns – found in AY101.
- Continue to develop a marsupial type robotic system for the 6 inch drain lines and ability to investigate the drain slots under the secondary liner.

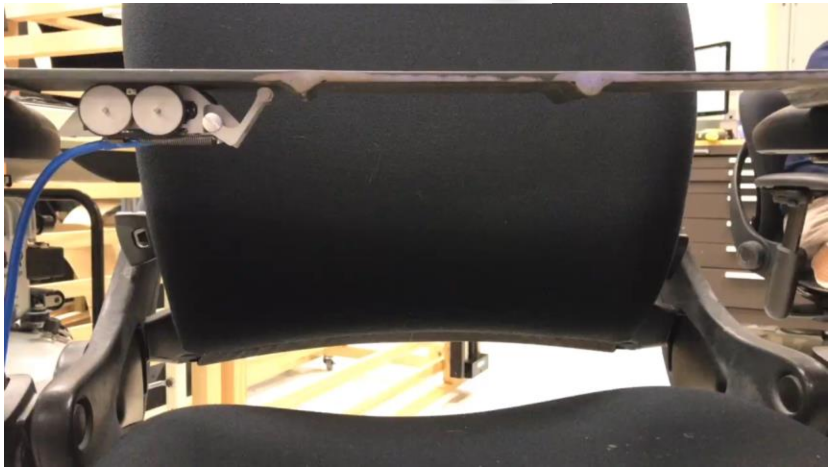
Task 18 - Technology Development and Instrumentation Evaluation

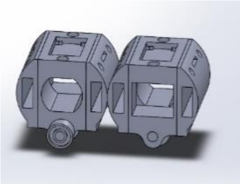
FIU Applied Research Center

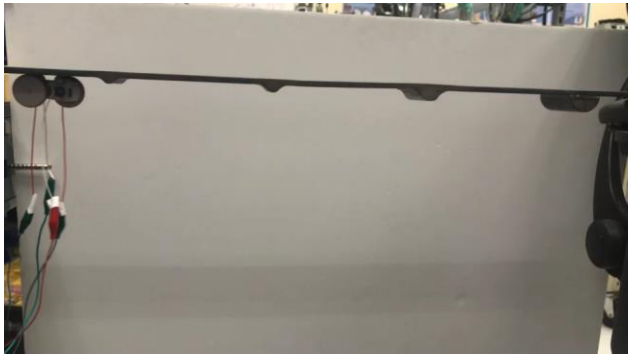
Accomplishments Year 9:

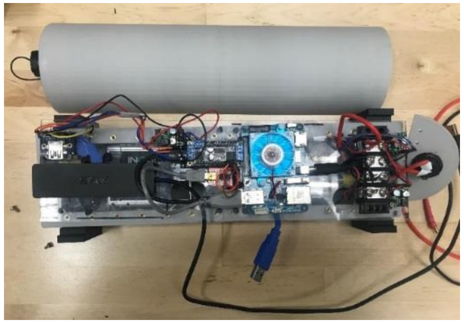
- Added a magnetic arm to be able to navigate over large weld seams.
- Began developing a caterpillar crawler to navigate around 90 degree turns.
- Developed control capsule to address voltage drop and video signal transmission over long cable lengths.
- Investigated and developed electronic boards, to move electronics onto unit and improve signal options.
- Conducted analysis of UT systems for testing and integration.









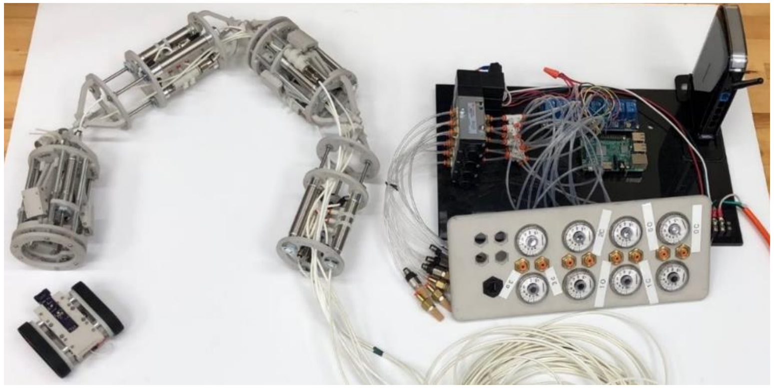


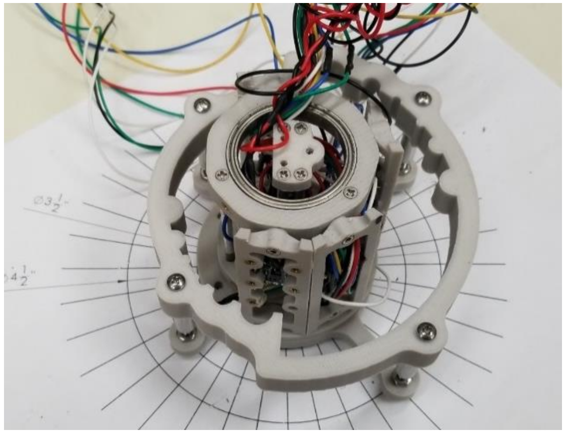
Task 18 - Technology Development and Instrumentation Evaluation

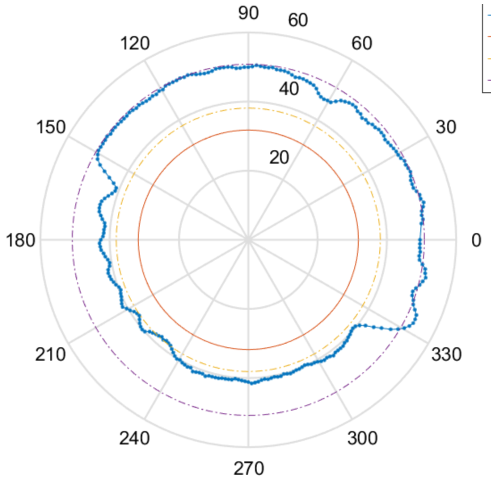
18.2 - Development of Inspection Tools for DST Primary Tanks

Accomplishments Year 9:

- Developed first prototype of 6-inch crawler and evaluated via bench scale tests.
- Developed a more structurally sound crawler which includes transverse pneumatic actuators and guides for centering.
- Competed testing of the sensor module that can be added to the 3 or 6 inch system.







Task 18 - Technology Development and Instrumentation Evaluation

18.2 - Development of Inspection Tools for DST Primary Tanks

Proposed Scope for Performance Year 10

Crawler

- Complete the development of the inspection tool for the secondary liner that travels through the 6 inch leak detection line.
- Integrate miniature rover and validate in the full-scale mock-up at FIU.

Miniature Rover

- Deploy current system in hard to access slots at Hanford Tank Farm.
- Complete the design and the integration of the UT sensor module.
- Validate sensor system in full-scale mock-up.
- Continue the development of a system that can traverse around the corners in the refractory slots of A-101.

Task 18 - Technology Development and Instrumentation Evaluation

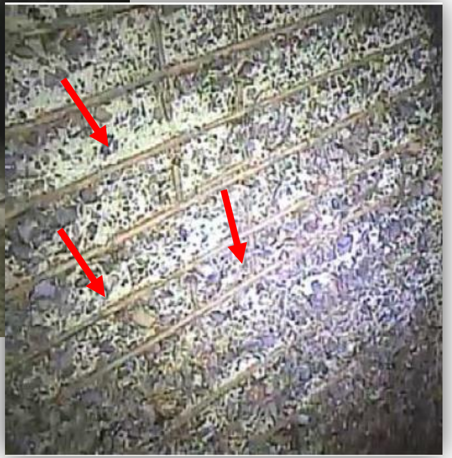
18.3 – Evaluation of coatings for the H-Canyon exhaust tunnel (New)

Site Needs:

Visual inspections of the H-Canyon exhaust (HCAEX) tunnel showed degradation of the concrete walls. Also, a recent tunnel fragility analysis identified safety issues of the affected concrete regarding their strength [1].

The identification and evaluation of repair materials to mitigate and prevent further degradation of the concrete walls is necessary.

Tunnel view



Degraded concrete exposing the steel rebar (red arrows).[1]

Objectives:

- Literature review of 1) HCAEX tunnel, 2) concrete degradation mechanisms, and 3) repair options to mitigate and/or prevent degradation.
- Evaluate potential concrete repair materials for future deployment.

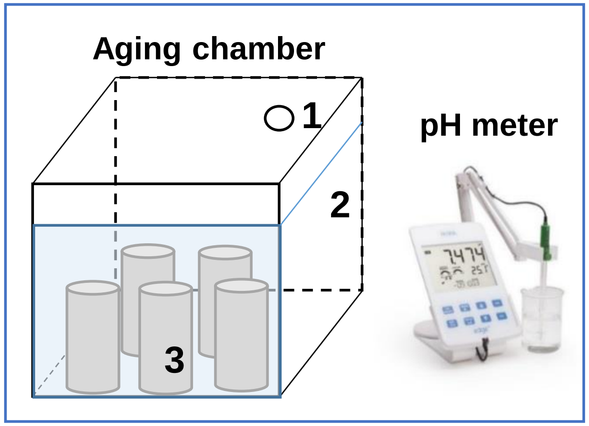
[1] Staff Report, Defense nuclear facilities safety board. H-Canyon exhaust tunnel fragility analysis input and assumptions. 2018.

Task 18 - Technology Development and Instrumentation Evaluation

18.3 – Evaluation of coatings for the H-Canyon exhaust tunnel (New)

Accomplishments Year 9:

- Conducted a literature review on the H-Canyon Exhaust Tunnel and procedures for aging and evaluating concrete.
- Potential repair materials were also evaluated.
- Developed an initial test plan to age and characterize the aged concrete and presented the plan to engineers at SRS.
- Began initial investigation of potential strategies to deploy the repair material.



1. Evaluation of concrete samples exposed to accelerated aging in simulated aggressive environments

2. Evaluation of selected concrete repair materials applied on aged concrete samples exposed to accelerated aging in simulated aggressive environments

3. Selection of potential repair materials from the testing findings

Coarse aggregates and steel rebar exposed (arrows)

Accumulation of concrete products (e.g. $CaCO_3$)

Water accumulation

Task 18 - Technology Development and Instrumentation Evaluation

18.3 – Evaluation of coatings for the H-Canyon exhaust tunnel (New)

Proposed Scope for Performance Year 10

- Complete initial bench-scale testing (stage 1) of the concrete samples including:
  - Evaluation of the aged concrete samples exposed to simulated aggressive environments.
  - Identification of key test parameters (acid concentration, exposure time, humidity, etc.) that may support the evaluation of repair materials (stage 2).
- Select potential repair materials for bench-scale testing (stage 2).
- Evaluate selected repair materials applied on aged concrete surfaces.
- Identify the best candidate repair materials from research findings.

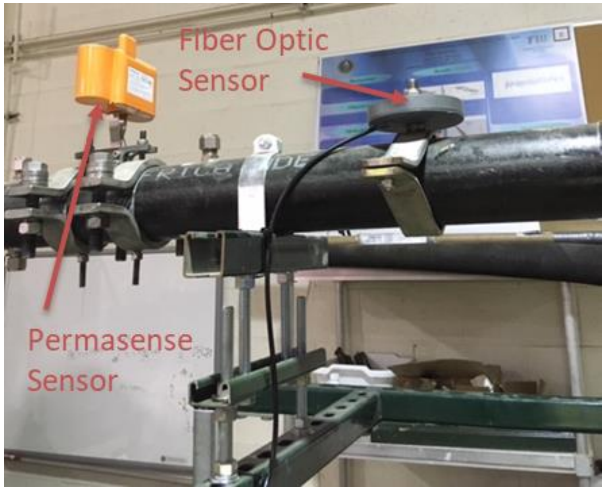
Task 19 - Pipeline Integrity and Analysis

19.1 - Pipeline Corrosion and Erosion Evaluation

Site Needs:

Due to uncertainties regarding the structural integrity of pipelines at Hanford, a Fitness-for-Service (FFS) program for the Waste Transfer System has been implemented.

A direct inspection and assessment of the condition of buried pipelines is required to evaluate the corrosion and erosion wear rates. To predict the existing system's remaining useful life.



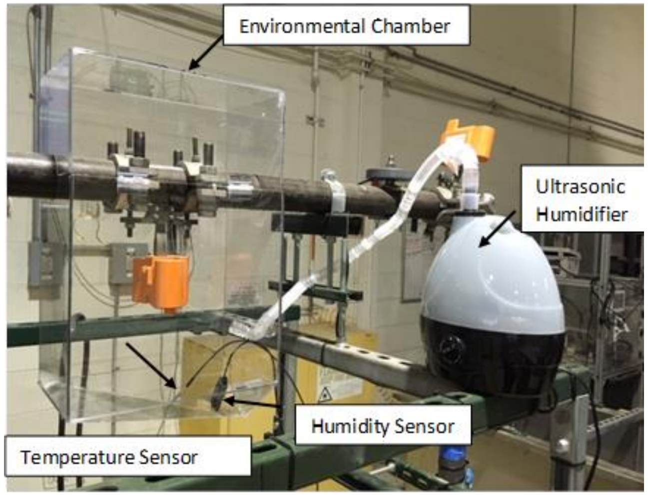
Thickness and Leak detection sensors

Objectives:

- Evaluate alternative approaches for real-time thickness measurements in pipes and waste transfer lines.
- Evaluating technologies that can be used to assess the integrity of pipelines.

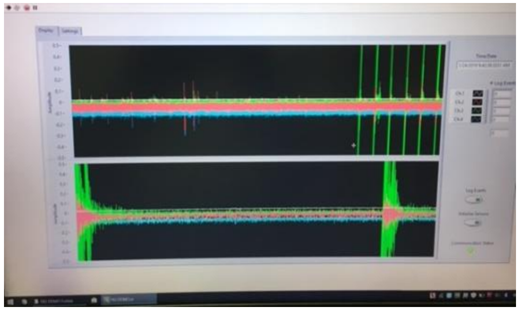
Task 19 - Pipeline Integrity and Analysis

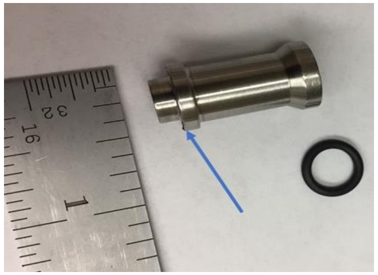
19.1 - Pipeline Corrosion and Erosion Evaluation

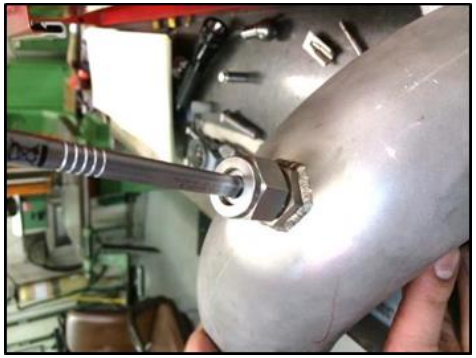


Accomplishments Year 9:

- Completed engineering scale testing and demonstrated the capability of the Permasense sensors.
- Constructed an environmental chamber and tested the sensors at elevated temperature and humidity.
- Continued to evaluate the SRNL erosion coupons and evaluated surface contours via SEM.
- Installed fiber optic/electroacoustic sensors from Cleveland Electric Laboratories to identify pipeline leaks or cracks.







Task 19 - Pipeline Integrity and Analysis

19.1 - Pipeline Corrosion and Erosion Evaluation

Proposed Scope for Performance Year 10

- Investigate the option of conducting radiation testing on the Permasense UT systems with Hanford and SRNL teams.
- Complete the evaluation of Permasense UT sensors under extreme environmental conditions and monitor real-time changes in pipe thicknesses.
- Evaluate CEL fiber optic sensor systems for leak detection in pipes
- Continue testing the SRNL mass loss coupons during the sand slurry erosion tests.
- Conduct material tests on eroded pipe sections and SRNL coupons.

Task 19 - Pipeline Integrity and Analysis

19.2 - Evaluation of Nonmetallic Components in the Waste Transfer System

Site Needs:

Nonmetallic materials are used in the US DOE's Hanford Site Tank Farm waste transfer system. These include inner primary hoses in the HIHTLs, Garlock® gaskets, EPDM O-rings, and other nonmetallic materials.

Nonmetallic materials are exposed to β and γ irradiation, caustic solutions as well as high temperatures and pressure stressors. How they react to each of these stressors individually has been well established, but simultaneous exposure of these stressors is of great concern.

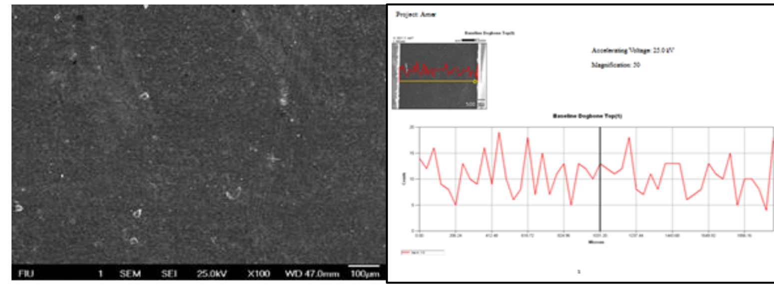
Objectives:

- Provide the Hanford Site with data obtained from experimental testing of the hose-in-hose transfer lines, Garlock® gaskets, EPDM O-rings, and other nonmetallic components under simultaneous stressor exposures.
- Due to experimental testing location limitations, no radiation exposure testing will be conducted.

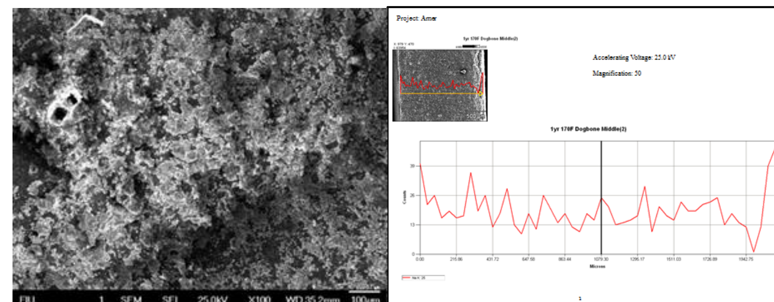
Task 19 - Pipeline Integrity and Analysis

Accomplishments Year 9:

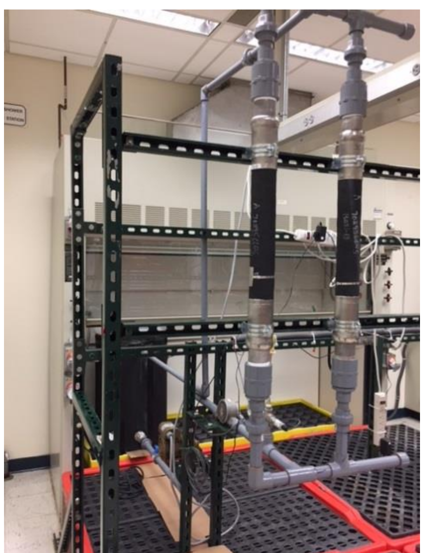
- Evaluated hose and dog-bone material samples using SEM-EDX to determine correlation between sodium penetration and burst pressure strength.
- To determine the effect of the NaOH on the material degradation, experiments were repeated with only water at 170°F.
- Test the burst strength of the 170°F water coupons.

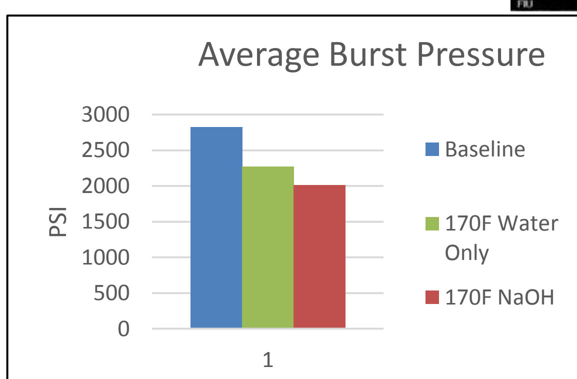


Baseline - Hose section



12 months – NAOH 170°F





Task 19 - Pipeline Integrity and Analysis

19.2 - Evaluation of Nonmetallic Components in the Waste Transfer System

Proposed Scope for Performance Year 10

- Complete SEM-EDX on both the HIHTL coupons and the material coupons.
- After discussing the water only test results with the site personnel, investigate obtaining additional HIHTL coupons to perform additional testing in consultation with site personnel.

Task 20 – Support for Technology Evaluation Using DST Mockup

Proposed Scope for Performance Year 10

- Provide access to DOE-EM and its contractors to use FIU's DST sectional mockup to evaluate the viability of inspection tools, robotic systems and sensors.
- Provide support for the testing and evaluation
- Work with engineers to make modifications to the mockup, as needed.