Nonmetallic Material Testing of Hanford's HLW Transfer System

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Introduction

- Nonmetallic materials are used in the United States Department of Energy's Hanford Site Tank Farm waste transfer system.
- Materials include the inner primary hoses in the hose-in-hose transfer lines (HIHTLs), Garlock® gaskets, Ethylene Propylene Diene Monomer (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 the nonmetallic components react to each of these stressors individually has been well established. However, simultaneous exposure of these stressors is unknown and is of great concern.

Objective

- 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 used in their tank farm waste transfer system under simultaneous stressor exposures.
- Due to experimental testing location limitations, no radiation exposure testing was conducted.

Previous Efforts

- Test plan for the irradiation of nonmetallic materials (Sandia Report) RPP-PLAN-50529
- Banded (Band-it) and Swaged Hose in Hose Transfer Line (HIHTL) Assembly, Service Life Verification Program (Lieberman Report) RPP-6711, Rev.3, Appendix L

Garlock® Gasket

EPDM O-Ring

EPDM HIHTL Inner Hoses

Method

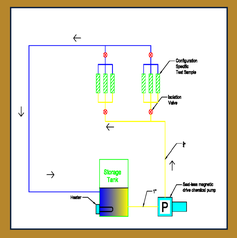
- This year's efforts (Phase 1) was limited to EPDM and Garlock® material testing. EPDM and Garlock® were selected for this phase of testing due to their use in multiple applications within the Hanford waste transfer system.
- The EPDM material will consist of EPDM HIHTL inner hoses and EPDM O-rings.
- Garlock® material will consist of Garlock® flange gaskets.
- All material samples had their mechanical performance and properties tested as per ASTM standards prior to any exposure.
- Materials were simultaneously exposed (aged) to both high temperature and caustic solution stressors.
- A 25% sodium hydroxide solution was used as the chemical stressor.
- Material will be aged while in-service configuration as well as coupons.
- Pre and post exposure mechanical performance testing will be conducted.

Experimental Testing

In-Service Configuration Aging

- The in-service configuration aging experimental setup consists of 3 independent pumping loops with three manifold sections on each loop.
- Each of the 3 loops will be run at a different temperature (85ºF, 130ºF and 180ºF). Each manifold section holds three test samples and is used for a corresponding exposure time of 180 and 365 days.
- Three samples of the EPDM inner hose along with three samples each of the EPDM O-rings and Garlock® gaskets are placed in two parallel manifolds on each loop.
- Isolation valves on each manifold allow removal of samples without affecting the main loop and the rest of the samples.

The temperature of the chemical solution circulating within each loop is maintained at a preset temperature by an electronically controlled heating system.

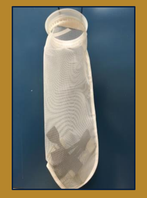


Aging loop Schematic

Aging loop

Coupon Aging

- The coupon aging experiment setup consists of 3 temperature controlled circulating fluid baths. Each bath will be maintained at a different temperature (85ºF, 130ºF and 180ºF).
- Each bath will have two sacks with ten coupons in each sack. Each sack will be submerged in the bath for a duration of 180 or 365 days.

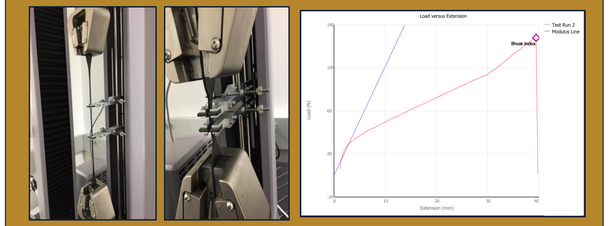


Coupon aging bag

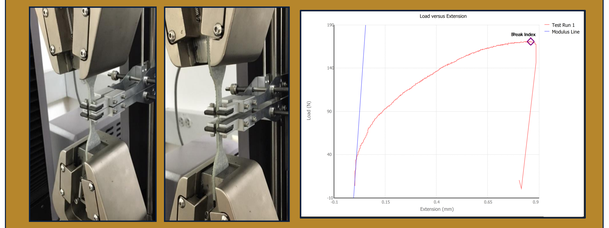
EPDM & Garlock® ASTM D412-C dumbbell coupons

Baseline Results

Mechanical Properties Testing



EPDM Pre-Aging Mechanical Properties Testing



Garlock® Pre-Aging Mechanical Properties Testing

Average Test Run Results - EPDM		
Display Name	Value	Unit
Peak Stress	0.002	kN/mm^2
Peak Load	0.13133	kN
Strain at Break	0.76367	mm/mm
Modulus	0.00833	kN/mm^2
Width	25	mm
Thickness	2.381	mm

Average Test Run Results - Garlock		
Display Name	Value	Unit
Peak Stress	0.003	kN/mm^2
Peak Load	0.17367	kN
Strain at Break	0.0167	mm/mm
Modulus	3.03967	kN/mm^2
Width	25	mm
Thickness	2.381	mm

HIHTL Pre-Aging Pressure Test Setup

Path Forward

Integration of Sensors

- **Thermocouples** – One per tank – To make sure the temperature in each test loop remains consistent.
- **Flow meters** – One per tank – To accurately measure the flow rate in each test loop.
- **Pressure Transducers** – One per tank – To accurately measure the pressure in each tank and assist in keeping it at 100 psi.

Remote Monitoring

- Integration of a remote monitoring system using a secured web server to display real-time data on any device with internet access.
- The purpose of this is to allow our staff and our partners at Hanford DOE Site to be able to see the status of our long-term experiment at any moment.

Experimental Testing

- After the sensors have been fully integrated into the test loops we will begin filling the tanks with a 25% sodium hydroxide solution.
- We will then begin our aging procedures; aged material and hose testing will proceed after the first 180-day specimens have been fully aged.
- All experimental procedures remain constant throughout the baseline and aged specimen testing and both follow the ASTM Standards listed in the 'References' section below.

References

ASTM D1349-14	Standard Practice for Rubber
ASTM D471-12a	Standard Test Methods for Rubber Property
ASTM D380-94	Standard Test Methods for Rubber Hose
ASTM D1414-94	Standard Test Methods for Rubber O-Rings
ASTM F37-06	Standard Test Methods for Sealibility of Gasket Materials

- Our HIHTL Pressure Testing will follow both ASTM D380-94 and the HIHTL pressure testing procedures used by River Bend Transfer Systems, LLC.

Acknowledgements

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