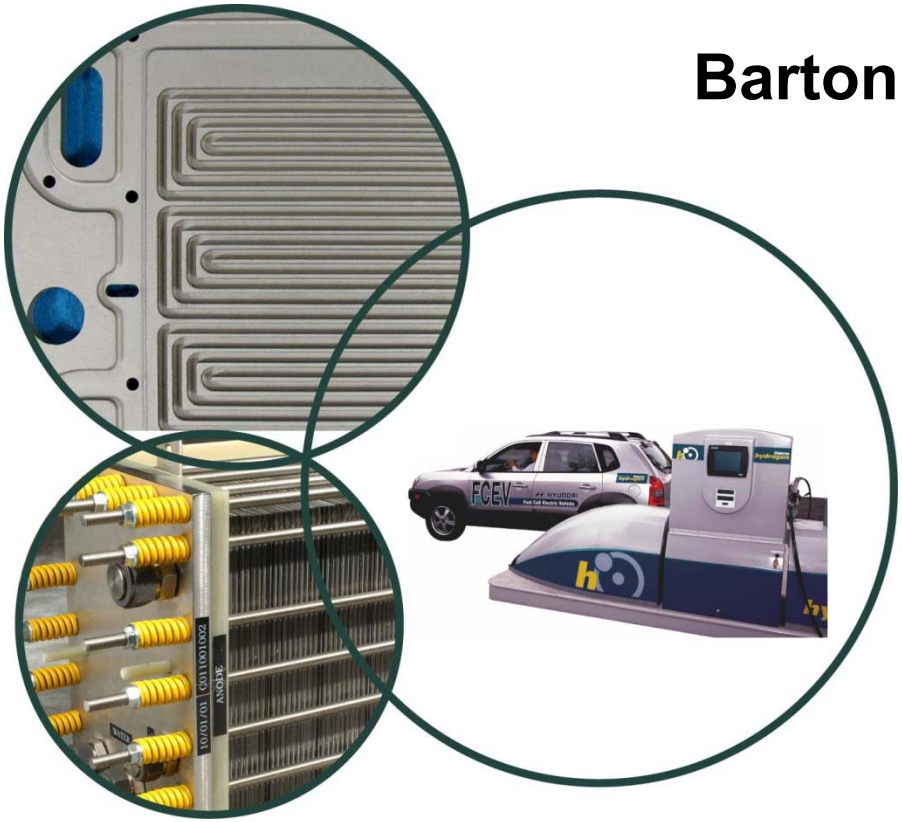
Lifecycle Verification of Polymeric Storage Liners



Barton Smith and Lawrence Anovitz

Oak Ridge National Laboratory

Annual Merit Review
Arlington, Virginia
May 19, 2009

Project ID #: STP_01_Smith

This presentation does not contain any proprietary, confidential, or otherwise restricted information.

Photos used with permission

Overview

Timeline

- Start: June 2008
- Finish: Project continuation & direction determined annually by DOE

Budget

- Total project funding
  - DOE: $400k
- Funding received in FY 08
  - $200k
- Funding for FY 09
  - $200k

Barriers

- D. Durability/Operability
- Technical targets

	430 bar	860 bar
Liner Durability	5500 cycles	5500 cycles

Partners & Collaborators

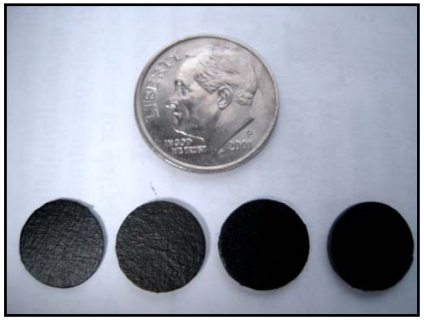
- Lincoln Composites
- Quantum Technologies
- Ticona

Project Milestones

Month-Year	Milestone or Go/No-Go Decision
May 2009	Milestone: Complete initial temperature cycle testing measurements (50% complete)
September 2009	Milestone: Complete lifecycle verification of first liner materials (25% complete)

Approach

- **Verify durability of polymer liners in high-pressure storage tanks**
  - **Subject polymer specimens to extreme-temperature cycling while pressurized with hydrogen**
  - **Measure hydrogen permeation at prescribed intervals to assess the ability of the liner materials to maintain the required hydrogen barrier capability.**
  - **Test protocol derived from SAE J2579, *Technical Information Report for Fuel Cell and Other Hydrogen Vehicles* (Jan 2008)**



1-cm-dia. tank liner specimens

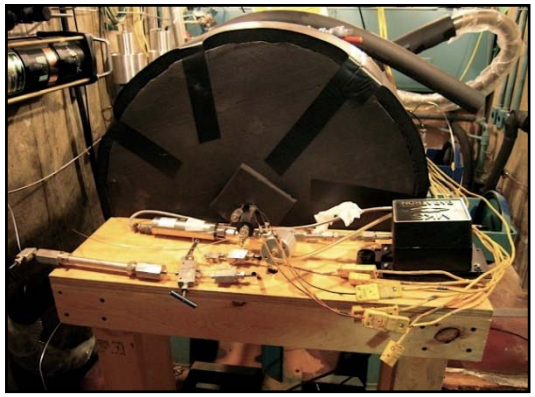
Approach-Test Protocol

- From SAE J2579 § 5.2.2 (January 2008)
  - 5500 temperature cycles: -40 to 125°
    - Goal is four cycles per hour (5 min heating, 10 minute cooling)
  - Upstream hydrogen pressures: 430 and 860 bar (6,250 and 12,500 psia)
- Measure permeation rates at -40, 25 and 125°C at completion of every 500 cycles

Technical Progress

- **High-pressure temperature cycling apparatus constructed, tested and in-use**
  - **Capable of cycling between -40 and 125°C about once per hour**
  - **Polymer specimen leak tight at hydrogen pressures up to 1000 bar**
    - **Getting polymer to seal against high-pressure hydrogen at low temperatures was especially challenging**

Low-temp chiller with 3.3 kW cooling capacity at -50°C



Internally heated high-pressure hydrogen permeation test vessel

Future Work

- **FY 2009**
  - Report results of initial verification measurements at 1500 cycles
  - Complete lifecycle verification at 5500 cycles
  - Begin cycling at 860 bar (12,500 psia)

- **FY 2010**
  - Temperature cycle testing of alternative liner materials: PA-6, PA-11, PPS
  - Measure hydrogen solubility in liner materials

Project Summary

Relevance:	**Durability of polymeric tank liners over the performance lifetime of high-pressure storage systems must be verified and validated**
Approach:	**Use relevant portion of SAE J2579 to develop and carry out durability test cycling measurements**
Progress:	**Automated high-pressure rapid temperature cycling apparatus online; initial verification testing underway**
Collaborations:	**Lincoln Composites, Quantum Technologies, Ticona**
Future:	**Long-term measurements of multiple liners at 430 and 860 bar, possible measurements of alternative liner materials, measurements of hydrogen solubilities in tank liner polymers**