IV.D.1k Development of Improved Composite Pressure Vessels for Hydrogen Storage

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Contract Number: DE-FC36-09GO19004

Project Start Date: January 1, 2009
Project End Date: December 31, 2013

Objectives

- To improve the performance characteristics, including weight, volumetric efficiency, and cost, of composite pressure vessels used to contain hydrogen in media such as metal hydrides, chemical hydrides, or absorbents.
- To evaluate design, materials, or manufacturing process improvements necessary for containing metal hydrides, chemical hydrides, or absorbents.
- To demonstrate these improvements in prototype systems through fabrication, testing, and evaluation.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Storage section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

(A) System Weight and Volume
(B) System Cost
(G) Materials of Construction

Technical Targets

This project is conducting fundamental studies for the development of improved composite pressure vessels for hydrogen storage. Insights gained from these studies will be applied toward the design and manufacturing of hydrogen storage vessels that meet the following DOE 2010 hydrogen storage targets:

	2010	2015
Gravimetric capacity:	>6%	>9%
Volumetric capacity:	>0.045 kg H_2/L	>0.081 kg H_2/L
Storage system cost:	<$133/kg H_2	<$67/kg H_2

Approach

Lincoln Composites is establishing and documenting a baseline design as a means to compare design, materials and manufacturing processes. This will be used to evaluate potential improvements in design, materials and process to achieve cylinder performance improvements for weight, volume and cost. Lincoln Composites will then down-select the most promising engineering concepts. These will then be evaluated to meet Go/No-Go requirements for moving forward.

Accomplishments

- Finalized design baseline and identified options for improvements in design, materials and processes.
- Identified the following areas for potential evaluation:
  - Evaluation of alternate fiber reinforcement
  - Evaluation of resin toughening agents
  - Evaluation of boss materials and designs
  - Evaluation of damage vs. impact
  - Evaluation of stress rupture characteristics
  - Evaluation of in situ non-destructive examination methods to detect damage
- Conducted testing addressing, specifically, permeation reduction through liner materials. Evaluated polymers with barrier additives and showed a 30-60% reduction in permeation through the liner. Lincoln Composites has also looked into the processing parameters of the liner materials. We evaluated different packing pressures (injection molding) to determine their effect on permeation.

Results showed no significant changes in permeation between the samples. Lincoln Composites has demonstrated testing to saturate and then rapidly depressurize liner samples. Initial testing has shown that with some coatings, blistering forms on the surface of the liner material after depressurization.

Future Directions

- Complete a final report outlining the baseline design.
- Continue to evaluate permeation reduction.
- The evaluation of toughened resin systems will be initiated.
- Stress rupture testing program and cylinder design will be defined and presented to industry members and Hydrogen Storage Engineering Center of Excellence partners for comment.

FY 2009 Publications/Presentations

1. 2009 DOE Hydrogen Program Annual Merit Review, May 20, 2009.