II.B.5 PEM Electrolyzer Incorporating an Advanced Low-Cost Membrane

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Subcontractors:
- Virginia Polytechnic Institute and State University, Blacksburg, VA
- Parker Hannifin Ltd, Hemel Hempstead, United Kingdom

Project Start Date: May 1, 2008
Project End Date: April 30, 2011

Objectives

GES will develop and demonstrate an advanced low-cost, moderate-pressure proton exchange membrane (PEM) electrolyzer system to meet DOE targets for distributed electrolysis.

- Develop high-efficiency, low-cost membrane
- Develop long-life separator
- Develop lower-cost prototype electrolyzer system
- Demonstrate prototype at the National Renewable Energy Laboratory (NREL)

Technical Barriers

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

(G) Cost - Capital Cost

(H) System Efficiency

(J) Renewable Electricity Generation Integration

Technical Targets

TABLE 1. GES Progress Toward Meeting DOE Targets for Distributed Electrolysis Hydrogen Production

Characteristics	Units	2012/2017 Targets	GES Status
Hydrogen Cost	$/kg H_2	3.70/<3.00	4.76
Electrolyzer Capital Cost	$/kg H_2	0.70/0.30	1.73
	$/$kW_e$	400/125	987
Electrolyzer Energy Efficiency	% (LHV)	69/74	67

Approach

To reduce the cost of PEM electrolyzers, GES is improving electrolyzer stack efficiency and reducing stack cost through development of an advanced low-cost membrane. GES is also reducing stack capital cost and increasing stack life through 1) development of a long-life separator, 2) decreasing stack costs by initiating scale-up to a larger active area, and 3) reducing the system capital cost by applying commercial production methods to PEM electrolyzer systems.

In each of the key development areas, GES and our team members will conduct focused development of advanced components in laboratory-scale hardware, with analytical support as necessary, followed by life-testing of the most promising candidate materials. GES will design a scaled-up stack having an active area of 290 cm^2, incorporating a low-cost stack sealing concept and the advanced components. Advanced system components to reduce cost and improve balance-of-plant efficiency will be developed and tested independently, then incorporated into the electrolyzer system. The scaled-up stack incorporating the advanced components and membrane developed in the project will be installed into the system, which will be tested for 500 hours at GES. To validate the improvements achieved in this project, a prototype system will be demonstrated at NREL.

Successful development of the advanced electrolyzer stack and system will result in a high-efficiency, low-capital-cost electrolyzer that will meet the DOE cost targets for hydrogen production, assuming high-volume production. This will provide competitively-priced hydrogen for delivery at forecourt stations to enable transition to a hydrogen economy.

Accomplishments

The project was initiated in May 2008. Experimental work is scheduled for September 2008.

Future Directions

Fiscal Year 2008 Objectives

- Develop viable low-cost, high-efficiency, high-strength PEM
  - Demonstrate electrochemical performance comparable to thin Nafion® (N112)
  - Demonstrate high strength to allow operation at 300 psig H_2/ambient O_2 and 80-90°C
  - Membrane durability testing ≥1,000 hr
- Initiate separator development
  - Demonstrate 10,000+ hr; goal is 50,000 hr
- Complete preliminary system design and development of lower-cost components

FY 2008 Publications/Presentations

1. Presentation at 2008 Hydrogen Program Annual Merit Review Meeting, M. Hamdan.

2. Presentation to 2008 Hydrogen Production Technology Team, M. Hamdan.