II.C.3 Hydrogen Generation from Electrolysis

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Project Start Date: March 1, 2004 (Note: This report covers work done since the project resumed in May 2007)
Project End Date: April 30, 2008

Objectives

- Establish a pathway to larger proton exchange membrane (PEM) electrolysis systems.
- Start with 100 kg/day with the intention of growth to 500 kg/day.
- Reduce capital cost and increase energy efficiency.

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) Capital Cost
(H) System Efficiency
(J) Renewable Electricity Generation Integration

Technical Targets

This project is developing a conceptual design of a PEM electrolyzer with decreased capital costs and increased efficiency, working towards the following 2012 Technical Targets:

- Hydrogen Cost: $3.70/gge
- Electrolyzer Capital Cost: $0.70/gge, $400/kW
- Electrolyzer Energy Efficiency (lower heating value, LHV): 69%
- At the completion of the project, there will be enough detail to make good estimates on cost and performance of a production system compared to the target values.

Accomplishments

Kickoff, budget and schedule complete; initiation of trade studies.

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Introduction

Small scale (100-1,500 kg/day) electrolysis is an important step in increasing the use of hydrogen as fuel. Until there is a large population of hydrogen fueled vehicles, the smaller production systems will be the most cost-effective. In addition, electrolysis allows the use of renewable energy sources, which reduces our dependence on fossil fuels and helps protect the environment.

The objective of this project is to reduce the capital costs and improve the efficiency of an electrolyzer, which will bring down the cost of hydrogen produced, while incorporating compatibility with renewable energy sources.

Approach

The first step of this project is to investigate trade-offs in several electrolyzer subsystems in order to select the best available components and configurations. Interactions among subsystems will be taken into account when evaluating the various options. The evaluations will be driven by the Technical Targets mentioned above.

The next step is to develop a conceptual design, both functional architecture (e.g. piping diagrams) and physical architecture (e.g. component sizing). This design will allow a more accurate estimate of cost and performance, which will provide a more accurate estimate of progress towards the technical targets.

Results

At this early stage of the project, there are no substantial results to report.

Conclusions and Future Directions

The trade studies to be performed include:

- Cell stack size, configuration, and number.
- Cell stack power supply topology and current vs. voltage – include compatibility with renewable energy sources.
- Drying efficiency – explore various technologies and configurations.
- Water management – separator size, quantity.
- Thermal and airflow management – ventilation vs. explosion proof components, heating and cooling options.

Conceptual design tasks include:

- Piping and instrumentation diagram.
- Top level electrical schematic.
- Subsystem design intent.
- PHA (preliminary hazard analysis).
- Preliminary component sizing.
- System computer aided design model.
- Heat and mass flow model/subsystem interaction.
- Site layout.

FY 2007 Publications/Presentations

1. L. Moulthrop, E. Anderson, O. Chow, R. Friedland, S. Porter, M. Schiller, S. Szymanski, Commercializing Larger PEM-based Hydrogen Generators for Energy and Industrial Applications; *Proceedings of the NHA Annual Hydrogen Conference, San Antonio, TX, 2007.*