

V.K.1 Effects of Impurities on Fuel Cell Performance and Durability

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Subcontractors:

- FuelCell Energy, Inc., Danbury, CT
- United Technologies – Hamilton Sundstrand, Windsor Locks, CT

Project Start Date: March 1, 2007

Project End Date: February 28, 2011

Objectives

- Identify the specific contaminants and contaminant families present in both fuel and oxidant streams.
- Develop analytical chemistry protocols and tools to detect the nature and fate of contaminating species within fuel cells.
- Determine both through controlled laboratory experimentation and literature study the main drivers for voltage decay.
- Develop contaminant analytical models and computer simulations that explain and predict these effects.
- Validate contaminant models through single cell experimentation using standardized test protocols.
- Develop and validate novel technologies for mitigating the effects of contamination on fuel cell performance.
- Disseminate results through outreach activities.

Technical Barriers

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

(A) Durability

Technical Targets

This project is conducting fundamental research into the effects of impurities on fuel cell performance and durability. This activity broadly supports the following technical targets established by DOE:

- By 2010, develop a 60% peak-efficient, durable, direct hydrogen fuel cell power system for transportation at a cost of \$45/kW; by 2015, a cost of \$30/kW.
- By 2011, develop a distributed generation proton exchange membrane (PEM) fuel cell system operating on natural gas or liquefied petroleum gas that achieves 40% electrical efficiency and 40,000 hours durability at \$750/kW.



Approach

While PEM fuel cells show significant promise to provide efficient, clean power for stationary and transportation applications, today's technology falls short of meeting existing and contemplated product performance and durability standards. One of the limiting factors is that the operational lifetime of membrane electrode assemblies becomes reduced when contaminants are introduced into the system. These contaminants impact the functionality of ion exchange groups within the electrolyte, degrade catalyst activity, and function as a diluent for the fuel and oxidant stream thereby negatively impacting overall cell efficiency and operational performance.

This project is focused on the experimental determination of the effects of key contaminants on the performance of PEM fuel cells. Experimental data will be leveraged to create mathematical models that predict the performance of PEM fuel cells that are exposed to specific contaminant streams. These models will be validated through laboratory experimentation and will be utilized to develop novel technologies for mitigating the effects of contamination on fuel cell performance. Results will be publicly disseminated through papers, conference presentations, and other means.

Accomplishments

- Completed calibration of test equipment using test protocols jointly developed amongst participating laboratories.
- Initiated contaminant testing.

FY 2007 Publications/Presentations

1. “Effects of Impurities on Fuel Cell Performance and Durability”, Presentation at the DOE Program Kickoff Meeting, February, 2007.
2. “Effects of Impurities on Fuel Cell Performance and Durability”, Poster Presented at the DOE Annual Merit Review, May, 2007.