V.R.2 Water Transport in PEM Fuel Cells: Advanced Modeling, Material Selection, Testing, and Design Optimization

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Subcontractors:
- Ballard Power Systems, Burnaby, BC, Canada
- BCS Fuel Cells, Bryan, TX
- ESI US R&D, Huntsville, AL
- RTI International, Research Triangle Park, NC
- SGL Carbon, Meitingen, Germany
- University of Victoria, Victoria, BC, Canada

Project Start Date: June 1, 2007
Project End Date: May 31, 2011

Objectives

- Develop advanced physical models for water transport and generation, and conduct material and cell characterization experiments;
- Improve understanding of the effect of various cell component properties and structure on the gas and water transport in a proton exchange membrane (PEM) fuel cell;
- Demonstrate improvements in water management in cells and short stacks; and
- Encapsulate the developed models in a commercial modeling and analysis tool.

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
(D) Water Transport within the Stack
(E) System Thermal and Water Management
(G) Start-up and Shut-down Time and Energy/Transient Operation

Technical Targets

This project is addressing fundamental issues in water transport within the fuel cell stack. The resulting understanding will be applied toward the design of stack components and operating strategies that enable meeting the 2010/2015 targets for transportation fuel cell stacks operating on direct hydrogen:

- Stack power density: 2,000 W/L
- Cold start-up time to 50% rated power @ 20°C: 5 secs
- Unassisted start from low temperature: -40°C

Approach

Our overall approach to improving the fundamental understanding of water transport is to:

- Characterize the impact of fuel cell component material properties and structure on water management through ex-situ and *in situ* experimental studies;
- Develop, test, and validate modeling tools for analysis of water and two-phase transport in fuel cells; and
- Apply the developed experimental and numerical capabilities to evaluating and optimizing fuel cell and stack-scale water management.

Brief descriptions of the contributions of the selected team members to this approach are as follows:

- **CFDRC**: model development, validation, demonstration of design improvements, and project coordination and management.

- **Ballard Power Systems**: ex-situ materials characterization, in situ diagnostics of water transport and related phenomena, technical consultation, and testing/applying new capabilities.
- **BCS Fuel Cells**: experimental parametric studies of cell performance and freeze/thaw sensitivity to component (gas diffusion layer [GDL], membrane electrode assemby, bipolar plate) properties, participation in development of design/process improvements, implementation and assessment of improvement strategies.
- **ESI Group**: model development support, integration into commercial software (CFD-ACE+) for fuel cell analysis with support from Ballard and CFDRC.
- **RTI International**: materials characterization and ex-situ water transport experiments, materials modification/improvement, participation in development of design improvements.
- **SGL Carbon**: GDL and bipolar plate materials supply, consultation and modification of components.
- **University of Victoria**: develop and apply suitable qualitative and quantitative two-phase flow visualization techniques to investigate flow in GDL and GDL/microchannel assemblies.

Accomplishments

We have started reviewing and assessing recently published relevant literature, and are reviewing plans with the subcontracting team members.