V.L.2 Adaptive Stack With Subdivided Cells for Improved Stability, Reliability, and Durability Under Automotive Load Cycle

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Subcontractor:
3M Corporation, St. Paul, MN

Project Start Date: May 1, 2007 (proposed, contract pending as of June 15, 2007)
Project End Date: April 30, 2009 (projected; 2 years from the actual start of the project)

Objectives

- Significantly increase state-of-the-art automotive stack life and provide stable performance under simulated automotive load cycling conditions.
- Offer smooth on-demand power transitions over the entire power range.
- Reduce the stack performance degradation associated with high cell voltage operation.
- Improve system efficiency and reliability during low power operation.
- Reduce cost and parts count for the power conditioning module (PCM) and other auxiliary units.

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

(C) Performance

(G) Start-up and Shut-down Time and Energy/Transient Operation

Technical Targets

TABLE 1. Plug Power Inc. (PPI) Progress Towards Meeting Technical Targets: Transportation Fuel Cell Stacks Operating on Direct Hydrogen

Characteristic	Unit	2005 Status	2010/2015 Target	PPI Status*
Durability with Cycling	Hours	2,000	5,000/5,000	n/a
Transient Response (time for 10% to 90% of rated power)	Seconds	< 3	1	n/a

* Project has not officially started at the time this report is prepared.

Approach

We offer a simple solution to the above issues with our creative stack architecture and corresponding operational procedures. A proton exchange membrane fuel cell (PEMFC) stack, with multiple substacks connected electrically in parallel, is constructed from membrane electrode assemblies (MEAs) with multiple subdivided electrodes and bipolar plates with multiple sub flow fields. Individual segments are electrically disposed in parallel and insulated from each other.

This architecture offers a simple and effective control scheme for increased system efficiency and reliability, improved performance stability and smooth power transitions over the entire power range, and extended stack durability at reduced system cost. In addition, our proposed stack architecture further advances the state-of-the-art because it is generic in principle. It is independent of fuel/component materials used and is not limited solely to PEMFC systems. Moreover, it is applicable to virtually any stack size and power output range, and can serve as a simple and flexible platform to meet diverse customer requirements for automotive applications, stationary power generation, and other fuel cell applications.

Future Directions

This project has not officially started at this time (contract pending). The planed activities are:

- **Task 1.** Cell/stack configuration selection and optimization (computational fluid dynamic modeling)
- **Task 2.** Component development and fabrication
- **Task 3.** Single cell/module tests (go/no-go decision point)
- **Task 4.** Stack assembly and test
- **Task 5.** DOE evaluation

FY 2007 Publications/Presentations

1. Bin Du and Richard Pollard, "Adaptive Stack With Subdivided Cells for Improved Stability, Reliability, and Durability under Automotive Load Cycle", DOE Fuel Cell Program Kickoff & Coordination Meeting, February 13–14, Washington, D.C.

2. Bin Du, "FCP18: Adaptive Stack With Subdivided Cells for Improved Stability, Reliability, and Durability under Automotive Load Cycle", in Proceedings of DOE Hydrogen Program 2007 Annual Merit Review, May 15–18, 2007, Crystal City, VA.