THE DOE TRANSPORTATION FUEL CELL PROGRAM: RECENT ACCOMPLISHMENTS AND FUTURE PLANS

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The Department of Energy (DOE) Transportation Fuel Cell Program supports highly focused R&D on critical technical issues related to development of fuel cells for automobiles. During the past year, significant technical achievements have resulted from this program including the development of microchannel technology for fuel processing components, fabrication and testing of membrane-electrode assemblies using new electrode structures, and development of composite bipolar plates. This paper provides a brief overview of the program and describes two of several recent technical highlights, as well as plans for fiscal year 2000.

U.S. DOE FUEL CELL PROGRAM

The DOE Transportation Fuel Cell Program is an ambitious, cost-shared, R&D program between government and industry that supports the Partnership for a New Generation of Vehicles (PNGV). The objectives of the Program are to:

By 2000, develop and validate fuel cell stack system technologies (50-kW net) that are:

- Greater than 57 percent energy efficient at 25 percent peak power.
- More than 100 times cleaner than EPA Tier 2 emissions.
- Capable of operating on hydrogen or hydrogen-rich fuel produced from gasoline, methanol, ethanol, and natural gas.

By 2004, develop and validate fuel-flexible fuel cell power system technologies that meet vehicle requirements in terms of:

- Cost-competitive with internal combustion engines.
- Performance, range, safety, and reliability.

Program Strategy

Successful development of fuel cell propulsion systems requires that significant technical challenges be addressed. These include size and weight reduction, rapid start-up and transient response capability, fuel processing development, manufacturing cost reduction, complete fuel cell system integration, and durability and reliability demonstration. To overcome these challenges, the Department works with all stakeholders through a Fuel Cell Alliance. This government/industry alliance includes domestic automakers, component suppliers, fuel cell developers, national laboratories, universities, and the fuels industry. The Fuel Cell Alliance has significant benefits for both DOE and U.S. automakers. It provides a mechanism for obtaining industry consensus and recommendations for Program direction, and for facilitating the dissemination of government-sponsored R&D within the domestic auto industry. In addition, close relationships between DOE national laboratories and developers, and between developers (i.e. suppliers) and automakers are evolving to ensure that R&D is carried out in a customer-driven fashion.

1999 R&D Highlights

Fuel Processing

Microchannel Fuel Processing Components

Pacific Northwest National Laboratory (PNNL) has demonstrated the technical feasibility of using micro thermal and chemical systems for energy conversion and chemical processing applications. These devices provide substantially higher process rates (per unit hardware volume) than can be realized with conventional hardware, due to advantages associated with rapid heat and mass transport in engineered microchannels. Ultra compact microchannel heat exchangers with extremely high convective heat transport coefficients and low pressure drops have been demonstrated. Gasoline fuel vaporizers based on this technology have been developed and successfully tested at Epyx Corporation. The vaporizer measures 3" x 4" x 1.5" and processes gasoline at 300 mL/min, a rate sufficient for a 50 kW_e fuel cell.

The success of the vaporizer led the PNNL team to apply the microchannel approach to steam reforming. Their 18-cm^3 test cell was run on isooctane at 0.5 to 1.0 kWe and 1 atm (designed for 5 kW_e and 5 atm). It produced reformate containing 67 to 72% hydrogen. Conversion was 67-90% and H_2 selectivity was 91-99% for residence times of 1.1 to 2.3 ms, steam to carbon ratios of 3:1 to 6:1, and temperatures of 630- 670°C. The cell currently uses an engineered catalyst developed at PNNL. If this performance holds after integration and scale-up, the team projects a total reformer volume of only 4 L, including a steam generator, combustor, vaporizer, and recuperative heat system. Their target is to demonstrate a bench-scale microchannel system (5 kW_e) integrated with a fuel cell during fiscal year 2000.

Fuel Cell Stack R&D

Composite Bipolar Plates

Molded composite bipolar plates have been developed by the Institute of Gas Technology (IGT) that are projected to meet the $10/kW DOE cost target at high-volume production. Because of the inherent flexibility of the molded parts, much thinner plates are possible compared to machined graphitized carbon plates, which can cost up to $150/kW in mass production quantities. Based on progress made at IGT, Stimsonite and ENDESCO Services, Inc. have formed a joint venture company called PEM Plates, LLC to mold the composite plates.

PLANS FOR FISCAL YEAR 2000

During FY 2000, the first integrated 50-kW fuel-flexible fuel cell system will be delivered. The system will include a 50-kW fuel cell stack, 50-kW partial oxidation reformer, and balance of plant components. New projects in FY 2000 will address development of continuous fabrication processes for membrane-electrode assemblies leading to high-volume manufacturing capability and lower cost, durability testing of fuel processors and fuel cell stacks, and development of higher voltage cathodes to meet DOE fuel cell efficiency targets.