XI.4 Advanced Direct Methanol Fuel Cell for Mobile Computing

James Fletcher (Primary Contact),
Joseph Campbell
University of North Florida (UNF)
1 UNF Drive
Jacksonville, FL 32224
Phone: (904) 620-1844
E-mail: JFletche@unf.edu

DOE Technology Development Manager:
Ned Stetson
Phone: (202) 586-9995
E-mail: Ned.Stetson@ee.doe.gov

DOE Project Officer: Katie Randolph
Phone: (303) 275-4901
E-mail: Katie.Randolph@go.doe.gov

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Objectives

- The project objective is to develop a direct methanol fuel cell (DMFC) power supply for mobile computing using the novel passive water recycling technology acquired by UNF from PolyFuel, Inc., which enables significant simplification of DMFC systems.
- The objective of the 2010 effort to date is to define the system concept and develop the required design requirements (system, sub-system, and component) in order to achieve the 2010 technical targets. Initial component development effort, based on the component design requirements (CDRs), is nearly completed.

Technical Barriers

- Storage Degradation - The prototype stack technology developed previously by PolyFuel displays a moderate level of degradation during storage, which needs to be understood and possibly mitigated before such technology can progress into commercialization. Extensive testing continues to refine hypotheses and zero in on root causes for such degradation. Recent testing has identified at least one factor and has also shown some degree of reduction is such degradation with extended time. As there are no qualified accelerated tests for this important barrier, such testing will continue in parallel with other activities for the duration of the project.
- Integration of Component Subsystems - Engineering efforts to create integrated subsystems which meet functional and power density targets and are also on the design path toward volume production is the near term technical barrier to be overcome. New components are being designed and evaluated to meet aggressive technical targets and brassboard testing is planned in the coming quarter.

Technical Targets

TABLE 1. UNF Progress toward Meeting Technical Targets for Advanced Direct Methanol Fuel Cell for Mobile Computing

Characteristic	Units	UNF 15 W DP3 2008 Status	DOE 2010 Target	UNF Proposed 20 W System Design
Specific Power[a]	W/kg	35	100	54
Power Density[a]	W/L	48	100	63
Energy Density	W-hr/L	250 (1 x 100 ml)[b] 396 (1 x 200 ml)[b]	1,000	198 (1 x 100 ml) 313 (1 x 200 ml) 507 (3 x 200 ml)
	W-hr/kg	155 (1 x 100 ml)[b] 247 (1 x 200 ml)[b]	N/A	180 (1 x 100 ml) 302 (1 x 200 ml) 532 (3 x 200 ml)
Lifetime[c]	Operating Hours	1,000 hrs in single cell	5,000	2,500 Integrated System
Cost	$/Watt	11 (est. in volume)	<3	<10 (est. in volume)

[a] Beginning of life, 30°C, sea level,50% relative humidity, excluding hybrid battery, power module alone.
[b] Normalized from DP3 data from 150 ml cartridge to either 100 ml or 200 ml for comparison purposes.
[c] Lifetime measured to 80% of rated power.
N/A – not applicable

This project will contribute to the relevance of DOE's objectives for ARRA projects in general and the DMFC projects in particular.

- Create direct and supporting jobs nationwide as the UNF fuel cell technology becomes commercially available.
- Reduce the necessity and use of the power grid as fuel cells power increasing numbers of portable electronic devices, thereby creating more "green" jobs.
- Create more business activity in the fuel cell supply industry.

- Expand the user base of new alternative power technologies.
- Increase the level of competition among producers of alternative energy technologies.

While this project is recently funded (January 1, 2010), significant milestones to date are:

- CDRs – 90% complete
- Design failure mode effects and analysis (FMEA) – 25% complete
- Key subsystems prototypes – 25% complete
- Fuel cartridge prototype – 25% complete
- Numerous other tasks at least 20% complete

Approach

The approach of the project is to develop a revised set of CDRs based on concept design that integrates revised component packaging and integration of key sub-systems. The focus of the approach is to both miniaturize balance-of-plant components and integrate them into sub-systems such as the fuel recirculation pump, the carbon dioxide separator and the retained liquid reservoir. These components will be rigorously tested individually, as sub-systems, and ultimately at the system level. Initially, existing components will be evaluated for durability and failure modes, and the results will be used to help further define component requirements. Once available, the new design prototype components will be evaluated for durability and robustness. As functional performance data from component and integrated sub-system testing become available, the system model will be refined to reflect the optimized performance characteristics. Sub-systems will be integrated for testing, first onto a brassboard enabling detailed instrumentation of the system and verification of sub-system design, and then into an integrated package with auxiliary instrumentation. Control system development will optimize the key operational protocols for start-up, rest/rejuvenation, and shut-down to optimize operating lifetime and minimize both operational and storage degradation rates. A test plan driven by the consumer electronics performance requirements for operational and storage degradation rates and nominal and extreme operating conditions will establish a benchmark for a statistically significant sample of systems for a thorough evaluation of durability and robustness of the system.

Accomplishments

The project was initiated in January 2010. Major accomplishments are:

- Submitted a hydrogen safety plan.
- CDRs completed.
- System design review with project members.
- Membrane electrode assembly prototype production facility online.

Future Directions

- Complete FMEA.
- Complete component development and rigorous testing.
- Assemble brassboard system for system testing.
- Key Milestone: Demonstrate component performance meets requirements.
- Complete development of advanced control strategies.
- Integrate components and sub-systems into packaged unit.
- Test the system extensively to evaluate performance, robustness, and durability.