V.J.5 Research and Development for Off-Road Fuel Cell Applications

Michael T. Hicks
IdaTech, LLC
63065 NE 18th Street
Bend, OR 97701
Phone: (541) 322-1040
Email: mhicks@idatech.com

DOE Managers
HQ: Kathi Epping Martin
Phone: (202) 586-7425
Email: Kathi.Epping@ee.doe.gov
GO: David Peterson
Phone: (720) 356-1747
Email: David.Peterson@go.doe.gov

Technical Advisor
Walt Podolski
Phone: (630) 252-7558
Email: podolski@anl.gov

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Subcontractors:
- The Toro Company, Bloomington, MN
- University of California, Davis, CA (UC Davis)

Project Start Date: August, 2007
Project End Date: September 30, 2012

Fiscal Year (FY) 2012 Objectives

- Build test stand for evaluation of commercial air filters for off-road applications.
- Evaluate air-filtration technologies for off-road applications.

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells section (3.4.4) of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

(A) Durability

Technical Targets

This project is evaluating the efficiency at which air filter remove compounds that are known contaminants to low temperature polymer electrolyte membrane fuel cells. Insights gained from these evaluations will be applied toward the design and synthesis of air filters that meet the DOE transportation requirements for:

- Stack durability: 5,000 hours
- Humidifier durability: 5,000 hours

FY 2012 Accomplishments

- Gathered information on the air contaminants that may have an effect on fuel cell operation.
- Built exterior test facility to house air filtration test stand.
- Built test stand for evaluating air filters. Test stand has the ability to control contaminant level, humidity, temperature and flow rate.
- Completed standalone application for data acquisition.
- Verified control loops are functioning properly.

Introduction

Air filters are a critical part of a fuel cell system. They remove harmful contaminants (oxides of nitrogen and sulfur) from the oxidant stream before they reach and damage the fuel cell stack. However, filter suppliers routinely characterize air filters according to standard test procedures that are not suitable for fuel cell systems. These test methods evaluate contaminants at ppm levels when ppb levels are more representative; they only test one contaminant at a time when multiple contaminants exist in ambient air; and they do not evaluate the impact of ambient air conditions (temperature and humidity) on air filter performance. These shortcomings make it impossible to extrapolate the results from the standard test conditions to fuel cell test conditions. As a result, IdaTech proposes to evaluate air filters under "real-life" conditions.

Approach

- Determine reasonable air contaminant levels.
- Perform ex situ testing of air filters to evaluate breakthrough and filter capacitance at different contaminant levels, gas flow rates, temperatures and relative humidity.
- Utilize statistical design of experiments to plan and analyze experimental data.

Results

Completed building outdoor test stand for air filtration. Initial shakedown testing revealed several significant issues in both hardware and controls. First, it was determined that all check values leaked under backpressure, and they were replaced. Second, the gas-sampling solenoid valves failed to seal and were rebuilt. Lastly, the control loops for temperature and humidity were not functioning as designed and were re-written. After implementing the hardware and software changes, the system ran successfully for two weeks under a preliminary test condition (no air contaminants) in order to verify the correct regulation of the test parameters and the new data acquisition system.

Future Directions

- Calibrate Horiba gas analyzers for oxides of nitrogen and sulfur.
- Start air contamination tests and data collection.