V.I.5 Research & Development for Off-Road Fuel Cell Applications

Richard J. Lawrance
IdaTech, LLC
63065 NE 18th Street
Bend, OR 97701
Phone: (541) 322-1112; Fax: (543) 383-3439
E-mail: rlawrance@idatech.com

DOE Technology Development Manager:
Kathi Epping Martin
Phone: (202) 586-7425; Fax: (202) 586-9811
E-mail: Kathi.Epping@ee.doe.gov

DOE Project Officer: David Peterson
Phone: (303) 275-4956; Fax: (303) 275-4788
E-mail: David.Peterson@go.doe.gov

Technical Advisor: Walt Podolski
Phone: (630) 252-7558; Fax: (630) 972-4430
E-mail: podolski@anl.gov

Contract Number: DE-FG36-04G014303

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

Project Start Date: August 9, 2007
Project End Date: June 9, 2010

Objectives

- Develop system to allow proton exchange membrane (PEM) fuel cells to operate in off-road applications.
- Evaluate air-filtration technologies for off-road applications.
- Conduct a program of study, evaluation and laboratory testing needed to establish comprehensive set of PEM fuel cell system requirements for turf and grounds maintenance vehicles.
- Fully integrate prototype PEM fuel cell system in a Toro Workman® e2065 mid-duty utility vehicle for field trials.

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

Accomplishments

- Measured the shock, and vibration spectrum for golf course maintenance vehicles.
- Gathered information on the air contaminants that may have an effect on fuel cell operation and developed an air filter for fuel cell systems.
- Developed the Workman® Model e2065 mid-duty utility vehicle equipped to operate on direct current (DC) voltage.
- Measured the power profiles of a typical maintenance vehicle on two golf courses.
- Designed and installed an IdaTech Liquid Fueled Fuel Cell System into a Toro Workman® Model e2065 mid-duty utility vehicle.

Introduction

Nearly no practical work has been performed by the fuel cell industry, and its suppliers and trade associations on the subject of off-road fuel cell operation. The environments encountered in off-road applications could adversely affect fuel cell performance and life, rendering current designs impractical.

One of the recognized challenges in fuel cell systems air purification is in providing a highly efficient particulate and chemical filter with minimal pressure drop. PEM integrators do not want additional parasitic loads added to the system as compensation for a highly efficient yet highly restrictive filter. Additionally, there is challenge in integrating multiple functions into a single air intake module tasked with effectively filtering high dust loads, diesel soot, pesticides, ammonias, high frequency noise, and other anticipated off-road contaminants. It is one key project objective to develop a strategy, and through it a solution, for achieving clean cathode inlet air.

Other off-road concerns are related to fuel cell power requirements and effect of shock and vibration. Mechanical stresses on differing material makeup and mass distribution within the system may render some components susceptible to impulse trauma while others may show adverse effects from harmonic disturbances or broad band mechanical agitation. The team will employ an established analysis, test and verification approach applied in various industries, such as the aerospace industry, that successfully manages mechanical stresses and enables long component lifetimes.

Approach

- Measure the air quality for off-road applications and develop an air filter.
- Measure the shock and vibration spectrum for off-road vehicles, and then subject an IdaTech fuel cell system to the spectrum.
- Design, assemble, and test a Toro Workman® Model e2065 mid-duty utility vehicle with an IdaTech Liquid Fueled (methanol/water) Fuel Cell System that meets cathode air intake quality requirements.

Results

An IdaTech 2.5 kW Liquid Fueled Fuel Cell System was assembled, tested at IdaTech, delivered to and demonstrated at UC Davis. Shock and vibration testing has begun at UC Davis to an established test plan and procedure.

Toro has determined the fuel cell systems vehicle performance specification for the Workman® Model e2065 and IdaTech's FCS 3000 system meets the specifications and incorporates the developed air filter. A Toro Workman® Model e2065 mid-duty utility vehicle was acquired by IdaTech.

Three fuel cell systems were assembled and all three met established performance requirements. One unit while sitting next to the vehicle was used to charge the battery. The unit was reconfigured and installed into the vehicle. A photo of the vehicle is shown in Figure 1.

FIGURE 1. Toro Workman® Model e2065 Mid-Duty Maintenance Truck

The fuel cell system has accumulated 290 hours of operation. The installed fuel cell is shown in Figure 2.

Conclusions and Future Directions

The work conducted shows that an IdaTech Liquid Fueled Fuel Cell System can be integrated into an off-road vehicle, and is compliant with performance requirements for off-road vehicle applications. Operation on a dynamometer to measure fuel mileage and operation on a real golf course atmosphere will begin soon and demonstrations will be scheduled for the end of the year. Arrangements have been made with a local golf course for field trials.

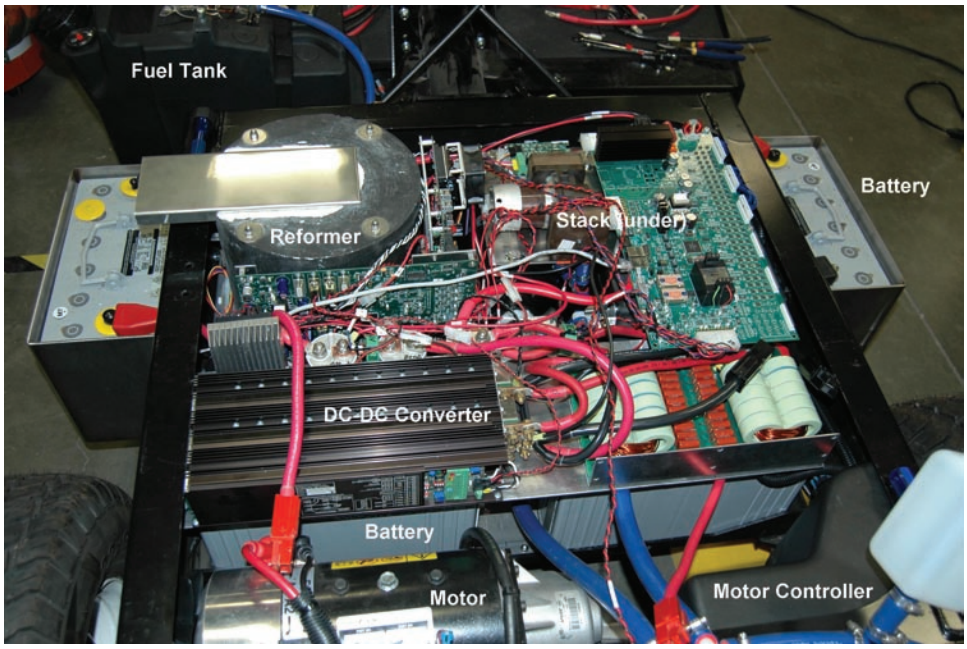

FIGURE 2. IdaTech Liquid Fueled Fuel Cell System Installed in Vehicle