XI.10 Complex Coolant Fluid for PEM Fuel Cell Systems

Satish C. Mohapatra
Advanced Fluid Technologies, Inc. dba Dynalene Heat Transfer Fluids
5250 West Coplay Rd.
Whitehall, PA 18052
Phone: (610) 262-9686; Fax: (610) 262-7437; E-Mail: satishm@dynalene.com

DOE Technology Development Manager: Donna Ho
Phone: (202) 586-8000; Fax: (202) 586-9811; E-mail: Donna.Ho@ee.doe.gov

Contract Number: DE-FG02-04ER83884

Subcontractors:
Lehigh University, Bethlehem, PA (Phase I & II)
The Pennsylvania State University (Phase II)

Start Date: July 13, 2004
Projected End Date: July 11, 2007

Objectives

- Develop and fully validate the technical potential of a fuel cell coolant based on glycol/water mixtures and an additive package that will exhibit less than 2.0 S/cm of electrical conductivity for more than 3000 hours in an actual polymer electrolyte membrane (PEM) fuel cell system.
- Demonstrate the potential for commercializing such a coolant at a price that is acceptable for a majority of fuel cell applications (i.e., < $8.0/gallon).

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
- D. Thermal, Air and Water Management

Approach

The proposed complex coolant fluid (CCF) consists of a base compound (glycol/water mixtures) and an additive package. The base compound mixture has a freezing point less than –40 ^{o}C, is non-flammable for transportation purposes, and can be used at temperatures up to 122 ^{o}C. The additive package consists of non-ionic corrosion inhibitors and ion-suppressing compounds (nanoparticles that are less than 100 nm) to maintain the electrical conductivity of the coolant at a low level. Use of this type of coolant will enable the fuel cell manufacturers to eliminate the de-ionizing filter they are currently using to maintain a low electrical conductivity of the glycol/water-based coolants.

The technical approach to developing the complex coolant fluid includes the development of the nanoparticles and the corrosion inhibitors, and studying the fluid performance (electrical conductivity vs. time) in short-term as well as long-term tests utilizing a dynamic test loop. Ultimately, the fluid will be tested in real fuel cell systems by the developers of PEM fuel cells.

In Phase I of the SBIR project, our technical approach was to develop preliminary candidate nanoparticles and formulate several CCF mixtures. Additionally, we designed and built a dynamic test system that simulated the flow rate and temperature of the coolants in real PEM fuel cell systems (Figure 1). This test system has the capability of online measurement of electrical conductivity, pH and temperature and storing the data in a computer. Tests were conducted using various coolant formulations as well as de-ionized water and propylene glycol (PG)/ water mixture. Figure 2 shows one of the results obtained during SBIR Phase I project to demonstrate the feasibility of the concept. It was observed that the electrical conductivity of a candidate CCF mixture could be maintained around 2.0 S/cm or lower for more than 300 hours.

Figure 1. Dynamic Test Loop at the Dynalene Facility to Test Various Fuel Cell Coolants

Accomplishments

- One of the preliminary coolant formulations showed same titration result (with 0.01 M NaCl) as a commercially obtained ion-exchange resin (DOWEX) particles (ground to 10 microns) used in de-ionizing filters. This result demonstrates that the nanoparticles have the potential to eliminate the de-ionizing filters used by the fuel cell developers, thereby reducing the initial and operating cost, weight and volume of the fuel cells.
- The preliminary coolant fluid passed the short-term test criteria (> 300 hours at 70 ^{o}C) in the dynamic test loop at the Dynalene facility.

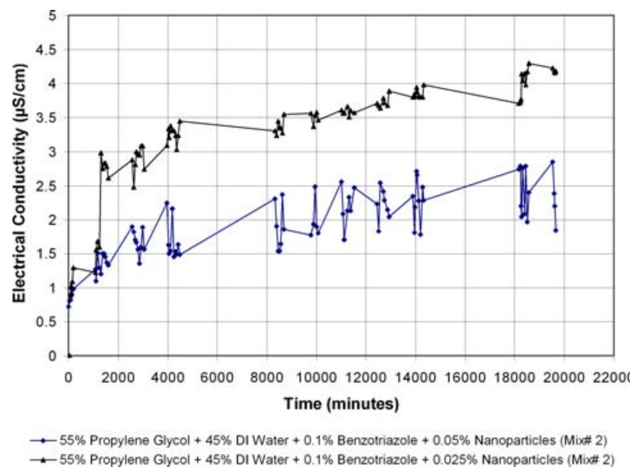

Figure 2. Electrical Conductivity as a Function of Time for a Candidate CCF Mixture