FuelCell Energy
World Leader in Ultra-Clean Power

Electrochemical Hydrogen Separator (EHS) Development

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Period of Performance: 2005-2008

Introduction: A central goal of President Bush's Hydrogen Fuel Initiative is to strengthen the U.S. economy and security by reversing America's growing dependence on foreign oil by developing technology for clean hydrogen production and commercially viable hydrogen powered fuel cells. A major barrier to widespread use of fuel cells for transportation applications, however, is availability of infrastructure to support generation, storage, and transportation of hydrogen. An interim solution to this hydrogen infrastructure problem would be a key component of the longer-term transition to a hydrogen economy.

EHS Technology: FuelCell Energy is developing an innovative solution for cost-effective distributed generation of hydrogen. It involves separating excess hydrogen generated by high-temperature fuel cells, such as Direct FuelCells® (DFC®) and solid oxide fuel cells. FCE's Electrochemical Hydrogen Separator (EHS) provides a unique way to separate the hydrogen with relatively low energy consumption and without requiring pressurization. Use of the highly reversible hydrogen electrode minimizes the amount of electrical energy required for the electrochemical separation. The hydrogen can also be compressed in the same step using relatively low energy input and without moving parts. The separation process is virtually emission-free.

Technology Development Status: EHS cells operated in the laboratory using simulated DFC® anode exhaust gases indicate significant savings in operating costs (30-60%) are possible when compared with today's commercially available hydrogen separation systems. Hydrogen separation efficiencies of up to 90% have been demonstrated. A 25-cell sub-scale EHS stack developed by FCE is shown in Figure 1. It has been designed for low-pressure drop for efficient integration with DFC®. It is highly modular and can be manufactured using mass-production processes.

Figure 1. EHS Stack Assembled with 25 Cells:
This Stack can Separate Hydrogen Without Any Moving Parts

This stack was integrated into a mobile system designed by FCE and has been operated for 6000 hours at the Global Fuel Cell Center, University of Connecticut, as shown in Figure 2.

Figure 2. FCE's EHS System in Operation at the University of Connecticut:
P. Patel of FCE (left) demonstrates elements of the EHS System, producing 30,000 liters/day of hydrogen, to U.S. Energy Secretary Samuel W. Bodman (middle) and U.S. Rep. Rob Simmons (R-Conn.)

A subscale system integrating a DFC® cell, anode exhaust gas conditioning reactors (designed to increase the hydrogen content of the anode exhaust stream and to lower the power requirement of the EHS) and EHS cell is undergoing testing at FCE.

Future Plans: Further scale-up of the EHS system to integrate with FCE's DFC300® power plant is underway. This co-production power plant is expected to produce 250+ kW of net

electricity and up to 300 lbs/day of hydrogen. This is enough hydrogen to support a fleet of up to 300 fuel cell vehicles.