FuelCell Energy

On-Site Hydrogen Production: Electrochemical Hydrogen Separator (EHS)

Background: FuelCell Energy (FCE) produces and sells stationary fuel cells and develops on-site hydrogen generation equipment for commercial, industrial, municipal and utility customers. In addition, FCE is currently developing leading edge hybrid fuel cell/turbine generators and solid oxide fuel cells for ultra-clean power under cost shared DOE-programs. Over the past 20 years support for the development of FuelCell Energy technology has been provided by DOE (EERE and NETL, The Hydrogen and Fuel Cell Program and SBIR Phase I and II awards), DoD and Connecticut State. FCE power plants have generated more than 180 million kWh of ultra-clean power using a variety of fuels including renewable wastewater gas, biogas from beer and food processing as well as natural gas and propane. The company's high efficiency Direct FuelCells® (DFC®) are operating power at over 50 locations worldwide, including Sierra Nevada Brewery in CA, Sheraton Hotels in NYC, NJ and CA, a Michelin tire manufacturing plant in Germany, and Epson plant in Japan. FCE has partnerships with major power plant developers, trading companies and power companies around the world, including Caterpillar, Pennsylvania Light and Power (PPL), Chevron, Logan Energy and Alliance Power in the US, Enbridge in Canada, Marubeni in Asia, POSCO in Korea and CFC Solutions in Germany. Over 500 million dollars have been invested in the technology development and commercialization.

FuelCell Energy can trace its roots back to 1969 and the founding The Energy Research Corporation (ERC) by early fuel cell research pioneer Dr. Bernard Baker and chemical engineer Martin Klein, an expert in advanced battery technologies. In 1992 the company successfully demonstrated a 120 kilowatt (kW) high temperature carbonate fuel cell system, and with commercialization of fuel cell technology in 2003, the company went public with an initial stock offering that raised $6.5 million. In 1997, the company selected a new CEO to commercialize its products and spun off its battery division to concentrate on innovative DFC® fuel cells that can process hydrocarbon fuels such as natural gas/renewable digester gas without an external reformer. The company was renamed FuelCell Energy in 1999. Today, FuelCell Energy has placed fuel cells (equipped with an internal hydrogen production sub-system) in six countries, employs over 400 employees in its production and research facilities, its 24 hour call center and support service team in CT. Latest sales figures show the company achieved $33 million in 2006 and year-to-date revenues were reported almost $32 million. The system availability has been increased from ~80% a few years ago to the 95% level now.

September 6, 2007 Event at UConn: A major barrier to widespread use of fuel cells for transportation applications is the availability of infrastructure to support generation, storage, and transportation of hydrogen. EERE's Hydrogen and Fuel Cells Program is focusing its technology development efforts on on-site production of hydrogen using renewable fuels. FuelCell Energy's Electrochemical Hydrogen Separator (EHS) can be considered an "early market bridging" technology because it provides a unique way to separate the hydrogen with relatively low energy consumption and without requiring pressurization. EHS separates the excess hydrogen generated by high-temperature fuel cells, such as Direct FuelCells® (DFC®) and solid oxide fuel cells with a reversible hydrogen electrode. This approach minimizes the amount of electrical energy required for the electrochemical separation. The hydrogen is compressed in the same step with little additional energy and the process is virtually emission-free.

All indications are that EHS cells offer a 30-60% savings in operating costs when compared with today's commercially available hydrogen separation systems. In fact separation efficiencies of up to 90% have been demonstrated. In June 2006, Energy Secretary Samuel Bodman visited the Global Fuel Cell Center at the University of Connecticut and was shown FuelCell Energy's 25-cell sub-scale EHS stack that has now been operating for more than 6000 hours (Figure 1). This subscale EHS has demonstrated the capability to separate hydrogen to refuel up to 3 fuel cell cars per day. Technology scale-up to 300-lbs/day hydrogen is in progress.

Projections indicate that a megawatt-class DFC-H_2 power plant can provide hydrogen for a fleet of over 1000 fuel cell vehicles and electricity for about 1000 homes. It operates on readily available fuels, such as natural gas and propane, as well as renewable fuels, such as anaerobic digester gas. Such a tri-generation system is expected to achieve efficiencies for hydrogen, electricity and heat of up to 85% making it ideally suited for the hydrogen stations that will be needed for fueling hydrogen fuel cell vehicles.

Figure 1. FCE's EHS System in Operation at the University of Connecticut:
U.S. Energy Secretary Samuel W. Bodman (middle) visited on June 2, 2006.

FCE Project Manager: Pinakin Patel (*ppatel@fce.com*)