Small Business Innovation Research (SBIR) Award Success Story

FuelCell Energy Inc., in collaboration with Sustainable Innovations LLC, develops highly efficient solid state electrochemical hydrogen compressor

FuelCell Energy Inc. manufactures stationary fuel cells for commercial and industrial applications as well as for government facilities and utilities. Based in Danbury, Connecticut, with more than thirty years of experience and roughly 440 employees, they are one of the world leaders in the manufacturing and commercialization of ultra-clean and efficient stationary fuel cells for electric power generation. Their manufacturing plant is located in Torrington, Connecticut and has a capacity of producing up to 90 MW per year with full utilization.

FuelCell Energy has received Small Business Innovation Research (SBIR) funding in the past for an innovative electrochemical approach to hydrogen pressurization techniques and processes. In 2009, the FuelCell Energy team was recognized by the U.S. Department of Energy with the Hydrogen Program Annual Merit Review award for the development of this technology. They have continued their research with an SBIR Phase II award.

FuelCell Energy team members showcase their electrochemical hydrogen compressor.

Challenge Met

Hydrogen compression has emerged as a key technical challenge in developing hydrogen as an energy carrier for distributed stationary power, portable power, and transportation applications. It is projected that the current state of hydrogen compressor technology will not be able to meet future infrastructure demands in a cost-effective manner. The on-board storage of hydrogen in light-duty vehicles, for example, requires compression pressures up to 12,000 psi at the fueling station. Although existing gas compressors can achieve this level of compression, they are inefficient and susceptible to rapid component wear, ultimately requiring substantial maintenance. Often, a back-up compressor is needed on site. These factors have a significant impact on fueling station cost.

To overcome this challenge, the FuelCell Energy team has demonstrated a single-stage, solid-state electrochemical hydrogen compressor (EHC) capable of pressurizing hydrogen up to 6,000 psi in single stage. A two-stage EHC system is expected to meet the refueling requirements of 6,000 as well as 12,000 psi vehicles. EHCs are more efficient than existing mechanical compressors, contain no moving parts, and have a modular architecture all leading to the potential to significantly reduce the operating, maintenance and capital costs of hydrogen compressions. Modularity also allows fueling station owners to increase the daily amount of hydrogen that can be dispensed by simply adding to the original EHC unit as needed.

Technology

In addition to pressurizing hydrogen up to 6,000 psi, EHCs have a demonstrated ratio of 300 to 1, a single cell durability of 3000hrs, hydrogen recovery efficiency up to 95%, and pressure cycling of 20 cycles to 3000 psi. The compressor employs a modified polymer electrolyte membrane (PEM) fuel cell architecture. When supplied with low pressure hydrogen and electrical current, the device ionizes the hydrogen, transports the resulting protons across an electrolyte membrane, and recombines these with re-routed electrons to re-form hydrogen inside of a closed chamber. As long as

EHC Hardware

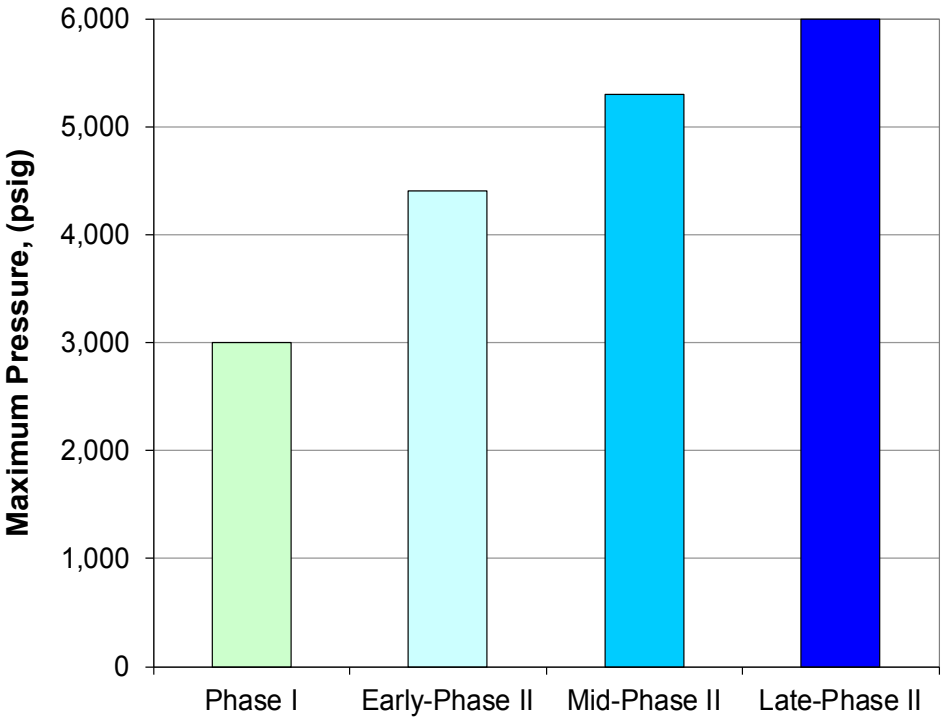
hydrogen and current are delivered to the EHC, hydrogen will continue to be transported and accumulated at higher pressure inside the chamber.

Next Steps

Ultimately, when developed to full scale, EHCs are expected to be used for hydrogen compression at fueling stations. However in the short term, EHCs can be used to compress hydrogen for industrial and commercial applications like metals heat treatment and glass and electronics production. Compressed hydrogen can also be used in stationary PEM fuel cell systems to produce peak power for Smart Grid applications or for secure back-up power systems. By providing a safer, more reliable, and lower-cost option to compress hydrogen, EHC can be integrated with high-temperature fuel cell power units, including FuelCell Energy's current DFC® power plant products and future solid oxide fuel cell products, to enable hydrogen co-production. These power plants generate their own hydrogen internally from various fuels, such as natural gas or propane, or from renewable sources, such as waste-derived digester gas. Some of the hydrogen is used by the fuel cell stack to generate electricity and the remainder can be separated and pressurized in the EHC for use in other applications.

For More Information

More information on the Fuel Cell Technologies Program is available at *http://www.hydrogenandfuelcells.energy.gov*.



Progress in H_2 Compression Capability of EHC

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