Major milestone in hydrogen research

December 7 2004

Researchers at the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory and Ceramatec, Inc. of Salt Lake City are reporting a significant development in their efforts to help the nation advance toward a clean hydrogen economy.

Laboratory teams have announced they've achieved a major advancement in the production of hydrogen from water using high-temperature electrolysis. Instead of conventional electrolysis, which uses only electric current to separate hydrogen from water, high-temperature electrolysis enhances the efficiency of the process by adding substantial external heat – such as high-temperature steam from an advanced nuclear reactor system. Such a high-temperature system has the potential to achieve overall conversion efficiencies in the 45 percent to 50 percent range, compared to approximately 30 percent for conventional electrolysis. Added benefits include the avoidance of both greenhouse gas emissions and fossil fuel consumption.

"We've shown that hydrogen can be produced at temperatures and pressures suitable for a Generation IV reactor," said lead INEEL researcher Steve Herring. "The simple and modular approach we've taken with our research partners produces either hydrogen or electricity, and most notable of all – achieves the highest-known production rate of hydrogen by high-temperature electrolysis."

This development is viewed as a crucial first step toward large-scale production of hydrogen from water, rather than fossil fuels.

The major private-sector collaborator has been Ceramatec, Inc. located at 2425 S. 900 West, Salt Lake City. “We’re pleased that the technology created over the nearly two decades dedicated to high-temperature fuel cell research at Ceramatec is directly applicable to hydrogen production by steam electrolysis,” said Ashok Joshi, Ph.D., Ceramatec chief executive officer.

“In fact, both fuel cell and hydrogen generation functionality can be embodied in a single device capable of seamless transition between the two modes. These years of investment, both public and private, in high temperature fuel cell research have enabled the Ceramatec-INEEL team to move quickly and achieve this important milestone toward establishing hydrogen as a part of our national energy strategy.”

“This research is the INEEL’s response to a national challenge to help the United States advance the President’s Hydrogen Fuel Initiative,” said Michael Anderson, DOE-Idaho initiative lead for the project. Anderson also hailed the steady focus from INEEL researchers and their partners for their determined efforts to overcome many research challenges to advance the technology.

“This research effort – building on the regional expertise Idaho and Utah have in this area – shows the INEEL is a hub for hydrogen technology development,” said DOE-Idaho Deputy Manager John Kotek.

The hydrogen production rate achievement of 50 normal liters (standard temperature and pressure) of hydrogen per hour is an initial result, midway through a more than three-year effort by a team of researchers at the INEEL that includes Herring, Carl Stoots, James O’Brien, Will Windes and Paul Lessing.

Hydrogen Production Research
Secretary of Energy Spencer Abraham recently announced a grant of

nearly $2 million to a Ceramatec-led effort teaming with the INEEL, the University of Washington and Hoeganaes Corp. to continue work in the broad area of high-temperature electrolysis and fuel cell development. This new grant will work to enlarge by 100 times the size of a hybrid solid oxide fuel cell (SOFC) that is capable of co-generating high-purity hydrogen and electric power from natural gas. The program will build on a cell stack architecture of alternating flat cells and gas distribution plates invented at Ceramatec for NASA.

“Cell designs and fabrication processes, which are scalable to a commercially practical size, are essential to securing our energy future,” said Ceramatec senior engineer Joseph Hartvigsen, who will lead the project.

Dave Swank, INEEL Thermal Spray Research Team lead, says he and his colleagues will leverage this new funding to focus on refining the fabrication of fuel cell electrodes using plasma spray coating processes.

“Our team has worked for over 15 years to develop process diagnostics that are now being put to use to improve and develop thermally sprayed coatings for industry,” Swank said. Thermal spray research team members include D.C. Haggard, Tim Hyde, Randy Bewley and Rich Williamson.

Ceramatec has nearly three decades of research and development experience in advanced electrochemical ceramic energy systems, and is considered one of the world leaders in planar SOFC systems. Cells have operated for over 40,000 hours, and cell stacks are routinely built and evaluated. Recent efforts have expanded to include developing technologies for hydrogen production and purification from a wide range of primary energy sources. The Ceramatec fabrication technology approach has emphasized the use of mature, low-cost fabrication processes that are easily scaled to mass production. Ceramatec has been

involved in the research and development of ionic ceramics ever since it was founded in 1976.

The INEEL is a science-based, multiprogram national laboratory dedicated to advancing the U.S. Department of Energy's strategic goals in the areas of environment, energy, science and national security. It is the home of science and engineering solutions and is operated for the DOE by Bechtel BWXT Idaho, LLC.

Source: DOE/Idaho National E & E Laboratory