

netlog

The NETL newsletter

The June 2006 NETL Newsletter



CONTACT

National Energy Technology Laboratory

1450 Queen Avenue SW
Albany, OR 97321
541-967-5892

2175 University Avenue South
Suite 201
Fairbanks, AK 99709
907-452-2559

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochran Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

One West Third Street, Suite 1400
Tulsa, OK 74103-3519
918-699-2000

Visit the NETL website at:
www.netl.doe.gov

Customer Service:
1-800-553-7681



NETL Tests First SECA Phase I Prototype Fuel Cell

In an important step toward developing fuel cells as a non-polluting, significant source of energy, researchers at the National Energy Technology Laboratory (NETL) are conducting verification tests on a prototype of a solid oxide fuel cell.

Most fuel cells use hydrogen along with oxygen from air to create electricity by an electrochemical process. Hydrogen may be produced from sources such as fossil fuel and even renewable energy sources. A fuel cell that uses pure hydrogen emits only heat and water.

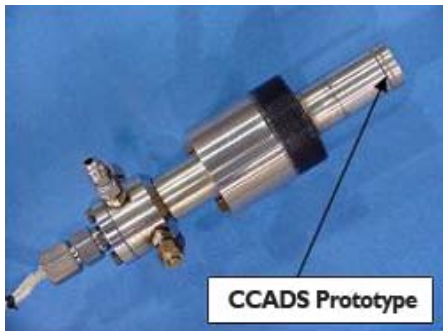
NETL works closely with industry, national laboratories, and academia in the **Solid State Energy Conversion Alliance (SECA)** to develop low-cost modular solid oxide fuel cells for a variety of applications providing stationary and mobile power.

NETL researchers have begun verification testing of the first SECA Phase I solid oxide fuel cell prototype to arrive at **DOE's Fuel Cell Test Facility**. Developed by Delphi Corporation, the prototype unit was started up on May 2, using methane fuel. The unit was operated at a peak power of 1.4 kilowatts for about one hour, and then held at 950 watts overnight.

The prototype unit was operated at a fixed load for about one month to acquire power degradation data and to complete the final portion of Delphi's prototype unit verification test plan. The early data show a peak efficiency of about 37 percent, within the SECA Phase I target of 35-55% for stationary units.

NETL is home to three facilities whose functions are important for development and deployment of fuel cells. The **Solid Oxide Fuel Cell Experimental Laboratory (SOFCEL)** is a test stand for fundamental research that addresses key topics in the area of solid oxide fuel cell development. The DOE Fuel Cell Test Facility provides independent verification of the performance and efficiency of SECA prototype fuel cells developed by Industry Teams. And finally, the Hybrid Performance Project (HYPER) Facility is used to study fuel cell control strategies for hybrid systems that combine turbines and fuel cells. For additional information contact **Randall Gemmen** at 304-285-4536.

http://www.delphi.com/news/pressReleases/pr_2006_06_20_001/



Licensed Sensor Analyzes Electrical Properties of Flame

In 1999, a couple of researchers at NETL had an idea for a sensor to analyze the electrical properties of flame. The idea took root in a very basic, economical way: the researchers picked up two wires and a butane lighter.

Today, the sensor they invented—known as the combustion control and diagnostics sensor (CCADS)—has been licensed to a leading industrial controls manufacturer and is being marketed to major gas turbine manufacturers.

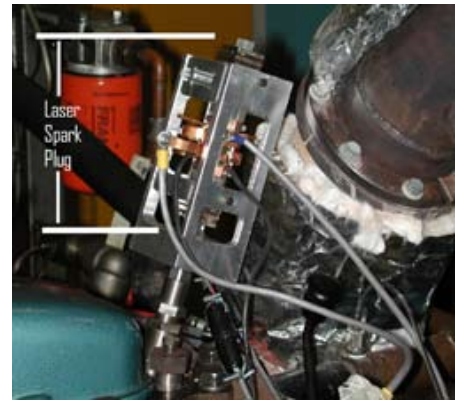
The CCADS technique utilizes two electrically isolated electrodes installed on the fuel nozzle. The electrode closest to the combustion zone is called the “guard” electrode, and the upstream electrode is called the “sense” electrode. When an equal voltage is applied to both electrodes, this novel arrangement facilitates current flow from the “guard” electrode through the flame. As a result, the “guard” electrode signal can provide a wealth of important information about the combustion process. On the other hand, a significant ionization current from the “sense” electrode is produced only when the flame enters the upstream region of the fuel nozzle (i.e., during auto-ignition

and/or flashback). The CCADS is incorporated into the center-body of a gas turbine fuel nozzle and is capable of sensing flame flashback, combustion instabilities (including flame oscillations), and variations in fuel/air mixture composition.

In 2002, NETL licensed the invention to Woodward Industrial Controls for commercial development. Woodward was chosen to commercialize CCADS because it has the design and manufacturing expertise and market knowledge to make the technology a commercial success. Woodward provides services and subsystems to most major gas turbine original equipment manufacturers (OEMs) and is the leading worldwide producer of nozzles for heavy frame engines (large turbines). Two cooperative research and development agreements have been negotiated between NETL and Woodward to enable them to work together to enhance the development and address R&D issues for commercialization. This joint approach has advanced the technology to the point where Woodward is marketing CCADS.

But the developers haven’t quit yet. The NETL researchers are working on advancements of CCADS’ already useful capability by developing an intelligent CCADS electronics interface, or ICE, which will provide high-speed measurement and analytical capabilities to make CCADS even more versatile. Also, Woodward engineers are working on more durable designs to improve reliability of the sensor in gas turbine applications.

The expectations are that the new development efforts will improve the sensor’s performance in advanced power turbines and make it possible to maintain tighter control of flame stability and reduce emissions. For additional information, contact [Jimmy Thornton](#) at 304-285-4427 in the Energy System Dynamics Division.



NETL’s Miniature Laser Igniter to Undergo Engine Testing

NETL researchers hope that a planned test of their miniature laser ignition system will make large inroads in natural gas-fueled engines.

NETL is developing laser-spark ignition for natural gas pipeline pumping and electrical power generation in support of DOE’s mission to improve natural gas-fueled reciprocating engine power generation efficiency and emissions.

The NETL miniature laser consistently produces robust sparks with intensities in excess of 400 gigawatts per square centimeter. If laser ignition is successful in natural gas-fueled engines, it would help meet efficiency and emissions demands in existing and future lean-burn engines. Higher in-cylinder pressures and leaner air/fuel ratios are required to meet the demands.

Contemporary spark plug ignition systems suffer in performance and durability as a result of the increase in spark energy required to maintain suitable engine operation under the required high-pressure, high-temperature conditions.

Past laser ignition testing at NETL has shown that resulting leaner engine operation at higher pressures provides reduced NO_x emissions and improved thermal efficiency. The present challenge NETL researchers are addressing is to develop a cost-effective and durable miniaturized laser spark plug that can withstand the operating environment of a large-bore engine while producing the required intensity for laser spark breakdown. Contact [Dustin McIntyre](#) at 304-285-1374 for more information.



Video Feature

New Sorbents For Carbon Dioxide

Inventors at NETL sometimes have an idea for a big deal in a small package.

Case in point: Ranjani Siriwardane recently received a patent for a material that is very effective at removing carbon dioxide, a greenhouse gas, from large-scale gas streams found at sites that use fossil fuels to generate electricity. The patent is for a new “sorbent,” a material that absorbs carbon dioxide.

The new NETL sorbent provides a low-cost solution to the problem of removing carbon dioxide from power-generating sites should Federal regulations require removal. The sorbent, which can be manufactured in the form of tiny beads or in cylindrical shapes, ranges in size up to about the head of a ballpoint pen and performs better at high pressures.

One method of preventing the carbon dioxide from being released into the atmosphere would be to store it in stable underground chambers where it would not leak. If the storage sites happened to be low-producing oil wells, the injected carbon dioxide would actually increase the production by displacing the remaining oil.

Siriwardane has invented other sorbents, some of which have been licensed to industry for commercial use. NETL plans to issue a solicitation for a commercial partner to develop this new sorbent, too. When the technology is ready for that stage of development, NETL will issue a solicitation for a partner in a cooperative research and development agreement.

The solicitation will focus on the use of the sorbent in fossil-fueled power plants, but other possible applications are in the food industry, chemical plants, wastewater treatment facilities, and natural gas processing.

The sorbents are made by incorporating mixtures of amines, ethers, and glycols in unit layers of a solid matrix. The solid sorbent captures compounds contained in gaseous fluids by the processes of chemisorption and physisorption between the unit layers of the substrate’s interior lattice. The method provides sorbents with absorption capabilities that are independent of the sorbents’ surface areas. The sorbents can be regenerated either by heating at temperatures in excess of 40 °C or by lowering the pressure.



NETL Engineer’s Work Supports Iraqi Power Reconstruction

In the midst of the war in Iraq, NETL general engineer Thomas L. Ochs has advised and provided support to the Iraqi Ministry of Electricity by working with available resources to provide as much electricity as possible to the Iraqi people. At great peril to himself and his team, Ochs worked in the field in central Iraq by visiting power plants, refineries, and oil fields.

As a DOE volunteer, Ochs spent a total of 10 months in Iraq in 2004 and 2005, on two separate details. Initially, he worked with the Coalition Provisional Authority and then with the Iraq Reconstruction Management Office.

As power generation capacity in Iraq is being rebuilt, new and alternate fuel sources must be matched to generation facilities. Using his knowledge base in advanced combustion systems, Ochs worked with the staff of CPA Oil, the Ministry of Electricity, and the Ministry Infrastructure Security offices to ensure availability of fuels and the readiness of units to burn alternate fuels as primary fuels became scarce. In the summer of 2004, during significant insurgent attacks targeting power delivery infrastructure, the group Ochs

burn alternate fuels as primary fuels became scarce. In the summer of 2004, during significant insurgent attacks targeting power delivery infrastructure, the group Ochs worked with kept the lights on in Baghdad by creatively rerouting liquid fuel and rapidly repairing transmission lines. Since that time, however, transmission lines have fallen to attacks by insurgents and have not been repaired.

Ochs was awarded the Joint Civilian Commendation Service Award by the CPA Administrator, Paul Bremer, for exceptional service while in Iraq.

Ochs continues to consult by email with those who are struggling to bring Iraqi power generation capacity back on-line. He also co-hosted 14 representatives from the Iraqi Ministries of Electricity and Oil who attended the PowerGen conference in Las Vegas in December 2005. He assisted the U.S. Trade and Development Agency in hosting the visit. Special sessions were organized with U.S. corporations to provide opportunities for discussion and education regarding power generation equipment and operation issues.

Recently, Ochs has been asked to serve on a panel to advise the Iraq Study Group (ISG). The Study Group is being formed to make an independent and bipartisan assessment of the current and future situation in Iraq. Former U.S. Secretary of State James A. Baker III and former Congressman Lee H. Hamilton have been appointed as the joint leaders of the ISG.

The advisory panel will present the ISG with ideas and review of proposals for the development of the oil, natural gas, refining, transportation, power generation, and electrical distribution components of Iraq's economy. The U.S. Congress requested the establishment of the ISG, and President Bush and the Executive Branch are fully cooperating in the effort.



Metal Sorbent Removes Mercury from Industrial Gas Streams

Two researchers at NETL have added a new mercury capture process to their growing inventory of inventions that support President Bush's goal of finding ways to use the nation's abundant resource of coal while protecting the environment.

Evan Granite and Henry Pennline have received a [patent](#) for a process using NETL-developed metal sorbents to extract mercury from many industrial gas streams, including such sources as coal gasifiers and coal-fired power generating plants.

Two of their previous patents for mercury-removal processes have been licensed to industry and are being developed for commercial applications. (Click [here](#) for thief process article. Click [here](#) for photochemical oxidation process article.

The Environmental Protection Agency (EPA) has issued a mercury rule to permanently cap and reduce mercury emissions from coal-fired power plants.

The rule limits mercury emissions from new and existing coal-fired power plants and further establishes a market-based, cap-and-trade approach to reduce utility emissions. When fully implemented in 2018, the EPA rule will reduce mercury emissions from power plants from the current 48 tons a year to 15 tons.

The new patent is for a process to facilitate mercury extraction from high-temperature flue and fuel gas using metal sorbents to capture mercury at ambient and high temperatures. According to Granite and Pennline, the sorbents can be used as pure metals or combinations of metals, or dispersed on an inert support to increase surface area.

The metals are palladium, platinum, iridium, and ruthenium. The process uses the metals as sorbents to adsorb mercury on their exterior and interior surfaces. The process is reversible and the sorbents are reusable.

In a recent visit to NETL, Jeffrey Jarrett, DOE Assistant Secretary for Fossil Energy, said, "Development of advanced coal technology at NETL is a keystone of the President's Advanced Energy Initiative. Advanced technology and coal can deliver new increments of electric power to our nation in the near- and mid-term in the volumes we will require it, at the times we will need it, on the terms we want it—abundant, always available, low cost and clean."

NETL inventions such as the mercury removal technologies are the types of advances that prompted Jarrett's remarks. Projections are that the United States will rely on coal to deliver about 70 percent of the growth in electric power supply over the next 25 years. Contact [Evan Granite](#) for more information at 412-386-4607.



[Video Feature](#)

NETL Researchers Collect Data on Flame Structure Measurements

Has a child ever grown up without being admonished by caring adults, “Stay away from the fire”?

It’s a good thing that researchers at NETL don’t follow that advice. The study of flames can provide important information about ways to control the efficiency of energy use and production, and NETL scientists have been at the forefront of the studies.

NETL’s Combustion Group has collected some of the most complete data available on turbine-scale hydrogen flames at pressure. High quality images of hydrogen/natural-gas flames were obtained in a premixed turbine-scale combustor at NETL’s Simulation-Validation combustion facility.

The NETL researchers also have obtained some of the best high-quality images of hydrogen/natural-gas flame ever captured by researchers. The data and images will become some of the first available for a multi-agency simulation-validation initiative being discussed by DOE, the Department of Defense, and NASA.

The data being generated by NETL researchers also will be important for development of turbines for FutureGen, DOE’s project to build the world’s first coal-based, near zero-emissions electricity and hydrogen production power plant.

The first measurements at pressure were made at NETL in collaboration with Sandia National Laboratories.

Since then, NETL has made significant improvements in the measurement signal strength and has been able to extend the range of measurements up to 8 atmospheres pressure.

These data will be used to help understand how to develop low-emission hydrogen combustors without problems of flashback or combustion instability. The data will also be useful to advance the state of the art in combustion simulation models. This work supports the DOE Turbines Program goals of developing advanced turbines for IGCC applications with lower NO_x emissions (less than 2 ppm NO_x) than current state-of-the-art turbines.

NETL Attains Recertification to ISO 14001:2004 Standard

NETL completed the process required for recertification to the **ISO 14001:2004** standard for environmental management systems (EMS). The process includes passing an external audit, which was completed on April 14, 2006, by NSF-International Strategic Registrations.

NETL obtained initial certification in August 2003. NETL employees, who embraced the EMS and have worked hard to reduce environmental impacts, made the recertification possible.

ISO 14001:2004 is an international standard for improving environmental performance using a management systems approach. Regulatory compliance is part of the EMS, but the system goes beyond compliance and provides a framework for continually improving environmental performance through planning, implementation, assessments, and management reviews.

System strengths noted by the auditor include:

- Management Review process and records—significant improvement has been shown.
- The Safety Analysis and Review System (SARS) process—particularly with improvements and enforcement
- The Internal Audit process—good improvement since last visit
- Emergency Planning and Response Program—predates the certification and is a good program
- Employee/personnel awareness and understanding of the EMS as it relates to their work
- Strong application of the EMS to the Morgantown Administration Building design and construction
- Use of EMS to weather management and organizational changes over the past three years

Having a certified EMS is evidence of NETL’s commitment to the environment and the public. NETL’s environmental management system reduces costs and environmental risks while increasing public and stakeholder confidence. This is important to energy technology organizations who partner with NETL because a certified EMS reduces their liability and increases their confidence in NETL’s ability to protect the environment. NETL’s residential neighbors know that NETL is looking out for their well-being and protecting the environment that they share



NETL Metallographer Featured in Chemical & Engineering News

NETL metallographer Paul Danielson is one of four scientists featured in the May 15 issue of Chemical & Engineering News in the article “The Gorgeous Inside Stories of Metal.” One of the images Danielson produced appears on the magazine cover. The article describes the incredible beauty of metallic microstructures that can be revealed by an optical microscope, beauty that contains valuable scientific information as well as aesthetic appeal. Danielson’s work is an integral part of the alloy

development and performance assessment studies at the Albany site. Utilizing a combination of polishing and chemical etching techniques, Danielson can produce images of an alloy in the optical microscope that change color as a result of localized changes in chemistry and structure. These color changes are authentic and not enhanced by any post-image processing techniques. Danielson has been practicing his craft for more than 40 years (five at the Albany site), and his work has appeared in numerous scientific books and journals, as well as on calendars. Click [here](#) to view the gallery online.

netlog is a quarterly newsletter which highlights recent achievements and ongoing in-house research at NETL. Any comments or suggestions, please contact Paula Turner at paula.turner@netl.doe.gov or call 541-967-5966.

