Fuel Cell System Testing

A computer-controlled electrical load simulates power demands on fuel cell systems.

Argonne's Electrochemical Analysis and Diagnostic Laboratory is internationally recognized as a valuable resource for the battery industry. It has now been joined by the Fuel Cell Test Facility, which makes a proven control and data acquisition system available for independent testing of fuel cell components and systems. This control system simulates changing power demands over time.

Stacks and systems up to 50 kW (automotive size) can be tested. The results help developers, automakers, and funding agencies focus their research, for shorter development cycles and lower costs. The standardized tests and tests conditions provide a benchmark across systems that aids objective assessment of performance, durability, operational characteristics, and quality control. Furthermore, different sizes and types of systems can be compared on an equivalent basis because of data normalization techniques developed at Argonne. Future testing is expected to include evaluation of fully integrated systems, incorporating their own fuel processing and air supply subsystems.

ARGONNE NATIONAL LABORATORY

Argonne National Laboratory is committed to developing high-quality, cost-effective technologies that meet the nation's goals of better **energy efficiency** and **reduced emissions**.

The Laboratory has forged **partnerships** with many firms in the energy and transportation sectors over the past two decades. Our location, right in the nation's heartland and industrial center, makes cooperative research easily accessible and cost-effective.

Argonne's fuel cell programs, comprising innovative fuel processor design, leading-edge materials research, independent testing, and comprehensive modeling, is providing solutions to the challenges of creating **cost-effective technologies for clean power** for vehicles, buildings, and industry. These programs are supported by the U.S. Department of Energy and U.S. industry.

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FUEL CELL

Research and Technology

Fuel Processing

Materials Development

Systems Modeling

Component and System Testing

ARGONNE NATIONAL LABORATORY

Fuel cell research at Argonne – clean power for the 21st century

Fuel cells hold the promise of clean electric power not only for cars and other vehicles but for houses, buildings, and industry. Argonne National Laboratory has been a leader in fuel cell research for more than twenty years, drawing on fundamental, interdisciplinary studies to produce a long line of innovations in materials, methods, and concepts for advanced fuel cells.

Fuel Processing

A critically important component of fuel cell-powered automobiles will be the fuel processor, which will convert gasoline, diesel, or alternative automotive fuels to a hydrogen-rich gas to be fed to the fuel cells. To be practical, the processor must be small, light, and responsive to changing power demands.

Argonne was the first to recognize that a conversion method called partial oxidation reforming could reduce the size of the conversion apparatus by at least an order of magnitude, compared to conventional steam reforming reactors, and improve its dynamic response capability dramatically.

We discovered a new catalyst to assist the conversion and designed a partial oxidation processor that operates at 700^{o}C on fuel, air, and some water. For gasoline, our device produces an output gas that contains 40 to 45% hydrogen and about 10% carbon monoxide. In a second stage, the carbon monoxide is consumed in producing more hydrogen, with the help of another Argonne catalyst.

The unit can be started up in about one minute and is efficient and dynamically responsive. We project that an automotive unit would be about the size of a computer monitor. Ongoing improvements to the catalyst may reduce the size even more.

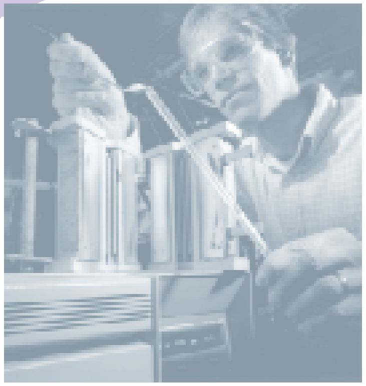
To treat the small residual amounts of carbon monoxide in the fuel after the second stage, Argonne is investigating ways to chemically bind it. The team has successfully demonstrated a sorption process that virtually eliminates any residual CO.

Materials Development

With high efficiency and low emissions, fuel cells are well suited for stationary cogeneration and primary power. Two types that look promising for these applications are molten carbonate fuel cells and solid oxide fuel cells, but performance issues stand in the way of their wide adoption.

The key to better performance in any type of fuel cell is the properties of its electrode materials. Anodes and cathodes must have good electrocatalytic properties, be excellent electronic conductors, have minimal diffusion overpotentials, and still be mechanically strong.

Argonne has developed alternative cathodes for molten carbonate fuel cells. The new cathode materials are more stable than those presently used. Also, for solid oxide fuel cells, we are currently working on new cathode materials that have better electrocatalytic properties. Both types of materials were found by systematically investigating the underlying reasons for the poor performance of present materials and then finding new solutions. The new cathode materials for solid oxide fuel cells represent a breakthrough in oxide-ion-conducting ceramics.



We have also developed a better electrolyte for molten carbonate fuel cells that virtually eliminates a type of degradation (electrolyte segregation) that limited performance. The new electrolyte composition allows the cells to be operated at higher power densities and lower temperatures, changes that lessen corrosion. To improve the corrosion resistance of the bipolar plates in these fuel cells, we are exploring layered composites of various types of alloys.

System Simulation and Analysis

We have developed a comprehensive system design and analysis tool for fuel cell and other power plants. A user can analyze any configuration of modules and flows under either steady-state or dynamic conditions. Such modeling is of particular benefit to component developers, who can evaluate design constraints in a range of systems without the capital expense of full-scale test setups. Vehicle manufacturers can obtain comparative data and life-cycle costs to guide decisions on long-term technology strategies. This software tool has been used to simulate both hydrogen-fueled and gasoline-fueled vehicles with polymer-electrolyte fuel cells under various fuel storage and processing schemes.