Argonne NATIONAL LABORATORY

Chemical Engineering Division

The "TuffCell" Solid Oxide Fuel Cell

Rugged, low-cost device could find use as auxiliary power unit in tractor-trailers

Argonne National Laboratory's Chemical Engineering Division has developed a unique solid oxide fuel cell design that holds great promise for use in auxiliary power units. Such units would provide electricity in tractor-trailers for operational needs, such as cargo refrigeration, and comfort, such as cabin heating and cooling. The key is the TuffCell's innovative metal-supported design, which provides easy fabrication and high mechanical strength.

Fuel cells convert the chemical energy of a fuel, such as hydrogen, into electrical energy without combustion, with little or no emission of pollutants and efficient electrical power generation. This is a significant improvement over internal combustion engines. Therefore, fuel cells are attracting great interest for transportation applications.

With the anti-idling bans for trucks in many states, the solid oxide fuel cell has become a leading candidate for use in auxiliary power units in heavy-duty tractor-trailer trucks. One important use would be to eliminate the need for idling—for example, to provide cargo refrigeration. The electricity generated by the auxiliary power unit also would be used for driver comfort (cabin heating and cooling, microwave and/or refrigerator in the cabin, and electronics for communication and recreation).

Solid oxide fuel cells operate at high temperatures (700 to 1,000°C), which greatly simplifies fuel processing. However, to permit operation at such high temperatures, current solid oxide fuel cell designs are based on all or mostly ceramic components, which leads to high materials and processing costs, and vulnerability to failure from shock, vibration or other mechanical stresses.

Argonne's Chemical Engineering Division has developed a unique concept that meets the shortcomings of current solid oxide fuel cell designs and holds great promise for use in auxiliary power units.

Argonne's Bipolar Plate-Supported Solid Oxide Fuel Cell

The Chemical Engineering Division's patent-pending TuffCell concept features a metal-supported design, high mechanical strength, easy fabrication and cell stacking, and high performance—all at a cost considerably lower than current SOFC designs.

Preparing to test TuffCell

The key to the TuffCell's performance is its metallic bipolar-plate-supported design, including a self-sealed fuel compartment and the co-sintering of stack elements. This design and the processing technique allow all TuffCell's building blocks (cathode flow field, dense interconnect, anode flow field, multi-layer anode structure, fuel gas seal and electrolyte) to be formed in one sintering step as one piece, eliminating costly multiple high-temperature treatment steps and providing excellent electrical contact across the various interfaces. In addition, TuffCell's fabrication method allows the use of any desired flow field and interconnect compositions that are not limited to commercially available metals and alloys.

TuffCell's superior mechanical properties have been proven in several rapid cycling tests from room temperature to 800°C. The physical and electrochemical integrity of TuffCell was verified by achieving close to theoretical open-circuit voltages

under hydrogen/air atmospheres and maximum power densities of >0.25 W/cm². Work on the TuffCell is continuing, with the goal of further increasing single cell performance to >0.5 W/cm² and testing of short stacks of two or more cells.

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For More Information

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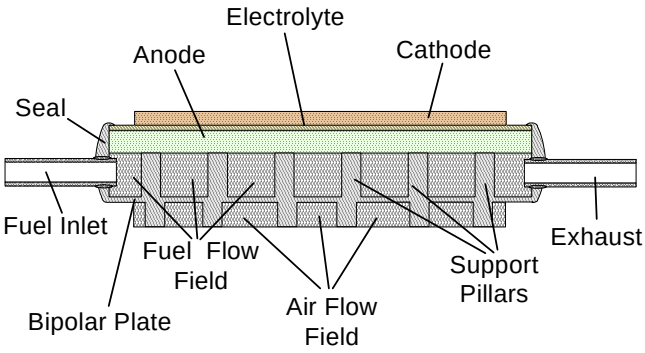
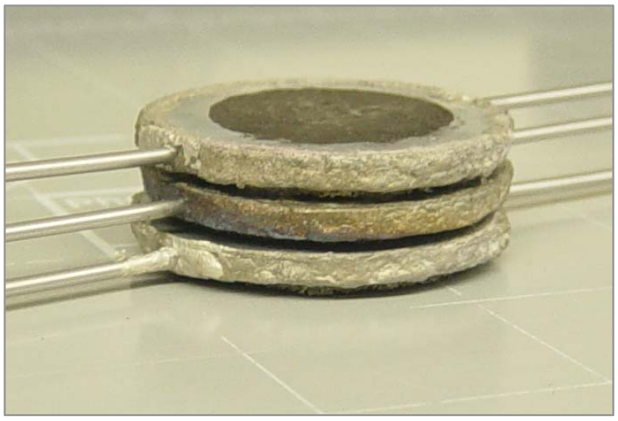
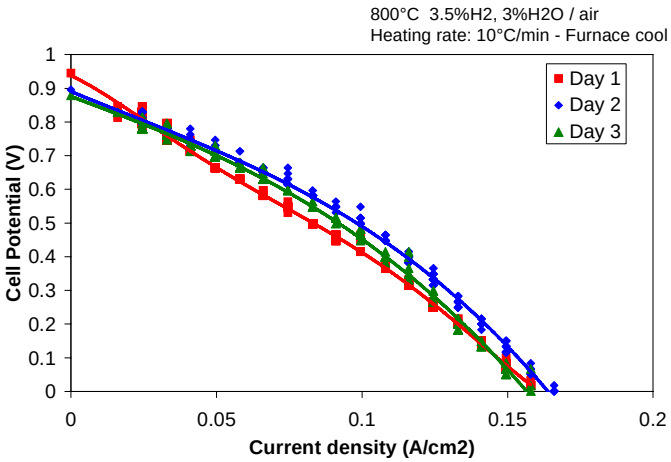


The TuffCell's metallic support (hatched areas in diagram) is constructed of stainless steel foam and distributed posts that constitute the fuel flow field, and a bipolar plate that forms the bottom of the fuel compartment. The perimeter of the cell is sealed together with a stainless steel edge that produces a gas-tight fuel compartment during the sintering



A stack is easily assembled or disassembled without the need for extraneous sealants. Cells stack like flashlight batteries.



TuffCell's design allows rapid heating and cooling without degradation of the cells.