

# Lightweight Stacks of Direct Methanol Fuel Cells

Power-to-mass ratios can be tripled.

NASA's Jet Propulsion Laboratory, Pasadena, California

An improved design concept for direct methanol fuel cells makes it possible to construct fuel-cell stacks that can weigh as little as one-third as much as do conventional bipolar fuel-cell stacks of equal power. The structural-support components of the improved cells and stacks can be made of relatively inexpensive plastics. Moreover, in comparison with conventional bipolar fuel-cell stacks, the improved fuel-cell stacks can be assembled, disassembled, and diagnosed for malfunctions more easily. These improvements are expected to bring portable direct methanol fuel cells and stacks closer to commercialization.

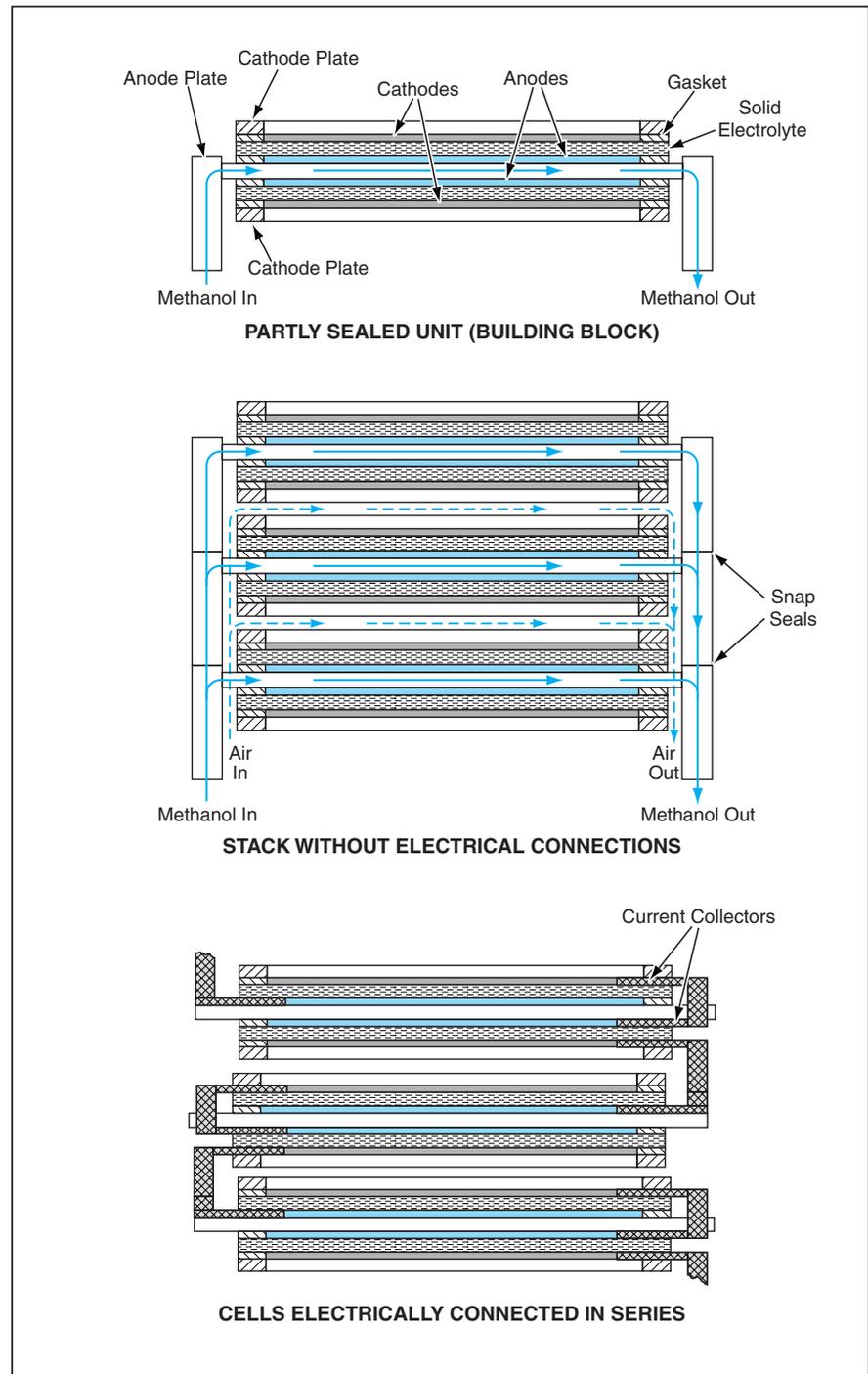
In a conventional bipolar fuel-cell stack, the cells are interspersed with bipolar plates (also called biplates), which are structural components that serve to interconnect the cells and distribute the reactants (methanol and air). The cells and biplates are sandwiched between metal end plates. Usually, the stack is held together under pressure by tie rods that clamp the end plates. The bipolar stack configuration offers the advantage of very low internal electrical resistance. However, when the power output of a stack is only a few watts, the very low internal resistance of a bipolar stack is not absolutely necessary for keeping the internal power loss acceptably low.

Typically, about 80 percent of the mass of a conventional bipolar fuel-cell stack resides in the biplates, end plates, and tie rods. The biplates are usually made of graphite composites and must be molded or machined to contain flow channels, at a cost that is usually a major part of the total cost of the stack. In the event of a malfunction in one cell, it is necessary to disassemble the entire stack in order to be able to diagnose that cell. What is needed is a design that reduces the mass of the stack, does not require high pressure to ensure sealing, is more amenable to troubleshooting, and reduces the cost of manufacture.

The present improved design satisfies these needs and is especially suitable for applications in which the power demand is  $\leq 20$  W. This design eliminates the biplates, end plates, and tie rods. In this design, the basic build-

ing block of a stack is a sealed unit that contains an anode plate, two cathode plates, and two back-to-back cells (see figure). The structural-support and flow-channeling components of the

units are made from inexpensive plastics. Each unit is assembled and tested separately, then the units are assembled into the stack. The units are joined by simple snap seals similar to



Partly Sealed Units Are Joined by Snap Seals and their current collectors are connected together to form a fuel-cell stack. Each sealed unit contains a back-to-back pair of fuel cells.

the zipperlike seals on plastic bags commonly used to store food. The cathode and anode plates include current collectors, the inside ends of which are electrically connected to the electrodes and the outer ends of which can be used to form the desired series and/or parallel electrical connections among the cells. Because the stack need not be clamped or otherwise held together under pressure, the stack can

easily be disassembled to replace a malfunctioning sealed unit.

*This work was done by Sekharipuram Narayanan and Thomas Valdez of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

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## Highly Efficient Vector-Inversion Pulse Generators

*Marshall Space Flight Center, Alabama*

Improved transmission-line pulse generators of the vector-inversion type are being developed as lightweight sources of pulsed high voltage for diverse applications, including spacecraft thrusters, portable x-ray imaging systems, impulse radar systems, and corona-discharge systems for sterilizing gases. In this development, more than the customary attention is paid to principles of operation and details of construction so as to maximize the efficiency of the pulse-generation

process while minimizing the sizes of components. An important element of this approach is segmenting a pulse generator in such a manner that the electric field in each segment is always below the threshold for electrical breakdown. One design of particular interest, a complete description of which was not available at the time of writing this article, involves two parallel-plate transmission lines that are wound on a mandrel, share a common conductor, and are switched in such

a manner that the pulse generator is divided into a "fast" and a "slow" section. A major innovation in this design is the addition of ferrite to the "slow" section to reduce the size of the mandrel needed for a given efficiency.

*This work was done by M. Franklin Rose of Radianc Technologies, Inc., for Marshall Space Flight Center. Further information is contained in a TSP (see page 1).*  
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