Solid Oxide Fuel Cell (SOFC)

1. Introduction

Japan faces demanding requirements for contribution to solve environmental problems by efficient utilization of fossil fuels, greater introduction of oil-replacing fuels (natural gas, coal, etc.), and CO_2 reduction. Solid oxide fuel cells (SOFC) have high power generating efficiency, can replace various fuels, and are applicable to a wide range of power supplies, from small-scale distribution power supplies to large-scale thermal power generation. Much expectation is placed on their prompt development into practical applications.

Based on the SOFC technology possessed by Acumentrics in the U.S., and jointly with Sumitomo Corporation, Nippon Steel are developing SOFC systems suited for the Japanese market.

2. Features

SOFCs are fuel cells that operate at high temperatures between 700 and 1000℃, and have the following advantages over proton exchange membrane fuel cells that have been developed for fuel cell automobiles and households.

1) Higher power generation efficiency.
2) Higher exhaust gas temperature, with a potential of the value-added utilization of exhaust heat in the form of steam generation or others.
3) Capable of generating power with fuel in a broad range covering not only hydrogen but carbon monoxide as well.
4) Permits simplification of fuel modification system components, because of its internal fuel property modification capability.
5) Expectable higher durability, because the electrolyte is solid consisting mainly of ceramics.
6) No noble metal used in the electrodes.

The SOFC of Acumentrics has a very simple construction of a cylindrical form of anode support type (**Fig. 1**), using no electric interconnectors between the cells. Being so simple, the cells are highly resistant to heat and shocks and can withstand abrupt starts and stops which conventional SOFC might not endure. The structural simplicity also permits simplification of cell production lines, and we actually foresee the possibility of achieving low-cost cell production by a wet process and continuous production lines. Acumentircs developed a 1kW-class SOFC system in 2001, a 2kW-UPS (Uninterruptible power supply) SOFC system thereafter, and are in the process of developing a 5kW SOFC cogeneration system.

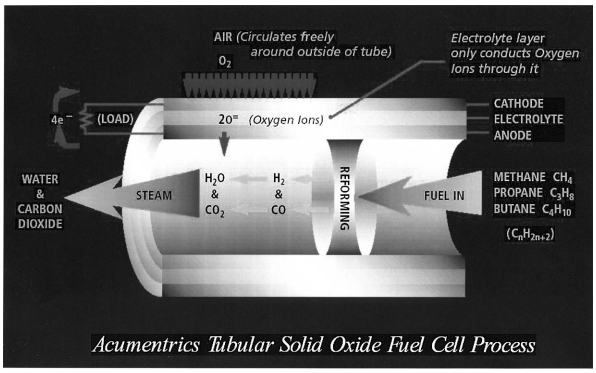

Fig. 1 Acumentrics tubular SOFC process

3. Activities

Using the SOFC stacks of Acumentrics, Nippon Steel has been developing SOFC systems to satisfy the needs of the market in Japan. We set up an SOFC experiment site in our Yawata Works, and introduced there a 2kW-SOFC-UPS system (**Photo 1**) in July, 2003 and started performance evaluation tests. There, we also introduced a single cell performance evaluation tester and have been storing test results data which is necessary for the development of an optimum system.

In October, 2003, Sumitomo Corporation and Acumentrics established Acumentrics Japan as an SOFC engineering company in Japan, and Nippon Steel took part in its capital investment as a technical business partner.

The first product targeted now is a small-scale cogeneration system for commercial use. Acumentrics Japan and Nippon Steel were jointly entrusted in June, 2004 by the New Energy and Industrial Technology Development Organization for the “development of solid oxide fuel cell cogeneration system,” and are now engaged in the development work to promptly achieve product commercialization.

Photo 1 2kW SOFC in Yawata Works

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