Molten carbonate fuel cells (MCFCs)

High temperature cells

Molten Carbonate Fuel Cells (MCFCs) are another type of high temperature fuel cell. A molten mixture of salts: lithium, sodium, potassium carbonate is used as the electrolyte. These salts melt and conduct carbonate ions (CO_3^{2-}) from the anode to the cathode when heated to about 600°C. Hydrocarbons have to be used as part of the fuel since the charge carriers in the electrolyte are carbonate ions.

Hydrogen is also needed at the anode. It is gained by internal reforming of hydrocarbon based fuels. The electrodes should be resistant to poisoning by carbon. The high exhaust temperature makes cogeneration of electricity with turbines possible; hence the efficiency (60% without and 80% with hybrid technology) is relatively high compared to other fuel cell systems.

MCFCs are mainly used for stationary power generation in the 50 kW to 5 MW range. Since it uses a liquid and high temperature electrolyte, it is rather unsuitable for mobile applications. The main problem with MCFC is the slow dissolution of the cathode in the electrolyte. Most of the research is therefore in the area of more durable materials and cathodes.

Molten Carbonate Fuel Cell

Historical summary

Both the solid oxide and the molten carbonate fuel cells are high temperature devices. Their development followed similar lines until the late 1950's. First, E. Baur and H. Preis experimented with solid oxide electrolytes in Switzerland.

The technical problems they encountered were again tackled by the Russian scientist O.K. Davtyan without success though. In the late 1950's, Dutch scientists G.H.J. Broers and J.A.A. Ketelaar focused on molten carbonate salts as electrolyte. By 1960, they reported the first MCFC prototype.

In the mid-1960's, the US Army's Mobility Equipment Research and Development Center (MERDC) tested several MCFCs made by Texas Instruments ranging from 100 to 1000 Watts. Ishikawjima Heavy Industries showed in Japan in the early 1990s that a 1000 Watt MCFC power generator can operate for 10000 hours continuously. Other large power plants with outputs of up to 3 megawatts are already planned.

M-C Power's molten carbonate fuel cell power plant in San Diego, California, 1997. Smithsonian Institution, from the Science Service Historical Images Collection, courtesy of National Energy Technology Laboratory.

The MCFC has been under development for 15 years as a stationary electric power plant. Although when most problems with the Solid Oxide Fuel Cell are solved, work on the MCFC might be stopped.

Source: http://www.doitpoms.ac.uk/tlplib/fuel-cells/mcfc_history.php