High temperature PEM Fuel Cell stacks

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ABSTRACT

High power applications are expected to greatly benefit from high temperature Polymer Electrolyte Membrane Fuel Cells (PEMFCs) operating at temperatures between 180-200°C. This work presents a combinatorial approach in which separately suitable electrode/electrolyte assemblies are developed and evaluated, while individual components and the whole fuel cell stacks are designed and manufactured. Design and engineering aspects are employed to result in reliable and effective stacks. These systems supply electricity in the range of 0.5 to 5 kW and are applicable in energy-heat co-generation units (CHP), auxiliary power units (APU), battery chargers with LPG, stationary back up power systems and energy production in off-grid regions.

The efficient operation of such devices [1] requires the development of suitable materials and components. The Membrane Electrode Assembly (MEA) is the core component of the stack and should have specific properties to withstand the strong conditions during the fuel cell operation. The state of the art MEA technology is based on H_3PO_4 imbibed aromatic polymer electrolytes [2] and Pt based catalysts [3]. In addition to the MEA, components such as the electrode microporous layer, gaskets, compression assembly elements, plates etc. are of great importance. The performance of a PEM fuel cell stack is affected by many internal and external factors, such as fuel cell design and assembly, degradation of materials, operational conditions, impurities or contaminants. The design of a HT PEMFC stack are mainly determined by the application and the operation conditions, and in most cases cost and weight limitations need to be considered. Of great importance is the design of the cooling system of the stack, which varies considerably and depends on the final application and tolerance of the materials to the temperature difference along the devices. Detailed mechanical and thermo-mechanical models for each part separately are necessary to predict the stress and strain fields and reduce the weight of the stacks. Special attention is given to the uniform distribution of the compression forces over the MEAs through the compression of the specially designed endplates.

Further subject to the aforementioned electrochemical devices is the development of integrated CHP systems from LPG and natural gas for residential or auxiliary power units, telecommunication antennas, heavy vehicles or maritime transport. They consist of two main units, the hydrocarbon reforming unit for hydrogen production and the fuel cell unit for the direct production of heat and electricity from hydrogen oxidation into water.

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