Experimental Investigation on Water Transfer in Passive Type PEFC

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The fuel cells are clean and highly efficient energy conversion devices, which generate electricity from hydrogen and oxygen without emitting anything but water. Among them, PEFC, the polymer electrolyte fuel cell, is now increasingly being made into practical use because of its easiness in handling and high power density. Most of the PEFCs now under research and development are referred to as stacks because of their stacked structure consisting of many cells and are aimed at automotive or domestic cogeneration system applications.

However, a fuel cell with a much simpler structure and capable of operating at nearly ambient temperature and pressure is suitable for small-sized generator sets for home and outdoor use. The passive type PEFC can operate under very low hydrogen pressure, taking in oxygen directly from the atmosphere. It needs neither a compressor to pressurize the supplied air nor a water cooling system for keeping the operating temperature around 80°C. It needs neither a humidifier nor a dehumidifier for hydrogen and air to maintain water management in the system. The simplified system configuration contributes to low failure probability and low manufacturing cost.

In this study, detailed experimental analyses were conducted with a passive type PEFC module consisting of 20 cells laid out in a plane. The passive type PEFC with the hydrogen circulating system using pressure difference has been proved to be effective for a long time operation, as it can avoid water plugging occurring in the hydrogen channels. Some properties were experimentally measured using the rated 55 W fuel cell module with the hydrogen circulating system during a constant current operation. The relationship between the properties, such as the output voltage of the fuel cell, the temperature of the module body and the temperature and humidity of hydrogen and air, was investigated. As a result, the water balance in the fuel cell module was clarified quantitatively and the behavior of generated liquid water, which probably caused output voltage fluctuation, was discussed intensively.

Keywords: passive Type PEFC, PEFC Module, Circulation System, Water balance