Stack Performances of Proton Exchange Membrane Fuel Cell

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I. Introduction

The development of proton exchange membrane fuel cells(PEMFCs) with high energy efficiencies and high power densities is gaining momentum because their performance characteristics are attractive for terrestrial(power sources for electrical vehicles, stand-by power), space and underwater application[1]. Fuel cells are capable of running on non-petroleum fuels such as methanol, natural gas or hydrogen and also have major impact on improving air quality. They virtually eliminate particulates, NO_x, SO_x, and significant reduce hydrocarbons and carbon monoxide. Especially, fuel cell-battery hybrid power sources appear to be well suited to overcome both the so-called battery problem(low energy density) and the fuel cell problem(low power density)[2].

The performance of proton exchange membrane fuel cell was investigated to optimize the fabrication method of membrane/electrode assembly, and to find appropriate operating conditions such as pressure, temperature and inlet gas humidification.

II. Experiments

A fuel dell, with a 5 cm^2, and stack with 50 cm^2 geometric area for membrane and electrode assembly, was used in this work. Fabrication methods of this assembly is stated elsewhere in detail[3]. Fuel cell was installed in the fuel cell test station, equipped with the necessary peripheral components(i.e. temperature-controllers, humidification-chamber, mass-flow controllers and back-pressure regulators). The performance evaluation of the single cell was carried out using a personal computer(IBM-PC compatible) and an electronic load(Hewlett Packard 6060A), inter-connected through a GPIB. Cell potential vs. current density measurements were made using O_2/H_2, over a temperature range of 50 to 90℃ and a prssure range of 1 to 4 atm.

III. Results and Discussions

It is the membrane electrolyte that has the decisive effect on cell performance. The optimum condition for humidification could be found by varying the inlet gas temperatures. Gas temperatures higher than 5℃ for oxygen and 10℃ for hydrogen that of cell temperature was found to the optimum humidification condition irrespective of the cell temperature. Increase in temperature and/or pressure generally result in enhanced cell performance. The cell performance operated at 1 atm, however, exhibited interesting temperature dependence. Enhanced performance with increasing temperature was obserbed up to 70℃, whereas cell temperature showed no appreciable effect above 70℃. This observation might be attributed to increased vapor pressure, with increasing temperature, which dilute inlet gas composition. Cells operated at higher pressure did not show this behavior where the effect of increased vapor pressure becomes relatively insignificant(Fig. 1).

Fuel cell stacks, which consist of 5 active cells of 50 cm^2 effective area are fabricated. Stack performance data operating on H_2 and O_2 shows 200 mA/cm^2 at 0.7 V. The uniformity of the performance of the 5 constituent cells except at high current densities is shown in Fig. 2.

IV Conclusion

1. During cell operation, it is found that the temperature of anode gas(hydrogen) and cathode gas(air) should be 10℃ and 5℃, respectively, higher than the cell temperature.
2. Stacks are fabricated with internally manifolded series- parallel bipolar plates. Stack performance of 300 mA/cm^2 at 0.7 Volt is attained at 2 atm.

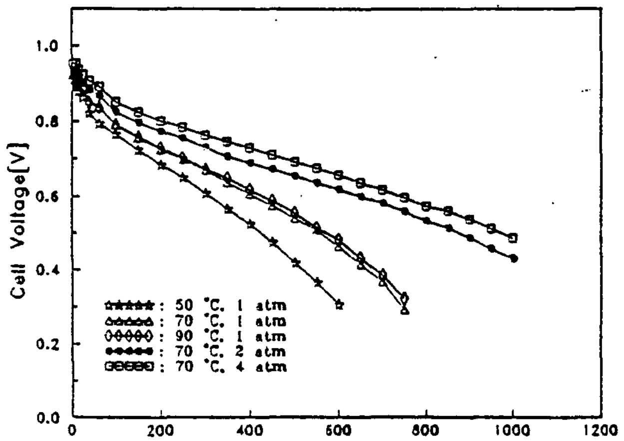

Fig. 1. Effect of operating temperature and pressure on cell potential vs. current density plot with Globetech electrode and Nafion 115 membrane in 5 cm^2 active area unit cell.

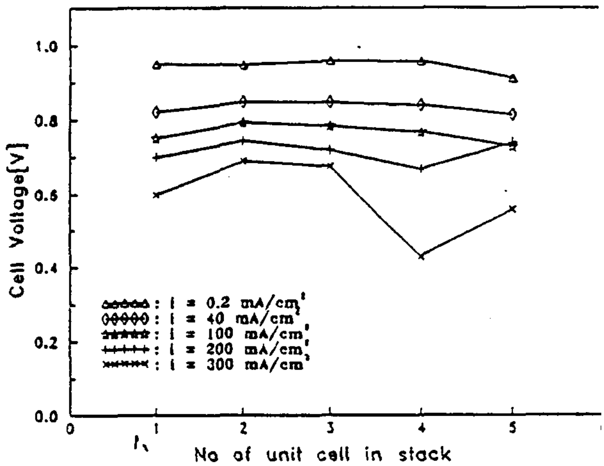

Fig. 2. Cell to Cell performance in 5 cell stack. 50 cm^2 active area with Globetech electrod and Nafion 115 membrane at 60°C, 6psig.

References

1. S. Srinivasan, O.Velev, A. Parthasarathy, D. Manko and A. J. Appleby, J. power Sources 36, 299 (1991).
2. A. J. Appleby, F. R. Foulkes, "Fuel Cell Hand Book", Van Nostrand Reinhold (1989).
3. Y. W. Rho, A.V.Velev, S. Srinivasan, and Y. T. Kho, J. Electrochem. Soc. submitted. (1993)