# A Study on Experiment of a PEM Fuel Cell with Open Cathodes


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**ABSTRACT**

The main objective of this study is to design and fabricate a PEM fuel cell stack with open cathodes, and to perform a serial of tests on this stack. By means of this work, the effects of operating conditions on the performance of a fuel cell stack were investigated. The results of this study show that the performance of a fuel cell stack depends on its operating conditions; especially, the mass flow rate of air flowing through the cathodes is the key parameter. The performance of a fuel cell stack can be raised by supplying ample air to the cathode, but this performance raise is limited to a certain extent. Increasing the air flow rate further, the fuel cell will carry more parasitic load and gain no more in performance. Knowing the optimal air flow rate under various stack output, together with the scheme of flow rate control, will be a great benefit to the development of fuel cell system.



Keywords : PEM Fuel Cell, Performance test, MEA.


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**REFERENCES**


[1] Chu D., and Jiang R.,“ Performance of polymer electrolyte membrane fuel cell stacks Part I. Evaluation and simulation of an air-breathing PEMFC stack ”, J. Power Source, . 83, 128-133 (1999).

[2] Paganin V.A., Ticianelli E.A., Gonzalez E.R.,“ Development of small polymer electrolyte fuel cell stacks ”, Journal of Power Sources, 70, 55-58 (1998).

[3] Ahn S.Y., Shin S. J., Ha H. Y., Hong S. A., Lee Y. C., Lim T. W., Oh I. H., "Performance and lifetime analysis of the kW-class PEMFC stack", Journal of Power Sources, 106 , 295-303 (2002).

[4] Lee H. I., Lee C. H., Oh T. Y., Choi S. G., Park I. W., Baek K. K., "Development of 1 kW class polymer electrolyte membrane fuel cell power generation system", Journal of Power Sources, 107, 110-119 (2002).

[5] Bruijn F. A., Papageorgopoulos D. C., Sitters E. F., Janssen G. J. M., "The influence of carbon dioxide on PEM fuel cell anodes", Journal of Power Sources, 110, 117-124 (2002).

[6] Susai T., Kawakami A., Hamada A., Miyake Y., Azegami Y., "Development of a 1kW polymer electrolytefuel cell power source", Journal of Power Sources, 92, 131-138 (2001).

[7] Philip L., Barry J., Mesped O.,“ New materials for polymer electrolyte membrane fuel cell current collectors, ” J .Power Source, 80, 235-241 (1999).

[8] Staschewski D.,“ Internal humidifying of PEM fuel cell, ” J. Hydrogen Energy, 21, 381-385 (1996).
[9] Li X., Marr C.,“ Composition and performance modeling of catalyst layer in a proton exchange membrane fuel cell ”, Journal of Power Sources, 77, 17-27 (1999).
[10] 黃鎮江,“ 燃料電池 ”,全華科技圖書股份有限公司, 2003.
[11] Dohle H., Kornyshev A.A., Kulikovsky A.A, Mergel J., Stolten D.,“ The current voltage plot of PEM fuel cell with long feed channels ”, Electrochemistry Communication, 3, 73-80(2001).
[12] Yan W.M., Soong C.Y., Chen F., Chu H.S.,“ Effects of flow distributor geometry and diffusion layer porosity on reactant gas transport and performance of proton exchange membrane fuel cells ”, Journal of Power Sources, 125, 27-39. (2004).
[13] 陳震宇,賴維祥,楊鎮丞,陳家進,甘恆全,“ 蜿蜒流道數目對 質子交換膜燃料電池流場影響之模擬研究, ” 中華民國燃燒 學會第十五屆學術研討會(2005).
[14] Zhixiang Liu, Zongqiang Mao, Bing Wu, Lisheng Wang and Volkmar M. Schmidt,“ Current density distribution in PEFC ”, Journal of Power Sources, 141, 205-210(2005).
[15] J. Soler, E. Hontanon and L. Daza,“ Electrode permeability and flow-field configuration: influence on the performance of a PEMFC ”, Journal of Power Sources, 118, 172-178(2003).
[16] Lee W.K., Ho C.H., Lee, Zee J.W.V., Murthy M.,“ The effects of compression and gas diffusion layers on the performance of a PEM fuel cell ”, Journal of Power Sources, 84, 45-51(1999).
[17] Nicolas C., Michel L., Guy L., Jean-Pol D.,“ Measuring the through-plane electrical resistivity of bipolar plates (apparatus and methods) ”, Journal of Power Sources, 143, 93-102(2005).
[18] Cho E.A., Jeon U.S., Ha H.Y., Hong S.A., Oh I.H.,“ Characteristics of composite bipolar plates for polymer electrolyte membrane fuel cells ”, Journal of Power Sources, 125, 178-182(2004).
[19] M.H. Oh, Y.S. Yoon, S.G. Park,“ The electrical and physical properties of alternative material bipolar plate for PEM fuel cell system ”, Electrochemical Acta, 50, 777-780(2004).