Characteristic Distributed Performance of Polymer Electrolyte Fuel Cells Under Low Humidity Conditions

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For automotive and portable applications, it is highly desired to operate a polymer electrolyte fuel cell (PEFC) under low humidity conditions. In order to better understand and optimize performance under these conditions, there is a need for detailed experimental data of the local conditions and performance throughout the cell. This paper will present results of a series of experiments designed to comprehensively examine distributed current density, species, and high frequency resistance for various anode and cathode inlet humidity levels.

Species distribution measurements are determined with an Agilent Real-Time Gas Analyzer (RTGA), which has been previously described by Dong *et al.*[1] The RTGA has the ability to measure the concentration of various species including water vapor, carbon monoxide, and oxygen in near real time (at the frequency of 1 Hz). Current density distributions are measured with a segmented cell approach as described in references 2 and 3. A multi-channel potentiostat is used to measure distributed high frequency resistance (HFR) data, which indicate the local ionic conductivity (and thus hydration state) of the electrolyte.

Figure 1 is a plot of current distribution versus fractional distance from the cathode inlet at different fuel cell voltages. Figure 2 is a generic sketch of the current density distribution along the flow channel for different combinations of inlet humidity on the anode and cathode. These distributions are key to understanding local performance for an under-humidified situation. Along with distributions of species and HFR, these data can contribute to an advanced understanding of PEFCs and will provide a set of benchmark data for detailed model validation.

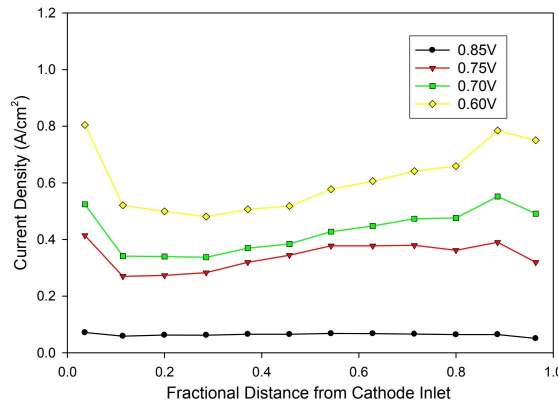

Figure 1: Steady-state current distribution as a function of fractional distance from cathode inlet. Test conditions: exit pressure A/C = 3.0 atm, 100% RH @ 80 ^{o}C hydrogen anode, 0% RH air cathode, ζ_c= 2.0, ζ_a= 1.2 equivalent.

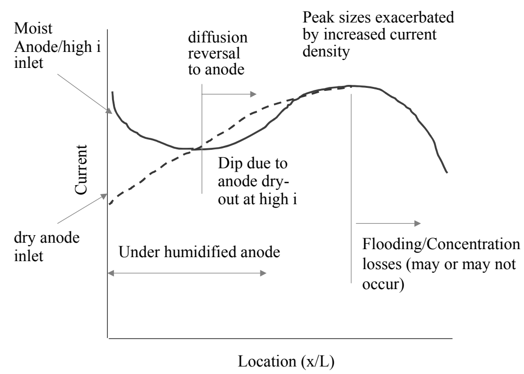

Figure 2: Illustration sketch of the generic relative current versus location along the flow channel for different combinations of inlet humidity on the anode and cathode

1) Q. Dong, E. C. Kumbur, J. Kull, D. Shields, and M. M. Mench, Abstract 354, Spring Meeting of the Electrochemical Society, San Antonio, Texas (2004).
2) M. M. Mench and C. Y. Wang, J. Electrochem. Soc., Vol. 150, ppA79-A85 (2003)
3) M. M. Mench, C. Y. Wang, and M. Ishikawa, J. Electrochem. Soc., Vol. 150, No. 9, pp. A1052-A1059 (2003)