WEDNESDAY, AUGUST 24, 2005, A.M.

SESSION 34B: INTERNATIONAL SYMPOSIUM ON FUEL CELL AND HYDROGEN TECHNOLOGIES

MODELLING SOFC - PEMFC

Sponsor(s): Materials Science and Engineering Section, The Metallurgical Society of CIM
Room: Imperial Ballroom 7
Chairmen: H. WANG and S. LIU, NRC Institute for Fuel Cell Innovation, Canada

PAPER 34B.1 — 10:20 (KEYNOTE)
IN-SITU DIAGNOSTIC TOOLS FOR PEM FUEL CELLS: ADVANCED METHODS FOR LIQUID WATER PROFILING.
J. STUMPER, M. LLHR, S. HAMADA, Ballard Power Systems, Canada

The control of the distribution and movement of liquid water is crucial for increased reliability and durability of PEM fuel cells: whereas the proton exchange membrane requires a minimum amount of liquid water for optimum operation, water excess in the GDL will impede reactant gas access to the catalyst layer thereby reducing performance.

In order to understand the relationships between water management on one hand and fuel cell performance and durability on the other, Ballard has been developing a number of minimally invasive techniques that can throw light on the role of liquid water for both cell performance and durability. This paper introduces a novel measurement method that can provide information about the amount and distribution of liquid water under operation. It is shown how the MEA Resistance and Electrode Diffusivity (MRED) method can be used to determine i) the amount of liquid water in the fuel cell, ii) the pure ohmic cell resistance and iii) the O_2 -diffusivity of the cathode. Furthermore, through a combination of the MRED method with current mapping it is possible to determine spatially resolved MEA resistance profiles.

PAPER 34B.2 — 10:40
EFFECTS OF CHANNEL ARRANGEMENTS ON FLUID FLOW IN PEMFC FLOW FIELD USING SERPENTINE CHANNEL SYSTEM WITH TRAPEZOIDAL CROSS-SECTION.
L. SUN, P.H. OOSTHUIZEN and K.B. MCAULEY, Queen's University, Canada

A numerical model has been developed to study the air flow in the flow plate and gas diffusion layer assembly on the cathode side of a PEM fuel cell. The flow plate in this type of fuel cell often has serpentine channels and the porous layer is adjacent to the flow plate to diffuse the air to the catalyst layer. Flow cross-over of air through the porous diffusion layer from one part of the channel to another can occur. This flow cross-over is a result of the pressure differences between different parts of the channel, and it causes the flow rate through the channel to vary with the distance along the channel. A numerical study of pressure distribution and flow cross-over through the gas diffusion layer (GDL) in PEMFC flow field using serpentine channel system has therefore been undertaken to compare the cases of a single channel and two parallel channel arrangements, with the channel having a trapezoidal cross-sectional shape. The purpose of the present work was to study the effect of the flow plate geometry on the basic fluid flow through the plate. The flow here has been assumed to be three-dimensional, steady, incompressible, isothermal and single-phase. The flow through the porous diffusion layer has been described using the Darcy model. The dimensionless governing equations have been written in dimensionless form and solved by using the commercial CFD solver, FIDAP. The solution depends on the following parameters, (1) Reynolds number, Re, based on the mean channel width and the mean velocity at the channel inlet, values of being between 50 and 200; (2) the permeability of the gas diffusion layer, values of 1.0E-19 and 1.0E-10 being used; (3) the channel cross-section geometry, the ratio, R, of the length of the wide side to the length of the narrow side of the trapezoidal cross-sectional shape, values of R being between 1 and 7 considered; (4) the flow channel arrangement, single channel and two parallel channels with different number of passes being considered. The effect of these parameters on the pressure and flow variations in the flow field has been examined.

PAPER 34B.3 — 11:00
EXPERIMENTAL MODELLING OF GAS DIFFUSION LAYER FOR PEM FUEL CELLS
G. YAN, J. ZHANG, J. SHEN, S. LIU and H. WANG, NRC Institute for Fuel Cell Innovation, Canada
D. P. WILKINSON, University of British Columbia, Canada

The gas diffusion layer (GDL) is one of the most critical components of the proton exchange membrane fuel cell (PEMFC) in achieving good performance. The GDL serves as a current collector, transport media for fuel and oxidant to the catalyst layers, a support for the catalyst layer and a medium for water management. In this paper, we will discuss the Modelling and experimental measurement of the reactant distribution in the GDL and to the catalyst layer. This will be done for some new and advanced engineered GDLs. Novel optical technique which correlates measured data with reactant distribution are used. This technique combined with Modelling allows optimal design of engineered GDLs.

PAPER 34B.4 — 11:20

ALONG-CHANNEL WATER AND THERMAL MANAGEMENT FOR PROTON EXCHANGE MEMBRANE FUEL CELLS.

W. HUANG, B. ZHOU and A. SOBIESIAK, University of Windsor, Windsor ON

Proper water and thermal management is essential for obtaining high performance of Proton Exchange Membrane Fuel Cells (PEMFCs). A steady, two-dimensional water and thermal management model was developed, aiming at considering pressure drop, open circuit voltage variation with stack temperature, water vapor effects on membrane conductivity, which made the model physically more reasonable and more suitable for various operating conditions. The model could predict the distributions of a series of important parameters along the flow channel, and thus the effects of various operating and design parameters on the fuel cell performance could be investigated easily by numerical trial-and-error method. The Modelling results compared well with the available experimental results from the literatures. The results also showed that the humidification is crucial for the performance of PEMFCs. The model could be a very useful engineering tool for the optimization of PEMFCs.