**The Interaction of Permeability and Flow-Field Geometry on PEMFC Performance**

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## Introduction

Many researchers have studied the problem of water management inside Proton Exchange Membrane Fuel Cells (PEMFCs) on both steady state and transient operations already discussed in Shimpalee et al.[1] and Lee et al.[2] Glandt et al.[3] added the effects of diffusion of gases to the MEA through stagnant liquid water films and studied the effects on single and double pass flow fields. Greenway et al.[4] used this model to study cyclic and symmetric flow field patterns at various cell conditions. With different reacting areas and flow patterns of fuel cell, this study will give us the idea to optimize size with the best possible flow field design for PEMFCs. Here we extend the work of Glandt et al.[3] and Greenway et al.[4] by investigating the effects of reaction area and Gas Diffusion Media (GDM) properties on flow field performance. Current density distributions, temperature contours, liquid water concentration (if present), and velocity fields will be discussed and compared with previous work.[3,4]

## Numerical Procedure and Results

Shimpalee et al.[1] provides a background on the three dimensional non-isothermal model used in this work, and a complete description of the model is found in Glandt et al.[3] Greenway et al.[4] showed that the performance of a PEM fuel cell is also a function of flow channel configurations of both cathode and anode. Figure 1 shows the model geometry for a cyclic flow-field pattern for a 10cm$^2$ reaction area. By changing GDM properties such as permeability, porosity and tortuosity as well as reaction area the profiles of the current density distribution, water concentration distribution, temperature contour, and other electrochemical variables are varied. Figure 2 shows the current density distribution for the cyclic flow-field in Figure 1. The current density drops off severely in the bottom right hand corner of Figure 2. The reasons for this effect are examined in this paper. Also the effects of channel length and reaction area (i.e., geometric scale effects) on these distributions are investigated. These results will lead us to the optimization of the flow-field design in PEMFC.

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**Figure 1: Model of a 10-cm$^2$ cyclic flow field without graphite current collectors.**

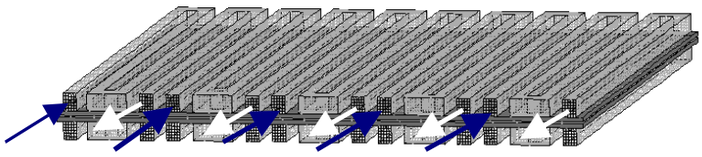
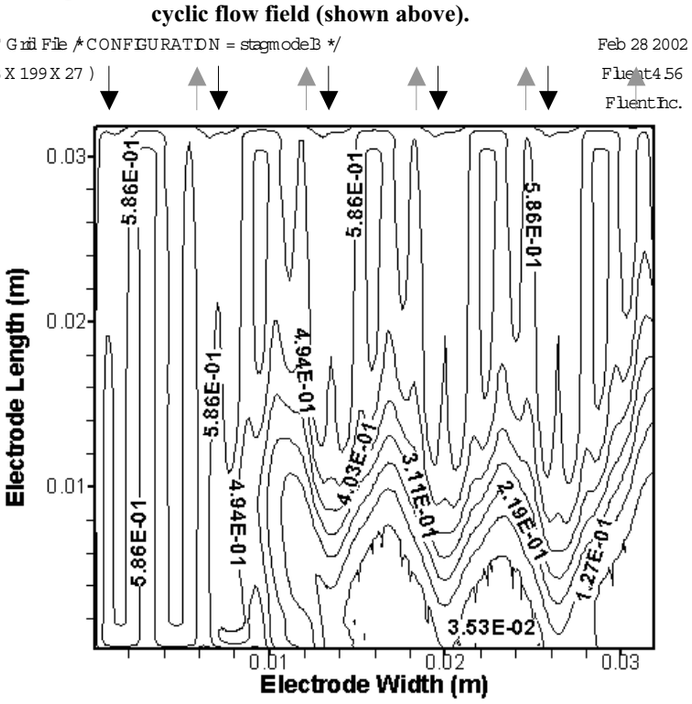


**Figure 2: Current density (A/cm$^2$) distribution for the cyclic flow field (shown above).**

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