An Investigation of the Impact of the Proton Exchange Membrane Fuel Cell Flow Field Plate Geometry and Design Using Computational Fluid Dynamic Modeling and Simulation

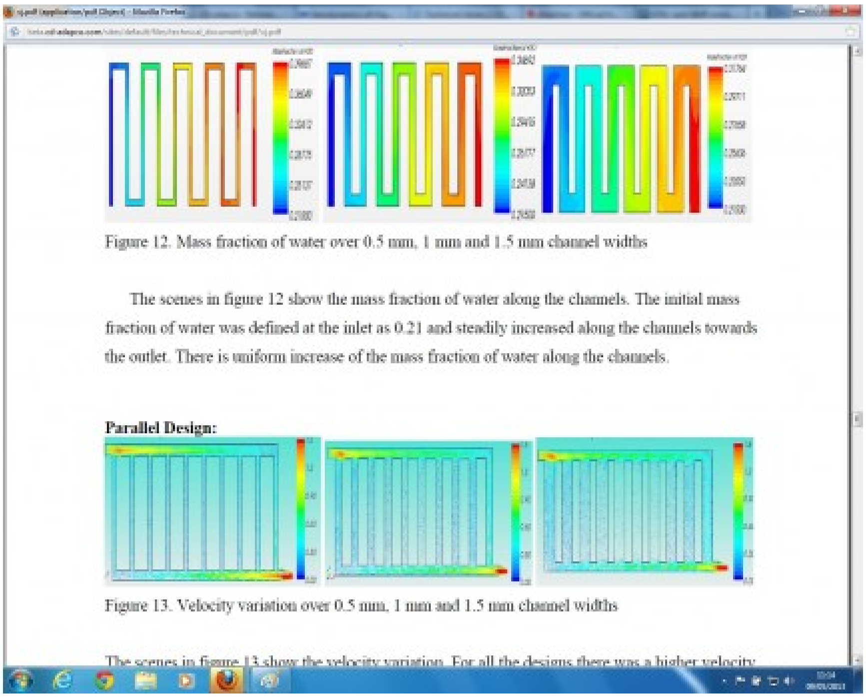

Figure 12. Mass fraction of water over 0.5 mm, 1 mm and 1.5 mm channel widths

The scenes in figure 12 show the mass fraction of water along the channels. The initial mass fraction of water was defined at the inlet as 0.21 and steadily increased along the channels towards the outlet. There is uniform increase of the mass fraction of water along the channels.

Parallel Design:

Figure 13. Velocity variation over 0.5 mm, 1 mm and 1.5 mm channel widths

Date:
Tuesday, February 21, 2012

Abstract:

Fuel cells are an appealing alternative to fossil fuels as they operate on hydrogen fuel without any toxic byproducts. A major drawback is the reliability and durability of the bipolar plates. In this
project, the bipolar plates and the Gas Diffusion Layer (GDL) were studied and the flow fields optimized using Computational Fluid Dynamics. The flow geometries of the bipolar plate on the cathode side of the fuel cell were studied to understand the impact on fuel cell performance. Steadystate, three-dimensional, laminar, isothermal, and segregated models were chosen to study the
designs, while varying the channel width. Serpentine and parallel flow fields were designed using CAD with the channel width parameterized. Six experiments were conducted per design while
varying the channel width. Pressure distribution, velocity variation and GDL pressure variations were studied along the flow channels. Water management is an important aspect as there should be

enough to hydrate the membrane, yet not cause flooding and impede fuel cell performance. As a result, the air and water mass fractions were also studied. It was concluded that flow field geometry
had an impact on the reactant distribution and water accumulation. The serpentine model was found to be the optimal model due to uniform diffusion of reactants with higher velocity, that minimized
water accumulation. The optimal channel to land ratio was found to be approximately 1.5 for the serpentine design and 0.98 to 1.5 for the parallel design. These optimal ranges can be further
narrowed by enhancing with electrochemical and thermal considerations.

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