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Controlling the Fluid Flow in Hydrogen Fuel Cells through Material Porosity Designs

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Abstract : Hydrogen fuel cells (HFCs) are environmentally friendly, energy converter devices that convert the chemical energy of the reactants (oxygen and hydrogen) to electricity through electrochemical reactions. The level of the electricity production of HFCs mainly increases depending on the oxygen distribution in the HFC's cathode gas diffusion layer (GDL). With a constant porosity of the GDL, the electrochemical reaction can have a great variation that reduces the cell's productivity and stability. Our findings bring a methodology in finding porosity designs of the diffusion layer to improve the oxygen distribution such that it results in a stable oxygen-hydrogen reaction. We first introduce a mathematical model involving the mass and momentum transport equations, in which a porosity function of the GDL is incorporated as a control for the fluid flow. We then derive numerical methods for solving the mathematical model. In conclusion, we present our numerical results to show how to design the GDL porosity to result in a uniform oxygen distribution.

Keywords : fuel cells, material porosity design, mathematical modeling, porous media
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