A study on the two-dimensional flow and mass transfer model for the cathode of a proton exchange membrane fuel cell

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ABSTRACT

A two-dimensional, transient mathematical model for the mass transfer of reactant gas in the cathode gas channel of a PEMFC is developed. This model accounts concurrently for gas flow and multicomponent species (oxygen, water vapor and nitrogen) transport in the gas channel at specified cell current densities. The governing equations along with the boundary and initial conditions are solved numerically by using finite-difference methods. The numerical results show that the oxygen and water vapor concentrations in the gas channel are strong functions of stoichiometry. However, at a fixed stoichiometry, the current density has only slight influence on the concentration variations. The fully-developed Sherwood number for oxygen mass transfer in the gas channel is found to be 6.0, which agrees well with the Sherwood number estimated from the correlation between mass and heat transfer. Furthermore, two-dimensional models by using for gas diffusion layer and catalyst layer are coupled with gas channel model in order to build the cell performance. An analysis can be made of the effects due to some design and operating parameters such as flow rate, inlet pressure, oxygen mole fraction to bring out physical meanings influencing on the cell and consequently obtain a fuel cell with high performance.

Keywords : PEM fuel cells, gas channel, stoichiometry, mass transfer

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