냉각채널 열관리에 따른 고분자연료전지의 성능영향 연구

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Thermal managing effects by cooling channels on performance of a PEMFC

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Abstract : Relative humidity, membrane conductivity and water activity are critical parameters of polymer electrolyte membrane fuel cells (PEMFC) for high performance and reliability. These parameters are closely related with temperature. Moreover, the ideal values of these parameters are not always identical along the channels. Therefore, the cooling channel design and its operating condition should be well optimized along the all location of the channels. In the present study, we have performed a numerical investigation on the effects of cooling channels on performance of a PEMFC. Three-dimensional Navier-Stokes equations are solved with the energy equation including heat generated by the electrochemical reactions in the fuel cell. The present numerical model includes the gas diffusion layers (GDL) and serpentine channels for both anode and cathode gas flows, as well as cooling channels. To accurately predict the water transport across the membrane, the distribution of water content in the membrane is calculated by solving a nonlinear differential equation with a nonlinear coefficient, i.e., the water diffusivity which is a function of water content as well as temperature. Main emphasis is placed on the heat transfer between the solid bipolar plate and coolant flow. The present results show that local current density is affected by cooling channels due to the change of the oxygen concentration and the membrane conductivity as well as the water content. It is also found that the relative humidity is influenced by the generated water and the gas temperature and thus it affects the distribution of fuel concentration and the conductivity of the membrane, ultimately fuel cell performance. Unit-cell experiments are also carried out to validate the numerical models. The performance curves between the models and experiments show reasonable results.

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