Numerical Simulation of the Gas Crossover Effect in a Proton Exchange Membrane Fuel Cell

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In a typical proton exchange membrane fuel cell (PEMFC), Nafion is applied in solid polymer electrolyte form to separate hydrogen (H2) and oxygen (O2). However, H2 and O2 diffuse through Nafion and cause side reaction on the anode and cathode. This is referred as the gas crossover effect, i.e. the mixed-potential effect, which decreases the theoretical potential between the electrodes. In this work, a steady-state PEMFC model is implemented to give widespread explain on the mixed-potential effect. Water vapor/liquid sorption of Nafion is given as a function of the temperature, relative humidity and volumetric fraction of liquid water to satisfy a numerous experimental data from other literature. Validity of the present model was evaluated by comparing the simulated polarization with experimental data. The direct-current polarization was measured by preparing the membrane-electrode-assembly using the decal transfer method. In addition, the molar concentrations of dissolved H2/O2, relative humidity effect and temperature effect were fully discussed in details.