Numerical Modeling of Performance and Degradation Rate for Membrane Electrode Assemblies in High Temperature PEM Fuel Cells

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The numerical model of degradation rate in high temperature proton exchange membrane fuel cell (HT-PEMFC) using phosphoric acid (PA) doped polybenzimidazole (PBI) membrane are developed. The model accounts for degradation factors in terms of activation, ohmic, and concentration over-potentials and subsequent degradation of performance for high temperature membrane electrode assemblies (MEAs). In addition, the model considers operating temperature effects on degradation rate for MEAs in HT-PEMFC since the degradation rate for MEAs are highly different according to their operating temperature normally between 150℃ and 190℃. The developed model is validated with HT-PEMFC degradation data after long-term operations reported in the literature. Numerical simulations are carried out to investigate the effects of operating temperature on HT-PEMFC performance degradation. The numerical results indicate that the effect of operating temperature on HT-PEMFC durability is significant and thus expected lifetime and average performance for high temperature MEAs are changeable due to the determined operating temperature.