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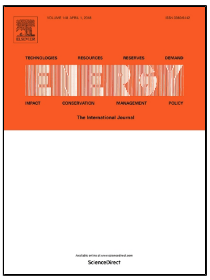

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Thermal and Electrochemical Performance Assessment of a High Temperature PEM Electrolyzer

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Abstract

In this paper, detailed effects of operating conditions and design parameters including temperature, pressure, gas diffusion layer (GDL) thickness, membrane thickness and GDL porosity on the performance of a high temperature proton exchange membrane electrolyzer cell (PEMEC) are studied. A CFD analysis is carried out using a finite volume method based on a fully three-dimensional model. The model is verified against experimental data and the realistic effects of varying operating conditions are considered. The results indicate that decrease of operating temperature from 403 K to 373 K results in reduction of hydrogen concentration at the membrane-catalyst interface from 2.2×10^{-4} to 1.9×10^{-4} mol/m^3. The temperature and hydrogen concentration under rib area of channel are relatively higher due to the accumulation of water under this area that leads to higher electrochemical rate. An increase of GDL thickness from 0.2 mm to 0.5 mm at a voltage of 1.65 V leads to reduction of current density from 0.426 A/cm^2 to 0.409 A/cm^2. The porosity of the GDL has no significant effect on the polarization curve. The current density of the PEMEC for a membrane thickness of 50 μm at voltage of 1.6 V is 48% higher than a membrane thickness of 200 μm.

Keywords: Proton exchange membrane electrolyzer; Three-dimensional model; CFD simulation; High temperature electrolysis; Membrane; Gas diffusion layer

1. Introduction

There is a rising global demand for renewable and clean energy resources as an alternative to fossil fuels. Renewable energy resources such as solar and wind energy are expected to increasingly