Computational Investigation of Water Dynamics in a PEM Fuel Cell Cathode Channel

This paper reports a computational investigation of water droplet emergence, growth, deflection, detachment and interaction in a cathode channel of a polymer electrolyte membrane (PEM) fuel cell. Though the PEM fuel cell is a promising technology for reducing CO2 emission, its performance is hampered at higher current densities due to water flooding. At higher current densities produced water floods the pores of gas diffusion layer (GDL) and flow channel preventing fresh oxygen to reach reactions sites. Therefore an effective water removal mechanism is essential for the efficient working of a PEM fuel cell. The present study focuses on the water removal problem. A two-phase volume of fluid (VOF) model has been utilised to track the interface of water droplet as it emerges from the GDL pores into the channel. Water droplet dynamic has been investigated for neutral and moderately hydrophobic surfaces. This study highlights that water removal is dependent on water droplets interaction. Once the water droplets start to interact and coalesce into bigger droplets, their removal becomes difficult irrespective of surface wettability. The effect of air velocity on the water removal has also been investigated and has been shown to have positive effect.

Author Name:
M. Hossain
Industries:
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Products:
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