

Thermal Analysis of Al₂O₃–water Ethylene Glycol Mixture Nanofluid for Single PEM Fuel Cell Cooling Plate: An Experimental Study

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ABSTRACT

Thermal enhancement through application of nanofluid coolant in a single cooling plate of Polymer Electrolyte Membrane (PEM) fuel cell was experimentally investigated and reported in this paper. The study focuses on 0.1 and 0.5% volume concentrations of Al₂O₃ dispersed in 60:40 and 50:50 of water (W)–ethylene glycol (EG) mixtures as coolant in a carbon graphite PEM fuel cell cooling plate. The study was conducted in a cooling plate with 22 parallel mini channels and large fluid distributors under constant heat load of 100 W. The effect of different flow rates to heat transfer enhancement and fluid flow in Reynolds number range of 20–120 was observed. Positive heat transfer enhancement was obtained where the heat transfer was improved up to 23% and 21% for 0.5% concentration Al₂O₃ nanofluid in 60:40 and 50:50 (W:EG) consecutively as compared to the base fluid. However, higher pressure drop was also experienced as much as 17% and 20% for 0.5% concentration Al₂O₃ in 60:40 and 50:50 (W:EG) consecutively as compared to the base fluid. Combination of both heat transfer enhancements and pressure drop demerits was then analyzed using advantage ratio. The results implied that 0.1% Al₂O₃ in 60:40 (W:EG) is the most advantageous nanofluid candidate followed by 0.1% Al₂O₃ in 50:50 (W:EG). Both nanofluids have advantage ratio values of greater than 1.

KEYWORDS: Nanofluid; PEM fuel cell; Heat transfer; Pumping power; Mini channe

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