Thermal Analysis of Al_2O_3–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 Al_2O_3 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 Al_2O_3 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 Al_2O_3 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% Al_2O_3 in 60:40 (W:EG) is the most advantageous nanofluid candidate followed by 0.1% Al_2O_3 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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