Experimental analysis of SiO_2-distilled water nanofluids in a polymer electrolyte membrane fuel cell parallel channel cooling plate

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ABSTRACT

An experimental report on the thermal performance of Silicone Dioxide (SiO_2) nanofluid coolants based on a PEM fuel cell cooling system is presented. The aim of this study is to evaluate the feasibility of applying these nanofluids coolants as an alternative to conventional distilled water through detailed analysis of thermofluids behaviour in a simulated cooling plate environment. SiO_2 nanoparticles were dispersed in distilled water at 0.1%, 0.3% and 0.5% volume concentrations and tested in a parallel channel cooling plate system. A constant heat load was supplied to simulate a fuel cell stack thermal condition. At inlet flow conditions from 750 to 900 Reynolds number, the SiO_2 nanofluids reduced the average plate temperatures by 15%–20% compared to conventional water coolant. The nanofluids also increased the cooling effectiveness by a similar margin, as well as improving the bulk heat transfer coefficient to a range between 2700 and 4400 W m^{-2}. $^{o}C^{-1}$. However, the required pumping power was also increased due to the added viscous effect. Through the Advantage Ratio (AR) analysis, it was concluded that the enhancement in heat transfer mechanics was more significant than the penalties in fluid flow dynamics. Thus, the SiO_2 nanofluids and the cooling plate design are possible options for advanced PEM fuel cell thermal management practice in future stack designs.

KEYWORDS

SiO_2 nanofluids; PEM fuel cell; Thermal management; Cooling plate

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