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Research Paper

Investigation on effective thermal conductivity and relative viscosity of cellulose nanocrystal as a nanofluidic thermal transport through a combined experimental – Statistical approach by using Response Surface Methodology

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HIGHLIGHTS

- Dispersion of CNC in EG-W mixture enhances thermal conductivity and viscosity.
- Thermal performance highly influenced by volume concentration and temperature.
- Empirical mathematical model is proposed.
- Proposed empirical model has good fit with experimental result.
- Dispersion of CNC in EG-W mixture has promising future as thermal transport fluid.

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ABSTRACT

Combined experimental-statistical approach for effective thermal conductivity and relative viscosity determination were investigated in this present study. Nanofluid used was dispersion of novel nanomaterial Cellulose Nanocrystal (CNC) in ethylene glycol-deionized water mixture at volume base ratio of 50:50 (BR = 0.5) and 60:40 (BR = 0.6). Influence of temperature, volume concentration and ethylene glycol volume base ratio (BR) is used to develop empirical mathematical model by using Response Surface Methodology (RSM) based on Central Composite Design (CCD) with aid of Minitab 17 statistical analysis software. The significance of the developed empirical mathematical model is validated by using Analysis of variance (ANOVA). Maximum effective thermal effectivity obtained is 1.127 and maximum relative viscosity is 4.521 which is recorded at 70 °C temperature, volume concentration of 0.9%, and BR of 0.5. Thus, effective thermal conductivity and relative viscosity has proportional relation with temperature and volume concentration which is supported by contour and surface plot from statistical software. Developed empirical model using RSM has good fit with the experimental data with maximum error of 0.77% for effective thermal conductivity and maximum error of 2.48% for relative viscosity.