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Assessment of Thermophysical Properties of Hybrid Nanoparticles [Graphene Nanoplatelets (GNPs) and Cellulose Nanocrystal (CNC)] in a Base Fluid for Heat Transfer Applications

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Abstract

This article comprehensively investigates single (GNP) and hybrid nanofluids (GNPs/CNC nanoparticles), including nanofluid preparation and thermophysical properties. Nanoparticles were characterized using field emission scanning electron microscope, transmission electron microscope and X-ray diffraction analysis. A two-step approach is used in nanofluid preparation, and various analytical practices determine the prepared nanofluids. The range of the temperature set to measure the thermal conductivity of nanofluids is 20 °C to 50 °C using the ASTM D2717–95 norm. The present study range of the nanofluid volume concentration is from 0.01 vol% to 0.2 vol%. For the single GNP nanofluid, temperatures at room level indicated the thermal conductivity value in the range of 0.366 $W{\cdot}m^{-1}{\cdot}K^{-1}$ to 0.441 $W{\cdot}m^{-1}{\cdot}K^{-1}$; for hybrid nanofluid, the thermal conductivity values are 0.501 $W{\cdot}m^{-1}{\cdot}K^{-1}$ to 0.551 $W{\cdot}m^{-1}{\cdot}K^{-1}$. In addition, nanofluid's viscosity, density and specific heat capacity are the experimental density value increased with the concentration of nanoparticles with 1050 kg/m^3 and 1060 kg/m^3 for 0.01 % concentration of single/hybrid nanofluids, respectively. Finally, based on the findings, it can be determined that the thermal properties of the selected nanoparticles are beneficial, and hybrid nanofluid is an acceptable alternative to conventional/water-based fluids in terms of thermal properties in operational systems.

Keywords Crystal nanocellulose · Graphene nanoplatelets · Hybrids · Thermal conductivity · Viscosity

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