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Characterization of BN-GNP Hybrid Nanofluids for Enhanced Heat Exchanger-Based Thermal Management

Joaquim Monteiro* and S M Sohel Murshed*
IDMEC, Instituto Superior Técnico, University of Lisbon,
1049-001, Lisbon, Portugal
joaquim.monteiro@tecnico.ulisboa.pt ; smurshed@tecnico.ulisboa.pt

Extended Abstract

Hybrid nanofluids, which consist of two or more types of nanoparticles, leverage synergistic effects to overcome the limitations of conventional nanofluids (mono-particle suspensions) [1-2]. Their tailored thermophysical properties, including enhanced thermal conductivity and superior convective heat transfer performance, make them highly promising for next-generation thermal management applications in compact heat exchangers, electronic cooling, and high-performance energy systems. Although various types of hybrid nanofluids have been studied for different applications in the literature [3-5], despite offering an excellent combination of stability and high thermal conductivity boron nitride (BN) and graphene nanoplatelet (GNP) hybrid nanofluids remain relatively unexplored, particularly with respect to their potential in advanced thermal management systems.

This study presents an experimental characterization of stability and thermophysical properties of BN and GNP hybrid nanofluids (HNFs) for potential application in compact heat exchangers. In this study, distilled water (DW) and DW/ethylene glycol (EG) mixtures at 90/10 and 80/20 volume ratios were employed as base fluids. Five BN/GNP ratios (50/50, 25/75, 75/25, 90/10 and 10/90) were prepared at lvery ow weight concentrations of 0.005%, 0.010%, 0.025%, 0.050% and 0.100%. Stability was assessed using UV-Vis spectrophotometry and time-dependent visualization. A comprehensive thermophysical properties characterization including pH, electrical conductivity, density, thermal conductivity and viscosity measurements was performed. While the prepared hybrid nanofluids were found well stable particularly in the course of their properties and performance characterizations. As usually while thermal conductivity was found to increase with concentration of nanoparticles as well as with increasing temperature, viscosity was found to be slightly higher than their base fluids and it decreases with increasing temperature. The results highlight the influence of nanoparticle ratio, base fluid composition and concentration on the thermophysical behavior of BN–GNP hybrid nanofluids, providing new insights into their potential for their enhanced thermal management performance particularly in a compact plate heat exchanger.

This work expands the current database of BN–GNP hybrid nanofluids by providing systematic experimental data at ultra-low concentrations, bridging the gap between fundamental property analysis and practical thermal management applications using heat exchangers.

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