Thermophysical properties of Natural Deep Eutectic Solvent based Nanofluids for enhanced heat transfer

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Today, an array of strategies is being explored and evaluated to determine the optimal approach for enhancing the productivity of heat transfer fluids, with a particular focus on nanofluids. Deep eutectic solvents (DESs) especially Natural Deep Eutectic Solvents (NADESs) have emerged as promising materials poised to address the needs for sustainable ecological processes and to unlock avenues for surmounting the constraints of traditional fluids. This study introduces the synthesis and analysis of novel nanofluids formulated from NADESs. These NADESs comprise Betaine (Be) as a Hydrogen Bond Acceptor (HBA) with Lactic acid (LA) and Ethylene glycol (EG) as Hydrogen Bond Donors (HBDs). In this work, nanofluids are prepared using ratios with Be: LA (molar ratio of 1:2) (NADES1) and Be: EG (molar ratio of 1:4) (NADES2). Amine functionalized multi-walled carbon nanotube (MWCNT-NH_2) nanoparticles are then dispersed into these solvents in three different volume fractions. Properties such as thermal conductivity, viscosity, specific heat capacity, density, and mass loss are measured and analysed before and after the dispersion of nanoparticles. The TGA analysis revealed that the onset temperature for mass loss is 20-25°C higher in nanofluid prepared from NADES1 whereas the onset temperature was about 5°C lower than its base fluid NADES2.This shows that the addition of nanoparticle has led to increase in thermal stability in nanofluid prepared from NADES1 and decrease in thermal stability in nanofluid prepared from NADES2. The stability of the nanofluids are evaluated through both visual observation as well as with the zeta potential measurements and the values obtained indicated good stability for the nanofluids. The thermal conductivity of both the nanofluids are 7-9% higher than that of the base fluid, and with an increase in the volume fraction of the nanoparticle, there was an increase in thermal conductivity. The increase in thermal conductivity has resulted in increase in thermal stability as well as increase in energy efficiency of the nanofluid. It is observed that the nanofluids offer enhanced thermal conductivity and heat transfer properties as compared to base fluids. With NADESs as base fluid, they are poised to drive innovation while reducing environmental footprint and enhancing sustainability.

References

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