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Copper oxide/polyaniline nanocomposites-blended in palm oil hybrid nanofluid: Thermophysical behavior evaluation

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ABSTRACT

In the present work, Copper Oxide-Polyaniline (CuO/PANI) nanocomposites-blended in palm oil hybrid nanofluid have been prepared via a two-step method and investigated as potential heat transfer hybrid nanofluids for the first time. Initially, CuO/PANI nanocomposites are synthesized via oxidative polymerization by varying the weight percentage of CuO nanoparticles (1, 5, and 10 wt%) and characterized using TEM, EDX, XRD, FTIR, and TGA analysis. The findings revealed a successful fusion of nanocomposite composed of spherical CuO nanoparticles embedded in flake-like PANI. The formulated CuO/PANI-palm oil hybrid nanofluids are prepared at a volume concentration between 0.01% and 0.5% and stabilized using an ultrasonication process without any surfactant. UV–vis and sedimentation observation revealed that all nanofluids remain stable for up to a month. FTIR analysis reveals that all formulated nanofluids are chemically stable as no formation of new peaks obtained with the dispersion of nano additives. The TGA analysis affirmed better thermal stability in all nanofluids compared to base fluids. Density evaluation of formulated nanofluids shows a linear relationship between density and volume concentration of nanocomposites but decreased with temperature. Rheology study indicates that palm oil exhibits viscous flow behavior similar to Newtonian behavior. Nanofluid containing 10 wt% CuO/PANI nanocomposites displayed having the highest viscosity and thermal conductivity properties (31.34% enhancement) compared to the rest prepared nanofluids. Mathematical equations were developed at the final stage of the research for future properties prediction.

1. Introduction

Solid metal nanoparticles exhibited to have excellent thermal conductivity behavior [1,2]. Therefore, suspending the nanoparticles into the base fluid (known as nanofluids) is anticipated to manipulate the thermal conductivity behavior of the traditional heat transfer fluids [3,4]. As such, the work concerning nanofluids has attracted considerable attention from the research community in recent years [5,6]. Choi et al., who first invented the nanofluid, observed an improved thermal conductivity from his prepared nanofluid compared to the conventional fluid [7,8]. Later, Lee et al. reported around 20% improvement in thermal conductivity from his formulated CuO/EG nanofluid compared to based fluid [9]. In the last few years, many works have been published in this field, and numerous research is in progress aiming to enhance the thermal performance of these nanofluids [10,11].

Recently, the idea of hybrid nanofluids has emerged, aiming to further enhance thermal properties [12,13]. Here, two or more different kinds of nanoparticles are dispersed into the base fluid to form a so-called hybrid nanofluid[14]. These nanoparticles differ in terms of their physical and chemical properties. Mixing and dispersing them into base fluid projected to capitalize the thermal properties not possessed by single nanomaterial-based nanofluid for a particular purpose. In other words, the addition of mixed element additives into base fluid is anticipated to form a synergistic

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