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Investigations of Stability and Physical Properties of BN-SiO_2 Hybrid Nanofluid

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Extended Abstract

Global energy consumption has been rising for decades [1]. As such, all scientific efforts with the goal of decreasing energy consumption are much needed steps in the right direction. In this sense, heat transfer is one of the main fields of energy study, in which heat exchangers and other thermal management systems have a central role, being used in numerous key applications. One way to improve the performance of heat exchange systems and minimise energy consumption is the use of nanofluids, which consist of dispersions of nanometer-sized particles in conventional heat transfer fluids [2]. Overall, nanofluids typically present better properties when compared to commonly used heat transfer fluids and have great potential not only for heat exchangers but also for many other applications which include microelectronics, transportation or HVAC [2-4]. In this context, this study presents new hybrid nanofluids formulated by dispersing boron nitride (BN) and silicon oxide (SiO_2) in a mixture of ethylene glycol (EG) and distilled water (DW) in a volume ratio of 30:70 (EG:DW), for possible use as coolant. Nanoparticles have been dispersed under the two-step method to obtain a mono nanofluid with 0.01 vol.% of SiO_2 and four hybrid nanofluids with concentrations from 0.02 to 0.1 vol.%. The loading in SiO_2 nanoparticles was kept constant at 0.01 vol.% for all samples. Thermal stability of the hybrid nanoparticles, as well as the viscosity and density of the nanofluids were investigated for the designed dispersions. The study of the stability was carried out by visual observation and by measuring absorbance of lights by the samples using a spectrophotometer (Shimadzu UV-1280, Kyoto, Japan) just after preparation and after 7 days. The BN-SiO_2 hybrid nanofluids showed acceptable temporal stabilities in EG:DW for a reasonable period without adding surfactants. Decreases in absorbance of 0.1% after 7 days were registered for 0.05 vol.% BN:SiO_2 hybrid nanofluid (mass ratio 1:4 BN:SiO_2), as an example. The viscosity was measured using a Brookfield Ametek DVNext rheometer (Middleborough, USA). The viscosity of base fluid and nanofluids was determined at four different temperatures between 293 to 323K. Rheological behaviour was also studied for all samples at 293 K and a linear relationship between shear stress and shear rate for all samples was founded confirming their Newtonian behavior. While the viscosity as usual decreases with the temperature, it increases with the loading of nanoparticles. For the hybrid nanofluid containing 0.05 vol.% BN:SiO_2 (mass ratio 1:4 BN:SiO_2), maximum increase in this property of 24.84% at 323 K with respect to base fluid was observed and such trends are common in the nanofluids literature [5]. Density is also important particularly for any convectional flow and heat transfer systems, and it was determined using a Kyoto Electronics DA-130N densimeter (Kyoto, Japan) from 293 to 308 K. Maximum differences of densities between base fluid and nanofluids were lower than 1.1% at 293 K and such insignificant changes in density is due to very low concentration of nanoparticles used.

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References

[1] Statistical Review of World Energy. Bp Global (2022). https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

[2] S. M. S. Murshed, Fundamentals and Transport Properties of Nanofluids, *The Royal Society of Chemistry*. London, UK, 2022.

[3] S. M. S. Murshed, K.C. Leong, and C. Yang, Thermophysical and electrokinetic properties of nanofluids- A critical review. *Appl. Therm. Eng.* 28, (2008) 17–18.

[4] W. Ajeeb and S. M. S. Murshed. Nanofluids in compact heat exchangers for thermal applications: A State-of-the-art review. *Therm. Sci. Eng. Prog.*, 30 (2022) 101276.

[5] S. M. S. Murshed and P. Estelle. A state of the art review on viscosity of nanofluids. *Renew. Sust. Energ. Rev.* 76 (2017) 1134-1152.