Stability of nanofluids CuO (40nm) in ethylene glycol or water base fluids with CTAB surfactant for biomedical applications

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Abstract

In this work, some properties of CuO nanofluids in distilled water and ethylene glycol base fluid were studied, comparing the stability of the nanofluid in samples with and without surfactant and measuring the electrical conductivity as a function of temperature and concentration.

Introduction

The dielectric properties of nanofluids based on water and ethylene glycol, of great relevance for several applications, have been studied by some researchers [1-5]. Some models used in estimating electrical properties describe equations that consider various factors such as volume concentration, nanoparticles shape, among others [1,5,6].
In this study, nanofluids were prepared by the two-step method, in 50 ml samples, with 40 nm CuO nanoparticles, supplied by MK-Nano, with 99% purity and 6.32 g/cm^3 density and distilled water and ethylene glycol base fluid, provided by Fisher Scientific, with 99% purity and 1.13 g/cm^3 density. Five volume concentrations from 0.1% to 0.5% were considered. The nanoparticles were weighed on a KERN ALJ analytical balance, model 220-4 NM, were gradually added to the base fluid placed in a flask and homogenized in an Eco Stir magnetic stirrer, model MS7-S. Subsequently, the sample was taken to a BANDELIN SONOPULS ultrasonic homogenizer, model HD2200, with a TT 13 titanium tip.
The electrical conductivity of the nanofluids was obtained from measurements performed with a HANNA Instruments conductivity meter, model HI 2550.

Studies have shown that the charge of the nanoparticles, the interaction between them and the dispersant directly affect the stability of the suspension [7,8]. To verify the improved stability of the nanofluid and the change in electrical conductivity behavior, samples of nanofluids were also prepared with distilled water and CTAB cationic surfactant, supplied by the company PanReac AppliChem.

Discussion and Results

The electrical conductivity was evaluated as a function of the concentration of nanoparticles, expressed as a percentage of sample volume and as a function of the temperature increase for the interval between 298,15 to 328,15 K, with increments of 5 K.
The results obtained for CuO and distilled water based nanofluids show that there is an almost linear increase in electrical conductivity with increasing temperature and that for the same temperature, electrical conductivity increases with increasing concentration. This evidence can be explained by several mechanisms proposed by different authors, nonetheless the most explain this phenomenon mainly by the formation of the electrical double layer [2, 6, 9, 10]. An analogous electrical conductivity study was carried out for the CuO and ethylene glycol based nanofluids, considering the same ranges of concentration and temperature. In this case, the results show that there is an increase in electrical conductivity with increasing temperature of the nanofluid with ethylene glycol base fluid, as happened with distilled water, however, this variation is not so linear. In the same way, it is verified that for the same temperature, the electrical conductivity increases with the increase of the concentration of nanoparticles.
When comparing the results obtained between the different nanofluids, it was verified that there is a more accentuated growth of the electrical conductivity of nanofluids with fluid based on demineralized water. Thus, it is possible to reach the conclusion that the electrical conductivity is strongly influenced by the base fluid, especially regarding to its polarity [1,6]. Regarding the stability of the nanofluids, it was found that the samples prepared with ethylene glycol base fluid were more stable over time, showing less deposition of nanoparticles. For this reason, only surfactant was used in nanofluids based on distilled water. The results obtained allow us to understand that the use of surfactant increases the stability and useful life of the samples but that it changes their properties, namely the electrical conductivity of the nanofluids, where there was a huge increase in the conductivity values.

Conclusions

The stability of nanoparticles is a crucial factor in the behavior of nanofluids, affecting the properties that make them so unique and much sought after for biomedical applications in order to harness the antibacterial power of CuO. [11]. In this study it was possible to prove that the electrical conductivity of nanofluids increases with the concentration of nanoparticles and with temperature and that nanofluids based on distilled water have higher electrical conductivity than nanofluids with ethylene glycol base fluid. It was found that the use of the CTAB surfactant leads to improvements in the stability of the nanofluid but that it significantly alters its electrical conductivity increasing significantly.

References

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