



## Copper (II) oxide nanoparticles as additives in RBD palm olein: Experimental analysis and mathematical modelling



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### ABSTRACT

In this research, Copper oxide (CuO) nanoparticles have been implemented as nano-additives in biodegradable and eco-friendly refined, bleached, and deodorized (RBD) palm olein base fluids. The formulated nanofluids, CuO/RBD palm olein nanofluids with different volume concentrations in the range of 0.01–0.5 vol%, were then evaluated to study their dispersion behavior and thermophysical properties. Sedimentation observation, DLS, and UV–vis are performed for stability evaluation. Meanwhile, thermophysical properties of formulated nanofluids such as density, rheological and thermal conductivity were experimentally measured. The theoretical model was utilized for a comparison study with the present data. Finally, a mathematical regression model is developed using RSM for prediction purposes. Evaluation of stability behaviour reveals that good stable nanofluids were achieved for one week, and the nanofluids started to precipitate after two weeks of preparation. FTIR spectrum TGA curve for all the nanofluids demonstrates that the CuO/RBD palm olein nanofluids are chemically and thermally stable. The density evaluation revealed that the density of 0.01 vol%, 0.03 vol%, 0.05 vol%, 0.1 vol%, 0.3 vol%, and 0.5 vol% CuO/RBD palm olein nanofluids enhanced about 0.04, 0.1, 0.36, 1.91, 1.92 and 1.93 % respectively at temperature of 60 °C. The rheology properties of all nanofluids were found to have Newtonian flow behavior fluids, and the viscosity increased with nanoparticle volume concentration, but their properties were diminished with temperature increment. The rheology studies found that the viscosity of CuO/RBD palm olein nanofluids with volume concentration of 0.01 %, 0.03 %, 0.05 %, 0.1 %, 0.3 % and 0.5 % enhances about 3.07, 8.69, 11.26, 16, 17.1 and 20.25 % respectively. 0.5 vol% CuO/RBD palm olein nanofluids achieved the highest enhancement in thermal conductivity properties with an enhancement ratio of 1.17. The experimental results were compared with the predicted outcome. All the plotted data found to have good agreement with the experimental data indicate the reliability of the developed mathematical model for response estimation.

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### 1. Introduction

Nanofluid is a stable suspension consisting of various nanomaterials dispersed in based fluid [1,2]. Nanofluid have been widely developed due to its ability to enhance the thermal conductivity of various fluid for more efficient engineering systems such as thermal devices and cooling systems [3,4]. Studies on nanofluid promote new ideas among the researchers to face challenges in heating [5,6] and cooling engineering devices [7,8]. A progressively discovered example is vegetable oil, which can provide good