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Improving the thermophysical properties of hybrid nanocellulose-copper (II) oxide (CNC-CuO) as a lubricant additives: A novel nanolubricant for tribology application

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ABSTRACT

The primary objective of the present analysis is to investigate the thermophysical properties of hybrid nanocellulose and copper (II) oxide nanoparticles added to engine oil as a lubricant for piston ring-cylinder liner application. Kinematic viscosity, viscosity index (VI) and dynamic viscosity have been performed for measurement of properties at varying temperatures (ranging from 30 °C to 90 °C) and different concentrations (ranging from 0.1 % to 0.9 % volume concentration). Thermal characteristics have been measured using similar temperatures and concentrations to determine thermal conductivity and specific heat capacity. In the results, as the concentration of the CNC-CuO nanoparticle increases, the VI also increases. This proves the combination of CNC-CuO particles with engine oil improves the lubricity of the base oil concerning its viscosity by 44.3 %-47.12 %. The lowest and highest improvements in the dynamic viscosity were 1.34 % and 74.81 %. The highest increment of thermal conductivity ratio for the selected nanolubricant was 1.80566 % in the solid concentration of 0.1 % at 90 °C. The specific heat capacity of nanolubricant tends to reduce slightly with an increase in temperature. Overall, the addition of CNC-CuO nanoparticle in the engine improved thermophysical properties behaviour's performance at 0.5 % concentration. The results can benefit the heat transfer application, especially tribological.

1. Introduction

The main benefits of nanolubricants are that they are resistant to temperature compared to conventional additives and restricted tribochemical reactions [1]. It is possible to use different kinds of nanoparticles, either organic or inorganic nanoparticles [2]. Organic nanoparticles mainly include polymers, exosomes, liposomes, protein-based nanoparticles, coal fly as, etc., while inorganic nanoparticles consist of silica nanoparticles, metal nanoparticles, carbon nanotubes, quantum dots and so forth [3–7]. Organic-inorganic, or hybrid, nanoparticles have caught the interest of researchers due to their potential applications because they can combine useful chemical, optical, and mechanical properties while retaining the various benefits of nanolubricants. The dispersion of these nanoparticles for tribological properties, such as Multi-Walled Carbon Nanotube (MWCNT) or the latest research organic nanoparticle using coal fly ash hybrid with different inorganic nanoparticles such as copper, alumina and silica, has piqued the interest of researchers and academics in recent years, as it leads to

Abbreviations: AlO_2, Aluminium oxide; TiO_2, Titanium oxide; CuO, Copper Oxide; MWCNT, Multi walled carbon nanotube; CNC, Cellulose Nanocrystal; EG, Ethylene glycol; SAE, Society of Automotive Engineer; SiO_2, Silica oxide; Cu, Copper; PAO, Polyalphaolefin; PTFE, Polytetrafluoroethylene; UV–vis, Ultraviolet; $ZnAl_2O_4$, Zinc aluminium oxide; ASTM, American Standard Testing Method; MoS_2, Molybdenum disulphate; MgO, Magnesium oxide; DSC, Differential scanning calorimeter; VI, Viscosity Index; C_p, Specific heat; CaO/Na_2O, Calcium oxide/sodium oxide.

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