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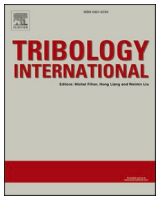

Enhancing stability and tribological applications using hybrid nanocellulose-copper (II) oxide (CNC-CuO) nanolubricant: An approach towards environmental sustainability

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ABSTRACT

The primary aim of the present study is to assess the stability and efficacy of hybrid nanocellulose (CNC) and copper (II) oxide (CuO) nanoparticles when integrated into engine oil as a lubricant for piston ring-cylinder liner applications. The assessment of system stability was conducted by employing zeta potential measurements. Furthermore, the coefficient of friction and specific wear rate were determined by using hydrodynamic lubrication in circumstances characterised by high speed and low load, as well as boundary lubrication in situations characterised by low speed and high load. The trials used a specially constructed friction and wear testing device miming the contact geometry between piston rings and cylinder liners in an internal combustion engine. Alongside SAE 40 oil, several nanoparticle concentrations (0.1%, 0.3%, 0.5%, 0.7%, and 0.9% added to SAE 40) were examined. The stability of the nanolubricant increased from 0.1% to 0.5% concentration and then declined at 0.9% concentration, according to the zeta potential data. The graph showed that the 0.5% concentration of the nanolubricant had the highest mean zeta potential, indicating exceptional stability. The CNC-CuO nanolubricants showed notable reductions in the friction coefficient regarding tribological performance. The friction coefficient reduced between 33% and 44% in mixed lubrication and 48% and 50% in boundary lubrication. There was a 9–13% decrease in the friction coefficient when hydrodynamic lubrication was used. The CNC-CuO nanolubricant only showed light scuffing, while the SAE 40 sample showed severe exfoliation and scuffing. Wear rates had been enhanced by 33.5%. Overall, the 0.5% concentration of CNC-CuO nanoparticles improved the engine oil's thermophysical properties and performance.

1. Introduction

The development of nanotechnology has made it possible to include nanoparticles into lubricating systems, which has resulted in significant improvements in lubricant effectiveness. The characteristics of the base oil can be modified either positively or negatively by including lubricating oil additives, contingent upon variables such as the morphology, dimensions, and concentration percentage of the nanoparticles.

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