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Improvement in stability and thermophysical properties of CNC-MXene nanolubricant for Tribology application

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ABSTRACT

The primary objective of the present work is to carry out an experimental study into the stability and thermophysical characteristics of cellulose nanocrystal, MXene, and hybrid cellulose nanocrystal-MXene added to engine oil as a lubricant for piston ring-cylinder liner application. There have been experiments with stability techniques like sedimentation observation, UV–visible spectroscopy, and zeta potential. Thermophysical characteristics have been measured using the viscosity index, dynamic viscosity, and thermal conductivity at various concentrations (ranging from 0.01 % to 0.05 %) and temperatures (from 40 °C to 100 °C). Even without any surfactants, the cellulose nanocrystal-MXene nanolubricants showed good dispersion during the first seven days. The results of the ultraviolet–visible spectrophotometer indicate that cellulose nanocrystal nanolubricants exhibit an absorbance ratio that is most similar to one. It can be shown that the zeta potential increases with a concentration in the distribution of cellulose nanocrystal, MXene, and cellulose nanocrystal-MXene nanoparticles. According to the viscosity index results, all nanolubricants reduce the lubricity oil's viscosity by 16.77 % to 20.33 %, with cellulose nanocrystal-MXene showing the greatest improvement at 0.05 %. At solid concentrations of 0.01 % cellulose nanocrystal and 0.05 % cellulose nanocrystal-MXene with temperatures of 40 °C and 90 °C, the dynamic viscosity was enhanced by 0.92 % and 130.87 %, respectively. The solid concentration of 0.05 % cellulose nanocrystal-MXene was determined to have the greatest effect on the thermal conductivity ratio of the chosen nanolubricant at 90 °C. Overall, at an average concentration of 0.05 %, the thermophysical properties' performance was increased by the addition of cellulose nanocrystal-MXene nanoparticle. The study's findings may be useful for applications involving heat transmission, particularly tribological ones.

1. Introduction

Current machinery and its whole system must be scaled above standard design parameters to increase total production at the lowest input cost. Tribology significantly improves machinery and internal combustion (IC) engine efficiency and aids in extending the life of moving parts [1]. Nearly 18 % of IC engines' ideal power is lost due to friction and hazardous exhaust emissions [2]. Reducing frictional losses can improve the IC engine's performance and fuel efficiency [3]. Therefore, efficient self-lubricating coatings [4] or lubrication [5,6] are compulsory for automotive engines, which presents a challenge to researchers and designers.

Numerous research teams have also evaluated the thermophysical and performance characteristics of nanolubricants used in engines [7-9].

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