Tribological Improvement Using Ionic Liquids as Additives in Synthetic and Bio-Based Lubricants for Steel-Steel Contacts

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Abstract

This study investigates the performance of three ionic liquids (ILs), trihexyl(tetradecyl)phosphonium bis(2,4,4-trimethylpentyl)phosphinate, trihexyl(tetradecyl)phosphonium decanoate, and 1-butyl-3-methylimidazolium tetrafluoroborate, as lubricant additives in synthetic oil polyalphaolefin (PAO8) and bio-based oil trimethylolpropane trioleate (TMPTO). The ILs were added at 0.5, 1.0, and 1.5 wt% concentrations and evaluated in terms of their miscibility with base oils as well as friction- and wear-reducing abilities. Four-ball and high-frequency reciprocating rig (HFRR) tribotesters were employed to evaluate the tribological performance under a boundary lubrication regime. Worn steel surfaces were characterized using optical microscopy, profilometry, scanning electron microscopy (SEM), and energy-dispersive X-ray (EDX) analysis. The results suggested that the addition of trihexyl(tetradecyl)phosphonium bis(2,4,4-trimethylpentyl)phosphinate and trihexyl(tetradecyl)phosphonium decanoate improved the tribological performance of both PAO8 and TMPTO at an optimum concentration of 1 wt%. They showed good friction reduction, lower overall surface wear, and improved surface finishing. 1-Butyl-3-methylimidazolium tetrafluoroborate managed to improve the tribological performance of both base oils only at 0.5 wt%. A further increase in 1-butyl-3-methylimidazolium tetrafluoroborate concentration caused detrimental effects on the steel surface due to the formation of halogenic compounds.

Keywords

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