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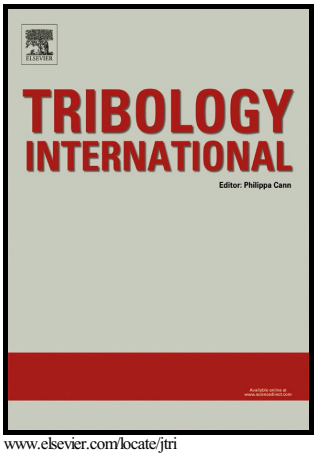

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Effectiveness of phosphonium cation-based ionic liquids as lubricant additive

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Abstract

Two phosphonium cation-based ionic liquids (ILs) were studied as additive to a mineral oil. Solubility tests and TGA of neat samples were performed. Three concentrations of the ILs were used in the tribological tests. Base oil–ZDDP mixtures were used as comparison samples. Tribological tests were made using a reciprocating ball-on-disc configuration. Load ramp and Stribeck curve tests were also performed. The worn surface was studied by different techniques. The results showed similar and better friction reduction properties for ILs– or ZDDP–containing mixtures than the neat base oil. The $[P_{66614}][(iC8)_2PO_2]$ –containing mixtures outperformed the antiwear behavior of the other samples. XPS results showed different mechanisms of lubrication when using ILs or ZDDP.

Keywords: phosphonium cation-based ionic liquids; additive; friction; wear

1. Introduction

Ionic liquids (ILs) were initially developed for use as electrolytes in batteries. Their potential value provoked in subsequent years a significant increase of research in diverse industrial applications such as catalysts, liquid crystals, extraction technology, synthesis and green solvents [1–3]. In addition, tribology interest in ionic liquids has also grown this century due to their unusual properties, which meet the requirements of high-performance lubricants [4]. These molten salts are usually called ‘‘green’’ lubricants because of their main properties: non-volatility, non-flammability, high thermo-oxidative stability, ashless character, high ionic conductivity and controlled miscibility with organic compounds, which enhance their potential performance in lubrication science [5–11]. Early works dealt with ILs with the imidazolium cation and fluorine-containing anions [12–16], but these anions tend to produce toxic and corrosion products in the presence of water [17]. The good lubricating properties of ILs are related to its polarity [18] and reactivity provoking the formation of adsorbed tribofilms on the metal surfaces and contributing to friction and wear reduction [19–21].

Due to the common inherent insolubility of ILs in non-polar hydrocarbon oils, a lot of research using ILs as a lubricant additive in very low concentrations or in oil–IL emulsions has been developed over the last decades [22–32]. In general, better compatibility was found when these substances were mixed with polar