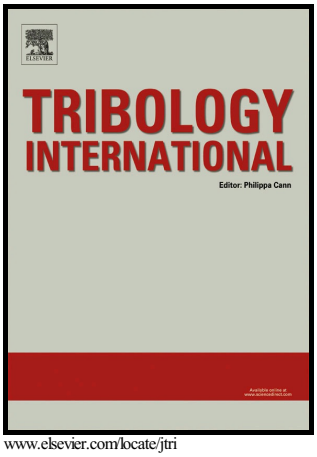

www.elsevier.com/locate/jtri

Synergistic Effects between Alkylphosphate-Ammonium Ionic Liquid and Alkylphenylborate as Lubricant Additives in Rapeseed Oil

Zhipeng Li, Tianhui Ren

PII: S0301-679X(16)30453-4
DOI: http://dx.doi.org/10.1016/j.triboint.2016.11.032
Reference: JTRI4472

To appear in: *Tribiology International*

Received date: 19 September 2016
Revised date: 13 November 2016
Accepted date: 16 November 2016

Cite this article as: Zhipeng Li and Tianhui Ren, Synergistic Effects betwee Alkylphosphate-Ammonium Ionic Liquid and Alkylphenylborate as Lubrican Additives in Rapeseed Oil, *Tribiology Internationa* http://dx.doi.org/10.1016/j.triboint.2016.11.032

Synergistic Effects between Alkylphosphate-Ammonium Ionic Liquid and Alkylphenylborate as Lubricant Additives in Rapeseed Oil

Zhipeng Li, Tianhui Ren*

School of Chemistry and Chemical Engineering, Key Laboratory for Thin Film and Microfabrication of the Ministry of Education, Shanghai Jiao Tong University, 200240, PR China.
*Corresponding Author. Tel.: +86 21 54747118. thren@sjtu.edu.cn

Abstract

The tribological properties of di(2-ethylhexyl)phosphate-di(2-ethylhexyl)ammonium ionic liquid (DOPD) and 2-(4-dodecylphenyl)-6-octadecyl-1,3,6,2-dioxazaborate (DBDB) as lubricant additives in rapeseed oil (RSO) were investigated. The results indicate that DBDB and DOPD have outstanding synergistic effects on extreme pressure, friction-reducing and antiwear properties and the synergistic effects are enhanced with the increase of applied load. SEM-EDS and XPS analysis results reveal that the outstanding synergistic effects between DBDB and DOPD originate from the good collaboration of the triboreaction products generated from DBDB and DOPD to form a stable and compact tribofilm with low shearing strength, which is composed of B_2O_3, BN, phosphates and/or polyphosphates, organic amine and organic and/or inorganic ammonium, as well as Fe_2O_3.

Keywords: Ionic liquid; Borate ester; Synergistic effect; Surface analysis.

1. Introduction

It is estimated that nearly one-third of the total fuel energy consumed was spent to overcome the friction and other mechanical and hydrodynamic losses in engines, transmissions, tires and brakes from a comprehensive study by Holmberg et al [1]. High performance, affordable and long term lubricants have been relentlessly explored for the efficiency and durability of equipment operation. Ionic liquids (ILs) have been reported as neat lubricants (or base oils) and lubricant additives with promising results over the past dozen years and are currently of great interest in both fundamental and applied research field [2-15]. Ionic liquids are salts composed of cations and anions, which are liquids below 100 ^{o}C and exhibit remarkable and tunable physicochemical characteristics such as negligible vapor pressure, high viscosity index, non-flammability, high affinities to metal ions and excellent thermal stability, promising their potential for the next generation of lubricants or additives to lubricant [16-20]. Due to the uniquely geometric and charge characteristics of the ionic liquids, the adsorption film of ionic liquids on the metal surface mediates efficient lubrication relative to conventional non-polar hydrocarbon liquids. On the one hand, the irregular shapes of cation and anion lead to low shearing stress, resulting in low friction compared to non-polar molecular liquids; on the other hand, the inherent polar nature of ionic liquids promotes the triboreaction with the surfaces of frictional pairs under tribo-stress and triboheat, revealing the generation of boundary thin film [21]. It is believed that such protective thin film of ionic liquids prevents the direct surface-to-surface contact between the metal surfaces, which is contributed to the antiwear property.

Moreover, boron-containing compounds are considered to be an attractive alternative to