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SYNERGISTIC EFFECTS OF IONIC LIQUIDS AND ZINC DIALKYLDITHIOPHOSPHATE (ZDDP) ON TRIBOLOGICAL PROPERTIES UNDER BOUNDARY LUBRICATION

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KEYWORDS

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ABSTRACT

Recently, there has been an increasing demand for lower-viscosity formulated oils to improve fuel efficiency of auto moutive engines because they can reduce friction and drag under fluid lubrication. However, lower-viscosity formulated oils have severl issues: sevier friction and wear under boundry lubrication. Therefore, lubricant additves such as friction modifiers and extreame pressure (EP) additives are important for achiving low fricton and wear under boudnary lubrication.

In such a background, zinc dialkyldithiophosphates (ZDDPs) are one of the most important additives for reducing wear under boundary lubrication. It is well known that ZDDPs form rough and pad-like tribofilms which can control wear by reducing direct contact of the two rubbing substrates [1]. However, in recent years, reducing ZDDP in formulated oils has been needed as it causes catalyst poisoning, generates sludge, and creates corrosion on copper-based alloy component [2]. Therefore, it is important issue to develop novel anti-wear additives for low- or zero-ZDDP formulations.

On the other hand, ionic liquids (ILs) have been explored as a new category of lubricants over the past dozen years. There are currently two approaches, using ILs as neat lubricants or base stocks and using ILs as lubricant additives. The latter approach has been reported by several research groups [2-3]. Qu reported that IL added lubricants exhibited much lower wear compared to pure base oils [3].

In this research, the effectiveness of ZDDP and IL mixed solutions were studied to achieve good tribological properties and low- or zero-ZDDP formulations.

Base oil used in this research was dioctyl sebacate (DOS). Lubricant additives were C3 & C6 secondary alkyl ZDDPs and 1-Butyl-3-methylimidazolium trispentafluoroethyl trifluoro-phosphate ([BMIM][FAP]).Lubricant solutions used in this research were pure DOS, DOS + ZDDP, DOS + [BMIM][FAP] and DOS + ZDDP + [BMIM][FAP]. Tribological properties were evaluated by using a cylinder-on-disk type tribotester. Worn surfaces were evaluated by using atomic force microscopy (AFM).

Fig. 1 shows the wear volume of steel disks after the friction test. In Fig.1, DOS + ZDDP + [BMIM][FAP] exhibited lower wear volume than the other solutions. Fig.2 shows the AFM topography images of steel disks lubricated with DOS + ZDDP and DOS + ZDDP + [BMIM][FAP] after the friction test. In Fig.2, for DOS + ZDDP + [BMIM][FAP], the tribofilm which is similar to ZDDP-derived tribofilms [as shown in Fig.2 (a)] was observed

All our results suggest that the synergistic effects of ZDDP and IL lead to low wear due to the formation of tribofilms on the worn surfaces.

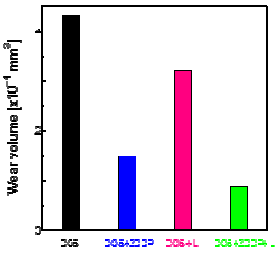
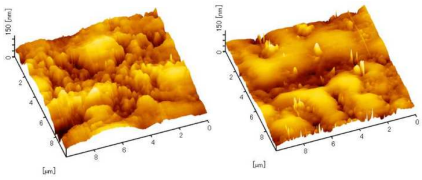


Fig. 1. Wear volume of each lubricant



(a) ZDDP (b) ZDDP+IL

Fig. 2. AFM topography images of sliding surfaces

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