TRIBOLOGICAL PERFORMANCE OF SEC-C6 CUDTP AND CHARACTERIZATION OF ITS TRIBOFILM

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ABSTRACT
Zinc dialkyl dithiophosphate (ZnDTP) has been widely used as additive in various lubricants because of its multifunctional characteristics. However, it is known to decompose by oxidation and heat, what eventually causing insoluble sludge in fluids, and problems such as filter blockage. In our previous study, it was shown that copper dialkyl dithiophosphate (CuDTP) outperformed ZnDTP in terms of antioxidative and antiwear performances. Furthermore, the detailed antioxidant mechanisms of CuDTP were previously investigated [1].

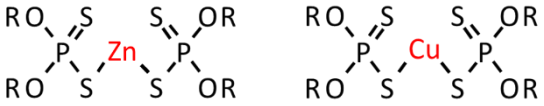

Fig.1 Structure of ZnDTP and CuDTP

The purpose of this study is to understand the difference of tribological behaviors between ZnDTP and CuDTP. For this purpose, the tribofilm compositions of these two additives were characterized using Scanning Transmission Electron Microscopy with Energy Dispersive X-ray Spectroscopy (STEM-EDX) and X-ray Absorption Near Edge Structure (XANES) spectroscopy.

Figure 2 presents the friction behavior obtained with CuDTP and ZnDTP during cylinder on disc tests. CuDTP shows lower friction coefficient than ZnDTP.

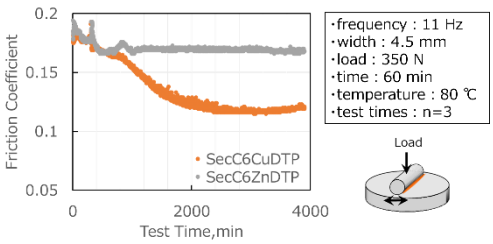

Fig.2 Friction curves obtained with CuDTP and ZnDTP

The tribofilms after the friction tests were observed and analyzed with STEM-EDX on cross-sections prepared by Focused Ion Beam (FIB). The chemical compositions of ZnDTP and CuDTP tribofilms are shown in Fig.3 and Fig.4, respectively. In the ZnDTP tribofilm, phosphorus, oxygen and iron atoms are detected. This result suggests the presence of phosphate glass and iron oxide as reported in literature [2]. On the other hand, in the CuDTP tribofilm, copper, sulfur, phosphorus and oxygen atoms are detected. However, no significant amount of iron atoms was observed within the CuDTP tribofilm.

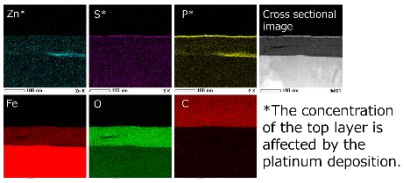

Fig. 3 Elemental analysis of ZnDTP tribofilm

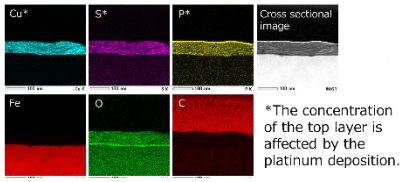

Fig. 4 Elemental analysis of CuDTP tribofilm

In addition, XANES study shows the presence of copper sulfides in the CuDTP tribofilm.

The present study reveals that CuDTP and ZnDTP form tribofilms with different chemical compositions, which probably influence their tribological properties.

REFERENCES
[1] K. Yagishita, et al "Antioxidant and Tribological Performance of CuDTP for Hydraulic Fluids," 7th World Tribology Congress, FRI-T5-S15-R6.
[2] J. M. Martin, et al "Friction-induced amorphization with ZDDP-an EXAFS study," ASLE Transactions, 29, 1986, 523-531.