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Antioxidant and Tribological Performance of CuDTP for Hydraulic Fluids

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Copper Dialkyl dithiophosphate (CuDTP) was applied to hydraulic fluids as a lubricant additive. The anti-oxidant and tribological properties of CuDTP were compared with Zinc Dialkyl dithiophosphate (ZnDTP). CuDTP showed better antioxidant performance than ZnDTP in a high-pressure hydraulic system. Tribological performance of CuDTP was equivalent to ZnDTP in four-ball tests and FZG tests.

Keywords (from 3 to 5 max): CuDTP, Hydraulic fluid, JCMAS P045, Four-ball test, FZG test

1. Introduction

ZnDTP has been widely used for lubricants such as engine oils and hydraulic fluids, because ZnDTP is a multi-functional additive. However, ZnDTP generates deposits and acids at high temperature and the performance as antioxidants is sometimes insufficient. In our previous study, the combination of ZnDTP and Copper (II) salt prevented the formation of deposits more effectively than ZnDTP alone, indicating the formation of CuDTP helped to improve antioxidant performance [1]. In order to understand the performance of CuDTP more clearly, this research investigated CuDTP using a hydraulic circuit, four-ball tests and FZG gear scuffing tests.

2. Methods

2.1. Materials

Figure 1 illustrates the chemical structure of CuDTP. CuDTP was synthesized according to the literature [2]. The mineral base oil with ISO VG46 was used in this study. ZnDTP was used for comparison. The phosphorus concentration of CuDTP and ZnDTP in the test oil is 400 mass ppm. A pour point depressant (PPD) and a metal deactivator (MD) were also added.

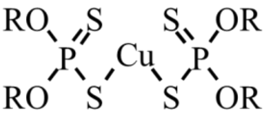

Figure 1 Chemical structure of CuDTP

2.2. Oxidation stability and tribological tests

The oxidation stability of test oils was evaluated using a hydraulic circuit with a high-pressure piston pump. This test was carried out at 80 °C and 34.3 MPa according to JCMAS (Japan Construction Mechanization Association Standard) P045, but no Cu catalyst was used. In order to evaluate tribological properties, four-ball tests and FZG tests were performed in accordance to ASTM D 4172 and DIN 51354-2, respectively.

2.3. Results

Figure 2 indicates the increase of acid number of test oils during the pump test. The test oil with CuDTP kept a lower acid number than that of ZnDTP, indicating that CuDTP prevented acid formation more effectively than ZnDTP. Antiwear (AW) performance in the four-ball tests is shown in Figure 3(a). CuDTP and ZnDTP showed similar sizes of wear scar diameters. Figure 3(b) presents Extreme Pressure (EP) properties in FZG tests, and the results showed the same failure load stage.

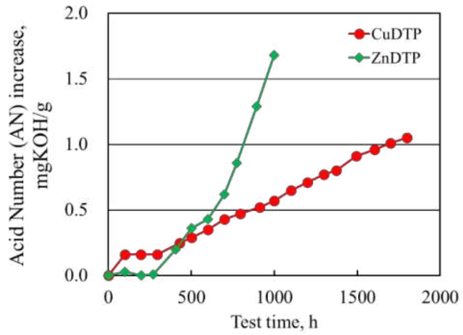

Figure 2: Acid number increase of test oils in piston pump test at 80 °C and 34.3 MPa.

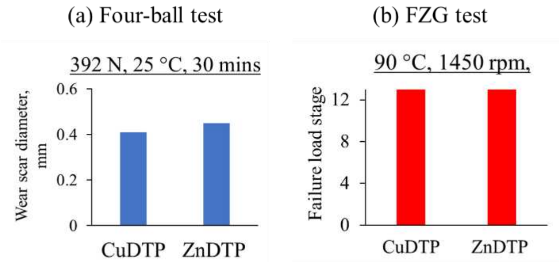

Figure 3: Tribological properties of CuDTP and ZnDTP in four-ball tests (a) and FZG tests (b).

3. Discussion

CuDTP kept a lower acid number than ZnDTP in the hydraulic system as shown in Figure 2. This result suggests that CuDTP functions more effectively as an antioxidant in improving the life of hydraulic fluids than ZnDTP. Regarding AW and EP properties, there is no significant difference between CuDTP and ZnDTP. CuDTP has multi-functions like ZnDTP, yet CuDTP shows better anitioxidant performance in hydraulic systems.

4. References

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