Tribological performance of raw and chemically modified RBD palm kernel

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ABSTRACT – This study compared the tribological performance of RBD palm kernel as alternative lubricant. Further, the analysis of chemically modified palm kernel oil with zinc-dialkyl-dithio-phosphate (ZDDP) additive was carried out to determine its lubricity performance by using modified pin-on-disc tester. Commercial mineral oil SAE 40 was used as reference lubricant. The experiment conditions include sliding speed, normal load, weight percentage of ZDDP, and lubricant's quantity. The findings reveal that the RBD palm kernel oil has better lubricity performance compared with mineral oil. The addition of ZDDP exhibited good friction reduction and anti-wear properties compared with raw RBD palm kernel oil.

1. INTRODUCTION

In industrial and machinery world, lubricant plays a vital role to reduce the friction between two moving surfaces or reduce metal to metal contact. Not only that, lubricant can help to prolong machine life and improve the efficiency of machine where it will protect the machinery parts against wear and reduce in energy loss [1]. Various type of lubricant was used in this world where mostly are petroleum-based lubricant [2]. But, recently there is an increase in environmental issue and depletion of fossil fuel has opened the world eye in seeking the alternative lubricant for industrial lubricants especially by using vegetable oil [3, 4]. Vegetable oils are potential substitutes for petroleum-based oil because of their numerous advantages including renewability, biodegradable, non-toxic and environmental friendly [5].

There are a quite few research studies on the tribological performance of vegetable oils. Various type of experiment was also done to improve the performance of vegetable oils due to their limitation on oxidation where many of researchers carried out the experiment by making chemical modification to vegetable oils. The goal of this study is to evaluate the refined, bleached and deodorized (RBD) palm kernel oil to be used as a potential substitute of petroleum-based oil and further investigate the tribological performance of chemically modified palm kernel oil with the addition of zinc-dialkyl-dithio-phosphate (ZDDP) additive.

2. METHODOLOGY

A pin-on-disc machine was used to evaluate the anti-wear and anti-friction properties of the refined, bleached and deodorized (RBD) palm kernel oil and commercial mineral lubricant (SAE 40) in accordance to American Standard Testing Material ASTM G99. The effect of the additive addition into the vegetable oils was also evaluated in term of their wear and friction performance where 5wt% of ZDDP was added to RBD palm kernel. In this experiment, pure aluminum A1100 hemispherical pin with diameter of 6mm and SKD11 modified disc was used. The disc was design with 10 mm width and 1 mm depth of groove at 70 mm wear track diameter (see Figure 1). The function of the groove was to make sure that the lubricant didn't flow out during the rotation of the disc. For each experiment, 2.5 ml of the lubricant will be used where all tests will be carried out at room temperature, 27 ± 2℃. RBD palm kernel will be heated first to change it into liquid form and cooled at room temperature before each experiment. All tests were carried out with a sliding speed of 1.5 m/s for 60 minutes under 1 kg applied load.

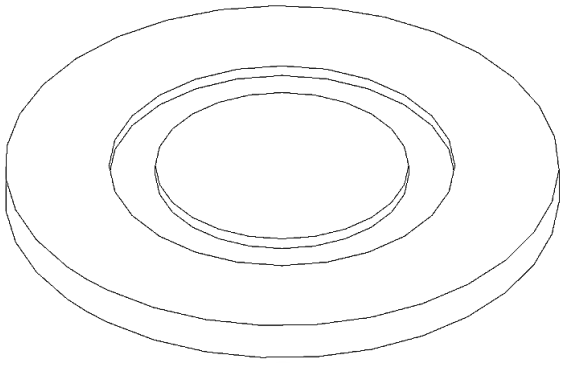

Figure 1 Modified grooved disc.

3. RESULTS AND DISCUSSION

The tribological performance of RBD palm kernel as alternative lubricant was investigated by using pin-on-disc tester. The coefficient of friction of the tested lubricants; commercial mineral oil (SAE40), palm kernel oil and palm kernel oil + 5% ZDDP is shown in Figure 2. It is clearly seen that SAE40 lubricant exhibited the highest coefficient of friction compared with palm kernel oil. The addition of 5% ZDDP into palm kernel oil has improved the anti-friction performance where more than 14% of friction coefficient was reduced compared with pure palm

kernel oil. Table 1 shows wear scar diameter of three tested lubricants under the same load and sliding velocity. The wear scar diameter becomes larger in the order palm kernel oil + 5%ZDDP, palm kernel oil and SAE40. The results indicate a direct relationship between the coefficient of friction and wear scar diameter. The wear scar diameter of palm kernel oil was almost similar with commercial oil SAE40. However, the wear scar diameter of the palm kernel oil + 5%ZDDP decreased about 33.45% compared with pure palm kernel oil.

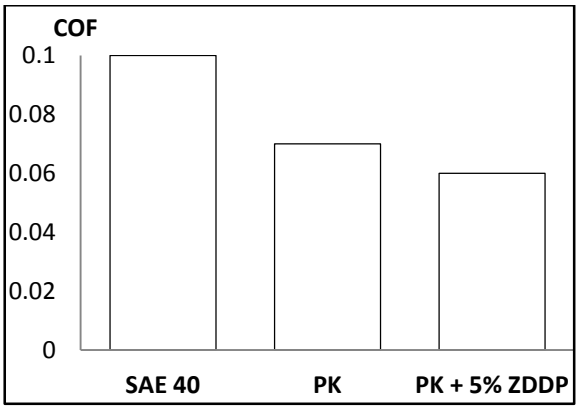

Figure 2 Coefficient of friction of commercial mineral oil (SAE40), palm kernel oil and palm kernel oil + 5% ZDDP.

Table 1 Wear scar diameter of pins in pin-on-disc test.

Tested lubricant	Wear scar diameter (mm)
SAE 40	2.82
Palm kernel oil	2.75
Palm kernel oil + 5%ZDDP	1.83

Palm kernel oil shows better lubricity performance compared with commercial mineral oil because vegetable oil contain long and polar fatty acid chains where the adsorption of polar compounds help in the formation of protective thin film hence prevents direct metal-to-metal contact [3,6]. This result indicates that fatty acid in vegetable oil help in reduction of friction coefficient and provides better anti-wear performance. Besides that, the addition of ZDDP in palm kernel oil also has improved the lubricity performance since ZDDP was able to create 'soap film' to form a protective layer against wear and prevent from direct metal-to-metal contact. 'Soap film' was the ability of a lubricant to provide a thin film by chemical absorption of fatty acid to the interface [7]. Presence of 5wt% concentration of ZDDP in palm kernel oil help in reduction of frictional torque on the contacting surface, hence minimize the friction coefficient [8]. The findings provide evidence that ZDDP additive was suitable to be used as an anti-wear and anti-friction additive in chemically modified RBD palm kernel oil.

4. CONCLUSIONS

The following is a summary of conclusions:

1) RBD palm kernel oil exhibit better lubricity performance compared with commercial mineral oil (SAE40).
2) The addition of 5% ZDDP into raw RBD palm kernel reveals a significant reduction in friction and wear.

5. REFERENCES

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