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Preliminary studies on physical property of canola oil + ZDDP as bio-lubricant

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ABSTRACT – Physical properties of canola oil added with Zinc Dialkyldithiophosphate (ZDDP) as bio-lubricant was investigated. Commercialized canola oil added with 0 wt%, 2 wt% and 5 wt% ZDDP were prepared and tested in a rotating disc electrode spectroscopy (RDE) and a heated viscometer. The blending method has been a success proven by the increment on zinc and phosphorous concentration observed by RDE. Canola oil with addition of 2 wt% ZDDP showed a promising kinematic viscosity value of 38.63 cSt which is lower compared to canola oil without any addition of ZDDP.

1. INTRODUCTION

According to Gawrilow, vegetable oils have been used as lubricants since way back in the 1650BC [1]. However, recent developments have put vegetable oil in the limelight as machinery lubrication as substitution to mineral based oil lubricants [2]. The increasing demand for this substitution is due to the fact of high concern for environmental protection [3]. The charecteristics of mineral oil which is non-biodegradable and non-renewable makes vegetable oil a good substitution [4].Vegetable oils are being explored as a source of environmentally acceptable lubricant as they have exposed their anti-wear and fatigue resistance properties as compared to mineral oils [3]. Furthermore, vegetable oil based lubricants possesses high viscosity index because of their high molecular weights and good lubricity for their ester bonds making vegetable oils more preferred for this characteristics [2].

However, the limitations of vegetable oils include poor oxidative and hydrolytic stability [5]. The high content of unsaturated fatty acids in vegetable oils causes the oil to be prone to oxidation. This will limit the ability of vegetable oil to act efficiently as machinery lubricants. The introduction of ZDDP in canola oil is to modify the properties of canola oil through stabilizing the oxidation process [6]. The rate of degradation of vegetable oil based lubricant can be slowed down by the addition of ZDDP into the base parent oil as the effective antiwear and antioxidant additive [7].

2. METHODOLOGY

Samples were prepared by addition of ZDDP into commercialized canola oil. Samples with 0 wt%, 2 wt% and 5 wt% ZDDP were prepared through direct introduction method. The prepared samples were then immersed in a 50ºC water bath for 20 minutes to ensure that ZDDP is properly dissolved into the parent base oil.

After sample preparation, the samples were then tested with a rotating disc electrode in accordance with ASTM D6595 and for kinematic viscosity at 40ºC using a Kittiwake Heated Viscometer.

3. RESULTS AND DISCUSSION

3.1 Concentration of Phosphorous and Zinc

Zinc dialkyldithiophosphates were originally prepared by the reaction of phosphorus pentasulfide (P_2S_5) and another different alcohol to give the dialkyldithiophosphoric acid, which was neutralized by the addition of zinc oxide to give the product [8]. Henceforth, to see the effectiveness of dilution, two elements were examined using an RDE spectroscopy which is Phosphorous and Zinc. From Table 1 it is evident that, with an increasing percentage of ZDDP in the oil, it will eventually give a positive increment of zinc and phosphorus concentration. This could suggest that ZDDP has been completely diluted into the parent canola oil.

Table 1 Concentration of phosphorous and zinc in canola oil with 0wt%, 2wt% and 5wt% ZDDP.

Properties	0 wt%	2 wt%	5 wt%
Zinc	<1ppm	1412ppm	2816ppm
Phosphorous	14ppm	1399ppm	3894ppm

3.2 Effect on Kinematic Viscosity

The prepared samples were tested using heated viscometer at 40ºC. Table 1 shows the kinematic viscosity of three different concentrations of oil tested using heated viscometer.

The value of kinematic viscosity at 40º of canola oil with 0 wt% ZDDP was observed at 40.33 cSt. The value of kinematic viscosity at 40º was then reduced to38.63 cSt after canola oil was added with 2 wt% of ZDDP. With the addition of 2 wt% ZDDP, the newly developed oil has been found to create a boundary film which forms on the metal surfaces contacting. This film acts as a friction mitigation agent showing that ZDDP additive in the right amount is beneficial [9]. However, the kinematic viscosity of canola oil with 5 wt% ZDDP showed an increment value to 43.73 cSt. At higher concentration the excess ZDDP adversely effect on the boundary film formation. With the increase of weight percentage of the oil, more film is formed on metal. This condition may contribute to the increase of the kinematic viscosity due to the excess of the metal present in the oil [10]. This resulted in significant increment of kinematic viscosity of oil with addition of 5 wt% ZDDP.

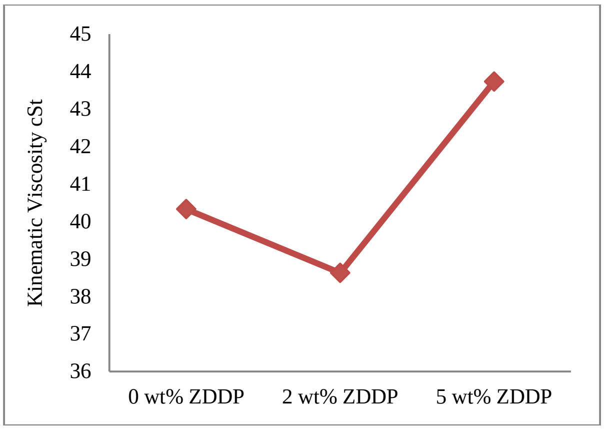

Figure 1 Kinematic viscosity of canola oil with 0 wt%, 2 wt% and 5 wt% ZDDP.

4. CONCLUSION

Vegetable oil based lubricants are prone to oxidation. Introduction of antioxidant additive, ZDDP to the base oil, canola oil were successfully produced using direct introduction method. Three different concentration of ZDDP were effectively added to canola oil and proven by RDE spectroscopy. Canola oil with 2 wt% ZDDP showed a promising lower kinematic viscosity at 40ºC of 38.63 cSt. The newly found results would encourage further studies on green bio-lubricants.

5. ACKNOWLEDGEMENT

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