Tribological behavioural of bio-oil extracted from peel waste of musa aluminata balbisiana

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Keywords: Oil; extraction; friction; wear

ABSTRACT – The aimed of this study is to investigate the effects of applied loads and temperatures on the tribological properties of MBS oil, which is a bio-oil extracted from banana peel waste of *Musa Aluminata Balbisiana.* Tribological evaluationof MBS oil was conducted using pin on disc tribometer as per G99 ASTM standard. The test was implemented by dropping 2 ml of MBS oil as a lubricating oil on sliding surface at varying loads from 20 to 100 N at 27 °C, 40 °C and 100 °C. The results show that, at steady state, at 80 N, the COF and scar diameter (WSD) were lower at all the tested temperatures. Microscopic analysis was revealed that, the above results due to the formation of tribo-chemical film which existed as protective layer on sliding surface thus prevent metal to metal contacted to each other's and hence contributed to the favor of frictional reduction.

1.0 INTRODUCTION

Energy efficiency is seen to have a national security benefit because it can be used to minimize the level of imports of energy from foreign countries and may slow down the rate at which domestic energy resources are depleted. In addition, the depletion of the world's crude oil reserve, increasing crude oil prices, and issues related to conservation have brought about renewed interest in the use of bio-based lubricants [1]. Furthermore, crude oil is not renewable, biodegradable, and environmentally friendly [2]. To solve these problems, biolubricants should be produce from vegetable oil, which is renewable, biodegradable, and cheap and has no adverse effects on the environment [3,4]. Nazri *et al*., [5] and Azmi *et al*. [6] investigated the lubrication in elliptical conjunction and study the friction and wear on natural oil-based lubricant respectively.

Banana skin has been often referred as slipping tools by the literature [7]. Hamid *et al*., 2015 [8] investigated the effects of banana peel of Cavendish species as a natural additive in paraffin oil. The tribological properties of the specimens were evaluated using four-ball tester. The study revealed that, coefficient of friction, μ and wear significantly reduced at high load, temperature and speed. At 100 ºC, the load of 500 and 1000 N, the COF value reduces from 0.1163 to 0.1012 and 0.1235 to 0.1174 respectively. At the same condition, wear scar diameter was found to decrease from 4.81 x 10^{-4} mm^3 to 2.33 x 10^{-4} mm^3 and 4.99 x 10^{-4} mm^3 to 2.75 x 10^{-4} mm^3 at 500 and 1000 rpm respectively.

However, research work on the study of tribological behavior of bio-oil extracted from banana peel wastes has not been reported in the literature. Hence, the objective of this paper is to study the tribological properties of bio oil extracted from the peel wastes of *Musa Aluminata Balbisiana* as an alternative biolubricant using pin on disc tribometer.

2.0 METHODOLOGY

In the present investigation, pin on disc had been used to study both wear and coefficient of friction. A pin was held firmly against a rotating disc connected to a certain dead weight with a beam and two pulleys. MBS oil was placed on the disc surface. During the experiments, new pins were used for each run and were cleaned with acetone to remove the impurities. The winducom 2008 software was used to record the data from the pin on disc machine.

The tribological testing was performed according to the ASTM G99-05 standard (ASTM, 2011) under wet sliding conditions at different temperatures and applied load.

The value of coefficient of Friction (COF) was calculated based on Equation 1 below:

$$COF = \frac{F}{W} \quad (1)$$

Specific wear rate was calculated on Equation 2:

$$WS = \frac{Vloss}{W * L} \quad (2)$$

Where, F is the frictional force, Ws is the specific wear rate (mm^3/Nm), W is the applied load (N) and L is the sliding distance (m).

Morphological characterization of the hemisphere pin surface was carried out using Scanning Electron Microscopy (SEM).

3.0 RESULTS AND DISCUSSION

Figure 1 shows an average data of COF at steady state of MBS oil at different load and operating temperatures.

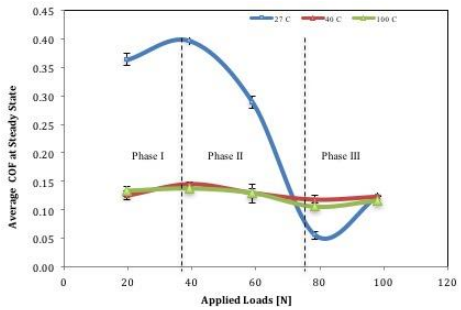

Figure 1 Average COF at steady state different applied loads [N] for operating temperatures of 27, 40 and 100 °C.

Wear is the progressive loss material due to interacting surfaces in relative motion. Friction and wear are related both are phenomenon of a solid contact between moving mating components. Figure 2 showed WSD (µm) at different loads and temperatures.

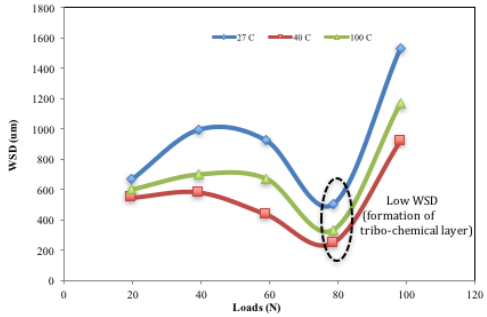

Figure 2 WSD (µm) at various loads and temperatures.

SEM images revealed that low COF and WSD was contributed by the formation of monolayer of protective fluid tribo-chemical film to prevent metal to metal contacted to each other's [9]. The tribo-chemical film is shown in Figure 3 and 4.

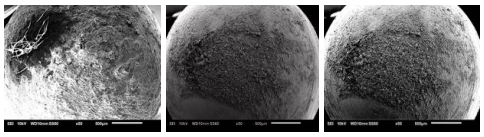

Figure 3 SEM micrograph of monolayer of tribo-chemical film at the hemisphere surface of the pins at a) 27°C, b) 40°C and c) 100°C respectively.

4.0 CONCLUSION

The investigation on tribological behavior of MBS oil was successfully performed using pin on disc tribometer. The results revealed that, at the load of 80 N, the COF value and wear scar diameter (WSD) loss are much lower due the formation of tribo-chemical film. The finding from this study contributed to the sustainable development of the bio lubricant fields. In addition, this study shows that, MBS oil, which extracted from the waste of banana peels, has a promising future to replace a mineral oil based lubricants.

ACKNOWLEDGEMENT

FRGS/1/2015/TK10/FKM/F00275.

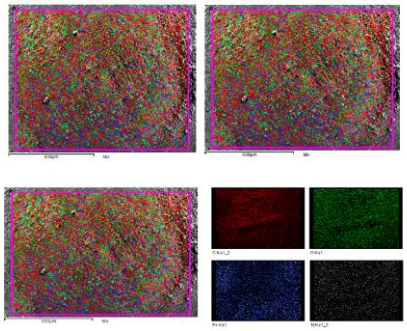

Figure 4 EDX mapping micrograph of monolayer of tribo-chemical film at the hemisphere surface of the pins at a) 27 °C, b) 40 °C and c) 100°C.

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