Effect of temperature on friction of bio-lubricant under high loading capacity

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ABSTRACT – The purpose of this study are to produce crude oil from Banana Peel (BP) as bio additives in paraffin oil, as well as to determine their physical and tribological properties as bio-lubricant under severe operation conditions to identify their ability for lubricants. Tribological performance of Banana Peel (BP) as a bio-lubricant was tested using four-ball test machined under extreme pressure conditions, according to ASTM D2783-03. Experimental results showed significant improvement in overall performance with increased BP content compared with paraffin oil (PO) through Coefficient Of Friction parameter (COF) at 100˚C, lower value of COF which 0.086 for 50%BP followed by 20%BP, 5%BP and 100%PO at values 0.089, 0.456 and 0.595 respectively.

1. INTRODUCTION

Tribology can be defined as the science and technology of interacting surface in relative motion which are present in various machined elements [1]. In almost every aspect of our daily lives, some appearances of tribology such as sliding, brushing, gripping, holding, machinery works, friction between skin and clothes, movement of artificial hip joints etc. [2]. Friction is the force that resisting the relative motion of solid surface, fluid layers and material elements sliding against each other. There are many types of friction like, lubricated friction, fluid friction and dry friction. An important consequence of many types of friction is wear which lead to decline in performance and/or damaged to components. Wear can be defined as undesired removal of material due to mechanical action [3]. The rough surface (deep valley of asperities) that formed helped to create an oil reservoir of the lubricant and prevented metal to metal contact [4].

Lubrication is the process or technique employed to reduced friction between two surfaces. Most of friction and wear are created during the start-up and shut down of engines, whereas Boundary Lubrication (BL) occur at low speed [5]. The major reasons of using lubricants in engines are to control friction properties, reduce wear, and improve the efficiency. The bio-based lubricant is promising to protect the surfaces from wear and damage in comparison with the mineral oil due to lower value of dynamic pressure [6].

In this study, Banana Peel (BP) had been investigated as an additive in lubrication system. This is a novel attempt to use banana peel in lubrication system. Hence, it is important and necessary to evaluate the characteristics of BP to show their effect of temperature on friction performance to test their validity in industry application. The dispersion of banana peel in paraffin is stable and smooth without any sedimentation problem. Moreover, oil shows good and promising tribological characteristic of lubricant [7].

2. METHODOLOGY

2.1 Material preparation

Cavendish banana skin or banana peel (BP) which is pericarp (outside skin) had been chosen as natural additives in paraffin oil. Paraffin oil as based-oil has been mixed with banana peels because of simple structure, unique tribological behavior and flexible for use under different percentage in preparation of lubrication samples.

2.2 Material and methods

There were four types of lubricant samples which are state in Table 1 below.

Table 1 Composition of lubricant samples.

Lubricant samples	Composition of Lubricant sample
Sample A	100% Pure Paraffin oil
Sample B	Paraffin oil +5% Banana Peel
Sample C	Paraffin oil +20% Banana Peel
Sample D	Paraffin oil +50% Banana Peel

Preparation of lubrication samples was determined by using Equation 1. Volume percentage was referred after solution was made by mixing two liquids. Total volume for each lubricant sample fixed to 100 ml that contained of banana peel and paraffin oil.

$$\text{C\% v/v} = \frac{V\ Substance}{V\ Solution} * 100\% \quad (1)$$

2.3 Friction Test

Three design parameter were performed which are percentage of lubricant, temperature and load. The four sample of lubricant are test under the temperature of 27, 80 and 100℃. The factor of coefficient of friction had been taken into account as results to evaluate significant performance for different concentration of lubricant samples. Friction test were carried out according to standard test methods for measurement of coefficient of friction (COF) and extreme pressure (EP) properties of lubricants until obtaining welding point on four-ball testing, according to ASTM D2783-03 [8]. The test has been conducted for 30 minutes at 27, 80 and 100 ˚C on four samples.

3. RESULTS AND DISCUSSION

3.1 Analysis of coefficient of friction

The results of variation value of COF with applied loads for various lubricants under different temperature shown in Figure 1 below. Test at lower temperature could not supply reliable information about oxidative stability and sometimes cannot evaluate the presence of protective film or anti-oxidation compound [9]. At high temperature, a film was formed on the metal surface during thermal decomposition, containing effective compounds, resulting in the friction reduction thus COF reduction. Hence, for bio-lubricant, mechanism of friction reduction could be achieved by increasing the content of banana peel in paraffin oil, especially at 100 ˚C, for lubricant 20% BP and 50% BP.

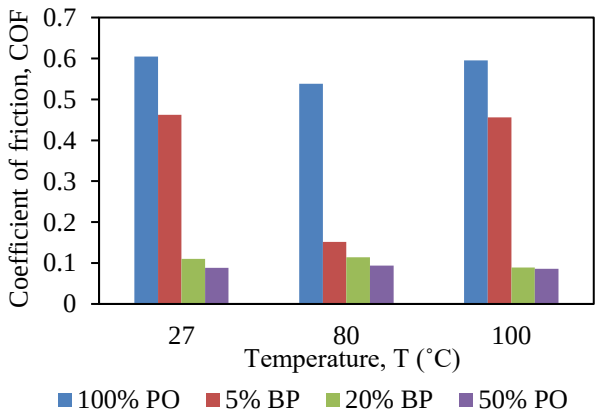

Figure 1: Effect of temperature (˚C) on value of Coefficient of friction, COF.

4. CONCLUSION

The Coefficient of friction was found to decrease with increase of banana peel content. The behavior of the lubricant under extreme pressure conditions became better with increase the of banana peel content. From the result, banana peel as natural additives have ability to improve physical and tribological properties of paraffin oil.

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