Preliminary study on tribological properties of banana peel broth as additive in paraffin oil

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ABSTRACT - Natural material as the additive in the engine oil promotes a sustainable material development through the utilization of renewable resources. This paper presents the preliminary study on the friction and wear of banana peel broth as the natural additive to the Paraffin oil conducted using four-ball tester at different load, temperature and speed. The mixture is prepared by dispersion method using the ultrasonic homogenizer. Inverted microscope is used to measure the wear scar diameter. It is found that the coefficient of friction and wear scar diameter reduced significantly at high load, temperature and speed.

1. INTRODUCTION

It is common to refer the banana skin as a slipping tool and yet sometimes would cause accidental slip. The banana skin has the ability to be used as a lubricant where it could help reduce the coefficient of friction (COF).

K. Mabuchi et al. [1] carried out studies on COF under banana skin on floor material. The COF was measured using six degrees of freedom force transducer under a flat panel of linoleum. A shoe sole pushed and rubbed by a foot motion on the panel with banana skin located in between to measure the frictional and vertical force simultaneously. COF resulted from the test is much lower compared to the value of common materials and similar to the well lubricated surface.

Lubrication has become an important part of improving the engine performance where it has simultaneously improved the fuel economy while reducing emissions. Research has been carried out with the aim to enable engine components to last longer by cutting down the COF, which saves energy, improves efficiency, and generally results in quieter operation.

Low oxidation stability is one of the major factors hampering industry acceptance of vegetable oil-based lubricants [2]. There is still a lack of tribological studies which incorporated natural material such as banana skin. Therefore, it is very important to investigate the potential of using the banana skin as lubricant in term of friction and wear to make sure it can be adapted by the industry.

2. METHODOLOGY

Tribological characteristics of paraffin oil with 20% banana peel broth were evaluated using a four-ball tester (TR 30L) at different speed, temperature and load as explained in Table 1.

Table 1 Parameters for tribological testing

Parameters	Value
Speed (rpm)	500, 1000
Load (N)	60, 250, 500
Temperature (°C)	27, 80, 100

The paraffin oil with 20 % of banana peel broth samples were prepared by dispersing the determined weight of blended banana peel broth in the paraffin oil using the ultrasonic homogenizer. The viscosity index of the mixture was then measured using a Brookfield Viscometer.

The lubricant used for the experiment is paraffin oil as based oil and paraffin oil with 20% of banana peel broth as to investigate the effectiveness of natural material as the lubricant in term of friction and wear.

In four-ball tester, three 12.7 mm diameter carbon-chrome steel ball were clamped together and covered with lubricant for evaluation. Fourth steel ball which referred to as top ball was held in collet and assembled at the spindle and rotate using an AC motor. Table 2 shows the mechanical properties of the ball bearing.

Data gathered by the TR 30 L four-ball tester was recorded using a data acquisition system is in form of frictional torque, T (N/m). This frictional torque was converted into form of kg/mm. The frictional torque in the unit of kg/mm was then used in determining the COF, μ using Equation (1).

Table 2 Mechanical properties of material

Properties	Ball bearing (Carbon-chromium steel)
Hardness (*H*),HRC	62
Density (ρ), g/cm^3	7.81
Surface roughness (R_a), μm	0.022

$$\mu = \frac{T\sqrt{6}}{3Wr} \quad (1)$$

Where, W is the applied load in kg and r is the distance from the center of the contact surfaces on the lower balls to the axis of rotation, which is 3.67mm. In order to obtain the wear volume losses L, the wear scar diameters, d was first measured using Axiovert 200-M inverted microscopes. The Equation (2) is used to determine the wear volume losses, V of the ball bearing with radius R.

$$V = \frac{\pi(d)^4}{64(R)} \quad (2)$$

3. RESULTS AND DISCUSSION

3.1 Viscosity index

From Table 3, it is clearly shown that the dispersion of banana peel broth increased the viscosity of the paraffin oil.

Table 3 Viscosity of the paraffin oil + 20 % of banana peel broth

Temperature (°C)	**40**	**100**
Kinematic Viscosity, cSt (mm²/s) of paraffin oil + 20 % banana peel broth	38.4	32.3
Kinematic Viscosity, cSt (mm²/s) of paraffin oil		17.5
Viscosity Index (VI) paraffin + 20 % banana peel broth	697.0	
Viscosity Index (VI) paraffin oil	102.0	

3.2 Effect of Load and Temperature to Coefficient of Friction

As refer to Figure 1, it is clearly shown that dispersion of banana peel broth in the paraffin oil is apparently reducing the COF at high temperature and speed. For all normal load tested, the COF reduced for 1000 rpm speed. It is evidence that the temperature gives a significant effect on the reduction of COF as refer to Figure 2. This suggests that banana peel broth is effectively protecting the frictional surface by reducing the contact surface and creating a separation boundary at high temperature, load and speed.

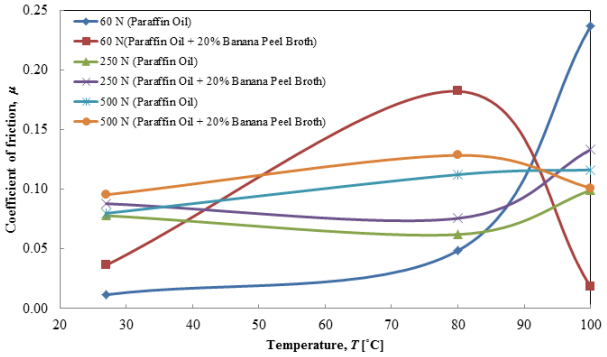

Figure 1 COF vs. temperature at 1000 rpm

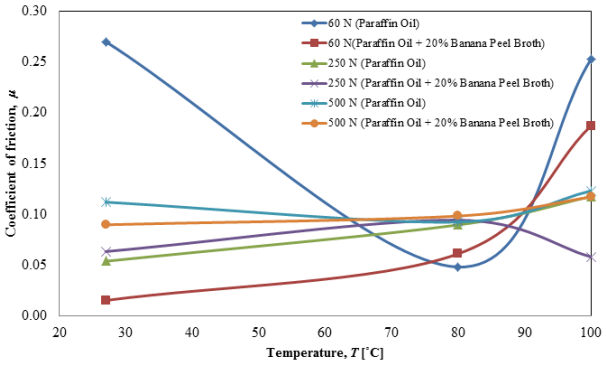

Figure 2 COF vs. temperature at 500 rpm.

3.3 Effect of load to wear volume

Wear volume losses for the test speed of 500 and 1000 rpm was reduced at each normal load tested as refer to Figure 3. This suggests that banana peel broth effectively played the role of ball bearings by changing the sliding friction to rolling friction between the friction pair which result in reducing the contact area between the frictional surfaces. Furthermore, a smoother worn surface obtained due to the polishing effect of lubrication containing banana peel broth [3]. This is in accordance with a significant reduction of wear volume losses.

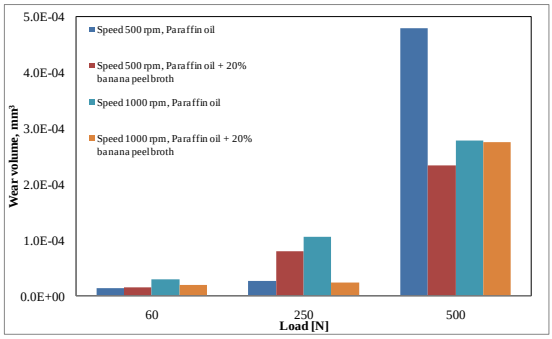

Figure 3 Wear volume plots against applied normal load for temperature of 100° C

4. CONCLUSIONS

Dispersion of banana peel broth in the paraffin oil has significantly reduced the COF and wear volume losses at high temperature of 100° C.

5. REFERENCES

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