Effect of virgin coconut oil, VCO as transmission lube oil based substitute on the friction properties

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ABSTRACT –The purpose of this study is to investigate the capability of virgin coconut oil, VCO as a substitute in transmission oil for friction improver. The friction test was conducted according to ASTM D4172 using four ball tester machine. The kinematic viscosity of each sample composition was measured by viscometer. Scanning Electron Microscopy (SEM) was used to measure the wear scar diameter. The result shows that the kinematic viscosity at 10 vol.% of VCO obtains the highest kinematic viscosity (33 cSt at 40^{o}C), while the lowest coefficient of friction, CoF (0.0739) and the smallest wear scar diameter, WSD (316.2 µm) obtain at 40 vol.% of VCO. As summary, the blends virgin coconut oil with automatic transmission oil shows better performance compared to the pure base oil and transmission oil.

1. INTRODUCTION

Lubricant is a substance which is used between two surfaces contact to reduce heat, wear and friction. Lubricant also acts as a cooler on the metal surface, sometimes it prevents the metal surface from corrosion and also cleans the surface from dust and particles contaminants. Nowadays, the world is facing the huge problem when using the crude oil as a lubricant in industrial and transportation application. The resources of crude oil began to decrease from day to day due to continuous used up to now. Furthermore, most of the lubricants which are available in the market currently are based on mineral oil derived from petroleum oil. Shahabuddin et al. [1] also mention, these lubricants are not adaptable to the environment due to its toxicity and non-biodegradability. According to Syahrullail et al. [2], mineral oil also contributed to the erosion of ozone layer and in a long-time period can affect to the soil and waterway.

A lot of research works [3-5] have been done in order to observe the usage of the lubricant and their availability. The usage of biodegradable oil has been introduced in the market which aims to replace the toxicity, and non-renewable. At the same time, the gear system has a long lifetime. This is an alternative to ensure that the use of crude oil can be reduced and meet future demand. As a solution, vegetable oil can be used as lubricant oil to replace the use of crude oil. The usages of vegetable oil as based oil obtained many advantages such as biodegradable, low viscosity-temperature characteristic, renewable, low volatility, environmentally friendly and poor stability on oxidation [3]. Vegetable oil is an alternative as lubricant or additives in lubricant to improve the quality of the lubricant. According to Rafiq et al. [4] vegetable oil has developed as an alternative to replace based oil and the use of vegetable oil has the advantage to the environmental.

The objective of this research is to investigate the effect of VCO as a substitute inside the transmission oil on the friction properties.

2. METHODOLOGY

Seven samples were prepared according to the Table 1 with the difference composition of VCO. The friction test was conducted according to ASTM D4172 test B which is a Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method). Figure 1 shows the schematic diagram of the four-ball testing mechanism.

Table 1 Samples composition.

Percentage (vol.%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Based-oil	100	-	90	80	70	60	50
VCO	-	100	10	20	30	40	50

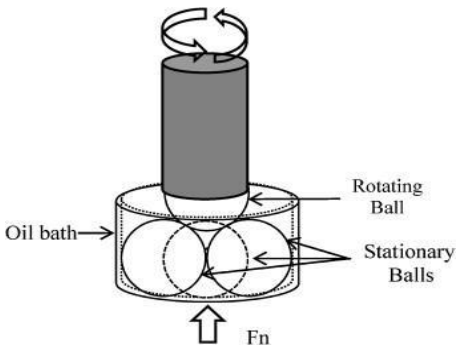

Figure 1 Schematic diagram of the four ball tribotester test condition.

3. RESULTS AND DISCUSSION

Figure 2 shows the CoF for all samples at a different composition. The lowest value of coefficient of friction indicate at 40 vol.% of VCO which is 0.0739 compare to other. This condition maybe due to optimum composition of VCO which resulting in fully lubricate asperities between the contacts surface. Even thought, the lubricant properties of vegetable oil have the low efficiency to reduce wear but in difference role it good in transferring energy between the surface contacts which help reduce the occurrence friction [6].

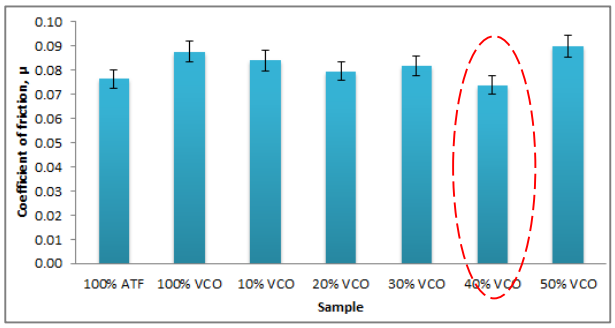

Figure 2 Coefficient of friction of all samples.

The result of the wear scar diameter for all samples are shown in Figure 3. The smallest wear scar diameter indicates by 40 vol.% of VCO composition. According to Jabal et al. [6] reported that the vegetable oil was suitable to use as the additive by mixing it with the base oil at the certain percent of the blends composition and it was believed that this oil might potentially forming the fluid film between the surfaces sliding. Several researchers [3,4] also mention that kinematic viscosity of blended vegetable oil play importance role in improving the friction properties of developed bio-lubricant.

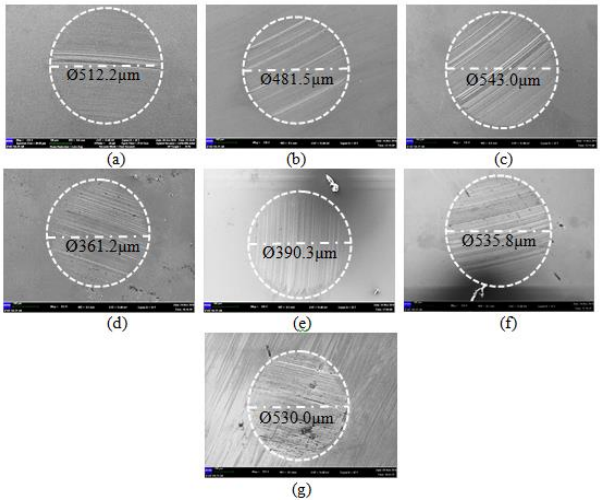

Figure 3 The wear scar diameter under SEM at sample of (a) 10% of VCO blends, (b) 20% of VCO blends, (c) 30% of VCO blends, (d) 40% of VCO blends, (e) 50% of VCO blends, (f) 100% of transmission oil and (g) 100% of VCO.

Figure 4 shows the average of the kinematic viscosity at the different blends of virgin coconut oil with the transmission oil at 40°C and 100°C. All the blended VCO with the transmission oil did not shown much differences. The kinematic viscosity at the temperature of 40°C and 100°C for 40 vol.% of VCO was 28.85 cSt, (40°C) and 6.39 cSt, (100°C). The liquidity of the mixing lubricant oil can cause a lower kinematic viscosity when at high temperature plus commonly transmission oil has higher viscosity based on its application to lubricate gear and protect the gear from dust or corrosion [5].

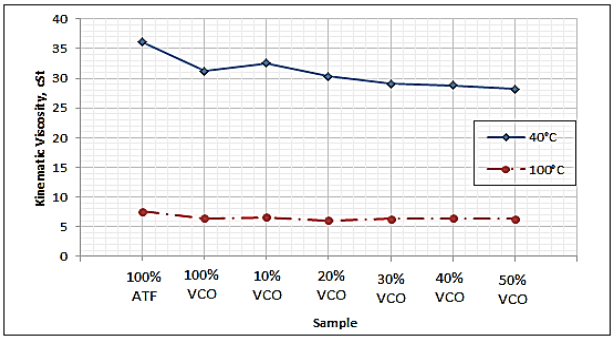

Figure 4 Average of kinematic viscosity of samples at 40°C and 100°C.

4. CONCLUSSION

In conclusion, the coefficient of friction for 40 vol.% of the mixing virgin coconut oil shows the most effective composition due to the low coefficient of friction. Furthermore, the smallest wear scar diameter was also obtained at 40 vol.% of the VCO composition.

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