Tribological Properties of TMP Ester Grease Thickened by Calcium Complex

Mohamad Ali Ahmad[1)*], Izatul Hamimi Abdul Razak[2)] and Siti Wahidah Puasa[3)]

[1)]Faculty of Mechanical Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.
[2)]Mechanical and Manufacturing Section, Universiti Kuala Lumpur, Malaysia France Institute, 43650 Bangi, Malaysia.
[3)]Faculty of Chemical Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.
*Corresponding author: mohama9383@uitm.edu.my

The palm trimethylolpropane (TMP) ester was thickened by 10-25 wt% compositions of calcium complex soap. The properties of the formulated greases in terms of the friction and wear properties were investigated according to the series of wear preventive and extreme pressure tests by a four-ball tester. The results show that the palm grease with 10-15 wt% of thickener producing soft grease with NLGI 0 and 1. While the 20-25 wt% compositions resulting in moderately soft grease with NLGI 2. The friction and wear properties of the greases were found comparable to the commercial greases even without an additive.

Keywords: palm oil ester, four ball, wear scar, chitosan

1. Introduction

Palm oil is one of the notable bio-lubricants. Comparing to other oil crops, crude palm oil (CPO) is a cheaper feedstock, with a high production rate and highest oil yields per hectare [1]. Besides, Oosterveer [2] stated that palm oil contributes to 36% of the global vegetable oil production in 2019, which is the highest in global use. It contains major fatty acid of palmitic acid (C16:0), oleic acid (C18:1), and stearic acid (C18:0) which generate strong interaction with the lubricated surfaces [3], and forming a strong, thick film between the metal contacts. This is due to the long, polar fatty acid chain triacylglycerol structure, that contributes to lower friction and better anti-wear properties [4].

2. Methods

The PALMESTER 2090 sample was provided by KLK OLEO (Petaling Jaya, Malaysia). The oil is C18-unsaturated, mixed esters with oleic acid and trimethylolpropane. It is chemically stable at environment temperature, non-toxic, and does not have any harmful effect, as well as easily biodegradability and not hazardous for water. Calcium hydroxide ($Ca(OH)_2$) and benzoic acid were provided by Ungerer Australia Pty.

The stearic and benzoic acids (in equivalent weight ratio) was firstly added into the pre-heated palm TMP ester. The mixture was mechanically stirred while heating to a temperature of 60°C in a glass beaker until the acids were completely dissolved. The $Ca(OH)_2$ (taken in a 1:0.75 ratio with the stearic acid) was then slowly added. The temperature was steadily raised to a maximum of 110°C and maintained for 60 minutes and stirred vigorously. After the stipulated time, the final mixture could gradually cool to room temperature to obtain the grease.

2.1. Grease Consistency

Grease consistency was checked using the SKF Grease Test Kit TKGT 1, according to a scale developed by the standard National Lubricating Grease Institute (NLGI).

2.2. Tribological Properties

Tests were conducted by a four-ball wear tester equipment according to the ASTM D2266.

2.3. Results

A homogenized soft, creamy white grease then was obtained after the cooling period (Figure 1).

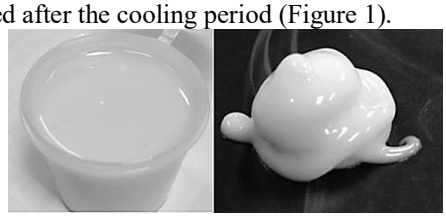

Figure 1: Formulated palm grease.

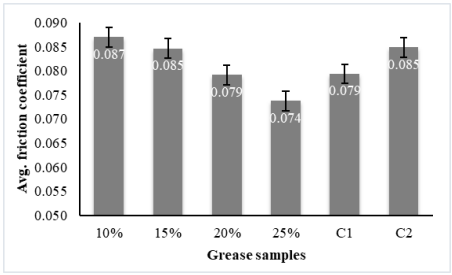

Figure 2: The average friction coefficient.

3. Discussion

The experimental results show that the palm-based greases without an additive have comparable friction and wear characteristics as that of commercial fully formulated greases. The study thus confirms the superiority of the palm TMP ester as the base fluid alternative for an industrial grease.

4. References

[1] Basiron, Y. (2007): Palm oil production through sustainable plantations. Eur. J. Lipid Sci. Technol., 109: 289–295.

[2] Oosterveer, P. (2020): Sustainability of palm oil and its acceptance in the eu. Journal of Oil Palm Research, 32(3): 365–376.

[3] Dandan, A., & Samion, S. (2017): Palm oil as an alternative lubricant oil: A brief review. The Colloquium, 11: 17–19.

[4] Fox, N. J., & Stachowiak, G. W. (2007): Vegetable oil-based lubricants-A review of oxidation. Tribology International, 40(7): 1035–1046.