講演番号	008

文献番号	20226008

Lubricity Performance and Mechanical Stability of New Bio-Grease Formulated From Non-Edible Vegetable Oil

Hilmi Amiruddin [1)] **Mohd Fadzli Bin Abdollah** [1)]

1) Fakulti Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia (E-mail: hilmi521980@gmail.com, hilmi@utem.edu.my)

KEY WORDS: **Grease, non-edible vegetable oils, coefficient of friction, mechanical stability**

Commercial grease is generally formulated using non-renewable petroleum derivatives and does not satisfy the requirements for sustainable development and environmental protection. However, the grease material that is derived from plant sources is seen to be a sustainable and effective substrate for developing a bio-lubricating material as it shows a high flash point, high viscosity, good biodegradability, low volatility and satisfactory lubricating properties. Several vegetable oils extracted from different sources like soybean, sunflower, rapeseed, coconut, palm, canola, etc., are commonly used as lubricants. However, few limitations were noted regarding the effectiveness of edible vegetable oil feedstocks owing to their use in the human food cycle and the environmental degradation that takes place due to the excessive utilisation of available agricultural land. Hence, this study has highlighted the need to explore non-edible vegetable oils that can be cultivated from neem, jatropha, castor, etc. These issues have increased the demand for high-quality, environment-friendly, reliable and sustainable grease materials. This strategy supported a few of the 8 principles that were listed under the National Policy on Environment for harmonising the economic developmental goals by using sustainable and natural resources.

Based on the above-mentioned issues, this study proposes to formulate a new grease material using bio-resources, showing good mechanical stability and lubricity. Mechanical stability is regarded as an important property of a lubricant material like grease that determines the change in grease consistency when it is used in moving parts that are subjected to significant mechanical stress. The non-edible vegetable oils (i.e., neem, castor and jatropha) were used as base oil, while beeswax was used as a potential thickener in the grease formulation. [(4)]. Beeswax is a natural substance that can be derived from honeycombs of bees, which is water-insoluble, sparingly soluble in alcohol, and completely soluble in ether. Furthermore, the hexagonal Boron Nitride (hBN) was used as the grease nano additive. hBN forms very stable chemical compounds that are safe to use, non-toxic, display good thermal stability, high wear resistance, low friction, and do not show any limitations regarding their operational use.

The results of the study indicated that base oil was the most significant factor that affected the Coefficient of Friction (COF) and the mechanical stability loss of the formulated bio-grease. Furthermore, it was noted that a 5 wt.% concentration of thickener in castor oil, showed the most optimal results. Castor oil consists of a small concentration of linoleic acid (2.6 - 3.7%), which made castor oil more stable than other non-edible oils like jatropha and neem oils.

The confirmatory tests were conducted for validating the conclusions. For this purpose, a new test run (Sample 10) was performed based on the optimal levels of the factors. In addition, the results of Sample 10 were compared with a test run containing the conventional grease material (Sample 11). Though the conventional grease material showed a high COF value of 0.09 in comparison to the bio-grease material (0.04), the values still lay within the acceptable range. However, any mechanical stability loss was not observed as a sudden increase in the COF values cannot be seen within 15,000 s. Fig. 1 present the COF and mechanical stability loss values for Test run 10 along with the 9-run experimental design. Sample run 10 showed the lowest COF value of 0.04 and the longest time for the mechanical stability loss (13,200 s). The performance of the experimental design proved the validity of the Taguchi-GRA technique for the multi-response optimisation of the COF values and mechanical stability loss.

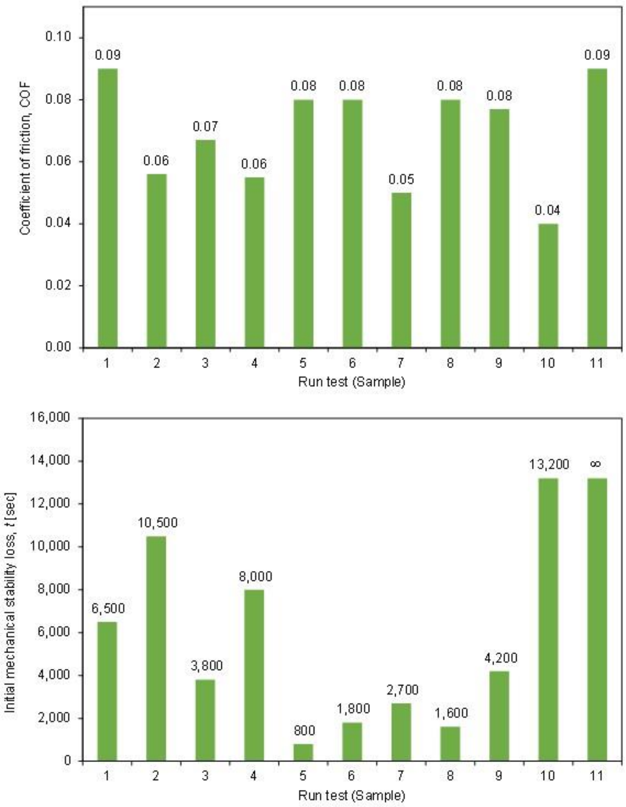

Fig.1 Actual values of COF and mechanical stability loss for the various samples, where Sample 10 was the optimally-formulated bio-grease and Sample 11 indicated the conventional grease material.