UNIVERSITI TEKNOLOGI MARA

TRIBOLOGICAL CHARACTERISTICS OF DIFFERENT LUBRICANTS WITH TITANIUM OXIDE NANOPARTICLES ADDITIVES

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ABSTRACT

This thesis is related to the study of tribological characteristics of different types of lubricating oils: synthetic oil (SAE 10W-40) and palm oil with titanium oxide (TiO_2). In many engineering systems, friction related problems become a critical issue and hence require a form of lubrication solution to reduce the frictional effect. Additives are added to lubricants to enhance the performance as required by the intended purposes. In this research work, the potential of titanium oxide (TiO_2) as additivies has been explored. Generally, the research covers two main objectives: (i) to optimize the selection of parameters affecting the tribological characteristics of synthetic and palm oil with and without TiO_2 nanoparticles using Response Surface Methodology (RSM) and (ii) to analyse the tribological characteristics of synthetic and palm oil with and without TiO_2 nanoparticles specifically on friction and wear characteristics. The study deployed the Response Surface Methodology (RSM) with Box-Behnken experimental design technique (BBD) in performing statistical predictions and appraising the influence of the three levels of independent variables (i.e. speed, load and concentration of TiO_2) on the tribological characteristic. The samples were prepared and tested using Pin-on-Disc tribotester to investigate the friction and wear characteristics. On the other hand, RSM offers an extensive variety of information on the response variables interrelationships, with a relatively 15 number of test runs instead of 100 experiments to be tested. In this experiment, synthetic oil and palm oil with different amount of TiO_2 nanoparticles concentration were tested using Pin-on-Disc tribotester to investigate the lubricant characteristics. From the experimental data, the viscosity of synthetic oil and palm oil was measured. It reveals that the viscosity index (VI) of palm oil is higher than the VI of synthetic oil by 5.87%. For friction analysis, the comparative result of RSM shows that the optimum zone for synthetic oil was at 1000 to 2000 rpm and 0.5 to 1.0 wt% of TiO_2 concentration. The interaction between speed and concentration had a large effect on the Coefficient of Friction (CoF) of synthetic oil. While for palm oil, two ranges showed the reduction of CoF which included (a) at speed 1300 to 2000 rpm with normal load at the range of 10 to 16kg and (b) at speed 700 to 1500 rpm with normal load of 19 to 20 kg. The interaction of speed and load followed by speed and interaction showed the most significant effects to CoF. In terms of wear characteristics, the experimental results clearly demonstrated that palm oil was higher than synthetic oil in terms of volume loss and wear rate by 49.06% respectively. The surface roughness analysis indicated that palm oil was faintly high at 200 rpm, 15kg and 1.0 wt% with 3.429 μm while synthetic oil at 1100 rpm, 10kg and 1.0 wt% with 3.180 μm. The current study also investigated on the reflection measurement from the ultrasound signal. The results shows that synthetic oil gives out better reflection pulse by 3.55% respectively. The outcome of this study is useful to the tribology community in general and the lubricant's developer in particular.

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To my parents,

Mohamad bin Hashim
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