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Experimental study on physical properties of modified jatropha oil-based nanofluids for machining purposes

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ABSTRACT

Vegetable-based crude jatropha oil (CJO) was utilized to substitute petroleum-based oil as a metalworking fluid. The usage of petroleum-oil based as a metalworking fluid causes a major concern to the environment and health issues. Besides that, it has a high quantity of free fatty acid (FFA), which causes physical deterioration. This study aims to physically test the new formulation oil-based on modified jatropha nanofluids as the metalworking fluid for machining purposes. To create modified jatropha oil (MJO), CJO was chemically modified through the esterification and transesterification process. MJO was combined with nanoparticles which are activated carbon (AC) at the concentration of 0.01 wt%, 0.025 wt% and 0.05 wt% to create the nanofluids. The properties of MJO nanofluids were tested using ASTM standards for viscosity and acid value and were compared with the synthetic ester (SE). All of the results indicate that the physical qualities improved during the storage period. MJOa3 (MJO + 0.05 wt% AC), it may be inferred, has potential as a long-term metalworking fluid for the machining process. Based on the experiment result, for kinematic viscosity, MJOa3 shows better results during the period from day 1 to day 7 compared to non-additive MJO. MJOa3 recorded the highest viscosity index (184). In addition, MJOs have the lowest acid value of 0.4 to 0.48 mg NaOH/g. In conclusion, the presence of AC helps MJO to improve their properties and MJOa3 shows excellent lubricant properties from all the samples.

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1. Introduction

There are two major issues in the machining operation, which are high temperature and friction. Due to this matter, lubrication plays a crucial role in increasing the efficiency of a machining operation by reducing the machining temperature and friction. The overwhelming majority of lubricants utilized in industrial applications are formulated with mineral base oils and synthetic base oils. While the importance of lubrication in the machining process is generally accepted, the use of mineral and synthetic oil during the machining process has become a big obligation. Improper treatment of metalworking fluid can destroy soil and water sources, which causes tremendous environmental losses.

Bio-based processing of lubricants using vegetable oil has the various benefits of a safe low-cost, biodegradable, and non-renewable source of adverse environmental effects. However, the problem with using vegetable oils is they lack thermal and oxidative stability due to the existing double bonds in their molecular structure [1]. The growth in the need for sustainable and biodegradable lubricants is highly anticipated due to environmental issues and increasing legislation on contamination and emissions [2]. Numerous investigations are ongoing to produce new bio-based metalworking fluids from different vegetable oils found around the world [3].

In the machining process, metalworking fluids are used to eliminate the impact of heat and friction, ensure lubrication between the chip tool, interfaces and flush chips away from machining and increase the surface finish of the working material [4]. In addi-

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