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Tribological investigations on the application of oil-miscible ionic liquids additives in modified Jatropha-based metalworking fluid

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Abstract

This paper studies the applications of modified Jatropha oil-based (MJO) lubricant as potential vegetable-based metalworking fluids, containing additives of two oil-miscible ionic liquids; [P66614][Phosphinate] (PIL) and [N1888][NTf2] (AIL) at 1%, 5%, and 10% weight concentration. The lubricant samples are validated for corrosion, four ball tribology and tapping torque experiments. Using optical microscope, profilometer, AFM, SEM, EDS and XPS analysis, worn surfaces were investigated. The lubrication performance of MJO+AIL10% and MJO+PIL1% samples provide competitive lubrication performance to that other lubricant samples used herein. They have shown improved corrosion inhibition, superior friction reduction, lower worn surface area, excellent surface finish and increased tapping torque efficiency. These superior tribological results correspond to the metal oxide tribofilm formation and anti-corrosion behavior of MJO+AIL10% sample.

Keywords: Ionic liquids; Jatropha oil; metalworking fluid; sustainable manufacturing

1. Introduction

Petroleum-based lubricants in 2016 have increased tremendously on high global consumption, showing at least 1% annual increments with 13,726 million tons of oil equivalent [1]. This has therefore, prevail another viewpoint of bad impact on the environmental pollution, the danger of large loss proportion (13-50 %) of the lubricants in the aquatic and terrestrial ecosystems, including continuous depletion of global energy and natural resources [2–4]. In the conduct of manufacturing industries, in working towards achieving the optimal situation of maximum benefit for minimum risk, many researchers have investigated the use of metalworking fluids (MWFs) from biodegradable lubricants and alternative lubrication methods [5,6] in order to reduce the dependency on traditional petroleum-based lubricants [4,5].

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