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The influence of modified vegetable oils on tool failure mode and wear mechanisms when turning AISI 1045

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Abstract

A newly developed bio-based metalworking fluid (MWF) from Jatropha oil is evaluated in this study as part of the research purposes for 'greener' machining activity. This work focuses on the machinability effects of using ionic liquids (ILs) added Jatropha-based MWFs of different weight concentrations (1, 5 and 10 %). The machining performance on AISI 1045 steel was analyzed based on the lubrication effects of the novel modified Jatropha-based lubricants (MJO). Experimental results for the ILs added MJOs, depending on the ILs treat rate, were superior to the synthetic ester-based MWF. In addition, MJO+AIL10% outperformed all the other lubricant samples on cutting force and temperature, surface roughness, wear mechanisms and tool life of the uncoated cermet inserts during the machining process.

Keywords: Ionic liquids; Jatropha oil; tool life and tool wear; wear mechanisms

1. Introduction

Material processing of finished goods with high product quality can be achieved by an excellent machining performance of the workpiece materials. Cutting tool wear can significantly affect the quality of the product's surface finish as well as the productivity of the manufacturing processes. In addition, sliding friction during metal cutting also contributes to the finish quality of the workpiece surface. Other influencing factors include the dynamic variety of sliding surface conditions such as cutting conditions, contact loads, cutting temperature, surface properties, tool material and geometry, workpiece material, lubrication and the process kinematic [1,2]. Friction force directly affects the structure deformation of the workpiece being cut especially in the primary shear zone. It also contributes to the direction of chip flow, the cutting energy being consumed, the heat generated at the cutting edge, chip size and form, tool life, and tool wear rate besides the workpiece surface finish. Controlling the cutting temperature on the tool-workpiece interfaces can reduce the heat generated being transferred into the chip and cutting tool surfaces. The use of metalworking fluids (MWFs) during machining facilitates cooling and lubrication effects at the tool-workpiece interfaces,

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