UNIVERSITI MALAYSIA SABAH

FINAL REPORT

FRG0210-TK-1/2010

WEAR MAP FOR CONVENTIONAL AND NANO COATED SOLID CARBIDE END-MILL

PROJECT LEADER:

ASSOC. PROF. DR. WILLEY LIEW YUN HSIEN

RESEARCHER:

AZLAN MOHD. BIN ISMAIL

Abstract

This work examines the effectiveness of palm oil methyl ester (POME) as lubricant additive and the effect of different combinations of feed rate and depth of cut on the wear of TiAlN coated tools in milling process. Wear map developed for low-speed milling indicates that cracking and fracture can be delayed by using the palm oil methly ester as additive in mineral oil, andcombintion of high speed and low feed rate. In milling stavax® with a hardness of 55 HRC under flood condition, three distinct stages of tool wear occurred, (i) initial wear by delamination, attrition and abrasion, followed by (ii) cracking at the substrate and (iii) the formation of individual surface fracture at the cracks which would then enlarge and coalesce to form a large fracture surface. Increasing the feed rate and reducing the speed caused cracking and fracture to take place at a shorter cutting distance. Compare to the flood lubrication, small quantity of mineral oil sprayed in mist form was more effective in reducing the coating delamination and delaying the occurrence of cracking and fracture. The effectiveness of mineral oil in suppressing coating delamination and delaying the occurrence of cracking and fracture could be enhanced by the presence of POME. The mechanism by which the POME suppressed these wear mechanisms could be explained by the results obtained in the four-ball tests which showed that the presence of POME as additive in the mineral oil reduced the friction coefficient, severity of welding of the asperities and wear scar, and increased the critical load for welding to occur.

Keywords: steel; lubricant additives; cutting tools; electron microscopy

1.0 Introduction

Additives are used to perform a wide variety of tasks such as reducing wear and friction. The performance of a lubricant depends collectively on the base oil, additives and formulation. Phosphorus, sulphur, zinc dialkyl dithiophosphates (ZDDP) are examples of some of the widely used additives. Without additives, even the best base fluids are deficient in some features. The environmental and toxicity issues of these additives as well as their rising cost related to a global shortage and remediation efforts due to its poor biodegradability led to renewed interest in the development of environmental friendly oils as lubricants and industrial fluids. Vegetable oil is a viable and good alternative resource because of its environmental friendly, non-toxic and readily biodegradable nature.