EFFECT OF AIR AND CHILLED EMULSION MINIMUM QUANTITY LUBRICATION (ACEMQL) IN MACHINING HARD TO CUT METALS

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DECLARATION OF THE CANDIDATE AND SUPERVISOR

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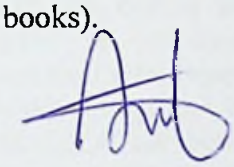
Signature:  Date: 29/09/2015

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Dr AKG Punchihewa

ABSTRACT

Effect of Air and Chilled Emulsion Minimum Quantity Lubrication in Machining Hard to Cut Metals

A novel approach of cutting fluid application was developed and its performance in machining hard to cut metalswas investigated. The study focused on turning AISI P20 and D2 tool steels using coated carbide cutting tools. For this study, an improved minimum quantity lubrication (MQL) method named, air and chilled emulsion minimum quantity lubrication (ACEMQL) method was developed to evaluate its effect on tool life and surface finish of material being machined. Trials were carried outfor ACEMQL with cutting fluid temperatures from 5°C to 20 °C in steps of 5 °C.In order to obtain a benchmark for comparison of results, set of trials were carried out for dry cutting and flood cooling at 25 °C while all other parameters kept same as in ACEMQL method. Trials for ACEMQL method resulted in better tool life and surface finish for both AISI P20 and AISI D2 tool steels when compared with dry cutting and regular flood cooling methods. Minimum tool wear in machining AISI P20, was observed at 15 °C with ACEMQL, and it has shown a trend of increasing tool wear when temperature was lowered to 10 °C and 5 °C. A tool wear reduction of 97% from dry cutting, and 93% of flood cooling, is observed with ACEMQL at 15 °C. At 10 °C also ACEMQL has shown a reduction in tool wear by 94% compared with dry cutting and 86% compared with flood cooling. However, at 20 °C, it is observed that there is an increase in tool wear compared to flood cooling by 29%. Similarly, in machining AISI D2, minimum tool wear was observed at 15 °C with ACEMQL, and it has shown a trend of increasing tool wear when temperature was further lowered to 10 °C and 5 °C. A tool wear reduction of 96% from dry cutting, and 93% of flood cooling, is observed with ACEMQL at 15 °C. At 10 °C also ACEMQL has shown a reduction in tool wear by 71% compared with dry cutting and 57% compared with flood cooling. Although use of ACEMQL shows an improvement in surface finish in machining both AISI P20 and D2, it has not shown significant difference with reduction of temperature in the investigated steps of temperatures. For AISI P20, the least surface roughness obtained is 0.97 µm Ra and it is at 5 °C. It is a 35% reduction with respect to dry cutting condition and 31% reduction in comparison with flood cooling condition. For AISI D2, the minimum surface roughness obtained is 0.82 µm Ra and it is at 5 °C. It is a 49% reduction with respect to dry cutting condition and 40% reduction in comparison with flood cooling condition.Research on the effect of cutting velocity, feed rate and depth of cut, on tool life and surface finish with ACEMQL is suggested as future work. Further, economic feasibility analysis is suggested to find out the suitability of ACEMQL in local die and mould manufacturing industry, and also research on relationship between chip colour and cutting condition, and reasons for the colourisation is suggested as future work.

ACEMQL, MQL, Surface roughness, P20, D2, Tool life, Coated carbide tools

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LIST OF ABBREVIATIONS

Abbreviation	Description
ACEMQL	Air and Chilled Emulsion Minimum Quantity Lubrication
AISI	American Iron and Steel Institute
BUE	Built Up Edge
CAMQL	Chilled Air with Minimum Quantity Lubrication
CBN	Cubic Boron Nitride
CF	Cutting Fluid
CMM	Coordinate Measuring Machine
CNC	Computer Numerical Control
CVD	Chemical Vapour Deposition
HRA	Rockwell Hardness Grade A
HRC	Rockwell Hardness Grade C
MWF	Metal Working Fluid
MQL	Minimum Quantity Lubrication
MQL_EP	MQL in Extreme Pressure
NDM	Near Dry Machining
SFPM	Surface Feet per Minute
SME	Small and Medium scale Entrepreneurs
WP	Work-piece

LIST OF APPENDICES