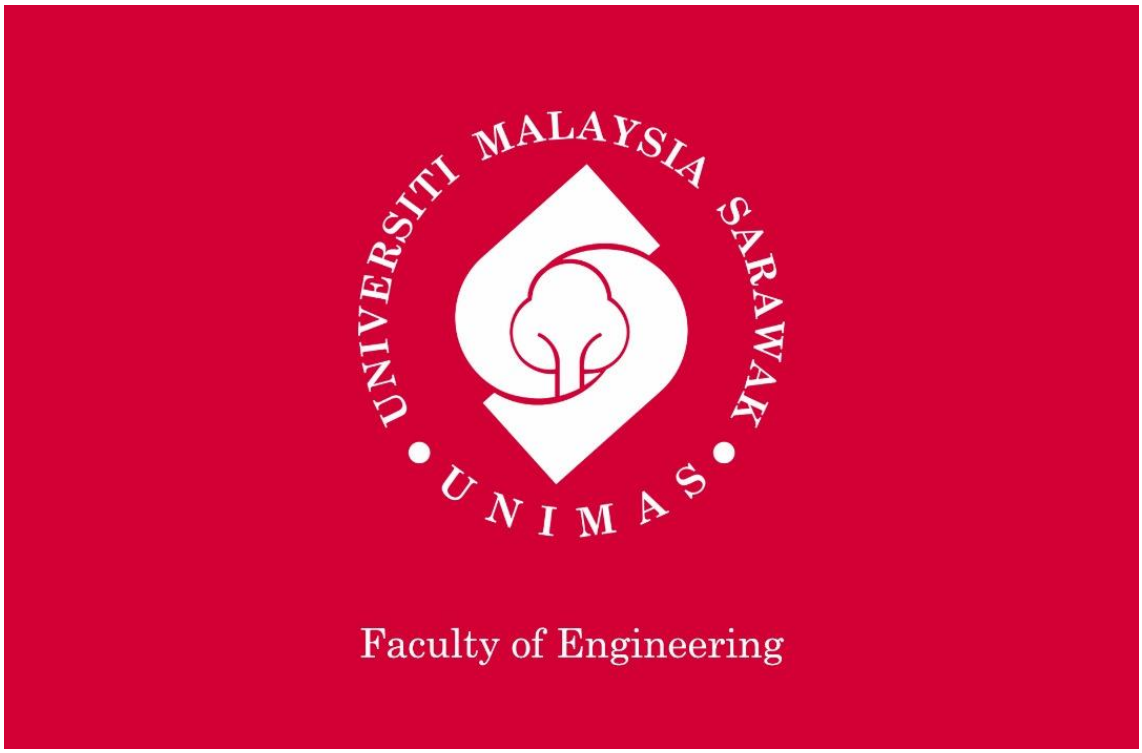

OBSERVING TOOL WEAR DURING MILLING MILD STEEL IN MINIMUM QUANTITY LUBRICATION (MQL) USING PALM OIL

Felix Fernandez Anak Banlehong

Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

2019

UNIVE P.KHIDMAT MAKLUMAT AKADEMIK UNIMAS ARAWAK
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PhD ☐

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This declaration is made on the 24 day of June 2019.

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Date submitted

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Supervisor's Declaration:

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APPROVAL SHEET

This project report which entitled “Observing Tool Wear during Milling Mild Steel in Minimum Quantity Lubrication (MQL) Using Palm Oil” was prepared by Felix Fernandez Anak Banlehong (50510) is hereby read and approved by:

_____ _____

Dr. Abang Mohd. Nizam bin Abang Kamaruddin Date

Project Supervisor

OBSERVING TOOL WEAR DURING MILLING MILD STEEL IN MINIMUM QUANTITY LUBRICATION (MQL) USING PALM OIL

FELIX FERNANDEZ ANAK BANLEHONG

A dissertation submitted in partial fulfillment

of the requirement for the degree of

Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

Faculty of Engineering

Universiti Malaysia Sarawak

2019

Dedicated to my beloved parents, friend and family for the never ending support, encouragements and motivation.

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ABSTRACT

In machining, the cutting parameters faced by the cutting tool and workpiece during machining of materials acts as a huge factor on cutting performance. Higher cutting temperature indirectly produces higher cutting force that eventually may increase cutting tool wear and decreases the tool life.

Benefits of cutting fluid is that it acts as lubricant and coolant during machining thus increases the lifespan of the cutting tool as it reduces cutting temperature and cutting force. The usage of cutting fluid increases the rate of manufacturing process but also cause an increase of manufacturing cost. Cutting fluid also possess threat to health and environment.

An alternative to overcome this problem is the introduction of a new method of minimally usage of cutting fluid. This method is known as Microlubrication or so called Minimum Quantity Lubrication (MQL). This alternative method help reduces the cost as the amount of cutting fluid used is reduced. This method also promotes healthy working environment as vegetable oil or specifically palm oil may be used to replace the conventional cutting fluid.

This research tested the MQL method by observing the tool wear after the cutting process. The tool wear are compared with dry cutting and wet cutting conditions. It is found out that tool wear in MQL using palm oil is much slower than it happened in dry cutting and also comparable with the tool wear in wet cutting.

ABSTRAK

Dalam pemesinan, parameter pemotong yang dihadapi oleh mata alat pemotong dan bahan kerja semasa proses pemesinan bahan bertindak sebagai faktor besar dalam prestasi memotong. Suhu pemotongan yang tinggi secara tidak langsung menghasilkan daya pemotongan yang lebih tinggi dan akhirnya memberi kesan pada ketajaman mata alat pemotong dan menurunkan jangka hayat alat.

Manfaat bendalir memotong adalah ia bertindak sebagai pelincir dan penyejuk semasa pemesinan dengan itu meningkatkan jangka hayat alat memotong kerana ia mengurangkan suhu dan daya pemotongan. Penggunaan bendalir memotong meningkatkan kadar proses pembuatan tetapi juga menyebabkan peningkatan kos pembuatan. Bendalir memotong juga memberikan ancaman kepada kesihatan dan alam sekitar.

Satu alternatif untuk mengatasi masalah ini ialah pengenalan kaedah baru penggunaan bendalir memoton secara minima. Kaedah ini dikenali sebagai Microlubrication atau disebut Minimum Quantity Lubrication (MQL). Kaedah alternatif ini membantu mengurangkan kos kerana jumlah bendalir memotong yang digunakan dikurangkan. Kaedah ini juga mewujudkan persekitaran kerja yang sihat kerana minyak sayuran atau minyak sawit secara khususnya boleh digunakan untuk menggantikan bendalir memotong konvensional.

Kajian ini menguji kaedah MQL dengan memerhati kondisi alat selepas proses pemotongan. Kondisi alat melalui kaedah pemotongan ini dibandingkan dengan pemotongan dalam keadaan kering dan basah total. Hasil kajian ini menunjukkan bahawa kondisi alat selepas menjalani pemotongan dalam kaedah MQL jauh lebih baik berbanding dalam kaedah pemotongan kering dan tidak jauh berbeza daripada kondisi alat dalam pemotongan basah total.

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LIST OF ABBREVIATION

MQL	-	Minimum quantity lubrication
BUE	-	Build-up edge
ASTM	-	American Society for Testing and Material
HSS	-	hollow structural sections
MRV	-	Material removal rate
PVD	-	Physical vapor deposition
SEM	-	Scanning Electron Microscopy

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Machining of material is manufacturing process that involves removing materials using cutting tools for getting rid of the unwanted materials from some work piece and converting it into the shape desired. A piece of stock such as in the shape of solid bar, flat sheet, beam or hollow tubes would be used for cutting processes. This process can also be performed on some existing part like forging or casting.

In the olden days, simple handheld tools made from bone, stick, or stone that is then replaced by bronze or iron as technology evolves was used in machining processes. During early inventions, power-driven metal cutting machines was using water or steam and currently electricity were used to deliver power to the tools (El-Hofy, 2008).

Machining operations are classified into three major principle processes and they are turning, drilling and milling. Miscellaneous categories such as boring, sawing, shaping, and broaching are also other operations in machining. Milling specifically falls under interrupted cutting operations which results in the end products having a flat or three-dimensional free-formed surface.

After hours of machining process, tool wear is a significant result that must be observed continuously as it would then affect other cutting performance such as

cutting force, cutting temperature and surface finish. Tool wear is highly relatable to cutting temperature and therefore the use of cutting fluid helps to reduce both of these parameters. Cutting fluid cut out a good amount of friction-heat generated and helps carrying away heat generated at the tool-workpiece interface (Shaikh, Boubekri & Scharf, 2014).

Malaysia is one of the biggest producer and exporters of palm oil and palm oil products. This leads to the importance of studying the benefits of application of palm oil in machining as this will eventually increase the productivity and competitiveness of the manufacturing industry in Malaysia specifically.

1.2 Milling Operations

Milling is a material removal process, works by cutting away the undesired part of a work piece which then produces variety of features on a part. Cutting tool with sharp teeth called cutter is installed onto the milling machine and rotation of the machines once switch on produces a number chips in one revolution removing unwanted material. A number of finishing choices such as holes, pockets, slots and three-dimensional contours are able to achieve in milling process. Various combinations of milling parameters such as depth of cut, spindle speed and feed rate will result in different surface finish (Daud et al., 2015).

1.3 Tool Wear

The definition of tool wear is stated as steady failure over time of the tool edge on the cutting tool during cutting process. Tool wear happened due the friction from continuous sliding of tool edge and the workpiece that forms hot spot. There are three type of tool wear namely flank wear, crater wear and corner wear. However, it is stated by Arsecularatene, Zhang and Montross (2006) that only two of those type, flank wear and crater wear that causes rapid tool wear.

Another factor that leads to faster tool wear is build-up edge (BUE). Even though this problem can be solved through coating the tool, once the coating is scratch tool wear will remain inevitable. The wear mechanism when machining Inconel 718 are BUE and adhesion that lead to tool coating's removal (Sharman, Dewes & Aspinwall, 2001). They concluded that coating of the tool has high affinity towards the material being machined thus leading to rapid tool wear.

1.4 Problem Statement

In small manufacturing industry, applying flooding and dry machining method are the most economical way to sustain good company financial position. Resulting from this, the tool life and overall quality of end product may not be taken seriously.

Inorganic coolant possesses high toxicity working space and environment. Emulsion used during cutting is quite expensive and the procedure to dispose it legally proposed a challenge. Disposing by dumping into river or water drainage which connects to public water sources would result in a serious negative health and safety issue towards the surrounding community and habitat. Introduction to the use of vegetable oil prevents the issues as stated. Vegetable oil is preferred as it is cheap, readily available and eco-friendly.

The main question is how far could palm oil as lubricant help to overcome rapid tool wear in dry machining especially. The next question is its performance significant enough that the difference compared to application of conventional cutting fluid is still in toleration range. Tool life will be compromised as a result of lack of lubrication to the frictional forces between the cutting tool and work piece.

1.5 Objectives

This research is conducted to observe tool wear in milling mild steel (using ASTM A36 standard mild steel grade). During this study, several other objectives are going to be discussed further on such as:

1. To observe different type of tool wears during milling mild steel in different condition.
2. To investigate the effectiveness of vegetable oil specifically palm oil towards reducing tool wear during milling.

We expect that by the end of this experiment, all the objectives can be achieved successfully in proper way and procedures.

1.6 Project Overview

For the thesis research, chapter one is about the introduction and background to the study. All the basic idea and knowledge are included in the first chapter. Next, the literature review are presented in the second chapter that provides all the sources

and information such as theory, concept and functions of previous study done by other researcher regarding the title of the project.

Chapter three, the methodology elaborates on the methods used in conducting the experiment and testing including the experimental set-up and controls. Meanwhile, chapter four portrays the result and findings as the experiment has been conducted. In the same chapter, in deep discussion and data analysis would be included to better understand and relates toward the objectives of the research. Finally, chapter five explains the conclusion to the project and states any error that improvements can be suggested for future experiment.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this particular chapter, all terms and studies from previous researches are elaborated to better understand the significance of this study and to compare the legality of result obtained from this particular study. Terms considered important in this study is tool wear, cutting temperature, cutting fluid and minimum quantity lubrication (MQL).

2.2 Tool Wear

Out of the performance characteristics during machining, tool wear is the main characteristic that is investigated thoroughly in this experiment. Tool wear is defined as steady failure over time of the tool edge on cutting tool during cutting process. Tool wear happened due to the engagement of the tool edge and the workpiece that creates hot spot at the interface.

Three types of tool wear are known namely; crater wear, flank wear and corner wear. As a result of friction between the machined surface of the work piece and the tool flank face occurs flank wear on the tool flank. Arsecularatene, Zhang and Montross (2006) claimed that this two progressive type of wear mention before; which is wear at the tool rake face and clearance face gives a legit prediction to the