UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Performance Analysis of Evaluation between Oil-Based Coolant and Combination of Oil-Based Coolant with Palm Oil on Cutting Surface in Turning Operation

Thesis submitted in accordance with the requirements of the Malaysia Technical University of Malacca for the Bachelor Degree of Manufacturing Engineering in Manufacturing Process

By

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This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The members of the supervisory committee are as follow:

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ABSTRACT

This project represents the performance analysis of coolant during turning operation. The analysis is made on the surface finish after machining. Generally, a few types of cutting fluid in market and being used as cutting fluid to the machining process will give a few advantages such as producing a good surface finish. The main purpose of this project is to investigate the performance of palm oil application as compound in coolant whether suitable or not for machining operation especially the turning operation. Other purpose is to compare and identify the best coolant between the oil-based coolant and the combination of oil-based coolant with palm oil in the aspect of surface machining. Experiment is conducted using a carbon steel AISI 1045 as a workpiece material with dimension of.250mm x 50mm. The workpiece is being turned by conventional lathe machine using (FUCHS) bacteriostatic emulsifiable cutting oil mixed with pure palm oil as coolant. The parameters setting such as cutting speed is set differently, 185rpm, 340rpm, 425rpm, and 625rpm. The feed rate is 0.5mm/rev and depth of cut is 0.5mm will remain constant. Surface roughness value is taken through the surface roughness tester and surface texture observation is done using metallurgy microscope. As the result, the palm oil compound will affect the surface machining and decreasing the quality of surface machining. A few factor is identified which will affect the surface roughness which are cutting speed and machining time.

ABSTRAK

Projek ini menerangkan analisis prestasi cecair penyejuk semasa operasi pemotongan logam jenis larikkan. Analisis tertumpu kepada hasil permukaan yang telah dimesin. Umumnya, terdapat pelbagai jenis cecair penyejuk dan aplikasinya dalam proses memesin akan memberi beberapa kelebihan seperti menghasilkan satu hasil permukaan yang baik. Tujuan utama projek ini dijalankan adalah untuk menyiasat prestasi minyak sawit apabila dicampurkan ke dalam penyejuk untuk mengetahui samada ianya sesuai atau tidak bagi tujuan pemesinan terutama untuk operasi melarik. Tujuan lain projek ini adalah untuk membandingkan dan mengenal pasti penyejuk terbaik antara minyak berasaskan penyejuk sahaja atau gabungan minyak berasaskan penyejuk dengan minyak sawit dalam aspek permukaan yang dimesin. Eksperimen ini menggunakan satu keluli karbon AISI 1045 sebagai bahan kerja berdimensi 250mm x 50mm. Bahan kerja akan dilarik menggunakan mesin larik konvensional dengan aplikasi (FUCHS) bakteriostatik emulsifiable dicampur dengan minyak sawit tulen sebagai penyejuk pemotongan. Parameter kelajuan seperti kelajuan memotong diaturkan secara berbeza- beza iaitu 185rpm, 340rpm, 425rpm, dan 625rpm. Kadar suapan adalah 0.5mm/rev dan kedalaman memotong adalah 0.5mm akan dikekalkan nilainya. Nilai kekasaran permukaan diambil terus daripada penguji kekasaran permukaan dan pemerhatian tekstur permukaan adalah dibuat menggunakan mikroskop metalurgi. Sebagai hasilnya, sebatian minyak sawit akan menjejaskan permukaan memesin dan mengurangkan kualiti permukaan yang dimesin. Beberapa faktor dikenalipasti akan memberi kesan kepada kekasaran permukaan yang adalah kelajuan memotong dan jumlah masa untuk memesin.

DEDICATION

For my beloved parents, my family and to those who always gives me courage and support for all these times.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS, SIGNS, AND SYMBOLS

AISI	-	American Iron and Steel Institute
BUE	-	built up edge
C	-	Carbon
CLA	-	centre line average
EP	-	extreme pressure
EPA	-	Environment Protection Agency
Eq	-	equation
Fe	-	Ferum
FKP	-	Fakulti Kejuruteraan Pembuatan
HSS	-	high speed steel
in	-	inch
ipr	-	inch per revolution
ISO	-	International Organization for Standardization
KeV	-	kilo electron volt
kPa	-	kilo Pascal
mm	-	millimetre (metric unit)
psi	-	per square inch
PSM	-	Projek Sarjana Muda
Ra	-	arithmetic mean value (roughness average)
Rpm	-	revolution per minute
Rq	-	root mean square average
SEM	-	scanning electron microscopy
sfpm	-	square feet per minute
UTeM	-	Universiti Teknikal Malaysia Melaka
µm	-	micrometer (1 millionth of a meter) (metric unit)
µin	-	microinch (1 millionth of an inch)

CHAPTER 1
INTRODUCTION

1.1 Introduction

Generally, cutting fluids usage in machining are vital because they help in dissipating heat generated by metal cutting process, reduce friction and wear, thus improving tool life and the surface finish of the workpiece, reduce forces and energy consumption, flush away the chips from the cutting zone. It also prevents the chips from interfering with the cutting process, particularly in operations such as drilling and tapping and protects the machined surface from environmental corrosion.

However, the cutting fluid itself are environmentally unfriendly, costly, and potentially toxic. The recent shift to dry cutting has not completely solved the problem. Dry cutting increases energy costs, increases per part costs, and requires a capital investment that is too large for most machine shops. This approach is a cost-effective or practical way to eliminate the use of environmentally unfriendly cutting fluids. They either require oils of questionable effectiveness or high-flow, high-pressure systems that would be costly and difficult to implement in a production environment.

Due to the many problems regarding to the healthy and the environmental issues, the vegetable oil such as the soybean oil and palm oil are finding their way into lubricants for industrial applications. It is seems that it is the suitable replacements of the conventional coolants. These oils such as palm oil, indeed offer significant environmental benefits with respect to resource renewability, biodegradability, as well as providing satisfactory performance in a wide array of applications.

Many techniques can be used to determine the performance of coolant and its effect to environment, human and productivity. We choose to compare the performance between only environmental friendly coolant and environmental friendly coolant mixed with palm oil on the value of the surface roughness obtained on the machined specimen and hopefully we can get the answer to the problems occurred in cutting fluids issue.

This paper will reveal the effects of both coolants tested based on the value of surface roughness using turning process. Details of related topics are discussed and presented also a result of the experiment that may provide a solution to the problems stated.

1.2 Problem Statement

Regarding to this project, we found that a few problems occurred in the process of selecting the right cutting fluid to be used. Therefore, solutions need to be found to solve the problems below:

a. Very little study on the development of palm oil into metalworking fluids lead to an unclear status of palm oil usage in machining operation.

b. Vegetable oil and soybean oil have been tested in machining and good result obtained. The cost of making those oils is quite expensive. In reducing the cost of production, cheaper natural source need to be develop.

c. The chemical based coolants used nowadays are harmful to the operator and environment compared to the environmental friendly coolants. The performances between those oils are similar. Since the issues of environment pollution and hazard to workers rise up, there is still less action in developing safe and efficient metalworking fluids.

1.3 Objectives

The objectives of this research are:

a. To carry out experiment using oil based coolant and combination of oil based coolant with palm oil in turning operation and evaluate the surface finish performance by analyzing the surface roughness of the specimen machined.

a. To compare and identify the best coolant between the oil-based coolant and the combination of oil-based coolant with palm oil in the aspect of surface finish

b. To determine whether palm oil is suitable for the machining operation and improve surface finish especially in turning operation.

1.4 Project Scope

Basically, this project conducted to compare the performance between oil based coolant and combination of oil based coolant with palm oil in turning operation and the performance is evaluated from the surface finish of the specimen machined. High speed steel (HSS) is used as a cutting tool and the material for turning operation is mild steel (AISI 1045). The process is performed under different parameters such as feed rate, cutting speed, depth of cut and cutting time. This study will be focusing on the surface finish obtained from the machining using two different types of coolants performance. Samples from the machining operation will be analyzed using surface roughness tester and metallurgy microscope. The value of surface roughness from the specimens will be recorded for making comparison for the both cutting fluids used. Discussions are made under the result obtain and the most suitable coolant to be used will be stated in conclusion made.

1.5 Limitation of Scope

This study is carried out only to analyze the cutting fluids performance on the specimen's surface. Although parameters in machining and other factors also play an important role in obtaining good surface finish, the discussion will be made only on the role played by cutting fluids used by evaluating the specimens surface roughness value. Also, the surface textures gained after being machined only being observed its character.

CHAPTER 2
LITERITURE REVIEW

2.1 Introduction

In this chapter, brief explanations about related topics on this research are revealed. This chapter will discuss about cutting fluids and criteria which are related to cutting fluids fundamentals which is suitable to be a revision for this study. Also being discussed in this chapter is about lathe machine and its operation such as turning and also about surface metrology. All of the fundamentals about related topics are taken from previous studies from journals, books and articles.

2.2 Introduction to Cutting Fluids

Cutting fluids are widely used throughout industry in many machining operations such as milling, grinding, boring, and turning. Large machining facilities use central fluid systems with capacities as high as 760 000 liters, and it is estimated that over 380 million liters of metalworking fluids are used each year (Gunther & Sutherland, 1999).

Cutting fluids are used to optimize a lot of machining operation such as turning, drilling boring, grinding and milling. The main purpose of using cutting fluid is to reduce cutting zone temperature in order to increase tool life and also to gain good surface finish (Diniz & Micaroni, 2007)

Depending on the type of machining operation, the cutting fluid needed may be a coolant, a lubricant, or both. The effectiveness of cutting fluids depends on a number of factors, such as the type of machining operation, tool and workpiece materials, cutting speed, and the method of application. Water is an excellent coolant and can reduce effectively the high temperatures developed in the cutting zone. However, water is not an effective lubricant; hence it does not reduce friction. Furthermore, it causes the rusting of workpieces and machine-tool components. On the other hand, as we have seen, effective lubrication is an important factor in machining operations (Kalpakjian & Schmid, 2001).

The need for a cutting fluid depends on the severity of the particular machining operation, which may be defined as the level of temperatures and forces encountered, the tendency for built-up edge (BUE) formation, the ease with which chips produced can be removed from the cutting zone, and how effectively the fluids can be applied to the proper region at the tool-chip interface. The relative severities of specific machining processes in increasing order of severity are: sawing, turning, milling, drilling, gear cutting, thread cutting, tapping, and internal broaching (Kalpakjian & Schmid, 2001).

Cutting fluids can be found in many types in nowadays market, the most common of which can be broadly categorized as cutting oils or water miscible fluids. Water miscible fluids, including soluble oils, synthetics and semi synthetics are now used in approximately 80 to 90% of all application. Although straight cutting oils are less popular than they were in the past, they are still the fluid of choice for certain metalworking applications (Anon.,University of Northern Iowa, 2003).