UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Analyze the Performance Evaluation between Oil Based Coolant and Environmental Based Coolant on Tool Wear In Turning Operation

Thesis submitted in accordance with the requirements of the University Technical Malaysia Melaka for the Degree of Bachelor of Engineering (Honors) Manufacturing (Process)

By

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DECLARATION

I hereby, declare this thesis entitled "Analyze the Performance Evaluation between Oil Based Coolant and Environmental Based Coolant on Tool Wear in Turning Operation" is the results of my own research except as cited in the reference.

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ABSTRACT

As the title of this project, analysis the performance evaluations between oil based coolant and environmental based coolant on tool wear in turning operation, the main goal is to investigate the associate of coolant effect with the cutting tool. Basically, the scope of this project is to select the best coolant utilization in FKP machining laboratory. Several coolants have been chosen based on their usage in the laboratory by using conventional lathe machine. The best coolant that can produces less wear at the tool and correlate well with the workpiece material will be select to be use in the laboratory. The material of the cutting tool and workpiece is high speed steel and mild steel respectively. The machining parameters of turning operation also involved because it existence influence the results. The involve machining parameters in turning operation that has been taken into highly consideration were the cutting speed, feed rate, depth of cut and cutting time of tool life. Considerably, the machining parameters will be varied in several times in turn to get the perfect results. The analyzing development will be conducted by Optical Microscope due to identify the types of tool wear occurred at the cutting tool with perfect image. From this analysis, we have realized that coolant characteristic can influence the tool wear produced.

DEDICATION

Special thanks dedicated to my late grandfather, Mr. Ghazali bin Musa. All your advice and guidance will not be forgotten. Thanks for all your love and support. The successful of this project cannot be achieved without your spirit left in me .Thank you for everything. May ALLAH S.W.T bless you.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

i.	RPM	- Revolution per Minute
ii.	μm	- Micron meter
iii.	HSS	- High speed steel
iv.	Mm/min	- Meter per minute
v.	FKP	- Fakulti Kejuruteraan Pembuatan
vi.	CNC	- Computer Numerical Controlled
vii.	UTeMM	- Universiti Teknikal Malaysia Melaka

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF PROJECT

As the title of this project, to analyze the performance evaluation between oil based coolant and environmental based coolant on tool wear in turning operation produce upon the high speed steel cutting tool, an emphasizing will be done at the type of coolant and its needed characteristic to cooperate with the machine and cutting tool. Generally, coolant or cutting fluids is one of the important factors in producing part with a better dimension according to the specification needed especially in surface terminology. There are some parameters need to be taken into consideration too in order to make sure the effectiveness of cutting fluids while in cutting operations, such as temperature, cutting speed, workpiece material and type of machining operations (turning process). Moreover, coolant utilization is essential when in high cutting speed.

As explaining before, there are 2 types of coolants will be discussed greatly in this report; oil based coolant and environmentally based coolant (Bacteriostatic Emulsifiable Cutting Oil). Their effectiveness will be determined according to the wear produce at cutting tool in turning operation. Normally, the selection of cutting fluids is usually ignored because people do not realize the effect of poor selection of coolants. Usually, an emphasizing will be done at the material of the cutting tool and workpiece, cutting speed and depth of cut. Selection of cutting fluids also playing an important role in order to improved cutting tool life and produce better surface finish.

1.2 SCOPE OF PROJECT

In this project, an emphasizing has been made about the coolant utilization in FKP machining laboratory. In order to reduce the usage of cutting tool and avoid large consumption of coolant, we have done an analysis about the performance evaluation of coolant in turning operation and the effect at cutting tool. A comparison will be made between an ordinary coolant with latest type produced coolant. Ironically, there are 4 types of cutting fluids in market nowadays, such as oils, emulsions, semi-synthetics and synthetic. A selection has been made according to the most popular coolant used in industry and there are generally based on minerals (oils and emulsion). The characteristic of these fluids will be explained greatly in literature review chapter. In this project, the equipments involve are conventional lathe machine and optical microscope provided by UTeM. The result of this study will be obtained importantly in selecting the appropriate coolant by considering their performance and capability using scientific test.

1.3 OBJECTIVES

The main objectives for analysis the performance evaluations of coolants regarding to the tool wear produced in turning operation are:

i.) To study about the types of tool wear develop in turning process regarding to the used of Oil Based Coolant and Environmental based coolant under particular turning parameters.

ii.) To do a comparison between 2 types of coolant used in this experiment due to the rate of wear produced.

iii.) To prepare the appropriate result for coolant utilization in FKP machining laboratory through data analysis.

1.4 PROBLEM STATEMENT

The selection of present cutting fluid used at conventional turning machine in FKP machining lab is randomly done without using any scientific test or research. The performance of the cutting fluid due to the reaction with the cutting tool material and workpiece material cannot be determined precisely. This situation will influence the cutting tool life-span and of course the cutting fluid itself.

A proper selection of cutting tool according to it relation with cutting fluid must be done through scientific research. There is still no scientific data about the relation of present cutting tool with the cutting fluid used in FKP Lab. The performance of the cutting tool is still unclear, which is whether the utilization of present cutting tool is suitable or not with current cutting fluid.

Due to these problems, it will increase the cost of changing the cutting fluid and cutting tool itself. In order to select the proper cutting fluid that is suitable with the current cutting tool use in FKP Lab, an analysis will be made about the performance of coolants and its effect on turning tool wear by through this research. Ironically, this research will result in costing changing of cutting tool and coolants.

CHAPTER 2

LITERATURE REVIEW

2.1 CUTTING FLUIDS

Analysis the performance evaluations of coolants in turning operation by emphasizing on effect of turning tool wear is focus on the investigation of relationship between cutting fluid, machining parameters, workpiece and cutting tool material. Cutting fluid, or in other names also known as lubricants or coolants, are used extensively in machining processes as well as abrasive processes. The main purposes cutting fluid usage in machining processes are (Kalpakjian, R. Schmid, 2000):

i. To cool the cutting zone, thus reducing workpiece temperature and thermal distortion
ii. Reduces forces and energy consumption
iii. Reducing friction and wear, thus improving tool life and surface finish
iv. Wash away the chip produce from the cutting process

Basically, cutting fluid must have criteria to act as a coolant and lubricant. While it reduce the high temperature cause by the friction between cutting tool and work piece, at the same time it must provide lubricant support to make the cutting process smooth and reduces friction. Sometimes, lubrication is more important than cooling in some machining operation such as tapping or broaching. Cutting fluid effectiveness in cutting operations depends on several factors, such as method of application, temperature, cutting speed and type of machining operation (Kalpakjian,

R. Schmid, 2000). Ironically, temperature increases as cutting speed increases. Therefore, cooling aspect at the cutting zone is important in high cutting speed.

A previous study has been made about the mechanism by which cutting fluids influence machining operation. In view of high contact pressures and high rate of relatives sliding at the tool – chip interface, cutting fluid penetrates the interface and influence the cutting process. Theoretically, the fluid is drawn into the tool – chip interface by the capillary action of the interlocking network of surface asperities. The cutting fluid access to the interface by seeping from the sides of the chip. Because of the small size of this capillary network, the cutting fluid should have a small molecular size and possess proper wetting characteristic.

2.1.1 Introduction to cutting fluids

Cutting fluid or coolant is liquid used to cool and lubricate the cutting edges of machine tools and the pieces they are shaping. It is pumped over the cutting site of machines such as lathes, milling machines, shapers and saws.

Metal cutting operations involve generation of heat due to friction between the tool and the pieces and due to energy lost deforming the material. This heat needs to be carried away or otherwise it creates white spots. Water is a great conductor of heat but is not stable at high temperatures, so stability is often achieved by making an emulsion of water with oil.

Basically, there are three types of coolants. Mineral (petroleum base and oil emulsion), semi-synthetic and synthetic. Mineral coolants are cheap and have a short life. Semi-synthetic coolants use special chemicals to solubalize the oil into water. Synthetic coolants do not contain oil and hence are much more stable but more expensive. Bacterial growth can be a problem in cutting fluids that contain water. In case the oil forms a layer on the top of liquid, anaerobic bacterial proliferate due to warm temperatures. This leads to a bad smell and renders the fluid unusable.

The properties that are sought after in a good cutting fluid are the ability to:

i. Keep the workpiece at a stable temperature (critical when working to close tolerances).
ii. Maximize the life of the cutting tip by lubricating the working edge and reducing tip welding.
iii. Prevent the growth of bacteria or fungi.
iv. Cutting fluid may also take the form of a paste when used for some applications, in particular hand operations such as drilling and tapping.

2.1.2 Types of cutting fluids

Cutting fluids are used in metal machining for a variety of reasons such as improving tool life, reducing workpiece thermal deformation, improving surface finish and flushing away chips from the cutting zone. Practically all cutting fluids presently in use fall into one of four categories:

i. Straight oils (petroleum base)
ii. Soluble oils (oil emulsion)
iii. Semisynthetic fluids
iv. Synthetic fluids

Straight oils are non-emulsifiable and are used in machining operations in an undiluted form. They are composed of a base mineral or petroleum oil and often contain polar lubricants such as fats, vegetable oils and esters as well as extreme pressure additives such as Chlorine, Sulphur and Phosphorus. Straight oils provide the best lubrication and the poorest cooling characteristics among cutting fluids.
Synthetic Fluids contain no petroleum or mineral oil base and instead are formulated from alkaline inorganic and organic compounds along with additives for corrosion inhibition. They are generally used in a diluted form (usual consent ration = 3 to 10%). Synthetic fluids often provide the best cooling performance among all cutting fluids.

Soluble Oil Fluids form an emulsion when mixed with water. The concentrate consists of a base mineral oil and emulsifiers to help produce a stable emulsion. They are used in a diluted form (usual concentration = 3 to 10%) and provide good lubrication and heat transfer performance. They are widely used in industry and are the least expensive among all cutting fluids.

Semi-synthetic fluids are essentially combination of synthetic and soluble oil fluids and have characteristics common to both types. The cost and heat transfer performance of semi-synthetic fluids lay between those of synthetic and soluble oil fluids.

2.1.3 Characteristic of Soluble Oils

Generally, two types of coolant use in this experiment are base on mineral or soluble oil fluids. Oil Based Coolant and Environmental based coolant are basically contains of oil and emulsions. Environmental Based Coolant has higher cost than Oil Based Coolant but it has special ability which is environment friendly and does not need special places for termination. Shown below are the characteristic and industry application for Oil Based Coolant. (FUCHS Mineral work: product information catalogue).

Performance Characteristic of Oil Based Coolant:

i. Easily combines with even hard water to form a highly stable emulsion that provides excellent cooling of machining and grinding operation.
ii. Protect workpiece and machine from rusting and corrosion.
iii. Using these products avoids the smoking and fumes that commonly occur with oil type cutting oils.
iv. Does not cause dermatological problem for machine operators.
v. It does not soften or lift paint on the machine tools.
vi. Will produce better surface finish at higher cutting/grinding speeds and with less tool wear and wheel loading.

As explaining in the introduction, we have used Environmental Based Coolant as comparable coolant to the Oil Based Coolant which is categorized as Bacteriostatic Emulsifiable Cutting Oil. Shown below are the characteristic and industry application for Environmental Based Coolant. (FUCHS Mineral work: product information catalogue).

Performance Characteristic of Environmental Based Coolant:

i. Very low foam formation even in soft waters.
ii. Excellent corrosion protection of both machines and machined parts.
iii. High cooling and wetting power, favouring the rapid dissipation of heat generated in the cutting area.
iv. Contains lubricity and extreme pressure additives, ensuring the cutting tools will last longer and providing excellent surface finish.
v. High pH stability.
vi. Free from chlorine, nitrites, phenols and heavy metal. Does not contain triazine preservative.

Applications at some typical metal working operations using Soluble Oil Coolant are:

i. Milling
ii. Turning
iii. Drilling
iv. Boring
v. Reaming
vi. Sawing
vii. Grinding
viii. Threading

Specification recommendation for dilution ratios is not feasible due to the wide variation in materials, tools and machining operation. However some general guidelines are as follows:

1. Free machining materials: Oil/water ratios of 1:25 to 1:20.
2. Tough or draggy materials: Oil/water ratios of 1:10 to 1:30.
3. Grinding: Oils/water ratios of 1:40 to 1:100.

2.1.4 The Principal Methods of Cutting Fluid Application

i) Flood Application of Fluids

Most machine tools are equipped with a recirculating system that incorporates filters. The fluid is applied at a rate of up to L/min for each simultaneously engaged cutting edge. For convenience, the tool is usually flooded from the chip side, although better cooling is secured by application into the clearance crevice, especially when the fluid is supplied under a pressure of 300kPa (40 psi) or more. High pressure system apply pressures of 5-35 MPa (0.8-5 kpsi) and, hitting at 350-500 km/h, help to carry away chips, but the entire workspace must be enclosed. A second nozzle may be necessary to clear away the chips in some operations. Figure 2.1 shows the example of floods application of cutting fluid.

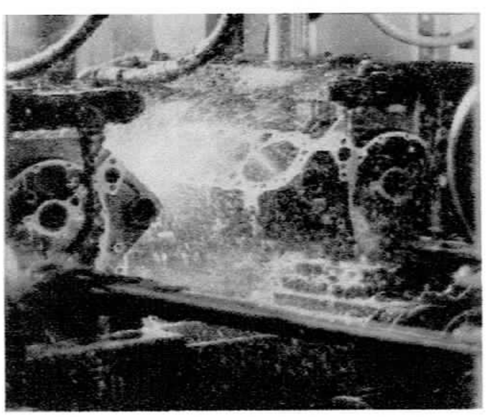

Figure 2.1 A Flood of Cutting Fluid Is Applied On the Workpiece