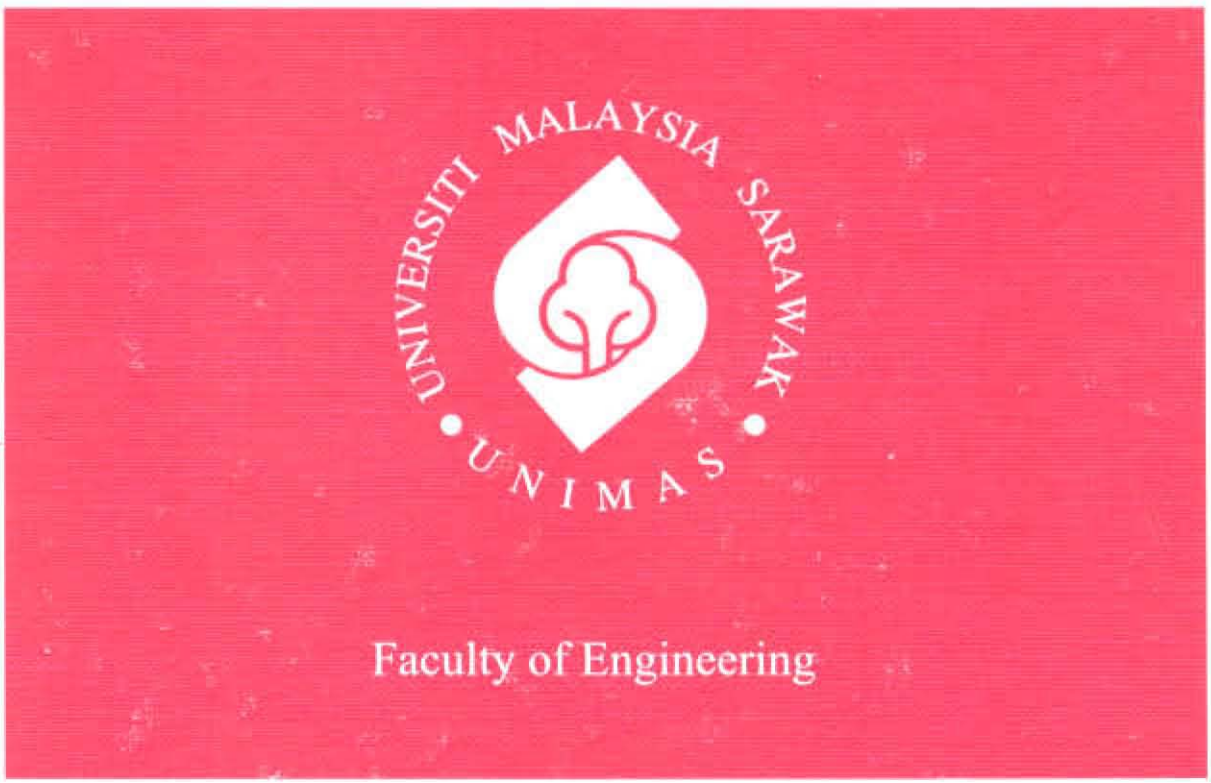


DESIGNING NEW MINIMUM QUANTITY OF LUBRICATION (MQL) APPLICATOR FOR MILLING

Steven Joel Anak Total

Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)
2017

UNIVERSITI MALAYSIA SARAWAK

Grade: _____

Please tick (√)
Final Year Project Report ☑
Masters ☐
PhD ☐

DECLARATION OF ORIGINAL WORK

This declaration is made on the 24 day of Juli 2012.

Student's Declaration:

I STEVEN JOEL ANAK TOTAL, (44260) FROM DEPARTMENT OF MECHANICAL AND MANUFACTUTING ENGINEERING OF FACULTI ENGINEERING hereby declare that the work entitled DESIGNING NEW MINIMUM QUANTITY OF LUBRICATION(MQL) APPLICATOR FOR MILLING is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

24/7/17
Date submitted

STEVEN JOEL ANAK TOTAL (44260)

Supervisor's Declaration:

I Dr. ABANG MOHD. NIZAM BIN ABANG KAMARUDDIN hereby certifies that the work entitled DESIGNING NEW MINIMUM QUANTITY LUBRICATION (MQL) APPLICATOR FOR MILLING was prepared by the above named student, and was submitted to the "FACULTY" as a * partial/full fulfillment for the conferment of BACHELOR OF MECHANICAL AND MANUFACTURING ENGINEERING, and the aforementioned work, to the best of my knowledge, is the said student's work.

Received for examination by: _____ Date: 24/7/2017
(Dr. ABANG MODH. NIZAM BIN ABANG KAMARUDDIN)

I declare that Project/Thesis is classified as (Please tick (√))

☐ **CONFIDENTIAL** (Contains confidential information under the Official Secret Act 1972)*
☐ **RESTRICTED** (Contains restricted information as specified by the organisation where research was done)*
☑ **OPEN ACCESS**

Validation of Project/Thesis

I therefore duly affirm with free consent and willingly declare that this said Project/Thesis shall he placed officially in the Centre for Academic Information Services with the abiding interest and rights as follows:

- This Project/Thesis is the sole legal property of Universiti Malaysia Sarawak (UNIMAS).
- The Centre for Academic Information Services has the lawful right to make copies for the purpose of academic and research only and not for other purpose.
- The Centre for Academic Information Services has the lawful right to digitalise the content for the Local Content Database.
- The Centre for Academic Information Services has the lawful right to make copies of the Project/Thesis for academic exchange between Higher Learning Institute.
- No dispute or any claim shall arise from the student itself neither third party on this Project/Thesis once it becomes the sole property of UNIMAS.
- This Project/Thesis or any material, data, and information related to it shall not be distributed, published or disclosed to any party by the student except with UNIMAS permission.

Student signature  Supervisor signature: 

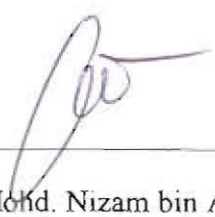
Current Address: Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University Malaysia Sarawak 94300 Kota Samarahan. Sarawak

Notes: * If the Project/Thesis is **CONFIDENTIAL** or **RESTRICTED**, please attach together as annexure a letter from the organisation with the period and reasons of confidentiality and restriction.

[The instrument is duly prepared by The Centre for Academic Information Services]

APPROVAL SHEET

This project report which entitled "Design new Minimum Quantity of Lubrication (MQL) Applicator for Milling" was prepared by Steven Joel anak Total (44260) is hereby read and approved by:



24/7/2017

Dr. Abang Mohd. Nizam bin Abang Kamaruddin

Date

Project Supervisor

DESIGNING NEW MINIUMUM QUANTITY OF LUBRICATION (MQL) APPLICATOR FOR MILLING

STEVEN JOEL ANAK TOTAL

Thesis is submitted to

Faculty of Engineering, Universiti Malaysia Sarawak

In Partial Fulfilment of the Requirements

For the Degree of Bachelor of Engineering

With Honours (Mechanical and Manufacturing Engineering) 2017

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

ACKNOWLEDGEMENTS

Firstly, I like to thank The Almighty God Jesus Christ for His Blessing and willing for the completion this thesis research. I would like to address my highest appreciation to University Malaysia Sarawak and the engineering faculty department of Mechanical and Manufacturing Engineering for providing the facility during the course of this research. I would like to express my heartfelt gratitude to my supervisor, Dr. Abang Mohd Nizam bin Abang Kamaruddin for his endless support and encouragements during ongoing of this research. My deepest thanks also for the faculty technicians for their guidance and support during experimentation and fabrication of this project. In alphabetical order they are: Mr Ireman Bolhassan, Mr Mohd Fairudy Mohd. Jamil, and Mr Sabariman Bakar I would also like to express thanks to fellow friends for the constant support and encouragements especially Ridhwan Shah bin Busrah and Mohd Ashaari Kiparwi. Last but not least, my family members for the overwhelming support until success of this thesis is achieved.

ABSTRACT

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

Usage of cutting fluid as lubricant and coolant during cutting conditions increases the life span of cutting tool as it reduces cutting temperature and cutting force. Not only that, the cutting fluid also prevents cutting chips from accumulating around the work piece which contributes to increases of work piece temperature

The use of cutting fluid increases the rate of manufacturing process but also cause increases its manufacturing cost. Cutting fluid also reduces health quality and the surrounding environment. To overcome this problem a new method of minimal used of cutting fluid is introduced This method is known as minimum quantity of lubrication (MQL). This alternative method help reduces the manufacturing cost as the amount of cutting fluid used is reduced This method also promotes health working environment as vegetable oil may be used to replace the conventional cutting fluid.

This research will test the MQL method by analyzing the cutting force during cutting process. The cutting force will be compared with dry and wet cutting conditions The expected result of this experiments are that this MQL method have lower cutting force than those obtain from dry cutting and equal or slightly higher than those obtain from wet cut cutting conditions. The experiments also will prove that vegetable oil may be used as a replacement to cutting fluid.

ABSTRAK

Dalam proses pemesinan, daya potongan yang dihadapi oleh mata alat potong ketika proses pemotongan merupakan faktor utama yang mempengaruhi prestasi mata alat. Daya potongan yang tinggi secara tidak langsung menghasilkan suhu potongan yang tinggi dan pekara ini mempengaruhi ketajaman dan jangka hayat mata alat

Penggunaan bendalir pemotang sebagai pelincir dan penjejuk ketika proses pemotongan akan meningkatkan jangka hayat mata alat. Bukan itu saja, bendalir pemotong juga mengelakan sisa memotong daripada terkumpul di alat kerja Pengumpulan sisa memotong mengakibatkan meningkatnya suhu pada alat kerja.

Penggunaan bendalir pemotong meningkatkan kelajuan pembuatan produk secara tidak langsung meningkatkan kos pembuatannya. Bendalir pemotong juga mengurangkan kualiti kesihatan dan menjejaskan persekitaran. Untuk mengelakan pekara ini, pengguinaan minima pada penggunaan bendalir pemotong di perkenalkan. Cara ini diberi nama Minimum Quantity of Lubrication (MQL). Penggunaan MQL mampu mengurangkan kos pembutaan kerana penggunaan bendalir pemotong dikurangkan. Penggunaan MQL menghasilkan keadaan kerja yang sihat dan selesa kerana penggunaan minyak sayur sebagai peganti bendalir pemotong

Kajian ini akan menguji cara MQl dengan menganalasasi daya potongan semasa process pemotongan. Daya potongan ini akan dibandingkan dengan daya potongan hasil daripada proses pemotongan kering dan basah. Hasil jangkaan daripada kajian ini adalam cara MQL memperolehi daya potongan yang lebih rendah daripada daya potongan hasil daripada proses pemotongan kering dan menyamai atau melebihi sikit daripada daya potongan hasil daripada proses pemotongan basah. Selain itu, kajian ini juga akan membuktikan bahawa penggunaan minyak sayur sebagai penganti bendalir pemotong adalah benar.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Project Background

Demands for custom made parts and special machining works are in high in demand nowadays. The mindset of using and patterning custom parts develops as technologies nowadays are getting more advanced. Young generations really test the limits of simple machining with production of parts has complex design Increasing in demands for high productivity and good quality product causes the cause of machining to increase. This factor limits the customer range for affordability as most of them are perusing a lower cost machining that can produce a high quality and high production of product. Machining process specifically to metal cutting operations requires removal of material according to the desired length, diameter, length, height and specific surface finishing of a product. During this process, friction between the work piece and cutting tool will generate heat. (T, 2014)

In high speed machining, variable like spindle speed, feed rate and cutting depth influence the friction between cutting tool and work piece. Hence, these three variables are a main factor to the total heat produce during machining. By using cutting fluid in the machining process, the generated heat can be reduces. The cutting fluid not only cools down the work piece by removing the chip but also provide lubrication between the cutting tool and work piece. Besides that, the cutting fluid also provides a layer of protection to the work piece. This property applies differently with different types of cutting fluid. (Kim, Effect of the minimum quantity lubrication in high-speed end-milling of AISI D2 cold-worked die steel (62 HRC) by coated carbide tools, 2008)

Using cutting fluid in machining work eliminate the use of coolant fluid which is hazardous when exposed to human and can cause dermatitis syndrome Using coolant fluid effect the overall machining cost that includes the maintenance, fluid depletion and disposal of them Eliminating this application may helps the machining companies to lower the machining price and increase their finically. (T, 2014), (Liu, 2015)

1.2 Importance of cutting fluid

There are two main functions of cutting fluid, first they act as a lubrication agent in low speed machining. Then, they act as a coolant agent in high speed machining. Not to overlook that they also act as a medium who removes chips from cutting zone and provide sufficient protection to machine tool and work piece against corrosion.

In low speed operating conditions, temperature produce form friction between the machine tool and work piece are not too high. Because of this, the cutting fluid acts as a lubricator to reduce the friction and build-up-edge. For this situation, the suitable cooling fluids used are oil based. The cutting fluid works to reduce the contact area between chip and tool and its efficiency depends on the ability of penetrating in the chip-tool interface and to create a thin layer in the short available time This layer is created by either chemical reaction or physical adsorption and must have a shearing resistance lower than the resistance of the material in the interface. In this way it will also act indirectly as a coolant because it reduces heat generation and therefore cutting temperature.

In high speed operating conditions, temperatures generated from friction between the machine tool and work piece are the main factor to be address. The cutting fluid flows through both the machine tool and work piece and dissipate heat generated. This lowers the overall heat temperature during the machining process. For this operation, it is more suitable to use a water based fluid as lubrication properties are secondary.

Efficiency of cutting fluid, mainly dependable on the different characteristics of cutting fluid and suitability of machining operations. However, the efficiency cooler fluid

reduces when the cutting speed and cutting depth increases Despite all this, the cutting fluid also promotes some disadvantages to the machining operation. Chemical properties in cutting fluid give out toxic when it changes in the form of a mist. This situation may cause dermatitis, damages to respiratory and digestive system and also death to be human. (Machado, 2001)

1.3 Minimum Quantity of Lubrications

The usages of cutting fluid are well known to contribute some health issue to the working environment in the metal machining industries. One of the ways to reduce this risk is to limit the usage of cutting fluid in the industries By introducing the minimum quantity of lubrication method, this issue can be solved.

Minimum quantity lubrication uses a small amount of biodegradable oil droplets mixed with compressed air is sprayed to the cutting area, this action helps to reduce the cutting temperature and lubricate the cutting tool. Using biodegradable oil is not only eco friendly but there are non toxic. Thus, will not expose hazardous materials to the workers. The low quantity of oil used in minimum quantity lubrication also helps the industry economically as less cutting fluid is being purchased.

The application of minimum quantity of lubrication also increases the tool life as it received a sufficient amount of lubrication during the machining process, this situation does not always occur with the conventional flooding method. Not only that, the application of minimum quantity of lubrication also applicable to milling, turning and many more machining operations. (Lin, Mechanism of minimum quantity lubrication in high-speed, 2007), (Machado, 2001), (Hodzic, 2016)

1.4 Problem Statement

In small manufacturing industry, the use of minimum quantity of lubrication is restricted due to the high cost of installation Besides that, the parts of assembly for a

minimum quantity of lubrication application need an authorised technicians for installation and maintenance work. These small manufacturing industries tend to apply the flooding and dry machining method during machining process. Resulting from this, the surface finished and overall quality of end product may be compromised.

Not only that, the tool life also will be compromised when in a dry machining process. This is due to lack of lubrication to the frictional forces between the cutting tool and work piece. Next the use of flooding method also consumes a large amount of cutting fluid that affect the economic factor and is not environmental friendly. Using a large amount of cutting fluid exposes the working environment to hazardous chemical and toxic that causes irritation and death to be human.

1.5 Objective

In this research, there are several objectives that can be identified:

1. To investigate the advantages and disadvantages of using conventional cutting fluid
2. To design a new type of minimum quantity of lubrication applicator in milling operation that is affordable and eco-friendly
3. To demonstrate the device performance under real minimum quantity of lubrication application.

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

1.6 Project overview

For this thesis project, chapter one is about the introduction and background to the study. All the basic knowledge and components were included in the first chapter. Next, the literature review is presented in the second chapter This chapter provides all the sources of information such as theory, concept and functions regarding to the title to the project.

Chapter three describe the methodology used to conduct experiment and testing to the material according to the chosen design concept. All the result and findings from experiments and testing are shown in chapter four. This chapter also describes all the calculation and explanation for result experiments. Finally, chapter five explains the conclusion to the project and states any suggestion of improvement future used.

CHAPTER 2

LITERATURE REVIEW

2.1 Cutting fluid

In machining process, shearing machining would occur during the reshaping process of the work piece to its end shape This process produces a high friction load between the cutting tool and the work piece, which directly cause increases in cutting temperature. Accumulating heat from the process may cause damages to cutting tool and work piece if it not properly controlled. The main sources of heat are normally generated in two areas known as the primary or shear zone (1) and tool-work piece interface (2) Moreover, a third zone (3) of heat is generated where friction between the tool and the chip occurs (Figure 2.1).

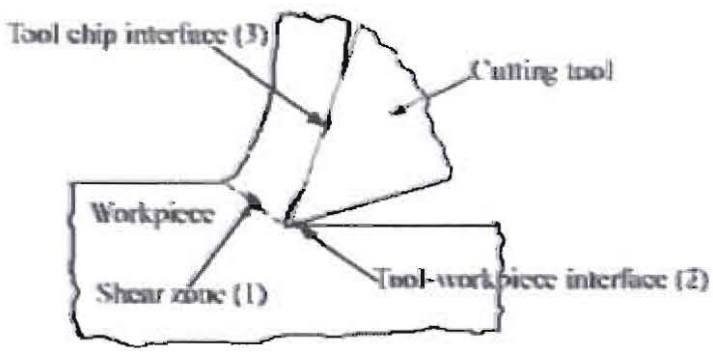


Figure 2.1: Shear diagram

Heat generated can be controlled by manipulating the variable of cutting temperature and friction. Adjusting both variables allows the machining process to achieve

its optimum efficiency as distinctive materials used to have distinct suitable cutting temperature. A higher cutting temperature would be necessary to make the deformation process occur easily; as in hot machining processes. On the other hand, it generates excessive heat, which will affect tool life and in some cases the surface integrity of components. (MULYADI, 2013)

The main function of cutting fluid is to provide a cooling action to the cutting zone during the machining process In addition to its cooling action, the lubricating effect of cutting fluid makes a significant contribution in friction reduction. Highest heat generated was during the interfacial face of the tool and chip, the presence of cutting fluid particles will enhance the lubricating action over the face In addition, cutting fluid in cutting operations also removes the chips off the machined surface to prevent the chips from scratching the machined surface. Cutting fluid also helps reduce enough friction between the cutting tool and work piece so that it won't cause unnecessary heat. Next cutting fluid also provides a layer of protection for the machined surface to prevent chemical reaction that could promote corrosion. The lubricant film also prevents the chips from being welded to the machined surface. (MULYADI, 2013)

2.2 Type of cutting fluid

There are mainly 4 types of cutting fluids used in industries

1. straight oils
2. soluble oils
3. synthetic
4. semi synthetic

All the different type of cutting fluids is used on different applications depending on their individual's properties. Bio-based cutting fluids have the potential to reduce the waste treatment costs due to their inherently higher biodegradability and may reduce the occupational health risks associated with petroleum-oil-based cutting fluids since they have

lower toxicity. The output is a healthier and cleaner in the work environment, with less mist in the air. (Lin, Mechanism of minimum quantity lubrication in high-speed milling of hardened steel, 2007)

2.2.1. STRAIGHT OILS (100% petroleum oil) (Lin, Mechanism of minimum quantity lubrication in high-speed milling of hardened steel, 2007)

Straight oils are cutting fluid that dose not contain water, are basically petroleum and mineral. They may have additives designed to improve specific properties In general, these additives improve the oil's wet ability, that is, the ability of the oil to coat the cutting tool, work piece and metal fines Besides that, they also improve the oil's ability to handle large amounts of metal fines, and help guard against microscopic welding in heavy-duty machining. For extreme conditions, additives (primarily with chlorine and sulfurize fatty oils) may exceed 20%. These additives strongly enhance the anti welding properties of the product

Advantages of straight oil:

1 Straight oils have excellent lubricity between the workpiece and cutting tool, mainly useful for low speed, low clearance machining operations and to achieve high quality surface finishes.

2 Straight oil Increases tool life

3. Straight oils offer good rust protection

4. Straight oil also resist rancidity (bacteria cannot thrive unless water contaminates the oil)

Disadvantages of straight oil

1. High costing.

2. Straight oil has poor heat dissipating properties and increased fire risk.

3. Straight oil creates a mist or smoke that is environmental friendly.