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JUDUL: EFFECT OF LUBRICATION CONDITION ON SURFACE ROUGHNESS BY USING LATHE MACHINE

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Saya, **ROHAIDA BINTI MOHD(860507-46-5270)**

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Alamat Tetap:

3274 Kampung Buluh Gading, **21200 kuala Terengganu,** **Terengganu Darul Iman.**	**MR LEE GIOK CHUI**
Tarikh: **6 NOVEMBER 2008**	Tarikh: **6 NOVEMBER 2008**

EFFECT OF LUBRICATION CONDITION ON SURFACE ROUGHNESS BY USING LATHE MACHINE

ROHAIDA BINTI MOHD

A report submitted in partial fulfilment of the requirements
for the award of the degree of
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NOVEMBER 2008

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project report and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing.

Signature : ______________________
Name of Supervisor : LEE GIOK CHUI, SMP,KMN
Date : 14 NOVEMBER 2008

Signature : ______________________
Name of Panel : SALWANI SALLEH
Date : 14 NOVEMBER 2008

STUDENT'S DECLARATION

"I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree"

Signature : …………………………….
Name : ROHAIDA BINTI MOHD
ID Number : ME05018
Date : 14 NOVEMBER 2008

SPECIAL DEDICATED TO MY BELOVED FATHER MOHD BIN UMAR,

MOTHER ESAH BINTI ISMAIL, SIBLINGS

&

MY SUPERVISOR, MR LEE GIOK CHUI

FOR THEIR SUPPORT AND CARE…..

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ABSTRACT

Cutting fluid is one of the important things in machining but it has many detrimental effects such as environmentally harmful and can cause skin and lung disease. Otherwise, cost of cutting fluid also had been issues lately because it frequently higher than cost of cutting tools and influence amount total machining cost. Because of that, dry machining and minimum quantity lubricant become alternatives to solve this problem. Objective of this project is identifying the effect of using minimum quantity lubricant compare with dry and wet machining on surface roughness. Three different materials are choosing as material test based on their hardness. There are ASTM B176 brass, AISI 1060 alloy and AISI 4340 steel. The experiment will performed under three different condition which are dry machining, minimum quantity lubricant and wet machining and will be conducted on lathe machine. After finished the experiment, it have find out that surface roughness grow slowly under minimum quantity lubricant continued by dry machining and wet machining. It means minimum quantity lubricant produced better surface finished compared with dry and wet machining. The result can significantly reduce cost and environmental pollution by using minimum quantity lubricant.

ABSTRAK

Cecair pemotongan adalah salah satu benda yang penting dalam pemesinan tetapi ia mempunyai banyak kesan yang merosakkan seperti membahayakan persekitaran dan akan menyebabkan kanser kulit dan paru-paru. Selain itu kos cecair pemotogan juga menjadi satu isu kebelakangan ini kerana kos cecair pemotongan kebiasaannye lebih tinggi daripada kos alat pemotong dan mempengaruhi kos keseluhan pemesinan. Oleh sebab itu, pemesinan secara kering, minimum kuantiti pelincir dan pemesinan secara basah menjadi alternatif untuk menyelesaikan masalah ini. Objektif projek ini adalah untuk mengenalpasti kesan penggunaan keadaan pelinciran yang berbeza terhadap tahap kekasaran permukaan. Tiga jenis bahan berlainan dipilih sebagai bahan ujikaji berdasarkan tahap kekerasannye. Ia terdiri daripada ASTM B176 brass, AISI 1060 alloy and AISI 4340 steel. Eksperimen ini dijalankan dengan tiga keadaan pelinciran iaitu pemesinan secara kering, minimum kuantiti pelincir dan pemesinan secara basah dengan menggunakan mesin larik. Selepas selesai menjalankan eksperimen, didapati kekasaran permukaan bertambah dengan perlahan menggunakan minimum kuantiti pelincir diikuti dengan pemesinan secara kering dan pemesinan secara basah. Ini bermaksud minimum kuantiti pelincir menghasilkan permukaan penyudah yg lebih baik dibandingkan dengan pemesinan secara kering dan basah. Keputusan itu bermakna kos dan pencemaran persekitaran dapat dikurangkan dengan menggunakan minimum kuantiti pelincir.

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LIST OF ABBREVIATIONS

Al	Aluminium
ASTM	American Society for Testing and Materials
GPa	Giga Pascal
MPa	Mega Pascal
SAE	Society of Automotive Engineers

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Cutting fluid or coolant is a liquid that important to reduce the friction coefficient between the grain and the workpiece by way of cooling and lubricating the cutting site of machine tools. The main purpose of using cutting fluid in machining process is to reduce cutting temperature and helps in carrying away the heat and debris produced during machining. It also can improve tool life and surface conditions.

Cutting fluids is one of important thing in machining but it has many detrimental effects. Many of the fluids, which are use in machining contain environmentally harmful or potentially damaging chemically constituents. These fluids are difficult to dispose and expensive to recycle. It also can cause skin and lung disease to the operator. For the companies, the amount of total machining cost influence by costs of cutting fluid. The cost relate to cutting fluids are frequently higher than those related to cutting tools. Consequently, elimination on the use of the cutting fluids if possible can be significant economic incentive. Because of that, alternatives has been sought to minimize using of cutting fluid in machining operations. Some of the alternatives are dry machining and minimum of lubricant [1][3].

Hence the implementation of machining without coolant (dry machining) will bring down the manufacturing cost but can cause tool wear problems and low surface finish. Minimum quantity of lubricant also can cut cost and produce better surface finish than cutting dry.

The main objectives of this research experimentally investigated the role of minimum lubricant on surface roughness in turning Aluminum Alloy, brass and steel by using carbide insert and compare the effectiveness of minimum lubricant with difference condition which is dry and wet machining.

1.2 PROBLEM STATEMENT

1.2.1 Problem

The advantages of using cutting fluid have been questioned lately, due to several negative effects. Cutting fluid can cause skin and lung disease to the operator and air pollution to the nature. For the companies, cost of the cutting fluid influence the amount of total machining cost. It means these company enforce spend a lot of money for cutting fluid. Elimination of using cutting fluid or dry machining can be significant to economic incentive but can cause tool wear problems and low surface finish.

1.2.2 Solution of the problems

Some of the alternatives has been sought to minimize the using of cutting fluid without decrease surface quality. For these situations, semi dry or minimum quantity lubricant is a best way because beside will produce better surface finish, it also will bring down manufacturing cost and relieve pollution and risk of lung disease.

1.3 OBJECTIVE

The objectives of this study are to:

i. Identify the effect of using minimum quantity lubricant compare with dry and wet machining on surface roughness.
ii. Identify effectiveness of minimum quantity lubricant when time machining increase.

1.4 SCOPE OF THE PROJECT

i. Test different conditions of lubricant on different type of material.
ii. Test effect of different conditions of lubricant on surface roughness.
iii. Operating of lathe machine
iv. Using perthometer to test surface roughness

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is discussing on some literatures review related to effect of cutting fluid condition on surface roughness by using lathe machine.

2.2 CUTTING FLUID

Cutting fluid is a liquid added to reduce the friction coefficient between the grain and workpiece by way of cooling and lubricating [8] the cutting site of machine tools by flooding or spraying. The main purpose of using cutting fluid in machining process is to reduce cutting temperature [1][2][3][5]. The cutting fluid also can improve tool life [4] and surfaces conditions [1][2][3][5][6] beside in carrying away the heat and debris produced during machining [2]. The cutting fluid has many detrimental effects. Many of the fluids, which are use in machining contain environmentally harmful or potentially damaging chemically constituents. These fluids are difficult to dispose and expensive to recycle. It also can cause skin and lung disease to the operator. For the companies, the amount of total machining cost influence by costs of cutting fluid. The cost relate to cutting fluids are frequently higher than those related to cutting tools [1][2][3][5][6][9]. As reported by some authors, metal working fluids cost ranges from 7 to 17% of the total machining cost while the tool cost ranges from 2 to 4% [4]. The base of specially prepared cutting fluid is commercially available mineral oil. The cutting fluid contains coolant, lubricant and additives such as surfactant, evaporator, emulsifier, stabilizer, biocide and deodorizing agent [7].

2.2.1 Soluble Cutting Oils

Water is an excellent cooling medium but has little lubricating value and hastens rust and corrosion. Therefore, mineral oils or lard oils which can be mixed with water are often used to form cutting oil. A soluble oil and water mix has lubricating qualities dependent upon the strength of the solution. Generally, soluble oil and water is used for rough cutting where quick dissipation of heat is most important. Borax and trisodium phosphate (TSP) are sometimes added to the solution to improve its corrosion resistance [13].

2.3 MACHINING CONDITIONS

Table 2.1: Recommended Lubrication Condition

MATERIAL	CUTTING OIL	
	Heavy Cutting	Light Cutting
Aluminum	-Dry -Soluble cutting oil	-Dry
Brass	-Dry -Soluble cutting oil	-Dry
Steel	-Soluble cutting oil	-Soluble cutting oil

2.3.1 Dry Machining

Dry machining is elimination on the use of cutting fluid. The interest in dry machining is often related to the low cost [2], healthy issues and environmentally friendly [1][3].Dry machining requires less power [8] .However, they are sometimes less effective [1][3]. This is because in dry machining higher order friction between tool and work and between tool and chip can lead to high temperature in the machining zone [2]. This high temperature at the machining zone will ultimately cause dimensional inaccuracies for the work piece and too wear problems [2] and also produce less surface finish.

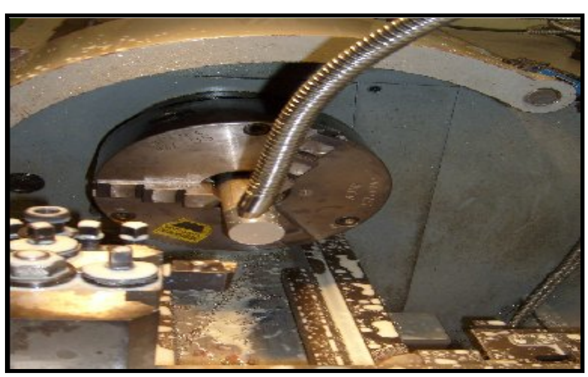


Figure2.1: Dry Machining

2.3.2 Minimum Quantity Lubricant

Minimum lubricant also known as semi-dry machining refers to the use of cutting fluids of only a minute amount-typically of a flow rate of 50-500ml/h. Which is about three to four orders of magnitude lower than the amount commonly use in flood cooling conditions [1][2][3][5]. Minimum quantity lubricant which can be regarded as replacement of dry machining [2] and also be considered as alternative to flood cooling [4][5]. The concepts of minimum quantity lubricant, sometimes referred to as near dry machining or micro lubrication [1][2][3][8]. Minimum quantity lubricant has been suggested a decade ago as a means of addressing the issues of environmental intrusiveness [5] and occupational hazards associated with the airbone cutting fluids particles on factory shop floors [1][3]. The minimization of cutting fluids also leads to economical benefits by way of saving lubricant cost, workpiece and tool [1][2][3]. Minimum lubricant with rapeseed oil has only a small lubricating effect in light loaded machining conditions. This was because the boundary film formed on the tool surface is not strong enough to sustain low friction and avoid adhesion of work material but minimum quantity lubricant with water droplets showed good lubrication performance during the same cutting conditions [1][2][3].

Figure 2.2: Minimum Quantity Lubricant

2.3.3 Wet Machining

In wet machining, both the tool and the workpiece are cooled using large quantities of lubricant. The coolant is subsequently cleansed and used again [1][3].

Figure 2.3: Wet Machining

2.4 LATHE MACHINE

The lathe is a one of the machine tools most well used by machining. It used principally for shaping pieces of metaland sometimes wood or other materials by causing the workpiece to be held and rotated by the lathe while a tool bit is advanced into the work causing the cutting action. The basic lathe that was designed to cut cylindrical metal stock has been developed further to produce screw threads, tapered work, drilled holes, knurled surfaces, and crankshafts. In order to get an efficient process and beautiful surface at the lathe machining, it is important to adjust a rotating speed, a cutting depth and sending speed.[6] Lathes must be lubricated and checked for adjustment before operation[15].

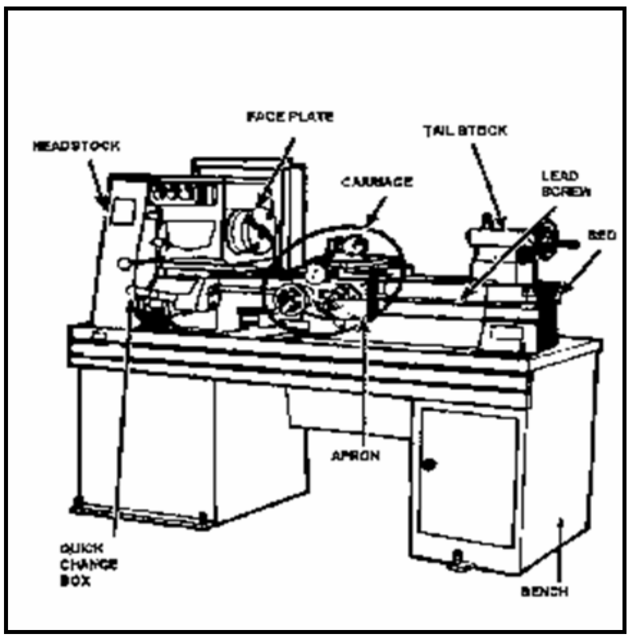


Figure 2.4: Lathe Machine

Source: America machine tools co. Instructions to Learn How to use a Lathe

2.4.1 Turning operation

Turning is another of the basic machining processes. Turning produces solids of revolution which can be tightly tolerance because of the specialized nature of the operation. Turning is performed on a machine called a lathe in which the tool is stationary and the part is rotated [15].

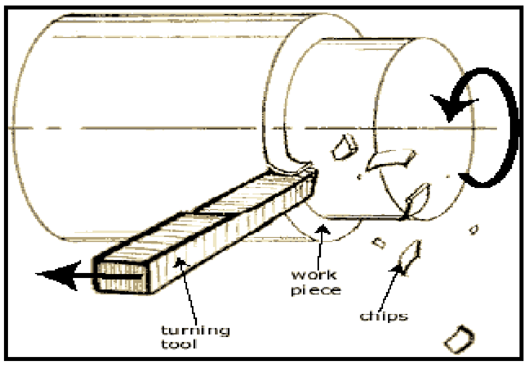


Figure 2.5: Cutting in Turning

2.5 MACHINING PARAMETERS

Table 2.2: Recommended Starting Parameters for Lathe Machine

MATERIAL	DEPTH(in)	FEED PER REV	CUTTING SPEED(fpm)
Aluminum	0.005-0.015	0.002-0.005	700-1000
	0.020-0.090	0.005-0.015	450-700
	0.100-0.200	0.015-0.030	300-450
Brass	0.005-0.015	0.002-0.005	700-800
	0.020-0.090	0.005-0.015	600-700
	0.100-0.200	0.015-0.030	500-600
Tool Steel	0.005-0.015	0.002-0.005	500-750
	0.020-0.090	0.005-0.015	400-500
	0.100-0.200	0.015-0.030	300-400

2.5.1 Cutting Speed

Cutting speed (V) is the largest of the relative velocities of cutting tool or workpiece [10]. It expressed with the number of rotations (rpm) of the chuck of the lathe. It is better to set low rotating speed at the first range. Cutting speeds depend on the kind of material are cutting and the kind of cutting tool are using.The harder the work material, the slower the cutting speed [figure 5]. The harder the cutting tool material, the faster the cutting speed [figure 6]. When the rotating speed is high, processing speed becomes quick, and a processing surface is finely finished.

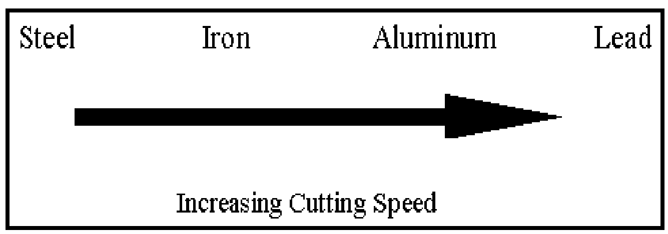


Figure 2.6: Relation between work material and cutting speed

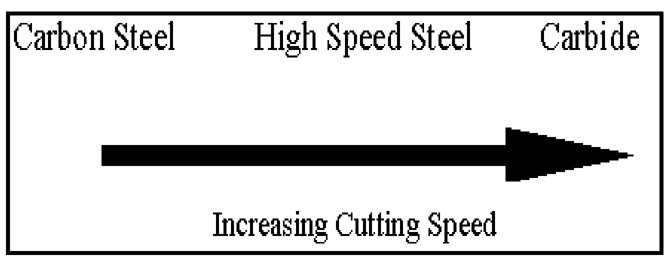


Figure 2.7: Relation between cutting tool material and cutting speed

2.5.2 Depth of Cut

Depth of cut (d) is the distance the cutting tool penetrates into the workpiece [10]. The cutting depth of the tool affects to the processing speed and the roughness of surface. When the cutting depth is big, the processing speed becomes quick, but the surface temperature becomes high, and it has rough surface. Moreover, a life of bite also becomes short. If suitable cutting depth is unknown, it better to start machining with small cutting depth [10].

2.5.3 Feed Rate

Feed also known as sending speed [13]. Feed (f) is movement of the tool per revolution. In turning, it is the distance the tool travels in one revolution of the workpiece and is given the units of mm/rev or in./rev[10]. When the feed is high, the processing speed becomes quick. When the feed is low, the surface finish is beautiful. There are manual sending which turns and operates a handle and automatic sending which advances a byte automatically. A beginner must use the manual sending because of serious accidents may be caused such as touching the rotating chuck around the byte in automatic sending [10].

2.6 CUTTING TOOLS

The lathe cutting tool or tool bit must be made of the correct material and ground to the correct angles to machine a workpiece efficiently. Lathe tool bit shapes can be pointed, rounded, squared off, or irregular in shape and still cut quite well as long as the tool bit angles are properly ground for the type of material being machined. The angles are the side and back rake angles, the side and end cutting edge angles, and the side and end relief angles. Rake angle pertains to the top surface of the tool bit. There are two types of rake angles, the side and back rake angles. The rake angle can be positive, negative, or have no rake angle at all. Rake angles cannot be too great or the cutting edge will lose strength to support the cutting action. The side rake angle determines the type and size of chip produced during the cutting action and the direction that the chip travels when leaving the cutting tool. Side and relief angles, or clearance angles, are the angles formed behind and beneath the cutting edge that provide clearance or relief to the cutting action of the tool. There are two types of relief angles, side relief and end relief. The overall shape of the lathe tool bits can be rounded, squared, or another shape as long as the proper angles are included. Tool bits are identified by the function they perform, such as turning or facing. They can also be identified as roughing tools or finishing tools.

2.6.1 Material of Lathe Cutting Tools

The most common tool bit is the general all-purpose bit made of high-speed steel. These tool bits are generally inexpensive, easy to grind on a bench or pedestal grinder, take lots of abuse and wear, and are strong enough for all-around repair and fabrication. High-speed steel tool bits can handle the high heat that is generated during cutting and are not changed after cooling. These tool bits are used for turning, facing, boring and other lathe operations. Tool bits made from special materials such as carbides, ceramics, diamonds, cast alloys are able to machine workpieces at very high speeds but are brittle and expensive for normal lathe work[12].

2.6.2 Carbide Cutting Tools

In industry today, carbide tools have replaced high-speed steels in most applications. These carbide and coated carbide tools cut about 3 to 5 times faster than high-speed steels. The major categories of hard carbide include tungsten carbide, titanium carbide, tantalum carbide, and niobium carbide. Each type of carbide affects the cutting tool's characteristics differently. A higher percentage of cobalt binder increases strength, but lowers the wear resistance. Carbide is used in solid round tools or in the form of replaceable inserts. The proper choice of carbide can double tool life or double the cutting speed of the same tool. Harder, chemically-stable types are required for high speed finishing of steel. Two-thirds of all carbide tools are coated.

2.7 SURFACE ROUGHNESS

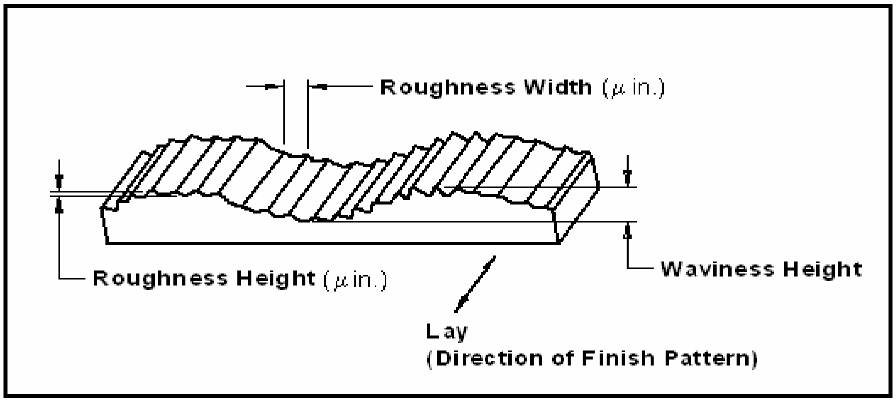


Figure 2.8: Surface Roughness

Surface roughness is the measure if the finer surface irregularities in the surface texture. The ability of manufacturing operation is base on many factors. The final surface depends on the rotational speed of the cutter, velocity of traverse, feed rate and mechanical properties of workpieces being machined. Type and amounts of lubricant use at the point of cutting also influence the surface produce.[4] Surface roughness grew very slowly under MQL conditions while grew quite fast under dry machining due to more intensive temperature and stresses. Surface finishes improved mainly due to reduction of wear and damage at the tool tip by the application of MQL. Such reduction in tool wear would either improvement in tool life or enhancement of productivity allowing higher cutting velocity and feed.[3].There are some of equipment to measure surface roughness like Hommelwerke T1000 profilometer [2], scanning electron microscope[4][7], perthometer S2 and Talysurf[1][3].

2.8 PERTHOMETR S2

The evaluation unit Perthometer S2 is featured by:

- Roughness and waviness measurements according to current standards (DIN EN ISO 3274, e.g. band-pass filter)
- A large high resolution graphics display to indicate results and profiles
- Easy operation based on the automatic teller principle and large operation buttons
- Storage facility on PCMCIA memory card for measuring programs, results and profiles
- Add-On program S2Prog for easy creation of measuring programs
- Extensive, easily applicable software functions, such as
  - automatic function for setting standardized filters and tracing lengths
  - Monitoring of calibration and maintenance intervals
  - ARC function for arc elimination
  - Dynamic and static calibration routines
  - Tolerance monitoring with sound and optical signals
  - Blocking of instrument settings to prevent unintentional modifications

plus possibility of password protection

- Integrated statistical functions

- Easy call-up and printout of measuring records and individual functions

Figure 2.9: Perthometer S2

2.9 CHIP FORMATION

2.9.1 Continuous chip

Continuous chips are normally produced when machining steel at high cutting speeds. The continuous chip which is like a ribbon flows along the rake face. Production of continuous chips is possible because of the ductility metal (steel at high temperature generated due to cutting) flows along the shear plane instead of rupture. Thus, on a continuous chip do not see any notches. It can be assumed that each layer of metal flows along the slip plane till it is stopped by work hardening. The condition which favor a continuous types of chip:

(i) High temperature
(ii) Sharp cutting tool
(iii) Fine feed
(iv) Larger rake angles
(v) High cutting speed
(vi) Ductile work material
(vii) Proper coolant

2.9.2 Non-Continuous chip

When brittle materials like cast iron are cut, deformed material gets fractured very easily and thus the chip produced is in the form of non-continuous segments. In this type the deformed material instead of flowing continuously gets ruptured periodically. Non-continuous chip are easier from the view point of chip disposal. However, the cutting force becomes unstable with the variation coinciding with the fracturing cycle. The condition which favor a non-continuous type of chip

(i) Low cutting speeds
(ii) Small rake angles on cutting tool
(iii) Brittle work material
(iv) Coarse machining feeds
(v) Major disadvantages – could result in poor surface finish

2.10 WORK MATERIAL

This is some properties of 1060 Aluminum Alloy, ASTM B176 Brass and AISI 4340 Steel. Properties consist of category, hardness, tensile strength, density and elastic modulus.

Table 2.3: Properties of material

PROPERTIES	MATERIAL		
	1060 Aluminum Alloy	ASTM B176 Brass	AISI 4340 Steel
Category	Aluminum Alloy	Copper Alloy	Steel
Hardness (HB)	23	55	217
Tensile Strength (Mpa)	83	379	472.3
Density (×1000 kg/m^3)	2.7	8.8-8.94	7.7-8.03
Elastic Modulus (GPa)	70-80	117	190-210

CHAPTER 3

PROJECT METHODOLOGY

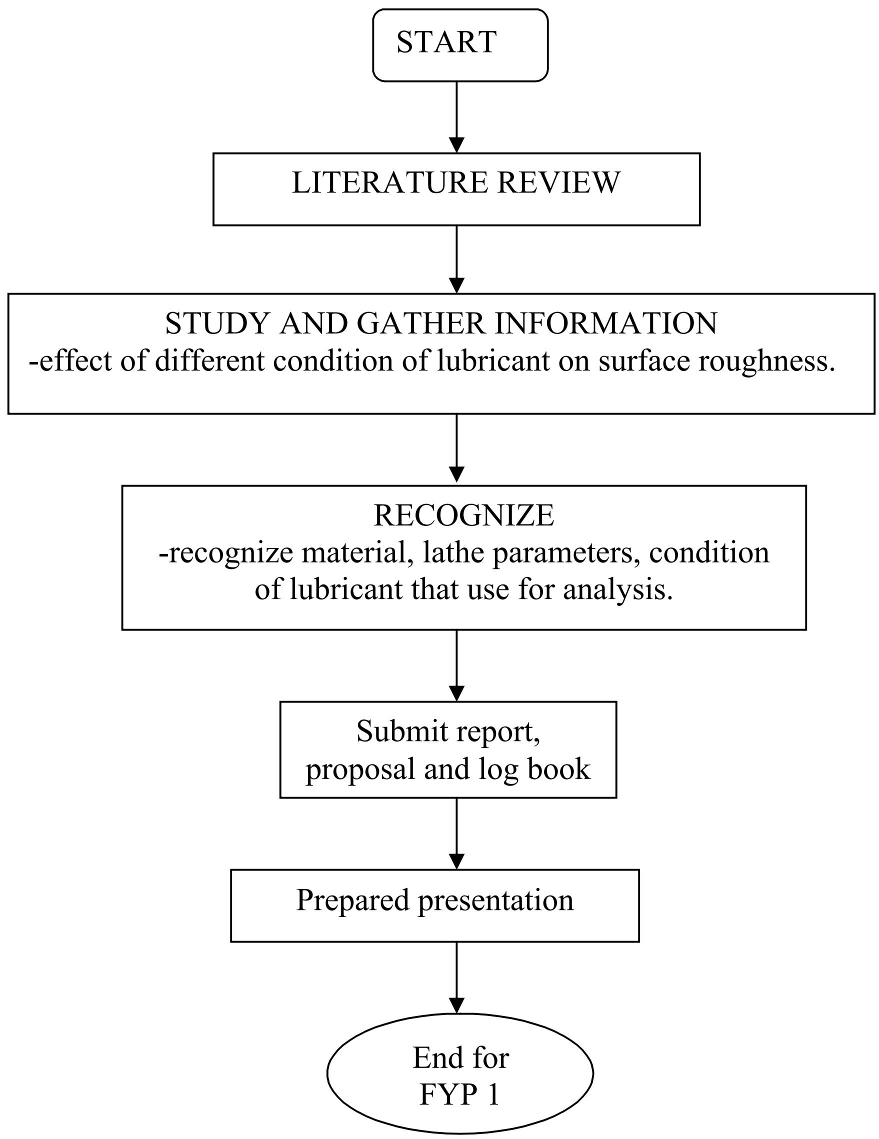
3.1 INTRODUCTION

Methodology is an important element in a project where it specifically describes the method that will used in this project. It also as guideline to ensure the project flow that have planned at the beginning will follow. Methodology also will help in order to make sure that the research run smoothly until get the result and achieve the project objective. Both of flow chart below is the flow of project procedures have been taken to achieve the project objectives.

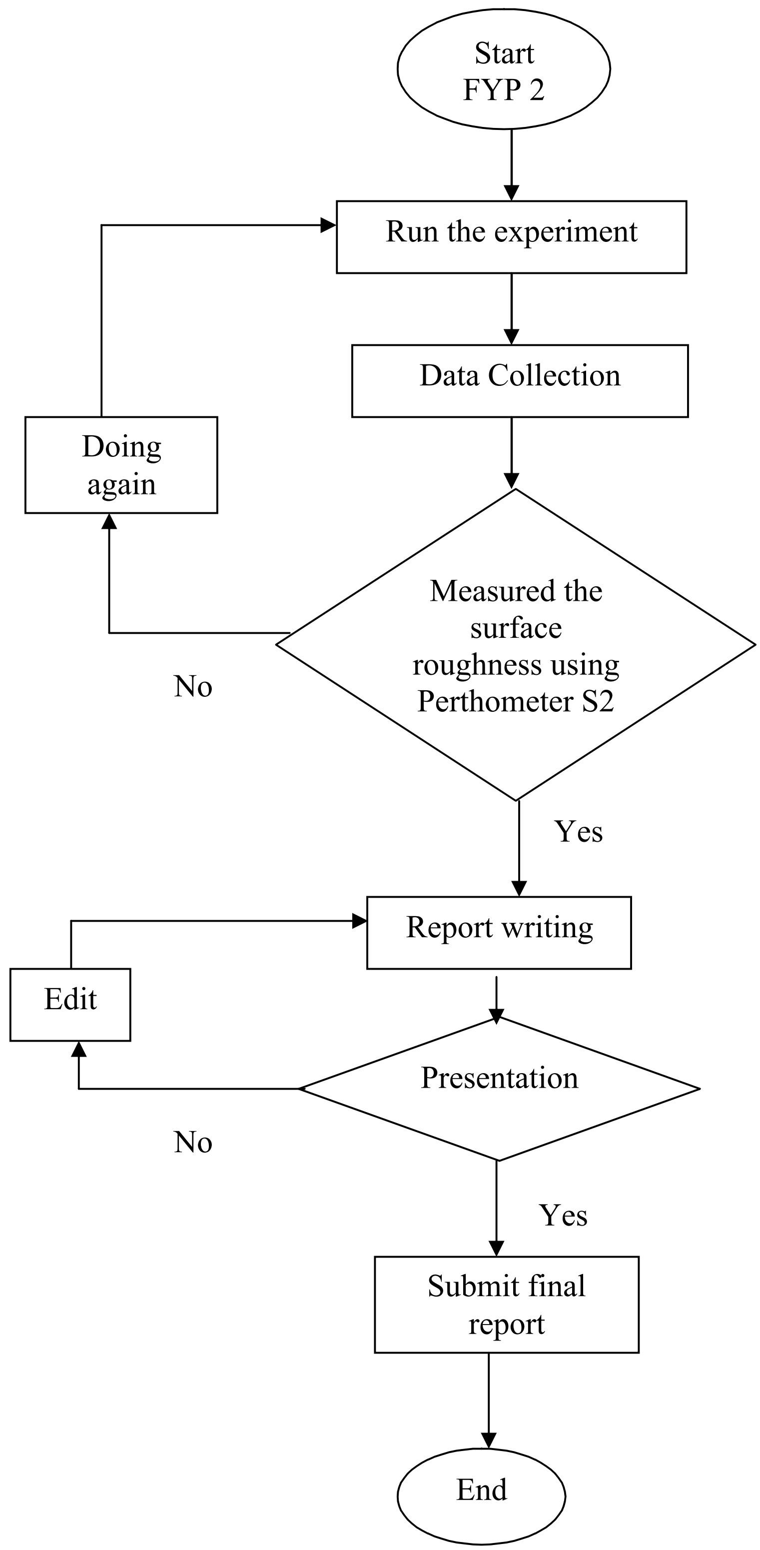
The experiments were conducted on lathe machine and have been carried out by turning process 30mm diameter and 150 mm long rod each. 1060 Aluminum Alloy, ASTM B176 Brass and AISI 4340 steel had selected as work material. From the experiment, cutting speed (V_c), feed rate (s_o), and depth of cut (t) were fixed at 110 m/min, 0.18 mm/rev and 0.6mm respectively. Coated carbide has selected as cutting tools. The experiments will performed under three different coolant environments of dry cutting, minimum lubricant and wet machining condition. For flooded, flowrate will apply at 1800ml/h while for minimum lubricant flowrate will apply at 300ml/h. Surface roughness for these specimens will test using Perthometer S2.

3.2 FLOW CHART

3.2.1 Flow Chart/ Project Flow for Final Year Project I (FYP)



3.2.2 Flow Chart/ Project Flow for Final Year Project II (FYP)



3.3 FIND INFORMATION

After finding information which related about this topic from reference book, previous journal, internet and discussion with supervisor, I had clearly understood about this topic. This topic discuss about effect of lubrication condition on surface roughness by using lathe machine.

Lathe is a machine tool which turns cylindrical material, touches a cutting tool to it and cuts the material. The lathe is one of the machine tools most well use by machining. In order to get an efficient process and beautiful surface roughness at the lathe machining, it is important to adjust a rotating speed, a cutting depth and a sending speed. These parameters cannot decide easily because these suitable values are quite different by materials, size and shapes of the part. Due to my studied, find that minimum quantity lubricant in end-milling process is very much effective. This is considering because lubricant can reach the tool more easily in milling operations. However, in this research lathe machine were choose because effectiveness minimum quantity lubricant in turning process want to investigate.

There are three conditions of lubrication which are dry machining, minimum quantity lubricant and wet machining. Dry machining means elimination on the use of cutting fluid while wet machining means both the tool and the workpiece are cooled using large quantities of lubricant. Minimum quantity lubricant also known as semi-dry machining refers to the use of cutting fluids of only a minute amount-typically of a flow rate of 50-500ml/h.

Each material and condition will machine four times for 2 minutes, 4 minutes, 6 minutes and 8 minutes.

Metal cutting fluids changes the performance of machining operations because of their lubrication, cooling, and chip flushing functions but the use of cutting fluid become more problematic. Knowing that disadvantages of cutting fluid in terms of cost, employee health and environmental pollutions. Because of these disadvantages, some alternatives has been sought to minimize or even avoid the use of cutting fluid in machining operations. Some of the alternatives are dry machining and minimum quantity lubricant.

Know how to handle and operating lathe machine and can recognize each part of lathe machine, function, parameter, specifications, tool and others.

Surface roughness is the measure if the finer surface irregularities in the surface texture. There are some of equipment to measure surface roughness like Hommelwerke T1000 profilometer, scanning electron microscope, perthometer S2 and Talysurf.

The most common tool bit is the general all-purpose bit made of high-speed steel. These tool bits are generally inexpensive, easy to grind on a bench or pedestal grinder, take lots of abuse and wear, and are strong enough for all-around repair and fabrication. High-speed steel tool bits can handle the high heat that is generated during cutting and are not changed after cooling. These tool bits are used for turning, facing, boring and other lathe operations. Tool bits made from special materials such as carbides, ceramics, diamonds, cast alloys are able to machine workpieces at very high speeds but are brittle and expensive for normal lathe work.

3.4 MATERIAL

The materials that will apply for the test are 1060 Aluminium Alloy, ASTM B176 brass and AISI 4340 steel. All material has chosen based on their hardness. Each material of the specimens was cut off in required length which is 150mm and the diameter was 30mm each. All the dimension of the material is constant. Table 4.1 below shows prediction of quantity of workpiece needed while table

Table 3.1: Prediction of quantity of workpiece needed

MATERIAL	CONDITION			TOTAL
	Dry Machining	Minimum Lubricant	Wet Machining	
1060 Aluminium Alloy	3	3	3	9
ASTM B176 brass	3	3	3	9
AISI 4340 Steel	3	3	3	9
TOTAL	9	9	9	27

Table 3.2: Material Hardness

MATERIAL	HARDNESS(HB)
1060 Aluminum Alloy	23
ASTM B176 brass	55
AISI 4340 Steel	217

3.5 LUBRICATION CONDITION

The experiments were performed under three different coolant environments of dry cutting, minimum quantity lubricant and wet machining condition. For flooded, flowrate will apply at 1800ml/h while for minimum quantity lubricant flowrate will apply at 500ml/h. Table below shows type of material and lubrication condition use.

Table 3.3: Lubrication Condition

MATERIAL	CONDITION		
	Dry machining	Minimum quantity Lubricant	Wet machining
1060 Aluminium Alloy			
ASTM B17 6 brass			
AISI 4340 Steel			

3.6 CUTTING TOOLS

Coated carbide has selected as cutting tools to eliminate the effect of tool coating on the result. Carbide also selected because carbide tools cut about 3 to 5 times faster than high-speed steels.

Shape of tool bit:	Rounded
Angle of tool bit:	80 Degree

3.7 CONSTANT PARAMETERS

Machining parameters for lathe machine were selected base on the tool manufacturer's recommendation. From the experiment, cutting speed (V_c), feed rate (S_o) and depth of cut (t) were fixed at 110m/min. 0.18 mm/rev and 0.6 mm respectively.

3.8 SURFACE ROUGHNESS

The surface roughness machine known as Perthometer S2 will be use to measure the surface finishes for each material. It will analyze base on the surface produce.

3.9 PROCESS OF MACHINING

i. Clean and lubricate the machine.
ii. Be sure all guards are in position and locked in place.
iii. Turn the spindle over by hand to be sure it is NOT locked nor engaged in back gear.
iv. Move the carriage along the ways.
v. Adjust the drive mechanism for the desired speed and feed.
vi. If the tailstock is used, check it for alignment.
vii. Clamp the cutter bit into an appropriate tool holder and mount it in the tool post. Do NOT permit excessive compound rest overhang as this often causes tool "chatter" and results in a poorly machined surface.
viii. Mount the work. Check for adequate clearance between the work and the various machine parts.
ix. In addition, to the above procedures, the operator must take some precautions. Sleeves should be rolled up and rings, jewelry and necktie or necklace removed.

Figure 3.1: chucking the workpiece

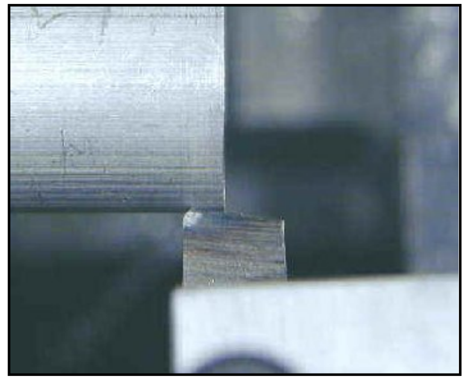


Figure 3.2: adjusting the toolbit

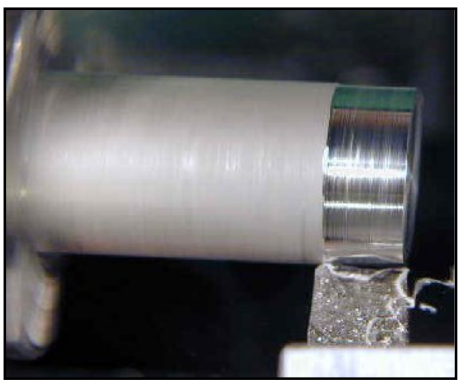


Figure 3.3: Turning process

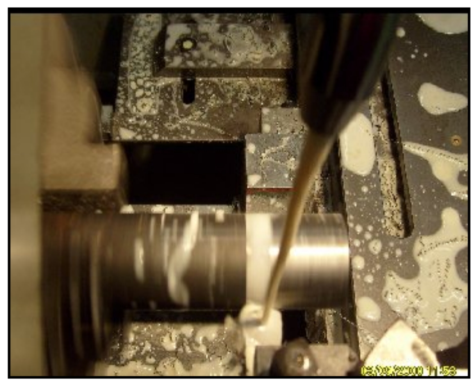


Figure 3.4: Lubrication process

3.10 RECORDING DATA

The data will be recorded in Table 7 based machining time for 2 minutes, 4 minutes, 6 minutes and 8 minutes. Each table separated based on condition condition of lubricant and type of material. The difference condition of lubricant will be applied on workpiece and surface roughness will measure using perthometer S2.

Table 3.4: Recording data

MATERIAL	SURFACE ROUGHNESS, R(µm)			
	Dry Machining			
	Reading 1	Reading 2	Reading 3	Average reading
1060 Aluminium Alloy				
ASTM B176 Brass				
AISI 4340 Steel				
	Minimum Quantity Lubricant			
1060 Aluminium Alloy				
ASTM B176 Brass				
AISI 4340 Steel				
	Wet Machining			
1060 Aluminium Alloy				
ASTM B176 Brass				
AISI 4340 Steel				

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter discusses the experimental result that obtained after done the process in methodology. Then all data had summarized in table and graph. Result will show in table of surface roughness and graph which discuss in experimental result.

Surface roughness is the measure if the finer surface irregularities in the surface texture. The ability of manufacturing operation is base on many factors. The final surface depends on the rotational speed of the cutter, velocity of traverse, feed rate and mechanical properties of workpieces being machined. Type of lubricant and type of lubrication condition use at the point of cutting also influence the surface produce. Lubrication condition is one of important consideration when machining because it related to cost and environmental problem. There are 3 lubrication condition consist of dry machining, minimum quantity lubricant and wet machining.

4.2 EXPERIMENTAL RESULT

All experiment result had fill in surface roughness table base on their machining time. Data in each table had analyzed using graph machining time (min) versus surface roughness, R(µm).

4.3 SURFACE ROUGHNESS

After all experiment had been conducted, surface roughness for 1060 Aluminium Alloy, ASTM B176 Brass, and AISI 4340 Steel of each condition had measured using perthometer S2. All the data had filled in table 4.1, 4.2, 4.3, and 4.4 based on their machining time which is 2 min, 4min, 6min, and 8 min respectively. Each condition takes average for three times reading to make sure it more accurate.

Table 4.1: Surface Roughness for Machining Time 2 minutes

MATERIAL	SURFACE ROUGHNESS, R(µm)			
	Dry Machining			
	Reading 1	Reading 2	Reading 3	Average reading
1060 Aluminium Alloy	0.196	0.198	0.189	0.194
ASTM B176 Brass	0.472	0.498	0.512	0.494
AISI 4340 Steel	2.814	2.798	2.863	2.825
	Minimum Quantity Lubricant			
1060 Aluminium Alloy	0.164	0.178	0.135	0.159
ASTM B176 Brass	0.337	0.346	0.298	0.327
AISI 4340 Steel	2.512	2.562	2.601	2.558
	Wet Machining			
1060 Aluminium Alloy	0.310	0.296	0.289	0.298
ASTM B176 Brass	0.622	0.619	0.588	0.610
AISI 4340 Steel	3.212	3.169	3.245	3.209

Table 4.2: Surface Roughness for Machining Time 4 minutes

MATERIAL	SURFACE ROUGHNESS, R(µm)			
	Dry Machining			
	Reading 1	Reading 2	Reading 3	Average reading
1060 Aluminium Alloy	0.451	0.487	0.465	0.468
ASTM B176 Brass	0.832	0.943	0.887	0.887
AISI 4340 Steel	3.228	3.386	3.372	3.329
	Minimum Quantity Lubricant			
1060 Aluminium Alloy	0.345	0.367	0.310	0.341
ASTM B176 Brass	0.571	0.577	0.589	0.579
AISI 4340 Steel	2.762	2.756	2.787	2.768
	Wet Machining			
1060 Aluminium Alloy	0.620	0.632	0.665	0.639
ASTM B176 Brass	1.047	0.987	0.954	0.996
AISI 4340 Steel	3.429	3.486	3.512	3.476

Table 4.3: Surface Roughness for Machining Time 6 minutes

MATERIAL	SURFACE ROUGHNESS, R(μm)			
	Dry Machining			
	Reading 1	Reading 2	Reading 3	Average reading
1060 Aluminium Alloy	0.642	0.654	0.721	0.672
ASTM B176 Brass	1.096	0.998	0.887	0.993
AISI 4340 Steel	3.542	3.534	3.568	3.548
	Minimum quantity Lubricant			
1060 Aluminium Alloy	0.420	0.432	0.476	0.443
ASTM B176 Brass	0.682	0.673	0.721	0.692
AISI 4340 Steel	2.987	2.965	3.042	2.998
	Wet Machining			
1060 Aluminium Alloy	0.842	0.854	0.912	0.869
ASTM B176 Brass	1.198	1.012	1.542	1.251
AISI 4340 Steel	3.625	3.698	3.742	3.668

Table 4.4: Surface Roughness for Machining Time 8 minutes

MATERIAL	SURFACE ROUGHNESS, R(μm)			
	Dry Machining			
	Reading 1	Reading 2	Reading 3	Average reading
1060 Aluminium Alloy	0.840	0.865	0.913	0.873
ASTM B176 Brass	1.442	1.476	1.398	1.105
AISI 4340 Steel	3.656	3.625	3.588	3.623
	Minimum Quantity Lubricant			
1060 Aluminium Alloy	0.598	0.634	0.612	0.615
ASTM B176 Brass	0.922	1.080	0.978	0.993
AISI 4340 Steel	3.124	3.289	3.089	3.167
	Wet Machining			
1060 Aluminium Alloy	0.988	1.096	1.187	1.09
ASTM B176 Brass	1.402	1.394	1.389	1.395
AISI 4340 Steel	3.980	3.887	3.928	3.932

4.3.1 Surface Roughness Based On Material

All the data from table 4.1, 4.2, 4.3 and 4.4 will be simplified based on their material on table 4.5, 4.6 and 4.7. Table 4.5 surface roughness for 1060 Aluminium Alloy while table 4.6 surface roughness for ASTM B176 Brass and table 4.7 for AISI 4340 Steel. All the tables shows surface roughness consists of 3 different conditions which are dry machining, minimum quantity lubricant and wet machining. Each machining contains 4 reading for machining time 2min, 4min, 6min and 8 min. Each reading was taking 3 times to make sure it more accurate. Unit for machining time is minute while for surface roughness is μm. Cutting fluid flowrate was apply at 500ml/s for minimum quantity lubricant and 1800ml/s for wet machining.

From the tables it can see that surface roughness increase when time machining increase because of temperature produced. Temperature increased when time machining increase. Surface roughness value for steel higher than value for aluminium alloy and brass. This is because steel is more hardness than aluminium alloy and brass. Hardness value for steel is about 123 Hb.

Then all the data from the tables will analyzed into graph machining time(min) versus surface roughness(μm) and will shown in figure 4.1, 4.2 and 4.3.

4.3.1.1 Surface Roughness For 1060 Aluminum Alloy

Table 4.5: Surface Roughness for 1060 Aluminium Alloy

MACHINING CONDITION	MACHINING TIME (min)			
	2	4	6	8
Dry Machining	0.194	0.468	0.672	0.873
Minimum Quantity Lubricant	0.159	0.341	0.443	0.615
Wet Machining	0.298	0.639	0.869	1.090

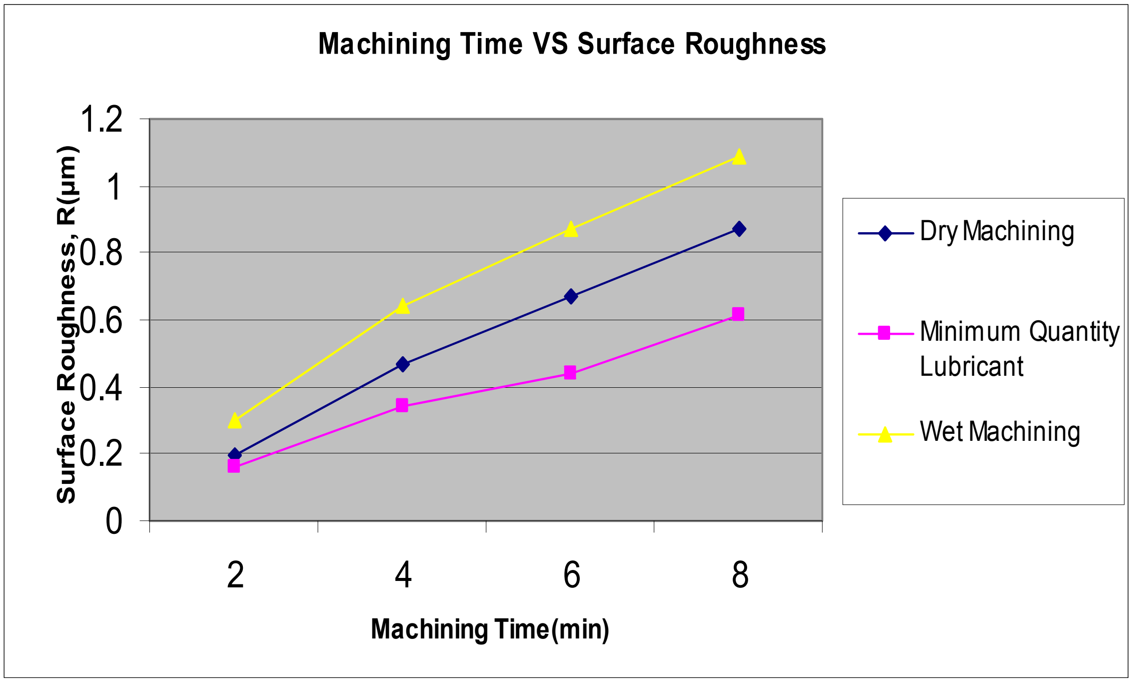


Figure 4.1: Graph Machining Time(min) versus Surface Roughness(μm) for 1060 Aluminium Alloy

Graph 4.1 shows machining time(min) versus surface roughness(μm) for 1060 Aluminium Alloy. The reading was taken for machining time 2 minute, 4 minute, 6 minute and 8 minute. There are 3 different colour lines which are blue, pink and yellow represent for different condition. Blue line represent for dry machining, pink for minimum quantity lubricant and yellow for wet machining.

It was observed that surface roughness grow slowly under minimum quantity lubricant continued by dry machining and wet machining. As it be can seen from value in figure 4.1, when time machining increase value for surface roughness also increase. It means so much machining time, so much temperature produce increase. In spite of that, minimum quantity lubricant still produces better surface roughness compare to wet machining.

Surface roughness grow faster under dry machining because in dry machining, higher order friction between tool and workpiece, and between tool and chip can lead to high temperatures in the machining zone. This high temperature at the machining zone will ultimately cause dimensional accuracies for the workpiece and tool wear problems.

Minimum quantity lubricant can deliver better life and surface roughness because of two reasons. First because of in minimum quantity lubricant give optimum concentration of lubrication can be specified and focused on cutting tool. Second because of minimum quantity lubricant can eliminating abrasive silicon particles suspended in the coolant. Aluminum workpieces contain approximately 13 percent silicon, which reduces tool life and leads to poor surface finishes. Fine aluminum/silicon particles can become suspended in wet machining coolant. While filtration systems eliminate 40-micron particles, particles smaller that 40 microns pass through the system to get recycled with the coolant.

4.3.1.2 Surface Roughness For ASTM B176 Brass

Table 4.6: Surface Roughness for ASTM B176 Brass

MACHINING CONDITION	MACHINING TIME (min)			
	2	4	6	8
Dry Machining	0.494	0.887	0.994	1.105
Minimum Quantity Lubricant	0.327	0.579	0.692	0.993
Wet Machining	0.610	0.996	1.251	1.395

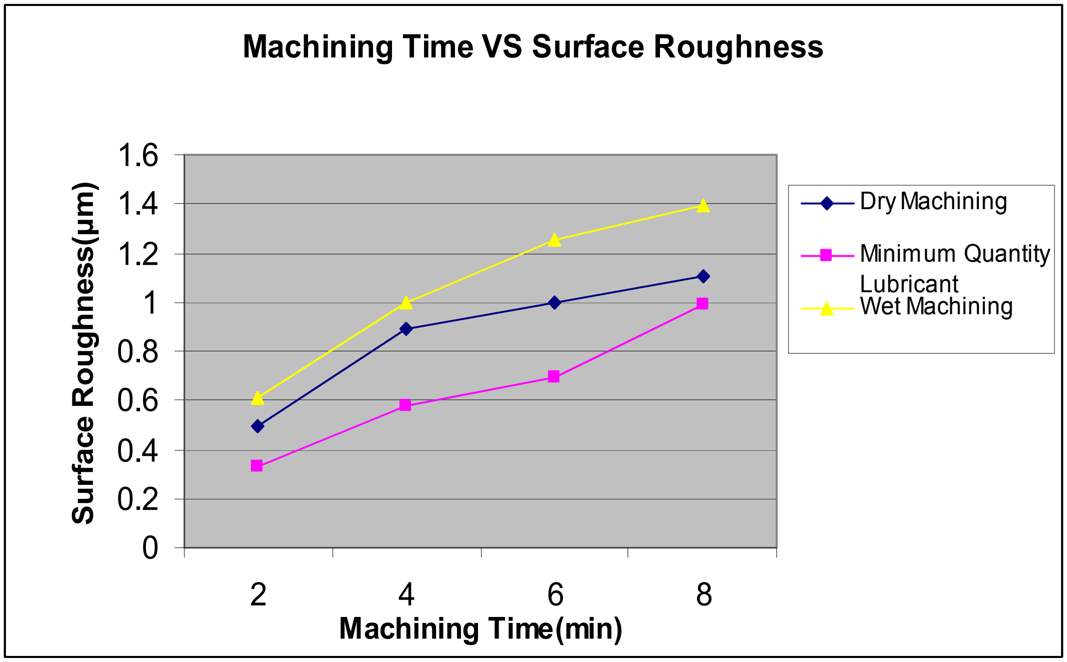


Figure 4.2: Graph Machining Time (min) versus Surface Roughness(µm) for ASTM B176 Brass

Graph 4.1 above shows machining time versus surface roughness for ASTM B176 Brass. The reading was taken from 2 minutes until 8 minutes and taken each 2 minutes.

As it can be seen from figure 4.2, surface roughness value for minimum quantity lubricant is lowest compare to dry and wet machining. For minimum quantity lubricant it starts from 0.327 µm at 2minutes and finish with 0.998 µm at 8 minutes while for dry machining starts from 0.494 µm and finished at 1.105 µm. For wet machining it start higher than other machining which is 0.610 µm and finished at 1.395 µm. It was observed that surface roughness grow slowly under minimum quantity lubricant continued by dry machining and wet machining for brass same likes aluminium alloy. Surface finishes improved mainly due to reduction of wear and damage at the tool tip by the application of minimum quantity lubricant

4.3.1.3 Surface Roughness for AISI 4340 Steel

Table 4.6: Surface Roughness for AISI 4340 Steel

MACHINING CONDITION	MACHINING TIME (min)			
	2	4	6	8
Dry Machining	2.825	3.329	3.548	3.623
Minimum Quantity Lubricant	2.558	2.768	2.998	3.167
Wet Machining	3.209	3.476	3.668	3.932

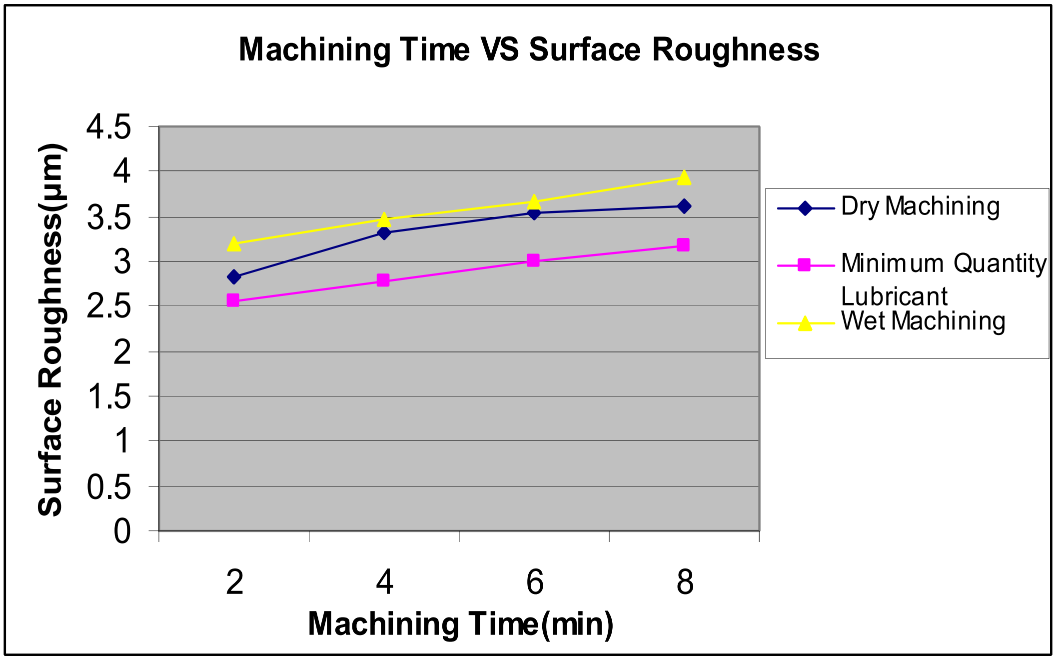


Figure 4.3: Graph Time Machining (min) versus Surface Roughness(µm) for AISI 4340 Steel

Figure 4.3 shows machining time versus surface roughness for AISI 4340 Steel. Every condition has 4 values for surface roughness which had taken at 2 min, 4 min, 6 min and 8 min.

Surface roughness for steel is higher than aluminium alloy and brass. As it can be seen from figure 4.3, surface roughness value for minimum quantity lubricant is lowest compare to dry and wet machining. For minimum quantity lubricant it starts from 2.558 µm at 2minutes and finish with 3.167 µm at 8 minutes while for dry machining starts from 2.825 µm and finished at 3.623 µm. For wet machining it start higher than other machining which is 3.209 µm and finished at 3.932 µm. For steel, surface roughness also grow slowly under minimum quantity lubricant continued by dry machining and wet machining for brass same likes aluminium alloy and brass. It means minimum quantity lubricant produced better surface finish compare with dry and wet machining.

4.4 CHIP FORMATION

Image of chip formation was taken for each material and condition for machining 2 minutes. There are 3 types of chip produced which are continuous chip, continuous chip with BUE and discontinuous chip. The continuous chip which is like a ribbon flows along the rake face. Thus, on a continuous chip do not see any notches. It can be assumed that each layer of metal flows along the slip plane till it is stopped by work hardening. The condition which favor a continuous types of chip like high temperature, sharp cutting tool, larger rake angles, high cutting speed and ductile work material. When brittle materials like cast iron are cut, deformed material gets fractured very easily and thus the chip produced is in the form of non-continuous segments. In this type the deformed material instead of flowing continuously gets ruptured periodically. Non-continuous chip are easier from the view point of chip disposal. However, the cutting force becomes unstable with the variation coinciding with the fracturing cycle. Discontinuous chip provide better surface finish. However in case of ductile materials they cause poor surface finishes and low tool life.

There are many factors that influence type of chip produced such as cutting speed, depth of cut, type of coolant, rake angle and lubrication condition. In this experiment all the factors are fixed except lubrication condition.

4.4.1 Chip Formation for 1060 Aluminium Alloy

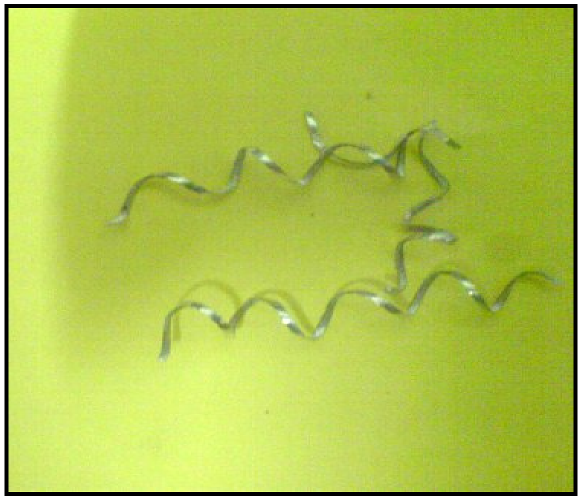


Figure 4.4: Dry machining

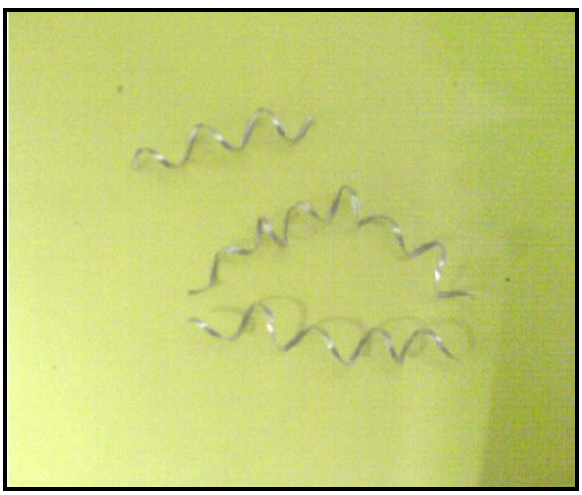


Figure 4.5: Minimum quantity lubricant

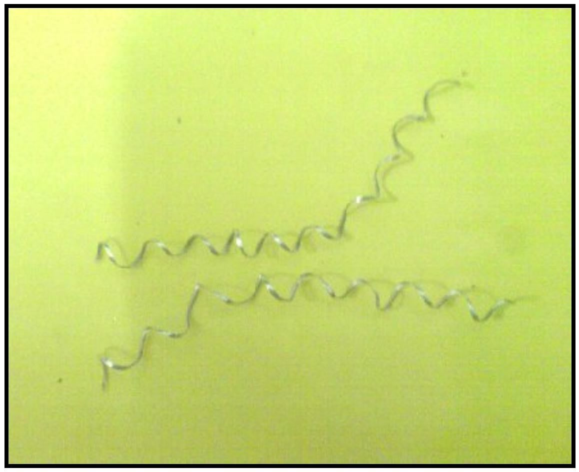


Figure 4.6: Wet machining

From figure below, it can be seen that minimum quantity lubricant produce shortest continuous chip compare to dry and wet machining. For 1060 Aluminium Alloy, chip produced by minimum quantity lubricant is about 3 to 5 cm each while dry and wet machining is about 6 to 7 cm. It means minimum quantity lubricant produce better surface finish continued by dry machining and wet machining. This is because high long continuous chip are produced at high temperature.

4.2.2.2 Chip Formation for ASTM B176 Brass

Figure 4.7: Dry machining steel

Figure 4.8: Minimum quantity lubricant

Figure 4.8: Wet machining

For ASTM B176 Brass, chip produced is non-continuous chip and it not much different for each condition. Chip produced seems like dust because of brass property. Under minimum quantity lubricant chip produced is much smaller while under dry machining, chip produced is smaller than wet machining but bigger than minimum quantity lubricant. It means, surface finish produce under minimum quantity lubricant is much better than dry and wet machining.

4.2.2.3 Chip Formation for AISI 4340 Steel

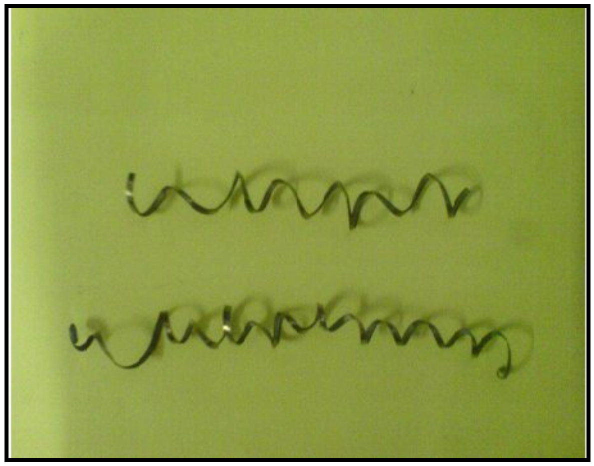


Figure 4.10: Dry machining

Figure 4.11: Minimum quantity lubricant

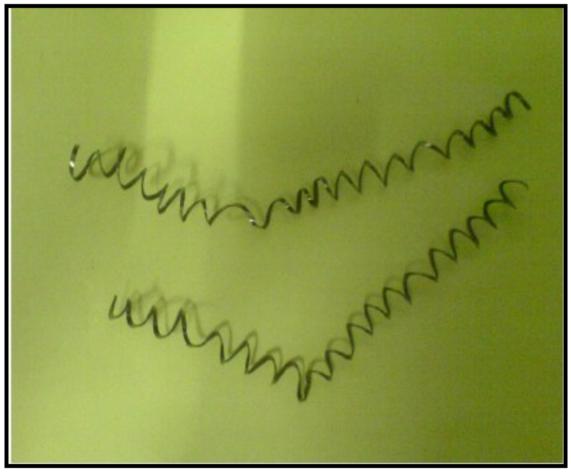


Figure 4.12: Wet machining

For AISI 4340 Steel, chip produced can be seen from figure 4.10 until 4.12. From that picture, it can conclude that minimum quantity lubricant produces better surface finish. This is because minimum quantity lubricant produce continuous chip about 2 to 3 cm long while dry machining produces 4 to 5 cm and wet machining about 6 to 8 cm.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

Conclusion is overall about this study either this experiment achieve their objective or not while recommendation about way to improve this study for next time. This conclusion is makes based on the result.

5.2 CONCLUSIONS

This experiment investigated effect of lubrication condition on surface roughness by using lathe machine. Based on the result of the present experimental investigation we know that lubrication condition one of the factor affect of surface roughness. The important conclusion drawn from this research was summarized as follows:

i. Minimum quantity lubricant produced better surface finish continued by dry machining and wet machining.

ii. The cutting performance of minimum lubricant machining is better than dry machining and wet machining because minimum lubricant provide the benefit mainly by reducing the cutting temperature, which improves the chip tool interaction and maintains sharpness of the cutting edges.

iii. Minimum of lubricant can definitely be regarded as the replacement of dry cutting and at the same time it may be considered as an alternative to wet machining from viewpoints of performance. Otherwise, it was choose as the replacement because it could reduce many cutting problems coming from high consumptions of lubricant like high machining cost, environmental pollution and worker health problems

5.3 RECOMMENDATIONS

The recommendations to improve this study are:

i. Considered more factors other machining time like depth of cut, spindle speed and feed rate.

ii. Study another effect like effect of lubrication condition on tool wear and flank wear.

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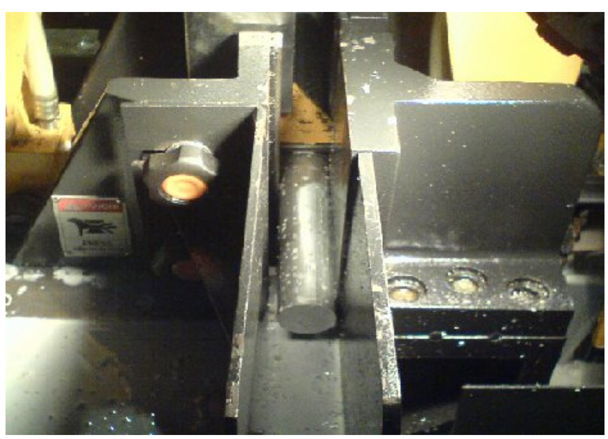
APPENDIX A

FIGURES

A.1 Vertical Bandsaw Machine

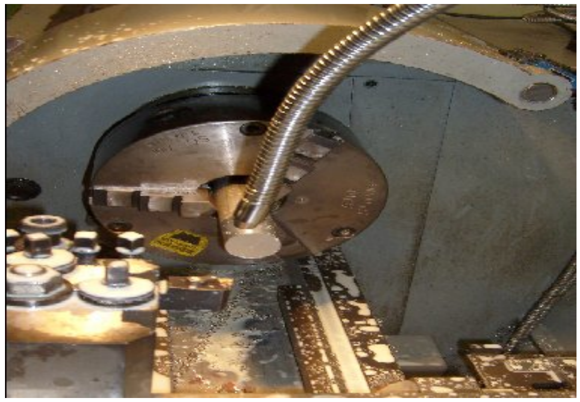
A.2 Cutting Material Process by Using Vertical Bandsaw



A.3 Lathe Machine

A.4 Turning Process by Using Lathe Machine

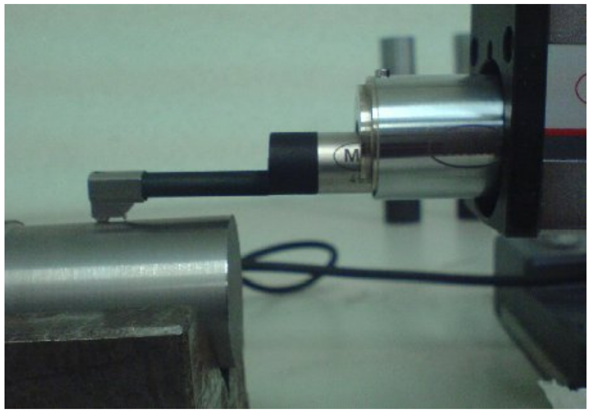
A.5 Dry Machining



A.6 Minimum Quantity Lubricant

A.7 Wet Machining

A.8 Measuring Surface Roughness Process by Using Perthometer S2



A.9 Figure of 1060 Aluminium Alloy

A.10 Figure of 1060 ASTM B176 Brass

A.11 Figure of 1060 AISI 4340 Steel

APPENDIX B

MEASURING RESULT

B.1 Profile of Surface Texture