RELATIONSHIP BETWEEN MACHINING PARAMETERS AND SURFACE ROUGHNESS OF BRASS USING LATHE MACHINE

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DEDICATION

Especially dedicated to

To my beloved father and mother
  Raja Idris Bin Raja Ismail
  Noriyah Binti Mat Ali
ACKNOWLEDGEMENTS

In the name of ALLAH, the most gracious, the most merciful.

First of all, I am very grateful to Allah S.W.T, for giving me opportunity to finish my Final Year Project. I want to express my greatest attitude and appreciation to the following person and organizations that have directly or indirectly given generous contributions towards the success of this project.

I would like to thanks my project supervisors, Puan Salwani Binti Mohd Salleh for his consistent guidance and advice throughout the project preparation and sharing his knowledge and experiences in finishing this project. This project would not be able to be completed in time without his constant encouragement and guidance.

Then, my special gratitude to my family for the unconditional faith during bad times always ignited a new spark of motivation. I also would like to thank all my friends that helps and gave valuable advices and tips when I encountered problems during the preparation of this project. Lastly, I also like to express my gratitude and thanks to University Malaysia Pahang (UMP) for having such a complete and resourceful library.
ABSTRACT

Surface roughness is a consequence of all machining operations and has been the subject of investigative research for the better part of the last century because the product produce good surface finish is very valuable. But, not all the product needs a good surface finish. If the product not demands a good surface finish, the time of machining can be reduce to minimize the cost. This is about the effect of machining parameters on surface roughness using lathe machine. The focus of this project is to study the effect of Cutting speed, feed rate, and depth of cuts on brass’s surface roughness. The experiment was design using Design of experiment (DOE) method and from which number of experiment was constructed. The result show that feed rate is the most effected parameter on surface roughness when machining process then followed by depth of cut and cutting speed. All the parameters are proportional with brass’s surface roughness.
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CHAPTER 1

INTRODUCTION

1.1 Project background

This project will investigate the effect of machining parameters for the brass including cutting speed, feed rate and depth of cut on surface roughness. The lathe machine will be used to test the sample because the all parameters of the lathe machine can be changed easily compared to CNC turning and the Perthometer Measuring machine will be used to analyze the surface roughness of brass.

1.2 Objective of Project

To study the effect of machining parameters (cutting speed, feed rate and depth of cuts) on surface roughness on brass.

1.3 Project Scope

The scopes of project are limited to brass, lathe machine, cutting speed, feed rate, depth of cut, and surface roughness.
1.4 Problem Statement

In general, brasses have excellent machining properties compared with other common engineering metals. However, an improvement in surface roughness can surely benefit the industry. In industry, some of product also needs a high surface for certain application. So, these papers provide guidance on how to vary the machining parameter to obtain certain surface roughness. This project was conducted to study the effect of machining parameters on surface roughness. Variables include will be the cutting speed, feed rate and depth of cut. This project only covers for the lathe machine because it uses a single cutting point which is easy to measure or collect the data.
CHAPTER 2

LITERATURE REVIEW

2.1 Machinability

While it is common to assume that the various “-ability” terms also refer to specific material properties, they actually refer to the way a material responds to specific processing techniques. As a result, they can be quite nebulous. Machinability, for example, depend not only on the material being machined but also on the specific machining process; the condition of that process, such as cutting speed; and the aspects of that process that are of greatest interest. Machinability ratings are generally based on relative tool life. In certain applications, however, may be more interested in how easy a metal is to cut or how it performs under high-speed machining and less interested in the tool life or resulting surface finish. For other applications, surface finish or the formation of fine chips may be the most desirable feature. As a result, the term machinability may mean different things to different people, and it frequently involves multiple properties of a material interacting with the condition of a process [1].
2.1.1 Definition of Machinability

The term machinability includes all those properties that showed figure 2.1. which are relevant for the machining and cutting process [2]:

- the wear of tools
- the necessary cutting force
- the resulting form of the chips
- the quality of the surface produced

![Definition of Machinability](image)

Figure 2.1. Definition of Machinability

2.1.2 The process of machining

Actually, arrangement of tool and workpiece is the most important criterion for the machining process and it will give big effect to the cutting tool and workpiece. In the machining processes, the machinability should be defined separately for turning, drilling and etc. In this project, it will show for turning process because of the clearly defined arrangements of tools and workpiece, the term machinability applies generally to the turning process. [2]
The result for the machining is depending to these parameters:

- Cutting parameters and tool geometry
- The machines used
- Material of the cutting tool

2.1.3 Form of chips

The form of chip is the important criterion in the machining because it will effect to the surface of workpiece. So, this part most important thing and it must concern with carefully. One of the technological parameters affecting the form of chips is the tool geometry. Thus, a reduced rake angle tends to form shorter chips in alloys which would otherwise deliver long chips. [3]

![Image of chip compression for large and small rake angles]

Figure 2.2. Chip Compression for Large and Small Rake Angles

2.1.4 Surface of Machining

In general, the quality of the surface produced by machining depends on three independent parameters:

- **The kinematical roughness**: This is the theoretical depth of roughness (peak-to-valley height), was calculated on the basis of the relative movement of tool and workpiece.
• **The machined surface roughness**: This reflects the separating behavior of the material, i.e. the typical characteristics of aluminium alloys in regard to surface quality.

• **External influences**: Such influencing parameters (stability of system, condition of cutting edges etc.) become extremely important especially when machining aluminium at very high speeds.

### 2.1.5 Tool Wear

The tool wear while machining aluminium occurs due to abrasion of the free surface. Consequently, the deciding criterion for measuring tool life objectively is the wear width VB. The wear of the free surface depends on the temperature and is caused mainly by abrasion. While using carbide-tipped tools one normally assumes an allowable maximum value of 0.3 to 0.5 mm for VB. [3]

![Cutting Edge Displacement and Wear Width](image)

**Figure 2.3. Cutting Edge Displacement and Wear Width**

So, the material of the workpiece and the cutting parameters are important things to avoid tool wear when machining. Material of the workpiece give very influence, wear increases with the number of large hard particles which are embedded in the workpiece and wear also increase with the strength of material because hard particles embedded in a soft matrix can be gouged out easily but, if the matrix material is harder, inclusions cannot be removed easily, it will increasing tool wear. Finally, wear also depends on the wear resistance of the free surface of the tool.
2.2 Brass

Zinc is by far the most popular alloying addition, and the resulting alloys are generally known as some form of brass. If the zinc content is less than 36%, the brass is a single-phase solid solution. Since this structure is identified as the alpha phase, these alloys are often called *alpha brasses*. They are quite ductile and formable, with both strength and ductility increasing with the zinc content up to about 36%. The alpha brasses can be strengthened significantly by cold working and are commercially available in various degrees of cold-worked strength and hardness. Cartridge brass, the 70% copper-30% zinc alloy, offers the best overall combination of strength and ductility. As its name implies, it has become a popular material for sheet forming operation like deep drawing.

With more than 36% zinc, the copper-zinc alloys enter a two-phase region involving a brittle, zinc-rich phase, and ductility drop markedly. While cold-working properties are rather poor for these high-zinc brasses, deformation can be performed easily at elevated temperature. [1]

2.2.1 Application of brass

Many applications of these alloys result from the high electrical and thermal ductivity coupled with useful engineering strength. The wide range of colors (red, orange, yellow, silver and white), enhanced by further variations that can be produced through the addition of a third alloy element, account for a number of decorative uses. Since the plating characteristics are excellent, the material is also a frequently used base for decorative chrome or similar coatings. Another attractive property of alpha brass is its ability to have rubber vulcanized to it without any special treatment except through cleaning. As a result, brass is widely used in mechanical rubber goods. [1]
2.2.2 Properties of brass

Most brasses have good corrosion resistance. In the range of 0 to 40% zinc, the addition of small amount of tin imparts improved resistance to seawater corrosion. Cartridge brass with tin becomes Admiralty brass, and the 40% zinc Muntz metal with a tin addition is called naval brass. Brasses with 20 to 36% zinc, however, are subjected to a selective corrosion, known as dezincification, when the exposed to acidic or salt solutions. Brasses with more than 15% zinc often experience season cracking or stress-corrosion cracking. Both stress and exposure to corrosive media are required for this failure to occur (but residual stresses and atmospheric moisture may be sufficient). As a result, cold-worked brass is usually stress relieved (to remove the residual stresses) before being placed in service. [1]

Copper-based alloys are widely used in marine environments, due to their excellent electrical and thermal conductivity, good corrosion resistance and ease of manufacture. Brass alloys have wide industrial applications as condensers and heat exchanger systems in saline water. Pitting corrosion, dezincification and stress corrosion cracking and of brass in water have been widely studied. Dealloying, or dezincification, in brass may be readily observed with naked eyes because the alloy develops a reddish color that contrasts with its original yellowish color. Generally, there are two types of dealloying. Uniform or layer dealloying commonly occurs in high zinc alloys where the outer layer is dealloyed and becomes dark while the inside is not affected; plug dealloying is typified by the presence of the dealloyed dark plugs in the unaffected matrix of low zinc alloys and. Two theories have been proposed for dealloying of brass. One states that there is anodic dissolution of the brass (both copper and zinc) while the copper ions plate back from the solution on the remaining brass surface as a porous layer; the other states that the less noble alloying elements are selectively dissolved, leaving vacancies in the brass lattice structure resulting in skeletal copper with poor mechanical integrity[8].
2.2.3 Corrosion

There are a wide range of brass compositions, and the alloys with less than about 15% zinc have corrosion characteristics similar to those of pure copper. As the zinc content increases over 15%, the susceptibility to dezincification, and stress corrosion cracking increases. Dezincification is one of the most insidious forms of corrosion in brasses; it occurs in seawater, in neutral water at elevated temperatures, or when stagnant water conditions occur.

Brasses with less than 15% zinc do not dezincify. Alloy with greater than 15% zinc are susceptible to dezincification, and beta or alpha-beta brasses with over 37% zinc are very prone to dezincification, especially in seawater.

There is a corrosion advantage in using high-zinc brasses. The tendency for impingement attack is lower. Muntz metal, admiralty metal, naval brass, and other copper alloys with about 40% zinc are used for impingement resistant tubing in heat exchangers. High zinc content ever, increases tendencies for stress corrosion cracking. [7]

2.3.2 Calculation

![Diagram](image)

Figure 2.4. This is schematic illustration of the basic mechanism of chip formation by shearing.
Cutting Ratio

It can be seen that the chip thickness, \( t_c \) can be determined by knowing depth of cut, \( t_o \), and \( \alpha \) and \( \varphi \). The ratio of \( t_o / t_c \) is known as the cutting ratio or (chips-thickness ratio), \( r \), and is related to the two angle by following relationships:

\[
\tan \varphi = \frac{\cos}{1 - \frac{\cos}{\cos(\varphi - )}}
\]

(2.1)

And

\[
\sin \varphi = \frac{\cos}{\cos(\varphi - )}
\]

(2.2)

Cutting speed

\[
= (\text{m/min})
\]

(2.3)

Where, \( D \) is initial diameter, \( N \) is spindle speed
2.4 Feed rate

2.4.1 General about feed rate

Feed rate is defined as the distance the tool travels during one revolution of the part. Cutting speed and feed determines the surface finish, power requirements, and material removal rate. This is the volume of workpiece material (metal, wood, plastic, etc.) that can be removed per time unit. It is often expressed in units of distance per time (typically inches per minute [ipm] or millimeters per minute)

Cutting speed and feed determines the surface finish, power requirements, and material removal rate. The primary factor in choosing feed and speed is the material to be cut. However, one should also consider material of the tool, rigidity of the workpiece, size and condition of the lathe, and depth of cut. [4]

Feedrate is dependent on the:

- Surface finish desired.
- Power available at the spindle (to prevent stalling of the cutter or workpiece).
- Rigidity of the machine and tooling setup (ability to withstand vibration or chatter).
- Strength of the workpiece (high feed rates will collapse thin wall tubing)
- Characteristics of the material being cut, chip flow depends on material type and feed rate. The ideal chip shape is small and breaks free early, carrying heat away from the tool and work.