UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATE SURFACE ROUGHNESS OF ALUMINIUM ALLOY 2024 UNDER WET AND DRY CONDITIONS

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process)(Hons.)

by

ANIS AFUZA BINTI AZHAR

B051110268

910325115248

FACULTY OF MANUFACTURING ENGINEERING

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TAJUK: **Investigate the Surface Roughness of Aluminium Alloy 2024 under Wet and Dry Conditions**

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This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) (Hons.). The member of the supervisory is as follow:

……

DR. MOHD HADZLEY BIN ABU BAKAR

(Project Supervisor)

ABSTRAK

Tesis ini, melalui eksperimen dan penyiasatan, mengkaji integriti permukaan aloi aluminium 2024 dalam keadaan basah dan kering. Integriti permukaan dibandingkan dalam dua keadaan yang berbeza iaitu keadaan kering dan basah. Bagi setiap keadaan Aluminium akan dimesin pada kelajuan pemotongan yang berbeza dengan kadar suapan malar dan kedalaman pemotongan. Masalah timbul apabila parameter pemotongan itu tidak digunakan dengan betul semasa melakukan pemesinan. Keadaan kering akan menghasilkan alat haus cepat disebabkan geseran yang tinggi di antara muka pemotong keadaan basah akan menghasilkan hayat alat lagi kerana geseran rendah dan persekitaran yang lebih sejuk. Walau bagaimanapun menggunakan penyejuk akan memberikan bahaya kepada alam sekitar. Teknik yang lebih baik untuk mesin aloi aluminium 2024 sama ada di kajian keadaan kering atau basah. Kajian ini akan menyiasat kelajuan pemotongan yang optimum untuk pemesinan Aluminium 2024 dalam keadaan basah dan kering untuk menghasilkan kemasan permukaan yang terbaik. Bagi mesin dan peralatan yang digunakan dalam eksperimen ini adalah mesin pelarik konvensional, penguji kekasaran permukaan, jalur kuasa gergaji, mikroskop stereo dan mikroskop imbasan elektron (*SEM*). Kajian ini membincangkan mengenai persediaan untuk memotong alat dan bahan kerja sebelum menjalankan eksperimen. Hasil kajian menunjukkan cecair pemotongan tidak memberi impak yang besar kepada kekasaran permukaan semasa pemesinan dan pengurangan kekasaran permukaan dengan peningkatan kelajuan pemotongan untuk kedua-dua keadaan pemotongan. Suhu akan meningkat dan ia akan memberikan lebih mudah ricih action. Kajian ini membantu untuk memahami kesan mengurangkan kelajuan di permukaan dalam keadaan pemotongan kering dan basah terutamanya kelajuan pemotongan yang rendah dan tinggi.

ABSTRACT

This thesis, by experimental and investigation, examines the surface integrity of aluminium alloy 2024 under wet and dry conditions. This study tries to explore the feasibility of cutting condition to machine Aluminium 2024. The dry and wet condition will be compared based on the surface integrity. For each condition the Aluminium will be machined at different cutting speed with constant feed rate and depth of cut. The problem arises when the cutting parameter is not applied correctly while doing machining. Dry condition will produces quick tool wear due to high friction at the cutting interfacewet condition will produces longer tool life due to lows friction and cooler environment. However using coolant will provide hazard to environment.Which techniques are better to machine aluminium alloy 2024 whether at dry or wet condition.This study will investigate the optimum cutting speed for machining Aluminium 2024 in wet and dry condition to produce the best surface finish. For the machine and equipment used in this experiment are conventional lathe machine, surface roughness tester, power band saw, stereo microscopes and scanning electron microscopes (SEM). This study discussed about preparation for cutting tool and workpiece before running the experiment. The result shows the cutting fluid did not give a big impact on the surface roughness during machining and the surface roughness decrease with the increasing of cutting speed for both cutting condition. This is because during shearing action, the temperature will increase and it will provide more easily shearing action.This study help to understanding the effect of cutting speed on surface in dry and wet cutting condition ecspecially when compared between low and high cutting speeds.

DEDICATION

Especially for beloved Father, mother, young brother, lecturer and last but not least my lovely friend as well as housemate for supporting me endless in term of courage, motivation and caring until now.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

CNC	-	Computer Numerical Control
F	-	Load
M	-	Saturated mass
n	-	Number of reading
Ra	-	Arithmetic Mean value
Rq	-	Root-mean Squire average
TL	-	Tool Life
Vc	-	Cutting Speed

CHAPTER 1
INTRODUCTION

This chapter presents the background of the study that is related to this project. The problem statement, objective and scope were being discussed on this section.

1.1 Background of the Project

Aluminium alloy is a material that widely used in manufacturing industries, especially in automotive and aeronautics sector because of its mechanical behaviour such as corrosion resistance, low density, high strength and low cost (Subramaniam, 2010). Aluminium alloy also is a lightweight material. It is becoming increasingly difficult to ignore that aluminium alloy has been trending for machining material in this day (Thangarasu, 2012). In recent years, there has been an increasing interest in research of machinability aluminium alloy that concentrate to reduce manufacturing cost and increase productivity (Kishawy et al., 2004). Aluminium 2024 is a high strength aluminium alloy. In general, Aluminium 2024 can be considered as metal bar with that form by the extrusion process in a form of wrought product (Kalpakjian, 2001). This materials considerably possessed high to moderate strength, good machinability and weld ability. This material also is excellent in corrosion resistance. All the quantity of the element that explain all the current that existing at the surface is called surface integrity. Surface topography and surface metallurgy is under surface integrity. Surface topography is about the roughness, about the texture at the outer of the surface of the workpiece. Surface metallurgy is about the nature of the altered layers below the surface with respect to the base or matrix material.

To get a better quality control, surface roughness is important things that should be consider. Surface roughness is a texture of surface. To produce better quality product in our industry, the surface roughness must be lower.

For that reason, study of surface roughness is an important in order to find suitable parameter for machining aluminium alloy because of the factor that affects productivity and manufacturing efficiency. In this study, the focused is on the surface roughness that is under the surface topography. In response surface roughness are being subject of interest to study their behaviour when machining on aluminium alloy. The cutting speed increase, the better the surface roughness.

For a quality and efficient manufacturing, the surface roughness should be dependent on their intended application, factors such as environment of operation or further manufacturing processes will determine this level of surface roughness required, as the performance and mechanical properties of the material can be affected. The dry and wet condition will be compared based on the surface integrity. The both wet and dry conditions have their benefits in relation to the intended application of the part, but mostly dry turning produces competitive surface roughness's in finish turning when compared to wet, and acceptable levels of tool wear while rough cutting. It would be recommended that in most circumstance for rough cutting, dry conditions should be employed with the knowledge of slight increased tool ware and possibly shorter life but with reduced manufacturing costs and environmental hazards. The methodology used in this project is experimental procedures. By referring to an experiment that will be done, the tools must undergo a machining test at various cutting condition before analysis is done with the tool. The evaluation of this research will be examined using a stereo microscope (SM), scanning electron microscopy (SEM) and Portable Surface Roughness Tester.

1.2 Process Description

A cylindrical material normally used a lathe machine. It usually changes the cylindrical material, make it touch with cutting tool and lastly the material was cut. It is the most well used machining in the industries. The material was put fixed into the chuck of a lathe. After the machine was switch on, it will rotate the chucks. The rotating speed, cutting depth and feed is important element for lathe machine. Figure 1 shows the three important elements of lathe machine.

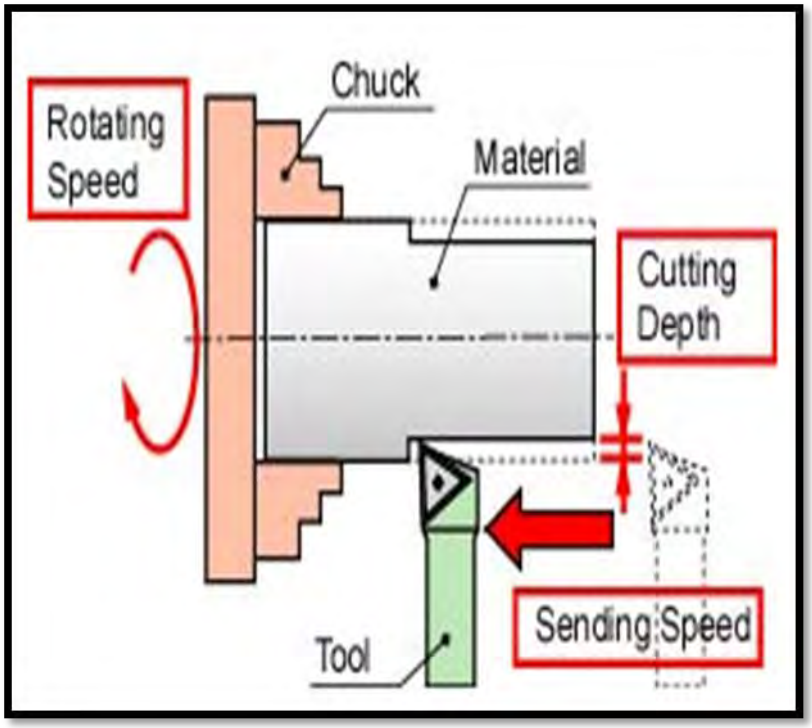

Figure 1: Three important elements (Hirata, 2002)

According to Khirata (2002), it usually operates with low rotating speed at the beginner, small cutting depth and low sending speed.

1.3 Problem Statement

Despite the advantages of this aluminium, there are some difficult to machine this material especially when the cutting parameter is not applied correctly. In any machining process, the most critical criterion is to produce the parts as many as possible with the minimum usage of cutting tool. Apart from that, the criterion of surface finish and dimensional accuracy are also important. Mostly, industry prefers to machine the material with minimum cost for their economical sustainability. There needs to produce high volumes of product with optimization of machining processes for the achievement of high responsiveness of production. The problem arises when the cutting parameter is not applied correctly while doing machining. Dry condition will produces quick tool wear due to high friction at the cutting interface wet condition will produces longer tool life due to lows friction and cooler environment. However using coolant will provide hazard to environment. So, this project investigates which techniques are better to machine aluminium alloy 2024 whether at dry or wet condition.

1.4 Aim and Objectives

The objectives of this project are:

i. To identify the effect of cutting speed on surface finish during machining Aluminium 2024 at dry condition.
ii. To identify the effect of cutting speed on surface finish during machining Aluminium 2024 at wet condition.
iii. To compare the surface integrity of Aluminium 2024 at dry and wet condition.

1.5 Scopes of Project

This project tries to explore the feasibility of cutting condition to machine Aluminium 2024. The dry and wet condition will be compared based on the surface roughness. For each condition the Aluminium will be machined at different cutting speed with constant depth of cut. The cutting tool used in this project is carbide tool. This experiment will be carried out using a lathe machine and the comparison of surface roughness will be analysed using surface roughness tester. Surface profile will be analysed using microscope. The effect of cutting speeds on surface integrity of these materials will be studied and evaluated in details.

1.6 Outline of Project

This project involve of five chapters which is covers introduction, literature review, methodology, result and discussion and lastly conclusion. Chapter 1 is about the introduction of the project, objective, problem statement and scope of project. For chapter 2 is the literature review which journal, book, website and others that was used as reference for discussing the information on certain project. For chapter 3 which is methodology, discussing about research methodology which design and framework be included to proceed and running the experiment of project. Next, chapter 4 is result and discussion where a data collection form experiments are be analysed and collected to be discussed in project. Lastly, chapter 5 is conclusion. In conclusion, it concludes the data from experiment and recommendation of the project.

CHAPTER 2
LITERATURE REVIEW

This chapter is about the literature review. It will provide part in order to get the whole data about lathe machine, cutting tools and workpiece material and will give an idea to run the project. This chapter will contain almost method including the history, machining properties and results. Literature review part will be working as a reference, to give information and guide base on journal, book and other source on the internet.

2.1 Introduction

Developing countries have awakened to fact that fabrication and processing of machine parts is a key to the technology that brings economic growth. The gross domestic product of the countries is tied to their manufacturing capacities. Hence the richest nations are those with powerful and flourishing manufacturing industries. Alabi et al. (2006) stated that machining; especially on the lathe is most important aspect of manufacturing process. Surface roughness plays an important role in product quality and manufacturing processes planning, which is also a technical requirement. Khidhir et al. (2009) found that cutting speed have a significant influence on the surface roughness produced. Atul et al. (2011) found that the effects of turning processes parameters are independent variables. Surface finish is responsible for its functionality, reliability, and lubrication. It has been an important design feature and quality measure in many situations such as parts subjected to fatigue loads, precision fits, fastener holes and aesthetic requirements. To increase the efficiency and productivity of the machining process, it is necessary to determine

the proper feature of the cutting tool, machine tools and machining parameters. According to Hari et al. (2004), the process parameter that may effect during turning process are cutting tool (geometry and cutting tool parameter), workpiece base parameter (composition, structure and hardness), cutting parameter (cutting speed,feed,depth of cut), wet cutting and dry cutting. A significant improvement of the productivity and efficiency can be obtained by processes parameter optimization that identifies the region of processes control factor (Lee et al, 2010).

2.2 Machining

Cheng (2009) has explained about the definition of machining. He said that machining processes are industrial processes in which typically metal parts are shaped by removal of unwanted materials. According to the International Institution of Production Research (CIRP), machining accounts for approximately 50% of all manufacturing techniques, which is a reflection of the attained accuracy, productivity, reliability, and energy consumption of this technique.

In addition, Kalpakjian and Schmid (2001) describe that good machinability indicates low force and power requirements, long tool life, and good surface finish integrity. As for chip control, long and thin (stringy) curled chips, if not broken up, can severely interfere with the cutting operation by becoming entangled in the cutting zone. Future machine tools must be highly dynamic systems to manage the required productivity, accuracy, and reliability. Both the machine tool system and machining processes are important to be optimized for their usability, cutting performance or the process capability to meet the productivity, precision, and availability requirements of the end user.

2.2.1 Machinability of Various Other Metals

a) Aluminum

Aluminum is generally very easy to machine, although the softer grades tend to form a built-up edge, resulting in poor surface finish. High cutting speeds, high rake angles, and high relief angles are recommended. Wrought aluminum alloys with high silicon content and cast aluminum alloys may be abrasive; they require harder tool materials (Kalpakjian and Schmid, 2001). Dimensional tolerance control may be a problem in machining aluminum, since it has a high thermal coefficient of expansion and a relatively low elastic modulus.

b) Cast Gray Iron

According to Kalpakjian and Schmid (2001), cast gray irons are generally machinable but are abrasive. Free carbides in castings reduce their machinability and cause tool chipping or fracture, necessitating tools with high toughness. Nodular and malleable irons are machinable with hard tool materials.

2.3 Lathe Machine

According to Atul et al. (2011), the turning processes are more common for analysis of the processes parameters on the surface roughness of a general component. Turning is still use in machining operation in industry although it is the oldest machine tools. Turning means the material is remove by cutting tool while the part is rotating when machined. Normally, the starting material use is a workpiece that has been made by other processes such as casting, forging, extrusion or drawing (Kalpakjian, 2001). The typical parts in a lathe machine are shown in Figure 2.1.

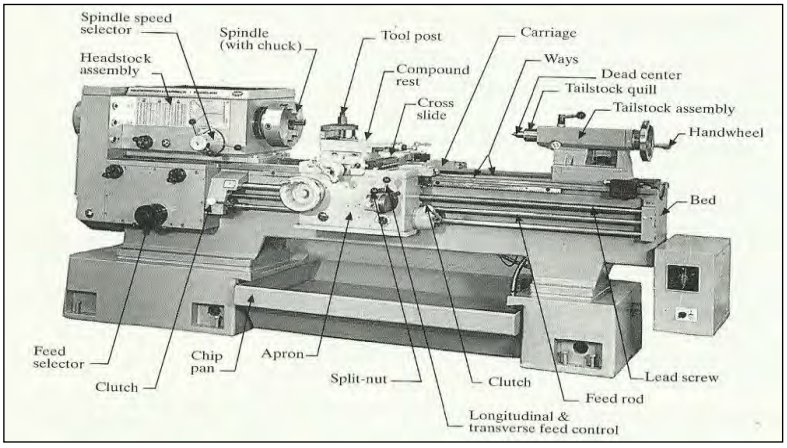

Figure 2.1: Typical parts in lathe machine (Atul et al, 2011)

2.4 Cutting Processes on a Lathe Machine

There are various operations that can be performed on a lathe. The operations are as follows:

i) Turning – to produce straight, conical, curve, or groove work pieces

ii) Facing – to produce flat surface at the end of the part

iii) Form tools- to produce various shapes for functional purposes or for appearance

iv) Boring – to enlarge a hole or cylindrical cavity made by previous process or to produce circular internal grooves.

v) Drilling – to produce a hole which may be follow by boring to improve accuracy

vi) Parting – to cut the piece from the end of the cut

vii) Threading – to produce external or internal threads

viii) Knurling- to produce a regularly shape roughness on cylindrical surface.

These cutting operation are typically performed on a lathe as in Figure 2.2. Turning can be perform by various depth of cuts , rotational speeds of the workpiece, feeds depending on the workpiece or cutting tools materials (Kalpakjian, 2001).