UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TOOL WEAR OF CARBIDE CUTTING TOOLS WHEN MACHINING ALUMINUM ALLOY 2024 UNDER DRY AND WET CONDITION

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

MUHAMMAD AMIRUL FAHMI BIN NADZERI
B051210161
910609145289

FACULTY OF MANUFACTURING ENGINEERING
2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **TOOL WEAR OF CARBIDE CUTTING TOOLS WHEN MACHINING ALUMINUM ALLOY 2024 UNDER DRY AND WET CONDITION**

SESI PENGAJIAN: **2014/15 Semester 2**

Saya **MUHAMMAD AMIRUL FAHMI BIN NADZERI**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

☐ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☐ TIDAK TERHAD

Disahkan oleh:

_______________________ _______________________

Alamat Tetap:
94-05-10 Apartment Putra Ria,
Jalan Bangsar 59200,
Kuala Lumpur.

Cop Rasmi:

Tarikh: _______________________

Tarikh: _______________________

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled "Tool Wear of Carbide Cutting tools when Machining Aluminum Alloy 2024 Under Dry and Wet Condition" is the results of my own research except as cited in the references.

Signature	:	…………………………………………….....
Author's Name	:	MUHAMMAD AMIRUL FAHMI BIN NADZERI
Date	:	

APPROVAL

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)

ABSTRAK

Projek ini membentangkan hasil kajian yang dibuat terhadap kesan permesinan keatas mata alat karbida bersalut dengan perbezaan kelajuan potongan dan keadaan potongan. Bahan kerja yang dipilih untuk projek ini adalah Aluminium Aloi 2024. Alat pemotongan bersalut karbida yang digunakan adalah jenis Canela dengan gred PM25. Alat pemotongan akan diuji menggunakan mesin larik dan kemudian akan di analisis untuk mengkaji prestasinya. Mata alat bersalut yang telah di pilih akan diuji dalam 2 keadaan yang berbeza (kering dan basah). Hanya satu parameter yang berbeza dikenakan iaitu kelajuan pemotongan. Kedalaman pemotongan dan kadar suapan adalah tetap untuk semua keadaan latar. Pada keadaan pemotongan , ciri-ciri kesan yang diukur termasuklah haus pada mata alat dan kasar pemukaan. Alat penguji kasar permukaan, scanning electron mikroskop (SEM) dan stereo mikroskop akan digunakan untuk memeriksa kehausan pada mata alat dan kasar permukaan benda kerja.Daripada analisa, keputusan menunjukan kehausan mata alat berlaku pada kedua-dua keadaan pemotongan. Walau bagaimana pun, permotongan dalam keadaan basah lebih baik dari pemotongan keadaan kering. Bagi kelajuan pemotongan pula menunjukan peningkatan kelajuan pemotongan akan menyebabkan kadar kehausan pada mata alat juga meningkat pada kedua-dua keadaan pemotongan.

ABSTRACT

This project presents the experimental investigation that was done on the machining performance of carbide coated cutting tools on difference cutting speed and condition. The workpiece materials selected in this project was Aluminium Alloy 2024. The coated cutting tools that used was Canela insert grade PM25. The cutting tools was undergo machining tests by lathe machine and then it will be analysed in order to study their performance. The selected coated cutting tools were tested at various cutting condition which involved two setting conditions (dry and wet). Only one parameter was varied which was cutting speed. The feed and depth of cut were kept constant for all the setting conditions. At the above cutting condition, the performance characteristics measured were the tool wear. A scanning electron microscope (SEM) and stereo microscope (SM) were be used to examine the tool wear and surface roughness. From the analysis, result showed that tool wear are occurred for both cutting conditions. However, wet cutting performed better as compared to dry cutting. As per cutting speed, it shows that increased of cutting speed also will increase tool wear of cutting tool at both conditions.

DEDICATION

Specially dedicated to my beloved family, project supervisor and all my friends that encouraged me throughout my journey of education.

ACKNOWLEDGEMENT

I wish to acknowledge and express my gratitude and appreciation to my supervisor, Dr Mohd Hadzley b. Abu Bakar for his supervision, encouragement, suggestion and assistance through the research and my parent Rasimah bte Mohd Jais whose constant encouragement, faith and confidence besides continuously moral support.

Sincere thank to all to those who helped me to solve various experiment problems and active involvement in parts of this research especially to Mrs. Farizan Binti Md Nor, Mr.Zameri bin Hamidi, Mr Azhar and Miss Anis Afuza binti Azhar.

Last but not least, to all my friend and those who indirectly contribute in this research. Thank you very much.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Al	–	Aluminium
BUE	-	Built up Edge
DOC	-	Depth of Cut
DOE	-	Design of Experiment
HSS	-	High Speed Steel
SM	-	Strereo Microscopes
SEM	-	Scanning Electron Microscopes
UTeM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

The introduction elaborates the main idea of the project, whereas it introduces the title, the project background, objectives, problem statement and scope of the project. The specification of the study is enlightening in this chapter as guidance and information about this project.

1.1 Background of Research

Aluminium alloy is a lightweight 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). It is becoming increasingly difficult to ignore that aluminium alloy has been trending for machining material in this day (Thangarasu and Sivasubramanian, 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, 2005). Tool wear is a natural occurrence in all machining processes, and can lead to tool failure. The need use of high cutting velocity and feed rate are increasing because of high productivity of machining. Furthermore machining essentially will produces high cutting temperature, which not only reduces tool life, but also affect the product quality. High performance cutting tools that have high strength, high toughness and high hardness, are required for machine these materials effectively and safely. (Azuan, 2013; Khan et al, 2009).

For that reason, study of tool wear is an important in order to find suitable parameter for machining aluminium alloy because of the factor that affects productivity and manufacturing efficiency. In response tool wear of carbide cutting tool are being subject of interest to study their behaviour when machining on aluminium alloy under dry and wet condition. However, research has consistently shown that tool wear are the consequence of the load, friction, and high temperature between the edge of cutting and the work piece. The major causes of tool wear are mechanical, thermal, chemical, and abrasion. The cyclic mechanical forces cause fatigue on the tool cutting edge. The temperature of a tool increases as the cutting speed increases (Gu et al, 1999).

More recently, literature has emerged that offers contradictory findings about machining condition of cutting tools. This is because when machining on wet condition it will produce longer tool life due to low friction and temperature (Kalpakjian, 2009). However, due to strict environmental regulations, coolants are a major source of pollution from the machining industry. On the other hand, the management and disposal of cutting fluids must follow rules of environmental guideline. This is because the worker may be affected by the bad effects of cutting fluids, such as by the skin and complications of breathing on the shop floor (Mazurkiewicz et al, 1989). The demand for environmentally sustainable manufacturing is the primary drivers for technology that reduces the use of liquid coolant, and dry cutting condition is introduced in order to solve the problem. Several studies have shown that tool wears are primarily happening due to abrasion at lower speed condition. When cutting speed is higher, the tool rake face temperature will rise consequently. This temperature can further increase on dry machining condition. This is due important deformation associated with large shear strains in the primary shear zone and to the friction effects along the tool chip interface (Moufki, 1998).

This project investigates tool wear of carbide cutting tools when machining aluminium alloy on wet and dry condition at different cutting speed. In this research, the evaluation of machining performance of the cutting tools mentioned above depends on the tool wear and wear mechanism. 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) and scanning electron microscopes (SEM)

1.2 Problem Statement

In industry, machining operation such as turning, milling, drilling and grinding commonly use especially in the manufacturing industry. There needs to produce high volumes of product in order to ensure their company always achieves their target. The optimization of machining processes for the achievement of high responsiveness of production. However, it can cause wear on the cutting tool. Which it a result of physical contact between cutting tool and workpiece that remove small parts of the material from the cutting tool. Tool wear can cause catastrophic failure of the tool that causes significant damage to the workpiece and even to machine tool after a certain limit.

As getting inspiration from this kind of situations, this project consists research of the tool wear and in the meantime includes the investigation of wear mechanism. The selected process is turning which will be performed by using a lathe machine. The parameter varying is cutting speed, while feed rate and depth of cut will keep constant. Therefore, it is necessary to compare the cutting performance in both cases of wet and dry cutting to know which techniques are better to machine aluminium alloy 2024.

1.3 Objective

(a) To identify the effect of cutting speeds on tool wear of the carbide cutting tools during machining aluminium alloy at dry and wet conditions.

(b) To analyse the type of wear mechanisms during machining aluminium alloy at dry and wet conditions

(c) To compare the performance of tool wear under dry and wet machining.

1.4 Scope of Research

The scopes of this research are to conduct machining process on aluminium alloy by using carbide cutting tools. In this project, the selected process is turning which will be performed by using a lathe machine; the varying parameter is cutting speed while depth of cut, feed rate and cutting time are kept constant. The performance measures to be evaluated are tool wear and wear mechanism of cutting tools.

CHAPTER 2

LITERATURE REVIEW

The literature review is one of the scope studies which is locating and summarizing the studies about a topic. 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 presents related study done by previous research on the tool wear, tool life and surface roughness. The purpose of this chapter is to gather the information that could contribute to this project.

2.1 Metal Machining

Over a year manufacturing industry has become one of most growth industries this day. Many manufactured products required machining at some of their stage production. Machining can be defined as the removal of unwanted material from the work piece into a finish product of the desired shape, size and surface quality. According to El-Hofy (2007), the evolution of new cutting tool material opened a new evolution for the machining industry where machine tool development took place. There are several classifications of machining process, one of it is machining by cutting and the common process is turning, cutting off, slab milling and end milling. Traditional machining required tool that harder than workpiece that is to be machined. The primary components of the typical metal cutting process are tools, work piece and the machine the machine tool as shown in figure 2.1.

2.1.1 Machining Element

According to Kalpakjian and Schmid (2009), there are several primary elements in the following below that are required for a machining process.

(a) Workpiece: Its shape and size for continuous and intermittent cutting, the chemical composition, mechanical properties and metallurgical properties.
(b) Tool: Material and geometry
(c) Chip: Types of chips and their geometry
(d) Cutting fluid: Its chemical composition, rate of flow and the mode of application.

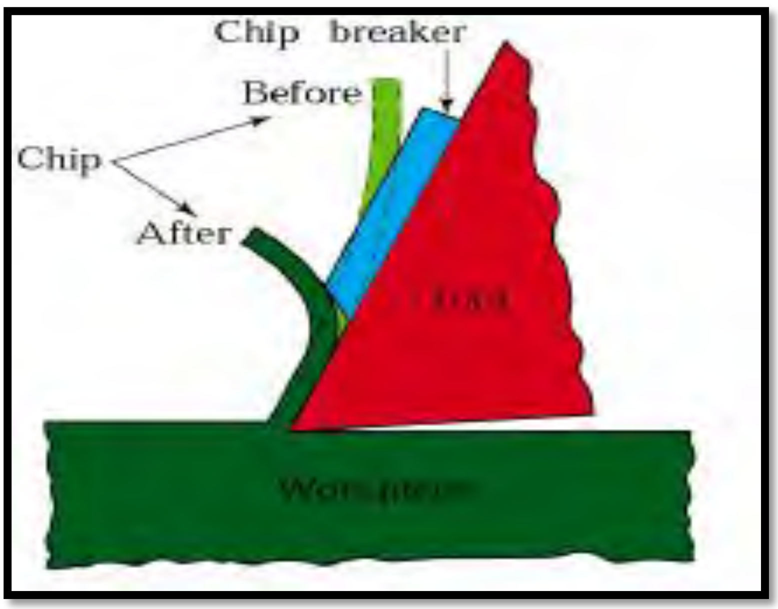

Figure 2.1: Machining by cutting (Kalpakjian and Schmid, 2009)

2.2 Mechanic of Cutting

The cutting process is influence of several factors which independent variable and dependent variable. Figure 2.2 shows a factor that influence machining operations.

Table 2.1: Factor influencing machining operations (Kalpakjian and Schmid, 2009)

Parameter	Influence and interrelationship
Cutting speed, depth of cut, feed and cutting fluid.	Forces, power, temperature rise, tool life, type of chip, surface finish and integrity.
Tool angles	As above, influence on chip flow direction, resistance to tool wear and chipping.
Continuous chip	Good surface finish, steady cutting force, undesirable, especially in automated machinery.
Built up edge chip	Poor surface finish and integrity; if thin and stable, edge can protect tool surfaces.
Discontinuous chip	Desirable for ease of chip disposal; fluctuating cutting forces; can affect surface finish and cause vibration and chatter.
Temperature rise	Influences tool life, particularly crater wear and dimensional accuracy of work piece; may cause thermal damage to work piece surface.
Tool wear	Influences surface finish and integrity, dimensional accuracy, temperature rise, forces and power.
Machinability	Related to tool life, surface finish, forces and

2.3 Lathe Machine

Lathe Machine is the oldest machine tool that has been used in manufacturing production. About one third of the machine tools, operating in engineering plants are lathe machine. Primarily lathe machine was designed to perform turning, facing and boring operations on a cylindrical workpiece. Nonetheless, other operations such as drilling, tapping, tapering, reaming, knurling and threading are possible on the lathe when various cutting tools and attachments are used (Helmi and El-Hofy, 2008). These machines are highly versatile and capable of a number of machining process that produces a wide variety of shapes. Figure 2.2 shows the typical lathe machine in the industry.

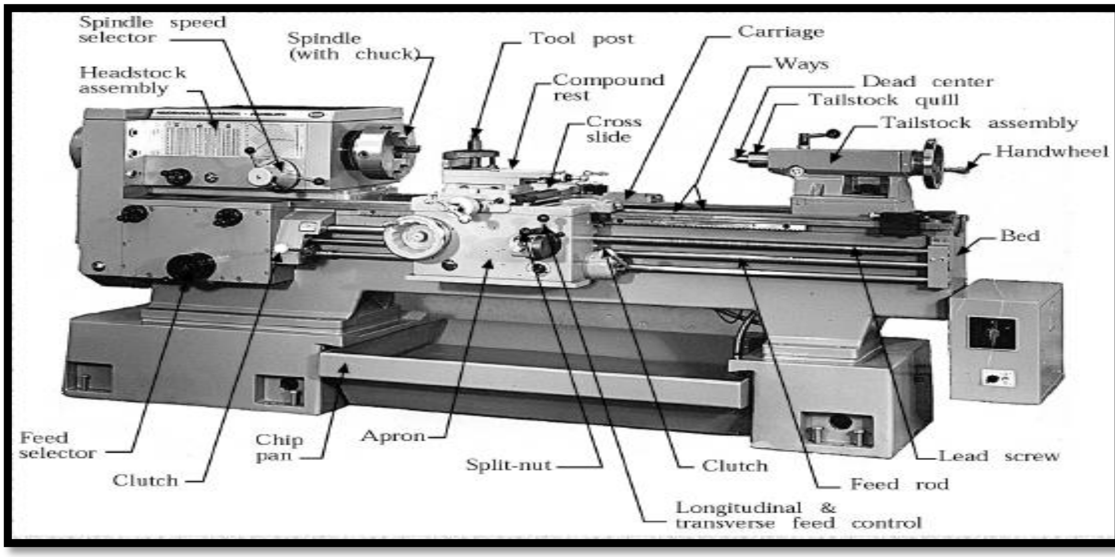

Figure 2.2: Lathe Machine (Kalpakjian and Schmid, 2009)

2.3.1 Lathe Components

Lathes are equipped with a variety of components and accessories such as bed, carriage, headstock, and tailstock as shown in figure 2.3.

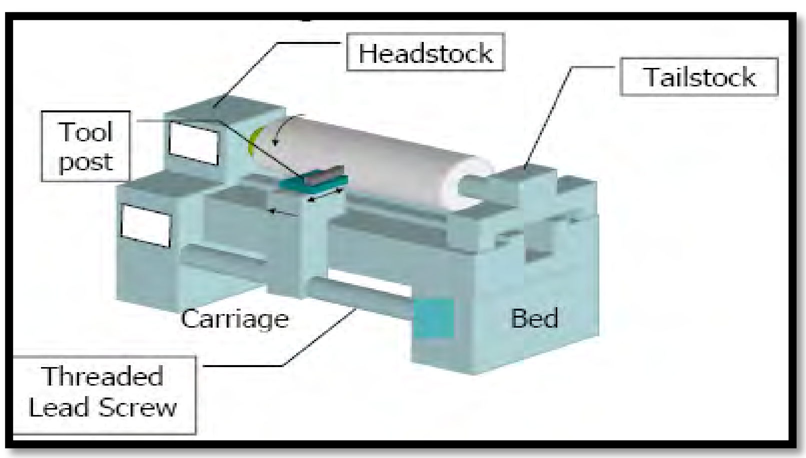

Figure 2.3: Component of lathe machine
(Source: < http://americanmachinetools.com/how_to_use_a_lathe.htm> 01/11/14)

(a) Bed

Bed is the base of lathe machine because it supports all major components in the lathe. The bed is built rigid and made from grey or nodular cast iron. The main features of beds construction are the ways in which formed at the top portion besides run the full length of the bed.

(b) Headstock

The headstock is permanent to the bed and it equipped with motors, pulley, and belts. It rotates the work by using a chuck. It driven by an electric motor connected either to a belt or pulley system or to a geared system. The speed can be set manually through controlled selector or by electrical control. For long bars or tubing workpiece, holding device such as chuck and collets is used with headstock for various turning operations.

(c) Tailstock

The tailstock is placed at the opposite end of the lathe from the headstock. Tailstock can be clamped in any position and can slide along the ways and support the other end of the workpiece. It has two types of centre which fixed centre or live centre.

(d) Carriage

The carriage consists of apron, saddle, compound rest, cross slide, and tool post that slides along the ways. Carriage is used to move and carry the cutting tool. The cutting tool is attached on the tool post. The cross slide moves radially in and out controlling the radial position of the cutting tool. The apron is equipped with mechanism for both manual and mechanized movement of the carriage and the cross slide by means of the lead screw