



# **UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

## **STUDY ON TOOL WEAR EFFECT ON MACHINING DIFFERENT TYPE OF MATERIALS**

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

by

**SYARIFAH BALQIS BINTI SYED MOHAMED**

FACULTY OF MANUFACTURING ENGINEERING

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Alamat Tetap:  
PT 29  
Kg. Padang Embun ,  
17030 Pasir Mas,  
Kelantan.

Tarikh: 15/05/2009

(TANDATANGAN PENYELIA)

DR. MOHD BIPAL BIN SALLEH  
Dekan  
Fakulti Kejuruteraan Pembuatan  
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I hereby, declare that this report entitled “**STUDY ON TOOL WEAR EFFECT ON MACHINING DIFFERENT TYPE OF MATERIAL**” is the result of my own research except as cited in the references.

Signature :

Author's Name : Syarifah Balqis Binti Syed Mohamed

Date :

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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) with Honours. The members of the supervisory committee are as follow:

.....  
DR. MOHD RIZAL BIN SALLEH

(Main Supervisor)

## **ABSTRACT**

This paperwork contains the report of the tool wear effect when machining different materials by using coated carbide tool. The materials used are mild steel and stainless steel. This The aim of this paperwork is to present the flank wear that occurred when machining mild steel and stainless steel using coated carbide tool with different parameter setting. Machining performance is determined by referring to flank wear obtained from the experiment. The machinery used in this experiment is conventional lathe machine. The material used for mild steel is mild steel with diameter 25 mm and for stainless steel is stainless steel with diameter 20 mm. The parameters varied are depth of cut, cutting speed and feed rate. The depth of cut is set to be 0.5 mm and 1.5 mm, with cutting speed 85 m/min. and 115 m/min, and feed rate 0.15 mm/rev. and 0.35 mm/rev. These variable are arranged according to the full factorial design. Wear that appeared on the cutting tool is measured with Sereo Zoom Microscope (SZM) and analyzed with Minitab software. From the result obtained, cutting speed and feed rate are the most significant factor that effect tool wear of the cutting tool.

## ABSTRAK

Kertas kerja ini mengandungi laporan mengenai kajian kehausan mata alat pemotong apabila proses pemotongan dilakukan ke atas bahan yang berbeza dengan menggunakan mata alat karbida yang disadur. Bahan yang digunakan adalah mild steel dan stainless steel. Kertas kerja ini adalah bertujuan untuk menunjukkan 'flank wear' yang terhasil apabila memotong dengan menggunakan factor yang berbeza. Tahap proses pemotongan dikaji berdasarkan 'tool wear' yang terhasil daripada eksperimen. Mesin yang digunakan untuk eksperimen ini adalah mesin larik. Diameter bahan yang digunakan masing2 adalah 25 mm untuk 'mild steel' dan 20 mm untuk 'stainless steel'. Fktor-faktor yang berubah ialah kedalaman pemotongan, kelajuan pemotongan, dan kadar pemotongan. kedalaman pemotongan yang digunakan ialah 0.5mm dan 1.5 mm manakala kelajuan pula ialah 85 m/min dan 115 m/min dengan kadar pemotongn sebanyak 0.15 mm/rev dan 0.35 mm/rev. Faktor-faktor ini disusun di dalam jadual mengikut 'full factorial design'. Keausan yang terhasil pada mata alat diukur dengan menggunakan 'Stereo Zoom Microscope' dan dianalisis menggunakan Minitab Software. Daripada keputusan yang diperolehi, kelajuan dan kadar emotongan merupakan factor yang paling mempengaruhi kehausan mata alat.



## **DEDICATION**

*This work is dedicated to my beloved family and friends*

## **ACKNOWLEDGEMENT**

First of all, I am grateful to Allah for giving me the chance to complete this project of “Study on Tool Wear Effect on Machining Different Type of Material” I also want to thank to Allah for giving me physically and mentally strength during the project progress. I would like to thank the most person that is behind this project, my supervisor, Dr. Mohd Rizal Bin Salleh, who always behind me until this project is completed. He supports me and gave me advice during the time to finish the study and complete the paper work. Then, I would like to thank the entire technician from FKP for helping me especially during the lab session. Not forgotten my beloved family and friends that always support me and be behind me. Finally, I would like to thank everyone who involved in the progression of this project.

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## **LIST OF ABBREVIATIONS**

Al<sub>2</sub>O<sub>3</sub> – Aluminium Oxide

CNC – Computer Numerical Control

CrC – Chromium Carbide

CS – Cutting speed

CVD – Chemical Vapour Deposition

DOC – Depth of Cut

DOE – Design of Experiment

f – feed

FR – Feed rate

HSS – High Speed Steel

OA – Orthogonal Array

PCBN – Polycrystalline Cubic Boron Nitride

PCD – Polycrystalline Diamond

Rpm – revolution per minute

Sfpm – surface feed per minute

SZM – Stereo Zoom Microscope

TiAlN – Titanium Aluminium Nitride

TiC – Titanium Carbide

TiCN – Titanium Carbonitride

TiN – Titanium Nitride

V – cutting speed

$V_b$  – Flank wear

ZrN – Zirconium Nitride

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 BACKGROUND**

Machining performance of tool coating is subjected to investigate the capabilities and limitations of coating material to different substrate (base material of cutting tool) in machining. To achieve the machining performance of tool coating, the tool's material must possess high strength at elevated temperature, good oxidation resistant, low coefficient of thermal, resistant to wear, chemical reactance resistance and high conductivity and can withstand for a long time for machining (Kalpakjian and Schmid, 2001). The conventional process cycle in the fabrication of hardened steel parts consists of initial turning, followed by hardening treatment and, finally, by finish grinding to obtain the desired dimensional accuracy and surface finish. Such an approach is characterised by drawbacks in terms of long time required by the finishing operation and number of operations involved. Furthermore, the potential for thermal damage in grinding is higher than in cutting operations with geometrically defined tools, with the formation of a thicker hard white layer (Bruni et al., 2007).

The alternative approach, consisting of turning the workpiece to its final dimension in the hardened state, can allow to reduce the white layer thickness, save time, decrease the number of operations of the process route, and manufacture complex geometries in one setup. This produces, in most cases, a substantial reduction of the manufacturing costs and makes such process very attractive in the manufacturing of bearing and chuck components, drive shafts, axis, forged parts, tools, etc.

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or lathe machine, workpiece, fixture, and cutting tool. The workpiece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The cutting tool feeds into the rotating workpiece and cuts away material in the form of small chips to create the desired shape.

Turning is used to produce rotational, typically symmetric axis, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners. Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed.

Turning machines, typically referred to lathes, can be found in a variety of sizes and designs. While most lathes are horizontal turning machines, vertical machines are sometimes used for large diameter workpieces. Turning machines can also be classified by the type of control that is offered. A manual lathe requires the operator to control the motion of the cutting tool during the turning operation. Turning machines are also able to be computer controlled, in which case they are referred to as a computer numerical control (CNC) lathe. CNC lathes rotate the workpiece and move the cutting tool based on commands that are preprogrammed and offer very high precision. In this variety of turning machines, the main components that enable the workpiece to be rotated and the cutting tool to be fed into the workpiece remain the same.

The tooling that is required for turning is typically a sharp single-point cutting tool that is either a single piece of metal or a long rectangular tool shank with a sharp

insert attached to the end. These inserts can vary in size and shape, but are typically a square, triangle, or diamond shaped piece. These cutting tools are inserted into the turret or a tool holder and fed into the rotating workpiece to cut away material. These single point cutting tools are available in a variety of shapes that allow for the formation of different features. All cutting tools that are used in turning can be found in a variety of materials, which will determine the tool's properties and the workpiece materials for which it is best suited. These properties include the tool's hardness, toughness, and resistance to wear. The most common tool materials that are used include, high-speed steel (HSS), carbide, carbon steel and cobalt high speed steel. The material of the tool is chosen based upon a number of factors, including the material of the workpiece, cost, and tool life.

In turning, the raw form of the material is a piece of stock from which the workpieces are cut. This stock is available in a variety of shapes such as solid cylindrical bars and hollow tubes. Turning can be performed on a variety of materials, including most metals and plastics. Common materials that are used in turning include aluminum, brass, magnesium, nickel, steel, thermoset plastics, titanium and zinc. When selecting a material, several factors must be considered, including the cost, strength, resistance to wear, and machinability. The machinability of a material is difficult to quantify, but can be said to possess the characteristics such as results in a good surface finish, promotes long tool life, requires low force and power to turn and provides easy collection of chips.

Most defects in turning are inaccuracies in a feature's dimensions or surface roughness. There are several possible causes for these defects, including incorrect cutting parameters, dull cutting tool, and unsecured workpiece.

## **1.2 PROBLEM STATEMENTS**

The coating of carbide cutting tools with thin surfaces layers of materials such as titanium carbide (TiC) has now been carried out for many years in order to improve their machining performance. The use of coating materials to enhance the performance of cutting tool is not a new concept. The first coated cemented carbide indexable inserts for turning were introduced in 1969 and had an immediate impact on metal cutting industry. These first generation TiC coated carbide tools were initially used in interrupted cutting applications such as the milling of steels. However, over the last few years there has been a considerable amount of interest in a new generation of coatings with significantly improved performance compared to conventional coatings. Today, 70% of cemented carbide tools used in the industry is coated. However, the tool wear still occur on the coated cutting tool. There are now efforts to produce the cutting tool locally thorough knowledge of the cutting process so that requirements of the tools are correctly identified.

## **1.3 OBJECTIVES**

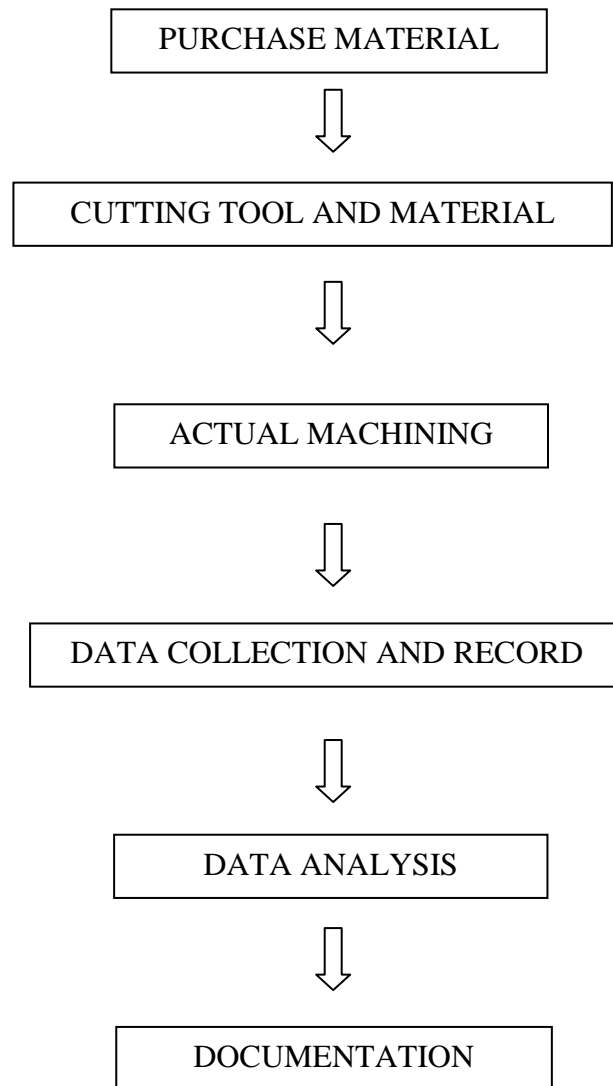
The objectives of this study is to focus on:-

- Investigation on tool wear effect of machining different materials.
- To study about the tool wear progression on the cutting tools used.
- Analyze the tool wear effect on machining of mild steel and stainless steel.

## **1.4 SCOPE OF STUDY**

Coated carbide tools have found widespread use in today's metal cutting industry, bringing about significant improvements in tool performance and cutting economy through lower the tool wear. For this project, the work will involve the setting-up and running of machining trial using coated carbide tool followed by detailed examination of the used tools and work materials using Stereo Zoom Microscopes. Work materials uses are mild steel and stainless steel. The tool wear will be obtain during machining trial is examine and analyze their result to relate with capabilities and limitations of tool coating (TiC) when applied to cutting tools. From that, the machining performance of the machining process that related with tool coating (cutting tool) will be find out. The results obtained will be extremely important in helping to develop the next generation of cutting tool coatings by quantifying their performance using series of controlled and scientific tests. There is also the intention to publish the results of this work.

To further this investigation, here are the process flow of the experiment.



**Figure 1.1:** work flow chart