UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SURFACE INTEGRITY OF AISI 1045 STEEL WHEN MACHINED WITH CARBIDE-TiC CUTTING TOOL

Thesis submitted in accordance with the requirements of the
University Technical Malaysia Melaka for the Degree of
Bachelor of Engineering (Honors) Manufacturing (Process)

By

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APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process). The members of the supervisory committee are as follow:

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DECLARATION

I hereby, declare this thesis entitled "Surface Integrity of AISI 1045 Steel When Machined With Carbide-TiC Cutting Tool" is the results of my own research except as cited in the reference.

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ABSTRACT

This research presents the effects of turning cutting parameter (cutting time, speed and feed rate) on the surface integrity for TiC cutting tools in turning AISI 1045 medium carbon steel. Scanning Electron Microscope (SEM) is used to evaluate the surface integrity and the surface roughness value were obtained using Mitutoyo's surface tester. The hard turning process is characterized by the generation of high temperature, high ratio of thrust tangential force component. The results shows that surface roughness and flank wear increased due to increased of the cutting time by fixing the cutting time, the cutting temperature can be controlled as the machining is subjected to the heat generate.

DEDICATION

For my beloved parent, my family and to those who’s with me all this time

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

C	-	Constant, y intercept cutting speed at tool life of 1 minute
D	-	Diameter
D_0	-	Original diameter of workpiece, mm or in
Df	-	Final diameter of workpiece, mm or in
Davg	-	Average diameter of workpiece, mm or in
d	-	Depth of cut, mm or in
F	-	Feed, mm/rev or in/mm
HSS	-	High Speed Steel
l	-	Length of cut, mm or in
N	-	Rotational speed of the workpiece, rpm
n	-	The index for the particular combination of tool and workpiece material
MRR	-	mm3/min or in3/min
P	-	Power
SEMs	-	scanning electron microscopes
T	-	Tool life in minutes
t	-	Time cutting, s or min
ν	-	Feed Rate or linear speed of the tool along workpiece length
V	-	Cutting speed of workpiece, m/min or ft/min
w	-	2 ΠN radians/min

CHAPTER 1

INTRODUCTION

Machines, metalworking and machining process are among the most importance elements of modern technology. Almost every modern product manufactured worldwide relies the vast array of disciplines practiced in these three major elements.

Machining is the process of removing the unwanted material from the workpiece in the form of chip. When the process involved material such as metal, the process is often called the metal cutting or the metal removal. Material removal process and machining are indispensable to manufacturing technology. Ever since lathes were introduced in the 1700's, many processes have been continuously developed.

Over the past few years in the manufacturing, have seen some progressed in the cutting tools technology. From the use of high-carbon steel, high-carbon speed steel, cobalt matrix and solid carbides to cemented or sintered carbides, ceramics and special cutting tools such as titanium nitride, titanium carbide and many more. All these developments have given very large advantages where we can see that the new technologies in cutting tools have been increased the production rates coupled with cost savings.

Today's coating technology has contributed significantly to the advancement of materials for the metal-cutting industries. Various coatings, especially those obtained by using PACVD (plasma assisted chemical vapour deposition) and PVD (physical vapour deposition), have been found to enhance tool life and increase cutting speed and feed-rate, resulting in higher productivity. This has been proven beyond a doubt for the coated tungsten–carbide tools and since it has been the practice to use coated tools whenever possible to get the best performance from a cutting tool.

The quality of machined surface is characterized by the accuracy of its manufacture with respect to the dimensions specified by the designer. Every machining operation leaves characteristic evidence on the machined surface. This evidence in the form of finely spaced micro irregularities left by the cutting tool. Each type of cutting tool leaves its own individual pattern which therefore can be identified. This pattern is known as surface finish or surface roughness.

A surface is a boundary that separates an object from another object or substance. Real surface is the actual boundary of an object. It deviates from the nominal surface as a result of the process that created the surface. The deviation also depends on the properties, composition, and structure of the material the object is made of.

1.1 Objectives

The objectives of this experiment are:

1. To study the relationship between the surfaces roughness values and turning parameters such as cutting time during high speed machining. From the study, we were able to study whether high speed machining would able to produces better surface finish.

2. To analyzed the surface integrity of the material of high speed machining operation such as the surface texture and surface profile.

1.2 Scope of project

This project is about investigating the surface integrity on AISI 1045 carbon steel during turning operation using Carbide-TiC cutting tools. This study is done on the CNC lathe machine in the room temperatures. During this machining several cutting parameters such as cutting speed remains constant which is 700 rpm and they are involved such as cutting speed and cutting time.

Surface roughness tester, microscope and Scanning Electron Microscope (SEM) will be used to measure and identify the surface roughness and the surface integrity. This will determine the surface integrity of the material after completing the machining operations. The factors that influence the surface integrity and the surface roughness are will be identified after the material have been machined.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

Machine tools and cutting tools have advanced in great developments in the past few years. In the past few years ago, machining is a difficult task to be performed but now this task has become commonplace and have been simplified with more advanced technology that have been involved. Machining, the broad term used to describe removal of material from a workpiece (Kalpakjian, 2001).

With the advancement of technology with the increased of development of higher grades of steel and other non-ferrous metal and high temperatures refractory materials and their application, has changed not only the technology of machining but also the development of cutting tools. In the wide development of the cutting tools, it also affects the surface of the materials that have been machined.

According to Finnie, who published a historical review of work in metal cutting (Finnie, 1956), early research in metal cutting started with Cocquilhat in 1851 (Cocquilhat, 1851) and was mainly directed toward the work required to remove a given volume of material.

In 1881, Mallock (Mallock, 1882) suggested correctly that the cutting process was basically one of the shearing the work material to form the chip and emphasized the importance of the effect of friction occurring on the cutting-tool face as the chip removed.

Today's coating technology has contributed significantly to the advancement of materials for the metal-cutting industries. Various coatings, especially those obtained by using PACVD (plasma assisted chemical vapour deposition) and PVD (physical vapour deposition), have been found to enhance tool life and increase cutting speed and feed-rate, resulting in higher productivity (To¨nshoff *et al*, 1997).

Several studies were carried out in order to determine the relationship between process parameters and layer properties on the last few years and surface integrity of the substrate material is important in order to meet the demands of sufficient coating adhesion (Gebauer *et al*, 1997). The surface technologies have been increased due to the development of the cutting tools and machine tools.

Turning is the one of the operation that involved in the material removal or cutting operation. Turning means that the part is rotating while it is being machined. (Kalpakjian, 2001)**.** Turning is then divided into two main processes which is roughing and finishing.

In the roughing operation, the surface of working material usually is roughness and not smooth surface because roughing is the first operation in turning before perform the finishing operation. Mean-while in the finishing process, it is a process which it involved small amount of material removal in one time and main purposed of this process is to get better finish of the materials.

2.2 COMMON MACHINE TOOLS

Machine tools are generally powered-driven metal-cutting or forming machines used to shape metal by:

I. The removal of chips
II. Pressing, drawing or shearing
III. Controlled electrical machining processes

Any machine tools generally have the capability of:

I. Holding and supporting the workpiece
II. Holding and supporting a cutting tool
III. Imparting suitable movement (rotation or reciprocating) to the cutting tool or the work
IV. Feeding the cutting tool or the work so that the desired cutting action and will be achieved

The machine industry is divided into several different categories, such as the general machine shop, the tool room and the production shop. The machine tools found in the metal trade fall into three broad categories:

1. Chip-producing machines, which form metal to size and shape by cutting away the unwanted sections. These machine tools generally alter the shape of the steel products by casting, forging or rolling in a steel mill.

2. Non-chip-producing machines, which form metal to size and shape by pressing, drawing, punching or shearing. These machine tools generally alter the shape of the sheet steel products and also produce parts which need little or no machining by compressing granular or powdered metallic materials.

3. New-generation machines, which were developed to perform operations, would be very difficult, if not impossible to perform on chip- or non-chip producing machines. Electro-discharge, electro-chemical and laser machines, for example, use either electrical or chemical energy to form metal to size or shape.

2.3 MACHINING OPERATION– TURNING LATHE

For this project, the main machining operation involved is the turning process. Turning is the machining operation that produces cylindrical parts. In its basic form, it can be defined as the machining of an external surface, it is performed on a machine called a lathe in which the tool is stationary and the part is rotated. The operation involved the following:

- The workpiece is rotated,
- Using a single-point cutting tool, and
- With the cutting tool feeding parallel to the axis of the workpiece and at a distance that will remove the outer surface of the work

Turning constitutes the majority of lathe work. The cutting forces resulting from the feeding the tool from right to left and be directed towards the headstock to force the workpiece against the workholder. The single-point tool is moved parallel to machine spindell for straight or contour turning of the outside diameter. From the tools, both flat and circular, were at one time fed into the workpiece to produce the desired contour of the part.

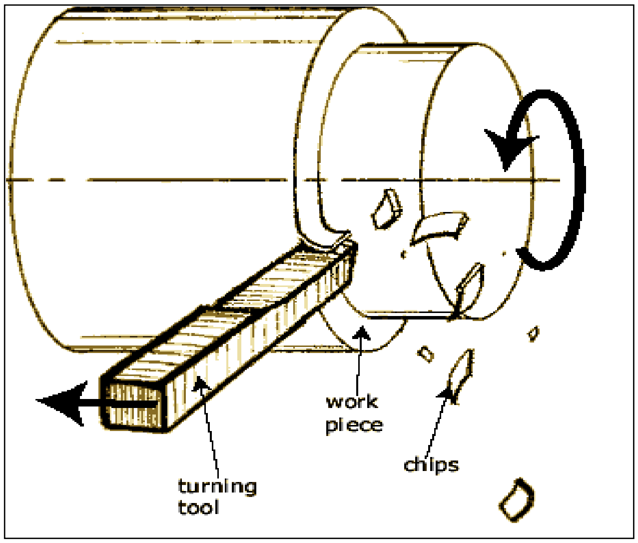

Figure 2.1: Schematic illustration of the basic principle of the turning operation (Efunda Engineering Fundamental, 2006).

2.3.1 The Basic Parts of Lathe Machine

In the lathe machine it is divided into five main parts. The five main parts of the lathe are:

I. the bed,
II. the headstock,
III. the carriage,
IV. the tailstock,
V. the gearbox