**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

# Study Performance of Cylindrical Grinding on Surface Roughness

Thesis submitted in accordance with the requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing Engineering (Manufacturing Process)

By

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

…………………….
(PSM Supervisor)
Mr. Mohamad Amri Bin Sulaiman
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#### ABSTRACT

This research presents the effects of cylindrical grinding parameters (spindle speed, traverse speed, and depth of cut; infeed) on the surface roughness for PS A 80 K 8 V 6N grinding wheel tools, in grind AISI 1040 medium carbon steel. The process of grinding was done by Universal Cylindrical Grinder SHARP OD618 S/H with traverse grinding operation selected. The intervals of parameters were decided after referred from suitable recommendation provided. The surface roughness value will obtained by using Mitutoyo's SJ-301 surface roughness tester. The result will compare with experiment hypothesis to measure the affect of variable parameter to surface roughness changes. Interpretation of result will used for further reference for checking suitable condition parameter on various conditions of operations.

# ABSTRAK

Penyelidikan ini merangkumi kesan parameter (*spindle speed, traverse speed* dan *depth of cut*) daripada operasi *cylindrical grinding* terhadap kekasaran permukaan dengan penggunaan pengisar batu canai *PS A 80 K 8 V 6N* pada bahan keluli karbon sederhana AISI 1040. Proses mengisar telah dilakukan oleh Universal *Cylindrical Grinder SHARP OD618 S / H* dengan kelajuan operasi mengisar yang telah ditetapkan. Selang bagi setiap parameter ditetapkan dengan merujuk aturan dan cadangan kelajuan bagi setiap parameter. Kemudian, nilai kekasaran permukaan akan memperolehi dengan menggunakan Mitutoyo's SJ-301; penguji kekasaran permukaan. Hasilnya akan bandingkan dengan hipotesis eksperimen mengukur kesan parameter serta pembolehubah untuk setiap perubahan kekasaran permukaan. Keputusan yang dicapai adalah berguna sebagai rujukan dalam memilih kesesuaian parameter di dalam pelbagai operation pencanaian.

## DEDICATION

*For my beloved parent, my family best friend and all friends, and to those who's with me all this time*

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| | |
|---|---|
| HV | Hardness Vickers |
| SEM | Scanning Electron Microscope |
| Sk | Skewness Of The Profile |
| AISI 1040 | Medium Carbon Steel Graded By American Iron And Steel Institute |
| Ra | Arithmetic Mean Deviation Of The Profile |
| Rmax | Maximum Peak To Valley Height Of The Profile |
| Rp | Maximum Profile Height |
| Ry | Maximum Height Of The Profile |
| µm | Micrometer (Micron) |
| CCD | Charge-Coupled Device |
| CLA | Center Line Average |
| PS A 80K V 6N | Wheel Grade: [PS; Manufactures Abrasive Code][A; Aluminum Oxide][80; Grain Size, Fine][K; Grade, Medium][V; Porosity][V; Bond Type, Vitrified][6N; Manufactures Bond Code] |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Project

Cutting processes are among the most important of manufacturing operation. They are often necessary in order to impart the desired surface finish and dimensional accuracy to component, particularly those with complex shape that cannot be produced economically or properly by other techniques.

A large number of variables have significant influence on the mechanics of chip formation in cutting operations. Commonly observed chip types are continuous, built-up edge, discontinuous and segmented. Among important process variables are tool shape and material, cutting conditions such as speed, feed, and depth of cut, use of cutting fluids, and the characteristics of the machine tool, workholding device, fixturing, as well as the characteristics of the workpiece material, parameters influenced by these variables are force and power consumption, tool wear, surface finish and integrity, temperature, and dimensional accuracy of the workpiece. Machinability of materials depends not only on their intrinsic properties, but also on proper selection and control of process variables.

The distinction between a finishing operation and other processes that affect the surface is that finishing processes are not intended significantly change the dimension of a part (William O. Feller, 2001). Rather, this finishing operation is intended to achieve closer tolerances and provide protective coating. It is also able to improve the appearance of the part.

Surface finish is specified by giving the desired waviness, roughness, and lay of the desired surface. Waviness refers to the long-range undulations in the surface, not necessarily those left by the tool marks. Roughness refers to the finely spaced textured irregularities. Roughness is usually determined by the tool marks of the final operation.

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.

## 1.2 Objective

The objectives of this experiment are:

(a) To study the relationship between the surfaces roughness values and cylindrical grinding parameters such as spindle speed, traverse speed and also depth of cut. From the study, we were able to study performance the cylindrical grinding due to its parameter to produces better surface finish.

(b) To analyzed the surface roughness of the material of cylindrical grinding operation such as the surface texture and surface profile.

## 1.3 Scope of Project

This project is about investigating the surface roughness on medium carbon steel AISI 1040 during cylindrical grinding operation using PS A 80 K 8 V 6N wheel as cutting tools. This process is done on the Universal Cylindrical Grinder OD-618 S/H in the room temperatures. During this machining several cutting parameters such as feed rate, spindle speed and depth of cut are frequent varied in selected range with 1960 rpm of grinding wheel are fixed. 45 samples are used to complete all parameters decided to further surface roughness analyzing.

Profilometer of Surface roughness Tester Mitutoyo SJ-301, of will be used to measure and identify the surface roughness and it values. This will determine the surface roughness of the material after completing the grinding operations. The factors that influence the surface roughness is 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 common place 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 S, 2001).

Each process should be studied in order to understand the interrelationships of design parameters, such as dimensional accuracy, surface finish and integrity, and process parameters such as speed, feed, depth of cut, tool material and shape, and cutting fluids.

A variety of abrasive processes and machinery are available for surface, external, and internal grinding. The selection of abrasives and process variable in these operations must be controlled in order to obtain the desired surface and dimensional accuracy. Otherwise, damage to surfaces such as burning, heat checking, and harmful residual stresses may develop. Several finishing operations are available for debarring. Because contribute significantly to product cost, proper selection and implementation of finishing operations are important.

In written of William O. Feller (Fellers W. O., 2001), the result to breaking and cutting a piece of material depends on several factors:

(a) The properties of the material being cut.
(b) The properties of the cutting tool.
(c) The speed at which the material is cut.

Those factor giving then the result on the workpiece such as geometric shape, dimension, appearance, and also surface integrity. Thus some parts that have been producing in machining would to have other finishing operations, such as grinding. This operation is important to obtain the desire final dimension and surface finish (Kalpakjian S, 2001).

The principle differences between the cutting action of grinding and other removal operation lie in the following (S C Black, 1998):

(a) Grinding grits are sufficiently hard to cut fully hardened steels of the order of 850 HV.
(b) The cutting angles of the grits have random geometry.
(c) The pitch of the grit cutting edges is much smaller than the pitch other cutter teeth.
(d) The size of the chips cut is very small for grinding.

## 2.2 Review: Grinding Due to Surface Finish

When study of a geometry and surface finish of metal removing, is necessary in order to achieve efficiency of operations. When roughing, the aim is to remove a particular volume of metal in minimum time, when finishing, the area finished surface produced is the criterion, and where the area surface produced is the decisive feature.

Since the metal removal rate $\boldsymbol{w = df \times V_c}$ $\mathbf{mm^3/s}$, any increase in cutting speed, depth of cut of feed will give a directly proportional increase in the metal removal rate. The power available at the machine spindle is one factor limiting the metal removal rate (Black S C, 1998).

Grinding and various abrasive-removal processes are capable of producing the finest accuracy and surface finish in manufactured products. The majority of abrasive processes are basically finishing operations that are usually performed on machined or cold-worked parts. However, abrasives are also used for large-scale material-removal processes, such as creep-feed grinding (http://industrialtech.freeservers.com).

As with other conventional grinding processes, cylindrical grinding is a manufacturing method using tools with lots of undefined geometrical cutting edges, which are formed by a large number of abrasive grains made of natural or synthetic abrasive material that remove the workpiece material at high speeds. In the case of external cylindrical grinding, two cylindrical bodies generally come into contact with each other. The length or surface of contact is relatively small (Tawakoli T. *et al*, 2006).

In the grinding process, because of the undefined geometrical cutting edges, there is a large amount of heat caused by different mechanism of shear, friction and separation, which is only partially dissipated by the chips and the rest can lead to a considerable thermal strain and burning on the workpiece and also on the tools. The reduction of heat build-up and proper cooling during grinding are therefore of immense importance (Tawakoli T. *et al*, 2006).

The geometrical parameters like tolerances or roughness are generally determined by the workpiece drawing and they are fixed. In order to achieve such geometrical parameters and defined accuracy, grinding parameters like depth of cut or traverse feed should be so selected in such a way that grinding forces do not exceed from a critical amount which causes thermal damage. It means that they must be relatively small. Unfortunately, these limited grinding forces decrease material removal rate and increase production time (Tawakoli T. *et al*, 2006).

Chatter is critical to grinding processes because accuracy and surface finish are the two major purposes for grinding processes. In addition, grinding processes are inherently susceptible to chatter. When chatter boundaries are known, one can design a grinding process without chatter. Thus, it is important to study chatter mechanisms and predict grinding chatter boundaries and growth rates (Hongqi Li *et al*, 2007).

Most recently, Li and Shin (Hongqi Li *et al*, 2007) presented a comprehensive time-domain dynamic model, which simulates cylindrical plunge grinding processes under general grinding conditions. The model focused on the prediction of grinding chatter boundaries. Critical issues were considered in the