EFFECT OF WHEEL GRINDER ON THE SURFACE ROUGHNESS WHEN GRINDING ALUMINUM ALLOY

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SUPERVISOR DECLARATION

I hereby declare that I had read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the purpose of the granting of Bachelor of Mechanical Engineering with Manufacturing Engineering.

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STUDENT DECLARATION

I declare that this thesis entitled "*Effect of Wheel Grinder on Surface Roughness when Grinding Aluminum Alloy*" is the result of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

Grinding is one of the most complex processes in machining operation. Usually it is use for the finishing process to give the best surface finish and accurate dimension to the product by removing small amount of material on surface. It is important for the product because it will be influence to the quality of the product. The purpose of this study is to investigate the effect of the surface roughness on the 1060 aluminum alloy when using different depth of cut, worktable speed and different type of wheel. The others purpose is to find the optimization parameters that effect to the surface roughness of the 1060 aluminum alloy. Precision surface grinding machine is use to grind the aluminum alloy. Taguchi method and analysis of variance (ANOVA) are use to analyze the result for experiments. From the result, it shows the highest worktable speed and depth of cut give the highest value of surface roughness for the aluminum oxide and silicon carbide. The lowest value of surface roughness gives the best surface finish. The most significant parameter when grinding 1060 aluminum alloy is worktable speed for aluminum oxide. Depth of cut is the significant factor when grinding using silicon carbide. The suitable wheel to grind aluminum alloy is silicon carbide it produce the lowest value of surface roughness. The optimization parameter for both wheels is 10 µm depth of cut with 100 mm/s worktable speed.

ABSTRAK

Pengisaran adalah salah satu proses yang paling kompleks dalam operasi pemesinan. Biasanya ia digunakan untuk proses terakhir bagi memberikan permukaan akhir yang terbaik dan dimensi produk yang tepat dengan membuang sejumlah kecil bahan pada permukaan. Ini pemting kerana ia mempengaruhi kualiti sesuatu produk. Tujuan dari kajian ini adalah untuk mengetahui pengaruh kekasaran permukaan pada paduan aluminium 1060 ketika menggunakan kedalaman potongan yang berbeza, kelajuan meja kerja dan jenis roda yang digunakan. Tujuan lain adalah untuk mencari parameter optimum yang mempengaruhi kekasaran permukaan gabungan aluminium 1060. Mesin pengisar permukaan digunakan untuk mengisar paduan aluminum dan analisis varians (ANOVA) digunakan untuk menganalisis keputusan ekperimen. Dari keputusan ekperimen, ia menunjukkan kelajuan meja kerja dan nilai kedalaman potong yang tertinggi menghasilkan nilai kekasaran permukaan yang tinggi untuk aluminium oksida dan silikon karbida. Nilai kekasaran permukaan yang rendah menghasilkan permukaan akhir yang berkualiti .Parameter yang paling ketara ketika mengisar paduan aluminium 1060 adalah kelajuan meja kerja untuk aluminium oksida. Kedalaman potong adalah faktor signifikan ketika mengisar menggunakan silikon karbida. Roda yang sesuai untuk mengisar gabungan aluminium ialah silikon karbida kerana ia menghasilkan nilai kekasaran permukaan yang terendah. Parameter optimum untuk kedua-dua roda adalah 10 µm kedalaman potong dengan 100 mm /s kelajuan meja kerja.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Grinding is one of the most complex and unpredictable metal working processes. In industry, although grinding widely used, it is remains perhaps the least understood of all machining processes. It depends upon the experience of the operator, rather than scientific knowledge about how to apply the grinding process.

There are many types of the grinding process. Some of them are surface grinding, centerless grinding, internal grinding, precision roll grinding, abrasive cut-off thread grinding and others. All of them are important to produce the part in industry. The industries which use grinding process are automotive, aircraft, shipbuilding, engine, turbine, bearing, metalworking machine industries and others. In general shops and tool rooms are using the grinding process to produce the certain part such as gear, blade, crankshaft and many of them. Grinding process is important to produce the precision and accurate measurement. It is also to make the good quality for the surface condition. Usually the grinding process is using as the last process to produce the part as finishing process by removing a small amount of material (Marinescu I.D. et al., 2006).

1.2 PROJECT BACKGROUND

Different types of parameter in grinding process will be effect to the characteristic of the workpiece such as surface roughness, temperature, force and others. There are many types of parameters in grinding process. Some of the parameters may be measured while the others may be calculated from those already known. Some of the parameters in grinding is needed for calculation of the others parameter (Marinescu I.D. et al., 2006 and Tawakoli T., 1993).

Some of the examples for the parameters are wheel speed, type of material, type of wheel, depth of cut, type of dressing, condition while grinding and worktable speed. These parameters will be affected to the temperature of the workpiece surface or wheel, hardness of the workpiece, grinding force, surface roughness and the others. These parameters can help to improve the wheel life and the quality of the workpiece. It is also can save the cost, time, energy and get the good quality for surface condition by using suitable parameter when do the grinding process (Youssef H.A. et al., 2008).

The main objectives of this research is to study about the effect of the surface roughness on grinding of aluminum alloy by using depth of cut, types of wheel and worktable speed as the parameters. By using different types of parameters, its can determines which parameters that have significant to the surface roughness of the workpiece.

1.3 PROBLEM STATEMENT

Aluminum alloy is using because of it is characteristics such as corrosion resistant, soft and light-weight. It is also one of the most important materials that used in industry. Therefore, the best quality and accurate dimension are very important. Surface roughness is affected to the quality of the product, cost and process time. The parameters use on grinding process must be control to get the best surface roughness. The effect of wheel grinder on the surface roughness when grinding aluminum alloy can be determines by using different type of parameters. In this experiment, the parameter uses are worktable speed, depth of cut and types of wheel.

1.4 OBJECTIVES

The objectives of this project are:-

(i) To investigate the surface roughness of the aluminum alloy for different depth of cut and worktable speed by using aluminum oxide and silicon carbide as wheel grinder.

(ii) To find the optimization parameter when grinding aluminum alloy.

1.5 SCOPE OF THE PROJECT

(i) The grinding wheels that will be used in this project are aluminum oxide and silicon carbide.

(ii) The parameters that will be set constant for the whole experiment are wheel speed, dressing mode and type of material for the workpiece.

(iii) The speed of worktable, depth of cut and types of wheel as independent variable and surface roughness of the workpiece as dependant variable.

(iv) The tester will be used to measure the surface roughness of the workpiece is Perthometer S2.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is discussing on some literatures review which related to the effect of wheel grinder to the surface roughness of the aluminum alloy by using grinding machine.

2.2 SURFACE GRINDING

In grinding process, there are many types of the grinding operation such as cylindrical grinding, deep grinding, centerless grinding and many others process. The most common of the grinding process is surface grinding. The surface quality produced in surface grinding is influence by some parameters such as abrasives, grain size, grade, structure, binder, shape and dimension for the wheel. For the workpiece are about fracture mode, mechanical properties, and chemical composition. Furthermore, wheel speed, depth of cut, table speed, and dressing condition also can influence to the surface quality.

Process parameters can be determines through the experiments to achieve the surface quality that required. Sometimes, may be a take long times and expensive method but also it cannot determine the exact optimum because of restricted experiments. Taguchi method can conveniently optimize the grinding parameters through the experiment that run well designed (Kwak J.S., 2004).

2.3 SURFACE ROUGHNESS

The quality of machined surface is characteristics by the accuracy of 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 or wheel leaves its own individual pattern which therefore can be identified. This pattern is known as surface finish or surface roughness. Figure 2.1 show the example of the pattern on the workpiece.

The surface roughness is a variable often used to describe the quality of ground surfaces and also to evaluate the competitiveness of the overall grinding system. Surface roughness is one of the most important features of a machining process because it affects the functions of the part. In a grinding process, it is very important to keep the surface roughness within specified requirements because this process is the final machining process which usually at the last stage of the machining (Agarwal S. et al., 2010).

The ability of manufacturing operation is base on many factors. The final surface depends on the rotational speed of the wheel, velocity of worktable, feed rate, types of workpiece being machined, depth of cut, types of wheel, and others parameter that can effect to the surface finish of the workpiece. Type and amounts of lubricant use for grinding process also influence the surface roughness. Different types of machine have different variable parameters that can be change to get the best surface finish (Marinescu I.D. et al., 2006 and Agarwal S. et al., 2010).

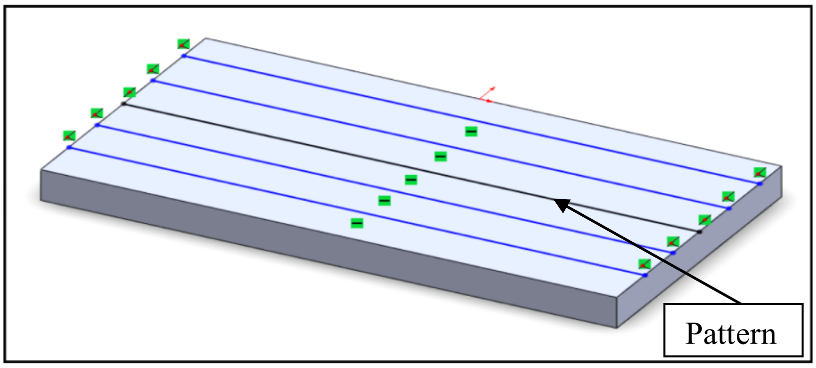

Figure 2.1: Example of the pattern on the workpiece

There are some surface characteristics can be determined after the finishing process such as:-

(i) Roughness is consists of surface irregularities which result from the various machining process. These irregularities combine to form surface texture.

(ii) Roughness height is the height of the irregularities with respect to a reference line. It is measured in millimeters or microns.

(iii) Roughness width is the distance parallel to the nominal surface between successive peaks. It is constitute the predominate pattern of the roughness. It is measured in millimeters.

(iv) Roughness width cut-off is the greatest spacing of respective surface irregularities to be included in the measurement of the average roughness height.

(v) Lay represents the direction of predominant surface pattern produced and it reflects the machining operation used to produce it.

(vi) Waviness is refers to the irregularities which are outside the roughness width cut off values. It is the widely spaced component of the surface texture. This may be the result of workpiece or tool deflection during machining, vibrations or tool run out.

(vii) Waviness width and waviness height is the peak to valley distance of the surface profile and it is measured in millimeters.

All of these surface characteristics are show in Figure 2.2 below.

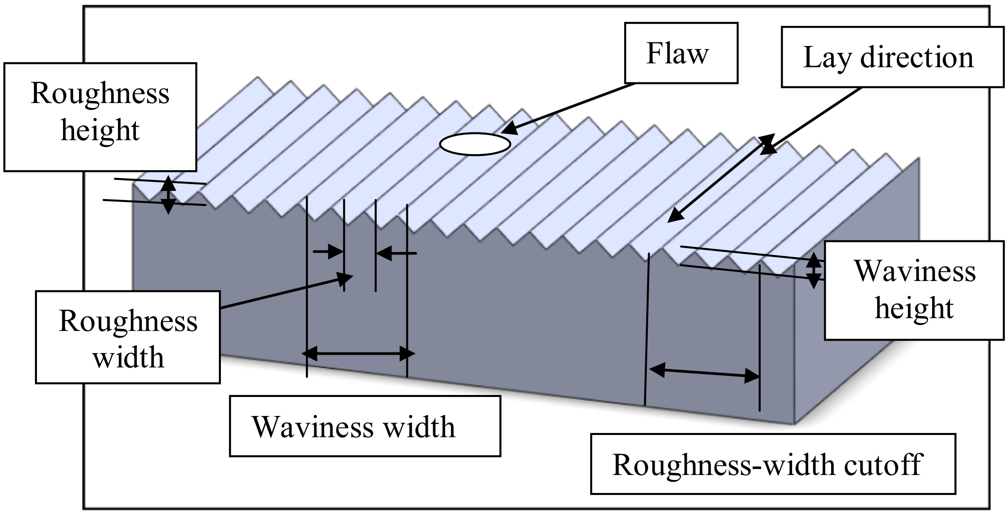

Figure 2.2: Example of the surface characteristics

2.4 GRINDING PARAMETERS

2.4.1 Depth of Cut

Depth of cut (d) is the distance of the grinding wheel penetrates into the workpiece. The depth of cut affects to the processing speed. When the cutting depth is big, the processing speed becomes quick and the surface temperature becomes high. The surface roughness of the workpiece will be change. Moreover, a life of bite also becomes short. If suitable cutting depth is unknown, it better to start machining with small cutting depth (Kwak J.S., 2004 and Merchant M.E., 1994).

2.4.2 Worktable Speed

Worktable speed is the speed of the worktable movements. The workpiece will be stick by magnetic worktable of the grinding machine. The speed of the worktable will be influence the rate of the grinding for the workpiece. The worktable speed can measure by using the tachometer for the conventional surface grinding machine. By change the worktable speed applied, the surface roughness of the workpiece also will be change (Kwak J.S., 2004 and Merchant M.E., 1994).

2.4.3 Types of Wheel

Types of wheel for the grinding process will be chosen depends on the material that will be use for the workpiece. If the material use for grinding process have high hardness, so the grinding wheel that will be use also have high hardness point. The suitable grinding wheel use for the grinding process is important to avoid the wheel and workpiece from broken. The ability of the wheel depends on its grit number. Larger grit number of the wheel will produce more fine surface finish (Kwak J.S., 2004 and Merchant M.E., 1994).

2.5 MATERIAL OF WORKPIECE

Aluminum is a silver white metal that has a strong resistance to corrosion and like gold, is rather malleable. It is a relatively light metal compared to metals such as steel, nickel, brass, and copper with a specific gravity of 2.7. Aluminum is easily machinable and can have a wide variety of surface finishes. It also has good electrical and thermal conductivities and is highly reflective to heat and light.

The typical elastic modulus of aluminum alloys at room temperature (25°C) ranges from 70 to 79 GPa. The typical density of aluminum alloys ranges from 2.6 to 2.8 g/cm^3. The typical tensile strength varies between 230 and 570 MPa. The wide range of ultimate tensile strength is largely due to different heat treatment conditions. Table 2.1 below show the properties of aluminum alloy and Table 2.2 show the composition of 1060 aluminum alloy (Kwak J.S. et al., 2008).

Table 2.1: Properties of Aluminum Alloy

Properties of 1060 Aluminum Alloy	
Density	2.7 x 10^3 kg/m^3
Elastic Modulus	70 - 80 GPa
Tensile Strength	83 MPa
Yield Strength	76MPa
Elongation	16%
Hardness	23 HB
Shear Strength	55 MPa
Fatigue Strength	28 MPa

Table 2.2: Composition of 1060 Aluminum Alloy (Wrought)

Composition of 1060 Aluminum alloy	
Si	0.25%
Fe	0.35%
Cu	0.05%
Mn	0.03%
Mg	0.03%
Zn	0.05%
Ti	0.03%
Others	0.03%
Aluminum (minimum)	99.6%

2.6 DRY MACHINING

Dry machining is the machining process without using the coolant. It is requires less power. However, sometimes it is less effective because in dry machining higher order friction between tool and work and between tool and chip can lead to high temperature in the machining zone. This high temperature at the machining zone will be effect to the accuracies for the work piece, too wear problems and give low quality for the surface finish. The interest in dry machining is often related to the healthy issues, low cost and environmentally friendly. Figure 2.3 show the example of dry machining for grinding process (Sreejith P.S., 2007).

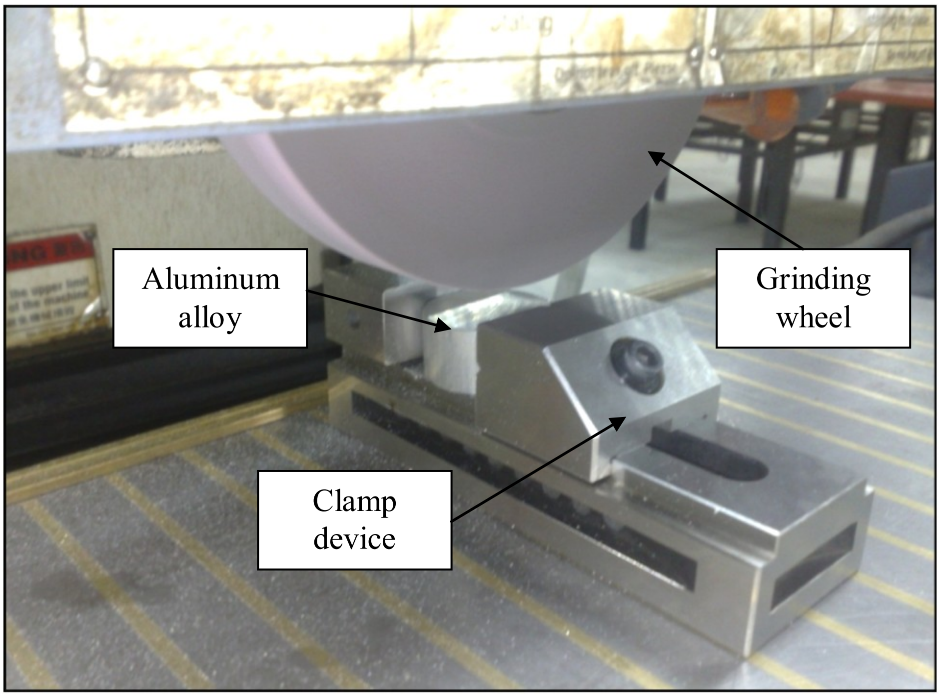

Figure 2.3: Example of dry machining for the grinding process

2.7 GRINDING MACHINES

A grinding machine is a machine which is used for grinding process. This machine used an abrasive wheel as the cutting tool. That abrasive wheels use the grain of abrasive on the wheel's surface cuts a small chip from the workpiece. Usually, the grinding machine is used only as a finishing tool on parts which require a special surface or in which greater accuracy is required than reached by the other machines and now it is become one of the large production factors. The work which comes to the grinding machine has usually rough turned to an approximate diameter, but it has been found that the grinding machine will completely finish the piece of work from the rough stock at a lesser labor cost, doing its own roughing and finishing (Youssef H.A. et al., 2008). There are many types of grinding machine. These machines include:-

(i) Belt grinder – This grinder used as a machining method to process metals and other materials, with the aid of coated abrasives.

(ii) Bench grinder – This grinder usually has two wheels of different grain sizes for roughing and finishing operations and is secured to a workbench.

(iii) Cylindrical grinder – This grinder have multiple grinding wheels. It is used to make precision rods.

(iv) Tool and cutter grinder - These grinder usually can perform the minor function of the drill bit grinder, or other specialist tool room grinding operations.

(v) Jig grinder –The function are in the realm of grinding holes and pins and used for complex surface grinding to finish work started on a mill.

(vi) Surface grinder – It's includes the wash grinder. Usually use for surface finishing to get more accurate dimension.

Figure 2.4 showed the illustration and the part that have in surface grinding machine and the Figure 2.5 showed the real picture of the surface grinding machine.

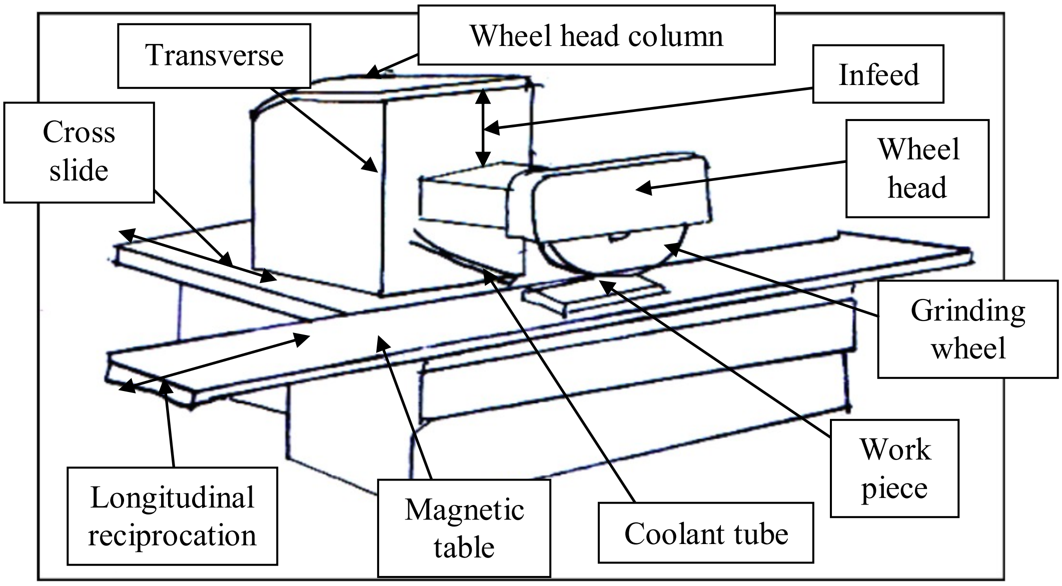

Figure 2.4: Illustration of Surface Grinding machine

Figure 2.5: Surface Grinding machine