UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Manufacturing Engineering

SURFACE ROUGHNESS STUDY ON ALUMINIUM IN HIGH SPEED TURNING PROCESS

Mohd Shazwan Bin Dahlan

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IR. DR. MOHAMAD BIN MINHAT
Pensyarah Kanan
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

Signature : ....

Supervisor Name : IR. Dr. MOHAMAD BIN MINHAT

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DEDICATION

As a young person growing up in the wilderness I have been moved by the annual migration of birds flying south in our winter and returning again in spring. As I grew older I realised how little real wilderness area is left over for them to rest and recover during the transit. This has motivated me to write this paper in the hope that something can be done to at least consolidate what they do have. I dedicate this work to that goal, which has sustained me during its creation. I also dedicate this work to my family especially my mother, father and my be loved wife that with to go through the hardship together until the end.

ABSTRACT

Surface integrity was the surface condition of a workpiece after being modified by a manufacturing process and it can change the material's properties. In surface topography, surface roughness (Ra) was concerned with the geometry of the outermost layer of the workpiece texture and the interface exposed with the environment affects several functional attributes of parts, such as friction, wear and tear, light reflection, heat transmission, ability of distributing and holding a lubricant, coating etc. Therefore, the desired surface finish was usually specified and appropriate processes were required to assess and maintain the quality of a component. The objective of the study aims to investigate the influence of machining parameters to the surface roughness value, Ra during high speed turning of aluminium steel material under dry condition. Experimental preparations were made to ensure the smoothness of the experimental operation. Pilot experimental will be conducted to verify all the machine parameter. All equipment used such as the CNC turning machines, microscope were inspected. CNC programming was also prepared before conducting the machining experiment. Using taguchi as the design of the experiment with three parameters such as cutting speed range within 158.96 m/min to 317.93 m/min, feed rate range of 0.1 mm/rev to 0.3 mm/rev and depth of cut range within 0.5 mm until 1.0 mm. From the experiment conduct, best result is 0.279 µm with parameters of 158.96 m/min, 0.2 mm/rev and depth of cut of 0.75 mm. Optimizations of parameters show that by using cutting speed of 172.509 m/min, feed rate of 0.25 mm/rev with depth of cut 0.99 mm; minimum surface roughness (0.014629 µm) can be achieved.

ABSTRAK

Integriti permukaan adalah keadaan permukaan bahan kerja selepas diubahsuai oleh proses pembuatan dan ia boleh mengubah sifat bahan. Dalam topografi permukaan, kekasaran permukaan (Ra) berkenaan dengan geometri lapisan terluar tekstur bahan kerja dan antara muka yang terdedah dengan persekitaran memberi kesan kepada beberapa ciri-ciri fungsian bahagian, seperti geseran, haus dan lusuh, refleksi cahaya, penghantaran haba, keupayaan mengedarkan dan memegang pelincir, salutan dan lain - lain. Oleh itu, kemasan permukaan yang dikehendaki biasanya ditentukan dan proses yang sesuai diperlukan untuk menilai dan mengekalkan kualiti komponen. Objektif kajian ini bertujuan untuk mengkaji pengaruh parameter pemesinan pada nilai kekasaran permukaan, Ra semasa pengalihan kelajuan tinggi bahan keluli aluminium di bawah keadaan kering. Persiapan percubaan dibuat untuk memastikan kelancaran operasi eksperimen. Percubaan perintis akan dijalankan untuk mengesahkan semua parameter mesin. Semua peralatan yang digunakan seperti mesin turn CNC, mikroskop diperiksa. Pengaturcaraan CNC juga disediakan sebelum menjalankan eksperimen pemesinan. Menggunakan taguchi sebagai reka bentuk eksperimen dengan tiga parameter seperti jarak laju pemotongan dalam 158.96 m / min hingga 317.93 m / min, julat kadar suapan 0.1 mm / rev ke 0.3 mm / rev dan kedalaman potongan jarak dalam 0.5 mm hingga 1.0 mm. Daripada tingkah laku percubaan, hasil terbaik adalah 0.279 μm dengan parameter 158.96 m / min, 0.2 mm / rev dan kedalaman potong 0.75 mm. Pengoptimuman parameter menunjukkan bahawa dengan menggunakan kelajuan pemotongan 172.509 m / min, laju suapan 0.25 mm / rev dengan kedalaman pemotongan 0.99 mm; kekasaran permukaan minimum (0.014629 μm) boleh dicapai.

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rotating cylindrical part. The cutting tool is fed linearly in a direction parallel to the axis of rotation. In turning, the parameters condition of cutting speed, feed rate and depth of cut are need to be selected properly in order to optimize the turning operation.

Another aspect that needs to be considered in affecting the surface integrity of material is the material to be machined. In most industrial common application, mild steel is the most common form of steel as its price is relatively low while it provides material properties that are acceptable for many applications. Mild steel has allowed carbon content (up to 0.3%) and is therefore neither extremely brittle nor ductile. It becomes malleable when heated, and so can be forged. It is also often used where large amounts of steel need to be formed, for example as structural steel. Mild steel material is widely used in basically the most common industrial products, such as bolts, nuts, sheet, plate, and tubes, and for machine components that do not require high strength. This includes motorcycle frames, automobile chassis, cookware and etc. But due to peculiar characteristics such suffer from yield-point runout and has a relatively low tensile strength (Degarmo, 2003). It is, highly susceptible to corrosion (rusting) when exposed to moisture and has several typical problems which usually can be identified by visual inspection. Good surfaces machining with generation of smooth surface on the mild steel components during turning operation is a challenge to the manufacturing engineers in practice.

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CHAPTER 1

INTRODUCTION

This chapter explains the introduction of the research on “Surface Roughness Study on Aluminium in High Speed Turning Process”. In extension, this chapter will elaborate on the problem statement, objectives and scopes of the research.

1.1 Project Background

The global manufacturing sector has undergone a great decade with large developing economies leaped into the first tier of manufacturing nations. Manufacturing industries in this modern era remains a critical force in both advanced and developing economies. As the end of the twentieth century approached, manufacturing industries faced new technology in many areas. In the latter, it remains a vital source of innovation and competitiveness, making outsized contributions to research and development.

When a traditional manufacturing process such a turning is used, the surface layer sustains local plastic deformation. Traditional processes involve the tool contacts with the workpiece surface. These processes will only damage the surface integrity if the improper parameters are used, such as dull tools, too high feed speeds, improper coolant or lubrication, or incorrect grinding wheel hardness. Turning operation is the machining operation in which a single-point cutting tools removes material from the surface of a

1.2 Problem statement

The manufacturing process of material and the specification or enhanced surfaces require an understanding of the interrelationship among metallurgy, machinability and mechanical testing. To satisfy this requirement, an encompassing discipline known as surface integrity was introduced and it has gained worldwide acceptance. Surface integrity is the surface condition of a workpiece after being modified by a manufacturing process. The surface integrity of a workpiece or item changes the material's properties and can have a great impact on a parts function and is very important for the components adapting to high thermal and mechanical loads during their applications (Axinte, Dewes and Twardowski, 2011). Surface integrity technology describes and controls the many possible alterations produced in a surface layer during manufacture, including their effects on material properties and the performance of the surface in service. Surface integrity is achieved by the selection and control of manufacturing processes, estimating their effects on the significant engineering properties of work materials, such as fatigue performance. Surface roughness is one of the various properties of an engineering surface that affect the performance of this surface in service (Davim, 2010). Surface roughness also affects several functional attributes of parts, such as friction, wear and tear, light reflection, heat transmission, ability of distributing and holding a lubricant, coating etc. Therefore, the desired surface finish is usually specified and appropriate processes are required to maintain the quality (Bhushan, 1999). Hence, the inspection of surface roughness of the work piece is very important to assess the quality of a component. To ensure better and finer surface roughness, special attention must be paid in selection of workpieces material, cutting parameters, tool material and geometry and tool coatings (Krolezky,Nieslony and Stoic 2013). The effect of machining parameters on the surface integrity in the context of surface roughness characteristics /quality of the machined part is very important in order to understand the relationship between machining parameters and finer surface roughness value.

1.3 Objectives

The objectives of the research are;

1. To investigate the influence of machining parameters to the surface roughness value, Ra during high speed turning of aluminium material under dry condition.
2. To define optimum process parameter setting to minimize surface roughness value, Ra of aluminium steel.
3. To develop mathematical model for surface roughness of machined surface.

1.4 Scope of study

The scope of the research focuses on the surface integrity (surface roughness) on sub-surfaces of aluminium alloy material grades 6061 – T6 during high speed turning with dry cutting condition. The surface roughness variations in single point turning operation are investigated at different cutting speed and feed rate. The machining parameters evaluated are feed rate, cutting speed and depth of cut. The depth of cut will be constant value mean while the cutting speed and feed rate are will be manipulate. The value of the parameters and types of cutting tool are discussed in Chapter 3.

1.5 Significant of study

This topic is being study because of the idea to find the smooth surface roughness while doing it in high speed. Also because of the facility that were have in here at Politeknik Muadzam Shah and UTeM so that it will make the experiment can be done easier as the facilities were near. Hence, we can see as the high speed turning will effect the surface roughness of aluminium and to see whether the deepest of the penatration will effect on the surface roughness in high speed. Nowadays situation, more faster machine, meant more product can be produce and without neglect of its quality. As for it, we can discover how surface roughness textures will be in the high speed turning process and how the deep of penatration will effect on surface roughness where in this case by using aluminium as its material to study.

The paper plan for this research is experimental type of research by controlling the variable in order to find the surface roughness result. The variable would be the quality of the surface roughness as to seen when applying the high speed turning process and the parameter in this research paper would be the speed of the turning process and the deep of the penatration.

CHAPTER 2

LITERATURE REVIEW

This research paper is about impact of surface roughness on aluminium in high speed turning process. The literature reviewed about workpiece material (aluminium alloy), turning operation, cutting condition (dry condition), cutting tool, tool wear, surface roughness and the design of experiments of methods.

2.1 Aluminium as material

Aluminium or also known as aluminum were one of the substance that exist in periodic table and located in the group of boron as group 13. It usually found as silvery-white, soft, nonmagnetic, ductile metal. Aluminium alloys have been the primary material for the structural parts of aircraft for more than 80 years because of their well known performance, well established design methods, manufacturing and reliable inspection techniques. Because of its characteristic that is less in weight, fatigue performance and corrosion resistance , it were becomes the main component in large commercial jet airliners for the fuselage, wing as well as other structural components nearly for a decade. There have been important recent advances in aluminium aircraft alloys that can effectively compete with modern composite materials (Tolga Dursun and Costas Soutis, 2014). The hardness of this material can be enhanced where thus strengthen the aluminium alloy (S.H Lee et al., 2002). Table 2.1 shows a short breakdown of each of the grades properties.

Table 2.1 : Type of aluminium alloys (metalsupermarket)

Alloy 1100	This grade is commercially pure aluminum. It is soft and ductile and has excellent workability, making it ideal for applications with difficult forming. It can be welded using any method, but it is non heat-treatable. It has an excellent resistance to corrosion and is commonly used in the chemical and food processing industries.
Alloy 2011	High mechanical strength and excellent machining capabilities are the highlights of this grade. It is often called – Free Machining Alloy (FMA), an excellent choice for projects done on automatic lathes. The high-speed machining of this grade will produce fine chips that are easily removed. Alloy 2011 is an excellent choice for production of complex and detailed parts.
Alloy 2014	A copper based alloy with very high strength and excellent machining capabilities. This alloy is commonly used in many aerospace structural applications due to its resistance.
Alloy 2024	One of the most commonly used high strength aluminum alloys. With its combination of high strength and excellent fatigue resistance, it is commonly used where a good strength-to-weight ratio is desired. This grade can be machined to a high finish and it can be formed in the annealed condition with subsequent heat treating, if needed. The corrosion resistance of this grade is relatively low. When this is an issue, 2024 is commonly used in an anodized

	finish or in clad form (thin surface layer of high purity aluminum) known as Alclad.
Alloy 3003	The most widely used of all aluminum alloys. A commercially pure aluminum with added manganese to increase its strength (20% stronger than the 1100 grade). It has excellent corrosion resistance, and workability. This grade can be deep drawn or spun, welded or brazed.
Alloy 5052	This is the highest strength alloy of the more non heat-treatable grades. Its fatigue strength is higher than most other aluminum grades. Alloy 5052 has a good resistance to marine atmosphere and salt water corrosion, and excellent workability. It can be easily drawn or formed into intricate shapes.
Alloy 6061	The most versatile of the heat-treatable aluminum alloys, while keeping most of the good qualities of aluminum. This grade has a great range of mechanical properties and corrosion resistance. It can be fabricated by most of the commonly used techniques and it has good workability in the annealed condition. It is welded by all methods and can be furnace brazed. As a result, it is used in a wide variety of products and applications where appearance and better corrosion resistance with good strength are required. The Tube and Angle shapes in this grade typically have rounded corners.
Alloy 6063	Commonly known as an architectural alloy. It has reasonably high tensile properties, excellent finishing characteristics and a high degree of resistance to corrosion. Most often found in various interior and exterior architectural applications and trim. It is very well suited for anodizing applications. The Tube and Angle shapes in this grade

	typically have square corners.
Alloy 7075	This is one of the highest strength aluminum alloys available. It has an excellent strength-to weight ratio, and it is ideally used for highly stressed parts. This grade can be formed in the annealed condition and subsequently heat treated, if needed. It can also be spot or flash welded (arc and gas not recommended).

The grades of the aluminium were registered in the IADS that stand for International Alloy Designations. The Aluminum Association Inc. Is the organization that responsible for the allocation and registration of aluminum alloys. These publications can be extremely useful to the welding engineer when developing welding procedures, and when the consideration of chemistry and its association with crack sensitivity is of importance. As for it, there were two system of identification such as 4 digit systems and the 3 digit and 1 decimal place system.

The first digit (Xxxx) indicates the principal alloying element, which has been added to the aluminium alloy and is often used to describe the aluminium alloy series.

Table 2.2 : Wrought aluminum alloy designation system (ESAB)

Alloy Series	Principal Alloying Element
1xx	99.000% Minimum Aluminum
2xx	Copper
3xx	Manganese
4xx	Silicon
5xx	Magnesium
6xx	Magnesium and Silicon
7xx	Zinc
8xx	Other Elements