UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CUTTING TOOL PARAMETER OPTIMIZATION FOR SURFACE ROUGHNESS OF MILD STEEL MATERIAL USING TAGUCHI METHOD

This report is submitted in accordance with the requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Process and Technology) With Honours

by

AFEEQA BT ABD GHANI

B071210235

911006-07-5482

FACULTY OF ENGINEERING TECHNOLOGY
2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **CUTTING TOOL PARAMETER OPTIMIZATION FOR SURFACE ROUGHNESS OF MILD STEEL MATERIAL USING TAGUCHI METHOD**

SESI PENGAJIAN: **2014/15 Semester 2**

Saya **AFEEQA BT ABD GHANI**

mengakumembenarkanLaporan PSM inidisimpan di PerpustakaanUniversitiTeknikal Malaysia Melaka (UTeM) dengansyarat-syaratkegunaansepertiberikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Silatandakan (✓)

☐ SULIT (Mengandungimaklumat TERHAD yang telahditentukanolehorganisasi/badan di manapenyelidikandijalankan)

☐ TERHAD (Mengandungimaklumat yang berdarjahkeselamatanataukepentingan Malaysia sebagaimana yang termaktubdalam AKTA RAHSIA RASMI 1972)

☐ TIDAK TERHAD

Disahkanoleh:

(AFEEQA BT ABD GHANI)

(SALLEH BIN ABOO HASSAN)

1173 AlorMerah, Sungai Dua

13800 Butterworth

Pulau Pinang,

Cop Rasmi:

Tarikh: 10 JANUARI 2016

** JikaLaporan PSM ini SULIT atau TERHAD, silalampirkansuratdaripadapihakberkuasa/organisasiberkenaandenganmenyatakansekalisebabdantempohlaporan PSM iniperludikelaskansebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Cutting Tool Parameter Optimization for Surface Roughness of Mild Steel Material Using Taguchi Method” is the results of my own research except as cited in references.

Signature **:………………………**

Name **: AFEEQA BT ABD GHANI**

Date **: 10 JANUARY 2016**

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the Bachelor of Manufacturing Engineering Technology (Process and Technology) With Honours. The member of the supervisory is as follow:

……………………………….

(SALLEH BIN ABOO HASSAN)

ABSTRACT

This report is the result of experiment to investigate the surface roughness during the end milling of mild steel. By using CNC milling machine to optimize the setting of cutting parameter of feed rate, spindle speed and depth of cut on surface roughness during face milling process of Mild Steel AISI 1050 asworkpiecematerial. Generally the cutting parameter was influenced on the surface roughness in end milling operation. To predict the surface roughness, Design of experiment using Taguchi Method was deployed. Signal-to-Noise ratio was usedto study the performance characteristics in CNC Milling Machine. Theanalysis also shows that the predicted values and calculated values werevery close, which clearly indicates that the developed model can be usedto predict the surface roughness in the milling operation of mild steel.

ABSTRAK

Laporaniniadalahhasildaripadaeksperimenuntukmengkajikekasaranpermukaansemasapengilanganakhirdaripadakelulilembut .Denganmenggunakanmesinpemotong automatic (CNC Milling) 3paksi untukmengoptimumkanpenetapanmemotong parameter kadarsuapan ,kelajuangelendongdankedalamanpemotonganpadakekasaranpermukaansemasa proses pemotonganpadapermukaanbahankelulilembut AISI 1050 sebagaibahankerja. Secaraamnyakadarnilaipemotonganakanmempengaruhipadakekasaranpermukaandalamoperasipemotonganakhir .Untukmeramalkankekasaranpermukaan, RekabentukEksperimenuntukKaedah Taguchi denganmenggunakanperisian MINITAB 17 untukmengiradata yang akandiperolehi. Nisbahisyaratbunyiuntuktelahdigunakanuntukmengkajiciri-ciriprestasidalam CNC Milling Machine.Analisisjugamenunjukkanbahawanilai-nilai yang diramalkandannilai-nilaidikirasangatrapat , yang jelasmenunjukkanbahawa model yang disusunolehkaedah Taguchi bolehdigunakanuntukmeramalkankekasaranpermukaandalamoperasipemotongankelulilembut .

DEDICATIONS

To my beloved parents, my siblings, supervisor and all members that help me to finished this report with the fixed time.

ACKNOWLEDGMENTS

Alhamdulillah. Thank to Allah for giving me the strength and patience to complete this experiment. I would like to thanks to my family for their support given in order for me to complete this final project thesis with successfully. Then, I would like to express my deepest appreciation to Mr.Salleh bin Aboo Hassan as my supervisor because conduct me to analyse this experiment from the beginning to the end. Teach me about the Taguchi Method till understand the method.I will never forget his guidance, advice and motivation that he have given to me.

I would like to thank to everyone that involve rather direct or indirect in helping us to complete this experiment. I really appreciate all the help, advisor and all information related to this experiment. Last but not least, thousand thank to the all technician in the laboratory that I have been use during analysis this experiment. They help during use CNC machine and to check the surface roughness by using surface roughness tester.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

CHAPTER 1

INTRODUCTION

1.0 Background Project

This project is study parameter of cutting which is spindle speed, feed rate and depth of cut on surface roughness because surface roughness is one of the important factors for evaluating work piece quality during the machining process. This is because the quality of surface roughness affects the functional characteristics of the work piece such as compatibility, fatigue resistance and surface friction. The material used was Mild Steel by using high speed milling CNC machine. Milling is the most paramount metal abstracting process for manufacturing the different mechanical components.

The material used is Mild Steel. It has a dull silvery appearance, because of a thin layer of oxidation that forms quickly when it is exposed to air. The Mild Steel had been chosen because of its suitability in machining allowances, therefore should be added when ordering. It does not contain any additions for enhancing mechanical or machining properties. The term ‘mild steel’ is also applied commercially to carbon steels not covered by standard specifications. Other than that, uncoated carbide tools are widely use in metal working industry it is to investigate the performance of uncoated carbide tool while dry machining mild steel in term of surface roughness.
The concept of material removal process in a state of high speed (HSM) has received increasing attention in this decade due to several advantages. An HSM advantage not only speed machining causes of low cost and high productivity, but also produces high surface quality without the need for a second process.

According to (Meena, 2011). Surface roughness is one of the important factors for evaluating work piece quality during the machining process because the quality of surface roughness affects the functional characteristics of the work piece such as compatibility, fatigue resistance and surface friction. The factors that affect the surface roughness during the cessation milling process include implement geometry, aliment rate, depth of cut and cutting speed. Several researchers have studied the cessation milling process in the recent years.

The Taguchi optimization method was used for low surface roughness value in terms of cutting parameters in the CNC face milling of mild steel material (Bagci E, Aykut S. A 2006). While, Taguchi method will used for optimization of surface roughness in face milling of hardened steel in terms of cutting parameters.(Ghani JA, Choudhury I.A,2004). The Taguchi optimization methodologies to optimize the finishing parameter in CNC milling machining use mild steel and tool is high speed steel

1.1 Problem Statement

Determining the accuracy of the cutting of parameters is very important before machining process. It is used to determine the level quality of the surface and the best cutting variable that can produced the minimum value of surface roughness. Previous studies found no robust tool life (Arun Kumar Gupta; PankajChandna; PuneetTandon 2011). In machining of parts, surface roughness is one of the most specified customer requirements where major indication of surface quality on machined parts. The process parameters such as feed rate, cutting speed and depth of cut will become the result of surface roughness. (TuğrulÖzel, April 2005). This situation makes the formation of residual stresses on the surface of the work piece and thus affects the dimensional accuracy. While the roughness of surface Mild Steel was measured using Surface Roughness Tester (Figure 1.1).

Figure 1.1: Mitutoyo Surface Roughness Tester

1.2 Research Objective

1. To determine the effect of spindle speed, feed rate and cutting speed on surface roughness during face milling process of Mild Steel workpiece.
2. To identify the optimized setting of cutting parameter of feed rate, spindle speed and depth of cut on surface roughness during face milling process of Mild Steel workpiece material.

CHAPTER 2

LITERATURE RIVIEW

2.0 Introduction

Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process. Machining is divided in many sections like drilling, turning, milling, grinding, chip formation and which are capable of generating a certain part geometry and surface texture. In milling, a rotating tool with multiple cutting edges is moved slowly relative to the material to generate a plane or straight surface. The direction of the feed motion is perpendicular to the tool's axis of rotation. The speed motion is provided by the rotating milling cutter. The two basic forms of milling are peripheral milling and face milling. In peripheral milling, the axis of cutter rotation is parallel to the work piece surface (Kalpakjian and Schmid, 2013). Meanwhile, for face milling operations of cutter is perpendicular to the workpieces surface (Kalpakjian and Schmid, 2013). Face milling process is basically used to remove the upper surface of work pieces and commonly used for roughing process. In end milling process it is as same as face milling but, it is capable to produces various profile and curves surfaces.

2.1 CNC Milling Machine

CNC Milling machine is a simply a machine tool held the piece of material being worked or workpiece in clamp, or spindle and rotated it is also a cutting tool that could machine the surface to the desire contour (Abbas FadhelIbraheen, 2008) . The rigidly of the cutting tool from movement is accurately. It can be installed on a common PC and is able to control a CNC machine read part programs and send instructions to the CNC machine for the cutting process. According (Rassiah 2010), milling is the process of removing material by whittling the workpiece using spinning cutting tool. CNC machine is widely used in industry due to versatile capability to perform several processes such as boring, drilling, and facing or others. This machining using G-code n M-code as instruction programmed command the machine. The type of CNC milling that were used for this project is 3 axis machines (x- axis move horizontal, y-axis move transversely, z-axis moves vertically). Milling process is influent by certain parameter such as spindle speed and feed rate. Spindle speed can be defined as the speed that the material moves past the cutting edge of the tool. Meanwhile feed rate can be defined as the velocity at which the cutter is feed, that the cutting tool advances against the workpiece.

2.2 End Milling

The end milling cutter usually rotates on vertical axis or perpendicular to the workpiece surface. End milling is important and commonly used for milling operational due to versatility and capability to produce various type of profile and curved surface. The size of end milling cutter is usually straight shank or small cutter size other than that is tapered shank or lager size. The end milling cutter also usually made from carbide or high-speed steel. (Kalpakjian&schmid, 2010). The common type of end milling cutting tool is made of two flutes or four flutes.

2.3 Cutting Tools

The selection of cutting tool materials for a particular application is among the most important factors in machining operations, as is the selection of mould and die material for forming and shaping process. The cutting tool is subjected to high temperatures, high contact stress, and rubbing along the tool chip interface and along the machined surface. Consequently, the cutting tool material must possess the following characteristic like hot hardness, toughness and impact strength, thermal shock resistance, wear resistance, and chemical stability and inertness.

2.3.1 High Speed Steel and Carbide

The two materials from which most cutting tools are made are carbide and high speed steel (HSS). While there are a vast number of classifications and metallurgical variations within each material, the most common grades used for rotary cutting tools such as engraving cutters are C-2 micro grain carbide and M2 HSS.

Carbide is an extremely hard and abrasion resistant material and is recommended for most typical engraving applications. While it is slightly more expensive than HSS, it can out last it by a factor of 5-10 times depending on the application. It can be used effectively both on plastic and metal and is the most cost-effective choice of engraving tools.

While HSS doesn't have the wear and life characteristics of carbide, it does tend to be more resilient and less brittle and is the best choice for deep cuts with small tip sizes in harder materials. Engraving seal dies which are typically done to a depth of .035"-.040" with a .007"-.010" tip is a good example.

One consideration in selecting which type of tool to be used is whether or not you do your own sharpening. Carbide tools last a longer time before becoming dull, but are more difficult to reshape. Achieving a perfect cutting edge requires the usage of a properly dressed and trued diamond grinding wheel of between 400 and 600 grit.

HSS tools do not last nearly as long as carbide ones, however they are much easier to be sharpen for the average user. They are generally sharpened using aluminium oxide grinding wheels in the 80 to 100 grit range. Since these wheels are relatively soft, they can be easily trued and dressed with the diamond dressing attachment which is an integral part of most cutter grinders.

2.4 Machining Parameter

In getting the best result in milling operations, the parameter have to be specified in term of cutting speed, feed rate, and depth of cut. Based on Alauddin et al. (1997), with increase in the cutting speed of machining, the feed, and the depth of cut will simultaneously decrease the life of cutting tool during machining operation. There are several factors that also affect the tool life during machining which is type of lubricant, cutting forces and type of tool material. As shown in Table 2.1 the parameter and level of Mild Steel material. The Figure 2.1 is shown the machining direction process that running.

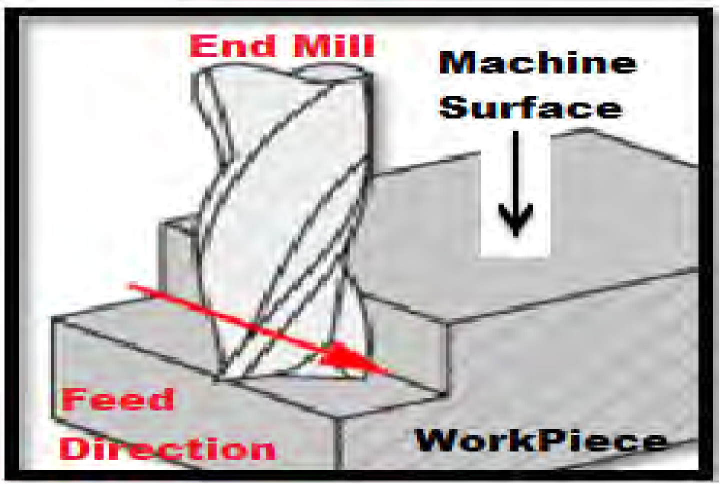


Figure 2.1: Cutting parameter of end mill

Table 2.1: Parameter and level of Mild Steel material

Control parameters	Level			Observed Value
	1	2	3	
	Low	Medium	High	
Spindle speed(rpm)	1000	1500	2000	1. Surface Roughness (Ra)
Feed Rate(mm/min)	300	400	500	
Depth of cut(mm)	0.10	0.16	0.20	

2.4.1 Spindle Speed

Spindle Speed, (rpm) is defined as the surface speed at diameter of the cutter rotating moving past a work piece (Kalpakjian, 2013). High cutting temperature and difficult chip disposal are two main problems encountered in high-speed face milling of Mild Steel. It is additionally inferred that there exists a proper scope of cutting speed in face milling of Mild Steel by cemented carbide tools. Actually, sustain does not have a critical impact for both sorts of milling operations (Liao et al., 2008). The speed is between the tool and workpiece in the main direction of cutting.

2.4.2 Feed Rate

Feed rate (mm/min) is the distance, in which the tool is moving or “feed”, through the work piece makes one finish revolution, divided by the number of effective cutting edges on the tool. Based on Ozel et al. (2007), at the lowest Feed Rate and the highest cutting speed it will produce the best of surface roughness. Generally the unit of Feed Rate is given in mm/min. “If you reduce your FeedRate too much relative to spindle speed, you will soon cause your cutter flutes to start "rubbing" or "burnishing" the workpiece instead of shearing or cutting chips.”(Ghani, J.A., Choudhury, I.A). Then, reduce feed rates while keeping the spindle speed up lightens the chip load and leads to a nice surface finish

2.4.3 Depth of Cut

Depth of Cut, in (mm) is a depth of cutting tool move down vertically to machine the thickness of material by one pass revolution of the cutting tool. Depth of Cut has a significant influence on cutting force, but an insignificant influence on surface roughness. Depth of Cut shows minimum effect on the surface roughness compared to other parameters, (Marandet B). Surface roughness further decreases with increase in Depth of Cut. Finer cut is usually associated with a better surface and for a long tool life.

2.5 Surface Roughness

The surface roughness is one of the essential properties for assessing the work piece quality amid the end processing methodology. The surface roughness has extraordinary influence in weariness quality and consumption safety, surface rubbing, light reflection, capacity of holding grease, electrical and warm contact safety, appearance, cost. High calibre of the surface after end processing makes further machining of the surface a bit much, which realizes diminished force utilization and environment load. Then again, streamlining of surface roughness is reliably tested by its vulnerability of forecast model and also different affecting parameters, which can be partitioned into controlled and non-controlled parameters. Fundamental parameter of the first sort incorporates axle rate, food rate, and profundity of cut. Also vibrations, instrument wear, machine movement mistakes, and material non-homogeneity of both the apparatus and work piece, chip arrangements have a place with the non-controlled parameters. The non-controlled slicing parameters are difficult to reach and their collaborations can't be precisely decided. Profile of surface roughness and waviness are indicated in Figure 2.2 show machining operation against the work piece related to the milling parameters.

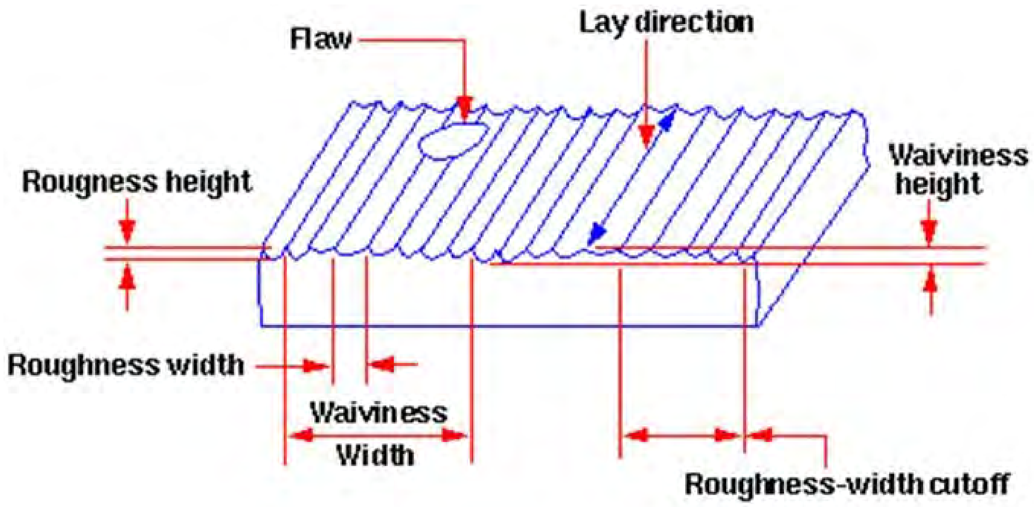


Figure 2.2: Machining Operation

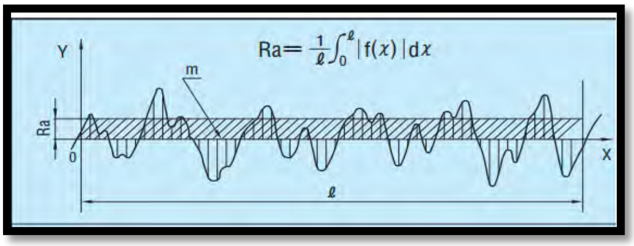
According to Liao (2007), in machining process, the common parameters that affect the surface roughness are Cutting Speed, Feed Rateand Depth of Cut. Based on Liao et al. (2007), the milling parameters of feed rate and method have significant affected on quality of surface roughness and they discover that the quality of surface roughness increased by increasing the Feed Rate. There are several factors that contradict the Feed Rate in affecting the surface roughness where high cutting speed will reduced the value of surface roughness. The previous research by Ozcelik and Bayramoglu (2006), the cutting parameter is the important part in producing a minimum surface roughness and long tool life. The minimum surface roughness was obtained when the cutting parameters was set at the lowest of feed rate and highest cutting speed (Ozel et al., 2007). The differences of machining process parameters will impact the quality and specifications of the products surface. At the same time the result of the higher surface roughness can affect the product performance in terms of friction, durability, operating noise and energy consumption.

CNC Milling cutting operation there areseveral factors that influence the final surface roughness that can be control such as Spindle Speed, Federate, Depth of Cut during initial setup. It is also involved a few aspects that uncontrolled in CNC milling such as material properties for cutting tool, and workpiece, tool wear. The reason to achieve the good surface finish because it can reduce the friction, increase the wear resistance, achieve high efficiency, dimensional accuracy, shinning or good look. This characteristic is an important aspect that gives huge impact in engineering technology, design and also in business field. (kalpakjian&Schmid, 2010).

2.5.1 Surface Finish Parameter

The surface finish may specify in several of machining operations. Ra, Ry, Rz means the value obtained by the following formula and expressed in micrometre (μm) when sampling only the reference length from the roughness curve in the direction of the mean line, taking X-axis in the direction of mean line and Y-axis in the direction of longitudinal magnification of this sampled part. Table 2.2 shows the typical way to obtain surface roughness which is Arithmetical mean roughness (Ra), Maximum peak (Ry) and Ten-point mean roughness (Rz).

Table 2.2: Typical way to Obtain Syrface Roughness

Typical way to obtain surface roughness	
Arithmetical mean roughness (Ra)	
Maximum peak (Ry)