Faculty of Mechanical and Manufacturing Engineering Technology

OPTIMIZATION PARAMETER OF FLANK TOOL WEAR FOR AISI 1018 LOW CARBON STEEL USING BORON INSERT IN WET TURNING PROCESS

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Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

2018

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A thesis submitted
in fulfilment of the requirement for the degree of Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **OPTIMIZATION PARAMETER OF FLANK TOOL WEAR FOR AISI 1018 LOW CARBON STEEL USING BORON INSERT IN WET TURNING PROCESS**

SESI PENGAJIAN: **2018/2019 Semester 1**

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ABSTRAK

Industri pembuatan kini adalah merupakan salah satu faktor utama yang dapat meningkatkan ekonomi sebuah negara. Dalam industri pembuatan, operasi pemesinan juga telah mengambil bahagian dalam proses penghasilan produk. Oleh itu, parameter pemesinan yang optimum perlulah sesuai dan mestilah dipilih sebaiknya untuk mendapatkan kualiti produk yang diinginkan dan juga dapat mengurangkan kos pemesinan. Seterusnya, isu yang paling penting dalam pemotongan logam ialah kehausan mata alat. Dalam kajian ini, kesan parameter pemesinan pada mata alat adalah dalam menggunakan cecair penyejuk. Objektif projek ini adalah untuk mengenal pasti parameter yang optimum bagi proses larik dan mengkaji faktor yang penting dalam kehausan mata alat dalam proses larik ini. Bahan yang digunakan dalam kajian ini adalah keluli karbon rendah AISI 1018. Eksperimen dilakukan dengan menggunakan tiga faktor iaitu kelajuan pemotongan, kadar suapan dan kedalaman pemotongan yang mana masing-masing mempunyai tiga peringkat. Sembilan eksperimen telah dilakukan pada mesin larik CNC. ANOVA digunakan untuk menentukan tahap kepentingan parameter pemesinan. Keputusan bagi eksperimen ini menunjukkan bahawa kedalaman potongan adalah parameter proses yang paling menyumbang untuk kehausan mata alat dengan peratus sumbangan 32.00%, diikuti oleh kadar suapan dengan peratus sumbangan 24.41% dan yang terakhir adalah kelajuan pemotongan dengan 17.37%. Kajian ini menunjukkan bahawa parameter optimum yang diperolehi dengan 400 RPM, kadar suapan 0.07 mm/min dan kedalaman pemotongan adalah 0.50 mm.

ABSTRACT

Nowadays, the manufacturing industry is one of the main factors that can increase the economy of a country. In the manufacturing industry is including the machining operation that takes part in a process to produce the product. Therefore, to reduced machining time and cost, the optimum machining parameters must be selected suitability for the turning process to achieve the desired quality of the finished product. Next, the most significant issues in metal cutting are tool wear. In this research, the effects of machining parameters on cutting tool under wet machining environment were studied. The objective of this project is to identify the optimum parameter for wet turning process and to study the significant factor of tool wear in this turning process. The material chosen to be performed in this study is low carbon steel AISI 1018. The experiments were conducted using three factors, cutting speed, feed rate and the depth of cut each having three levels. Nine experiments were executed on a CNC Turning Machine. ANOVA was used to determine the level of importance of the machining parameters on tool life. The results shown that depth of cut is the most significant process parameter for tool wear with a percent of contribution 32.00%, followed by feed rate with a percent of contribution 24.41% and lastly is cutting speed with 17.37%. This research concluded that the optimum parameter obtained with 400 RPM, feed rate 0.07 mm/min and depth of cut is 0.5 mm.

DEDICATION

I am dedicating this thesis to my beloved parents, En. Mohd Adnan bin Sahrom and Puan Haslina binti Hashim. This is for both of you and thanks for all your support and sacrifice during I'm finishing this thesis. Not forgetting my supervisor En. Mohd Hairizal bin Osman, a lot of thanks to him for his guidance and patient in completing this thesis.

ACKNOWLEDGMENT

Bismillahirrahmanirrahim, firstly praised to Allah SWT for His willing and guidance that giving me an opportunity to complete this Final Year Project.

I would like to express my sincere thanks to En. Mohd Hairizal bin Osman a lecturer at Universiti Teknikal Malaysia Melaka and also as my supervisor who guided me during finish this thesis. I place on record, my deepest thanks to UTeM staffs like En. Ridzuan bin Mohamad Kamal, En. Muhammad Syafiq bin Jumali, En. Basri bin Bidin, En.Mohd Azimin bin Ibrahim and En. Norhisyam bin Abdul Malik that also help me involving directly or indirectly through out this process.

I also thank to both my parents for their love and support for me to finish up this thesis. Not forgotten for the special person and friends that always give a full cooperation and suggestion from beginning till the end I sincerely appreciate all your help.

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AISI	-	American Iron and Steel Institute
CNC	-	Computer Numerical Control
HSS	-	High-Speed Steel
LST	-	Laser Surface Technology
EDM	-	Electron Discharge Machining
FIB	-	Focused Ion Beam
mm	-	Millimetre
RPM	-	Revolution Per Minute
kg	-	Kilogram
Mpa	-	Mega Pascal
Gpa	-	Giga Pascal
ANOVA	-	Analysis of Variance
OA	-	Orthogonal Array
UTS	-	Ultimate Tensile Strength

CHAPTER 1

INTRODUCTION

1.0 Introduction

Inside this chapter, it is an explanation of the introduction and the flow of the project. This chapter will cover the introduction, project background, problem statement, objectives and project scope.

1.1 Project Background

Nowadays in a modern manufacturing, there are a lot of challenges in the manufacturing industry. The example of the challenges in this modern manufacturing is the quality of the final product and the increase the productivity. Because of that, many people realize that the importance of the manufacturing industry.

In this industry, the manufacturing sector will produce goods or service that will improve and generate national growth. So, this is an important thing to make sure the manufacturing industry is one of the main factors for a country. It also can help to increase the job opportunities for workers by having a large sector of the manufacturing industry.

In the turning process, turning machine is the oldest device tool that is still the most commonly used machine in the manufacturing industry to create cylindrical parts. It is broadly utilized as a part of a considerable measure of manufacturing industries including automotive and aerospace sectors. This turning process can be either in dry condition and

wet condition, which is dry condition there is no cutting fluid and wet condition by having the cutting fluid The quality of surface is a crucial role within the performance of turning because the good-quality turned surface is critical in increasing fatigue strength, corrosion resistance, and creep life.

For this type of machining, there are several techniques that be used to reduce the manufacturing costs and to protect the environment. In the machining process, the application of lubrication could be an important part in different parameters such as tool life, cutting temperature, surface finish, chip formation, and material removal rate. About the range of 7 to 17% the use of cutting fluid in the manufacturing costs. Related to this view, to reduce the cost and at the same time to protect the environmental the dry machining process can be applied. The main problem of using the cutting fluid instead of reducing the cutting zone temperature is the aerosol group during the machining process.

The main roles of cutting fluid in machining processes are to reduce the tool and workpiece temperature. This cutting fluid also can reduce the heat generate coefficient between tool and chips by decreasing the friction, which minimizes cutting forces as well as tool and piece heating.

In this project, low carbon steel AISI 1018 is undergo turning process with CNC turning machine. This experiment will be held in wet conditions which mean there is a present of lubricant or cutting fluid applied to the workpiece during the operation. The machine parameters are being considered during this experiment, which is the depth of cut, cutting speed and feed rate on the surface of the cutting tool.

1.2 Problem Statement

Machining by turning includes the utilization of a turning machine and is used mainly to produce cylindrical parts. The optimality in this turning machining process is achieved wherein wear rate is minimum and maximum productivity This process usually used a cutting fluid (coolant) that acts as cooling medium to prevent the workpiece and tool bit from overheating during the process. This cutting fluid was introduced to control the temperature during machining and also can improve especially the tool life and surface roughness.

By this type of machining process, it makes a bit challenger to the researcher to find the best or the optimum cutting condition which can minimize the tool wear. Tool wear results in undesirable effects such as loss in dimensional accuracy of the finished product, possible damage to the work piece, decreased surface integrity, residual stress and roughness, and amplification of chatter during the cutting process. For these reasons, it is very important to evaluate tool wear and to predict tool life. Cutting tool wear is caused by a forces taken by the tool's rake face and flank face of cutting tools. Thus it is for tool materials must reveal good hardness properties. The flank tool wear that contributed to this turning operation is obtained. In this study, the flank wear for cutting insert will be analyzed regarding to the experimental layout. Moreover, the structured of the cutting tool also can decrease the tool wear during the cutting process.

1.3 Objective

This project is a study on the parameter of tool wear in wet turning conditions using CNC turning machine. So, here are the objective of this project:

1. To identify the optimum parameter for wet turning process of AISI 1018 low carbon steel.
2. To study the significant factor of tool wear in wet turning condition process.

1.4 Work Scope

i. Use lubricant and coolant used during the turning operation.

ii. Machining variables that be measured are cutting speed, feed rate, and depth of cut.

iii. Turning operation is performed using Computer Numerical Control (CNC) Turning Machine - (CNC Turning Machine CTX310 Ecoline).

iv. The tool wear is observed by using a Stereo Microscopes SMZ745T.

v. The material used as the workpiece is low carbon steel AISI 1018.

vi. The cutting tool inserts are Boron steel.

vii. The experiment layout is used Taguchi's L9 Orthogonal Array and ANOVA.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter is contents of the literature reviews related to the previous studies from other people about the tool wear parameter in the wet turning process. This literature reviews can help for a better research about this topic. In this chapter consist of the turning process, the material uses mild steel and cutting tool for turning process.

2.1 Turning Process

The turning process is the machining process that required a lathe or turning machine, workpiece specimen, fixture, and cutting tool. This machining process is removal process of the material to makes the shape. During this process, the cutting tool is feed into the rotating workpiece and removes away the material (Krishna Madhavi, Sreeramulu and Venkatesh, 2017). Turning process also a removal of outer diameter rotating cylindrical of the metal workpiece. In turning process, is to reduce the workpiece diameter until to specified dimension (Butola *et al.*, 2017).

This is very important in turning process to improve the surface roughness, increase tool life, reduce cutting force and also the material removal rate through an optimization study. The surface roughness and material removal rate are the most important parts of the performance of a turning process. Next, there are parameters that mostly affect the

performance methods in turning process is feed rate, cutting speed, depth of cut, workpiece material, tools and cutting fluid. The most appropriate machining conditions must be used in order to reduce the machining cost, increase the machining efficiency, and improve the quality of machined parts (Office *et al.*, 2012). According to the authors, there are some important factor and parameter that can affect the result of the machining part and also during the turning process.

Based on (Mia *et al.*, 2018), the turning process can be defined as the process is using a single point cutting tool from a rotating workpiece where there is a form of the chip will produce by from the rotating workpiece. In this process, the chips will produce due to the cutting tools and originated surface were slides each other and causes damage to the tool as well as the surface integrity of machined part by the friction induces high temperature.

In turning process, the main movement in this process is the feed motion of cutting tool and the rotation of the workpiece. The feed motion is the movement of cutting tools in a parallel way or also can be called as "longitudinal turning". During in cutting process, a cutting tool with a single cutting edge is used to remove material from a rotating workpiece to produce a cylindrical shape (Bar-Hen and Etsion, 2017).

The example of the rotational part and the parts that have many structures that be used in turning process is holes, threads, tapers, various of diameter steps, and even for contoured surfaces. Turning is also usually used as a secondary process to add or rework the structures on parts that were being created. Turning process that offers the high surface finish and high tolerances. Therefore, the part whose has the basic part already been formed, it is very suitable for adding precision rotational features on it. The Figure 2.1 below shows the basic turning process.