EFFECT OF CUTTING PARAMETER ON THIN WALL MACHINING ACCURACY

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management)

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 in Bachelor of Manufacturing Engineering (Manufacturing Management). The member of the supervisory committee is as follow:

………………………………

Supervisor

ABSTRAK

Tujuan dari penilitian ini adalah menyiasat pengaruh parameter pemotongan pada ketetapan mesin dinding nipis. Kesan ini di sebabkan oleh pemotongan parameter kekasaran pada permukaan dalam operasi cnc mesin. Pengaruh parameter berdasarkan kelajuaan pemotongan,kedalaman pemotongan dan cengkaman pemotongan. Selain itu untuk kajian kes yang telah melalui proses pemotongan,keperluan tentang keadaan pemotongan dan parameter proses yang paling penting. Untuk menentukan parameter pemotongan, pemahaman perilaku logam harus di ketahui terlebih dahulu sebelum memutuskan dalam pemilihan bahan. Kelajuan pemotongan, kedalaman pemotongan dan pengaruh sudut adalah salah satu ciri yang perlu di ketahui dalam proses pemesinan. Kemudian adalah meramal pada keadaan kesan. Ujian pengesahan akan di ambil selepas mendapat keputusan parameter daripada analisis dan pengesahan nilai. Untuk pembolehubah terdiri daripada parameter mesin dan ciri-ciri mesin. Pembolehubah parameter iaitu kelajuan pemotongan, kedalaman pemotongan dan cengkaman pemotongan. Sementara itu, untuk ciri-ciri terhadap parameter pemesinan merupakan alat pemotongan, bahan yang digunakan dan dimensi dinding nipis.

ABSTRACT

The purpose of this research is investigating the effect of cutting parameters on thin wall machining accuracy. This effect is caused by cutting parameter of surface roughness in a cnc lathe operation. The effect of machining parameter are feed rate, depth of cut, clamping force and cutting speed. Beside that for the case study which is had cutting process, the requirement about the cutting condition and process parameter is most highly important. To determine the cutting parameter, the understanding of metal behavior must be known first before we decide in material selection. The depth of cut, cutting speed, feed rate and effect of rake angle is a feature that we have to know in effective machining process. Next is calculating the estimation result at effect condition. The confirmation test will be taken after getting the effect parameter result from this analysis in order to verify the value. For variable selection, it consists of machining parameter and machining characteristic. The variables of machining parameter are feed rate, depth of cut, clamping force and cutting speed. Meanwhile, for machining characteristic response to machining parameter are cutting tools (mild steel), material used and thin wall dimension.

DEDICATION

For my beloved parents:
YAHAYUDIN BIN MAT TAIB
SALMIAH BINTI CHIN

For my supportive siblings:
MARLINA BINTI YAHAYUDIN
MOHD NIZAM BIN YAHAYUDIN
NORAINI BINTI YAHAYUDIN

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LIST OF ABBREVIATIONS

CAD	-	Computer Aided Design
CAM	-	Computer Aided Manufacturing
CM	-	Centimeter
CNC	-	Computer Numerical Control
HSS	-	High Speed Steel
m	-	Meter
m/min	-	Meter Per Revolutions
min	-	Minute
mm	-	Millimeter
mm/rev	-	Millimeter Per Revolutions
NC	-	Numerical Control
No.	-	Number
PSM1	-	Projek Sarjana Muda 1
PSM2	-	Projek Sarjana Muda 2
Rev	-	Revolutions
RPM	-	Revolutions Per Minute
DOE	-	Design of Experiment
MCU	-	Machine Control Unit
MDI	-	Manual Data Input
ATC	-	Automatic Tool Changers
CMM	-	Coordinate Measurement Machine

CHAPTER 1

INTRODUCTION

In this section, this chapter will provides and explain the background, scope, problem statement and the importance of the study. Besides, this section will briefly touch the concept of material stability, machine parameters, and tool for precision cutting of irregular shape of certain ferrous metal.

In machining operations, one of the types of machining process is turning. Turning is the process whereby a single point cutting tool path is parallel to the surface. It can be done manually, in a conventional lathe, which frequently requires continuous supervision by the operator, or by using a CNC lathe. Turning includes those operations that produce a cylindrical conical part or any different geometrical shapes. It involves the use of rotating work piece which creates a cutting motion. There are a number of turning operations which are common to the machining of metals, woods, and plastics. Among the most important are straight turning, taper turning, facing, etc. Turning process can also be classified based on their part size, type of machine, processing capacity, machining accuracy, principle of operation design features, number of spindles and workpiece position.

Normally, the axis between the cutting tool and the rotation of spindle are either perpendicular or parallel. So, it was the factor that influences the quality of the surface of the material. Meaning to say that the vibration can happen in certain case which will cause product is not produced in good quality. Do take note that vibration cannot be completely eliminated because even a workpiece with simple geometry could also produce minimum vibration. An optimal strategy to control and isolate the vibration from machining operation is applied in this case study. In terms of cutting process, material removal rate play important note in generating vibration. The material removal rate depends on two factors which are feed rate and depth of cut. By maintaining and control the position between the cutting tool and workpiece is a way to get very good surface quality and positioning accuracy in the machine tool parameter and measurement.

Control the factors that influence in the performance of this case study is a contributor to make some project achieved. By control and examine the characteristic during the operation from disturbance like the position of material(radial and feed), clamping force of machine tool, the cutting speed, also the parameters of machine like the cutting speed, feed rate during the cutting operation, depth of cut and others small factors that influence the performance of project. By highlight and alert all of this characteristic will make the proposed of this case study succeeded in reducing the cutting tool vibration and its performance.

Force on the tool involve in the important aspect in machining to provide a good result of some project of case study. It means the right selection and correct measurement example like the clamping force, the tenacity of material and others can make project succeeded. For any manufacturer or who want to involve in machine tool producing, the knowledge and value added for the estimation of force specially in design of machine tool, the performance of machine, the tool holder and fixtures and the strength of material is important to learned about the force. The cutting force is a priority in optimizing the tool with right angle and accurate measurement.

Materials that are used are ferrous metal and cast iron. Iron based alloys account for a large portion of a metals production. The range of compositions and microstructures of iron based alloys is far wider than any other system. Pure iron is soft and ductile. Development of scratch free and deformation free grain structures is difficult. Sheet steels present the same problem, which can be complicated by protective coatings of zinc, aluminum, or Zn-Al mixtures. In general, harder alloys are much easier to prepare. Cast iron may contain graphite, which must be retained in preparation. Inclusions are frequently evaluated and quantified. Volume fractions can vary from nearly 2% in a free machining grade to levels barely detectable in a premium, double vacuum melt alloy. A wide range of inclusion, carbide and nitride phases has been identified in steels. Addition of 12% or more chromium dramatically reduces the corrosion rate of steels, producing a wide range of stainless steel alloys. Tool steels cover a wide range of composition and can attain very high hardness‟s. Preparation of ferrous metal and alloys is quite straightforward using contemporary methods. Edge retention and inclusion retention are excellent, especially if automated equipment is used.(D.Scott Mackenzie, George E.Totten 2006).

Nowadays, the features during the turning operation are an important part to be mention clearly because it was a factor that can succeeded some case study or project. A good understanding of the behavior of machine, the relationship between the workpiece metal and cutting tool material is a way to do in making a very good condition during the operation. For the case study which is had cutting process, the requirement about the cutting condition and process parameter is most highly important. To determine the cutting parameter, the understanding of ferrous metal behavior must be known first before we decide in material selection. The depth of cut, cutting speed, feed rate and effect of rake angle is a feature that we have to know in effective machining process. The selection of cutting tool materials for particular application is among the most important factors in machining operations. Characteristic of cutting tool is thermal shock resistance, wear resistance, chemical stability and inertness and lastly is toughness. The familiar cutting tool that have been used in industry nowadays is high speed steel (HSS), coated carbide, ceramics, diamond and many others. (Serope Kalpakjian, 2006)The characteristic, the application, and limitations of these tool materials in machining operation, including the required characteristic we outlined and including cost.

High speed machining has been currently used in this high technology era. Since 1990‟s, the estimation of high speed machining has been extensive. By applying the high speed machining to the ferrous metal using turning process to determine the effect of tool material, coating, and cutting operating parameter on cutting force, tool life, and workpiece surface. The majority of turning operations involve the use of simple single point cutting tools. The geometry of a typical right hand cutting tool for turning is familiar using. Such tools are described by a standardized nomenclature. Each group of tool and workpiece material has an optimum set of tool angles, which have been developed largely through experience.

1.1 Problem Statement

Nowadays in this high technology era, anything can be providing with any ways especially in engineering field. The demand from customer must be followed by the manufacture to make customer satisfaction. Sometimes the requirements are unpredictable and from there, the new ways have to create to make the project can achieve the target. In machining process, the main factors that have alert are the parameter of tool, the material selection and others. When machining a thin wall cylinder the ovality problem always arise. The jaw design and development, and cutting parameters will determine the result like the minimum ovality can get. The effect of all this parameters needs to be determined in order to get the maximum good finishing product in term of hole diameter accuracy.

1.2 Objective

The main purpose of this project is:

(a) To study the preferred size of thin wall hollow cylinder used in industrial component making.

(b) To investigate the factors affecting accuracy of thin wall cylinder.

(c) To generate mathematical model for cutting of thin wall cylinder.

(d) To determine the thin wall cylinder accuracy with difference cutting parameters using CNC turning machines.

1.3 Importance of the study

The importance of the study is determine the effect cutting parameter during the turning operation using carbide cutting tool and the factors affecting in determining the accuracy of thin wall cylinder and can generate the mathematical model by using DOE method. Also, can setting the parameter that include feed rate and speed where the result will prolong a service life of engineering components particularly for manufacturing industries.

1.4 Scope of the study

The main purpose of this project is:

(a) Investigation of thin wall machining accuracy of ≤ 5mm thickness.

(b) Hollow cylinder of ≤ 100mm.

(c) Material of hollow cylinder is mild steel.

(d) Machine used is CNC lathe

CHAPTER 2

LITERATURE REVIEW

This chapter will explained about all the elements used for this report. First explanation will come to the machines, processes, cutting tools and operation sequences for lathe machine in order to know the element used to calculate the machine parameter and the value of stability for thin wall. Then we will come to the explanation on how the calculation of parameter and stability can effect of cutting parameters on thin wall machining accuracy.

2.0 Thin wall cylinder

The primary objectives of this thesis are to analyze the effect of cutting parameters on machining of thin-walled structures. The thesis will aim to investigate the factors which are primarily the reason of higher cutting forces and dimensional inaccuracies. Thin walls are the components in which the thickness to length ratio is much smaller. These components are mainly used in aerospace applications and engineering sector. The cost of materials is high and these materials have poor mach inability characteristics. This work will be dealt with these issues in order to increase the machining accuracy and efficiency. The main outcomes of the thesis can be used to increase the machining accuracy and efficiency in lathing process. The results obtained from the analyses will be used to accurately machine highly critical components having thin-walled structures mainly used in aerospace industry and engineering sector.

2.0.1 An Analysis of the Effects of Cutting Parameters on Machining of Thin Walled Components

Machining of thin-walled parts is a key processing technology in aerospace and engineering industry. The part deflection caused by the cutting force is difficult to predict and control .Many components used in aerospace industry and engineering industry sector are usually thin-walled structures. Due to their lack of stiffness and low rigidity, thin-walled parts tend to deform easily in a chip removing process. Cutting forces have the major role for forming the deformations, which induces mainly dimensional inaccuracy, low machining efficiency and higher manufacturing costs. Cutting parameters have considerable effect on cutting forces which occur due to fractional effects. Therefore, the deformation analysis of a thin-walled machining process is coupled with cutting forces and cutting parameters. Cutting parameter are literally known as spindle speed, depth of cut and feed rate in a milling process. This parameter has direct effect on machining efficiency, dimensional accuracy and machining time. In order to have an accurate model for predicting machining precision, these parameters have to properly to select.

2.0.2 Discussion about effect of cutting parameter in thin wall

Cutting forces have the major role for forming the deformations, which induces mainly dimensional inaccuracy, low machining efficiency and higher manufacturing costs. So effects of the defined cutting parameters such as spindle speed, depth of cut, feed rate, will be examined on deflection. The deflections and surface errors will be obtained. In order to have an accurate model for predicting machining precision and surface error will be obtained. In order to have an accurate model for predicting machining precision, these parameters have to properly select. So, properly and optimal selected cutting parameters would be the first step prior to modeling of deformation analysis and it can be used for obtaining better dimensional accuracies and machining efficiency

2.1 CNC (Computer Numerical Control)

A computer numerical control (CNC) machine is an NC machine with the added feature of an onboard computer. The onboard computer is often referred to as the machine control unit or MCU. Control units for NC machine are usually hardwired, which mean that all machine functions are controlled by the physical electronics elements that are built into the controller. The onboard computer, on the other hand, is “soft” wired, which means the machine functions are encode into the computer at the time of manufacture, and they will not be erased when the CNC machine is turned off. Computer memory that holds such information is known as ROM or read only memory. The MCU usually has an alphanumeric keyboard for direct or manual data input (MDI) of part programs. Such programs are stored in RAM or the random access memory portion of the computer. They can be played back, edited and processed by control. All programs residing in RAM, however, are lost when CNC machine is turned off. These programs can be saved on auxiliary storages devices such as punched tape, magnetic tape, or magnetic disk. Newer MCU units have graphics screen that can display not only the CNC program but the cutter paths generated and any errors in the program. (J.V.Valentino, J. Goldenberg, 2008). CNC technology has evolved to include “conversational programming” which is software that allows the CNC operator to create CNC programming at the machine. Most common method of programming is still computer aided software. APT is one software system that used for creating CNC programs. There is much other such software system that can perform the CNC processes. The postprocessors are the part of software that converts computer language to CNC code to match a specific CNC machine. (Robert Quesada, 2005). Computer numeric control (CNC) system use a dedicated program to perform NC functions in accordance with control commands stored in computer memory. The computer provides basic computing capacity and data buffering as a part of the control unit. Parts program are entered either manually to the tape reader or interactively using CAM (computer aided manufacturing) software. CNC machine tools incorporate many advantages, such as programmed optimization of cutting speeds and feeds, work positioning, tool selection, chip disposal, and accuracy and repeatability. This last advantage is an important feature to evaluate CNC equipment. Accuracy is the ability to position the machine table at desired location. Repeatability is the ability of the control system to return to a given location that was previously programmed into the controller. (P.F.Ostwald, J.Munoz, 1997).

2.2 CNC Lathe Machining

This section explained several opinions based on literature that has been collected. Rajendar Singh say, Lathe is one of the most versatile and widely used machine tools all over the world. It is commonly known as the mother of all other machine tool. The main function of a lathe is to remove metal from a job to give it the required shape and size. The job is secure1y and rigid1y held in the chuck or in between centers on the lathe machine and then turn it against a single point cutting tool which wi1l remove meta1 from the job in the form of chips. (R.Singh, 2006**)**. Around 1950s, servomechanisms were applied to lathe machine as the lathe machine can be controlled together with other machine tools via numerical control (NC). It is often that the lathe machine was coupled with the computers in order to yield the computerized numerical control (CNC). From year 1970 onwards, new design of machining tools had been introduced into machining industry that brought along an effect of greatly reducing the times for tool positioning and movements between cuts. These new CNC design had been designed base directly to the development of numerically controlled (NC) machine tools from 1950s. In CNC machining tools, all the motions are mechanically separated and each different motion are driven by their own motor and coordinated electronically that allow more complicated feed motion can be done. As year 1970 come, the CNC lathe machine has more precise numerical control of feed motion, along with reduction of set-up time than can approximately halving the machine tools non-productive cycle times. In around 1980s, the reduction of non-productive cycle time for lathe machine had becoming more intense as the spread throughout all manufacturing industries of new types of machine tools that have become called turning centers. These new tools that had been first develop in year 1960 for mass production industries that individually can make operations that before this need to be done with several machine tools. The reduction in non-productive cycle times is possible because of the rucing loadings and set-ups. Individual time‟s savings increase with part complexity and the number of setups that can be eliminated. Centres are also much more expensive than more simple