UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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A STUDY OF SURFACE ROUGHNESS OF AISI 1045 CARBON STEEL BY USING WET CNC TURNING

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

by

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APPROVAL

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

………………..………………

DR. UMAR AL-AMANI BIN HJ. AZLAN

(Project Supervisor)

ABSTRAK

Projek ini (PSM) dilakukan dengan tujuan untuk mendapatkan hubungan antara pemotongan parameter dan hasil daripada kekasaran permukaan. Skop projek ini adalah untuk mengkaji parameter pemotongan yang kelajuan gelendong dan kadar suapan dan mengkaji kekasaran permukaan keluli karbon AISI 1045 dengan menggunakan pemotong basah CNC mesin beralih yang menggunakan penyejuk semasa pemesinan operasi. Kemudian, lapan (8) ujian eksperimen keluli karbon AISI 1045 akan dijalankan. Pemotongan jenis alat akan digunakan adalah alat memasukkan. Selepas pemesinan operasi, kekasaran permukaan akan diukurkan dan keputusan yang diperolehi akan di analisis dengan mudah alih penguji kekasaran permukaan dan mikroskop stereo.

ABSTRACT

This project (PSM) is carried out with the purpose to get the relationship between cutting parameters and the result of surface roughness. The scope of this project is to study the cutting parameters which spindle speed and feed rate and to study the surface roughness of AISI 1045 carbon steel by using wet cutting CNC turning machine which use coolant during machining operation. Then, eight (8) experimental tests of AISI 1045 carbon steel will be carried out. The cutting tool type will be use is insert tool. After machining operation, the surface roughness will be measure and the result obtained will be analysis on it with portable surface roughness tester and stereo microscope.

DEDICATION

Especially for beloved father, mother, sister, lecturer and last but not least my lovely friend for supporting me endless in term of courage, motivation and caring until now.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Modern machining industries have some challenges that are mainly focused on the achievement of high quality, high production rate, less wear of cutting tools and the product performance is increase with reduce environmental impact. In general, good surface quality can reduce manufacturing cost. The good surface quality can also reduce assembly time and prevent from secondary operation. Improving of fatigue strength, corrosion resistance and creep life is depends on the good-quality surface (Satheesh et al.,2012).

In the manufacturing process, the surface roughness of machine part plays an important role due to the increasing demand of higher precision components for its functional aspect (Satheesh et al.,2012). The surface roughness affects some functional attributes of parts such as wearing, light reflection, heat transmission, ability of distributing and holding the lubricant and resistance fatigue (Satheesh et al.,2012). In general, turning is one of the machining operations which are carried out on lathe.

In this project, the surface roughness of AISI 1045 carbon steel will be studied. The cutting parameters of CNC turning machine that will be used are spindle speed and feed rate. The cutting parameter of this machine operation will affect the surface of carbon steel. The surface roughness and the quality of carbon steel can be performed by machine operation. The properties of carbon steel will be observed by using surface roughness tester and optical microscope.

The impacts of the four cutting parameters such as spindle speed, feed rate, depth of cut and tool nose will affected the surface finish. It is discovered that a greater tool nose range is utilized the surface roughness enhances with higher depth of cut, fast and high feed rate (Muruganandam et al., 2012).

1.2 Problem Statement

In general, the quality and productivity of product must meet a certain standard whereby the CNC is being used as one of the machine tools. Surface roughness is basic properties in choosing its qualities of thing. In general, the surface roughness is highly dependent on machine operation. The quality of material is exceptionally needed as work piece in machine operation. In engineering application, surface roughness estimation is very important task. A few variables that impact the final surface roughness in CNC turning operation which is spindle speed and feed rate. The surface roughness plays an important role in many areas and in an evaluation of machining precision (Palanikumar, 2006). The surface roughness is one of the most important factor parameters to determine the quality of the product. Muruganandam et al. (2012) stated that the quality of the surface is a factor of importance in the evaluation of machine tool productivity and it is important to achieve a consistent tolerance and surface finish which helps to maximize productivity.

1.3 Objectives

The objectives of this project are as below:

i. To study the effect of spindle speed and feed rate of wet cutting CNC turning machine on surface roughness of carbon steel (AISI 1045).
ii. To identify the optimum spindle speed and feed rate based on characterization studies.

1.4 Project Scopes

As stated earliest, two different parameters of the CNC turning will be studied which are spindle speed and feed rate. Both parameters will be used to improve the surface roughness of carbon steel. The surface roughness of AISI 1045 carbon steel will be studied by using wet cutting CNC turning which use coolant during machining operation. There are three types of carbon steel which are high, low, medium and plain. Type of carbon steel that will be studied is AISI carbon steel with 8 experimental tests will be made. The characteristic of samples will be then tested using surface roughness tester and observed by stereo microscope. This can be simplified in Figure 1.1.

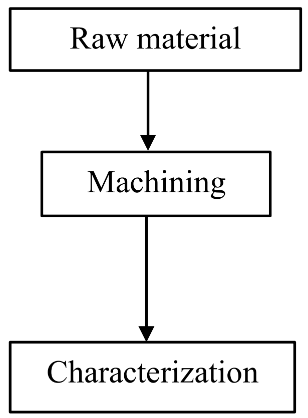

Figure 1.1: Flow chart of wet cutting CNC turning on carbon steel

CHAPTER 2

LITERATURE REVIEW

2.1 Turning Process

Metal cutting processes are modern processes in which metal parts are molded or removal of undesirable material. It is a standout among the most essential and generally utilized assembling processes as a part of manufacturing industries. In the investigation of metal cutting, the output quality is very important. Lathe machine is the most established machine device that is still the most widely recognized utilized machine as a part of the manufacturing industries to deliver round and hollow parts but now days CNC machines are generally utilized for good quality, accuracy and high efficiency (Nikunj et al., 2012).

Thamizhmanii et al. (2007) stated that turning is plays an important machining process which a single point cutting tool removes unwanted material. It is metalcutting process used of cylindrical surfaces. Turning is carried on a lathe that provides the power to turn the work pieces at a given rotational speed and to feed to the cutting tool at specific rate and depth of cut. During turning operation, three cutting parameters such as cutting speed, feed rate and depth of cut need to be determine. Turning operation are accomplished using lathe machine, including conventional, CNC or advanced 5 axis CNC machines. The expanding significance of turning operations is increasing new measurements in the present mechanical age, in which the developing competition calls for all the efforts to be coordinated towards the economical production of machined parts and surface finish is a most critical quality measures in mechanical products (Neeraj et al., 2012).

In general, turning is characterized by steady states of metal cutting. But toward the starting and end of the cut, the forces on the cutting tool and the tool tip temperature are basically steady. For the special case of turning, the shifting cutting speed will influence the device tip temperature. Higher temperatures will be experienced at the bigger widths on the workpiece. However, since cutting speed has just a little impact on cutting forces, the strengths following up on a facing tool may be required to remain practically steady during the cut (George. 2010).

A variety of other machining operations can be performed on a lathe in addition to turning and facing which are chamfering, parting, threading, boring, drilling and knurling. Chamfering is the tool that used to cut angle on the conner of a cylinder. Parting is the tool that fed radially into rotating work at a specific location along its length to cut off the end of a part. Threading is a pointed tool is fed linearly across the outside or inside surface of rotating arts to produce external or internal threads. Boring is an enlarging a hole made by a previous process which is a single-point tool is fed linearly and parallel to the axis of rotation. Drilling is processes that producing a hole by feeding the drill into the rotating work along its axis which drilling can be followed by reaming or boring to improve accuracy and surface finish. Knurling is metalforming operation that used to produce a regular cross-hatched pattern in work surface. In turning process, there are some operating conditions. The operating conditions control three important metal cutting variables which are metal removal rate, tool life and surface finish. The operating conditions selected must be correct to balance these three variables and to achieve the minimum machining cost per piece. The successful of machining operation is dependent on the set-up of workpiece and the cutting tool (George. 2010).

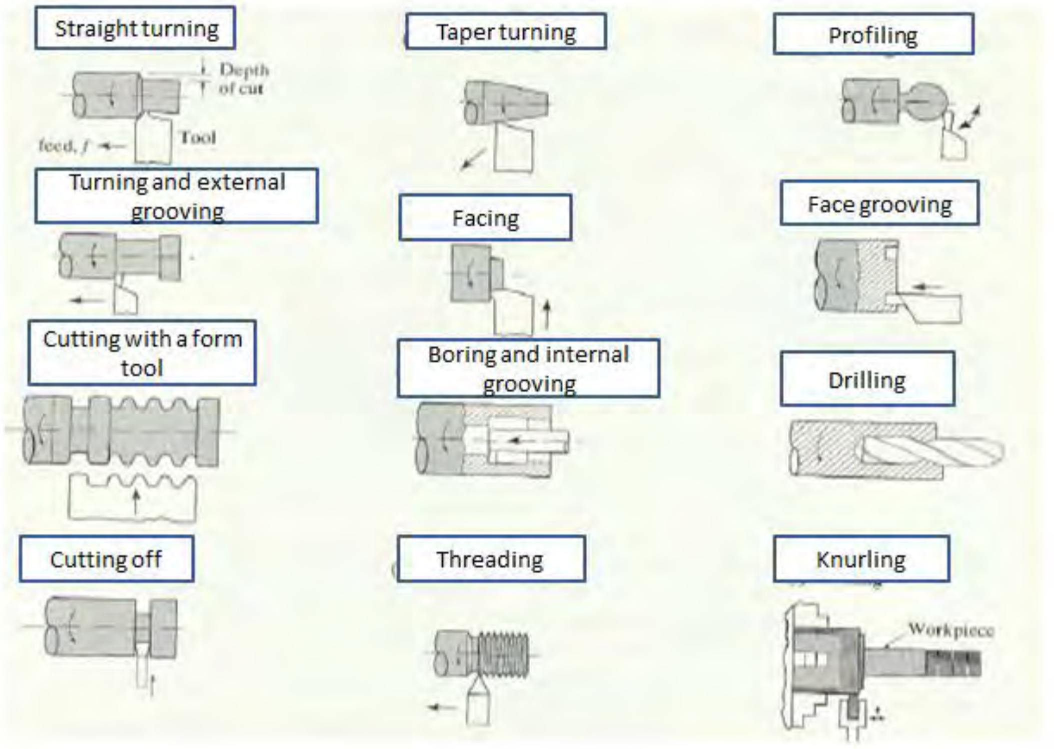

Figure 2.1: Various cutting operation that can be performed on a lathe (Kalpakjian, 2001).

Figure 2.2 and Figure 2.3 shows that the operating condition and cutting operation in lathe machine. Cutting tool movement is in horizontal and forward direction.

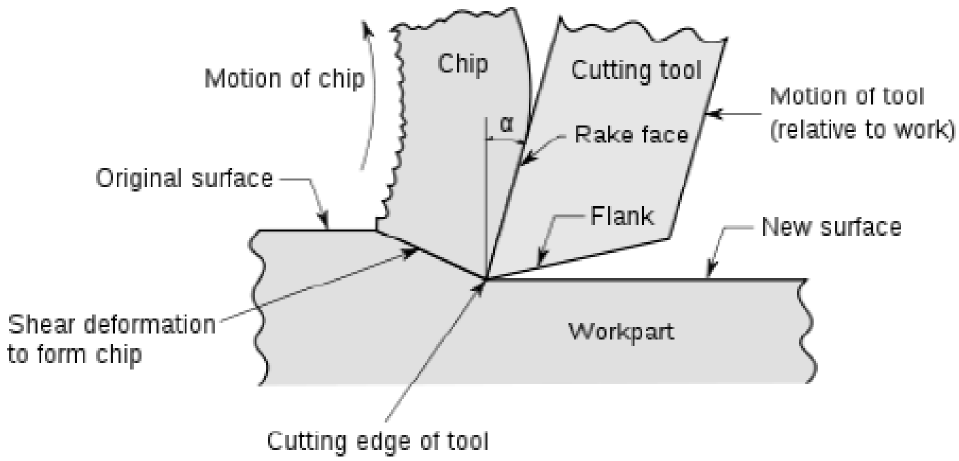

Figure 2.2: Operating conditions (Muruganandam et al., 2012)

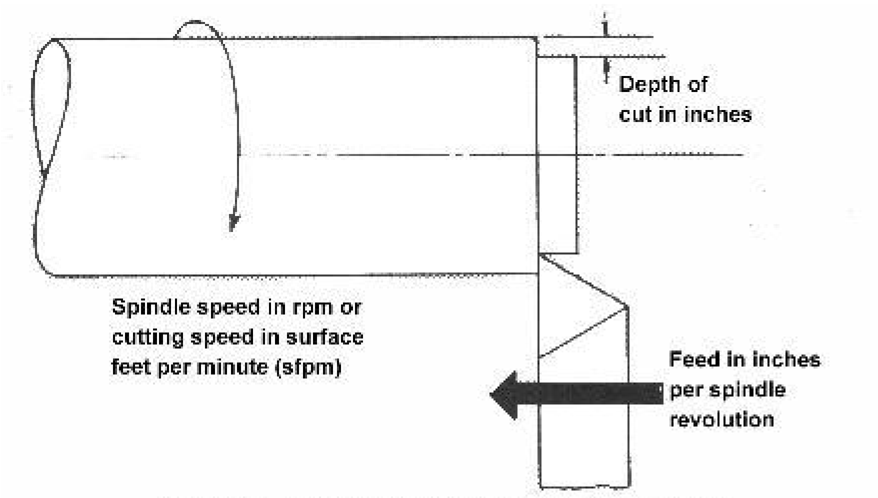

Figure 2.3: Cutting process in lathe machine (Chikalthankar et at., 2014)

2.1.1 Part of lathe machine

George et al., (2010) stated that lathe machine is most important machine in manufacturing industries. There are many parts of machine which are headstock, tailstock, carriage, apron, cross slide, compound rest, tool post, bed and ways. Every part of this machine has specific functional. The headstock is the powered end and is constantly situated at the operators left. It is contains of rate changing gears and the rotating, driving axle (spindle), which any of a few sorts of work holders is joined. The center of the spindle is empty so that long bars can be put it for machining.

The tailstock is non-rotating but on hardened ways, it can be moved to one left or right, to change the length of the work and it can likewise be offset for cutting small-angle tapers. The carriage can be moved to left or right either by hand wheel or power feed. This is gives the development along the Z axis and this travel turning cuts are made. The apron are appended (attached) to the front of the carriage, holds the control levers. These incorporated (included) the levers that engage and reverse the feed lengthwise (Z axis) or transversely (X axis) and the lever that connects with the threading gear. The cross slide is mounted on the carriage and can be moved in and out (X axis) opposite to the carriage movement. This is a section that moves when facing cuts are made with force sustain or whenever a cut must be made square with the Z axis. Accordingly, the compound is likewise used to situated (set) the depth of cut when turning. The cross slide can be moved by its hand wheel or by force sustain. The compound rest is mounted on the carriage. It can be moved in and out by its hand wheel for facing or for setting the depth of cut. It can likewise be turned 360 degrees and fed by its hand wheel at any edge. The compound does not have any force sustain but rather it generally moves longitudinally with the cross slide and the carriage.

Something else, the tool post is mounted on the compound rest. This can be any few varieties however in its least difficult structure is slotted cylinder that can be moved to left or right in the T-slot in the compound and braced set up. It also can be rotated in order to present the cutter to the work at whatever edge is best for the work. The bed is a backbone of machine. It must be rigid to avoid deflection in any direction under load. The bed is made of cast iron and steel weldment, in a box or I-beam shape and is support on legs or a bench. The methods for the machine are the flat or V-shaped surfaces on which the carriage and the tailstock are moved left and right. Each of them has its different pair of ways, frequently one level surface, for stability and one V-way for direction in a perfectly in straight line. The basic accuracy of movement of the carriage depends on the ways (George et al., 2010). The Figure 2.3 shows the part of conventional lathe machine.

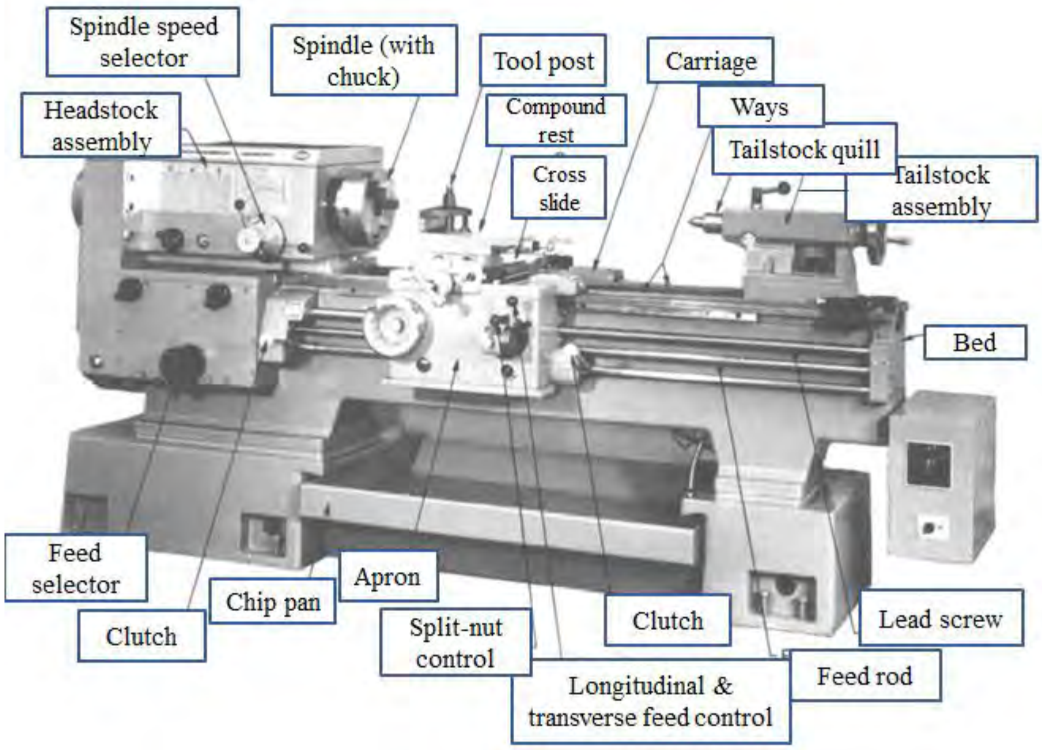

Figure 2.4: Conventional lathe machine (Mahendra, 2010)

2.2 CNC Machine

Computer numerical control (CNC) machines are widely used in manufacturing industry. According to (Elie, 2010) stated that computer numerical control is a computer controller that reads G-code instruction and drives a machine tool, a powered mechanical device typically used to fabricate components by the selective removal of material. Its does numerically directed interpolation of a cutting tool in the work envelope of a machine. There are several types of CNC machine in industry which are milling, turning, EDM wire cut, waterjet, routers, die sinking and others. This machine has some advantages and disadvantages. Its can be used continuously 24 hours a day, 365 days a year and only need to be switched off for occasional maintenance. The machines are programmed with a design which can be manufactured hundreds or thousands of times and its can be operated by improving the software used to drive the machines.

Then, a less skilled or trained people can operate CNC unlike manual lathes or milling machines and other machine which needs skilled engineers. The machines also can be update by improving the software used to drive the machines and its can be programmed by advanced design software such as Catia, Delcam and others. The modern design software allows the designer to stimulate the manufacture of the idea and sometimes only the cutting tools need replacing occasionally. A skilled engineer can make same component at many times. Otherwise, the used of CNC machines have some disadvantages. There are, more expensive than manually operated machines, the machine operator only needs basic training and skills and less workers are required to operate CNC machines compared to manually operated machines. The Figure 2.4 shows that the tool without and with damper in lathe machine. The amplitude of vibration, average tool temperature and surface roughness can be measured using with and without damping pad in lathe machine (Rahul et al., 2014).