VARIATION OF CUTTING PARAMETERS IN THE PROCESS OF TURNING AISI 4340 STEEL ON SURFACE ROUGHNESS

M. Sobron Y. Lubis , Erwin Siahaan , Steven Darmawan, Adianto,Ronald
Programs Study Teknik Mesin , Fakultas Teknik, Universitas Tarumanagara
Jl. Let.Jen S.Parman No. 1 Jakarta 11440, Indonesia
Email:sobronl@ft.untar.ac.id

Abstract- *In the metal machining process, cutting speed and feed rate are cutting parameters that affect the surface quality of the workpiece produced. The use of improper cutting parameters can cause the workpiece surface to be rough and the cutting tool age to be shorter. This study was conducted to determine the effect of cutting parameters and the use of carbide tools on the surface roughness of metal steel workpieces. The research was carried out using the experimental method of AISI 4340 steel metal workpiece turning using cutting tool coated. Five variations of cutting speed used are: 140 m / min, 150 m / min, 160 m / min, 170 m / min, 180 m / min and three variations in feed rate: 0.25 mm / rev, 0.3 mm / rev, 0.35 mm / rev. after the turning process, the surface roughness of the workpiece is measured using a surface tester. From the results of the study it was found that the surface roughness value was directly proportional to the feed rate and inversely proportional to the cutting speed. The smallest surface roughness value is 9.56 µm on cutting speed 180 m / min and feed rate is 0.25 mm / rev.*

Keywords: *machining process, cutting parameter, cutting speed, feed rate*

INTRODUCTION

In metal machining process, the quality of the product is depend of parameters and cutting tool that be used. Generally machining parameters that determine on machining process is feed rate that mean feeding speed by cutting tool, and cutting speed.

The research carried out by Handoko (2012) on optimization parameters for machining of Ductile Iron Materials, states that the cutting parameter optimization is determined by the ratio of the parameter comparison to obtain the optimization parameters (Gunter,2015).

Using various cutting parameters is done to find out the surface conditions of the workpiece that is produced and also to know the length of life of the cutting tools. Of course, in the machining process, ou want good surface conditions. A good surface condition is determined if the value of surface roughness produced is as planned. Determination of the appropriate cutting speed can produce the good workpiece surface conditions. Generally, the value of cutting speed and feed can be obtained through the table presented by Kalpakjian (1991). But specifically each cutting tool provides recommendations for the use of cutting parameters that are effective in cutting each workpiece. However, no information on the use of cutting speeds that results in a good surface roughness value is obtained. Therefore, it is necessary to conduct a scientific study on the use of various cutting parameters in the AISI 4340 steel turning process using carbide cutting tools to determine the surface conditions of the resulting workpiece.

METERIAL AND METHODE

Experimental process of AISI 4340 steel turning using Mazak CNC lathes.The cutting tool used is TNMG carbide coated type

Figure 1**.** Carbide Coated

Chemical Composition of AISI 4340 Steel

Element	**Content (%)**
Iron, Fe	95.195-96.33
Nickel, Ni	1.65-2.00
Chromium, Cr	0.700-0.900
Manganese, Mn	0.600-0.800
Carbon, C	0.3700-0.430
Molybdenym,Mo	0.200-0.300
Silicon,Si	0.150-0.300
Sulfur,S	0.0400
Phosphorous	0.0350

Properties of Material

Properties	Metric
Tensile strength	745 MPa
Yield strength	470 MPa
Bulk modulus (typical for steel)	140 GPa
Shear modulus (typical for steel)	80 GPa
Elastic modulus	190-210 GPa
Poisson's ratio	0.27-0.30
Elongation at break	22%
Reduction of area	50%
Hardness, Brinell	217

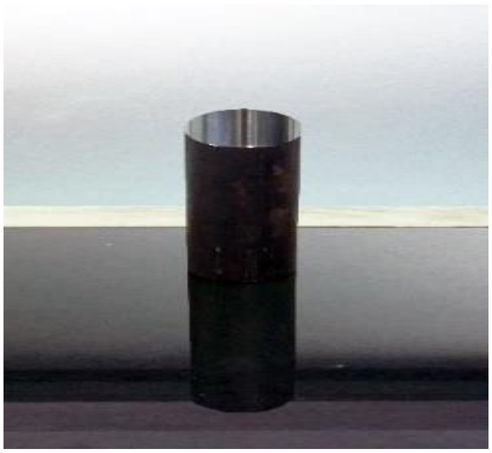

Figure 2. AISI 4340 Steel

AISI 4340 steel is a difficult to machine material because of its high hardness, low specific heat and tendency to get strain hardened. It is known for its toughness and capability of developing high strength in the heat treated condition while retaining good fatigue strength. Machining is best done with this alloy in the annealed or normalized and tempered condition. AISI 4340 has good ductility in the annealed condition and most forming operations are carried out in that condition. It can be bent or formed by spinning or pressing in the annealed state. AISI 4340 is high tensile strength general engineering steel ideal for automotive and aircraft components. Axles & axle components, arbors, extrusion liners, lines extrusion, magneto drive coupling, shaft & wheels, pinions & pinion shafts are the application range of AISI 4340 alloy steel. AISI 4340 is a tougher and more ductile material than EN-19 due to the Ni and Chrome alloying additions. (Sudhansu.2013).

Measurement of the surface roughness of the workpiece using a surface tester Mitutoyo type 211.

Figure 3. Surface Tester Mitutoyo 211

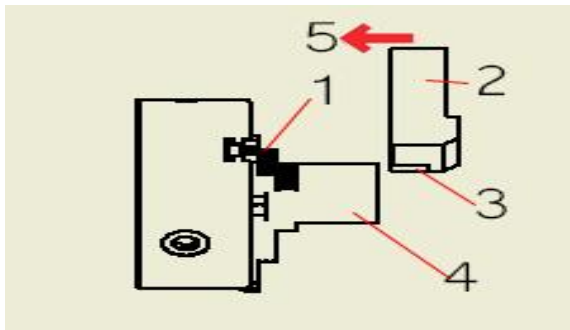

Figure 4. Mechanism of Cutting Process in CNC Turning. (1.Chuck, 2.Tool holder 3.Cutting tool insert, 4. Workpiece 5. Cutting motion)

Methods

This research was carried out by experimental method; the experiment was carried out with variations in cutting speed and cutting conductivity. The workpiece is gripped on the lathe chuck; the carbide insert cutting tool is attached to the tool holder and attached to the lathe. Cutting speed and cutting conductivity are determined on the lathe. The cutting tool is then moved close to the surface of the workpiece. The spindle rotates, and the cutting tool moves towards the workpiece surface to carry out the cutting process. The

Cutting process is carried out so that it reaches the specified cutting length limit. Then the machine is stopped, then the surface roughness tester is placed above the surface of the workpiece then the observation and surface roughness of the workpiece are carried out. In this machining process is done without using coolant. The value of the surface roughness obtained is then inserted into the table to be further made into the graph and analyzed. After taking the data of surface roughness values, the turning process is carried out again by changing the combination of cutting speed and cutting conductivity that has been designed.

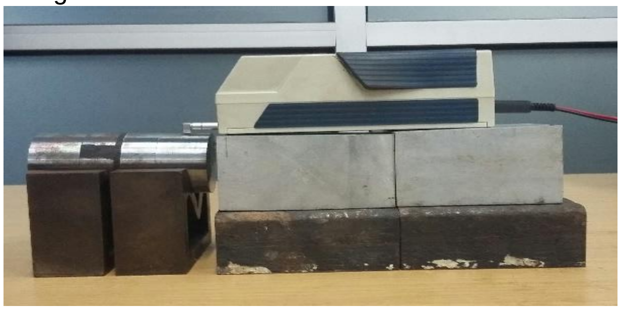

Figure 5. Surface Roughness Measurement

The surface roughness value for the gear surface quality standard is 1.04 μm [3].

The surface roughness values obtained in each machining parameter used are

Table 1. Surface Roughness AISI 4340 Steel

Cutting parameter	Surface roughness (Ra) (µm)				
	Vc1 =	Vc2	Vc3	Vc4	Vc5
F1	10,04	9,986	9,746	9,562	8,848
F2	18,538	17,60	17,29	17,14	16,97
F3	26,9	26,67	26,10	25,43	25,41

Vc1 is 140 m/min, Vc2 is 150 m/min
Vc3 is 160 m/min, Vc4 is 170 m/min
Vc5 is 180 m/min
F1 is 0.25 mm/rev, F2 is 0.30 mm/rev,
F3 is 0.35 mm/rev

RESULTS AND DISCUSSION

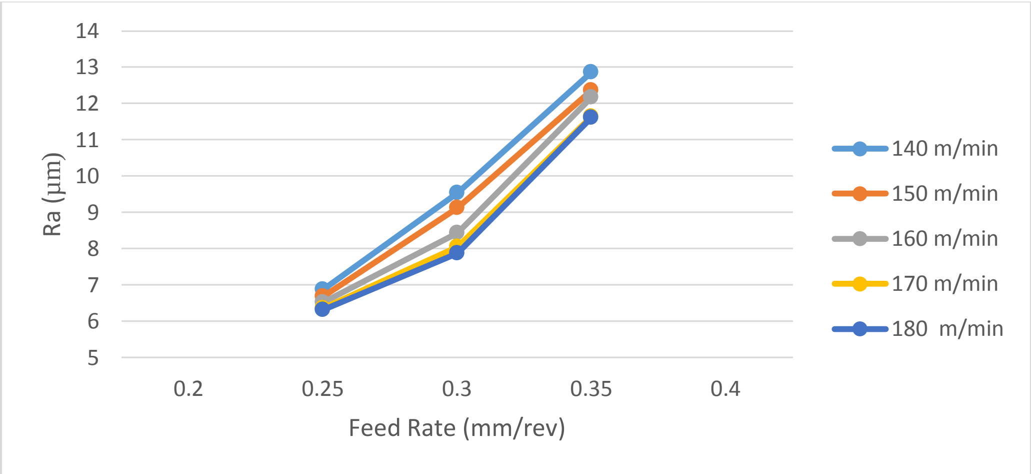

Figure 6. Graphic Feed Rate vs Surface Roughness

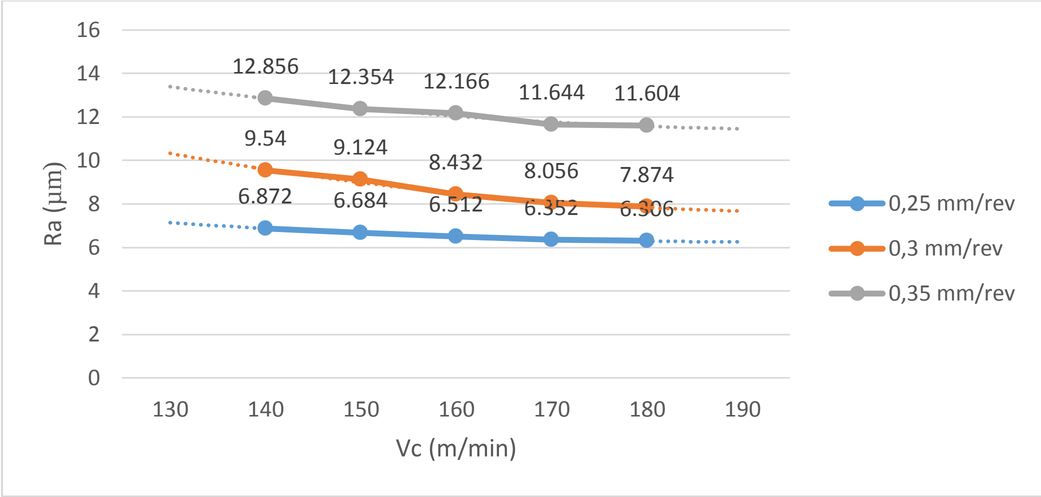

Figure 7. Graphic Cutting Speed Vs Surface Roughness

Feed Rate Effect On Surface Roughness:

The graph above can be seen that the increase in the feed rate value has an effect on changes in the value of the surface roughness of the workpiece, the value of the surface roughness of the workpiece is greater. This happens because the feed rate is a cutting motion that causes the cutting tool's tip to move to the surface of the workpiece which scratches the surface of the material with a cutting speed, the smaller the feed rate value is used, the feeding speed becomes slower, which results in a tighter all parts of the workpiece surface uniformly. However, if the feed rate is high, swipe that occurs per rotation faster so that it does not touch the entire surface of the workpiece in one rotation. This causes an uneven surface to appear and has a higher surface of the workpiece.

Cutting Speed Effect On Surface Roughness:

Based on observations made, obtained the value of cutting speed affects the results of the quality of the workpiece surface. There are differences in the results of the surface roughness level on variations in cutting speed. The higher the cutting speed used, the smaller the surface roughness value in other words, the better the surface quality of the workpiece. High cutting speed results in a decrease in the cross-sectional area of the sliding area. When the spindle rotation is high, the cutting speed is also high and the cutting tool moves quickly to scratch the workpiece surface. This results in a narrower cross-sectional area resulting in narrowing of the cross-sectional area resulting in better surface quality. It is also seen that the variation in cutting speed changes in surface quality.

The use of cutting speed variations results in differences in the level of surface roughness produced. The lowest surface roughness was obtained at the highest cutting speed of 180 m / min and the lowest feed rate was 0.25 mm / rev. the use of a low cutting speed and a high feed rate results in larger surface roughness values. The condition of cutting speed variation has limitations, meaning that the higher the cutting speed used, it can lead to narrowing of the cross section area. The narrowing of the cross-sectional area affects the surface quality

CONCLUSION

The conclusions obtained from the experiment and data analysis are as follows:

Ra value is directly proportional with feed rate, while inversely proportional with cutting speed (Vc). Then to get a low surface roughness value or smooth need a high cutting speed and low feed rate. Cutting tool coated also has a resilience when do a machining process without coolant. The smallest surface roughness value is 9.56 µm on cutting speed 170 m/min and feed rate is 0.25 mm/rev.

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