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THE EFFECT OF CUTTING SPEED ON SURFACE ROUGHNESS IN THE TURNING PROCESS OF AISI 1045 CARBON STEEL USING KOBE M2 HSS CHISELS

Bersyeba Tarigan[1], Muksin Rasyid[1], Supriono[1]
[1] Faculty of Engineering, Al Washliyah University Medan, Indonesia

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ABSTRACT

The purpose of this multilevel shaft turning performance is to analyze the specimen used, namely medium carbon steel alloy and get good workpiece results, knowing the ductility of the workpiece by adjusting the tool blade, speed, time, depth of cut, and surface roughness. The research method used is the impact test method to see the results of the influence of strong currents in steel joints. The results of this study are cutting speed is very influential on the results of the surface roughness of the test material, can be seen from the data analysis and research results. The surface of the test material with the highest level of smoothness is obtained from the use of the lowest cutting speed (100 m/min) with a roughness level of (4.1). The highest roughness level (7.1) with the cutting speed used (200 m/min). The higher the cutting speed used, the greater the price of the surface roughness value obtained or produced. However, the wear of the tool blade used is likely to also affect the level of surface roughness. Geram income depends on the cutting speed, the greater the feeding motion used, the greater the thickness of the resulting geram. The smaller the cutting speed used, the smaller the resulting furrow.

Corresponding Author:

Bersyeba Tarigan,
Faculty of Engineering, Al Washliyah University Medan, Indonesia.
Email: tariganbersyeba@gmail.com

1. INTRODUCTION

Metal fabrication is a metal production process that includes, among others, engineering (design), cutting, forming, connecting, assembling or finishing (Suwardi, 2017) Metal is a chemical element that has properties - strong, clay, hard, conducting electricity and heat, and has a high melting point. Metals are divided into two types, namely ferrous metals and non-ferrous metals. Ferrous metal is iron metal (Fe). Iron is a material that is needed in engineering, but pure iron is too soft and brittle as a work material, construction material and others. Therefore iron is always mixed with other elements, especially charcoal / carbon (C). Ferrous metals are divided into several types, namely, cast iron, wrought iron, soft steel, medium carbon steel, high carbon steel and high carbon steel with a mixture. Ferrous metal processing is also often carried out on a lathe to produce a workpiece.

Turning operations are one of the machine tools that are needed in the machining process because of its function that can make various kinds of shapes that fit the limitations. Turning operations are the process of forming workpieces using a lathe. A lathe is a type of machine tool whose work process moves around the workpiece and uses a cutting tool as a tool to cut the workpiece to obtain certain results. The quality of turning products includes good surface roughness in accordance with existing references for certain materials /

materials. In the turning process there are various factors that greatly affect the turning results, one of which is the cutting speed. In this research, with the variation in the use of cutting speed, differences in surface roughness will be obtained. The work of this study was carried out with a dry machining process where this process is an alternative choice to wet machining because in addition there is no large amount of used cutting fluid which will have a bad impact on the environment, dry machining is also very helpful in saving the cost or cost of this research.

From the background description, it can be seen that this research focuses more on the effect of cutting speed and feeding on surface roughness in machining with AISI - 1045 medium carbon steel specimens, on the grounds that these parameters greatly affect the surface quality of the material where in the workshop - the production workshop pays less attention to this so that the quality obtained is not good.

The shaft is a rotating stationary part, usually with a round cross-section to which elements such as gears, pulleys, flywheels, cranks, sporckets and other moving elements are attached. Shafts can receive bending loads, pulling loads, compressive loads or twisting loads that work alone or in combination with one another. (Joseph Edward Shigley, 1983).

The shaft in a machine serves to forward the power together with the rotation. Each rotating machine element such as a rope disk, engine belt pulley, cable disk, cable drum, road wheel and gear is mounted rotating against a fixed support shaft or fixed to a rotating support shaft.

Machining

is a process in the world of manufacturing using production machines which are advanced in the process of forming metal into raw materials in the form of wrought iron or alloy steel or formed through a casting process that is prepared with a shape that is close to the actual shape of the object. In the machining process there are several processes to produce products starting from raw materials that are processed in a certain way in a sequence and systematically so as to produce a functioning product. A machine component has ideal geometry characteristics if the component can be used in accordance with what is needed by the machine, and must have the right size / dimensions, perfect shape and smooth surface (Rochim, 1993). The machining process is the process of forming a product by cutting and using machine tools.

Based on technical drawings, where the geometric specifications of a machine component product are stated. For a process level, the objective size is determined and the tool must remove some of the workpiece material until the objective size is achieved.

This can be accomplished by determining the cross-section of the slurry (before cutting). In addition, after various technological aspects have been reviewed, the speed of the tool removal can be selected so that the cutting time is as desired. This kind of work will be encountered in any machining process planning.

The lathe is one type of cutting machine tool with the working principle of cutting parts of a rotating workpiece to obtain a certain shape and size. The workpiece rotates on its axis at a certain speed, then cutting or cutting using a tool that is moved translationally parallel to the rotating axis of the workpiece.

Lathe chisel is one of the cutting tools that are indispensable in the turning process, because lathe chisels with various types can make workpieces with various shapes according to the demands of the job for example, can be used to turn the surface / facing, flat, multilevel, groove, champer, tapered, shape, enlarge holes, make threads and cut.

The ability/performance of the lathe tool in cutting is strongly influenced by several factors including the type of material/material used, the geometry of the lathe tool and the technique of use. If some of these factors can be met based on predetermined standards, then the lathe tool will maximize its ability / performance.

In a certain type of machining work, a tool of the appropriate material type is required. The limitations of the ability of a type of tool material need to be taken into account. Here are the chisels that are often used in order from relatively soft materials to the hardest.

In engineering terms, a surface is a boundary that separates an object from its surroundings. In practice, the materials used for objects are mostly iron or metal. Therefore, solid objects made of soil, stone, wood and rubber will not be mentioned in the discussion of surface characteristics and measurements.

There is also another term related to the surface, namely profile. The term profile is often referred to by another term, namely shape. The profile or shape associated with the term surface has its own meaning, namely the line of normal cutting or a cross section of a surface. To measure and analyze a surface in three dimensions is difficult. Therefore, to facilitate measurement, the surface cross section needs to be cut. There are usually four ways of cutting, namely, normal, oblique, tangent and tangent cuts with the same depth distance. The line of cutting results is what is called a profile, in relation to the surface. In the analysis is only limited to normal cutting.

2. RESEARCH METHOD

To complete this final project, there are several processes carried out, namely The first step taken in this study is the observation of problems regarding the surface roughness of the workpiece (shaft), literature studies that support research. Furthermore, the selection of the type of shaft material and cutting tool that will be used. After that, the workpiece is made using a lathe. And the results of the lathe process are measured cutting time and surface roughness.

Before the surface roughness measurement is carried out, first calibrate the roughness measuring instrument so that the accuracy of the measuring instrument is obtained according to the standard. The surface roughness measurement process is carried out on the surface of the test object, where each time the feeding is measured 3 (three) times in one experiment at different speeds. When measuring the roughness value at each predetermined point, the surface roughness value will be seen. On the screen display of the measuring instrument. The next step is to compare the surface roughness values that have been obtained for each measurement result. Then conclusions are drawn from the machining process carried out in the experiment.

To obtain the surface roughness value, several stages of the measurement process are required, namely:

a. Calibrate the surface roughness measuring instrument with the standard surface roughness Ra.
b. Setting the end of the surface sensor parallel to the test piece by providing an additional cross section on the test piece.

3. RESULTS AND DISCUSSIONS

The results of research on the effect of cutting speed on surface roughness in machining AISI - 1045 carbon steel using HSS M2 tools. Obtained data in the form of numbers (values). The data is obtained through surface roughness tests. Before carrying out the surface roughness testing process, the test material first goes through the machining process. The machining process used is turning.

Surface roughness testing is the second stage in this research. Surface roughness testing produces data in the form of numbers (average surface roughness value (Ra). The data is obtained from measurements using a roughness measuring instrument (surface test) on AISI - 1045 carbon steel. The measurements were taken after the carbon steel was turned with five variations of spindle rotation speed, namely 200 Rpm, 175 Rpm, 150 Rpm, 125 Rpm, 100 Rpm with 0.13 mm feeding. After the turning process, different surface roughness levels will be obtained.

No.	N (r/min)	f (mm/r)	A (mm)	Surface roughness value Ra (µm)			Rā (µm)	tc (min)
				Ra1	Ra2	Ra3		
1.	200	0,13	0,5	7,5	7	6,8	7,1	01.18
2.	175	0,13	0,3	6,1	5,9	6,2	6,07	01.22
3.	150	0,13	0,5	4,7	5,2	5,3	5,07	02.03
4.	125	0,13	0,3	4,9	4,6	5,1	4,87	03.08
5.	100	0,13	0,5	4,3	4,3	3,7	4,1	03.54

Tabel 1. Carbon Steel Specimen Surface Roughness Value Data

In addition to feeding and cutting speed, the speed at which the material is produced is also influence. To be able to calculate the growl-producing speed of a process of turning test objects on a lathe using the equation:

$$Z = f \times a \times n$$

Then the results of the experiment calculations are entered in the following table:

No.	Cutting Speed (m/menit)	Snarl Generating Speed (cm^3/menit)
1.	100	6.5 x 10^{-3}
2.	125	8.1 x 10^{-3}
3.	150	9.8 x 10^{-3}
4.	175	11.4 x 10^{-3}
5.	200	13 x 10^{-3}

Tabel 2. Data from the calculation of the speed of the rasp generator

After calculating the speed of the snarling producer through the formula, we can see in the table that the faster the cutting speed used in this work, the speed of the snarling producer increases.

From the research results obtained that cutting speed affects surface quality in cutting speed variations.

The higher the cutting speed used, the higher the roughness level of the surface of the test material. This is because when the cutting speed is high the movement of the tool during the cutting process will be faster so that the cutting results are not maximized. Not maximizing the results of an incision results in beram not being cut to the maximum so that there are flakes - coarse flakes on the surface of the test material so that the surface becomes rougher.

When the spindle rotation is high, the cutting speed will also be high. It can be seen that in the variation of cutting speed there is a difference in surface quality. The results of the surface roughness value on carbon steel specimens are obtained based on the average value of the calculation results. The surface roughness value in each test is: The surface roughness value at a cutting speed of 200 m/min is 7.1 μm, at a cutting speed of 175 m/min is 6.07 μm, at a cutting speed of 150 m/min is 5.07 μm, at a cutting speed of 125 m/min is 4.87 μm, and at a cutting speed of 100 m/min is 4.1 μm. The parameters that determine the surface roughness are the depth of cut, feed rate and cutting speed.

Rochim (1993) says that the results of the turning process components, especially surface roughness, are strongly influenced by the cutting angle of the tool, feeding speed, cutting speed, thickness of the burrs and others. Rotary speed (n) (speed) is always associated with the spindle (main axis) and the workpiece. Since the rotating speed is expressed as revolutions per minute (rpm), it describes the speed of rotation. However, what is prioritized in the lathe process is the cutting speed (cutting speed or cs) or the speed of the workpiece through the tool / workpiece circumference. Basically, during the lathe process, the speed is determined based on the workpiece material and the tool (Widarto, 2008).

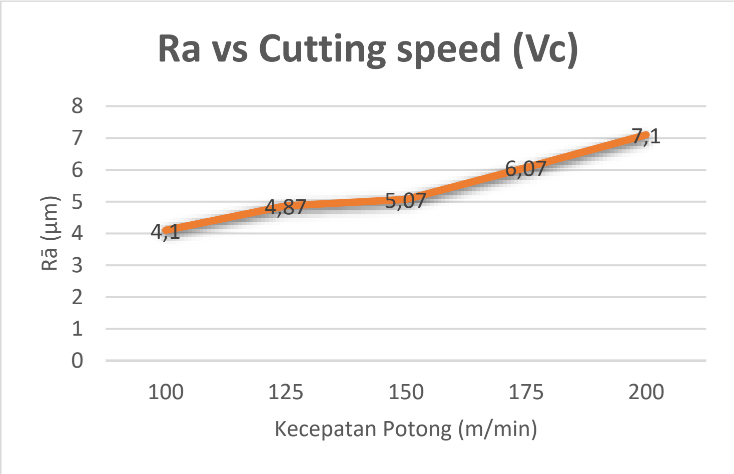
Surface quality is influenced by cutting speed because the cutting force decreases with the greater the cutting speed value. This statement is in accordance with the theory (Rochim, 1993) that the greater the cutting speed value, the cutting force will decrease.

The higher the cutting speed will also have an impact on reducing the compression ratio of the grit. This is because a high cutting speed will actually reduce the cutting force. The decrease in cutting force will affect the decrease in the cross-sectional area of the shear plane. Thus, a high cutting speed will reduce the cutting force. The cutting force will affect the surface quality of the workpiece. Geram compression ratio itself is the ratio of the thickness of the resulting geram to the thickness of the original geram - the beginning (Setiyana. 2005). This is in accordance with Rochim's statement. The higher the cutting speed, the cutting force will decrease. According to Samsir (1989) also said that the quality of the cut surface will depend on the cutting conditions, for example low cutting speed with feed and small depth of cut produces a rough surface (roughing) otherwise high cutting speed with feed and small depth of cut produces a smooth surface. This statement is in line with the results of research that has been done.

The results of previous research from Ganjar (2005) also state that cutting speed, feed rate, workpiece hardness and depth of cut have a statistically significant effect on surface roughness. Cutting speed and feed rate as well as cutting speed and depth of cut also appear to have an effect. In particular, it was found that a rotational speed of 200 rpm at a cutting speed of 23.22 m/min produced a rougher surface than a rotational speed of 100 rpm at a cutting speed of 15.48 m/min. It can be seen in the research results obtained that the lower the cutting speed variable, the better the surface quality of the test material.

The results of the surface roughness value on carbon steel specimens are obtained based on the average value of the calculation results. The surface roughness value in each test, namely, the surface roughness value at a cutting speed of 100 m/min is 4.1 μm, at a cutting speed of 125 m/min is 4.87 μm, at a cutting speed of

150 m/min is 5.07 µm, at a cutting speed of 175 m/min is 6.07 µm and at a cutting speed of 200 m/min is 7.1 µm.



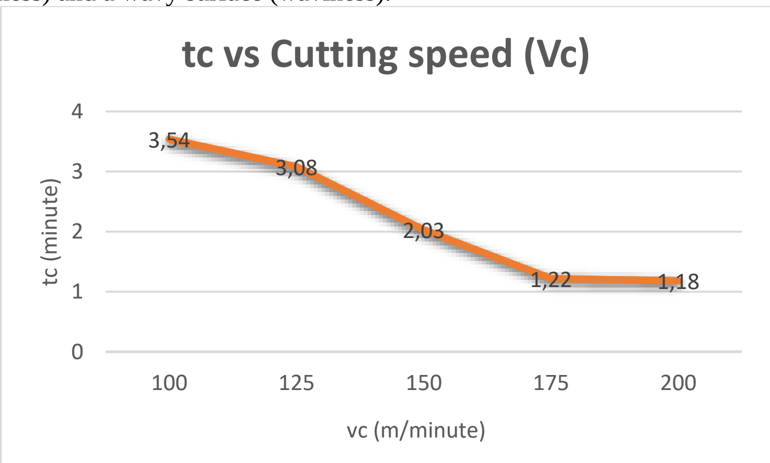
Graphic 1. Arithmetic Surface Roughness

In graph 1 it can be explained that the higher the cutting speed used, the higher the roughness level obtained:

1. Starting from the lowest speed of 100 m/min which obtained a roughness value of 4.1 µm.
2. Likewise, the next speed, 125 m/min poto speed obtained a roughness value of 4.87 µm.
3. Cutting speed of 150 m/min obtained a roughness value of 5.07 µm.
4. Cutting speed of 175 m/min obtained a surface roughness value of 6.07 µm.
5. At the highest cutting speed of 200 m/min, the surface roughness value is 7.1 µm.

It can be seen that at each cutting speed used, the roughness results obtained always increase according to the level of cutting speed used. This is influenced because the higher the cutting speed used, the tool displacement during the turning process becomes so fast that the results obtained are not so smooth. Not only that, the feeding value used also greatly affects the surface roughness value in each turning process using various levels of cutting speed.

By looking at the shape on the graph, the shape of a surface can basically be divided into two, namely a rough surface (roughness) and a wavy surface (waviness).



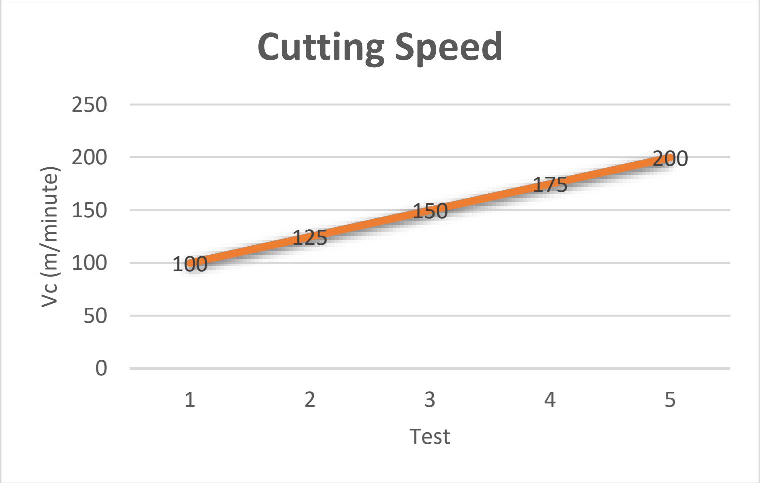
Graphic 2. Cutting Time (tc)

In graph 2 it can be seen that the cutting speed is very influential on the cutting time. When using the lowest cutting speed the cutting time results will be longer due to the slow spindle rotation.

1. At the lowest cutting speed of 100 m/min it takes 3.54 min for the turning process

2. At the next cutting speed of 125 m/min it takes 3.08 min for the turning process.
3. And then at a cutting speed of 150 m/min it takes 2.03 min for the turning process.
4. At a cutting speed of 175 m/min it takes 1.22 min for the turning process.
5. While at the highest cutting speed used, 200 m/min, it takes the shortest time of 1.18 min for the turning process.

This is because when the cutting speed is increased, the cutting process is faster and the cutting time required will be less. However, the less time it takes, the rougher the surface on the test piece. However, the level of roughness on the surface of the material is also influenced by whether or not the tool is used.

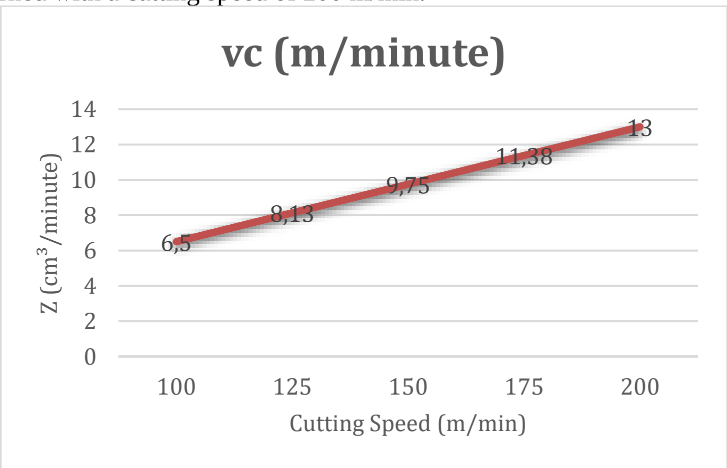


Graphic 3. Cutting Speed (Vc)

The higher the spindle rotation, the faster the cutting time required. Thus the cutting speed is determined by the diameter of the workpiece, the workpiece material factor and the tool material. Basically, during the turning process, the cutting speed is determined based on the type of workpiece material and the tool. In the turning process, the speed of producing geram also needs to be considered because this can affect the quality of the surface roughness of the test material.

It can be seen in graph 4.3 that in each test performed the cutting speed used is different. This is done to see the surface quality of each test which is the main objective of the research conducted. Based on the things that have been determined on each sepesimen, different cutting speeds are used, namely:

1. Specimen 1 was turned with a cutting speed of 100 m/min.
2. Specimen 2 was turned with a cutting speed of 125 m/min.
3. Specimen 3 turned with a cutting speed of 150 m/min.
4. Specimen 4 turned with a cutting speed of 175 m/min.
5. Specimen 5 turned with a cutting speed of 200 m/min.



Graphic 4. Calculation of Rasp Generating Speed (Z)

After doing the calculations, it can be seen that the geram produced in the experiment, the higher the cutting speed, the greater the geram produced and when the spindle rotation is getting slower, the results of the geram will be less.

It can be seen in graph 4.4 that the speed of producing geram obtained at each use of different cutting speeds - different results are also obtained. Can be seen from the first experiment to the fifth, namely:

1. The snarling speed obtained by using a cutting speed of 100 m/min is 6.5 cm^3/min.
2. The cutting speed obtained by using a cutting speed of 125 m/min is 8.13 cm^3/min.
3. The slurry generation speed obtained using a cutting speed of 150 m/min is 9.75 cm^3/min.
4. The slurry generation speed obtained using a cutting speed of 175 m/min was 11.38 cm^3/min.
5. The cutting speed obtained by using a cutting speed of 200 m/min is 13 cm^3/min.

The results of the turning process at each step of surface roughness are influenced by the cutting speed, depth of cut and feeding motion in the turning process, where the resulting surface will be smoother if the spindle rotation speed is increased and the depth of cut and feeding motion is minimized. Therefore, the income of the furrow depends on the feeding motion, the greater the feeding motion used, the thicker the resulting furrow will be and vice versa.

4. CONCLUSION

The results of this study are cutting speed is very influential on the results of the surface roughness of the test material, can be seen from the data analysis and research results. The surface of the test material with the highest level of smoothness is obtained from the use of the lowest cutting speed (100 m/min) with a roughness level of (4.1). The highest roughness level (7.1) with the cutting speed used (200 m/min). The higher the cutting speed used, the greater the price of the surface roughness value obtained or produced. However, the wear of the tool blade used is likely to also affect the level of surface roughness. Geram income depends on the cutting speed, the greater the feeding motion used, the greater the thickness of the resulting geram. The smaller the cutting speed used, the smaller the resulting furrow.

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