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LEVEL OF SURFACE ROUGHNESS SS41 STEEL DUE TO NOSE RADIUS AND CUTTING SPEED IN CNC LATHE

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ABSTRACT

The surface roughness of the turning process influenced by several factors. Factors such as cutting speed, nose radius, feed, depth of cut, and material can affect the surface roughness resulting from turning. Several studies have conducted to determine the relationship between these factors. This study aims to determine the level of surface roughness in SS41 steel material due to nose chisel radius and cutting speed. Testing of SS41 Steel turning with variable nose 0.4 mm and 0.8 mm insert KYOCERA type D. Cutting speeds vary from 145 m/min, 160 m/min, 175 m/min, and 190 m/min. Fixed cutting depth of 0.63 mm and fixed feed motion of 0.17 mm/rev. Specimen material SS41 steel with a diameter of 25 mm and a length of 100 mm. Each turning variation uses three specimens. Turning process using the EMCO Turn 242 CNC lathe. The results of turning tested for surface roughness using SE300 Surfcorders. The results matched with the surface roughness level based on ISO 1302. Standard Based on the test results, the nose radius and cutting speed influence the surface roughness of the workpiece. Surface roughness with a nose radius of 0.8 mm smoother than a nose radius of 0.4 mm. The lowest roughness value obtained at a cutting speed of 190 m/min. The lowest average surface roughness with a value of 1.154 µm occurs on the nose radius 0.8 mm with a cutting speed of 190 m / min. While the highest average surface roughness with a value of 2.817 µm occurs on the nose radius of 0.4 mm with a cutting speed of 145 m/min. Surface roughness values are at the position of N6 and N7 when using nose radius 08 mm with variations in cutting speed. While the roughness value remains at N8 when using a nose radius of 0.4 mm with variations in cutting speed.

Key words: nose radius, cutting speed, surface roughness, SS41 steel.

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1. INTRODUCTION

The surface roughness of a product becomes an important measure for the accuracy and surface quality of a manufacturing industry product [1]. The surface roughness of a machining product affects several product functions, such as surface friction, stress concentration, ability to spread lubrication, coating, and others [2]. Like a shaft, the more beautiful the surface of the shaft, the lower the friction between surfaces, the smaller the concentration of surface tension, and the better the spread of lubrication [3].

Surface roughness usually the first determination in determining the quality of machined products. To obtain surface roughness, parameters such as nose chisel radius, cutting speed, feed rate, depth of cut need to arranged in such a way as to achieve the desired surface roughness. How much influence these parameters have on surface roughness usually obtained from experiments and research results. Several studies have conducted such as research conducted by [2] [3] [4] [5] [6].

The turning process, the workpiece slashed by turning the workpiece and fed to the tool that moves translationally parallel to the rotating axis of the workpiece. Rotational motion of the workpiece called relative cutting motion, while the translational motion of the cutting tool called feeding. The combination of the two movements will produce a thin spiral groove along a cylindrical workpiece. If the feed movement slows compared to the cutting motion, it will produce a workpiece with a spiral groove that almost invisible. When the translation infestation motion accelerated, and the cutting motion slowed down, the shape of the spiral groove that surrounds the workpiece will become clearer especially if the groove deepened it will form a screw spiral. So that by adjusting the ratio of the rotational speed of the workpiece to the translational speed of the tool, a different surface profile will obtained [7]. In Figure 1 shows the turning process for worpieces.

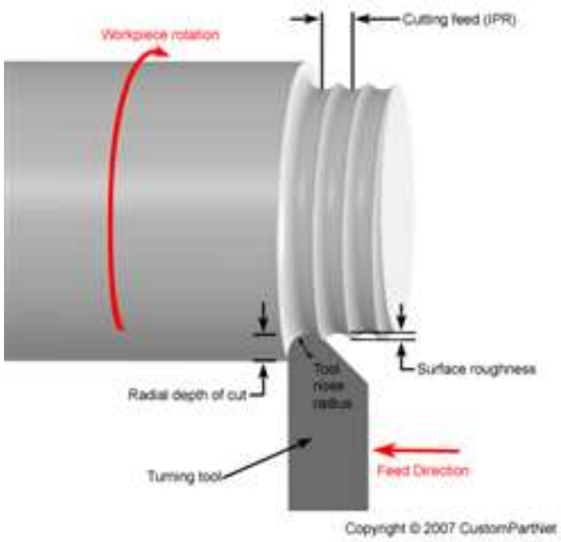

Figure 1 Turning process [8]

Another factor that can affect the value of surface roughness in turning a tool. Chisel one of the main components used in turning to change the shape of the workpiece according to the desired shape [9]. One type of tool that commonly used in CNC lathes the insert tool. Insert tool or insert can installed permanently using brazing or indefinitely by using a clamp or bolted L as a binder on the tool body (insert) [10]. The tool with the inserts attached usually remains sharpened again when it has worn out. While the tool with inserts that clamped does not need to sharpen and when the cutting edge wears the tool insert, this type must replaced with a new one by reversing the insertion position or replacing it with a new insert if the entire side active/second the cutting edge has worn out. On the insert tool, there a radius of the edge of the lathe tool which functions as a workpiece slicer to formed, known as the nose radius [11][12]. Nose radius very influential on the quality of the product produced because the nose radius directly in contact with the workpiece, thus it can interpreted that the nose radius dramatically affects the value of surface roughness resulting from turning. The higher the corner radius value on the tool can reduce the value of the surface roughness of the workpiece, otherwise, the smaller the corner radius value used in the cutting process, the value of surface roughness will increase. However, the larger the corner radius used can also increase the radial force produced so that for cutting systems that tend to non-rigid (long shafts with relatively small diameters) allow machine vibrations to decrease the quality of the product geometry [5]. Therefore, before carrying out the machining process, the readiness of the engine condition used must ensured in good condition so that the engine vibration can ignored.

The radius of the chosen radius must also pay attention to furious feeding, both the cutting depth and the speed of the picking used. The higher the feed done, the radius corner used must stronger. The choice of nose radius based on determining the depth of the cut. Table 1 the relationship between the depth of cut with nose radius.

Table 1. Nose radius to the depth of the cut

Depth of cut (mm)	Nose radius (mm)
0 - 3	0.5 - 0.8
3 - 10	0.8 - 1.5
10 - 20	1.5 - 2.0

Based on the above, then how the influence of the difference in nose radius and cutting speed on the level of surface roughness resulting from turning of CNC lathes according to ISO 1302 [13]. For this reason, feed and depth of cut fixed so that the influence of nose radius and cutting speed can seen.

2. METHODS AND MATERIALS

The purpose of this study to test and prove whether or not the influence of the difference in nose radius and cutting speed on the level of surface roughness resulting from turning by using a CNC lathe. The material used in this study SS41 steel with an initial size of 25 mm in diameter and 100 mm in length. Feeding length of 60 mm done in one feed stage. The test consists of eight variations with each variation consisting of three specimens so that the specimens used to amount to 24 with details as shown in Table 2.

Table 2. Test variations

No.	Nose radius (mm)	Cutting speed (m/min)	Feed rate (mm/rev)	Depth of cut (mm)	Sample
1	0.4	145	0.17	0.63	3
2	0.4	160	0.17	0.63	3
3	0.4	175	0.17	0.63	3
4	0.4	190	0.17	0.63	3
5	0.8	145	0.17	0.63	3
6	0.8	160	0.17	0.63	3
7	0.8	175	0.17	0.63	3
8	0.8	190	0.17	0.63	3

The tool used in this study uses the DCMT11T304XQ and DCMT11T308XQ insert types. The insert tool specifications can see in Table 3.

Table 3. Cutting insert [14]

Kyocera Insert Turning Catalog				
Insert type	DCMT11T304XQ		DCMT11T308XQ	
Nose radius (mm)	0.4		0.8	
Chip breaker type	XQ (*low carbon steel, medium finishing*)			
Cutting speed (m/min)	100	190	120	240
Depth of cut (mm)	0.50	1.50	0.50	1.50
Feed rate (mm/rev)	0.10	0.25	0.10	0.25

Figure 2.CNC Lathe EMCO Turn 242

In this turning process, the assumptions made in this study are: the tool and lathe considered rigid so that the effect on surface roughness can ignored, the parameters observed as variables the nose radius of the tool and the cutting speed, but feed and depth of cut fixed, the results observed surface roughness resulting from turning, the research experiment focused on elongated turning, test material a solid rod-shaped SS41 with a diameter of 25 mm, a length of 100 mm, the overhang tool and lathe considered to quite rigid, to absorb vibrations that occur during the cutting process, the turning process carried out with the EMCO Turn 242 CNC lathe as shown in Figure 2.

Figure 3 Lathe machining process with

During the process of turning the workpiece, the liquid coolant sprayed onto the workpiece that undergoing suctioning by the insertion tool. The turning process by spraying the liquid inside the machine can seen in Figure 3. After the turning process complete, the next process to measure the surface roughness resulting from turning. The tool used the SE300 Surfcorder. For the standard used in this measuring instrument JIS1982, Using this standard it possible to obtain the selection parameter *Ra*. Figure 4 shows the process of testing surface roughness with SE300 Surfcorders.

Figure 4 The process of surface roughness testing

3. RESULTS AND DISCUSSION

The results of surface roughness measurements using SE300 Surfcorder can seen in Table 4. This the result of turning using a carbide-based insert tool with cutting speed variation and nose radius on SS41 Steel workpieces.

Table 4. Surface roughness measurement results

No.	Nose radius (mm)	Cutting speed (m/min)	Feed rate (mm/rev)	Depth of cut (mm)	Sample	R_{a1} (μm)	R_{a2} (μm)	R_{a3} (μm)	R_a (μm)
1	0.4	145	0.17	0.63	Sample 1	3.175	2.603	2.715	2.817
					Sample 2	2.924	2.811	2.877	
					Sample 3	2.706	2.845	2.704	
2	0.4	160	0.17	0.63	Sample 1	2.343	2.522	2.830	2.659
					Sample 2	2.718	2.567	2.674	
					Sample 3	2.842	2.679	2.761	
3	0.4	175	0.17	0.63	Sample 1	2.642	2.679	2.633	2.636
					Sample 2	2.585	2.660	2.581	

					Sample 3	2.658	2.670	2.619	
4	0.4	190	0.17	0.63	Sample 1	2.935	2.989	2.930	2.609
					Sample 2	2.891	2.340	2.284	
					Sample 3	2.609	2.340	2.172	
5	0.8	145	0.17	0.63	Sample 1	2.182	1.950	2.381	2.193
					Sample 2	2.655	2.805	2.680	
					Sample 3	1.679	1.704	1.710	
6	0.8	160	0.17	0.63	Sample 1	2.321	1.881	1.873	2.006
					Sample 2	2.308	1.967	1.894	
					Sample 3	2.017	1.900	1.895	
7	0.8	175	0.17	0.63	Sample 1	1.265	1.204	1.352	1.257
					Sample 2	1.253	1.118	1.245	
					Sample 3	1.395	1.209	1.291	
8	0.8	190	0.17	0.63	Sample 1	1.200	1.196	1.185	1.154
					Sample 2	1.141	1.116	1.143	
					Sample 3	1.149	1.149	1.115	

Value surface roughness has a class of surface roughness N1 to N12 (ISO 1302). Table 5 the roughness value obtained from the specimen test results.

Table 5. Surface roughness level of turning

Nose radius (mm)	Cutting speed (m/min)	Ra (μm)	Roughness level
0.4	145	2.817	N8
	160	2.659	N8
	175	2.636	N8
	190	2.609	N8
0.8	145	2.193	N7
	160	2.006	N7
	175	1.257	N7
	190	1.154	N6

Based on Table 5 it known that the achievement of surface roughness in the turning process with variations of nose radius and cutting speed between N6 - N8, means that the resulting level of rooting on the workpiece surface corresponds to the level of surface roughness for the finishing process. The effect of the difference in nose radius and cutting speed based on the data taken affects the value of the surface roughness of the workpiece. The effect of the difference in nose radius and cutting speed on surface roughness resulting from turning can seen in Figure 6.

Based on Figure 6, the nose radius and cutting speed influence the surface roughness of the workpiece. Surface roughness with a nose radius of 0.8 mm smoother than a nose radius of 0.4 mm. The lowest roughness value obtained at a cutting speed of 190 m / min. The lowest average surface roughness with a value of 1,154 μm occurs on the nose radius 0.8 mm with a cutting speed of 190 m / min. While the highest average surface roughness with a value of 2,817 μm occurs on the nose radius of 0.4 mm with a cutting speed of 145 m / min. At high cutting speeds, a nose radius of 0.8 mm still able to significantly reduce the value of surface roughness. Unlike the nose radius of 0.4 mm when using high cutting speeds, the value of surface roughness did not experience a significant decrease. The nose roughness value of 0.4 mm remains on the N8. This has the advantage of using a 0.8 mm nose that has the results of the roughness of N6 and N7.

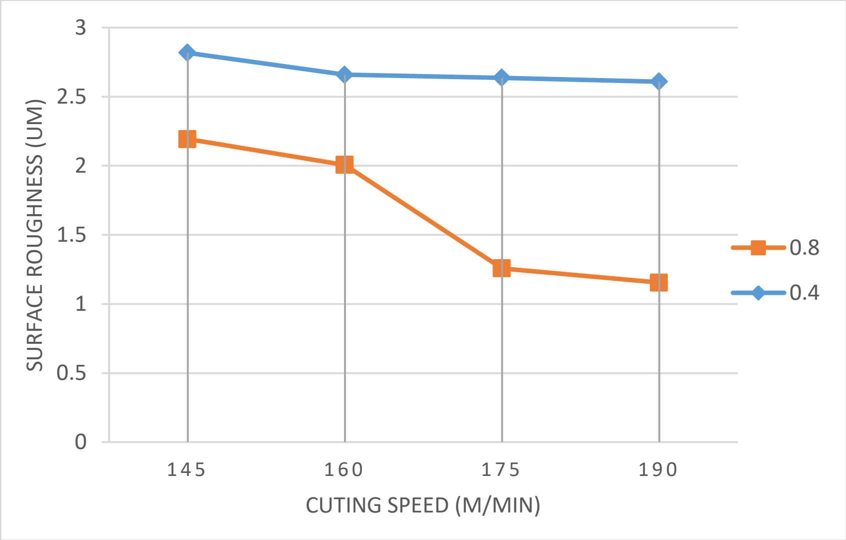

Figure 6 Graph of the relationship of changes in cutting speed and nose radius to surface roughness

4. CONCLUSIONS

Nose radius affects the surface roughness of SS41 workpieces as a result of turning the finishing process using CNC lathes. The value of surface roughness has decreased when using a nose radius with a diameter of 0.8 mm with an increase in cutting speed. Whereas with the use of nose radius diameter of 0.4 mm, the roughness value has increased. Cutting speed influences the surface roughness of the workpiece resulting from the finishing process using CNC lathes. Surface roughness values are at the position of N6 and N7 when using nose radius 08 mm with variations in cutting speed. While the roughness value remains at N8 when using a nose radius of 0.4 mm with variations in cutting speed.

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