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Effect of the cutting angle and the depth of cut toward wear of carbide tool on the lathe

Iswanto*, M. Fachrur Firmansyah, Mulyadi

Universitas Muhammadiyah Sidoarjo, Sidoarjo, Indonesia

*iswanto.sda@gmail.com

Abstract. The following paper discusses how the effect of the angle and the depth of cut toward wear and tear of chisel on the lathe, then sought relationship influence of both. In this study, the wear and tear of the chisel to be studied is the edge wear (VB). The varied machining parameters are cutting angle and depth of cut. Variation of cutting angle is equal to 60°, 75° and 90°. While the depth of cut is varied by 0,5 mm, 1,0 mm and 1,5 mm. The lathe used is a conventional lathe with 400 rpm spindle spin. After testing the wear of chisel, it can be concluded that the greater the angle of cutting the higher the level of wear chisel. So also on the variation of cut depth, the greater the depth of cut then the higher the wear rate of the chisel also. From the factorial test also shows that the cutting angle and depth of cut have a close relationship in the process of forming the tool wear.

Keywords: The cutting angle, depth of cut, wear and tear chisel

1. Introduction

On the lathe there are some important components that are used during the process of lathe, one of them is chisel of cut or commonly called chisel lathe that serves to flatten, slash, form workpiece as needed [1].

In the machining process, the chisel will interact with the workpiece that is experiencing a friction where the chisel will cut the workpiece. Friction that arises on this chisel that will cause a wear and tear. The wear of this chisel will grow to a certain extent so that the chisel can not be used anymore or the chisel is damaged [2,3].

The age of this chisel is strongly influenced by several kinds of process variables, ie machining process, workpiece material and chisel, chisel geometry, machining / cutting conditions and coolant used [4,5].

In this study the authors use a chisel without any treatment again on the chisel before chisel is used, so the chisel conditions will always be the same. The chisel used is chisel of carbide, the material used is ST 42 steel. In this study the cut angle and cutting depth are varied, while other process variables are determined.



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2. Experimental Method

The research method used in this research is the experimental method, that is the method used to test by adding some variation treatment, so that later will get the value of tool wear every addition of tested variables. Starting with the determination of the variables and the number of levels to be used, as shown in table 1.

Table 1. Variable with level amount arrangement

Variable	Unit	Level 1	Level 2	Level 3
Cutting angle (K_r)	°	60	75	90
Depth of cut (a)	mm	0,5	1,0	1,5

From the number of variables and the number of levels, then obtained nine variations of specimens. The lathe process is based on the number of variations of the specimen, with details such as table 2.

Table 2. Planning of machining process (lathe process)

No	Depth of cut (mm)	Cutting angle (°)
1	0,5	60
2	0,5	75
3	0,5	90
4	1,0	60
5	1,0	75
6	1,0	90
7	1,5	60
8	1,5	75
9	1,5	90

Tools and materials used in this study is:

- Machine Lathe with specifications
 - Merk : Trunmaster
 - Spindle RPM : 25 – 2000rpm
 - Motor type : There Phase Electric Motor
 - Motor power : 3 kW
- The tool used is a double-edged carbide tool
- Workpiece used ST-37 solid cylinder steel
- Nikon Measurescope for measuring tool wear

Machining process

In the machining process using a lathe is done in accordance with the following steps:

- Prepare workpiece to be processed lathe
- Cutting workpiece to size
- Preparing the tool to be used is Carbide tool, as presented in figure 1
- Install the tool on the tool post and set the angle variation in the tool post
- Install the workpiece on the head (chuck), then tightened
- Setting the machine
- Turn the machine on and do the lathe with a predetermined variation to complete

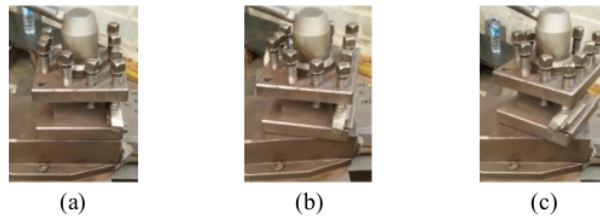


Figure 1. Variation of cutting angle (a) 90°, (b) 75°, and (c) 60°

3. Results and Discussion

In this research the result is quantitative data in the form of numbers. Where the numbers express the wear of carbide tool. The quantitative results of this study are prepared in tabular form. The table is the processing of wear data from the tested sample. Table 3. is the result of testing of tool wear affected by cutting depth and cutting angle.

Table 3. Test Result of Tool Wear

No	Tool brand	Machining parameters			Cutting angle (°)	Wear values /VB (mm)
		n (rpm)	f (mm/rev)	a (mm)		
1	Bohler	400	0.12	0.5	60	0.562
2	TNMG				75	0.570
3	160404				90	0.675
4				1.0	60	0.674
5					75	0.684
6					90	1.180
7				1.5	60	0.820
8					75	1.250
9					90	1.330

It can be seen in Table 3. which shows the different wear of each tool, where the difference in the values shown is strongly influenced by the increase in angular value and cutting depth.

3.1 Variation of cutting depth against tool wear

After performing tool wear testing, we get a depth of cut relationship table on tool wear, 5 shown in table 4. The data contained in table 4. then made a graph of the relationship between the depth of cut to tool wear, as presented in figure 2. From figure 2. it can be seen that, the greater the depth of cut results in higher tool wear. And conversely the smaller the depth of cut resulting in lower tool wear.

Table 4. Cut depth variation against tool wear

Depth of cut (mm)	Cutting angle (°)	Tool wear/VB (mm)
0.5	60	0.562
	75	0.570
	90	0.675
1.0	60	0.674
	75	0.684
	90	1.180
1.5	60	0.820
	75	1.250
	90	1.330

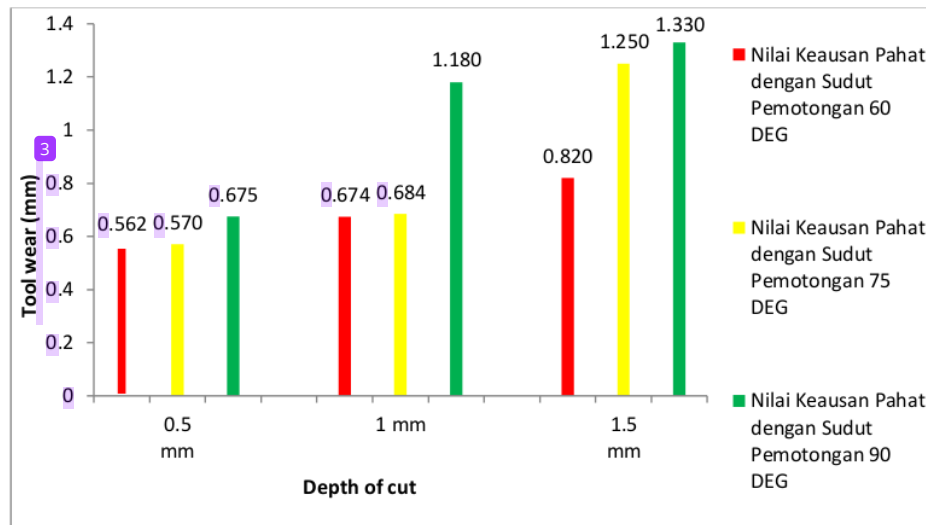


Figure 2. Graph of wear scale value with depth of cut variation

3.2 Variation of cutting angle against tool wear

Next is to create a table of relations between the effect of the cutting angle on the tool wear, as shown in table 5. From the data contained in table 5. next made graphs the relationship between the cutting angle to the tool wear, as shown in figure 3. From figure 3. it can be seen that the greater the cutting angle will result in the greater tool wear, and the smaller the cutting angle result the smaller also the tool wear.

Table 5. Variation of cutting angle against tool wear

Cutting angle (°)	Depth of cut (mm)	Tool wear /VB (mm)
60	0.5	0.562
	1,0	0.674
	1.5	0.820
75	0.5	0.570
	1,0	0.684
	1.5	1.250
90	0.5	0.675
	1,0	1.180
	1.5	1.330

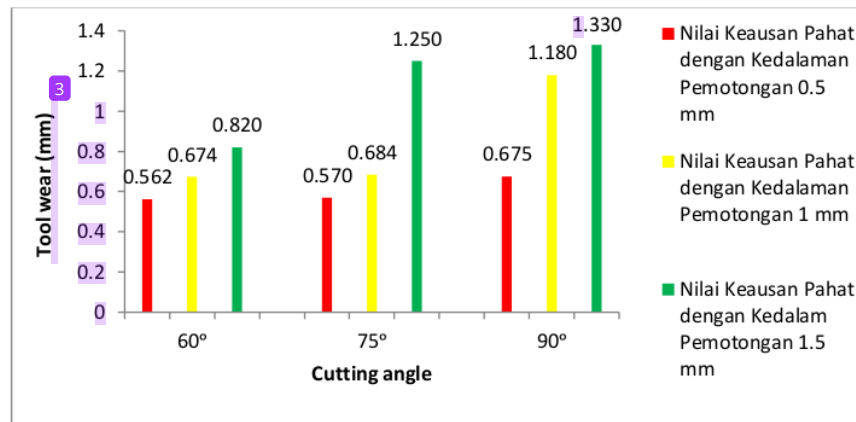


Figure 3. Graph of wear scale value with cutting angle variation

3.3. Factorial analysis

Factorial analysis is an analysis used to determine the effect of variation conducted on experimental research which has two or more independent variables. For this research, the analysis is conducted to know which process variable has significant effect on the tool wear, whether it is one or both.

- F table for cutting angle: $F(\alpha, df_1, df_2) = F(0,05, 2, 4) = 6,94$
- F table for cutting depth: $F(\alpha, df_1, df_2) = F(0,05, 2, 4) = 6,94$

For cutting angle factor, $F_{\text{calculate}} 13,8 > F_{\text{table}} 6,94$, then H_0 is rejected
for cutting depth factor, $F_{\text{calculate}} 7 > F_{\text{table}} 6,94$, then H_0 is rejected

Based on the hypothesis test of F distribution, the angle factor and cutting depth significantly influence the tool wear. It can be concluded also that the two variations have a relationship between one another in the process of tool wear. Where if the cutting depth is low and the cutting angle is low then the tool wear will be low, if the cutting depth is high and the cutting angle is low then the tool wear is low and vice versa, but if the angle and depth of cutting is high then the tool wear will also be high.

4. Conclusion

- a. The larger the tool angle resulted in the greater the tool wear value, and vice versa the small tool angle resulted in the smaller the tool wear value. The greater the depth of cut the tool wear value will be greater, and the smaller the depth of cut leads to less value of tool wear.
- b. From the results of the factorial test show that between the cutting angle and the cutting depth have a close relationship in the process of forming the tool wear.

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