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Comparison of Tool Wear Rate of Insert Lathe TNMG160404-MA and TNMG160404-TF

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ABSTRACT

Lathe machines are used to work on cylindrical objects. Tool wear is often a problem in the turning process and impacts the results of the machining process. The research aims to compare lathe insert tool wear levels TNMG160404-MA and TNMG160404-TF. The research used the experimental method directly using a lathe with variable machining on feeding (f) 0.04 mm/rev and 0.08 mm/rev, spindle (n) 540 rpm, and depth of cut (a) 4 mm. Tool wear was measured using an optical microscope by measuring the maximum edge wear on the tool (VBmax) and to determine the significance of tool wear using statistical analysis. The results showed wear level insert tool of TNMG160404-MA at a feeding of 0.04 mm/put an average of VBmax = 85.00(μm) and a feeding of 0.08 mm/put VBmax = 63.23(μm). TNMG160404-TF insert tool wear at 0.04 mm/put feed VBmax = 76.18(μm) and 0.08 mm/put feed VBmax = 58.43(μm). On a feeding, 0.08 mm/put motion, the standard deviation (s) of the TNMG160404-MA insert tool is 16.2, and the standard deviation (s) of the TNMG160404-TF insert tool is 17.8. On a feeding of 0.08 mm/rev, the results of t-count = 0.630 and t-table = 2.101, so t-count < t-table (0.630 < 2.101), the statistical analysis results using the t-test showed no significant difference in the level of wear of the two types insert tools.

Keywords: *Tool Insert*; *Tool Wear*; *Flank Wear*; *Statistic Analysis*

Introduction

A lathe is a kind of machine tool used to cut cylindrical objects. A lathe is a cutting procedure that makes an incision by rotating the workpiece and then applying it to the tool. This is done to carry out cutting. The rotational motion of the workpiece, known as the relative cutting motion, is contrasted with the feed motion, which refers to the translational motion of the tool [1]. Metal cutting methods are used to produce different shapes of the same piece of metal. One of the many categories of cutting processes is the cutting process with a machine tool, or rather the cutting process with a cutting tool mounted on a machine tool. Other cutting processes fall into other categories as well [2].

The machining process is a process to create products through stages of raw materials to be changed or processed in certain ways sequentially and systematically to produce a functioning product. The degree of flatness of the surface greatly affects the yield of the workpiece after processing on the lathe [3]. Based on experience in the field, in the turning process, in order to obtain good quality surface flatness of the workpiece, good component selection is also needed. Lathe chisels become the main component in the machining process in addition to lathes and workpieces [4].

A lathe chisel is a tool used to cut workpieces. The requirement for a good cutting process is that the tool material must have a higher hardness than the material cut [5]. Carbide insert chisels have been widely used by the manufacturing industry because of the consideration of affordable prices, the final product results of using carbide insert chisels show that carbide insert chisels have high strength and hardness, resistance to wear, high temperatures, low roughness and accurate product dimensional accuracy [6]. The selection of carbide insert lathe tools aims to determine the comparison of tool wear rates of several brands.

Tool wear is a common problem and cannot be avoided in any way in the machining process. Friction that occurs between the tool and the workpiece results in heat and wear on the to [7]. During the cutting process, wear will increase until it reaches the allowable wear limit. The length of time to reach the allowable wear limit is defined as tool life. Tool life is influenced by tool geometry, material type of workpiece and tool, cutting conditions (cutting speed (Vc), cutting depth (a) and feeding motion (f)), coolant and type of machining process [8].

The rate of expiration of the service life of the tool is largely determined by the rate of accumulated wear. In most cases, increased edge wear begins with relatively rapid growth immediately after the tool is used, followed by linear growth consistent with an increase in cutting time (the amount of time required for cutting operation), and then rapid growth occurs once again. The point at which the rate of rapid wear increase begins to repeat is believed to be the tool life limit, and this usually occurs at almost the same edge wear value (VB) for cutting speed[9], [10].

Figure 1 illustrates the features of some of the tool wear changes that can occur and explains how those changes occur [11]–[16]

1. The cutting temperature and the action of the shale flowing on the surface of the rake are responsible for producing the crater surface, also known as the creator.

2. Wear on the tool side (flank) VB is wear on the tool side in the form of abrasive mechanical wear that occurs on the edge of the tool due to changes in the shape of the cutting tool tip. This type of wear occurs on the side of the cutting tool.

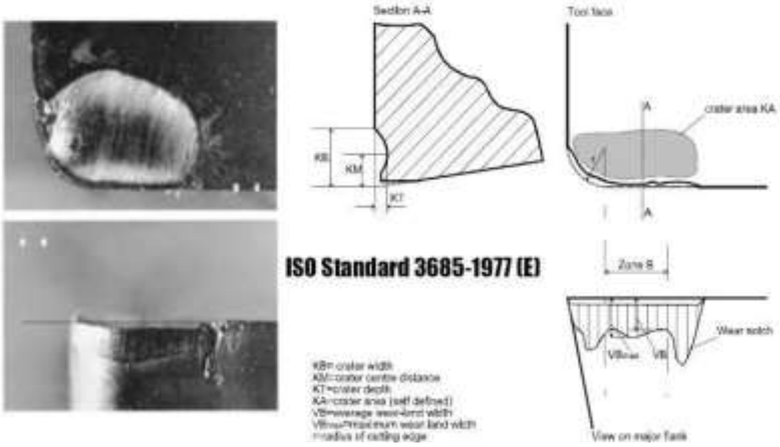


Figure 1. Tool Wear

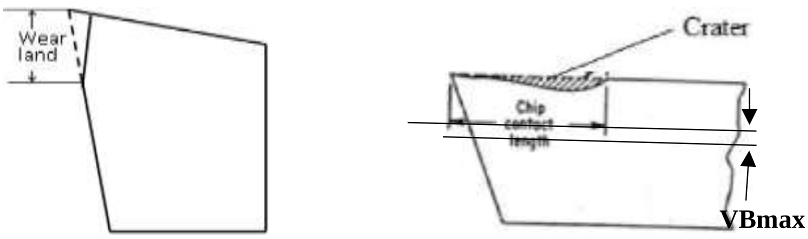
During the cutting process, the amount of edge wear (VB) and crater wear (KT) will increase in magnitude (grow) as the amount of time spent mowing, measured in minutes, is extended. The circumstances under which the cutting process is carried out significantly affect the factors contributing to wear and tear.

Research Methods

Process parameters are parameters that are made to control and control a study because their value can be determined by the researcher. In this study, the parameters used are feeding motion (f), cutting depth (a), spindle rotation (n). The parameters of this research process can be seen in Table 2. The tool used in the cutting process is then measured at maximum edge wear (VBmax) using a microscope, where the cutting eye plane is arranged so that it is parallel to the optical axis. The amount of side/edge wear can be determined by measuring the length of the VB, which is the distance between the cutting edges before wear occurs to the maximum line of wear marks in the main plane. The illustration of VB on the chisel can be seen in Figure 2 [17]–[22].

Table 1. Parameters of the research process

No	Vc (m/min)	f (mm/put)	a (mm)	n (rpm)
1.	35,6	0,04	4	540
2.	35,6	0,08	4	540



(a) (b)

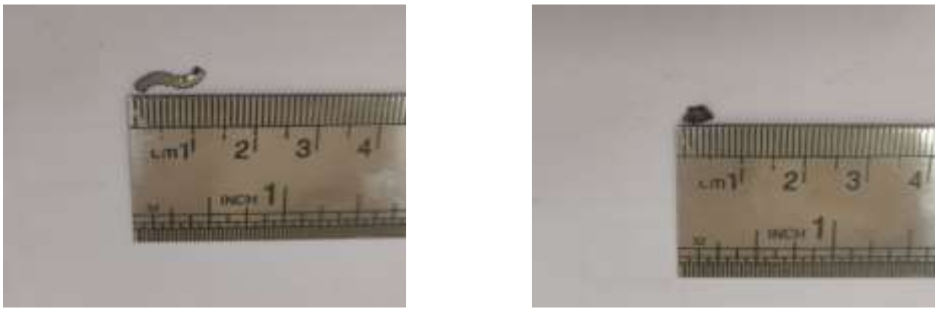
Figure 2. (a) Flank wear (b) crater wear.

Results And Discussion

The lathe machining process aims to determine the wear of the tool used. The results of tool use in the machining process are used to compare tool wear values. Tool wear is observed using a microscope on a 5x magnification scale. The material used as test material on each tool is ST42 Steel with a diameter of 25 mm and a turning length of 300 mm. The material was chosen because in addition to the existing availability, especially in the Yogyakarta area and from several experiments carried out have shown results in tool wear.

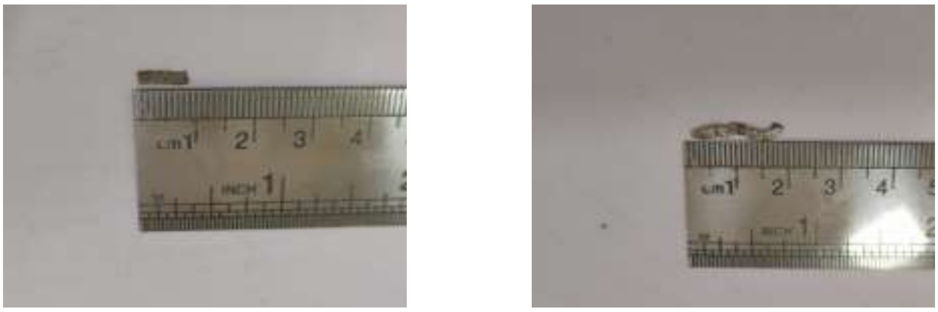
Figure 3. ST42 steel from turning.

The growl shape of the TNMG160404-MA tool cutting with the TNMG160404-TF tool has a different size. The feeding motion of 0.04 mm/put chisel TNMG160404-MA measures a furious length of 13 mm, and in the feeding motion of 0.08 mm/put the length is furious 9 mm. While the TNMG160404-MA chisel eats 0.04 mm / put measuring 6 mm long and 6 mm growl, and at eating 0.08 mm / put measuring 20 mm long growl. The elongated growl will speed up the wear process because the heat from the friction between the workpiece and the tool is not wasted directly so that heat will be stored on the tool, while the short growl shape will directly dissipate the heat from the cutting so that the tool does not experience excessive heat. In research that has been carried out, the shape of the growl does not greatly affect tool wear in the turning process, the results of wear measurements can be seen in figure 4. and figure 5.



(a) (b)

Figure 4. Furious results of TNMG160404-MA tool machining. (a) Feeding motion 0.04 mm/put, (b) Eating motion 0.08 mm/put.



(a) (b)

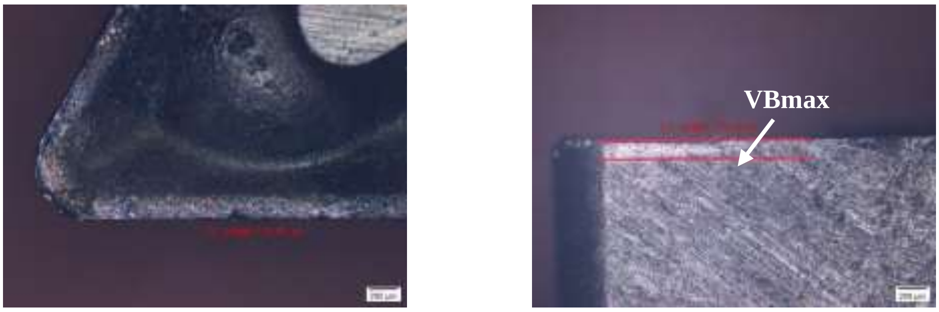
Figure 5. Furious results of TNMG160404-TF tool machining. (a) Feeding motion 0.04 mm/put, (b) Eating motion 0.08 mm/put.

The result of the wear, tool wear, feeding motion 0.04 mm/put.

Feeding motion affects the rate of wear growth on the chisel. The results shown in figure 6 of the TNMG160404-TF insert chisel experienced crater wear of 104.41 magnitude and edge wear. While figure 7 presents the TNMG160404-MA insert chisel with crater wear of 126.47, and edge wear of 119.1267,65 $\mu m \mu m$ μm μm.

(a) (b)

Figure 6. Tool wear of TNMG160404-TF insert. (a) Crater wear, (b) Edge wear

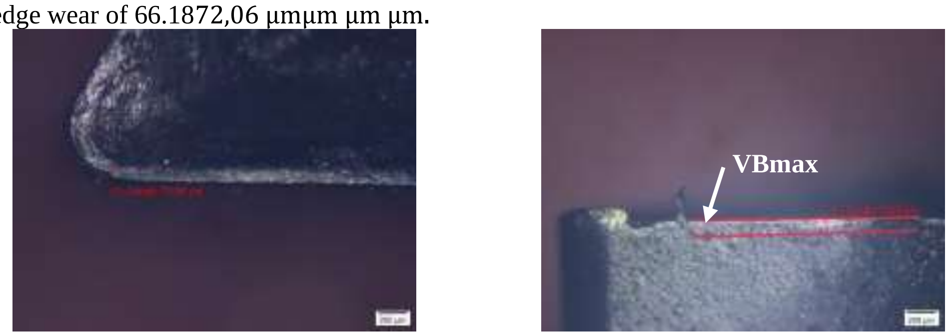


(a) (b)

Figure 7. Tool wear of TNMG160404-MA insert. (a) Crater wear, (b) Edge wear.

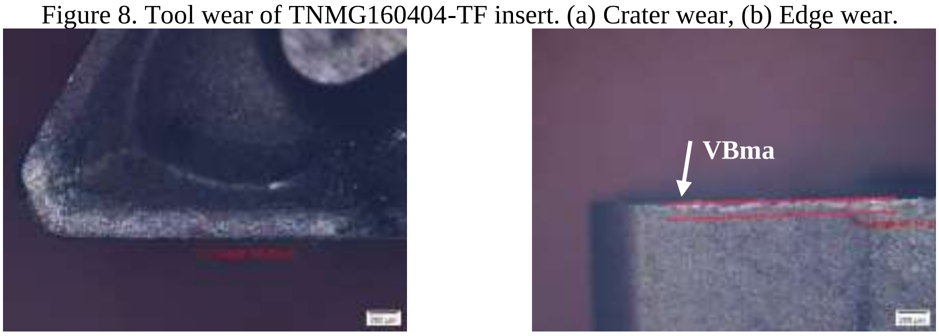
The result of tool wear measurement in feeding motion 0.08 mm / put.

The feeding motion (f2) shown in figure 8 of the TNMG160404-TF insert tool has crater wear of 70.59 magnitude and edge wear of 70.59. While figure 9 is the insert chisel TNMG160404-MA experienced crater wear of 155.88, and edge wear of 66.1872,06 µmµm µm µm.



(a) (b)

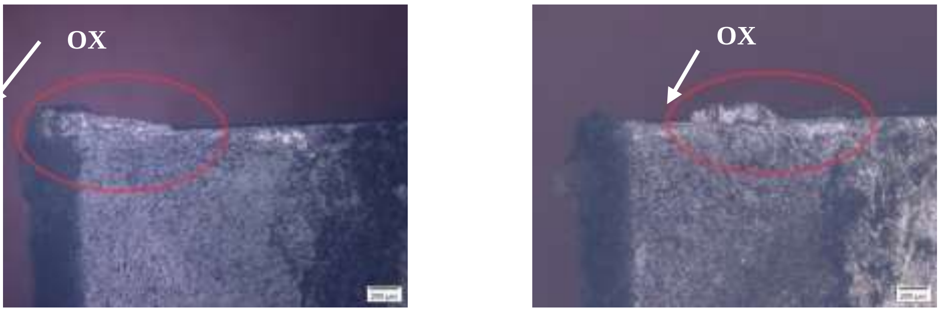
Figure 8. Tool wear of TNMG160404-TF insert. (a) Crater wear, (b) Edge wear.



(a) (b)

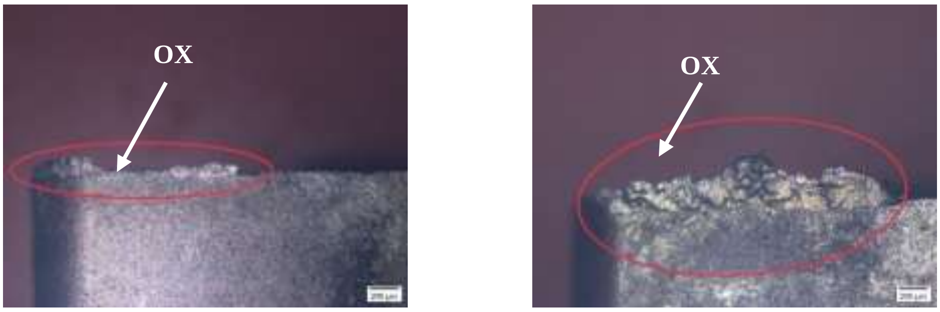
Figure 9. Tool wear of TNMG160404-MA insert. (a) Crater wear, (d) Edge wear.

The surface of the cutting tool is found with many furious sticks or what is called BUE (Built Up Edge). BUE will grow and at some point the BUE layer will be shifted / peeled off and repeated with the process of stacking a new metal layer. This adhesion force will produce a furious buildup at the tip of the tool. This can be seen using an optical microscope as in figures 10 and 11.



(a) (b)

Figure 10. BUE insert TNMG160404-TF. (a) f1=0.04 mm/put, (b) f2=0.08 mm/put.



(a) (b)

Figure 11. BUE insert TNMG160404-TF. (a) f1=0.04 mm/put, (b) f2=0.08 mm/put.

Chisel failure

The insert tool used to cut the material for a long time will experience damage called tool failure, tool failure will have an impact on the lathe material if it is not immediately handled in the right way, the impact of tool failure on the lathe material such as the surface roughness of the workpiece continues to increase, vibrations arise during the machining process, grams of undirected machining results so that they can hit the operator. An example of tool failure can be seen in figure 12. How to deal with a damaged chisel is to replace it with a new tool because the insert tool cannot be sharpened again like the HSS tool which if it has experienced wear or damage can still be repaired by re-sharpening,

(a) (b)

Figure 12. Tool failure (a) Crater, (b) Edge.

Statistical analysis

This study is a statistical analysis used to process lathe tool wear data to calculate the wear ratio on the tool, whether there is a significant difference or not.

Tool wear on feeding motion 0.04 mm/put.

Table 2. Edge wear measurement result (VBmax) in feeding motion f1 = 0.04 mm / put, spindle rotation 540 rpm.

No	Pahat Insert

	TNMG160404-MA (TNMG160404-MA)μm	TNMG160404-TF ()μm
1	**61,76**	**70,59**
2	119,12	92,65
3	117,65	126,47
4	66,18	58,82
5	86,76	63,29
6	83,82	45,59
7	77,94	38,24
8	73,53	104,41
9	88,24	111,76
10	75,00	50,00
Average	85,00	76,18

Table 3. The results of statistical analysis of wear on feeding motion f = 0.04 mm / put.

	Group Statistik					
	Brand	N	Average ()μm	t-count ()μm	t-table ()μm	Std. Deviation ()μm
Wear	TNMG160404-MA	10	85.00	0.77	2.101	19.49
	TNMG160404-TF	10	76.18	0.77	2.101	30.59

The critical value t with a free degree of 10 + 10 – 2 = 18 and a significance level of 5% is 2.101
Data Interpretation [23]–[29]:

The mean wear of the tool TNMG160404-MA was 85.00 () with a standard deviation of 19.49 and the average tool wear of TNMG160404-TF was 76.18 () with a standard deviation of 30.59. From the calculation above, a thit value of 0.769 is obtained. To find out the significance of this obtained calculated t-value, it is necessary to compare it with the t-value of the table. In the table with degrees of freedom of 18 (df = N − 2 = 20 − 2) and significance () 0.05 obtained a ttab value of 2.101. Because the thit value is smaller than the ttab value (0.769 < 2.101). Thus, Ho is accepted because the t-value obtained is significant. The conclusion from the results of this statistical analysis is that there is no significant difference in tool wear of TNMG160404-MA and TNMG160404-TF inserts.$\mu m \mu m \alpha$

Tool wear on feeding motion 0.08 mm/put.

Table 4. Edge wear measurement result (VBmax) in feeding motion f2 = 0.08 mm/put, spindle rotation 540 rpm.

No	Pahat Insert	
	TNMG160404-MA (TNMG160404-MA)μm	TNMG160404-TF ()μm
1	95,51	45,59
2	57,35	70,59
3	61,76	54,41
4	58,82	62,24
5	66,18	97,06
6	75,00	38,24
7	70,59	70,59
8	42,65	45,59
9	38,24	58,82
10	66,18	41,18
Average	63,23	58,43

Table 5. The results of statistical analysis of wear on feeding motion f = 0.08 mm / put.

	Group Statistk					
	Brand	N	Average ()μm	t- calculate ()μm	t-table ()μm	Std. Deviation ()μm
Wear	TNMG160404-MA	10	63.23	0.63	2.101	16.18
	TNMG160404-TF	10	58.43	0.63	2.101	17.80

The critical value t with a free degree of 10 + 10 – 2 = 18 and a significance level of 5% is 2.101

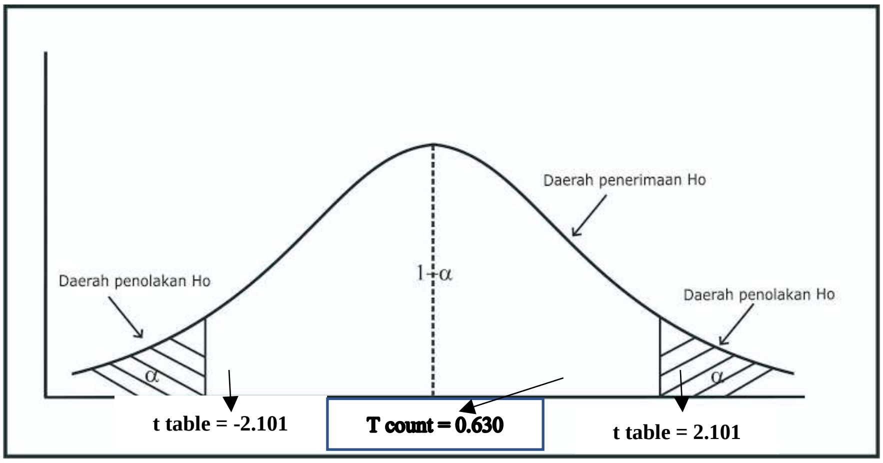


Figure 13. two-tailed t-test curve.

Data Interpretation:

The average wear of the tool TNMG160404-MA was 63.23 () with a standard deviation of 19.49 and the average tool wear of TNMG160404-TF was 58.43 () with a standard deviation of 30.59. From the calculation results described above, a thit value of 0.630 was obtained. To find out the significance of this obtained calculated t-value, it is necessary to compare it with the t-value of the table. In the table with degrees of freedom of 18 (df = N − 2 = 20 − 2) and significance () 0.05 obtained a ttab value of 2.101. Because the thit value is smaller than the ttab value (0.630 < 2.101), there is no difference in tool wear of TNMG160404-MA and TNMG160404-TF. Thus, Ho is accepted because the t-value obtained is significant. The conclusion from the results of this statistical analysis is that there is no significant difference in tool wear of TNMG160404-MA and TNMG160404-TF inserts.$\mu m \mu m \alpha$

Conclusion

The results of the study comparing the wear rate of the insert lathe tool can be concluded that the average tool wear of TNMG160404-MA in f1 feeding motion is 85.00() and f2 is 63.23(), while the average tool wear of TNMG160404-TF in f1 feeding motion is 76.18() and f2 is 58.43(). The results of tool wear observations using a microscope showed that the greatest average wear value occurred in the TNMG160404-MA tool in feeding motion (f1), the factor that causes the difference in wear at the feeding speed (f1) with (f2) is a longer cutting time at the feeding speed (f1). At 0.04 mm/put the standard deviation of the TNMG160404-MA tool is 19.5(), the standard deviation of the TNMG140404-TF tool is 30.6() with a t-count value of 0.769. While in the eating motion of 0.08 mm/put the standard deviation of the TNMG160404-MA tool is 16.2(), the standard deviation in the TNMG140404-TF tool is 17.8() with a t-count value of 0.630. The growl shape produced in the cutting process does not show an influence on the wear of the tool used but affects the level of surface roughness of the workpiece being lathed, the results of statistical analysis show that there is no significant difference from different tool wear rate measurements because the thit value is smaller than the ttab value (0.630 < 2.101).

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