© OCT 2024 | IRE Journals | Volume 8 Issue 4 | ISSN: 2456-8880

Analysis Of The Effect Of Cutting Conditions On Tool Life In Drilling Process Using S45C Carbon Steel Workpieces

TERTIUS VY ULAAN, ST, M.T[1], ROMELS LUMINTANG, ST, M.T[2], IRVAN RONDONUWU, B.Eng, M.T[3]

[1, 2, 3] Department of Mechanical Engineering, Faculty of Engineering, Sam Ratulangi University, Manado

Abstract-Chisels are one of the most important components in the process of cutting a workpiece. In the drilling process, tool wear will increase to a certain limit or it will be damaged. The length of service time is called tool life which has an impact on production costs. This research aims to analyze the effect of cutting conditions on tool life in the drilling process using S45C carbon steel workpieces. The method used in this research is a quantitative method that is experimental by testing the cutting process on a bench drilling machine by varying the cutting conditions and then analyzing the tool life in the process. Based on cost tests carried out on the IXION BT 25 bench drilling machine using coolant, the results showed that the longest tool life was at a cutting speed of 29,908 m/minute, a tool diameter of 17 mm which resulted in a tool life of 1.8 minutes, and the lowest tool life. at a cutting speed of 28,150 m/minute with a tool diameter of 8 mm, which results in a tool life of 0.0495 minutes. . From these results it can be seen that cutting speed greatly influences tool life.

Indexed Terms- Cutting Condition, Tool Life, Drilling

I. INTRODUCTION

Drillingis a process where friction occurs between the chisel and the workpiece resulting in high heat so that the chisel used will experience wear. This chisel wear in the cutting process causes noise, the chisel is quickly damaged and broken, endangering the operator and finally the surface quality of the workpiece becomes rougher. The length of time this wear is called the chisel life which has an impact on production costs. [1]

Machine*bench drill*IXION BT 25 in the Unsrat Mechanical Engineering Laboratory, has been previously researched, namely a cooling system was created to cool and lubricate when carrying out the drilling process. To implement this research, it is important to analyze the effect of cutting conditions on the tool life in the drilling process using S45C carbon steel workpieces. Thus, the Technology Readiness Level (TKT) is level 3 with achievement indicators that candevelop a bench drill machine so that the influence of cutting conditions on the life of the drill bit used can be known.

II. LITERATURE REVIEW

2.1. State Of The Art

This research includes several previous research concepts related to this research concept:

1. Analysis of Tool Bit Wear and Cutting Time in the S45C Steel Drilling Process (Lubis, et al, 2021). The results show that the carbide tool type has a longer cutting time compared to the HSS tool type, the cutting time can be seen that the carbide tool type has a cutting time for each combination of cutting parameters. [2]

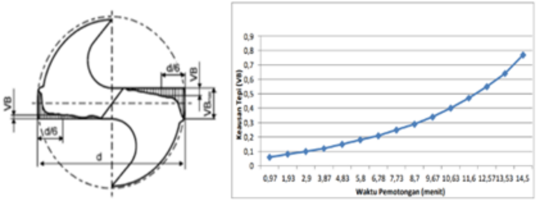


Figure 2.1 Cutting Time Vs Wear [2]

2. Analysis of the Effect of Cutting Parameter Variations and Coolant on the Wear Level of HSS

End Mill Tools from CNC Router Milling on Aluminum Sheet 1100 (Rahmat, et al, 2019). The results are 1) The use of low feed motion, small cutting depth will reduce the level of tool wear 2) The parameters that are significant or influential in tool wear are coolants which provide a greater contribution than cutting depth. [3]

3. Effect of Cutting Speed and Feed on Tool Life in Magnesium Alloy Milling Machining (Ansyori, 2015). The results are 1) The highest tool life is obtained at a cutting speed of 22.85 m/min with a feed of 0.15 mm/rev, which is 88 minutes, while the lowest tool life is at a cutting speed of 42.70 m/min with a feed of 0.25 mm/rev, which is 18 minutes. 2) The higher the cutting speed, the faster the rate of wear of the milling tool that occurs, which is caused by high temperatures as a result of friction between the tool and the workpiece. [4]

2.2. Proposer's Research Roadmap

Research that has been conducted by the proponent for the development of the drill machine related to the roadmap of this research:

1. In 2021 the proposer has independently carried out regardingThe Effect of Cooling Media Composition on *Machinability*Machine *Bench Drill*IXION BT 25. The resultwith the increase in cutting parameters, be it rotation or cutting depth in the drilling process, it will decrease the specific cutting energy. Thus, this shows thatThe condition of the lathe is considered good because reducing the specific cutting energy can reduce production costs.[5]
2. In 2022 the proposer has conducted independent research on Tool Wear Analysis in Drilling Process with Cutting Conditions Without Using Coolant. The result is that the tool wear in the drilling process is that the increasing rotational speed and feed rate, the tendency for tool wear increases significantly. If this is allowed and the tool is still used, the growth of wear will be faster and at some point the tip of the tool will be completely damaged, resulting in the workpiece produced being less than optimal. [6]
3. OnIn 2023, the proposer has conducted Basic Research on Superior Cluster 2 (RDUU K2) on Design of Cooling System on Ixion BT 25 Bench Drill Machine to Reduce Cutting Heat. The result is that the manufacturing process starts from identifying working drawings and identifying components using existing tools or machines, ordering and procuring from the market for other components. Thus, a cooling system can be produced to reduce cutting heat on the IXION BT 25 bench drill machine. [7]

Figure 2.2 Cooling System Design Results on the IXION BT 25 Bench Drill Machine [7]

From the research that has been conducted, the proposer submits a research proposal with the title "Analysis of the Effect of Cutting Conditions on Tool Life in the Drilling Process Using S45C Carbon Steel Workpieces", where the research road map is as explained in the following figure.

From the research that has been conducted, the proposer submits a research proposal with the title "Analysis of the Effect of Cutting Conditions on Tool Life in the Drilling Process Using S45C Carbon Steel Workpieces", where the research road map is as explained in the following figure.

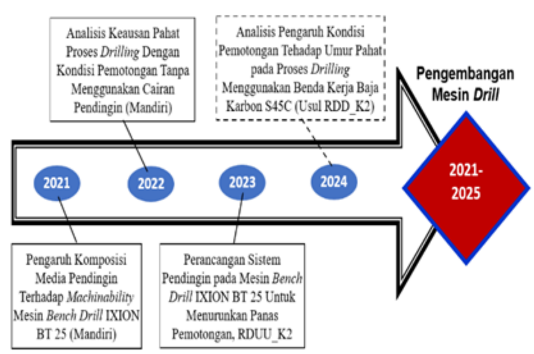


Figure 2.3 Research road map

2.3. Process Drilling

Drillingis the simplest machining process among other machining processes, but this process is most often used. The drilling process is a machining process to make a round hole in the workpiece. The drill bit has two cutting edges and performs the cutting motion because it is rotated by the main axis of the drill machine. The rotation can be selected from several rotation levels available on the machine, or set at will if the drill machine rotation transmission system is a continuous system (stepless spindle drive). Feeding motion with motor power (power feeding), while for small types of drill machines (bench drill machines) the feeding motion cannot be ascertained because it depends on the strength of the hand to press the press arm from the main axis. In addition, the drilling process can be carried out on a lathe where the workpiece is rotated by the chuck from the main axis and the feeding motion is carried out with a drill bit mounted on the loose head on the lathe. (Rochim, 1993)

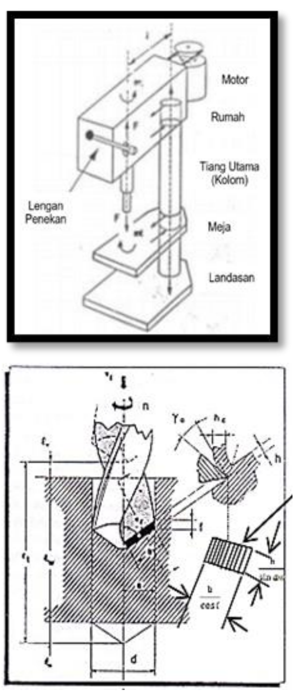


Figure 2.4 Drilling machine and drilling process (Rochim, 2007)

Cutting speed in drilling is defined as the speed of the outermost surface of the drill tool relative to the surface of the workpiece. Cutting speed can be calculated using the formula:

$$V = \frac{\pi . d_0 . n_0}{1000} \left(\frac{\text{m}}{\text{menit}}\right) \quad (2.1)$$

Where,

d_0= drill bit diameter (mm);

n_0= main shaft rotation of the drill machine (rpm).

Feeding rate

$$V_f = f_z . n_0 \left(\frac{\text{mm}}{\text{menit}}\right) \quad (2.2)$$

Where, f_z = feed movement (mm/r);

Cutting time

$$t_c = \frac{L_t}{V_f} \text{ (menit)} \quad (2.3)$$

Where, L_t = Workpiece thickness (mm).

Lt = l + 0.3do

2.4. Tool Wear and Tool Life

During the chip formation process, the tool will suffer high pressure and temperature. Friction between the chip and the tool, between the workpiece and the tool, causes wear on the main areas of the tool (the tool face and the main cutting plane). This wear process continues so that it can change the shape of the cutting edge.

Tool life can be defined as the length of time required to reach the specified wear limit. When the machining process takes place, the tool has reached the specified wear limit (its life) from the following criteria: (Rochim, 2007)

- There is an increase in cutting force;
- Vibration/chatter occurs;
- Decreased smoothness of machined surfaces;
- Changes in product dimensions/geometry.

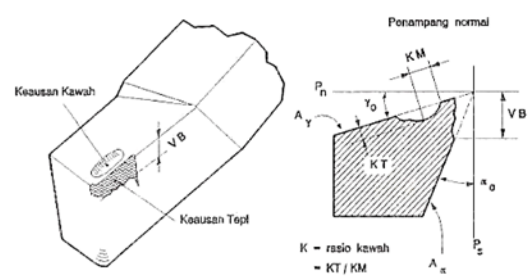


Figure 2.5 Crater wear and edge wear

The greater the chisel wear, the more critical the condition. If the chisel is still used, the wear growth will be faster and at one point the chisel tip will be completely damaged.

The permissible wear limits for a type of tool used to cut a type of workpiece are as follows: (Rochim, 2007)

Table 2.1 Critical wear limits (Rochim, 2007)

No	Chisel	Workpieces	Wear and tear, V_B (mm)	K
1.	HSS	Steel and cast iron	0.20 – 0.80	-
2.	Carbide	Steel	0.20 – 0.60	0.30
3.	Carbide	Cast iron and non-ferrous	0.40 – 0.60	0.30
4.	Ceramics	Steel and cast iron	0.30	-

Age dimension can be a quantity of time, which can be calculated directly or indirectly by correlating to other quantities. This is intended to simplify the calculation procedure according to the type of work done.

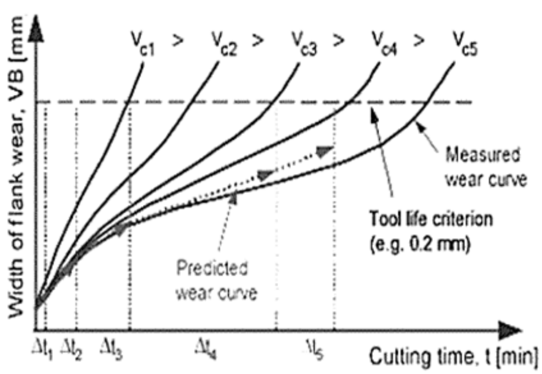


Figure 2.6 Different tool wear growth and cutting speeds (Rochim, 2007)

Basically, the wear dimension determines the tool life limit. Thus, the wear growth rate determines the rate at which the tool life ends. The growth of edge wear generally follows the form, namely starting with relatively rapid growth immediately after the tool is used, followed by linear growth equivalent to increasing cutting time and then rapid growth occurs again. The time when rapid wear growth begins to repeat itself is considered the tool life limit, and this generally occurs at relatively similar edge wear values () for different cutting speeds.V_B

III. RESEARCH METHODS

This research was carried out in several cycles of interrelated stages. Testing of the drilling process was carried out on the IXION BT 25 bench drill which has been developed using a coolant. The test specimens were made using S45C carbon steel measuring 50x50x5 mm. This material was cut using a cut-off cutting machine with a total of 12 test objects, as shown in Figure 3.1.

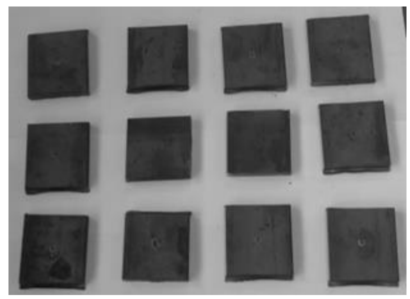


Figure 3.1 Workpiece cutting results

The drilling process was carried out on 12 test objects using 12 chisels for 3 variations of drill tool diameter, namely 8 mm, 12 mm and 17 mm. Each drill tool diameter was tested 4 times to obtain the average measurement results. Drill Tool Wear Measurement on 12 chisels that have been used in testing the drilling process using a digital microscope.. From the results of drilling tool wear measurements, tool wear size data was obtained which is the input data for this research. Next, the cutting calculation process is carried out, in the form of calculating the feeding speed and cutting time. At this stage, tool life is also determined graphically based on the growth of drill tool wear, in order to obtain the tool's ability to take the length of time to reach the wear limit (Tool Life).

IV. RESULTS AND DISCUSSION

After the drilling process was carried out on 12 work piecesS 45 C strip steelmeasuring 50x50x5 mmby using coolant on the four HSS chisels with varying diameters of 8 mm, 12 mm and 17 mm, the results of the chisel wear measurement values were obtained, where the wear measurement was carried out on each machining process. The test result data can be seen in Table 4.1.

Table 4.1 Drill tool wear measurement results data

Test Object							
Material : Steel Strip S 45 C							
Drill Chisel : High Speed Steel (HSS)							
Test object diameter : 50x50x5 (mm)							
No	D (mm)	n (Rpm)	V_B (mm)				
			I	II	III	IV	Average
1	8	1120	0,277	0,276	0,278	0,277	0,277
2	12	800	0,054	0,056	0,054	0,054	0.054
3	17	560	0,018	0.020	0.017	0.018	0.018

The following is data from the test results and calculations that have been carried out on each variation of HSS chisel diameter based on engine speed (rpm).

Table 4.2 Test and calculation results data

No	n (rpm)	D (mm)	V (m/men)	t_c (menit)	T (menit)
	1120	8	28.150	0.037	0.0495
2	800	12	30.160	0.060	0.34
3	560	17	29,908	0.1	1.8

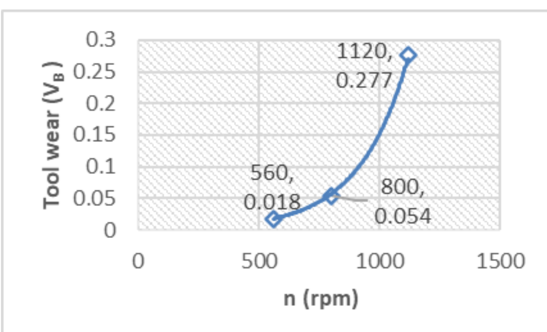


Figure 4.1 Graph of the relationship rotation (n) Vs tool wear (V_B)

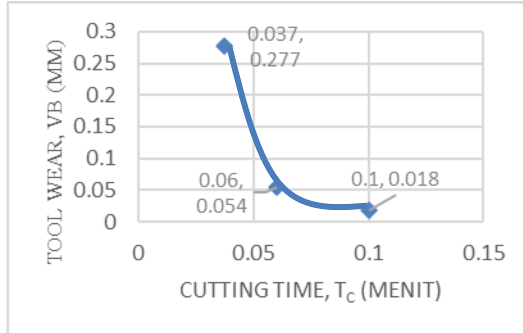


Figure 4.2 Graph of the relationship cutting time tc Vs tool wear (V_B)

Based on the results of observations and testing of the drilling process on the workpiece which are depicted via graphs in Figures 4.1 and 4.2, it can be explained that the tool wear rate is very dependent on the spindle rotation. Where the greater the rotation, the faster the cutting time, the greater the wear value. From the graph and table of observations and calculations above, it can be seen that the tool diameter (D) 8 mm with cutting time tc = 0.037 minutes has a wear value of 0.277 mm and then the tool diameter (D) = 12 mm with cutting time tc = 0.060 minutes The wear value is 0.054 mm, tool diameter (D) = 17 mm with cutting time tc = 0.1 has the smallest wear value, namely 0.018 mm.

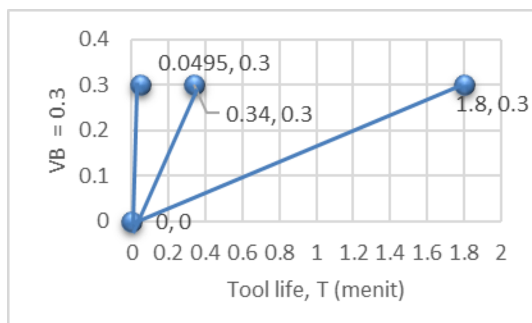
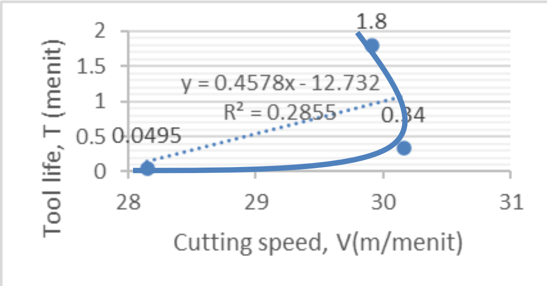


Figure 4.3 graph of the relationship tool life, T (minutes) Vs tool wear limit (VB=0.3)

The results of testing the drilling process on the IXION BT 25 bench drilling machine which has been developed using a coolant for the relationship between cutting speed and tool life, as shown in the graph in Figure 4.3.



Gambar 4.3 Hubungan kecepatan potong dengan umur pahat

Tool life is the entire cutting time (tc) to reach the specified wear limit (VB ≤ 0.3). Tool life can be determined using a graphical analytical approach. Based on the tool life graphic as shown in the graph above, it can be seen that with faster cutting time (tc), the tool wear rate will increase and the tool wear (T) will decrease. This can be seen in table 4.2 that the shortest tool life occurs with a tool with a diameter of 8 mm with a rotation (n) of 1120 rpm, namely 0.0495 minutes, while the longest tool life with a diameter of 17 mm with a rotation (n) of 560 mm is 1.8 minutes. From these results it can be seen that tool life in the drilling process using coolant will decrease with increasing cutting speed

CONCLUSION

From the tests that have been carried out on S45C carbon workpieces using the IXION BT 25 bench drill machine which has been developed using coolant, with variations in tool diameter, 8 mm, 12 mm and 17 mm, it can be concluded that the increase in cutting speed (V) will Accelerates tool edge wear (V_B), so tool life will decrease. This is also influenced by the size of the tool diameter and the number of revolutions.

Based on the results obtained, the shortest tool life occurred on a tool with a diameter of 8 mm with a rotation (n) of 1120 rpm, namely 0.0495 minutes, while the longest tool life was a 17 mm diameter tool with a rotation (n) of 560 mm for 1.8 minutes.

ACKNOWLEDGEMENTS

The author would like to express his thanks to God Almighty for His wisdom and strength, thanks to the leadership of the Department of Mechanical Engineering Faculty of Engineering who has helped with the process of carrying out this research, as well as the leadership of the LPPM and the leadership of Sam Ratulangi University Manado, who have provided research funding for PNBP BLU 2024 so that this research can be carried out

REFERENCES

[1] Rochim, T. 2007. Klasifikasi Proses Gaya dan Daya Pemesinan, Institut Teknologi Bandung.

[2] Lubis, S., Reynaldi., Askolani, A., & Ariyanti, S. 2021. Analisis Keausan Mata Pahat Dan Waktu Pemotongan pada Proses *Drilling* Baja S45C. Seri Seminar Nasional Ke-III Universitas Tarumanagara, Jakarta.

[3] Rahmat, M., & Haripriadi, B. 2019. Analisa Pengaruh Variasi Parameter Pemotongan Dan Pendingin Terhadap Tingkat Keausan Pahat *End Mill* HSS Hasil Pemesinan CNC Router Milling pada Aluminium Sheet 1100. Jurnal Polimesin Lhokseumawe Volume 17. 2 pp 13-20.

[4] Ansyori, A. 2015. Pengaruh Kecepatan Potong dan Makan terhadap Umur Pahat pada Pemesinan Freis Paduan Magnesium. Mechanical, 6 (1) pp 28-35.

[5] Poeng, R., & Ulaan, T. 2021. Pengaruh Komposisi Media Pendingin Terhadap *Machinability* Mesin *Bench Drill* IXION BT 25, Penelitian Mandiri Jurusan Teknik Mesin Unsrat.

[6] Ulaan, Tertius. 2022. Analisis Keausan Pahat Proses *Drilling* Dengan Kondisi Pemotongan Tanpa Menggunakan Cairan Pendingin. Penelitian Mandiri Jurusan Teknik Mesin Unsrat.

[7] Ulaan, T., Poeng, R., Gede, I., & Lumintang, R. 2023. *Design of Cooling System on Ixion BT 25 Bench Drill Machine to Reduce Cutting Heat*, IRE Journals Volume 7 Issue 2 ; 271-274