Comparative analysis of speed and cutting results of st-37 soft steel using HSS and carbide chisel knife

Vina N. Van Harling

Mechanical Engineering, Saint Paul Polytechnic Sorong

Abstract. This study aims to analyze the comparison of the speed and results of cutting ST-37 soft steel using a High-Speed Steel (HSS) ø: 16 mm chisel and a Caribida chisel blade, ø: 16 mm. The research was conducted at Work Training Center (BLK). Based on the research data, the results obtained: maximum and minimum speed for each chisel blade with an infeed depth of 0.5mm, 1mm, and 1.5mm is different, with the results of cutting the chisel knife of the High-Speed Steel (HSS) type the steel is cut better (finer), on the other hand, the Caribida type milling knife can make the final result of the steel cutting rough or look like before (normal).

1. Introduction
To produce a professional workforce, prospective workers must have more skills regarding the production process and use of machines in the machinery industry. One of the institutions capable of improving the abilities and skills of job seekers is the Job Training Center (BLK). Work Training Centers (BLK) are better known by the community as training places to acquire skills or expertise of a person in accordance with his / her field of ability, as well as the availability of a competent and competitive workforce.

Work Training Center at Sorong have 13 (thirteen) vocational programs and 39 (thirty-nine) vocational sub-vocations in which there are sub-vocational production machines. From this sub-vocational program, there is a training scheme for the operation of a milling machine. Milling machine is a machine that is used to mechanically control the direction and movement of cutting of the multi-cutting tool rotating the rotation cycle.

The Milling Machine was invented by Eli Whitney around 1818. This milling machine carried out the first duplicate spare parts production operation with. This machine makes better finishes to the limit of precision much better than the heavy cutter can be taken without much harm to finish or precision. The milling machining process (milling) is the process of cutting a work piece using a cutting tool with rotating plural cutting edges. The incision process with the many cut teeth that surround this knife can result in a faster machining process. An incised surface is usually flat, angled, or curved. The surface of the work piece can also be a combination of several shapes. The machine used to hold the work piece, rotate the knife, and cut it is called a milling machine [7]. The milling process can be classified into three types. This classification is based on the type of tool, the direction of cutting and the relative position of the tool to the work piece. [2]
The milling machines consist of column and knee milling machines, hobbling machines, thread machines, spline machines, and key milling machines. For mass production, a multi-spindles planer type and a continuous action-rotary table, as well as a drum type milling machine, are usually used [5]. The milling machine used in BLK Sorong is usually used for the process of making bolts, making squares, cutting thinner steel. In the steel cutting process, the steel material used has different textures or thicknesses, so the cutting process must use the appropriate speed so that the steel being cut does not experience damage. The cutting speed for the milling process can be defined as the average work on a circular point on the cutting tool in one minute. [5] Cutting speed (Cs) is the ability of the cutting tool to slice the material safely to produce pieces of length/time (meters/minutes or feet/minute). In a rotary motion such as a milling machine, the cutting speed (Cs) is the circumference of the work piece circle (\( \pi d \)) multiplied by the rotation (n) or [1]:

\[
Cs = \frac{\pi d N}{1000}
\]  

Information:
- \( Cs \) = cutting speed (meter / minute)
- \( D \) = Cutter Diameter (mm)
- \( N \) = Engine speed/work piece (Rpm)

In principle, the cutting speed of a material cannot be calculated mathematically. Because each material has its cutting speed based on its characteristics and the price of cutting speed for each material can be seen in the table contained in the book or reference.

Previous research on cutting analysis was carried out by Hari Yanuar and Akhmad Syarief Hari and Syarief in 2015 concerning "The Effect of Variations in Cutting Speed and Depth of Feeding on Surface Roughness with Various Cooling Media in Conventional Milling Processes" in this study the material tested was ST-42 with Different cooling media, namely oil mixed with water 1: 1 and coolant which is milled using a carbide chisel, then the milling process is carried out by varying the cutting speed of 28.13 m / min, 41.1 m / min, and 53.41 m / min, and infeed thickness 0.1 mm, 0.3 mm, and 0.5 mm. From the results of this study, the surface smoothness of the test object that has been milled for all materials used in the test using a carbide cutter is included in the roughness value category that is on the standard, namely N6 to N9 which has a value of 0.8 μm to 6.3 μm.[7]

Other research has also been carried out by Raul, Widiyanti, Poppy in 2017, regarding the Effect of Variations in Cutting Speed and Cutting Depth on Lathes on the Surface Roughness of Work pieces ST 41, that cutting speed affects the results of the surface quality of the work piece. There is a difference in the surface roughness of the turning result at the variation in cutting speed. The higher the cutting speed used, the better the quality results. High cutting speed results in decreased cutting forces and shear area [8]. Based on this, the researcher in this study will analyze the speed and results of the BLK's milling machine, slightly different from previous studies in this study using the ST-37 type of mild steel by using 2 types of chisel blades. High-Speed Steel (HSS) ø: 16 mm and Caribida Chisel, ø: 16 mm.


2. Methodology

2.1 Research Flowchart

![Research Flowchart]

2.2 Tools and Materials

The tools and materials used in this research are 1 measuring instrument Tachometer, 1 unit Milling machine (milling machine). While the materials used are Mild Steel ST-37 type, High-Speed Steel Milling Knife with ø: 16 mm, and Caribida ø: 16 mm.

2.3 Data Collection process

In collecting data, several preparations must be done, namely:
1. Preparing the workpiece to start the analysis (ST-37 type steel)
2. Start/start the engine.
3. Adjust the position/seat of the workpiece on the machine worktable.
4. Carry out the cutting process on the workpiece.
5. Measure the cutting speed (maximum and minimum) of the workpiece.
6. Measurement of cutting speed is carried out repeatedly to get really good results.

3. Result and Discussion

3.1 Result

*Milling Machine Cutting Speed with High-Speed Steel (HSS) Type Milling Blade*

The data obtained from the results of cutting the milling machine on mild steel using the High-Speed Steel (HSS) Milling Chisel Blade material is shown in table 1. This testing process is carried out for each cutting depth with 3 repetitions to obtain the minimum and maximum cutting speed. The results taken are the average speed of 3 repetitions.
Table 1. Results of Testing Data on Cutting of ST-37 Soft Steel with High-Speed Steel (HSS) Milling Chisel Blades

| No | Infeed | depth of cutting | cutting speed | axis speed |
|----|--------|-----------------|---------------|------------|
|    |        |                 | Min           | Max        | X  | Y  | Z   |
| 1  | One time | 0,5 mm          | 1.190 rpm     | 1.200 rpm  | 50 | 21 | 0,5 |
| 2  | One time | 1 mm            | 700 rpm       | 800 rpm    | 50 | 21 | 1   |
| 3  | One time | 1,5 mm          | 400 rpm       | 400 rpm    | 50 | 21 | 1,5 |

Information:
Axis, X = Feeding aside
Axis, Y = Forward feeding
Axis, Z = depth of cutting

Based on the data above, using equation (1), the results of the calculation of the maximum and minimum cutting speed of the milling machine with High-Speed Steel (HSS) type chisel blades are shown in Table 2.

Table 2. Calculation of Minimum and Maximum Cutting Speeds with High-Speed Steel (HSS) Milling Chisels

| No | Infeed | Depth of infeed | Cutting speed | Calculation of cutting speed |
|----|--------|-----------------|---------------|-------------------------------|
|    |        |                 | Min           | Max                          |
|    |        |                 | Minimum       | Maximum                       |
| 1  | One time | 0,5 mm          | 1.190 rpm     | 1.200 rpm                    | 59,79 m/s | 60,28 m/s |
| 2  | One time | 1 mm            | 700 rpm       | 800 rpm                      | 35,17 m/s | 40,19 m/s |
| 3  | One time | 1,5 mm          | 400 rpm       | 400 rpm                      | 15,07 m/s | 20,10 m/s |

Milling Machine Cutting Speed with Caribida Type Milling Blade

Cutting data obtained using a Caribida type milling knife. The testing process was carried out for each cutting depth with 3 repetitions to obtain the minimum and maximum cutting speeds. The results taken are the average speed of 3 repetitions. These results are shown in Table 3.

Table 3. Results of Testing Data on Cutting of Soft Steel Type ST-37 with a Caribida Type Milling Chisel Knife

| No | Infeed | Depth of cutting | Cutting speed | Axis speed |
|----|--------|-----------------|---------------|------------|
|    |        |                 | Min           | Max        | X  | Y  | Z   |
| 1  | One time | 0,5 mm          | 1200 rpm      | 1500 rpm   | 50 | 21 | 0,5 |
| 2  | One time | 1 mm            | 1000 rpm      | 1300 rpm   | 50 | 21 | 1   |
| 3  | One time | 1,5 mm          | 800 rpm       | 1100 rpm   | 50 | 21 | 1,5 |

Information:
Axis, X = Feeding aside
Axis, Y = Forward feeding
Axis, Z = depth of cutting

The test results above are then entered into equation (1) to obtain the maximum and minimum cutting speed calculation data from the milling machine data above. The calculation result data is displayed in Table 4.

Table 4. Calculation of Minimum and Maximum Cutting Speeds with a Caribida type milling tool knife

| No | Infeed | Depth of infeed | Cutting speed | Calculation of cutting speed |
|----|--------|-----------------|---------------|-------------------------------|
|    |        |                 | Min           | Max                          |
|    |        |                 | Minimum       | Maximum                       |
| 1  | One time | 0,5 mm          | 1200 rpm      | 1500 rpm                    | 60,28 m/s | 75,36 m/s |
| 2  | One time | 1 mm            | 1000 rpm      | 1300 rpm                    | 50,24 m/s | 65,31 m/s |
| 3  | One time | 1,5 mm          | 800 rpm       | 1100 rpm                    | 40,19 m/s | 55,26 m/s |
3.2 Discussion

The equation in this study is the diameter size of the HSS and Caribida chisel blades. Where the two types of blades used have the same diameter of 16mm, as well as a measure of the depth of cutting for each knife. Each of these chisel blades will cut ST-37 type mild steel with a cutting depth of 0.5mm, 1mm, and 1.5mm. The same depth of cutting of steel using different chisel blades inevitably results in different cutting speeds.

Based on the data obtained for the 0.5mm infeed depth, the minimum speed of HSS chisel blades with Caribida is 1190 rpm and 1200 rpm, respectively, while the maximum speed for the same cutting depth is 1200 rpm for HSS tool blades and 1500 rpm for chisel blades. carbide. As for the infeed depth of 1mm for the ST-37 type mild steel cutting, the maximum speed of the HSS chisel is 700 rpm while the carbides chisel is 10000 rpm. The minimum cutting speed for a depth of 1.5 mm on the ST-37 type mild steel cutting using HSS and Caribida chisels is 300 rpm and 800 rpm, respectively, while the maximum cutting speed for HSS chisel blades is 400 rpm and the cutting speed of the knife Caribida type chisel of 1100 rpm.

Based on the data, it can be seen that the cutting speed and infeed thickness factors determine the speed of the HSS and Caribida chisels. Besides, based on the data, Caribida chisel blades are much faster when compared to HSS chisel blades. These results are in line with the results of research conducted by Yanuar et al. [7] in a study on the Effect of Cutting Speed and Depth Variations on Surface Roughness with Various Cooling Media in Conventional Milling Processes. Where the results were obtained, there was an effect of cutting speed on the surface roughness value of SAE 40 oil coolant media mixed with 1: 1 water and coolant media, where the higher the cutting speed used, the smaller or finer the roughness value would be.

4. Conclusion

The results of the analysis regarding the comparison of the speed and results of cutting ST-37 type mild steel using HSS and Caribida chisels are as follows:

1. The speed resulting from cutting ST-37 soft steel using a Caribida tool knife is much faster than the HSS tool knife for the same cutting depth.
2. High-Speed Steel (HSS) chisel blades can make the final result of cutting the steel better (smoother), on the other hand, a Caribida milling knife can make the final result of cutting the steel rough or look like before (normal).

References

[1] Selamat Riadi, Selamat Triono dan Muslim. 2020. Teknologi Permesinan: Pembelajaran Terstruktur & Mandiri Bagi Mahasiswa. Yayasan Kita Menulis.
[2] Anonim. 2019. ncahyoo.blogspot.com.
[3] Sari, Nasmi Herlina. 2018. Material Teknik. Edisi 1, cetakan 1. Yogyakarta: Deepublish.
[4] Pratama, A.R., 2018. Studi Suhu Pemotongan pada Pahat Karbida CVD Berlapis (Al₂O₃/TiCN) pada Pembubutan Keras Baja AISI 4340 Secara Eksperimental dan Numerikal. Repository Institusi USU
[5] Ansyori, A., 2015. Pengaruh Kecepatan Potong dan Makan terhadap Umur Pahat pada Pemesinan Freis Paduan Magnesium. MECHANICAL, 6(1).
[6] Mulyadi. 2009. Analisa Pengaruh Putaran Spindle dan Kecepatan Makan Terhadap Kekasaran Permukaan Baja SCM 4 Pada Proses Milling. Sidoarjo: LPPM Universitas Muhamadiyah Sidoarjo
[7] Yanuar, Hari., Syarief Akhmad., Kusairi Ach. 2014. Pengaruh Variasi Kecepatan Potong dan kedalaman Terhadap Kekasaran Permukaan dengan Berbagai Media Pendingin Pada Proses Frais Konvensional. Jurnal Ilmiah Teknik Mesin Unlam Vol. 03. No. 1 pp 27-33, 2014

[8] Raul, R., Widiyanti, W. and Puspitasari, R.P., 2017. Pengaruh variasi kecepatan potong dan kedalaman potong pada mesin bubut terhadap tingkat kekasaran permukaan benda kerja ST 41. JURNAL TEKNIK MESIN, 24(1).

[9] VAN HARLING, V.I.N.A., 2018. Pengaruh Jumlah Katalisator pada Hydrocarbon Crack System (Hes) dan Jenis Busi terhadap Daya Mesin Sepeda Motor Honda Supra X 125. Jurnal Voering, 3(1), pp.5-18.

[10] Van Harling, V.N. and Apasi, H., 2018. PERANCANGAN POROS DAN BEARING PADA MESIN PERAJANG SINGKONG. SOSCIED, 1(2), pp.42-48.