Jurnal Media Mesin, Vol. 25 No. 1
Printed ISSN: 1411-4348
Online ISSN: 2541-4577

ANALYSIS OF CUTTING FLUID ON MASS LOSS OF CARBIDE INSERT IN THE MILLING PROCESS

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ABSTRAK

Proses pemesinan adalah proses manufaktur yang banyak digunakan di seluruh dunia. Cairan pendingin pada proses pemesinan menurunkan suhu, melumasi, dan membersihkan gram pada proses pemotongan. Penerapan cairan pendingin pada proses pemotongan akan menjaga kualitas benda kerja dan meningkatkan umur pahat sehingga pahat tidak cepat aus. Banyak upaya dilakukan untuk mendapatkan pendinginan dengan baik, mengingat dampak keausan. Penelitian bertujuan untuk melihat pengaruh cairan pendingin berbasis kimia (*dromus*) oil dan berbasi nabati (CPO) terhadap keausan pahat pada pemesinan face milling, serta mengetahui efektif atau tidaknya cairan tersebut untuk menurunkan dan memperlambat keausan pada pahat. Dalam penelitian yang dilakukan ini, pemesinan face milling ini menggunakan spesimen material besi tuang kelabu (gray cast iron) sebagai spesimen benda kerja yang dipakai dan juga dengan menggunakan alat potong mata pahat insert karbida dengan tipe TPKN 22 VC2. Penelitian dilakukan dengan cara memvariasikan putaran mesin dan juga variasi cairan pendingin, variasi putaran mesin yang digunakan 80, 360 dan 720 rpm. Pada proses pemberian cairan pendingin menggunakan metode *spray* langsung pada area permukaan benda kerja yang dipotong secara terus menerus, pada pemesinan face milling dengan variabel respon yang di dapat berupa data ataupun nilai keausan pahat yang telah diamati dan dilakukannya pengujian dengan menggunakan alat uji mikroskop, menggunakan metode berat (massa) untuk melihat nilai keausan. Hasil dari pengamatan pada penelitian, cairan pendingin yang lebih efektif pada saat percobaan dilakukan adalah cairan pendingin berbasis nabati (CPO), karena nilai keausan pada pahat insert lebih kecil dibandingkan dengan minyak berbasis kimia (dromus).

Kata kunci: mesin frais, cairan pendingin, keausan pahat, insert karbida.

ABSTRACT

The machining process is a widely used manufacturing process worldwide. The coolant in the machining process lowers the temperature, lubricates, and cleans the gram in the cutting process. Coolant application in the cutting process maintains the workpiece's quality and improves tool life so that the tool does not wear out quickly. Many efforts were made to get cooling well, considering the impact of wear out. This study aims to determine the effect of a chemical-based coolant based on dromus oil and vegetable CPO on tool wear in the face milling process and to determine whether or not the liquid is effective in reducing and slowing down tool wear. In this research, the face milling process used a grey cast iron specimen as the workpiece specimen used and also used a carbide insert chisel cutting tool with the TPKN 22 VC2 type. The research was carried out by varying the engine speed and also the coolant variation, the engine speed variations used were 80, 360 and 720 rpm. In the process of administering coolant using the method, it is sprayed directly onto the workpiece area which is cut continuously, in the milling process with a response variable that can be in the form of data or tool wear values that have been observed and tested using a microscope test tool, using the weight (mass) method to see the wear value. This research aims to see how effective the use of vegetable-based coolant (CPO) during experiments as a coolant in the machining process aims to ensure that the final value of tool insert wear must be smaller with (CPO) compared to chemical coolant (dromus).

Keywords*: *milling, coolant, tool wear, carbide insert.

1. INTRODUCTION

Advanced process in forming workpieces or it may also be the final process of forming metal into products [1]. Machinings such as milling, turning, and drilling are widely used in industry. For the machining process, the end result and product quality are very important [2]. The need for the industrial world to continuously use machine tools, for example in the use of milling machines for both production and educational purposes, is urgently needed for better products [3].

Machining is a widely used industrial manufacturing process, where cutting fluid (coolant) often plays an essential role in machining quality and efficiency. The coolant lubricates, cools and separates the chips produced by machining, and its role can also prevent acceleration corrosion on the material [4]. Currently, vegetable-oil coolants or biodegradable esters are increasing [5]. Understanding the functions and different types of cutting fluids is critical to maximizing their performance during any machining process [6][7]. Coolant also plays a role in slowing down damage to the chisels eye [8].

Tool wear plays an important role in determining the machinability of any material. Each material causes a different tool wear mechanism. In the case of titanium machining, chipping, notching and catastrophic failure are the main failure mechanisms [9]. Tool wear is also caused by temperature changes resulting from friction between the tool surface and the specimen material [7][10].

The occurrence of tool wear depends on the ability of the coolant to maintain the tool temperature. As the rate of shear strain increases, the temperature also increases, and this causes an increase in the tool wear rate. The main cause of flank and crater wear is diffusion driven by high temperatures [11][12]. Researchers in recent years have tried to optimize machining process parameters that can affect tool wear and surface roughness such as depth of cut, material hardness and coolant [13][14]. Tool life plays a role in determining the operating costs of producing a product. Good manufacturing processes can produce good quality products. This study aims to look at the wear of the insert tool using two types of coolant, namely chemical-based coolant (dromus) and vegetable-based coolant (CPO) by weighing the mass of the insert tool.

2. METHOD

The purpose of this study was to look at the wear of the tool insert from the face milling process with a conventional emcoF3 milling machine using dromus chemical-based coolant with CPO vegetable-based coolant. The milling machine used is capable of performing face mills, end mills and profile mills. Tool wear data collection method uses two methods. The first method is loss of mass (weight) and the second is by looking at the length of the side damage on the chisel using a microscope with a magnification scale of 50 x. To see the weight loss from the insert tool, a digital balance is used with the accuracy of the digital balance of 0.01 gr as shown in Figure 1 below.

Figure 1. Weighing The Initial Weight of The Insert Tool

The method and calculation in analyzing wear with the mass of the insert tool use the following formula.

$$\Delta m = m_0 - m_1 \tag{1}$$

Where:

Δm : *Mass Difference*
m_0 : *Initial Mass*
m_1 : *Final Mass*

Then to calculate the length of wear that occurs on the tool both the tool that has been used and the tool that has not been used with the results of microscopic measurements using the wear length method (linear) as written in equation 2 as follows.

$$\left(\frac{initial\ mass\ -\ final\ mass}{initial\ mass}\right)\times 100\% \tag{2}$$

The face milling process in this study used the type of shoulder cutting incision which can be seen in Figure 2. The spindle rotates with the research variables 80, 360 and 720 rpm in a position fixed and the specimen object moves in the direction determined by the feed motion Vf 20 mm/min. The process of cutting the workpiece is carried out 5 times repeatedly by spraying coolant on the workpiece continuously during the cutting process.

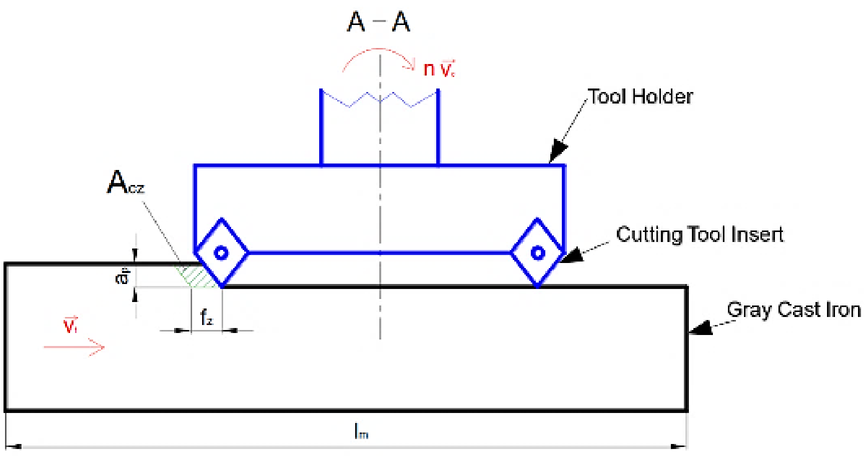


Figure 2. Machining Face Milling Type Shoulder Cutting [15]

The insert tool material used is the carbide insert tool. TPKN22 VC2 carbide type. Details types of carbide tools shown in table 1.

Table 1. Carbide Insert Specifications TPK22 VC2

Grade Name	: Valenite Solid Carbide / VC2
Insert Material	: Uncoated Medium Grain
ISO	: K10 – 20 (For working cast iron)
Process	: Rouging, Threading-Grooving, Semi Finishing,
Hardness Test	: 1300 – 1800 HRV (Hardness Vickers)
Heat Resistance	: 1000°C
Density	: 10.39 (gr)

The test material (specimen) in this study was grey cast iron. The mechanical properties of the test material can be seen in Table 2.

Tabel 2. Mechanical Properties Gray Cast Iron

Density	: 7.15 g/cm3 (0.258 lb/in3)
Elasticity Modulus	: 1034 MPa (150000 psi)
Toughness	: 18 MPa-m1/2
Tensile strength	: 276 MPa (40000 psi)
Elongation	: 0.51 %

The grey cast iron specimen has dimensions of 10 mm thick, 100 mm long and 700 mm wide. for more details, of the specimen are shown in Figure 3.

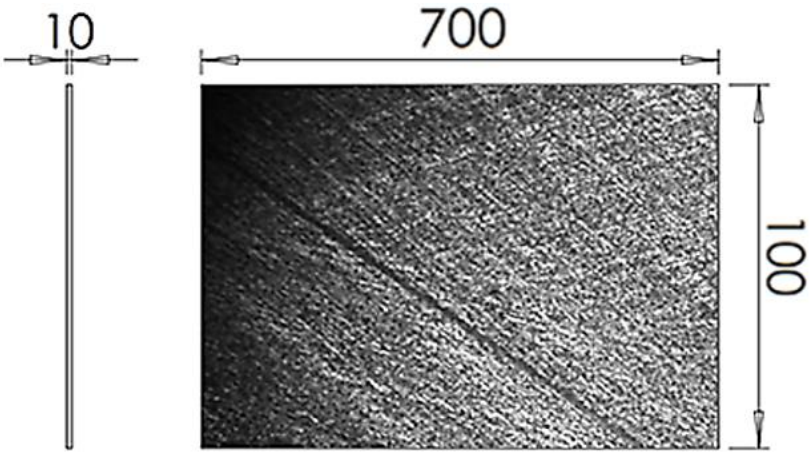


Figure 3. Gray Cast Iron Specimens

Machining process in this research is by varying the spindle speed. Spindle speed in machining is very clout on the product being worked on [16]. The spindle speed used is 80, 360, and 720 rpm according to the existing machine table properties. The research variables can be seen in Table 3.

Tabel 3. Variable Research

Spindle Speed (*rpm*)	Dept of Cut (*a*) mm	Feeding (*Vf*) mm/min	Coolant
80	0.1	20	Dromus
360			
720			CPO

Coolant is the most important factor in this research. The coolant used is CPO and dromus. Mixing dromus and water in this study was 1:5. The viscosity of the coolant greatly affects tool life. The viscosity of the coolant used in this study is shown in Table 4.

Tabel 4. Viscosity Coolant

Coolant	Viscosity, Ns/m^2	Viscosity, Ns/m^2
	27°C	80°C
CPO	48.7	3.5
Dromus : Water	0.13	0.09

3. RESULTS AND DISCUSSION

3.1 Results

The results of tool wear measurements before and after using the insert tool mass loss method are shown in Figures 4(a) and 3(b). In this case the spindle speed used is 80 rpm using coolant dromus. The result of measuring the mass of the chisel before use is 10.39 grams, and the result after use is 10.37 grams.

Figure 4. Mass Wear (a) Before, (b) After

Then the measurement results at a spindle speed of 360 rpm wear mass on the chisel is 10.34 gr and at a spindle speed of 720 rpm, the mass wear on the tool is 10.32 gr. For the results of mass wear measurements using CPO coolant, results are not much different from dromus liquid. Before being used the chisel mass was 10.39 gr, the spindle speed was 80 rpm the chisel mass was 10.34 gr and the spindle speed was 360 rpm the tool mass was 10.32 gr, then at the spindle speed 720 rpm the tool mass was 10.31 gr. The results of the wear measurements that occur on the tool eye are shown in Tables 5 and 6.

Furthermore, the measurement of wear by looking at the damage to the tool side using a microscope can be seen in Figure 5. The results of measuring the damage to the side of the tool can be concluded that the damage that occurs is the wear of the crater (crater ware) on the tool side which is directly in contact with the gray cast iron material. The wear length of the tool side at 80 rpm spindle speed was 0.71 mm, the side wear at 360 rpm spindle rotation was 0.72 mm and the side wears at 720 rpm spindle speed was 0.74 mm using coolant dromus. Then the measurement of side wear using CPO coolant at 80 rpm spindle speed is 0.78 gr, and 360 rpm spindle speed is 0.8 gr side wear, then side wear on the spindle speed tool 720 rpm is 0.81 gr.

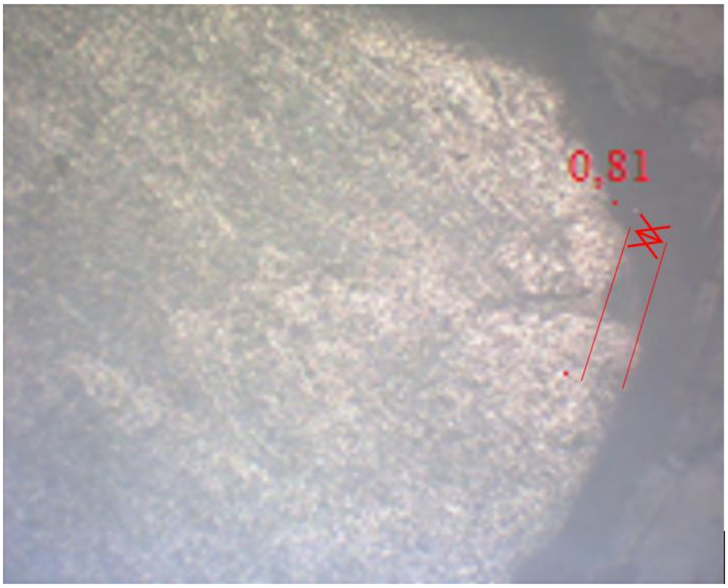


Figure 5. The Wear of The Tool With a Coolant CPO Spindle Speed Of 720 rpm

Table 5. Tool Wear Mass Using The Dromus

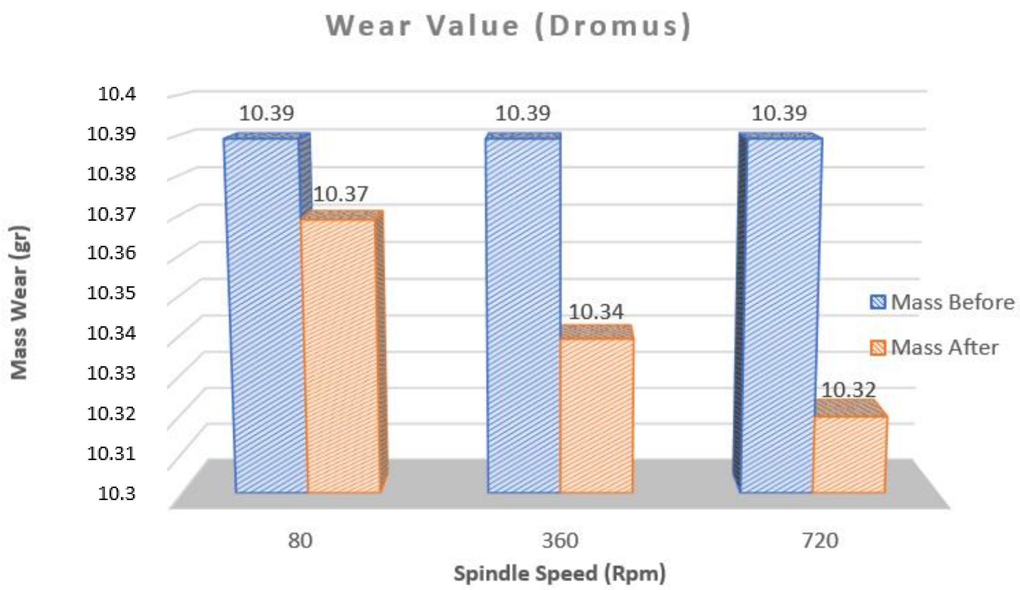
Spindle Speed (*rpm*)	Dept of Cut (*a*) mm	Feeding (*Vf*) mm/min	Mass Before (gr)	Mass After (gr)	Mass Wear (gr)
80			10.39	10.37	0.02
360	0.1	20	10.39	10.34	0.05
720			10.39	10.32	0.07

Table 6. Tool Mass Wear Using CPO

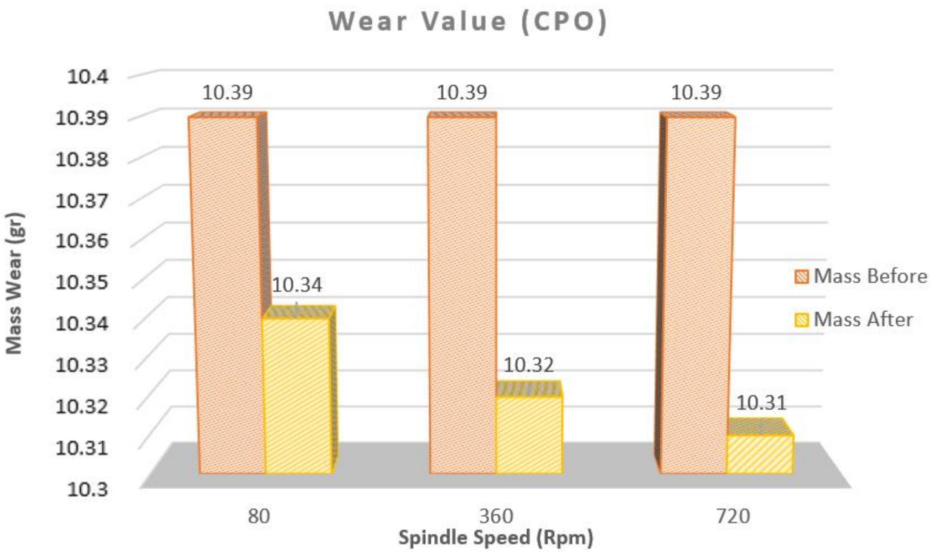
Spindle Speed (*rpm*)	Dept of Cut (*a*) mm	Feeding (*Vf*) mm/min	Mass Before (gr)	Mass After (gr)	Mass Wear (gr)
80			10.39	10.34	0.05
360	0.1	20	10.39	10.32	0.07
720			10.39	10.31	0.08

3.2 Discussion

Observations result from the results of wear measurements using the mass measurement method and microscopy measurements, the results are not so significant. The results of using coolant dromus (a) and coolant CPO (b), to compare the mass wear values on the chisels can be seen in Figure 6 below.



(a)



(b)

Figure 6. Mass Wear Value of The Tool Using (a) Coolant Dromus, (b) CPO

The large increase in wear is in line with the increasing speed of spindle rotation [17]. The results of this research indicate that the lowest wear rate occurs when using a spindle speed with a low rotation and the highest wear rate occurs when using a spindle speed with the highest rotation. The faster the spindle rotation, the more frequently the tool will come into direct contact with the workpiece [18]. The results of this study are in accordance with the research conducted and the literature, that the coolant used for metal machining based on vegetable oil can be an environmentally friendly machining model with a similar performance system using metalworking fluids based on mineral oil and the use of vegetable-based coolant can prevent environmental pollution due to the waste [15]. Based on the observations in this study, the results of tool wear experienced by using CPO coolant using the method of measuring the mass on the tool, the value of tool mass wear is very low compared to dromus coolant. This shows that CPO can be a coolant recommendation at low spindle speed [10].

4. CONCLUSION

The use of coolant in the machining process is to produce high-quality products and prevent damage to the tool insert. In this study, a good product result was the use of a CPO cooler at low speed. Because judging from the value of the wear mass, the highest value at low speed uses a coolant dromus. This proves that the CPO cooler has been properly applied during processing. From these results, the viscosity of the coolant becomes one of the effects of maintaining the state of the inserted tool used. CPO coolant lubricates the machining process more effectively at low spindle speeds.

ACKNOWLEDGEMENT

Thank You from the authors to the Chair of the Mechanical Engineering Study Program and the Production Process Laboratory, Faculty of Engineering, Universitas Muhammadiyah Sumatera Utara.

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