STUDY OF HARD MATERIAL MACHINING USING CARBIDE INSERTS ON DRY TURNING PROCESS

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Abstract
This study aims to determine the characteristics of hard material machining using a lathe and cutting tool carbide inserts. The machining process without cooling water (dry machining) under the influence of machining variables. The research method was experimental by selecting the research variables: machining variables (rotation = 700 rpm, 900 rpm, 1200 rpm, 1300 rpm; depth of cut = 0.2 mm, 0.25 mm, 0.3 mm; feed speed = 40 mm/minute). After the machining process, surface roughness was measured using a Surface Tester Mitutoyo Surftest 301. Measuring the results of surface roughness showed that the depth of the cut had more influence on surface roughness compared to changes in the work piece rotation. Data the roughness measurements obtained ranged from 0.45 µm to 1.95 µm, this means that the value of surface roughness obtained is still in the standardized area (Ni ÷ N7 = 0.02 ÷ 2.4 µm) or it can be said that the machining variable selected can be used as a variable turning of hard materials

Keywords: Tools carbide insert, machining variables, turning, roughness

INTRODUCTION
The latest machining concept consists of two types, namely: high speed machining and hard machining. High-speed machining is triggered by increasing demand to increase productivity with low production costs. With a high cutting rate, the volume of material release from the parent material will increase so that significant machining time savings will be obtained. In addition, high speed machining is able to produce smooth products and more precise sizes. While hard machining is done on work pieces that have a hardness greater than 40 HRC. The hard lathe process can be carried out on various types of metals such as alloy steel (steel alloy), steel for bearing (steel), hot and cold work tool steel, high speed steel, die steel, and hardened cast steel (Baggio, 1996). To support the latest machining, a cutting tool that is reliable and has material properties, wear resistance and high temperature is needed. One development of cutting tools is the use of hard materials (hard metal).

Hard metal cutting tools are a cutting tool that can minimize break down time because this type of tool is easy to replace when the tool is worn. The use of hard metal cutting tools has resulted in productivity being maximized so that it will increase product reliability and precision, reduce production time and production costs so that the selling price of products is affordable and ultimately will strengthen the company's ability to compete with its competitors. Hard metal Cutting Tools consists of two main parts, namely the holder or holder and insert or tool insert. The holder is a rectangular or cylindrical rod where one end is clamped to a machine tool (lathe or milling) while the other end is used to pinch the cutting tool (insert tool) that can be replaced.

The study of the use of tools in turning has been carried out by several researchers, as investigated by Thamizhmanii, 2011 using hard material AISI 440 C martensitic stainless steel and SCM 440 alloy steel, variations in cutting rates and feeds, medium depth of cut remains. The results of his study concluded that the cutting speed and in feed combination in the cutting process would increase the working voltage of the cutting tool and consequently the cutting tool would blunt quickly. With a blunt cutting tool, the product quality and productivity decrease. Ghani et. al, 2004, using a carbide tool coated with Titanium alloy, using a variety of cutting rates, in feed rates and in feed depth. And concluded that at a simple cutting rate the wear of the tool is determined by the friction between the tool and the work piece.

Some researchers have conducted research on the use of tool inserts in the machining process, especially for hard machining. Various methods have been used in the machining process to determine cutting parameters,
cutting tool types, measured quantities and analysis methods. All methods used lead to optimization of machining, namely obtaining a low cutting force and small surface roughness results. Besides that, the development of metal cutting processes with machine tools is also directed to tool resistance, low production costs and product accuracy. One solution is the use of carbide inserts.

Venkatesan (2014) conducted a study on the effect of cutting parameters of Ni-Cr, Inconel 625 alloy, using a coated carbide insert tool (AlTiN PVD) and using a dry machining process. In this study measurements of cutting force and surface roughness were carried out. This is intended to analyze the effectiveness of the machine while to find cutting optimization and analyze the effect of cutting parameters carried out signal-to-noise comparison (S/N), analysis of variance (ANOVA), and regression analysis. This analysis is carried out to obtain a lower cutting force and a good surface finish quality in dry cutting conditions.

Wet machining is machining which in the process is carried out with coolant. The main function of coolant is to reduce the cutting temperature by reducing the frictional force and as a heat carrier medium from the cutting area, it also functions as a furious carrier. As the cutting temperature decreases, the tool life will increase. This will be different in the dry machining process where in the dry machining process there is found a large friction force so that the cutting temperature becomes very high. This high cutting temperature will reach the melting point of the tool material and can change the microstructure at the end of the tool. Because the tip of the tool becomes soft and experiences pressure as a result of cutting parameters, which causes the cutting of the tool strength. This will have an effect on machining products.

Based on the description above, a more in-depth study of the use of tool inserts is needed in the dry turning process of hard material under conditions of cutting parameters (feed, depth of cut, cutting speed). In this study it is expected to show an overview of the quality of lathe machining products and their relationship to the surface roughness of dry turning products of hard materials.

Cutting material with machine tools is a major industrial activity to form machine components or other equipment. To facilitate human work and to produce quickly, effectively and economically, it is the basis for the development of tools and machine tools.

The turning process is a process of changing the shape of a product using a cutting tool and lathe. In the process of turning all the energy is converted to heat, where this heat is caused by friction between growls and chisels and between tools and workpieces. The presence of high pressure due to high cutting forces and temperatures results in a furious release process. This is the impact of the frictional surface friction force of the tool with the workpiece. At temperatures that are too high can damage the tool and will affect the quality of the production, also to a certain extent affect the work of the lathe.

The quality of machining products is also affected by cutting parameters and cutting temperatures (Tp). Cutting parameters, namely: cutting speed (cutting speed, Vc), depth of cut (depth of cut, a) and feeding (f). In the machining process it is important to know the value: cutting force (F), cutting temperature (cutting temperture, Tp), the rate of formation of rage (chip remover, Z) and cutting time (time cutting, t).

Cutting speed is very influential on the quality of machining products by which the determination of the speed value is very important to know and the cutting speed is directly proportional to the rotation of the workpiece. The relationship of cutting speed with rotation is shown by the following equation:

$$ V_c = \frac{\pi \cdot d \cdot n}{1.000} \text{ [m/min]} $$  

(1)

The following equations are used to determine machining characteristics, namely:

- **Feed speed**,  
  $$ V_f = f \cdot n \text{ [mm/min]} $$  

(2)

- **Cutting time**,  
  $$ T_c = \frac{L}{V_f} \text{ [mm/min]} $$  

(3)
RESEARCH METHODS

In this study used work piece material ST 60, diameter 50 mm, length 350 mm with a tensile strength of 194.56 kg/mm² while the cutting tool used carbide inserts. The machining process used is turning and without cooling machining. The machining variables were chosen: rotation = 700 rpm, 900 rpm, 1200 rpm, 1300 rpm; depth of cut = 0.2 mm, 0.25 mm, 0.3 mm; feed speed = 40 mm/min and tool geometry does not change. Fig. 1 showing the carbide insert tool and tool holder used.

The geometry identity of the inserts follows the American National Standard Institute (ANSI) and DNMG-432, as follows:

- D: Insert shape of 55° diamond.
- N: Relief angle of 0°.
- M: Tolerance of the inscribed circle and thickness of ± .002 and ± .005 respectively.
- G: Insert with a hole and chip breaker on both faces.
- 4: Inscribed circle of ½ inch.
- 3: Thickness of the insert of 3/16 inch.
- 2: Nose radius of 1/32 inch.

The machining process is done with 1 set of treatment (rotation, feed and depth of cut) of 20 mm, then roughness measurements are carried out. The roughness measurement results are then graphed the relationship of surface roughness with machining variables.

RESULTS

Lathe machining process on ST 60 material is carried out along 20 mm with variations in rotation, infeed speed and cutting depth. Turning is done first by adjusting the rotation, feed speed and cutting depth, then changing the cutting depth by 3 variations where the rotation and feed speed are not changed. After that, the change in rotation is 4 times the variation. After finishing the turning process, measurements of surface roughness are carried out every 1 data set. In this case the roughness measurement is done 12 times (data set = 12).

Measurements of surface roughness were carried out using the Mitutoyo Surftest Surface Tester 301. Data the roughness measurement results were made in the form of a rotational relationship graph with surface roughness and the results shown in Figure 2.

This result was reinforced by Kouam (2013) study comparing the machining process using Alluminium using cooling water (wet), semi-dry and dry as shown in Figure 3.

Fig 3 shows that dry machining produces small roughness values compared to cooling and semi-wet machining. Similarly, the cutting speed has little effect on the value of surface roughness.
CONCLUSIONS

The results showed that the higher the work piece rotation, the smaller the surface roughness, while at large cutting depths, the surface roughness was also greater. The change in rotation variable has little effect on the value of surface roughness compared to changes in variable depth of cut. In this study the surface roughness was obtained 0.45 µm to 1.95 µm, this means that the surface roughness obtained was still in the standard area (Ni ÷ N7 = 0.02 ÷ 2.4 µm) or it could be said that the variable the selected machinery can be used as a variable turning the hard material.

REFERENCES


