Jurnal Polimesin
Department of Mechanical Engineering
State Polytechnic of Lhokseumawe
http://e-jurnal.pnl.ac.id/polimesin

e-ISSN	: 2549-1999	No.	: 1	Month	: February
p-ISSN	: 1693-5462	Volume	: 22	Year	: 2024

Article Processing Dates: Received on 2023-05-16, Reviewed on 2023-05-16, Revised on 2023-07-24, Accepted on 2023-07-26 and Available online on 2024-02-29

Investigation Of Turning Results Using Used Chisel Bit File And Chisel Bits From ST-37 Steel Pack Carburizing

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Abstract

Much research in the manufacturing industry has been conducted on variations in cutting force, temperature, and chip directly related to tool wear and cutting performance. Therefore, this research analyzed the cutting performance of cutting tools from the pack carburizing-used files against the results of turning facings. Then, the chisels were welded to ISO 6 tool holders after welding. The chisels were used to turn low carbon steel ST-37 with a diameter of 50.4 mm using a timeway CL-460 lathe with 0.2mm feeding and 400, 605, 910, and 1330 RPM variations. The test results indicated that the bit of carbide from the pack carburizing had a roughness value of 0.890 µm, belonging to class N6. Hence, the roughness value was lower (smoother) than turning facing using a file used from pack carburizing with a roughness value of 3.014 µm.

Keywords:
Pack carburizing, ST-37, chisel holder ISO 6.

1 Introduction

The performance of cutting tool materials is continuously being improved in response to user requirements for higher cutting speeds. Carbide inserts account for most cutting tool material because they can cut the workpiece faster than high-speed steel. In the second half of the 1970s, cemented carbide tools were coated with alumina or titanium compounds[1].Cemented carbides are composite materials consisting of a hard phase, tungsten carbide, and a ductile phase, cobalt-based binder. Because of the unique combination of different properties, including high hardness, fracture toughness, abrasion resistance, and strength, cemented carbides are widely employed for the fabrication of different types of tools, particularly metal-cutting tools, mining tools, construction tools, and so on[2].

Inserted carbide bits can significantly improve machining faster than conventional bits[3]. The increase in cutting speed is commonlyknown to be affected by the cutting innovation of carbide inserts which work by achieving steel cutting speeds of 100 to 150/min, approximately four times the cutting speed of high-speed steel (20 to 40m/min)[4], coating on carbide tool bits inserts that can extend the life of carbide tools[5]. Furthermore, severalresearch studies have reported that abrasion and friction were the main factors of wear and tear that were most dominant on carbide inserts when performing machining work[6].

The machining process will greatly affect the surface roughness level of the workpiece being made, where the roughness level is a reference for evaluating a product[7]. In the industrial world, workpiece surfaces have different surface configuration values according to the needs of the tool[8]. Surface configuration includes surface roughness and the direction of work or texture, which significantly contributeto designing a machine element related to friction, wear, lubrication, fatigue resistance, custom adhesiveness, and so on[9], [10]. Furthermore, surface roughness is the arithmetic mean deviation from the profile mean line, hereinafter referred to as the roughness value (Ra). The quality of surface roughness is classified by ISO into 12 roughness levels, starting from the N1 value with the smallest surface roughness value (Ra) of 0.025 µm to the N12 value with the largest roughness value (Ra) of 50 µm. This value genuinely depends on the ability of manual processing or machining during the production process[11], [12].

Carburizing is a thermochemical treatment process, generally applied to types of materials that are easily hardened so that the steel can be surface hardened[13]. The solid carburizing method is easier than the liquid or gas carburizing method. The advantages of this method include: (a) economical, (b) simple equipment and process, (c) abundant solid media, and (d) relatively safe[14]. If the carbon concentration is high, carbide will form[15]. The carburizing process in this research aims to obtain carbide bits that are not easily damaged or worn out to produce workpieces with a standardized smoothness by utilizing used file bits whose results are compared to carbide chisel bits. Therefore, the researchers researched the investigation of turning results using used chiselbit file and carbide chisel bitsfrom ST-37 steel pack carburizing.

2 Research Methods

In this research, two types of specimens were prepared: used file specimens and carbide chisel specimens. Both of them were carried out by the pack carburizing process[16] as shown in Fig. 1.

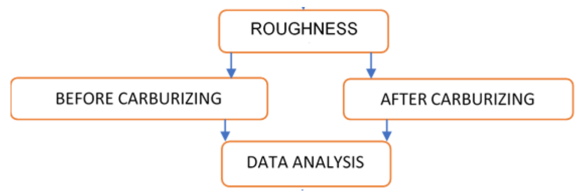

Fig. 1. Research method.

The pack carburizing process was carried out using coconut shell charcoal at an austenite temperature of 850ºC with a holding time of 180 minutes. The results of the specimens that have undergone the pack carburizing process were then welded to the ISO 6 tool holder, followed by turning with a lathe model CL-460 (Fig. 2) on the ST-37 material sample with the same feeding, namely 0.2mm and *spindle* variations 400, 605, 910 and 1330 RPM.

Fig. 2. CL-460/1000 timewaylathe[17].

The tests carried out were surface roughness testing with the surfcorder SE300 roughness tester (Fig. 3 and Table 1) to determine the quality of the workpiece smoothness results that met the standards on turning results using the JIS-B0601-2001 measurement standard with the sampling value sought, namely the average value of Ra (µm) at three different areas in each specimen.

Fig. 3. Surface roughness.

Table 1. Roughness test specifications[18]

Merk	SurfcorderKosakaLabocatorymade in Japan
Model	SE 300
Date	6-2012
No.	No. ME-52083
Standard	JIS 01R

3 Results and Discussion

The results of making ISO 6 tools using carbide tools without carburizing and carbide tools with carburizing, for welding using the brassing method with brass patch material as shown in Fig. 4.

Fig. 4. ISO 6 chisel with a carbide bit.

The results of making ISO 6 tools using carbide tools without carburizing and carbide tools with carburizing, for welding using the brassing method with brass patch material as shown in Fig. 5.

Fig. 5. ISO 6 chisel with used file bits.

The results of the surface roughness test on a cylindrical workpiece (facing) with a chisel tip from a used carburized file as shown in Fig. 6.Visually in Fig. 6, the turned object using a tool blade from a used file that has been carburized at 1330 RPM produces the lowest roughness.

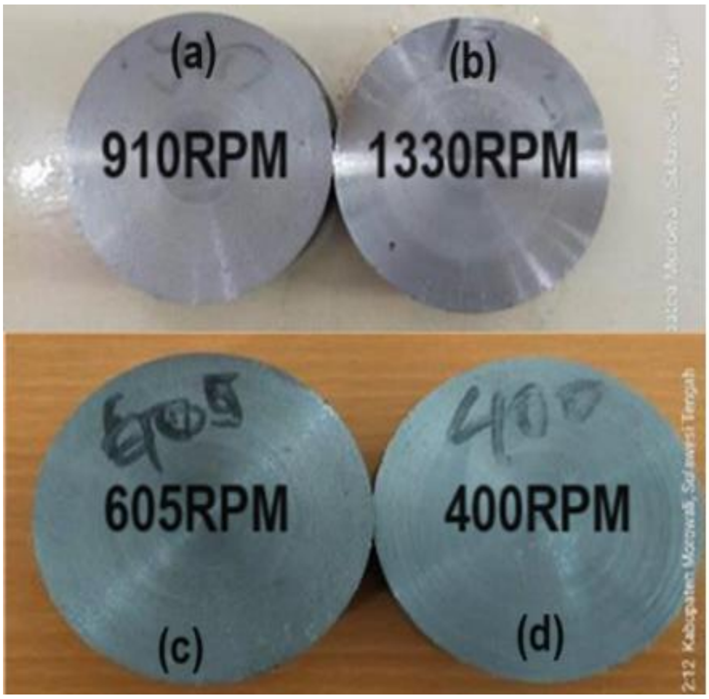

Fig. 6. Turning results of the ST-37 specimen against the chisel tip from the pack carburizing-used file.with variation in spindle rotation (a). 910RPM, (b). 1330RPM, (c). 605RPM, (d). 400rpm

Based on the measurement results of the roughness level of ST 37 steel machining process with a lathe, as shown in Table 2, the results of turning facing with used file carburizing tool bits obtained a roughness value where at 400 RPM spindle rotation value of workpiece roughness from used pack carburizing bits got a Ra-value of 7.320 µm, which identified the results of the roughness value into groups in the N9 roughness class. At 605 RPM spindle rotation, the workpiece roughness value from the tool used as a result of the carburizing pack obtained a Ra-value of 6.243 µm, which identified the results of the roughness value as a group in the N8 roughness class. At 910 RPM spindle rotation, the workpiece roughness value from the used chisel bit from the carburizing pack obtained a *Ra*-value of 3.700 µm, which identified the results of the roughness value as a group in the N8 roughness class. At the highest spindle speed of 1330 RPM, the workpiece roughness value from the used chisel from the carburizing pack results obtained Ra 3.014 µm, which identified the results of the roughness value as a class in the lower (finer) roughness class and classified in the N7 roughness class.

Table 2. Surface roughness (µm) of the used chisel tip from the pack carburizing

Surface roughness (Ra) µm	Spindle variation (RPM) 400	605	910	1330	Feeding
Area 1	7.077	6.171	3.459	3.024	
Area 2	7.426	6.261	3.904	3.01	0.2
Area 3	7.456	6.296	3.738	3.009	
Average Ra µm	7.320	6.243	3.700	3.014	

Meanwhile, the results of roughness testing on lathe-*facing* objects with carbide chisel bits that had been carburized are shown in Fig. 7. Visually in Fig. 7, the turned object using the carburized cabida tool blade at 1330 RPM produces the lowest roughness.

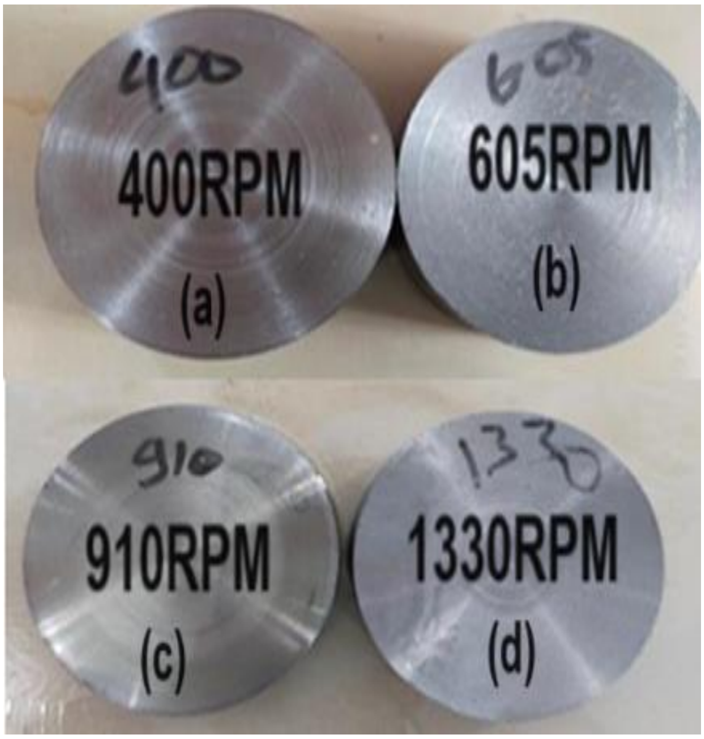

Fig. 7. Turning results of the ST-37 specimen against carbide bits resulting from pack carburizing.with variation in spindle rotation (a). 400RPM, (b). 605RPM, (c). 910RPM, (d). 1330rpm

The results of measuring the roughness level of the ST 37 steel machining process with a lathe, as shown in Table 3, the results of turning facing with carbide tool bits resulting from pack carburizing obtained a roughness value where at 400 RPM spindle rotation the workpiece roughness value of carbide tooling bits resulting from carburizing packs obtained a Ra-value of 5.386 µm, which identified the results of the roughness value into groups in the N8 roughness class. At 605 RPM spindle rotation, the workpiece roughness value from the carbide chisel as a result of the carburizing pack obtained a Ra-value of 3.412 µm, which identified the results of the roughness value as a group in the N8 roughness class. At 910 RPM spindle rotation, the workpiece roughness value from the carbide tool bit as a result of the carburizing pack obtained a Ra-value of 2.305 µm, which identified the results of the roughness value as a group in the N7 roughness class. At the highest spindle speed of 1330 RPM, the workpiece roughness value from the pack carburizing–used chisel obtained *Ra* 0.890 µm, which identified the results of the roughness value as a class in the lower (finer) roughness class and classified in the N6 roughness class.

Table 3. Surface roughness (µm) of carbide bits resulting from pack carburizing

Surface roughness (Ra) µm	Spindle variation (RPM)				Feeding
	400	605	910	1330	
Area 1	5.376	3.368	2.470	0.887	0.2
Area 2	5.390	3.377	2.215	0.894	
Area 3	5.392	3.490	2.315	0.890	
Average Ra µm	5.386	3.412	2.305	0.890	

Based on the data analysisin Fig. 8, it can be implied that the spindle speed (RPM) parameter variable affected the surface roughness of the turning material without neglecting the feeding rate as the second influencing parameter. For both types of blades, the spindle speed, referred to the rotational speed of the workpiece, and the feeding rate was kept constant at 0.2 mm. Surface roughness decreases with increasing spindle speed because increasing cutting speed reduces cutting force. It was in line with Sathessh Kumar's research[19], namely the effect of spindle rotational speed and feeding rate on the surface roughness of carbon steel, the results of CNC revealed that the rotational speed increased from 339 to 980 RPM with feed rates varying from 0.05 mm to 0.15 mm with a single operating rate making the surface roughness decrease produce a smooth surface quality[20]. High cutting speeds caused high friction increasing the temperature of the cutting tool. It led to increased tool wear and affected the surface roughness. However, it would significantly impact if machining was carried out at high cutting speeds with longer machining times[21],[22].

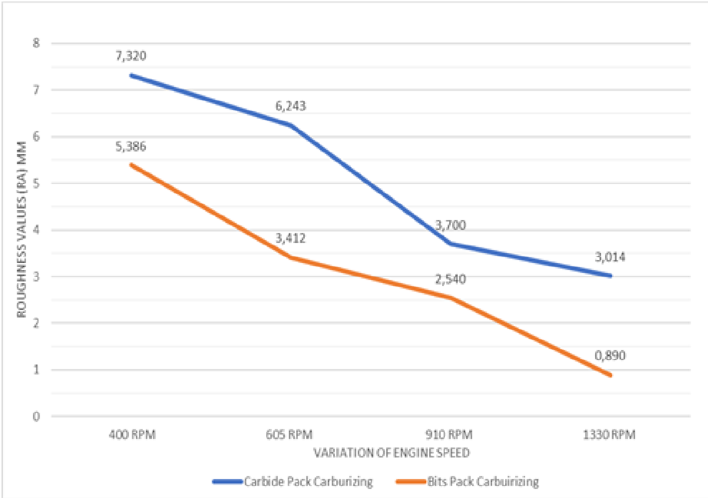

Fig. 8. Comparison of the turning results of the ST-37 specimen against chisel heads from used files and carbide pack carburizing results.

The actual surface roughness would increase with increasing feeding rate in the feeding rate variable. The feeding rate refers to the workpiece's speed relative to the cutting tool. A higher feeding rate value would result in a faster machining process so that the cutting load in contact with the chip cross-sectional area was more significant, which caused the cutting tool to wear out faster, affecting the surface outcome quality [22].

4 Conclusion

The conclusions obtained from research results concerning the surface roughness value of the ST-37 machining material were:

1. The facing turning using a chisel bit used as a pack carburizing result obtained the results:
   a. At 400 RPM spindle rotation, the Ra 7.320 µm roughness value was included in the N9 roughness group.
   b. At 605 RPM spindle rotation, the Ra 6.243 µm roughness value was included in the N8 group.
   c. At 910 RPM spindle rotation, the Ra 3,700 µm roughness value was included in the N8 group.
   d. At 1330 RPM spindle rotation, the Ra 3.014 µm roughness value was included in the N7 group.
2. The facing turning using carbide bits from the pack carburizing results obtained the results:
   a. At 400 RPM spindle rotation, the Ra 5.386 µm roughness value was included in the N8 roughness group.
   b. At 605 RPM spindle rotation, the Ra 3.412 µm roughness value was included in the N8 group.
   c. At 910 RPM spindle rotation, the Ra 2.305 µm roughness value was included in the N7 group.
   d. At 1330 RPM spindle rotation, the Ra 0.890 µm roughness value was included in the N6 group.

In short, facing turning using carbide bits resulting from pack carburizing had a roughness value into the lower (fine) roughness class of 0.890 µm; while facing turning using used file bits resulting from pack carburizing obtained the Ra-value of 3.014 µm.

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