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A Study on Surface Roughness in External Cylindrical Grinding

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In the present study, the influence of machining parameters in external cylindrical grinding process on surface roughness of workpiece was investigated. The experimental study carried out in dry and wet (%5 emulsion cutting fluid) machining conditions using AISI1050 steel at various workpiece speeds and feed at constant wheel speed and grinding depth. The relationships between grinding parameters and surface roughness were determined.

1. INTRODUCTION

Grinding is one of the most popular machining processes to improve surface quality and obtain dimensional accuracy of workpiece. It is used as the finishing process as well as the main machining process.

The effects of grinding parameters on surface quality have been some interest. Krabacher [1] applied cylindrical grinding to investigate machining parameters on material removal rate and surface roughness. He noticed that surface quality was found to improve with decreased material removal rate. Matsou and Matsubara [2] used five different grinding wheels at constant cutting speed. They reported that an increase on material removal rate produced a higher surface roughness. The width of wheel and workpiece did not affect surface quality, but a type of wheel was important factor on surface roughness. ZS type grinding wheel produced the best surface quality.

Mayer and Fang [3] investigated surface quality in the grinding of ceramic. Various grinding parameters were studied and they concluded that using higher grit size and depth of cut decreased surface quality as well as by increase of average chip cross-sectional area.

Weinhert et. al. [4] compared dry machining with graphite as lubricant and %4 emulsion cutting fluid as coolant and lubricant in the grinding of 100Cr6/52 steel. As a result, the dry grinding, they reported, produced a higher surface roughness comparing to graphite and cutting fluid application. Shaji and Rathakrishnan [5] also used graphite as lubrication in the grinding of AISI1030 and AISI52100 steels and compared to dry and soluble oil use. They informed that the use of graphite produced the lowest surface roughness at higher infeeds.

Zhou and Xi [6] carried out a study to predict surface roughness in grinding.

Hecker and Liang [7] predicted surface roughness due to mainly chip thickness in grinding. They also expressed the effects of grinding depth, cutting speed and wheel micro structure.

As a result, the literature survey could not provide clear information on surface roughness due to grinding parameters. Therefore, the aim of this study is to determine the effects of some grinding parameters on surface roughness in the external cylindrical grinding of AISI1050 steel. Different workpiece speeds and feeds were applied at constant wheel speed and grinding depth. The grindings were carried out as dry and wet processes. %5 emulsion cutting fluid was applied during wet grinding. The effects of selected grinding parameters on surface roughness were determined. The comparison of dry and wet grindings was given.

2. EXPERIMENTAL SET-UP

The experimental study carried out by using following grinding parameters.

Grinding wheel: SiC (Grit size 60)	Workpiece speed: 63, 280 and 500 rev/min
Workpiece: AISI1050 (∅40x120mm)	Feed: 50, 6000mm/min
Wheel speed: 20m/sec.	Grinding conditions: dry, wet(%5emulsion)
Grinding depth: 0.025 mm	

The experimental study completed on external cylindrical grinding machine tool. The workpiece was set between two tailstocks. The cutting fluid applied directly on grinding surface. Before each grinding experiment, the wheel was redressed. Surface roughness measurements were done using Taylor Hobson Surtronic 3+ type surface test equipment. The length of measurement was selected as 2.5 mm. Each measurement was taken from three different places of each ground workpiece surface.

3. EXPERIMENTAL RESULTS AND DISCUSSION

It was observed the effects of workpiece speed and feed on surface roughness in dry and wet grinding. These results were shown in Figure 1 and 2.

It was noticed that an increase on workpiece speed produced lower surface roughness in dry grinding. It was also observed that a higher feed rate increased surface roughness. This situation became more clear with increasing of workpiece speed (Fig 1).

The effect of wet grinding (%5 emulsion cutting fluid application) at the same grinding parameters also examined. It was noticed that a higher workpiece speed increased surface roughness. This result was obvious when a higher feed was used. Surface roughness increased due to high feeds (Fig 2).

In this study, the material removal rate per wheel width was taken as main parameter which is calculated by using an equation, based on reference [8], as follow;

$$z = \pi\, a\, s\, n_w\, d_w / b \qquad (1)$$

Where; z: material removal rate per wheel width (mm^3/mm.min); a: grinding depth (mm); s: feed (mm/rev); n_w: workpiece speed (rev/min); d_w: workpiece external diameter (mm), b: wheel width. The relation of material removal rate with workpiece surface roughness was given in Figure 3.

A low material removal rate, which means low feed rate and workpiece speed, presents minimum surface roughness. This result was observed for both dry and wet grinding processes. However, higher material removal rates produced a decrease on surface roughness

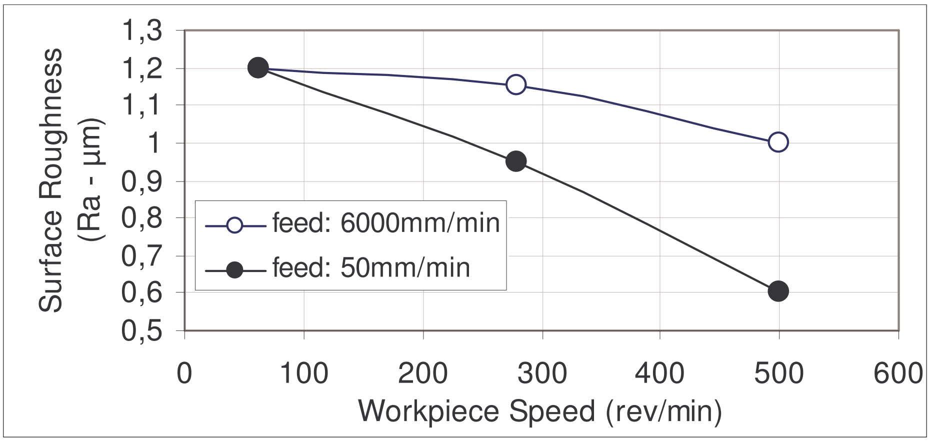

Figure 1. Effects of grinding parameters on surface roughness (Grinding condition: dry, Wheel speed:20 m/sec, Grinding depth:0.025mm)

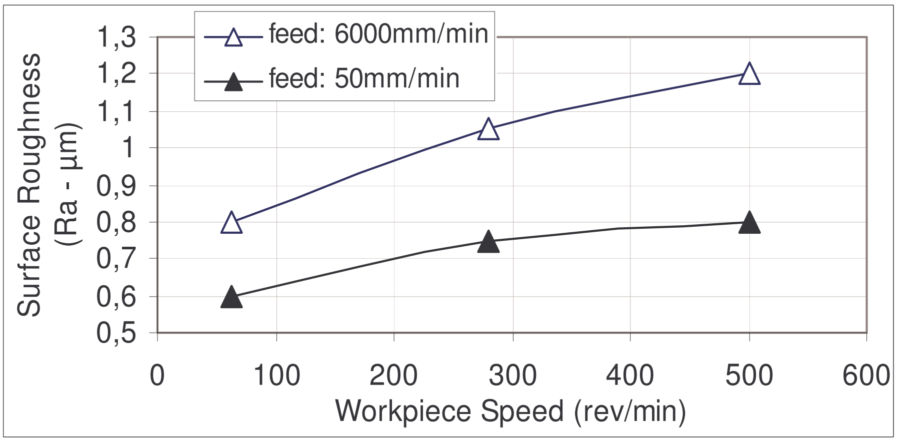

Figure 2. Effects of grinding parameters on surface roughness (Grinding condition: %5 emulsion cutting fluid, Wheel speed:20 m/sec, Grinding depth:0.025mm)

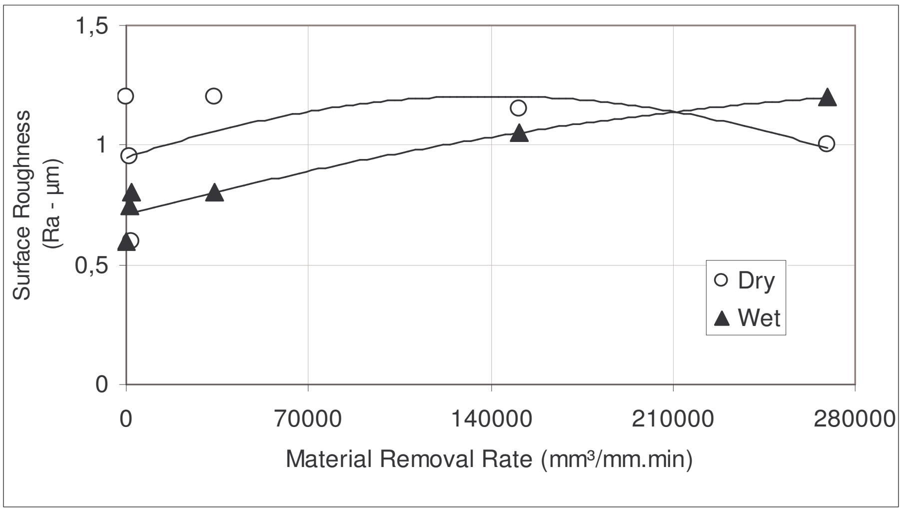

Figure 3. Changes on surface roughness depending on material removal rate in dry and wet grinding conditions

in dry grinding and an increase in cutting fluid application. It was noticed that this result was similar to the study of Weinhert et. al. [4].

Average temperature in grinding zone in the case of high workpiece speed and feed in wet grinding is lower than dry grinding. This may be causes high surface roughness. From the same point of view, a similar observation could be expressed for low workpiece speed and feed in dry grinding.

In grinding, by using high value of machining parameters, which means high material removal rate, cutting fluid application did not provide an advantage on surface roughness. In contrary, for the same grinding parameters, dry grinding produced a lower surface roughness. This comment covers to the study of Wallen et. al.[9], based on turning with using a single point cutting tool. They observed similar result that the surface roughness doubled in wet machining in comparison to dry machining depending on the variation of depth of cut.

4. CONCLUSION

In this study, the effects of some grinding parameters such as workpiece speed and feed on surface roughness were determined in both dry and wet conditions. In dry grinding, an increase on workpiece speed decreased surface roughness. This result was opposite in the application of cutting fluid that increase on workpiece speed produced a higher surface roughness.

As a conclusion, to obtain better surface quality in dry grinding should be completed at high workpiece speed and low feed. However, in wet grinding, both workpiece speed and feed should be kept low for a lower surface roughness.

Wet grinding produced a lower surface roughness up to certain value of material removal rate. After this value, which was around 200000 mm^3/mm.min in this study, dry grinding provided a better surface quality.

REFERENCES

1. E.J. Krabacher, J. Engineering for Industry, (ASME), 81 (1959), 187-200
2. T. Matsou and K. Matsubara, Annals of the CIRP, 32 (1983), 233-236
3. J.E. Mayer and G.P. Fang, Annals of the CIRP, 44 (1995), 279-282
4. K. Weinhert, M. Buschka, G. Jahler and C.Wilisch, VDI-Z, 140 (1998), 46-49
5. S.Shaji and Radhakrishnan, Int. J. Mach. Tool. Manufact., 42 (2002), 73-740
6. X.Zhou and F. Xi, Int. J. Mach. Tool. Manufact., 42 (2002), 969-977
7. R.L.Hecker and S.Y. Liang, Int. J. Mach. Tool. Manufact., 43 (2003), 755-761
8. Machinability Data Center Metcut Research Assoc., Machining Data Handbook, 1972
9. P. Wallen, S. Jacobson and S. Hogmark, Int. J. Mach. Tools Manufact., 28 (1988),515-528