Internal Grinding Characteristics with Ceramic and CBN in Nitriding Treated Steel

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Abstract

The internal grinding process has precise and narrow tolerance areas in both its size and form-shaping aspects. In the conventional grinding process, which grinds normal tempered hardened steel, aluminum oxide is predominantly used as a grinding wheel material. This has the advantage of self-sharpening during the process. Together with this conventional material, CBN has emerged as a new substitution in steel grinding. In this study, grinding characteristics when using ceramic and CBN wheels for internal grinding were analyzed. Ceramic wheel cutting edge sharpness is much better than the CBN wheel, and in the CBN wheel case, initial wheel status causes glazing and loading which slightly increase grinding power.

Keywords: *Quenching-tempering heat treatment, Ceramic wheel grinding, CBN wheel, Surface roughness, Roundness*

1. Introduction

Grinding is a machining process which employs an abrasive grinding wheel rotating at high speed to remove material from a softer material. In the conventional grinding process, which grinds normal tempered hardened steel, aluminum oxide is predominantly used as a grinding wheel material. Together with this conventional material, CBN has emerged as a new substitution in steel grinding. CBN's grit hardness gives it longer wear resistance and longer re-dress life than the alternatives. In area of steel materials, mechanical property improvements are consistently executed for the longer life and sustainable reliability of mechanical components [1, 2].

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2. Material Specification and Heat Treatment Method

Table 1. Chemical Composition of STB2 Bearing Steel(wt.%)

Elements	C	Si	Mn	P	S	Cr	Ni	Al	Ti	O
Contents	1.02	0.25	0.31	0.02	0.015	1.53	0.2	0.026	0.001	7ppm

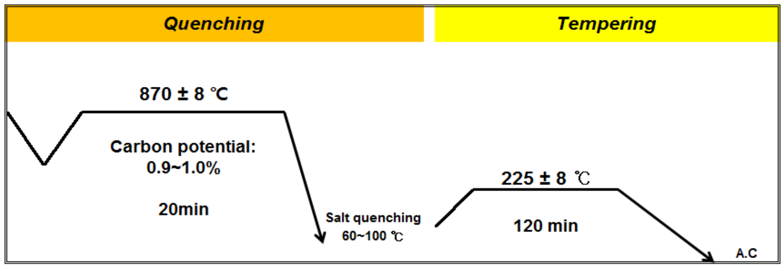

Figure 1. Normal Quenching-tempering Heat Treatment Cycle

STB2 bearing steel was chosen and given special attributes by heat treatment. After the heat treatment, surface hardness was up to HRC 60~62. Figure 1 is heat treatment cycle for normal quenching and tempering treatment. After quenching and tempering heat treatment material hardness was raised to HRC 60~62 and retained austenite increased by 8~17 vol % [2].

3. Grinding Wheel Specification and Machine Set-up

3.1 Grinding Wheel

Tool life shows much deviation between ceramic and CBN wheels. Re-dress life is also much longer in CBN wheel, the main reason being that CBN grit hardness enables continuous grinding without re-dress or truing. Viewed from an economical aspect, this will be the indisputable reason to adopt CBN wheels for grinding. But still ceramic wheels have some advantages in cost and even in tolerance handling, as they show much better behavior with their self-sharpening ability during grinding operations. In the industrial field there are still some constraints in the cost and maintenance aspects related to dressing units, so ceramic wheels maintain the dominant grinding tool position [1, 3, 4].

3.2 Machine and Measuring Device Set-up

Grinding machine	ARR01-G (FAG Germany) Spindle motor capacity: 350V-18kW
Wheel	Ceramic: 21A100L8V (30*19*10) CBN: CBN230OVDW (30*18*22)
Work piece	STB2, Inner diameter: 35mm Width: 15mm Hardness: HRC60
Grinding conditions	Wheel speed : 30 , 45 , 60m/s Work piece speed : 1,042rpm Depth of cut: 100, 200 ㎛ Oscillation: 3mm / 2500m/min Spark-out time: 0.5sec
Dressing	Ceramic: Diamond tip dresser (1/10ct) CBN: Ø15 Rotary dresser (1/50ct)
Grinding Fluids	CASTROL-HYSOL RD-KR(BP)

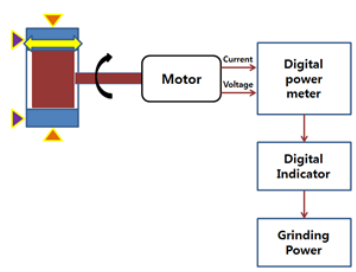

Figure 2. Experimental Set-up and System Configuration of Grinding Machine & Power

4. Results and Discussions

4.1 Grinding Power and Load Results

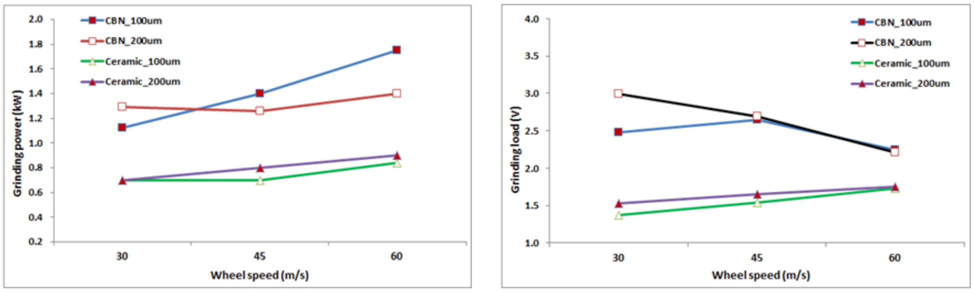

Figure 3. Grinding Power and Load Results in Various Grinding Condition

Figure 3 is grinding power and load progress under various grinding conditions. With cutting depth increasing, cutting amount in each cutting edge increased simultaneously. This increased grinding power. With the CBN wheels, grinding power increased more than ceramic wheel condition. It depends on the abrasive grain build-up; CBN wheel grain is much harder and combined much tighter. This means the ceramic wheel cutting edge sharpness is much better than the CBN wheel, and in the CBN wheel case, initial wheel status causes glazing and loading which slightly increase grinding power. Under ceramic wheel conditions, the grinding load increased with wheel speed and depth of cut increases but it did not show noticeable differences [5, 6, 7].

4.2 Surface Roughness and Roundness

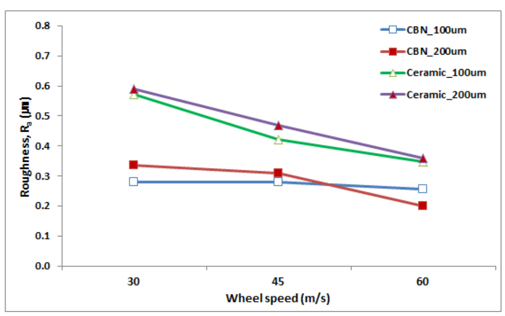

Figure 4. Surface Roughness Results in Various Grinding Condition

Figure 4 is surface roughness results under various grinding conditions. Both the ceramic and CBN wheel conditions show roughness improving as wheel speed increases; the reason is that, as cutting depth increased, the contact between the wheel and grinding material exacerbated abrasive grain wear and drop out quickly. This dropped out grain interferes with the surface during grinding process and makes surface roughness much bad. But surface roughness trend is much poor in ceramic wheel condition when compared to its low grinding power [2, 3, 4].

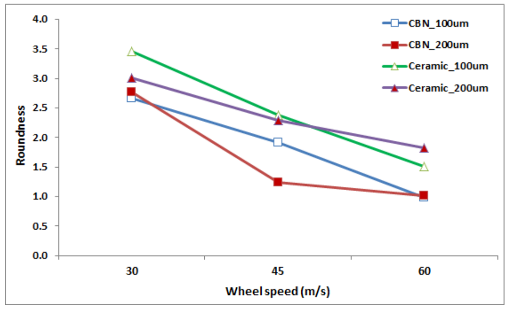

Figure 5. Roundness Results in Various Grinding Condition

Figure 5 shows roundness results under various grinding conditions. Roundness trends became more stable when wheel speed increased. This is similar to surface roughness. The roundness trend was much better under the CBN wheel conditions, which mainly depend on CBN wheel grain combine status [3, 4].

5. Conclusions

1. In grinding normal quenching-tempering hardened bearing steel, ceramic wheel condition showed less grinding power than CBN wheels. The ceramic wheel grain dropped out quickly and incurred sharpening edge than CBN wheel and cause little glazing and loading occurrence in surface.

2. Surface roughness showed better behavior when wheel speed increased in both ceramic and CBN wheel condition. But ceramic wheel case showed poor quality self-sharpening effect in dressing operation.

3. Roundness showed better behavior at high wheel speeds.

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References

[1] I. D. Marinescu, M. Hitchiner, E. Uhlmann, W. B. Rowe, I. In-asaki, “Handbook of Machining with Grinding Wheels”, CRC Press, **(2007)**.

[2] G. E. Totten, Ph.D., FASM, “Steel heat treatment”, CRC Press, **(2007)**.

[3] J. F. G. Oliveira, E. J. Silva, C. Guo and F. Hashimoto, “Industrial challenges in grinding”, CIRP Annals-Manufacturing technology, vol. 58, **(2009)**, pp. 663-680.

[4] D. Herman and J. Krzos, “Influence of vitrified bond structure on radial wear of CBN grinding wheels”, Journal of Materials Processing Technology, vol. 209, **(2009)**, pp. 5377-5386.

[5] R. Cai and W. B. Rowe, “Assessment of vitrified CBN wheels for precision grindings”, International Journal of Machine tools & Manufacture, vol. 44, **(2004)**, pp.1391-1402.

[6] J. Takagi and M. Liu, "Fracture Characteristics of Grain Cutting Edges of CBN Wheel in Truing Operation", Journal of Material Processing Technology, vol. 62, **(1996), pp.** 397-402.
[7] S. -J. Choi, W. -S. Lee and A. Kang, "A study on the electrical switching properties of oxide metal", vol. 9, no. 3, **(2009)** June, pp. 173-178.
[8] K. -D. Kim, R. Y. -C. Kim and J. -H. Kim, "A Study on Reliability Evaluation for Embedded Software", vol. 9, no. 3, **(2009)** June, pp. 209-215.
[9] M.-J. Lim, Y. -M. Kwon, J. -J. Kang, "The Verification and Retrieval Method for selection of Compatible Object Model", vol. 9, no. 5, **(2009)** October, pp. 169-174.

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