Effect of grooves and their geometry on the wear behavior of structured grinding wheels

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Synopsis

The dry and wet wear behavior of different structured abrasive grinding wheels, with different grooves geometry, were investigated and compared with an unstructured abrasive composite. It was found that the grooves, as well as their geometry, play a decisive role in the wear behavior of abrasive composites.

Introduction

Grinding wheels are the most used tools in manufacturing industry for roughing operations and surface finishing of components through a chip removal process. However, to achieve this goal, the wear resistance of the grinding wheel materials and their ability to promote wear on the opposing surface determine the performance of these tools. During these operations, very high cutting forces are required and the friction between the tool and the part to wear generates a high heat effect in the contact zone: this may induce thermal damages to the workpiece and a decrease in the grinding wheel performance [1,2]. The surface structuring/texturing of abrasive wheels has been a proposal to reduce the operating temperature [3]. In this work, two different kinds of grooved abrasive discs were produced, with spiral and hexagonal geometry. The structured grinding wheels were evaluated for their dry and wet wear behavior, being compared with an unstructured one.

Methods

Vitreous grinding wheels, made of alumina abrasive grains, were tested. All grinding discs under study were produced with ∅62 x 8 mm. Fig. 1 shows the difference between the unstructured abrasive disc (R) and the two structured discs with spiral grooves (S) and hexagonal grooves (H). The grooves were produced with 4 mm depth and 0.5 mm width.

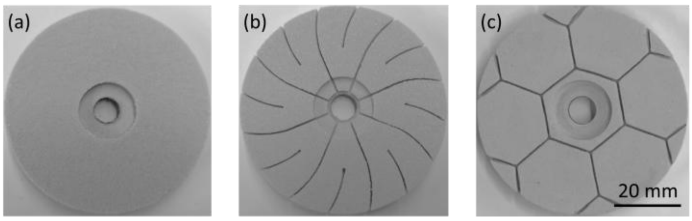

Figure 1 – Abrasive discs tested surface: (a) unstructured, structured with (b) spiral and (c) hexagonal grooves.

Wear tests were carried out in a pin-on-disc geometry. Each type of abrasive disc was tested with and without distilled water flow (6 ml/min) as a coolant fluid (CF). Alumina pins were used as counterface (∅5 mm), creating particularly hard contact conditions. The normal applied load, the sliding speed and the sliding distance were kept constant at 20 N, 0.5 m.s^{-1} and 1800 m, respectively. The wear rate of mating samples was measured by gravimetric method.

Results and Discussion

Fig. 2 shows the wear rate of the discs (Fig. 2(a)) and of the corresponding alumina pins (Fig. 2(b)), as well as the grinding ratio (pin/disc wear rates) for each tested tribopair (Fig. 2(c)). When comparing wear tests with and without CF, results show that the CF contributes to a significant reduction in the wear rates of abrasive discs (up to 91 % for H) and of alumina pins (up to 67 % for H), increasing the grinding wheel durability. The presence of the CF during wear tests increases the grinding ratio of the tested pairs, i.e. performance of the grinding wheels. This effect is significantly enhanced for structured grinding wheels (Fig. 2(c)). On the other hand, the beneficial effect of abrasive wheel structuring on its performance depends on the design of the wheel grooves. The hexagonal grooves (H) seems to have a coolant reservoir effect allowing better lubrication of the pin-disc contact, which significantly reduces the wear rates of the disc and of the pin. However, the spiral grooves (S) may allow a greater fluid flow favoring the removal of wear debris. In this way, the spiral geometry provides better grinding wheel performance than hexagonal geometry structure (H).

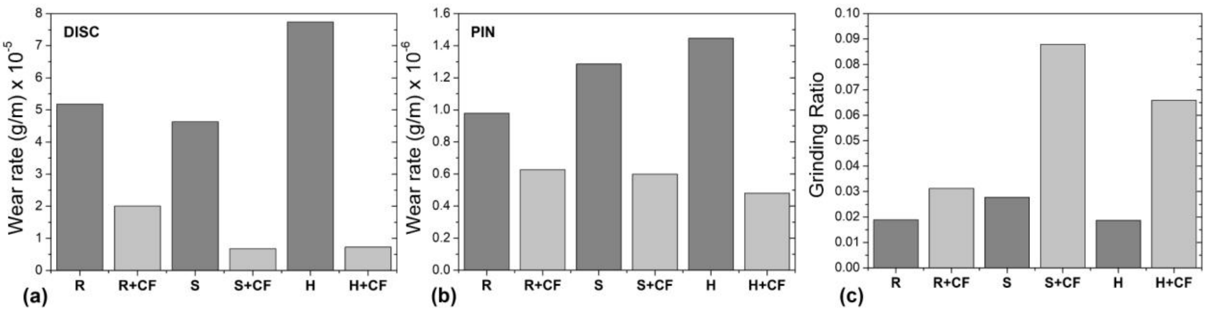

Figure 2 – Wear rate of the (a) abrasive discs, (b) alumina pins counterface and (c) grinding ratio of the tribopairs.

Conclusions

The use of coolant fluid always results in a reduction of the wear rate of the grinding wheels. The coolant increases the performance of the grinding wheels (grinding rate) and this effect is more noticeable for the structured wheels. The beneficial effect of wheel structure depends on the wheel grooves geometry. Spiral grooves allow for increased fluid flow and better removal of wear debris. Spiral grooved grinding wheels outperform hexagonal grooved grinding wheels.

References

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