

Nozzles and Grinding Fluids

Attention to the fluid delivery system can increase overall performance

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While most people agree that grinding fluids are important for precision grinding, few give serious thought to the nozzle, hoses, and connectors that deliver the fluid to the grinding zone. However, the importance of nozzles and other parts of this delivery system on grinding wheel performance was the subject of a recent program at the Grinding Center.

There is not much research specifically on nozzles for grinding applications so background information came from the research in fire hose technology. Research by others showed that shape of a nozzle has great effect on the stream of fluid as it leaves the nozzle, and small eddy currents and secondary flows within a hose can slow the flow. Transitions at connectors create destructive flow patterns that persist through even long portions of hoses or pipes. These effects of secondary flows can be diminished with small honey-combed flow conditioner inserted in the hose.

But are these findings for fire hoses applicable to grinding applications and grinding fluids? Past work at the Center for Grinding Research show that fluid delivery is important, and the volume of fluid needs to exceed a certain amount before it benefits grinding. So the Research Center conducted a number of studies on the effects of nozzle design that included measurements of the influences of fluid flow rates, wheel speed, and wheel structure, as well as the effect of fluid delivery on grinding efficiency.

Research results

Test results show that secondary flows can be a serious problem. The lengths of pipe within a typical system are far too short to attenuate the effect of elbows and transitions along the fluid path. The cooling effects of the grinding fluids can be changed significantly by good nozzle design and optimum wheel characteristics. Nozzles designed with a convex internal surface and smooth surface finish increase the available flow rate to the process. The shape and size of the aperture (the opening in the nozzle for fluids) affects the shape of the jet stream. The greater the discharge distance for a nozzle, the more difficult it is to aim the jet.

Research conclusions are:

1. The proper delivery of coolant is affected by the nozzle design. In particular nozzle geometry, surface finish, nozzle fillets, break-edges and size of opening are very important.

2. Matching the speed of the fluid to wheel peripheral speed is best.
3. Burn can be reduced when fluids exceed a critical speed in the grinding zone and sufficient flow is available.
4. The coolant delivery systems should be designed with attention to changes in the shape and size of hoses, pipes, and connectors. Important are nozzles, nozzle positions, flow rate settings, pump capacity, flow conditioners, large diameter straight pipes, and flexible hoses. Increasing nozzle distance tends to reduce the cooling performance of the grinding fluid especially with nozzle designs that produce low coherence jet streams. A single or a cluster of round nozzles can replace expensive profiled nozzles.
5. In creepfeed grinding applications, a second nozzle is necessary to prevent burning on the back edge of the workpiece. The second nozzle should not reduce the flow of the primary nozzle when there is limited pump capacity.
6. With induced or high porosity wheels, water-based fluids give higher stock removal rates than straight oils. The opposite is true for wheels with dense structure.
7. Refrigeration of fluids will improve stock removal rates.

With care and attention to details of the grinding fluid delivery system, grinding fluids can keep parts cooler and improve the performance of the grinding wheel.