An oelSmart® approach to heat management; grinding oil, filtration and monitoring for optimal cooling

Modern grinding systems are extremely sensitive to the slightest change in temperature. With high or fluctuating temperatures, tolerances on precision parts cannot be guaranteed and even minuscule temperature variations can have a negative impact on part quality, especially when it comes to micro tools.

Grinding fluid manufacturer oelheld UK Ltd is encouraging toolmakers to be oelSmart when it comes to managing heat within grinding processes through the selection of an appropriate grinding oil and coolant filtration unit, along with proactive monitoring of the system as a whole.

Heat generation in the grinding process

During the grinding process, heat is generated by friction and other forces involved in particle removal from the workpiece. The resulting thermal energy is distributed between the workpiece, debris, grinding wheel and coolant and released into the machine enclosure. The degree to which heat is transferred between each element can vary greatly depending on the application setup.

Research has shown that in circumstances of poor or inadequate cooling, the workpiece can absorb as much as 43 percent of the thermic energy created, the swarf 30 percent and the coolant as little as 16 percent. Such conditions present the risk of micro-crack formation and inconsistencies between parts, which may fail to meet defined tolerances due to material expansion caused by increased temperatures, ultimately leading to higher scrappage rates.

By comparison, optimised cooling conditions can alter the heat distribution dramatically. It is possible to direct up to 60 percent and 26 percent of the heat generated to the swarf and coolant, respectively, with the airspace and grinding wheel receiving 11 percent in total, leaving just 3 percent for the workpiece to contend with.

The role of cooling lubricants

Cooling lubricants can be classified as water-miscible (emulsion or solutions), or non-water-miscible (mineral, semi-synthetic or fully synthetic) oils. Both categories offer lubrication, cooling, cleaning, flushing, and protection against corrosion but there can be marked difference between the performance and suitability of each when it comes to grinding processes.

Historically, water has been used within many metalworking applications to provide cooling. Water has twice as much heat capacity and five times as much thermal conductivity as oil but since water evaporates at 100˚C (212˚F) and turns to water vapour, which has no lubricating effect and is a poor thermal conductor, it has limited uses in contemporary manufacturing processes.

While water-based solutions and emulsions are often used during conventional grinding processes, non-water-miscible cooling lubricants with boiling points of at least 240˚C (464˚F) and which contain special friction-reducing properties are required as grinding speeds increase.

In today's high-speed processes therefore, a semi or fully synthetic grinding oil is required with additives specifically designed for top performance under high temperatures to provide: lubrication, which reduces friction and heat generation; reduced foaming, which can get impede cooling; flushing properties to remove debris which can retain a large proportion of thermal energy.

In the selection of a suitable coolant, a grinding oil's performance over time is also an important consideration from a productivity perspective. The additives found within a high-quality product will be better able to withstand the high temperatures of modern-day grinding in the long-term, and so require changing less frequently.

The role of filtration

Alongside careful coolant selection, effective filtration that ensures grinding oils are not only optimally filtered, but cooled too, is a prerequisite for high-speed toolmaking. This is something microfiltration system manufacturer VOMAT GmbH understands well and the reason why the German manufacturer has placed such an emphasis on the development of accurate and precisely controlled cooling systems.

As well as ensuring oil filtered to NAS7 purity, 3-5 µm, is readily available for delivery to the workpiece through full-flow filtration with 100 percent separation of clean and dirty oil, VOMAT's range of standalone and centralised systems come equipped with in-built and optional add-on cooling technologies, providing continuous oil cooling to pre-set temperatures when in continuous micro-filtration mode as standard.

For the smaller VOMAT units, up to the FA240 model, which are designed to serve

just one or two machines, this comes in the form of an integrated, easy-to-service, AC compressor unit with an in-built condenser mounted in the lid of the unit's access hatch. If additional cooling is required, a cold-water heat exchange which can be operated using plant-wide cold water cooling systems can be integrated, as can modules that provide drive or spindle cooling, if a machine requires it.

In all cases, VOMAT's innovative technology offers temperature accuracy of +/- 0.2K, within an ambient room temperature of 15-35˚C, making them an ideal option for precision grinders for whom temperature control is a priority.

The role of ongoing monitoring

Another crucial aspect of temperature management is ongoing monitoring. As part of the company's strategy to support customers in taking a proactive and holistic oelSmart approach to the management of grinding fluids, oelheld UK Ltd has recently introduced oelSense remote monitoring service.

Making use of wireless sensors installed at critical points within filtration equipment, oelSense systems provide 24/7 real-time monitoring of key filtration variables such as oil level, flowrate and temperature, which could affect production. The technology allows for automated alerts should any variable fall out of tolerance, which can prove particularly useful for volume batches or overnight runs.

The service means customers can walk away from jobs safe in the knowledge that should any of the monitored variables change, they'll be notified straight away. For oelheld customers who hold a service contract with the company, those notifications can be sent directly to the company's team of service engineers.

Ultimately, effective temperature control is a crucial element in the production of modern precision tools to meet increasingly high customer expectations in terms of performance, service life and surface finish. However, in addressing the issue, it is possible that toolmakers may be able to find a way to add value and a potential source of competitive advantage through improved productivity and tool quality, by taking a proactive and whole-system approach.

To discuss your coolant, filtration, or ongoing monitoring requirements, contact oelheld UK's team of technical engineers who will be happy to provide advice relating to any aspect of your metalworking fluid system.

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