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Micro-Improvement

Advanced lubricants and nozzles improve fluid-mist systems.

Imagine tripling parts production while extending tool life and significantly reducing the use of cutting fluids, coolants or lubricants. It's possible with a fluid-mist-dispensing system.

With these systems, which have been around for many years, the lubricating fluid used makes up less than 1 percent of the air-fluid mixture. As a result, the lubricant is essentially consumed during machining. No residue is left on the machine or workpiece, nor is there any airborne mist.

Now, lubricants containing extreme-pressure additives (EPAs) and improved dispensing-nozzle designs have led to the development of "microdispensing" systems. They perform even better than traditional mist systems.

Technological Developments

Effective delivery of a mist depends on the kinetic energy [$KE=\frac{1}{2}mv^2$] of the mist particles carried by the airstream. Increasing the particle size marginally increases the kinetic energy. But increasing the velocity raises the particle's kinetic energy by the square of the velocity. That represents a large increase.

Advances in nozzle designs have improved lubricating performance substantially by increasing the velocity of the lubricant-carrying airstream. This allows a high-velocity airstream to be directed at the tool/workpiece interface while minimizing the tearing effect—the propensity to form droplets—in the lubricant.

Older designs induce rapid decompression at the nozzle tip, which reduces velocity dramatically as the air-lubricant mixture is delivered. This creates a tearing of the lubricant into droplets with very little mass, thereby reducing the droplets' striking power, or kinetic energy. Additionally, since a droplet's mass is lighter than air, the result is more like fog than a well-directed stream.

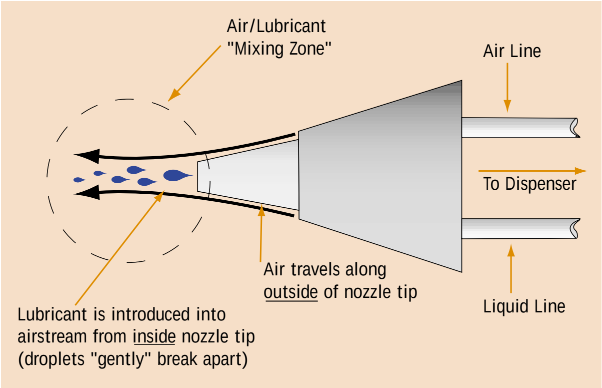
Tests performed on earlier nozzles illustrate a severe reduction of lubricant being delivered to the workpiece at distances greater than 3". And less than 30 percent of the lubricant actually made it to the test surface at a distance of 6" from the nozzle. This means that 70 percent of the lubricant either remained suspended in the air as a fog or settled onto machine surfaces and the shop's floor—everywhere except where it was needed.

Newer nozzles deliver 90 percent of the lubricant to the same test surface. The improved design utilizes laminar airflow along the outside of the nozzle. The lubricant and air are carried in their own separate, dedicated lines. The lubricant, which travels inside the nozzle tip, is introduced into the airstream outside and in front of the tip. This external laminar flow eliminates the rapid decompression of the air-lubricant mixture. With the new design, droplet mass increases to a point where excess lubricant does not remain airborne as fog, since the resulting droplet mass is heavier than air.

In addition, new developments in lubrication technology have enhanced lubricity.

The improved lubricity makes the fluids extremely effective at reducing premature tool wear and allows higher material-removal rates. When properly formulated, the lubricants are almost invisible on the tool and workpiece.

Many of these lubricants are formulated with approximately 90 percent base material, with the remaining 10 percent consisting of high-performance additives to improve stability under extreme pressure. The base material can be a synthetic, semisynthetic or vegetable oil. The result is a lubricant with a high performance-to-quan-



All images: Trico Mfg.

With a microdispensing unit, lubricant and air are carried in their own separate, dedicated lines, and the air and lubricant mix outside and in front of the nozzle tip, where the droplets "gently" break apart while retaining a mass that's heavier than air.

tity ratio. When applied to the tool/workpiece interface as a high-velocity fluid stream, tool wear and operating temperatures are reduced significantly.

Applications

Tapping is one operation where microdispensing, combined with the proper lubricant, excels. In one application, a vegetable-based lubricant reduced the number of 12-28 nitrided taps required for tapping 304 stainless steel castings. Before switching to the vegetable-based lubricant, each hole required a two-step tapping procedure and tool life was 35,000 to 40,000 individual operations per tap. After switching lubricants, each hole required only a single tapping procedure and tool life increased to 55,000 to 65,000 holes per tap. The improvement resulted in a 25 to 33 percent reduction in process time for the job. Also, since cleanup was eliminated, additional savings were gained prior to plating the finished parts.

Milling is also a good fit for microdispensed lubricants. The high-velocity air ensures excellent chip clearance and lubricant application. Both feed and speed rates can be increased significantly without reducing tool life.

Delivering coolant or cutting oil by traditional spray methods is less cost-effective than microdispensing. A direct comparison was performed for a milling operation by first spraying coolant and then switching to microdispensing. Spraying required over 2 gals. of coolant while microdispensing required less than 2 oz. to do the same job. When such small amounts of lubricant are delivered to the cutting zone, there is no airborne mist or residue produced—and operator safety is enhanced.

Turning most metals is also greatly enhanced with microdispensing. Reduced tool wear or higher mrrs are, in many cases, an immediate result.

In an application that involved turning a nylon part, heat reduction was critical to prevent the workpiece from melting. Flood coolant allowed the speed to be increased, but the nylon continued to melt. Microdispensed fluids, however, prevented heat buildup, allowing the nylon chips to remain brittle and break. Microdispensing also improved part finish and permitted a 20 percent increase in speed and a 10 percent boost in the feed.

Microdispensing can make drilling more efficient, too, since the high-velocity air carries the lubricants into the hole more effectively. Reduced cycle times, longer tool life, reduced chip welding and improved finishes have been realized.

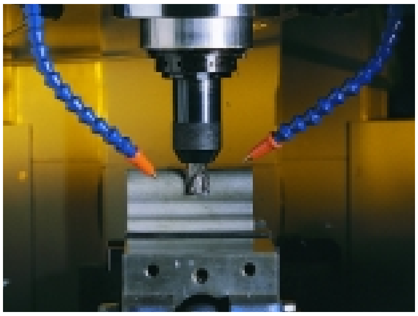
Bandsawing is yet another operation that benefits from microdispensing technology. By precisely directing the nozzles at the blade, it remains clean and effectively lubricated.

Microdispensing with advanced fluids has proven effective when sawing structural shapes up to 6". Interrupted cutting is also enhanced, because the lubricant remains on the bandsaw blade between cuts.

Operational Savings

Besides saving on fluid costs, microdispensing can be a profit center. Producing dry chips increases their scrap value. And since microdispensed lubricants make up less than 1 percent of the air-lubricant mixture, post-machining lubricant residue on chips is practically nonexistent.

Moreover, microdispensed parts that require heat treating, plating, painting or anodizing no longer require intensive cleaning after machining. Additionally, part-cleaning solutions last longer, finishing costs are reduced, and machine surfaces, shop floors and tools are cleaner.



Microdispensing coolant via a focused, high-velocity airflow reduces coolant consumption dramatically.

Microdispensing is an alternative to flood and spray cooling for many applications, but each method has its place. When all three methods are available, a shop's lubricating and cooling arsenal is complete.

Many lubricants designed for microdispensing are biodegradable. By utilizing biodegradable vegetable oils, such as corn or soybean, environmental safety is ensured should spillage or overuse occur. In many cases, vegetable oil-based lubricants provide higher levels of performance than mineral oil-based lubricants.

While no single lubricating or cooling method works for every metalcutting operation, by understanding the benefits and limitations of flood cooling, spray cooling and microdispensing, appropriate choices can be made for your shop's operations.

About the Author

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