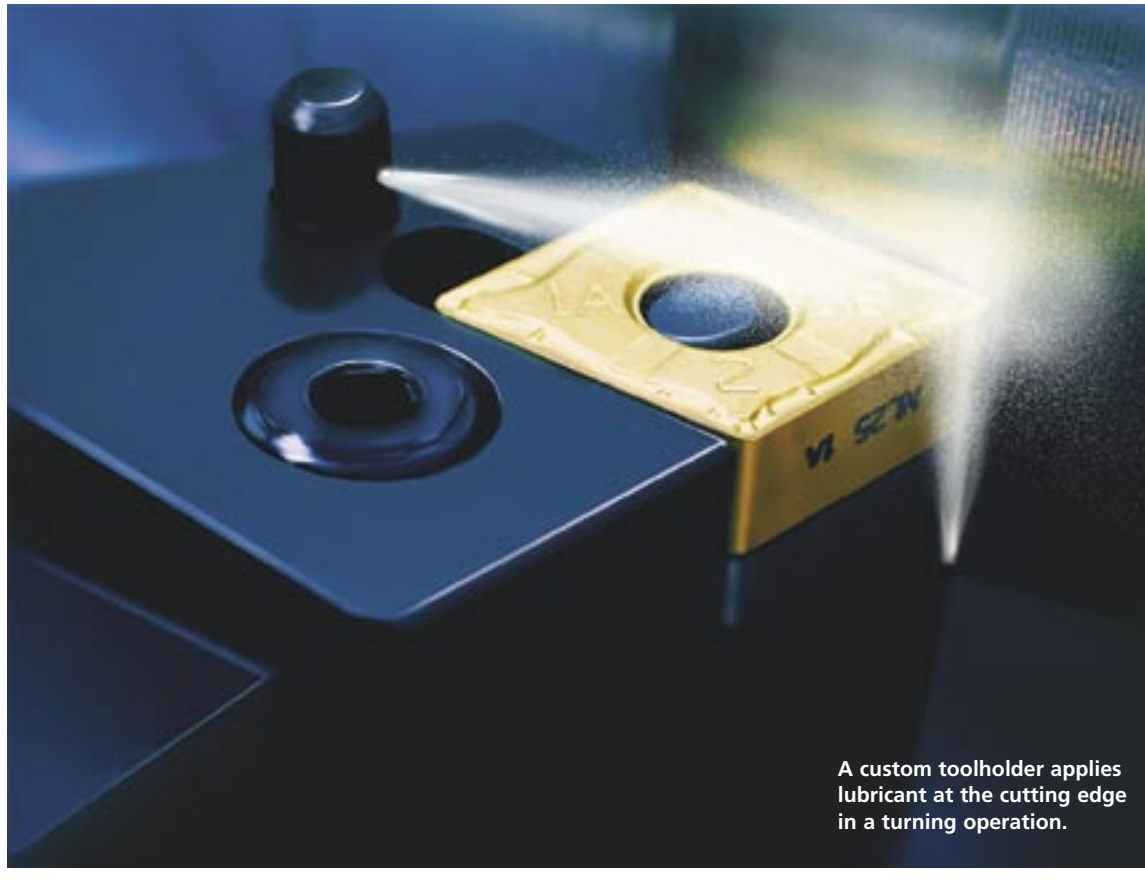
➤BY SUSAN WOODS, FEATURES EDITOR

Nearly Dry



A custom toolholder applies lubricant at the cutting edge in a turning operation.

Fuji BC Engineering

Equipping existing machine tools to perform near-dry machining.

Although near-dry machining has been around for more than 50 years, it is still not a common practice. This is surprising considering the benefits of near-dry over conventional methods.

With near-dry, because so little lubricant, usually vegetable oil, is used, fluid treatment and disposal are eliminated. Near-dry also means fewer health problems for workers, such as skin irritations and respiratory problems. It can be used for all metalcutting operations, in both ferrous and nonferrous materials.

A big part of getting over the hurdle is stopping people from thinking they have to see this massive amount of flood coolant for it to be working.

Even with all these benefits, manufacturers are reluctant to switch to near-dry machining. Because the machine tools are only equipped for conventional methods, they assume that is what they should be doing.

"A big part of getting over the hurdle is [stopping] people [from] thinking they have to see this massive amount of flood coolant for it to be working," said Rob Myers, business unit manager for Accu-Lube, a lubricant and equipment division of ITW Rocol North America, Glenview, Ill.

While external—meaning external nozzles are used—near-dry machining has been around a long time, what recently has become the focus is internal near-dry machining. "The push in the last 7 years or so has been to develop near-dry machining that utilizes

through-coolant tooling systems," said Myers.

Making the Change

So what does it cost to reconfigure a machine tool that has flood coolant or through-coolant capability to near-dry machining? "It is not as expensive as one might think," said Wally Boelkins, president of Unist Inc., Grand Rapids, Mich. "A machine can be converted fairly easily. It depends on the machine. Through-coolant would be more expensive, but, in any case, it would be difficult to exceed $5,000."

However, converting to internal or external near-dry machining does require some equipment and tooling changes to be made. These include adding a system that will precisely apply the lubricant and choosing the appropriate cutting tools. Users must also consider a method for removing chips.

Just about any machine equipped for flood coolant can be converted, but "every machine has to be evaluated separately, not just by type, but by manufacturer design," said Boelkins.

With external near-dry machining, the lubricant is carried by compressed air to the nozzle tip. The nozzle is positioned to spray the lubricant toward the tool/workpiece interface.

Controlling the amount of lubricant delivered is important. According to Terry Peterson, vice president and marketing manager for Aetna Manufacturing Co., Kenosha, Wis., a common misconception is that more lubricant is better. "A lot of times, people use too much lubricant and fog up an area with overspray. The ideal setting is when the lubricant is used up during the cut so there isn't overspray or foggy situations," he said.

For external near-dry, dispensing systems consisting of reservoir metering pumps and valves are mounted on the machine exterior. Nozzles are mounted and aimed directly at the tool's cutting edge. The nozzles can be "snap-together" plastic, steel or copper. They are much smaller than those required for flood coolant.

There are some drawbacks to external near-dry machining. With the nozzles, the lubricant and air cannot reach some tool/workpiece interfaces, such as the bottom of a deep hole being drilled. Also, the nozzles may interfere with automatic toolchangers.

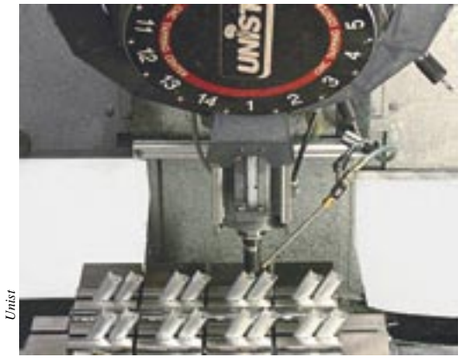
With internal, or through-coolant, near-dry machining, the lubricant is mixed with compressed air, then fed to the cutting edge through the holes in the cutting tool. In some systems, the lubricant and air are mixed before they enter the spindle, and the lubricant is kept suspended in the air until it gets to the cutting edge.

"What we are doing is taking the lubricant itself and breaking it up into tiny little particles and then transferring the lubricant through a stream of air through what was already there—the channels for the through-coolant tooling," said Myers.

In other systems, the lubricant and air are kept separate as long as possible. "With high-pressure coolant, there is usually a rotary union in the spindle and we convert that over to a coaxial arrangement to keep the air and lubricant separate until they get up to the toolholder," said Boelkins.

Will It Work?

When converting to through-coolant near-dry machining, the first step is to perform an evaluation to see if the machine tool can accommodate this method.


Unist

Sixteen saw nozzles are milled while an external dry-machining nozzle applies lubricant.

Myers, referring to the lubricant-suspended-in-air system, said that first, they bring in a demonstrator unit and show the customer what it takes to hook it up to the current system. "We blow air and lubricant through the machine's through-coolant tooling system and see if the mist comes out the end of the tool. It usually only takes about a half hour to find out if a machine is going to be compatible or not."

If it doesn't work, the next step is to find out where the lubricant is collecting. It can collect in a number of places, including the rotary union in the spindle and around the toolholder.

Often, there are many turns in the channels of through-coolant tools, which means the lubricant/air mixture has to change directions. "Many designs used for through-coolant will not work with the near-dry method," said Myers. "With conventional coolant, you are just filling up all the channels with liquid. Once there is no place else for the liquid to go, it will come out the end of the cutting tool. Imagine having a heavy mist of oil floating through compressed air trying to make all these turns. You need smooth, even direct flows from the coolant pump, through the channels and out of the cutting tool."

Unist

A Unist machinist loads parts into a Brother CNC machine to perform near-dry machining.

At the Cut

With external near-dry machining, the same cutting tools used for flood coolant will work. However, for through-coolant near-dry, the user may need to invest in new tools to optimize the operation.

Round (solid) cutting tools are usually not a problem, but coolant-fed tools with inserts are a different story. The configuration needs to be such that the direction of the flow is not disturbed.

"The main consideration when you are designing cutting tools for near-dry machining is that the flow of the oil/air mixture be disturbed as little as possible," said Bruce Carter, rotating product manager, Sandvik Coromant Co., Fair Lawn, N.J. "The more places the flow changes direction, the more chance of the oil separating from the air." Maintaining air/oil velocity is key.

The larger the diameter of the cutting tool, the more the lubricant/air mixture has to change direction to reach the inserts. It comes through the center of the spindle and the toolholder, but then has to bend to reach the OD.

"With larger tools, the coolant flow has to change direction to get to the perimeter of the tool," said Carter. "The best you can do is try to make the bend as gradual as possible, instead of making a sharp turn. You need to change how the coolant channels are put into the tools."

Removing Chips

"A misconception on the part of some machine designers and builders is that they need flood coolant to get rid of chips," said Boelkins.

In fact, flood coolant can complicate chip evacuation. When chips are wet they have a surface-tension property to them, and tend to adhere to the machine surfaces. "But if you have chips with a thin layer of nonoxidizing lubricant on them, gravity takes over," Boelkins said. "They fall to the bottom of the machine."

Myers recommends using external air-only blow-off nozzles to clear chips. "We don't recommend trying to use the oil/air mist, because if you do, it will simply blow the lubricant right past the cutting edge and you have to be careful that you don't create oil mist in the air."

In Combination

Can the machine tool still be used for conventional coolant once the near-dry equipment has been added? The answer is yes, but with concessions.

For external near-dry machining, "we don't destroy the flood coolant system when we put our equipment on," said Boelkins. "That doesn't mean you can do a 3-minute changeover and be back to flood coolant, but it is possible."

For internal near-dry machining, Myers said the user could conceivably use two ball valves with a Y configuration to feed the rotating union at the top of the spindle with either the high-pressure coolant or lubricant/air mixture.

"You would need to program it so one valve closes while the other is open, because you would not want the coolant to backflow into the mist delivery system," he said.

Whether internal or external, manufacturers can reduce costs by switching from conventional coolant to near-dry machining. But a lot depends on "the material being machined, the tool, the coating on the tool, the speeds and feeds, and many other factors," said Boelkins. △

The following companies contributed to this report:

Aetna Manufacturing Co.
(262) 654-1170
www.aetnamfg.com

Haas Automation Inc.
(800) 331-6746
www.haascnc.com

ITW Rocol North America
(800) 452-5823
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Sandvik Coromant Co.
(201) 794-5000
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Unist Inc.
(800) 253-5462

Help from MOM

Haas Automation Inc. doesn't build machine tools specifically for near-dry machining, but it does have a new option that allows its machines to do just that.

The Minimum Oil Machining (MOM) system for newer Haas vertical machining centers and gantry routers consists of an externally mounted fluid reservoir with integral pump and a programmable nozzle that injects a precisely aimed, high-velocity stream of coolant directly onto the cutting tool.

The MOM injector mounts in tandem with the Haas programmable coolant nozzle, which is adjusted for the length of each tool via entering M code in the CNC or manually from the control panel.

"Essentially, you are able to attain different positions up and down," said Dave Hayes, product manager at Haas, Oxnard, Calif. "So, for instance, if you change to a longer tool, then you adjust the nozzle to the appropriate height with a button on the front pendant and change a setting in the control for unattended operation. There are 20 different positions."

The MOM system can be programmed to deliver a specific amount of lubricant to an individual tool during canned cycles, or can be pulsed continuously to deliver a minimal amount of lubricant for near-dry machining. However, the system injects a measured stream of liquid rather than an aerated mixture, so switching from wet to near-dry on the same workpiece is easy. "The difference from traditional near-dry is in our delivery," said Hayes. "We technically aren't misting. We're actually injecting or shooting a packet of oil at the cutting tool."

Easily switching between wet and near-dry machining helps with chip removal, as the user can use flood coolant to wash away the chips. Or, chips can be removed using the automatic air-gun option.

—S. Woods