▶ BY AGNES SHANLEY, CONTRIBUTING EDITOR

Mist Collection: The pressure is On

Lower-cost, more-compact mist-collection systems target atomized particles from high-speed cutting operations.

In today's challenging economy, mist collection isn't high on many manufacturers' capital expenditure priority lists, particularly since the strict air-quality standards (see sidebar, page 48) recommended by the U.S. Occupational Safety and Health Administration and National Institute for Occupational Safety and Health have yet to become law.

Most companies would rather buy a new machine than install an air cleaner, said Bill Wesche, sales director at Metal-Fab Inc. of Wichita, Kan., which manufactures Micro Air clean-air systems.

The level of interest in air quality often depends on company size, said Steve Hall, sales manager with Monroe (Mich.) Environmental Corp. "Auto industry suppliers are addressing the issue, but, with the mom-and-pop-type shops, it's hit or miss."

Given the potential worker health risks involved, more metalcutting facilities would do well to make indoor air quality a priority. Posing the greatest threat are atomized mists, whose particle diameters are measured in tenths of a micron. And with the growth of high-speed machining practices, these mists are becoming more common (Figure 1) at companies, many of which are using mist-collection systems that only remove much larger, micron-size particles.

For example, more users of Swiss-style machines are incorporating high-pressure coolant pumps, said Ira Golden, vice president of sales and marketing at Air Quality Engineering Inc., Minneapolis. Where, traditionally, pumps would operate at 300 to 800 psi, today some pumps are running at up to 2,000 psi, Golden said. "They're atomizing the heck out of their cutting fluids, and collection can be a problem."

Traditional mist-collection technology, such as filters, rotating drums or cyclones, collect particles about 1µm in diameter but don't work, by themselves, on smaller particles. In addition, studies conducted by researchers at the University of North Carolina at Chapel Hill have shown that fibrous filters, once they're wet, lose efficiency over time (Figure 2).

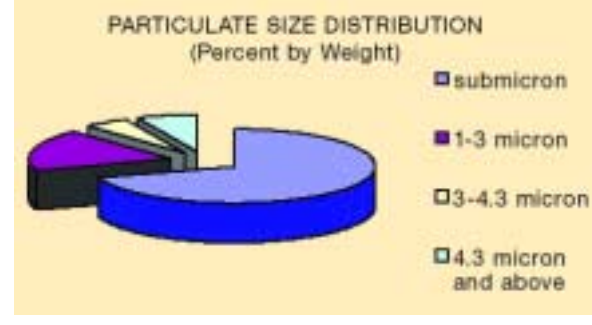
The best options for removing submicron mists are high-efficiency particulate air (HEPA) filters, electrostatic precipitators (ESPs) and fiber-bed systems. Each has drawbacks. HEPA filters are expensive and can become clogged, losing their effectiveness. Disposable filters mean hidden replacement costs and can result in costly maintenance and disposal. ESPs require frequent maintenance and cleaning. Fiber-bed systems, meanwhile, offer high collection efficiency and easy maintenance, but are typically larger and require more horsepower to operate.

No single mist-removal system offers a panacea, but the technology is evolving steadily. Vendors are improving and combining mist-collection technologies, and they're offering new, more-compact systems that allow users to meet proposed indoor air-quality standards at a lower cost.

Electrostatic Precipitators

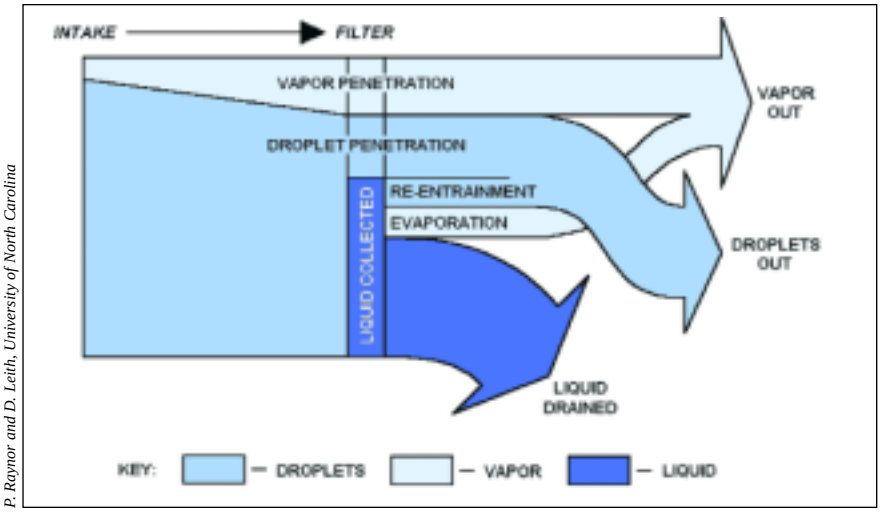
Electrostatic precipitators use charged collector plates in either wet or dry form (Figure 3). A static charge is placed on mist particles, which are then drawn to oppositely charged plates.

Maintenance is an issue. "We tried ESPs, but they required lots of cleaning. We had to have a guy come in just to clean them and it got to be pretty ex-



Enviro-Chem Systems

Figure 1: Cutting and grinding operations, particularly those that run at high speeds and temperatures, generate submicron-particle mists. Shown here is the mist-particle-size distribution resulting from grinding.



P. Raynor and D. Leith, University of North Carolina

Figure 2: At the filter, some droplets and volatiles will be removed from the air, but the remainder pass through and are re-entrained. Some wind up being retained "indefinitely" and, over time, can reduce filtration efficiency. The best filters maximize droplet removal and minimize evaporation and re-entrainment at a reasonable pressure drop.

pensive," said Kirk Worounig, engineer with NTN Bearing Corp. of Canada Ltd., Mississauga, Ontario. The company ultimately chose fiber-bed technology and is installing its 13th Enviro-Chem unit.

ESPs, working alone, typically don't provide mist-removal efficiency over 98 percent. Air Quality Engineering, however, has developed a two-pass ESP system that offers 99.9 percent removal efficiency, according to Golden. The system was introduced about 6 months ago, he said, and allows users to meet the recommended 0.5mg/m^3 per 8-hour period NIOSH limit for machining-fluid mist without the need for additional HEPA filtration.

The unit features a four-stage filtration process. In the first, mechanical mist impingers capture large mist droplets, which are transferred to a coolant sump. Then a second-stage ESP collects smaller atomized contaminants, and a third-stage ESP catches most remaining particles. A fourth-stage post-filter, made of aluminum, traps any particles that may pass through the ESPs.

No Consumable Filters

MistBuster Quad, a 1,250-cfm unit, requires no consumable filters. Designed with nominal pressure drop, it can be driven by a fractional-horsepower motor instead of the 1- to 3-hp motor typically required, and it can run on less than 500 watts.

Trion Inc., Sanford, N.C., offers modular ESPs and has developed automated cleaning systems for its larger units. "Cleaning is a given, at some point, since you're taking garbage out of the air," said application engineer Wayne Breeding. However, automated systems make it a "nonissue," he added.

As an alternative to an ESP for smaller facilities, Trion recently introduced the Air Boss Mist Arrestor, a three-stage mist-removal device. The compact system, available in 600- and 1,200-cfm sizes, uses a combination of particle agglomeration and filtration to achieve 98 percent removal efficiency, as measured by American Society of Heating, Refrigerating and Air-Conditioning Engineers standards. *(Agglomeration is a process by which smaller particles consolidate, forming larger particles that can be more easily removed.—Ed.)* Customers can achieve mist-removal of 99 percent and above by fitting a HEPA filter onto the system, he said.

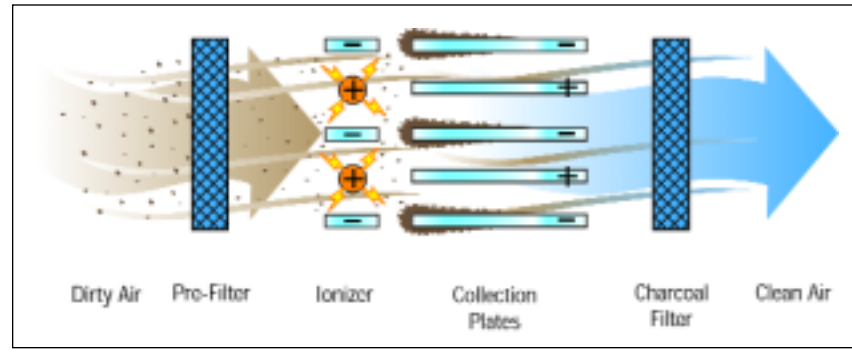
Air Boss MA was designed to reduce maintenance and energy requirements. Instead of impingers, chevrons and filters, which would need to be stocked and replaced, the system uses multi-layer agglomerating filters that can be cleaned and reused. (*Chevron collectors feature a characteristic V-shaped baffle angle.—Ed.*) Air Boss MA allows both filtered oil- and water-based coolants to be collected for reuse, and uses washable initial and secondary filters to minimize saturation and replacement filter costs.

First, a 12-layer filter pulls out 2µm-dia. particles; smaller particles collect and agglomerate into larger particles, which are then caught by the second, seven-layer filter. A final polishing filter captures remaining materials.

Maintenance becomes a very minor issue, said Breeding. The polishing filter needs to be changed once a year, and the prefilter should be cleaned roughly once or twice every 12 months. A 1,200-cfm unit lists at $4,108. Customers can achieve mist-removal of 99 percent or higher by fitting a HEPA filter onto the system, he said.

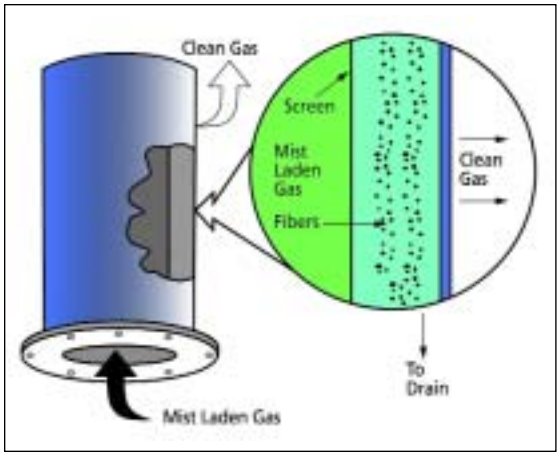
Fiber-Bed Mist Collectors

Fiber-bed collection systems were developed about 40 years ago and are used primarily in chemical process in-



Trion

Figure 3: The principles of electrostatic precipitators are outlined here. Basically, ESPs place a charge on airborne mists, which are then collected on oppositely charged plates that can either be dry or washed continually ("wet").



Monroe Environmental

Figure 4: Fiber-bed systems offer high aerosolized mist removal with low maintenance costs. Shown here, the principle behind a system developed by Koch Industries' Glitsch-Otto York and Monroe Environmental, and now being offered to the metalcutting industry.

dustries. These systems use beds of fiberglass in a cage structure, collecting fluid via Brownian diffusion. *(This is a process by which ultrafine particles, subject to the random forces that result in Brownian motion, move from areas of higher to areas of lower concentration.—Ed.)*

Although the systems can remove 99.5 percent of submicron-mist particles and don't require much maintenance, they operate at high pressure drops, necessitating high-horsepower motors. Their filters typically require a larger footprint than competing technologies, and initial costs are higher than those for filter and ESP technologies.

"Basically, people complained that the units were too big, too expensive and used too much energy," said Roy Durgan, product manager at St. Louis-based Enviro-Chem Systems, whose parent, Monsanto, invented the first commercial "Brink" fiber-bed technology.

Enviro-Chem has addressed fiber-bed's limitations with its MistGard M3, which requires roughly half the horsepower that its predecessors did and is far more compact. The new device can be mounted on the ceiling or directly on the tool, Durgan said. A 1,000-cfm unit costs roughly $3,000, compared with $8,000 for previous versions of the equipment. It also allows the fluid to be recovered, in pure form, and be returned to the process stream.

Also offering fiber-bed technology is Glitsch-Otto York, Wichita, Kan. Glitsch, in partnership with Monroe Environmental, started marketing to the metalcutting industry about 18 months ago (Figure 4). A fiber-bed's higher initial costs, relative to ESP and HEPA systems, are offset by much lower operating and maintenance costs, said Glitsch's Greg Boles. In harsh turbine applications, he said, some customers have used the same beds for over 20 years.

In metalcutting applications, a fiber-bed system offers an excellent investment for submicron-mist removal, provided that good dust collection and prefilter systems remove larger particles from the atmosphere. List prices for small units up to 1,000-cfm range between $7 and $10 per cfm, said Monroe sales manager Steve Hall. For larger units, however, list prices drop to between $3 and $4 per cfm.

'Recommended,' not 'mandatory'

Airborne cutting-fluid mist particles have been linked to skin problems such as contact dermatitis, as well as a number of respiratory problems, including asthma, bronchitis and "machine operator's lung," or hypersensitivity pneumonitis, which affects the alveoli. In addition, exposure to the liquids, typically mixtures of oils, detergents and lubricants, has been linked to elevated cancer risks.

Ten years ago, the United Auto Workers asked OSHA to cut the permissible exposure limit (PEL) for workers handling machining fluids from 5mg/m^3 to 0.5mg/m^3 per 8-hour period. Many suppliers have already adopted this standard, which NIOSH has also recommended.

In 1999, OSHA issued new recommendations for an 8-hour, time-weighted PEL of 0.5mg/m^3 total particulate, and released a "best practices" manual in November 2001. However, the limits are still recommended, rather than mandatory, and, at this point, OSHA says that it has no plans to enforce them.

—*A. Shanley*

For more information and a summary manual of OSHA's "best practices" for controlling mists of these and other metalworking fluids, please visit www.osha-slc.gov/SLTC/metalworkingfluids/metalworkingfluids_manual.html.

The following companies contributed to this report:

Air Quality Engineering Inc.
(800) 328-0787
www.air-quality-eng.com

Chip Blaster Inc.
(814) 724-6278
www.chipblaster.com

Enviro-Chem Systems
(314)275-5782
www.enviro-chem.com

Hench Mfg. Inc.
(949) 492-0125
www.fogbuster.com

Metal-Fab Inc.
(316) 943-2351
www.microaironline.com

Monroe Environmental/ Koch Industries
(800) 992-7707
www.monroeenvironmental.com

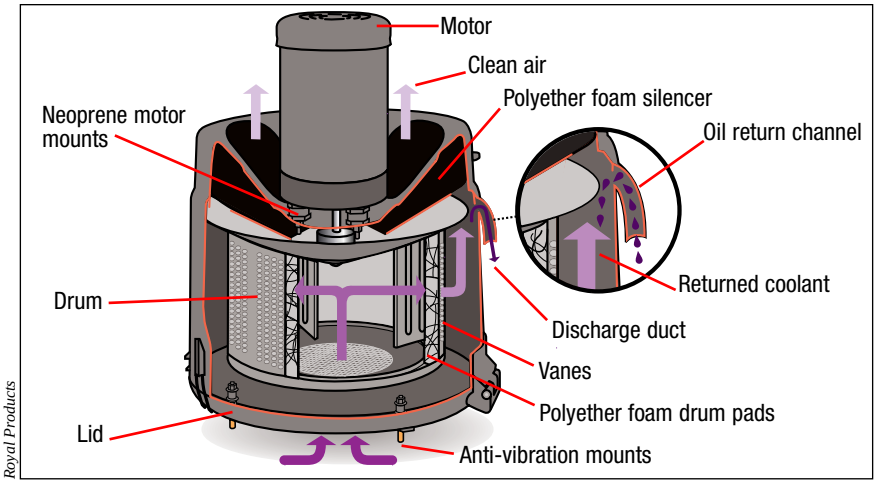
NTN Bearing Co.
(905)564-2700
www.ntn.ca

Royal Products
(631) 273-1010
www.royalprod.com

Sternvent Co.
800-383-DUST
www.sternvent.com

Trico Mfg. Corp.
(262) 691-9471
www.tricomfg.com

Trion Inc.
(919) 775-2201
www.trioninc.com



Royal Products

Figure 5: Mechanical systems are economical, but require pre- and post-filtration systems to remove submicron particles effectively. In Royal's centrifugal impaction system, shown here, mist particles collide with vanes and coalesce into larger drops, then pass through openings in a rotating drum onto the walls of an outer case and into an oil-return channel, from which they are drained back into the coolant tank.

Mechanical mist collectors have also been improved or incorporated into multistage processes to allow metalcutting facilities to remove higher levels of submicron particles. Royal Products, Hauppauge, N.Y., for example, offers a centrifugal impaction mist-collection system that delivers a 97 percent collection efficiency (Figure 5). Using a cyclone collector as the first stage and a HEPA after-filter would allow for a mist-removal efficiency over 99 percent, said product manager Tom Sheridan. The cost of a mist-removal unit ranges from $1,410 for a 275-cfm model to $2,155 for a 1,200-cfm model, according to Sheridan; the after-filter costs $347 and the cyclone is $600. Royal will release a new design in September, he added.

Utilizing a combination of mist-removal technologies is the MistBlaster. The system, available from ChipBlaster Inc., Meadville, Pa., was developed to work with the company's ChipBlaster high-pressure coolant-delivery system. It mounts on top of the coolant-delivery unit, resulting in a system that combines tramp-oil recovery, mist collection and filtration. This arrangement allows users to meet NIOSH standards, said ChipBlaster President Gregory Antoun.

MistBlaster is programmed so that when the machine doors are closed, it runs just fast enough to create a slightly negative air pressure, e.g., 100 cfm, to prevent the mist from escaping. When the machining cycle ends and coolant shuts off, the unit speeds up to 1,500 cfm for a preprogrammed amount of time—typically 10 to 15 seconds—to increase the rate of mist removal.

Cleaning Up

Given current economic conditions, new equipment purchases may be difficult, if not impossible, to justify. However, there is much at stake, including the need for a healthy, productive workforce.

Chances are your facility already meets, or is well on its way to meeting, proposed air-quality standards. But if you haven't given much thought to mist collection, you might want to start. It's never too soon to prepare for the stricter standards that eventually will come.

At-the-source reduction

A number of new technologies take a different approach to reducing aerosol mists by controlling the amount of coolant delivered to the workpiece. Near-dry machining, or micro-dispensing, is one solution.

In these systems, explained Rojean Thomas, engineering manager at Trico Manufacturing Corp., Pewaukee, Wis., the lubricant is virtually consumed in the machining operation, leaving no residue on machine surfaces or workpieces and no airborne mists. Improvements in nozzle design and in the lubricants themselves have advanced in recent years, she said.

Trico offers Micro-Dispensing fluid-delivery systems that reduce the amount of fluid required by 99 percent. Typically, 1 oz. of fluid is used per 8-hour shift.

Hench Manufacturing, San Clemente, Calif., offers the Fogbuster delivery system, which allows for precise control of coolant delivery to eliminate aerosolized particles. Randy Hench invented and patented a low-pressure sprayer with a new nozzle design in 1993.

The system allows particles to travel along with the air stream, so that the drops do not break up. Hench's Fogbuster is currently being used by Lawrence Livermore National Laboratories, Boeing, Procter & Gamble and a number of other companies.

One university physics department recently opted for the system, Hench said, when they found it would eliminate the need for more-expensive collection and filtration systems.

—A. Shanley