Coolant Maintenance for Machining Operations

Minnesota Technical Assistance Program ■ FACT SHEET

Machining coolants are an important component of metal working operations. Coolants improve machinability, increase productivity and extend tool life by cooling and lubricating the part and cutting tool. When performing these functions coolants can quickly become contaminated with foreign materials, causing coolants to lose effectiveness and develop foul odors. As a result, many coolants are used only for a short time then discarded.

The practice of discarding and replenishing coolants can be costly and wasteful. Developing and implementing a coolant maintenance program can help minimize contamination, prolong coolant life and reduce cost.

Coolant Selection

Coolants affect the overall performance of machining operations, so proper selection is important. Using an unsuitable coolant may lead to premature tool failure or produce an undesirable finish on parts and may shorten the useful life of the coolant. When selecting a coolant determine if it is suitable for the type of metal and machining operation being used and if it will produce the desired finish quality.

Biodegradable fluids—subject to breakdown by bacteria and living organisms—should be considered if coolant spills are likely, or if spent coolant will be discharged to a wastewater treatment system or landspread. The most stable, non-biodegradable coolants give most machine shops the best performance over the longest period. Disposal of these coolants generally includes separating the oil for fuel blending.

Facilities should use the *minimal* number of coolant types. Many metalworking facilities require no more than two types of coolants for their operations, one for machining and one for grinding. Using a large number of coolant types requires extra storage space; adds to inventory and maintenance needs; increases the chance for mix ups and cross-contamination; and requires more staff expertise.

Contaminant Removal and Prevention

Coolants are most frequently contaminated by metal chips and fines, tramp oil, bacteria and dissolved salts. Chips and fines are removed from coolants to eliminate surfaces for bacteria to grow on. Free oils are removed to eliminate a food source for bacteria and surface films that prevent oxygen from dissolving into the coolant. They also can deplete oil soluble components of the coolant and oils reduce the cooling capability of the metalworking fluid. Dissolved salts are removed because they affect tool and coolant life, foaming characteristics, filtering efficiency and emulsion stability.

By removing contaminants, machining facilities can reduce costs by prolonging the effective life of coolants. The table at the end of this fact sheet describes the equipment and techniques used to control and remove the four most frequent contaminants. A good first step is teaching machine operators not to use coolant sumps as trash receptacles. Waste food, cigarettes and other trash cause bacterial contamination and feed bacterial growth.

Coolant Monitoring and Control

When a coolant is in use, heat and contaminants can change its composition and performance. Routine monitoring of coolants for quality is necessary to optimize performance and prevent problems. Include monitoring pH and maintaining concentration in a coolant maintenance program.

pH control. A change in pH can quickly deteriorate coolant quality, corrode metals and irritate skin. Proper coolant pH operating ranges are specified by the manufacturer. For most coolants this range is 8.5 to 9.0. Within the proper pH range, corrosion and bacterial growth are minimized. Drops below the recommended limit may be a symptom of a bigger problem and are most likely caused by excessive bacteria or excessive diluting. Correct these problems first. If needed, pH levels can be increased to the

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recommended range by carefully adding an alkaline chemical like dilute caustic soda. Adding chemicals to coolants on a frequent, ongoing basis can cause problems, such as the buildup of dissolved solids, and indicates that other problems have not been solved. Using low-cost tools for monitoring pH levels such as portable pH meters and pH paper, can help determine when pH needs adjusting. For specific recommendations about maintaining coolant pH, contact chemical or coolant suppliers.

Coolant concentration. Maintaining the proper coolant-to-water ratio is critical because coolants are designed to perform best at specific concentrations. Overly diluted coolant may reduce tool life, and concentrated coolant results in using more coolant than necessary. The same is true for coolant additives. Coolant suppliers can provide information on proper coolant concentrations for specific applications.

Refractometers can provide accurate measurements to determine the coolant-to-water ratio and are fairly inexpensive and simple to operate. Titration kits, supplied by some coolant manufacturers, are another way to maintain proper concentration. Coolant metering or feed pumps can also improve the rate at which coolants are added.

In addition to monitoring pH and coolant concentration, a comprehensive coolant maintenance program should include monitoring tramp oil concentration, suspended solids, alkalinity, spot corrosion of parts and bacteria count.

Contaminant Control and Removal

Contaminant	Control Method	Contaminant Removal Process
Metal chips and fines	Bag and cartridge filters	Over time, small chips and metal fines accumulate and settle in coolant sumps. Coolants should be filtered routinely to remove these contaminants. Usually a 50-micron bag filter is used, followed by a 5- or 10-micron cartridge filter.
	Centrifuges	With high-speed centripetal force, centrifuges can separate very fine, suspended particles from coolant.
	Hydrocyclones	Hydrocyclones help concentrate solids from a coolant. With coolant entering at high speed, the conical shape of a hydrocyclone draws a clean coolant flow upward and forces a heavy solids flow downward. Solids are then removed by filtration.
	Screens and conveyors	Placing metal screens and drag conveyors at coolant sumps will collect the majority of metal chips and turnings.
Tramp oil	Belt and disk skimmers	Used to skim off tramp oils floating on the surface of the coolant, skimmers are designed to fit on top of settling tanks or accessible machine sumps.
	Coalescers	Coalescers contain a series of plates that allow tiny oil droplets to cling together causing the oil to rise at a faster rate, increasing the amount of oil removed.
	Prevent and fix leaks	Repair leaks to prevent tramp oil from contaminating coolant.
	Settling tanks	A settling tank provides a calm environment and ample time for tramp oil to rise to the surface of the coolant. Tramp oil can then be removed using a skimmer. Baffles within a tank help localize tramp oil for more efficient removal.

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Contaminant	Control Method	Contaminant Removal Process
Bacteria (anaerobic)	Aeration	Aeration is the simplest method to control the growth of anaerobic bacteria. Aeration creates an oxygen-rich environment, preventing anaerobic conditions and the growth of anaerobic bacteria. Non-aerated coolant sumps provide ideal conditions for the growth of anaerobic bacteria: water and no oxygen. Anaerobic bacteria break down sulfur-containing compounds in coolants, and generate acidic hydrogen sulfide (H_2S) gas, recognized by its "rotten egg" smell. If bacterial growth is not controlled in the coolant, the H_2S can impede lubricating qualities and can create a corrosive environment that could damage tools and parts. Aeration is accomplished by recirculating the coolant in the sump when the machine is not in operation, or by adding a stirring mechanism or an air bubbler to the sump.
	UV light, ozone, heat pasteurization and chemical biocides	Many other methods are available to control bacterial growth problems. When selecting one, determine if it is compatible with the coolant used and if it will control the bacterial strains present. Coolant suppliers can help determine which method to use for specific applications. Add chemical biocides only when needed. Excess biocide can cause coolant pH to fluctuate and can have an adverse affect on human health, such as aggravated dermatitis. As a last resort for controlling bacterial growth, use an EPA-approved chemical biocide.
	Sump cleaning	Routine sump cleaning controls bacterial growth. When a coolant is replaced, the sump should be chemically or steam cleaned to remove any residual bacteria that could contaminate the new coolant.
Dissolved salts	Water treatment: dionization, reverse osmosis, or distillation	City or well water usually contains significant amounts of calcium and magnesium, making it hard water. It may also contain other minerals and possibly some suspended solids. These contaminants affect tool and emulsion stability. As coolant life is extended these contaminants build up. Hard water minerals can cause scaling on equipment and upset the chemical balance of the coolant. Suspended solids provide surfaces for bacterial growth and can end up as abrasive solids in the cutting zone. Water softening is not a useful treatment method because it introduces sodium salts, which can be corrosive when combined with chlorides and sulfates in the coolants. Using purified water to make coolants generally improves performance and life. If foaming problems occur try blending purified water with city water to create an intermediate water quality.

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Additional Resources

Suppliers of coolants and industrial chemicals can provide recommendations on what types of coolant to use in specific machining operations. Suppliers can also assist with management information that will extend the usefulness of coolants.

The MnTAP reference list, "Coolant Maintenance Equipment and Supplies [#4]," available online at <mntap.umn.edu>, provides information about sources for the equipment identified in this fact sheet.

For More Information

MnTAP has a variety of technical assistance services available to help Minnesota businesses implement industry-tailored solutions that maximize resource efficiency, prevent pollution and reduce costs.
Our information resources are available online at <mntap.umn.edu>. Or, call MnTAP at 612/624-1300 or 800/247-0015 from greater Minnesota for personal assistance.