# Developing a Coolant Maintenance Program for Machining Operations

Minnesota Technical Assistance Program ■ FACT SHEET

Machining coolants are an important component of metalworking operations. Coolants improve machinability, increase productivity and extend tool life by cooling and lubricating the work piece and cutting tool. When performing these functions, however, coolants can quickly become contaminated with foreign materials, which cause the coolants to lose their effectiveness and develop foul odors. For this reason, most coolants are used only once and then discarded.

However, the conventional practice of discarding and replacing once-used coolants is costly and wasteful. Developing and implementing a coolant maintenance program can help minimize contamination, prolong coolant life and reduce the frequency of disposal.

## Developing a Coolant Maintenance Program

An effective coolant maintenance program should address three key issues:

1. Proper coolant selection
2. Efficient contaminant removal and prevention
3. Routine monitoring and control

### Coolant Selection

When developing a coolant maintenance program, a facility needs to evaluate what types of coolants are the most appropriate to use.

Because coolants affect the overall performance of machining operations, it is important to select the proper type of coolant. For example, using an unsuitable coolant may lead to tool failure or produce an undesirable finish on tools, and it may shorten the useful life of the coolant. Therefore, when selecting a coolant, determine if it is suitable for the type of metal and machining operation used, and if it will produce the desired finish quality.

A coolant maintenance program also should be based on using a *minimal* number of coolant types. Most 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 different coolant types requires extra storage space and adds to inventory and maintenance needs.

### Coolant Contamination: Removal and Prevention

Coolants are most frequently contaminated by: chips and fines, tramp oil, bacteria and dissolved salts. By removing these contaminants, machining facilities can reduce costs by prolonging the life and effectiveness of coolants.

A variety of equipment is available for removing each of the four major types of contaminants. The following table describes the equipment and techniques used to remove these contaminants.



(continued)

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| Contaminant | Equipment | Contaminant Removal Process |
|---|---|---|
| Metal Chips and Fines | Screens and Conveyors | Placing metal screens and drag conveyors at coolant sumps will help collect the majority of metal chips and turnings. |
| | Bag and Cartridge Filters | Over time, smaller chips and metal fines will 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 10- or 5-micron cartridge filter. |
| | Hydrocyclones | Hydrocyclones help to concentrate a solids stream from a coolant. With coolant entering at high speed, the conical shape of a hydrocyclone draws clean coolant flow upward and forces the heavy solids flow downward. These solids are then removed by filtration. |
| | Centrifuges | With high-speed centrifugal force, centrifuges can separate very fine particulate and suspended particles from coolant. |
| Tramp Oil | Belt and Disk Skimmers | Skimmers are designed to fit on top of settling tanks or accessible machine sumps. They are used to skim-off tramp oils floating on the surface of the coolant. |
| | Settling Tanks | A settling tank provides a calm environment and ample time for tramp oil to rise to the surface of the coolant. The tramp oil can then be removed using a skimmer. Baffles within a tank help localize tramp oil for more efficient removal. |
| | Coalesces | Coalesces contain a series of plates that allow tiny oil droplets to cling and rise at a faster rate, which increases the amount of oil removed |
| Bacteria (anaerobic) | Aeration | Aeration is the simplest method of controlling the growth of anaerobic bacteria. Aeration creates an oxygen-rich environment, which prevents anaerobic conditions and the growth of anaerobic bacteria. However, nonaerated coolant sumps provide ideal conditions for the growth of anaerobic bacteria: water and no oxygen. Anaerobic bacteria break down the sulfur-containing compounds in coolants, and generate acidic hydrogen sulfide ($H_2S$) gas, recognizable by the "rotten egg" smell. If bacterial growth is not controlled, the $H_2S$ can degrade the coolant's lubricating qualities, and can also create a corrosive environment in the coolant that could attack tools and parts.<br>Aeration can be accomplished by continuing to circulate 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. |

*(continued)*

| Contaminant | Equipment | Contaminant Removal Process |
|---|---|---|
| | Sump Hygiene | Instruct employees that cigarette butts, food scraps, paper and many items from outside the metal working process are contaminated with bacteria and can seed bacteria into the coolant if dropped in the sump. Keep all extraneous material out of the coolant sump. |
| Bacteria (anaerobic) *(continued from page 2)* | 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. |
| | Biocides | In general rely on the automatic additions of brocide contained in coolant make-up additions. Add extra biocide only if all other coolant maintenance techniques are being used fully and odor or other measures indicate high bacteria levels.<br>Many different biocides are available to control bacterial growth problems. When selecting a biocide, determine if it is compatible with the coolant used and if it will control the bacterial strains present. Coolant suppliers can help determine which type of biocide to use for specific applications. |
| Dissolved Salts | Water Treatment: Deionization, Reverse Osmosis, or Distillation | Incoming, untreated water usually contains significant amounts of calcium and magnesium causing it to be "hind." Untreated water also contains other minerals and suspended solids. These contaminants tend to build up as water evaporates and they affect tool and coolant life, foaming characteristics, filtering efficiency, and emulsion stability. Pretreatment removes these minerals and suspended solids. Water softening is generally not a practical solution since it introduces sodium salts, which in turn may be corrosive when combined with the chlorides and sulfates in the coolants. |

**Coolant Monitoring and Control**

While a coolant is in use, heat and contamination can change the coolant's properties and composition. Routine quality control and monitoring of the coolant is necessary to optimize performance, and to prevent or anticipate future problems. Therefore, a coolant maintenance program should include monitoring coolant pH and concentration.

- **pH Control.** A change in pH can quickly deteriorate coolant quality, corrode metals and promote skin irritation. The proper coolant pH level is between 8.5 and 9.0. At this level, corrosion is minimized and bacterial growth is less likely to occur. If the pH is lower than 8.5, neutralizing agents, such as dilute caustic soda, can be used to increase and maintain the desired pH. Using low-cost tools for monitoring pH levels in-house, such as portable pH meters and pH paper, can help determine when pH adjustment is necessary. 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 optimally at specific concentrations. Overly diluted or concentrated coolant may reduce tool life and result in using more coolant than is necessary. The same is true for coolant additives. Coolant suppliers can provide information on the proper coolant concentrations for specific applications. To determine the coolant-to-water ratio, refractometers can provide accurate measurements, and are fairly inexpensive and simple to operate. Coolant metering or feed pumps can improve the accuracy of coolant amounts used and the rate at which they are added.

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

## Further Information

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.

MnTAP has a reference list available, "Coolant Maintenance Equipment and Supplies," that provides information about sources for the equipment identified in this fact sheet. To request a copy of this publication, or to obtain technical assistance for reducing waste machining coolants, call MnTAP at 612/627-4646 or 800/247-0015.

# Metal Working Fluid Waste Reduction Program

**Gary Hunt, Pollution Prevention Pays Program**

Before an effective waste reduction program can be developed, accurate and current information on waste generation must be edited. Some of the information which should be collected is listed in **Table 1** (see page 5). A log can be used to keep track of how much of each fluid is used by each machine. Using a log to track oil usage will help identify why fluid is being dumped. This may point out areas for better fluid management, training, maintenance, etc. Also, one area which should be stressed in the survey is how the fluid is handled after it leaves the machine. For example, is it segregated, poured into a trench or central sump, discharged to a city sewer, mixed with straight oil, or recovered and reused.

Based on the results of the assessment, a waste reduction program for metal-working fluid can be developed. An active system can maintain fluid performance over extended periods of time and may even eliminate the generation of spent fluid. Such a program is comprised of two major components: (1) a metal-working fluid management program and (2) a fluid recovery system.

**Table 2** (see page 5) lists some components of a comprehensive metal-working fluid management program. The key to the success of any program is to educate and train the machine operators on proper fluid management procedures. They should be informed of the purpose of the program, how it affects them, and the benefits to the company as well as to themselves. The management program should be developed with input from the machine operator as well as the foreman and supervisor. This will help overcome worker resistance to the program.

One of the first steps in establishing a fluid management program is to correct any machine-caused failure in the fluid. This can include excess levels of tramp oil or solids buildup. Most tramp oil comes from leaking fittings which allow hydraulic fluid, lubricating oils and greases into the metal-working fluid. An effective equipment maintenance program should be a part of any fluid management program. This should include a preventive maintenance program to replace seals or other components, tighten fittings, and inspect for leaks. All existing tramp oil removal devices and solids removal devices must be regularly inspected and properly operated.

Criteria for fluid removal also have to be established. This can be based on the experience the machine operator has and carried out on a regularly scheduled basis or by some predetermined basis (i.e. number of hours of operation, results of a quality test, etc.) Regardless of the method selected, a record must be kept of the frequency of changes for each machine. This will help track fluid usage and identify problem areas.

Responsibility for fluid addition, removal and recovery should be under the control of a single person or team. This will allow for proper fluid makeup, sump clean-out, proper handling, replacement of fluid when actually needed, and insure segregation of waste fluid by type. Using the minimum number of fluid types will greatly simplify this process and any recovery operation. A central oil storage/recovery area with feed and return lines to each machine can greatly improve material handling and reduce fluid loss. Alternatively, a single or split chamber sump cleaner can be used to transport the fluid between the machine and the recovery system. Deionized water should be used for makeup to reduce slat buildup in the fluids.

Once a metal-working fluid management program is in place, then a recovery system can be used to reclaim the spent fluid. There are a number of techniques which can be used on-site to recover coolants. These include settling, filtration, hydrocyclone, centrifugation and magnetic filters. The selection of the type of unit(s) which will be used to recover the waste fluid will depend on the level of contaminants (such as tramp oil, solids and bacteria) it contains and the fluid specifications that must be met. If there is not much oil or solids, then an inexpensive settling tank, skimmer or coalescing plate separator may be used. If very high coolant specifications must be met, then a centrifugation system may be necessary.

These systems may be purchased individually or as a complete skid-mounted system. These systems are available with a number of options including automatic coolant concentrate addition, deionized water systems for makeup, automatic timers and fill/empty controls, pasteurization for bacteria control, etc. The cost for complete systems starts at $15,000 and goes up depending on the options, capacity and type of equipment used.

## Correction

In our last issue of Focus we listed the *proposed* regulations for F006 waste subject to the Land Ban. The final regulations in the August 17, 1988 Federal Register made certain changes:

**F006 TREATMENT STANDARDS**

| Constituent | TCLP (mg/1) |
|---|---|
| Cadmium | 0.066 |
| Chromium(Total) | 5.2 |
| Lead | 0.51 |
| Nickel | 0.32 |
| Silver | .072 |
| Cyanides (Total) | (Reserved) |

EPA does not intend to propose and promulgate numerical treatment standards for F006 wastewaters until May 8, 1990. If generated, it will be a "soft hammer" waste until then.

Examples of F006 wastewater include sump collections of floor rinsing, accidental spills, general maintenance, etc.

**TABLE 1: Information on Metal-Working Fluid Waste Generation**

**For each machine:**

- Type of metal-working fluid used.
- Actual water-to-fluid ration used.
- Size of sump.
- Frequency of sump clean-out.
- Manual vs. hard-piped fluid addition.
- Inspection for: hydraulic and lubrication oil leakage; sump and fluid condition; fluid leakage or spillage; effectiveness of machine coolant cleaning system; etc.
- Reason fluid is dumped.
- Fluid cleaning devices used.

**Facility information:**

- Chemical oxygen demand of each metal-working fluid.
- How fluid is removed from machines and where taken
- Inspect fluid storage areas. Examine fluid concentrate handling procedures, note any leaks or spills.
- Waste hydraulic oil handling procedures.
- Chip handling procedures.
- Quantity of fluid used per week.
- Type of fluids used and where.
- Cost of waste fluid disposal.
- Cost of virgin fluid.
- Current waste management techniques.

**TABLE 2: Components of a Fluid Management Program**

1. Assign responsibility of fluid control to one person.
2. Train machine operators in proper fluid handling procedures.
3. Minimize loss of coolant due to spillage, leaks,carry-out, splashing and evaporation.
4. Properly maintain and inspect all machines.
5. Thoroughly clean out sumps, machines, and fluid-handling equipment before fresh fluid is added.
6. Select a premium performance product.
7. Use deionized water for makeup.
8. Add additives to recovered fluid as needed.
9. Control tramp oil and any emulsification.
10. Remove solids from machine sumps on a regular basis.
11. Establish efficient fluid transfer methods.
12. Aerate fluid.
13. Establish fluid removal criteria or schedule.

## City of Raleigh Announces Household Hazardous Waste Collection Day

The City of Raleigh has scheduled a Household Hazardous Waste (HHW) Collection Program for April 1, 1989. The collection program will be at the Public Utilities Operations Center off Lake Woodard Drive. This program is a one day pilot project for City residents. The collection day came about because of the community's interest in HHW.

The City of Raleigh's Environmental Quality Advisory Board began examining the possibility of having a collection day last year. Its first task was to identify if the citizens of Raleigh had hazardous waste they would bring to a collection site. The questionnaire defined a substance as hazardous if it could catch fire, if it could react or explode when mixed with other substances, if it was corrosive or if it was toxic. Products that were specifically mentioned were antifreeze, paint/thinner, pesticides, solvents, fuel oil, gasoline, kerosene, motor/other oil, fertilizer, home care products and battery acid.

The Raleigh program will not only focus on the collection activity, but also on educating citizens about hazardous waste. A public relations firm will be hired to prepare brochures, videos and other materials to educate the citizens of Raleigh.

The collection program will also emphasize recycling activities. The items that Raleigh is considering accepting in this program are motor and other oil, solvents, batteries, paints and pesticides.

Please feel free to call Cindy Kling at (919) 890-3400, if you would like more information of the Raleigh pilot project.

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