Coolant Filtration Systems For Machining Operations

Applying full-flow, bypass-flow, or batch clarification improves equipment efficiency and reduces costs

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General consensus in the metal working industry is that coolant filtration equipment is more justified for grinding and other finishing operations than for machining. The prevalent feeling is that machining applications are satisfied by simply intercepting and removing relatively large, easy-to-handle chips.

Fortunately, there is a growing awareness that machining equipment and their sophisticated controls and precision moving parts demand clean coolant to perform efficiently and economically. There are several options available to provide adequate filtration and still meet the operating limitations of time, space, and money.

Reasons for Filtration
A typical machining operation creates three types of contaminants.

Direct contaminants, such as chips, granular material, and swarf, are produced as metal stock is cut.

Indirect contaminants are a byproduct of the operation, such as metallic soaps generated by the machine's heat, scum, and chemical reactions with the coolant.

Foreign contaminants are introduced outside the machining operation, such as from tramp oils, plant debris, or material carried on the metal from a previous activity.

The need for clean coolant in today's sophisticated machining operations goes beyond longer tool life and a better surface finish. A number of factors associated with the equipment demand filtered coolant to operate effectively:

- Fixtures — Mechanisms holding the part must be relatively clean to orient the piece properly for machining.
- Machine ways — Precision machine tool parts need high quality lubrication.
- Tool changers — Mechanical components moving, orienting, and replacing tools must be dirt free.
- High-speed production — Faster proc-

Fig. 1. Three types of closed-loop coolant filtration (clarification) systems are applied to metal working operations. “Device” is the technique that cleans the fluid (separators, filters, or combination of the two). “Process” is the machining operation creating the contaminant.
Direct, indirect, and foreign contaminants are removed by full-flow, bypass-flow, or batch filtration

Fig. 2. Without coolant clarification, contaminants eventually reach the maximum acceptable limit. The system is shut down, the sump is cleaned, and the system is recharged with fresh coolant.

Fig. 3. With continuous filtration, some contaminants always remain in the coolant; however, the maximum acceptable level is never reached. The system runs indefinitely.

Typical Filtration Systems

Three types of closed-loop filtration (clarification) systems (Fig. 1) are used in metal working operations. The “device” blocks on the diagrams refer to the technique used to clean the fluid, which is a separator, filter, or combination of the two. The “process” boxes are the machining operations that create the contaminant while performing their function.

Full-flow systems are designed with the amount of coolant entering the devices slightly greater than flow to the machining process. Coolant is contaminated at the process, moves into a dirty liquid reservoir, and travels to the device. Clean liquid enters a reservoir and is then returned to the process. Excess coolant is sent back to the dirty liquid reservoir directly from the clean reservoir without going through the process.

This arrangement allows the system to recirculate coolant through a separate loop. Extra flow from the clean reservoir to the dirty tank aids in balancing the pumps. The full-flow concept ensures that the total volume of coolant is filtered before reaching the clean liquid reservoir.

Bypass-flow systems move liquid to the device through a separate loop parallel to the process loop. Bypass flow is usually less than process flow. This approach achieves
an acceptable level of clarity without treating the total process flow.

Performance and capability are similar to that of a full-flow system. However, this method does not offer the assurance that all liquid always flows through the device before going to the process. If properly balanced and controlled, acceptable levels of clarity are achieved.

Batch systems literally remove the coolant from the process reservoir and clean it in a remote location. Cleaned coolant is then exchanged with another contaminated batch on a routine basis.

Reaching Equilibrium

A fundamental axiom of the closed-loop filtration concept is that the device removing solids attempts to reach a state of equilibrium. In other words, the contaminant level in the coolant remains constant. This condition is referred to as "constant cleaned" coolant.

In this state, the system reaches equilibrium. Solids removed by the cleaning device are equal to the amount coming in from the process. Although the coolant has some contaminant, it still functions properly if the level is below an acceptable limit. Therefore, the cleaning device is not dumped because of solids accumulation. The key is to develop a cleaning system which maintains the solids accumulation at an acceptable level.

Figure 2 shows a curve plotting contaminant accumulation versus operating time for a metal cutting operation without coolant clarification. Contaminants eventually reach a degree of concentration (maximum acceptable limit) where the operator determines that it is impossible to continue because of problems created by dirty coolant. The operation is shut down, the sump is cleaned, and the system is recharged with fresh coolant. This cycle is routinely repeated.

Figure 3 shows the same operation with a cleaning system added to remove contaminants on a continuous basis. The system does not remove all of the solids, but enough so that equilibrium is reached at a point below the tolerable level. The system runs indefinitely.

Figure 4 provides a more realistic picture of what happens with many installations. The clarification device attempts to reach equilibrium, but cannot because the contaminant level hits the acceptable limit first. The operation shuts down for cleaning.

Fig. 4. Most realistic coolant filtration scenario has the clarification device attempting to reach equilibrium, but cannot because the contaminant level hits the acceptable limit first. The operation shuts down for cleaning.

experiences three dumps within the given time frame. Some clarification reduces the dumpings to two. This saving is one-third the previous dumping, recharging, and disposal cost. Additional benefits result from operating with a cleaner coolant for a longer period of time.

For more information... The author is willing to answer technical questions relating to this article. Mr. Joseph can be reached at 315-437-0217.

Mr. Joseph has authored a comprehensive book on equipment applications and system designs. Information concerning Coolant Filtration can also be obtained at the above phone number...

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