Machining

White Paper: Troubleshooting the Most Common Problems in Metalworking Fluids

Brought To You by Castrol | May 09, 2023

Job shops have unique needs when it comes to cutting fluids. These shops typically perform a variety of machining operations for different industries using a wide range of materials. Additionally, their customers often demand short production runs and fast turnarounds, and they must be able to customize and deliver high-quality end products. As a result, they face diverse operational and metallurgical challenges.

In this whitepaper, Castrol addresses the most common cutting fluid problems encountered by job shops: foam, corrosion, residues, dermal irritation and odor – and how to overcome these challenges for optimal machining performance.

FOAM

Foam is created when air is entrained within a fluid – by either a mechanical or chemical process or, in rare cases, by both. The first step in solving foam issues is to determine which process is creating the problem. To determine if the root cause of your foam problem is mechanical or chemical, place an adequate amount of fluid from the machine tool's sump in a covered clear container and shake the sample vigorously for 10 seconds. After shaking, watch how the foam responds. If there is a significant layer of foam that does not dissipate quickly, the issue is chemical. If there is no significant foam layer, or the foam dissipates rapidly, the issue is mechanical.

> **The first step in solving foam issues is to determine which process is creating the problem.**

MECHANICAL

If the shake test showed the issue is mechanical, the first thing to investigate is whether low fluid levels in the reservoir are causing pump cavitation. A simple inspection of the reservoir while the system is running will determine if low volume is the root cause. The second item to investigate is whether a crack or leak in a pump's housing or intake piping is allowing air entrainment in the fluid. Again, make

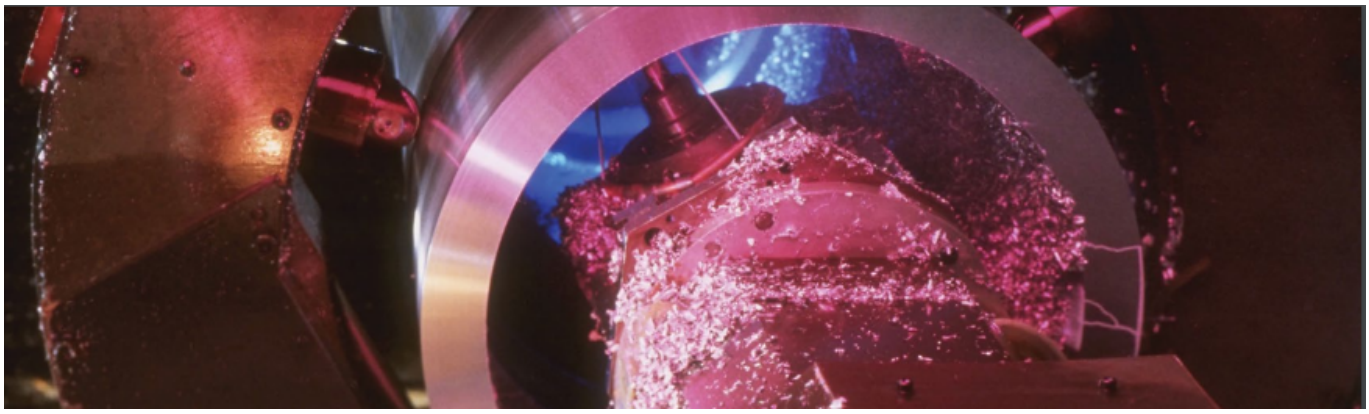
a thorough inspection of the system and its components. Finally, inspect the system for any areas that generate excessive agitation. These include sharp corners in return flumes, significant pipe-diameter reductions, coolant waterfalls, high fluid velocities and high outlet pressures. Often, simple changes in machine design, such as inserting a metal plate to reduce a waterfall to a consistent return stream, will eliminate the foam issue.

CHEMICAL

If the shake test showed a significant layer of foam that remained, you should investigate the chemical issues creating the foam. First, investigate the source of water used to dilute your cutting fluid. A simple water-hardness test will indicate if you need to make adjustments. A hardness level less than 5 grains per gallon is considered soft. Soft water will increase the propensity for foaming in some fluid and might require a change in water quality or changing to a different cutting fluid. If the quality of your make-up water is acceptable, look at the concentration of your cutting fluid. High concentrations (typically > 10%) can increase the potential for foaming. Reduce the concentration by adding water to the system.

If you determined that your make-up water and fluid concentration are acceptable, look for any type of chemical contamination in your fluid system, which can come from the following sources: Incompatible fluids from prior operations, excessive levels of tramp oil (hydraulic oils, way lubes, spindle oils, etc.) from the machine tool itself or other chemical compounds utilized within the shop. Often, the contaminating fluid can be managed with tankside defoamers and will dissipate over time; however, if immediate improvement is necessary, a dump and recharge is required.

Eliminating foam issues with your cutting fluids not only provides increased performance for your machine and higher throughput, it makes for a much happier operator.



FERROUS CORROSION & RUST

Corrosion or rust as it is commonly known, is an electrochemical reaction between a metal surface and its environment. Corrosion is a costly problem in the job shop, resulting in rework, scrap, downtime, and reduced machine tool life. In general, three elements are required for corrosion to occur: oxygen, water and a metal surface susceptible to corrosion. Since all three elements are required to produce corrosion, eliminating any of the three theoretically eliminates corrosion. All metalworking fluids offer some degree of in-process corrosion protection to the workpiece, the tooling and the machine tool components themselves. The degree of protection, however, can vary widely among different fluid and fluid types.

When corrosion occurs in a machine shop, many factors must be analyzed to determine the root cause and subsequent corrective action. It is important to investigate all potential causes, as corrosion is commonly caused by several factors.

CONCENTRATION

The concentration of your metalworking fluid is the first item to investigate. For most metalworking fluids, low concentrations are those generally below 4%. If concentration is lean, simply add sufficient concentrate to bring the system within the recommended range.

HARDNESS

If the concentration is acceptable, next check for dissolved minerals and ions in the solution. Pitting is the most common type of corrosion when metalworking fluids contain excessive minerals and ions. These minerals and ions usually come from the makeup water used for dilution and because they do not evaporate the result is a gradual buildup of water hardness and ions. Check the hardness, a level greater than 25 grains per gallon significantly increases the potential for corrosion. In addition to water hardness, chloride also increases the potential for corrosion. Laboratory tests show that corrosion becomes increasingly likely when chlorides are above 300 ppm.

PH

If the concentration and mineral levels are acceptable, check the fluid's pH. Most metalworking fluids are designed to have a pH of 8.0 to 9.5, partially to assist in corrosion protection. A fluid pH below the recommended range can be caused by several factors, including lean concentration, the presence of bacteria and contamination.

METAL PARTICULATE

If concentration, mineral levels and pH are all acceptable, check for high levels of metal particulate in suspension, or a fluid reservoir full of chips and swarf. Re-circulating metal fines in solution, and subsequently depositing these fines on a freshly machined metal surface, typically results in pitting corrosion. These fines increase the amount of metal-to-metal contact, trap moisture on the metal surface and interfere with the metalworking fluid's ability to form a uniform corrosion protective layer.

Finally, if none of the above situations apply, inspect the storage and operating conditions of the facility. Wet parts in contact with one another and hot, humid atmospheric conditions as an example, will increase the likelihood of corrosion.

Corrosion issues are often the most difficult and costly problems to resolve. Many shops dump and replace their metalworking fluids regularly to solve the problem, only to have corrosion re-emerge several months later. Utilizing the approach above can help identify the root cause of corrosion, and eliminate the problem permanently.

RESIDUES

Most cutting fluid residues can be described as oily and/or tacky deposits found on surfaces in and around machine tools. During use, fluids splash and generate mist which evaporates, leaving the dirt, fines, swarf, product components, hard-water soaps and dissolved solids behind on the surfaces of the machine tool. Fluids containing oil generally leave a larger volume of oily residue, while synthetic fluids leave a more difficult tacky residue, but less of it. Adjust guards, shields and other mechanical control devices to minimize excessive misting and splash.

CAUSES

Residues may be caused by either chemical or mechanical issues. To find the cause, first check the concentration of the fluid in the machine tool. If it is too high, add water to bring the concentration within the proper range.

Next, check the hardness level of both the make-up water and the fluid in the sump. High levels of water hardness (calcium and magnesium ions) can lead to residue formation. To treat the problem, a partial system dump or treated make-up water may be required.

Fluid contamination may also be the culprit. Tramp oil (hydraulic fluids, way lube, spindle oils, etc.) left in the cutting fluid will increase residue formation. Also, check the fluid reservoir to make sure it is not full of chips or other debris that may be contributing to the residue problem.

Continue reading this ***white paper*** *in its entirety to help you troubleshoot the most common problems in metalworking fluids.*

Previously Featured on Castrol's website.