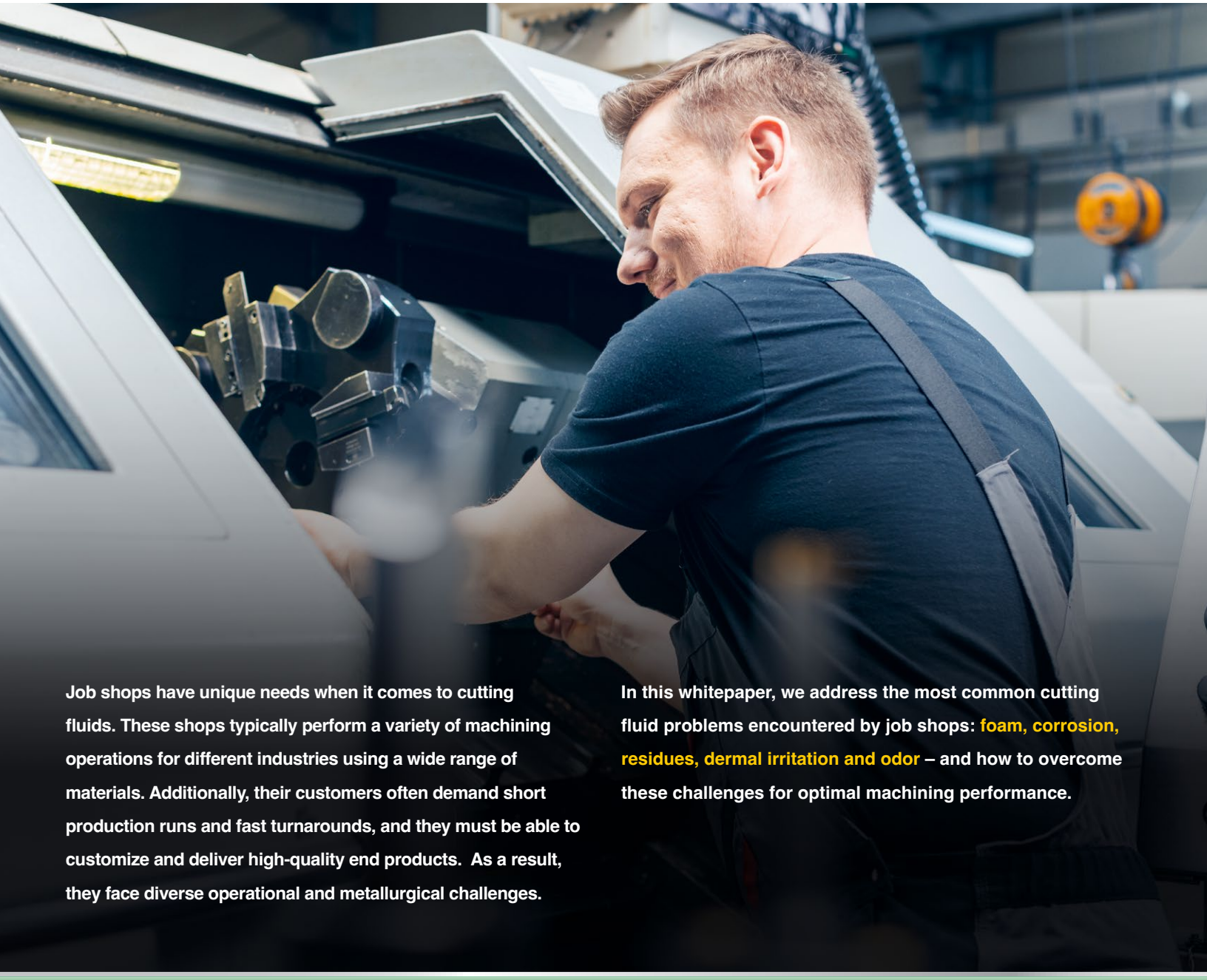
TROUBLESHOOTING THE MOST COMMON PROBLEMS IN METALWORKING FLUIDS

WHITEPAPER: JULY 2022



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, we address 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.

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.

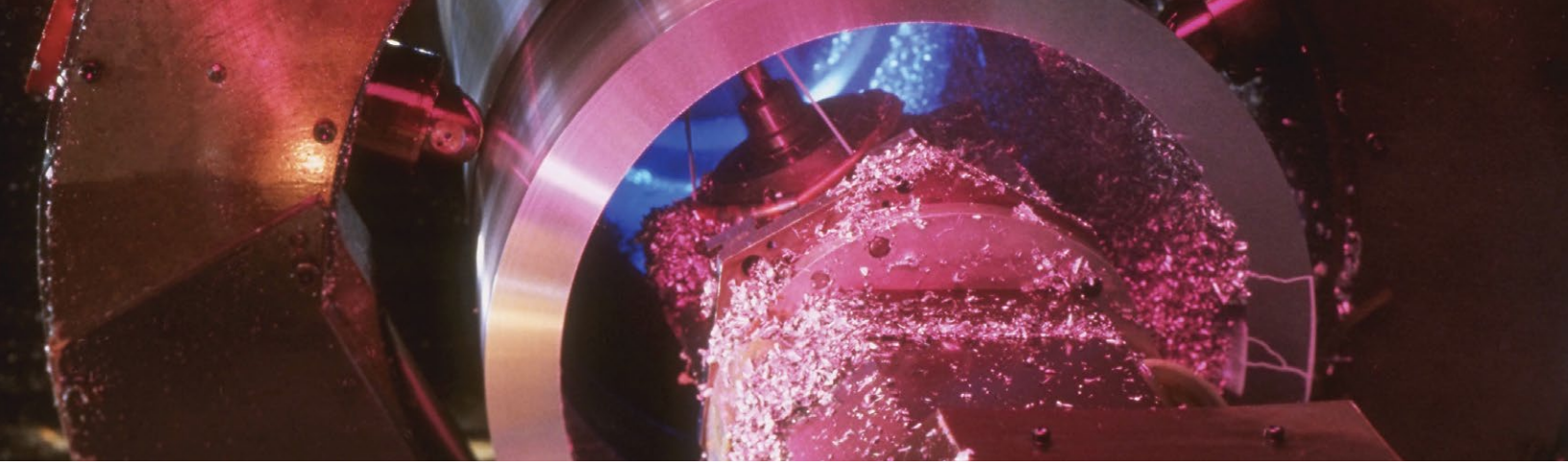
CHEMICAL

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.

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

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.

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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 make-up 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.

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DERMAL IRRITATION

Dermatitis is an inflammatory response of the skin. Redness, swelling, itching and tiny pimple-like eruptions on the skin surface are signs at the onset of dermatitis. In more severe cases, deep cracks and open sores may develop. Fortunately, the condition is usually readily reversible when exposure to the causative agent(s) is ceased. Medical attention may be necessary for more severe cases.

Dermal irritation can be caused by any combination of chemical (acidic or basic), petroleum (lubricants or solvents) or metals-based (nickel, chrome, cobalt or zinc) exposure. Poor housekeeping and fluid-management practices that lead to high concentrations and/or contaminant-laden fluid are leading culprits for dermal irritation. With remedy comes the reduction of this risk.

Dermal irritation risks can be reduced through the following activities:

- Control cutting fluid concentration, upgrade to a high-performance fluid if higher concentrations are needed to achieve satisfactory performance.
- Control system contaminants, if this is not possible, it is usually best to dump, clean and recharge contaminated sumps.
- Keep the cutting fluid free of oil and dirt contamination, maintain separators and filters in good working order, and keep harsh chemicals, solvents and abrasives away from the skin.

> Although cutting fluids are designed with operator health and safety in mind, operators can experience varying degrees of dermal irritation up to and including dermatitis.

- Promote proper skin care, the use of skin creams and resistant gloves that cover the entire forearm.

ODOR

Odor can be a challenge to diagnose and resolve, because the source may be difficult to locate. Generally, odors are either biological (from bacteria and/or fungus growth in the metalworking fluid) or chemical.

BIOLOGICAL

Odor complaints are most often the result of rancidity or bacteria growth in the fluid – think a rotten egg, sulfur smell. Metalworking fluids contain organic compounds and other components that bacteria utilize as a source of nutrition. Less frequently, odor may be caused by the presence of fungus or mold, which typically manifest as musty, locker-room type smells. Both bacteria and fungi create various issues in addition to objectionable odors, including decreases in pH, reduced corrosion protection and emulsion stability, formation of slime and residue and deterioration of tool life and surface finish.

Since bacteria are found nearly everywhere in a typical machine shop the opportunity for bacteria growth in the fluid is significant. Once bacteria inoculate a metalworking fluid, their growth rate is rapid.

Spoilage due to bacteria is one of the most prevalent causes of shortened life and frequent change-outs of metalworking fluids and can have a significant impact on the shop's bottom line. An alternative to fluid change-out is to treat the system with a tank-side biocide. The biocides approved for metalworking fluids are often extremely expensive and may subject operators and plant personnel to potentially harmful chemicals. And while this approach may increase fluid longevity, it is often a short-term solution.

Fluids formulated without FRAs, boron and biocides are available and can help extend fluid life and improve working conditions. Castrol® is one lubricant producer that offers a range of such metalworking fluids.

The first step in preventing bacteria or fungus growth is to choose a metalworking fluid that has been specifically designed and tested to resist biological growth. The second step is proper fluid maintenance.

Utilizing a high-quality metalworking fluid and good maintenance practices will minimize odor issues due to bacteria and fungus.

However, when an odor complaint does arise, the first step in troubleshooting is to understand the nature of the odor - is it caused by anaerobic or aerobic bacteria. For instance, anaerobic bacteria flourish in oxygen-starved environments, such as an idle sump that has a layer of tramp oil floating on the surface of the fluid. This condition often occurs over weekend shut-downs. As the oil-covered fluid sits idle in the sump, the oxygen depletes and allows these anaerobic bacteria to proliferate. Many shops resort to installing compressed air bubblers or other devices to keep the fluid circulating and oxygenated. This can be a costly, temporary approach. Keeping the fluid circulating only restricts anaerobic bacteria growth; the aerobic bacteria still proliferate, resulting in odors and other issues.

Whether the odor is rancid or musty, or caused by bacteria or fungus, the following steps can eliminate the odor and prevent it from returning.

CAUSES

First, confirm whether the odor is caused by bacteria, fungus or possibly both. As an immediate corrective action, the fluid may need to be treated with a biocide to eliminate the existing bacteria and fungus. Subsequently, the key to eliminating future bacteria and fungus outbreaks is to diagnose how and why they got there.

The first step in keeping a metalworking fluid free of bacteria and fungus is to continually maintain proper concentration levels, generally between 5 to 10. When concentration levels are low, the components in the fluid that provide biological resistance are insufficient to protect against biological growth. For most metalworking fluids, low concentrations are those generally below 4. Regular concentrate additions are vital to ensuring optimum fluid performance.

If concentration levels are adequately controlled, check the system for excessive contamination. Contaminants can come from the machine tool or machining process such as tramp oils, grinding swarf and metal fines, as well as from external sources.

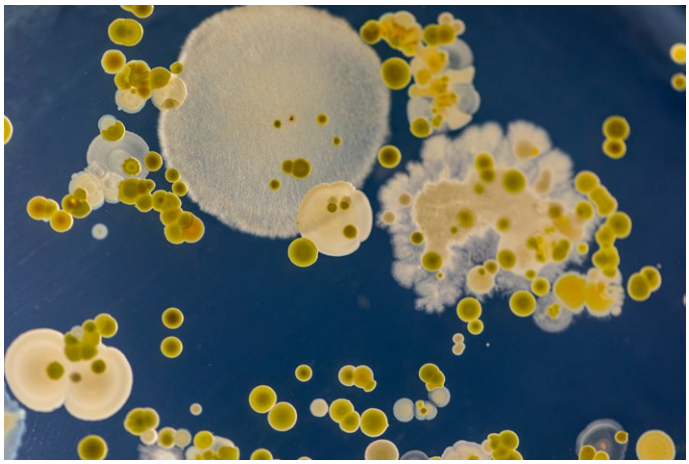
> Once bacteria inoculate a metalworking fluid, their growth rate is rapid.

Tramp oils are ideal food sources for bacteria and fungus, so taking steps to remove it from the fluid are important. The buildup of metal fines and swarf in the coolant reservoir also creates a potential breeding ground for bacteria because the fluid and its bio-resistive components cannot fully penetrate the chip accumulation. As a matter of good housekeeping and fluid maintenance, external contaminants should be aggressively prevented from polluting your metalworking fluid.

If neither concentration or contaminants appear to be the root cause of the biological odor, inspect the system for stagnant areas. These are ideal breeding grounds for both bacteria and fungus. If stagnant areas are identified or the machine tool remains idle for long periods, take the necessary steps to ensure adequate fluid circulation.

CHEMICAL

While odors associated with metalworking fluids are most often assumed to be biological in nature, chemical odors do occasionally occur. Chemical odors can normally be divided into those caused by the fluid, and those caused by contaminants.



Every fluid has its own distinctive odor. Some fluids have a strong smell upon initial charge-up that dissipates over time. Chemical odors caused by the fluid are different than the normal fluid smell. Most frequently, fluid-related chemical odors are the result of excessive concentration, generally greater than 15. If the concentration is excessive, dilute the system with a sufficient amount of water.

Less frequently, chemical odors are the result of a reaction within the fluid. For example some fluids incorporate a formaldehyde-release biocide as a preservative. Under the right conditions, a reaction can occur in which ammonia gas is released from the fluid. Using a fluid that does not contain a formaldehyde-release biocide is one means of prevention.

Chemical odors caused by contamination can vary widely, depending on the contaminant. First, review the chemicals in the machine shop to determine which, if any, may have been inadvertently added to the metalworking fluid. Second, perform a visual inspection to determine if the fluid has been contaminated. A sudden, distinct change in fluid appearance, such as a change in color, is often a sign of contamination. Other changes, such as foaming or changes in pH, are also potential signs of contamination.

If you still need help – contact us. We have technical support to solve problems rapidly and the expertise to guide you in choosing the right metalworking fluid for your shop.

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