

CIMCOOL[®]

Technical Report

Milacron Marketing Co. | Consumable Products Division | Cincinnati, Ohio 45209

RANCIDITY CONTROL OF WATER-BASED METALWORKING FLUIDS

Rancidity is one metalworking fluid problem which demands immediate attention. Employees will not tolerate a foul smelling fluid and even if they would, the rust, loss of finish, poor tool life, and the generally poor metalworking fluid performance that accompany rancidity are major problems in metalworking operations.

Rancidity can be prevented by understanding the causes and following a few simple control practices.

Causes of Rancidity

Microorganisms (bacteria, mold, and yeast) cause rancidity by multiplying in metalworking fluids after the concentrate is diluted with water for use. As sold, CIMCOOL[®] metalworking fluids are free of microorganisms. It is only after these products are diluted and charged into a reservoir that they become contaminated with microorganisms.

Bacteria and fungi are everywhere (in water, air, on operator's hands, parts, and machines, etc.) It is only natural that they get into metalworking fluid mixes. The amount of harm they do depends upon the type of microorganism, the number present, the physical conditions of the system, the available food supply, and the rancidity control of the product.

CIMCOOL metalworking fluids are formulated to control rancidity, and only a limited number of bacteria can survive in this environment. Among those commonly found in metalworking fluid mixes are:

Aeromonas sp.
Pasteurella sp.
Acinetobacter sp.
Moraxella sp.
Bacteroides sp.
Citrobacter freundii
Desulfovibrio desulfuricans
Alcaligenes sp.
Desulfovibrio aestuarii
Serratia sp.

Pseudomonas putrefaciens
Pseudomonas fluorescens
Enterobacter aerogenes
Escherichia coli
Proteus vulgaris
Providencia sp.

These bacteria are classified as gram negative bacteria based on their staining characteristics and additional LPS (Lipopolysaccharide) layer. It is the LPS layer of gram negative bacteria that is associated with endotoxins. Endotoxins are capable of causing illness, particularly short-term flu-like symptoms with fever and chills. Although endotoxins have been identified in fairly high levels in metalworking fluids, the relationship they have to human disease has not been proven.

Although gram positive bacteria are not as common in metalworking mixes, we sometimes find *Bacillus*, *Micrococcus*, and environmental *Mycobacteria*. *Bacillus* and *Mycobacteria* are commonly found in water, soil, and air. Environmental *Mycobacterium chelonae* has been isolated from plant water used to charge up individual machines and central systems. It generally takes at least a week to grow these bacteria. In contrast, gram negative bacteria take two days to grow. Environmental strains of *Mycobacteria* are non-pathogenic unlike the TB strain.

Although present in a metalworking fluid mix, these bacteria cause problems only if conditions are conducive to excessive growth. One way to classify bacteria is according to their need for oxygen, Aerobes require oxygen for growth; anaerobes flourish in the absence of oxygen; and facultative anaerobes prefer oxygen, but can live either in the presence or absence of oxygen.

AEROBIC BACTERIA

Studies of water-based metalworking fluid mixes have shown that *Pseudomonas* is the most common inhabitant since it is a strict aerobe. They thrive in the presence of oxygen and use numerous substrates for nourishment (such as minerals in the mix water, metalworking fluid ingredients, discarded food, etc.) The more food that is available, the faster they multiply.

Aerobes usually are not responsible for odor problems. In contrast, the Coliforms are facultative bacteria which produce a fecal odor, and are possible indicators of "raw sewage" contamination. This is not generally the case with metalworking fluid mixes. Pathogens, disease-causing bacteria, are rarely found in metalworking fluid mixes, but *Coliforms* are indicators that they may be present. *Coliforms* in metalworking fluids do not

CIMCOOL[®] Technical Report

Milacron Marketing Co. | Consumable Products Division | Cincinnati, Ohio 45209

constitute a health hazard, but their presence indicates recent contamination of the product by dirt tracked in from the outside or raw sewage, which is cause for concern. However, any level of *E. coli* indicates that drinking water may be unsafe for consumption.

FACULTATIVE ANAEROBIC BACTERIA

When a metalworking fluid system is shut down for the weekend, the aerobic bacteria rapidly use up the dissolved oxygen in the mix. This process is accelerated when the metalworking fluid mix is blanketed by a layer of oil. After the oxygen is gone, the facultative anaerobes continue growing and may produce unpleasant odors.

In the absence of oxygen, strict anaerobes also begin to grow and pave the way for rancidity by creating conditions that are favorable to the development of "rotten egg" odors.

ANAEROBIC BACTERIA

These are some of the bacteria that produce the "rotten egg" or "Monday morning" odor, chemically called hydrogen sulfide. Specifically, *Desulfovibrio desulfuricans* and *Desulfovibrio aestuarii* are the bacteria (sulfate reducers) responsible for breaking down sulfur compounds. As these compounds are consumed, a reaction takes place from which hydrogen sulfide evolves.

If sulfonates are eliminated from a metalworking fluid formula, this is no guarantee that the "rotten egg" type of rancidity can be avoided. All metalworking fluid mixes become contaminated with extraneous oils (lubricating, hydraulic, etc.) which often contain sulfur compounds. In the presence of water, the *Pseudomonas* species attack the oil constituents and break them down into forms suitable for use by the *Desulfovibrio* species.

FUNGI

Fungi include both mold and yeast. If they inhabit a metalworking fluid reservoir, a musty or "mildew-like" odor develops. Fungi, unlike bacteria, are not known to cause serious production problems in metalworking fluid mixes. Molds do cause slimy, rubber-like masses on machines, in lines, and on components of the fluid reservoirs.

It has been published that bacterial biofilms make it easier for mold to attach based on cellular charge. This fact indicates the importance of keeping bacterial numbers under control so mold biomasses will not become a problem.

Problems Caused by Microorganisms

Offensive odors are bad enough, but microorganisms also create other metalworking fluid problems. Bacteria can:

1. Frequently darken the metalworking fluid mix;
2. Cause staining of parts;
3. Promote metalworking fluid breakdown (oil-water separation);
4. Reduce rust-inhibiting properties in the fluid mix, and
5. Cause product imbalance.

Note: Contrary to popular opinion, the bacteria commonly found in metalworking fluid mixes do not cause dermatitis.

Fungi, in addition to causing odors:

1. Grow in unsightly masses,
2. Plug metalworking fluid lines or pipes, and
3. Reduce rust-inhibiting properties of the metalworking fluid.

Control of Rancidity

While it is not feasible, or even desirable, to eliminate all microorganisms from a metalworking fluid system, it is possible to limit their growth and prevent rancidity by a few simple control practices.

SANITATION

Keep the metalworking fluid clean! This is extremely important for good overall performance, and especially so for rancidity control. Plant cleanliness and good personal hygiene help keep bacterial contamination of the metalworking fluid at a low level. Some measures that should be taken to prevent rancidity are:

1. Clean the machines, lines, troughs, reservoirs, etc., thoroughly with a good machine cleaner before each charge with a fresh mix. CIMCLEAN[®] 30 cleaner removes sludge, dirt, fines, and oil which serve as a breeding ground for microorganisms, and this helps to prevent rancidity.

The most thorough cleanout of a contaminated system can be accomplished after production is shut down and this should be done periodically. It is possible before dumping a system, however, to add CIMCLEAN[®] 30 to a dirty CIMCOOL mix and continue machining or grinding as the cleaner circulates. This minimizes the loss of production time.

2. Do not dump floor cleaning solutions into the reservoir. Many contain chemicals, such as phosphates, which may contribute to skin irritation and also promote the growth of odor-producing microorganisms.
3. Avoid using reservoirs for garbage disposal. Items such as cigarette butts, food scraps, sputum, and candy wrappers inoculate metalworking fluid mixes by supplying nutrients for microbial growth.

CIMCOOL[®] Technical Report

Milacron Marketing Co. | Consumable Products Division | Cincinnati, Ohio 45209

OPTIMUM CONCENTRATION

Despite efforts to keep the metalworking fluid clean, it is still susceptible to microbial attack for other reasons. Lean mixes do not provide the full benefit of the product's rancidity control capabilities. The starting dilution, as recommended on the product label, will provide good rancidity control under ordinary circumstances. Adjustments must be made, depending on conditions, to find the optimum concentration.

To keep the mix concentration at an optimal effective level, we encourage the use of a premix tank or station or, better yet, one of the inexpensive proportioning units. These devices mix water and product concentrate at a dilution which is preset to maintain the correct ratio in the system. When a CIMCOOL mix is maintained at the proper dilution, it inhibits excessive microbial growth under normal conditions.

AERATION

Atmospheric oxygen is detrimental to the growth of odor-producing anaerobes. During circulation, oxygen enters the metalworking fluid at a maximum rate, but at a much lower rate when the system is shut down. The following are examples of ways aeration of a system can be improved:

1. Small pumps can be used to bubble air into reservoirs, either continuously or periodically, as needed. Air lines are not only useful in aerating quiet systems, but also "dead" areas where circulation is inadequate because of system design.
2. On machines where air lines are not available, merely circulating the metalworking fluid aerates it. If a machine tool is shut down for a day, aerating it for a short time prolongs metalworking fluid life. Start the machine and circulate the fluid for half an hour.
3. Since oil floats prevent the passage of oxygen into a metalworking fluid, it is important to keep machine tools in good repair so that a minimum amount of lubricating oils leak into water-based products. If leaks cannot be repaired, use oil skimmers or centrifuging equipment to remove oil before it builds up and causes problems.

ADDITIVES

Cleanliness, proper concentration, and aeration of a water-based metalworking fluid mix help to maintain its rancidity control properties during use. Under some circumstances, however, systems become heavily contaminated and bactericidal and fungicidal additives are required. Their use can prevent loss of performance and prevent or eliminate offensive odors.

When You Need Help

Whenever rancidity is severe or persistent, do not hesitate to talk the problem over with your Products Division Territory Manager or Cimcool Technical Service Specialist. They have experience in problem solving, and are backed by laboratories and a service organization that specialize in metalworking fluids. ■