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Controlling Coolant Contamination

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Controlling Coolant Contamination

A look at the problems caused by microbial growth in fluid-transfer systems, the types of organisms found and the methods for evaluating contamination.

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As industry seeks to improve the economy of plant operation, responsible managers are paying more attention to factors that affect efficient and reliable operation of their facilities. One area of attention that can pay off handsomely is the control of microbiological activity in coolant systems. Many engineers and plant operations personnel are just beginning to appreciate the effects on their machining operations caused by their plant "biosphere," which contains bacteria, fungus, mold and other contaminants.

Understanding how microbial life affects metalworking fluids helps plant managements determine how best to minimize microbial problems with confidence. Such knowledge also enables managements to more effectively evaluate the data provided by plant operators and service-company representatives.

Effects of Microbial Growth

Fluid-transfer systems consist of pipes, valves, sumps, treatment units, towers and storage tanks used for containing and/or transporting working fluids or process fluids in an industrial operation. Excessive microbial growth causes seven principal types of problems: deterioration of working or process fluids; generation of odors; fouling of lines, valves and filters; acceleration of corrosion; poor quality and production performance; environmental deterioration, including immediate workplace; and other areas such as possible contributions to skin and/or respiratory irritation.

The deterioration of fluids is a complex process, the progress of which depends on the chemical composition of the fluid. Metalworking fluids contain a variety of organic compounds that may serve as both food and energy sources for microbes. Hydrocarbons, petroleum sulfonates, fatty acids and fatty esters, to name a few, although attacked slowly by individual types of microbes, can be degraded rapidly by consortia of microorganisms.

"Consortium" is the currently accepted term used to describe a mixed population of microbes acting as a unit to carry out activities that individual members of the population cannot. These consortia can and do attack the chemicals in various additive packages such as anticorrosives and even biocides. Fig. 1 illustrates how biocides used at low doses can actually stimulate microbial growth.

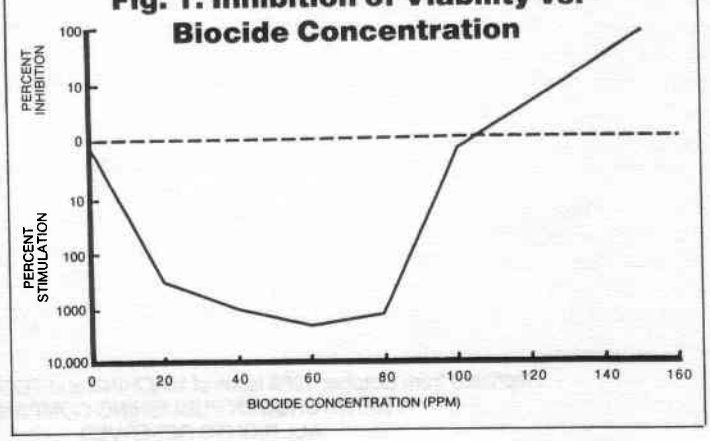
Indirect effects of microbial deterioration of working fluids include loss of pH control, lubricity, cooling properties and emulsion stability. Fluid viscosity may either decrease, as is most often the case, or increase, depending on the specific organisms and chemicals present.

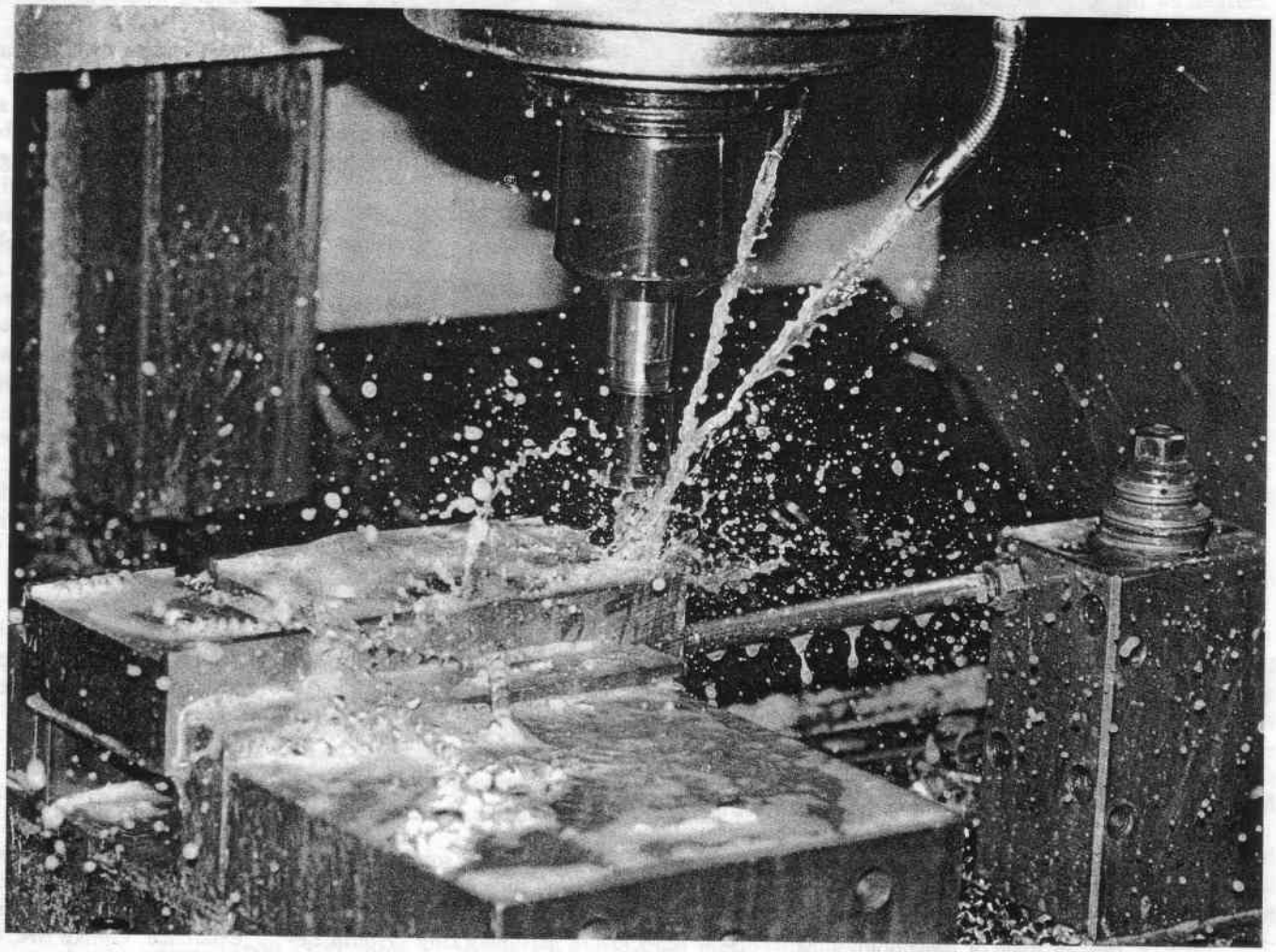
Odor production is closely related to fluid deterioration since it is the result of the liberation of volatile products of microbial metabolism. A variety of odor-causing chemicals is produced, some of which are noxious, and others, such as hydrogen sulfide, are highly toxic. Adding deodorizers to sumps neither addresses the problem nor eliminates its cause.

Microorganisms tend to form films on surfaces. These films can become several millimeters thick, causing flow restrictions, preventing proper valve operation and substantially reducing filter life. Additionally, these films are good insulators and can cause significant reductions in the efficiency of heat exchangers.

Microbes living within films are often protected against biocide treatment. This is why biocides that seem to work well in bench

Fig. 1. Inhibition of Viability vs. Biocide Concentration





Metalworking fluids operate in a plant "biosphere" that contains bacteria, fungus, mold and many other contaminants.

tests are sometimes ineffective in actual plant situations. Microbes within the film, which are referred to as the "glycocalyx," are important agents of microbial corrosion.

Physically, the film forms a nonuniform barrier between the fluid and pipe or other component surface. This causes electropotential differences around certain regions of the component surface, creating microscopic galvanic cells. In addition to producing hydrogen sulfide, which is highly corrosive itself, sulfate-reducing bacteria and certain other species use the hydrogen ions that tend to accumulate at the cathode of these cells. This accelerates the galvanic reaction. Other microbes in the film produce corrosive organic acids as byproducts of their metabolism.

From a human health standpoint, the primary microbial concerns relate to skin and perhaps respiratory irritation, discomfort and general unpleasant conditions.

Types of Microorganisms Found in Metalworking Systems

Two principal groups of microorganisms that create problems in metalworking fluids are bacteria and fungi. They can coexist in the system. Either bacteria or fungi can predominate in a system at any given time, depending upon the existing physical and chemical conditions. For example, fungi tend to have a higher temperature and lower pH tolerance than most bacteria. However, bacteria are the only organisms found at extreme temperatures or pHs.

Bacteria are microscopic, single-cell organisms that differ from the rest of the biological kingdom by their lack of an obvious internal organization. Fungi, though also microscopic, occur as either single cells or filaments. They have a cell structure similar to all higher organisms.

Fungi may occur as yeasts or molds. As yeasts, they are single-cell organisms that reproduce by budding. As molds, they form complex mazes of filaments and colorful, spore-bearing structures that give many molds their powdery appearance. A single species of fungus may exist either as a yeast or mold, depending on environmental conditions and the stage of its life cycle. Most fungi, however, exist primarily in either the yeast or mold form.

Cephalosporium is a slime- and odor-forming mold commonly recov-