

# Extending Cutting Fluid Life

*Unless they are properly cared for, the water-based fluids tend to deteriorate for any of a multitude of reasons. Here are the problems — and some of the cures*

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MANY FACTORS CONTRIBUTE to the microbial deterioration of water-based cutting and grinding fluids, which include emulsifiable oils, and chemical and semichemical solutions and emulsions. Those of primary importance can be classified according to the opera-

tion, the fluid, and maintenance procedures. Operational factors, including the material being machined or ground, the type of operation, and the size of the coolant system, are generally not controllable — the first two because of engineering requirements, and the third because of economic considerations.

**Fluids Used.** Type of fluid, concentration ratio, and makeup rate are major factors affecting deterioration. Germicidal effectiveness varies with the specific type of fluid, as well as with different products of the same type. Disregard for recommended concentration ratios is a common abuse. Using less than optimal concentration can not only drastically affect the cutting and cooling functions, but may also make the fluid more sensitive to microbial attack.

Problems may also be encountered by mixing two different products in the same system. This could occur in using a new formulation as makeup to grad-

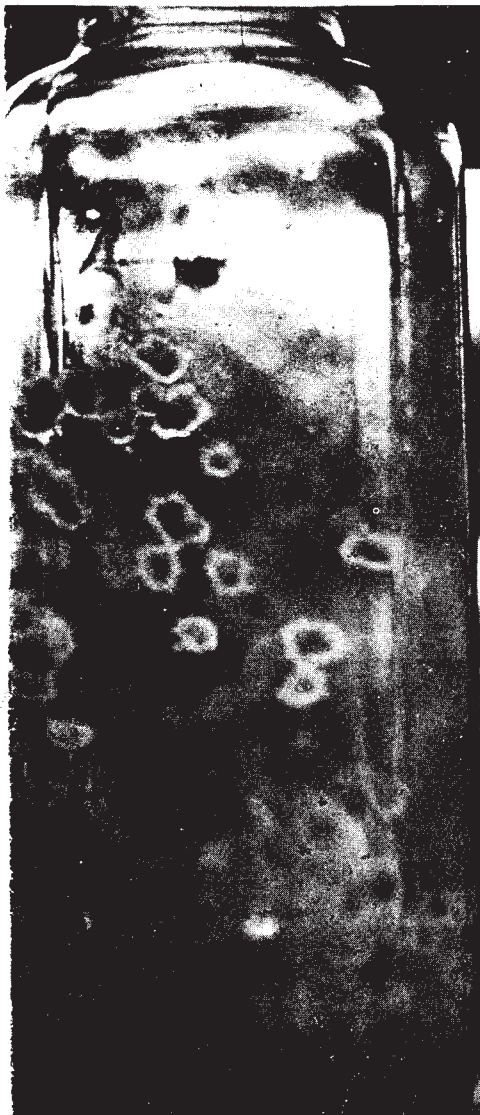
1. **FUNGI COLONIES** cover inside of glass container after cutting fluid made up of hard water has been poured out . . . illustrating "iceberg effect."

2. **FUNGAL MASS** attached to tip of glass rod is the result of using an inappropriate germicide in a laboratory coolant system.

ually replace an older fluid, especially in the case of large central systems, where it would be impractical to dispose of the entire content. Without extensive testing, it may not be possible to determine compatibility of the two fluids. In one system, the gradual replacement of a soluble oil with a synthetic fluid was uneventful until the ratio exceeded four parts synthetic to one part soluble oil. Then the remaining soluble oil became unstable and partially separated from the rest of the fluid. The oil coalesced into large black masses and became semisolid. While the fluid itself had little or no fungal count, the solidified oil had counts as high as 30,000 fungi per gram.

The value of using deionized water of controlled hardness in improving cutting fluid efficiency and minimizing bacterial growth has been well established. Also, in comparable situations, it has been found that deionized water has no effect on antifungal activity, and that hard water eventually permits fungi to grow. Hard water also causes separation and variations in droplet size. Such a system is illustrated in *Figure 1*, after the contents were poured out. Fungal counts were fairly low, but colonies of fungi cover the inner surface of the container. This is referred to as the "iceberg effect," with low fungal counts or even only a musty smell being the tip of the iceberg.

**Maintenance Practices.** Maintaining sanitary conditions is essential for fluid longevity. One of the surest causes of microbial deterioration of a new fluid is its addition to a system that has just been dumped, but not thoroughly cleaned, to remove residual contamination. Any contamination present puts an immediate initial load on the biocide that in most cases it cannot overcome. Where there is no spoiled fluid and no bacterial growth due to residual contamination, fungi will survive but eventually die.



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Worker hygiene is equally important because food, tobacco products, human waste, and other foreign material serve as appetizers for the bacteria as they prepare to attack the basic components of the fluids, and contribute to the depletion and oxidation of many biocides. Such contaminants also serve sometimes to shift the balance of power in the fluids, and create microbial populations that tend to be obnoxious.

**Effects of Deterioration.** The effects of microbial deterioration can be classed as physical, chemical, and biological. Physical effects relate primarily to the action of the fungi which interfere with fluid flow, machine operation, and filtration. High ambient humidity is an ideal condition for initiation and continuance of fungal growth on flumes, sidewalls, and filters of coolant systems, and the use of fans might reduce this problem.

Chemical effects refer to the reduction in lubricity resulting from the utilization of active ingredients by the organisms, and also, in the case of emulsions, their splitting as a result of extensive bacterial growth. Extensive microbial growth is also associated with great variations in the size of the oil droplets. Biological effects of microbial action relate to the environment's effect on the worker's sense of smell, which can have serious consequences.

**Extending Fluid Life.** In small coolant systems (up to about 300 gallon capacity), where contact time is short and makeup rate high, efforts to extend fluid life need only be minimal compared to those required for large central systems. Small systems may not require the use of biocides, particularly if good cleaning and other sanitary practices are maintained. However, the longer fluids stay in a system, the greater the chance for microbial adaptation, growth, and subsequent deterioration of the fluid. Ways extrinsic to the properties of the cutting fluid that can be used for control of microorganisms are chemical and physical methods.

**Chemical Methods.** The most common method for controlling microbial growth in cutting fluids is the use of biocides. Their effectiveness depends on proper selection and use, and awareness of their shortcomings. The result of using an inappropriate germicide in a laboratory setup, often duplicated in plant coolant systems, is seen in *Figure 2*, which shows a fungal mass attached to the tip of a glass rod. There is no universal biocide — one that will work equally well in all fluids against all kinds of microorganisms, last indefinitely in the coolant system, degrade immediately when released, and be economical to use.

Solubility is an important parameter. If the biocide is to be placed in the

concentrate, it may have to be 20 or 30 times more soluble than in the working solution. There may also be a problem of dispersion and solubility in the working solution as well. Stability in concentrates is an additional concern, since interactions with the formulations may be more probable because the reactants are present in higher concentrations, and they may be subjected to greater extremes of temperature during shipping and storage. Some active biocides cannot tolerate the high ambient pH of the concentrate.

Perhaps the best approach to dealing with multiple microbial groups involved in cutting fluids is to mix synergistic biocides that complement each other's actions. However, there is always the danger of antagonistic results, with one biocide modifying the action of the other. Two different biocides should never be mixed without prior evaluation in a definitive system.

As fluid longevity increases, breakdown products of both the fluid and germicides will accumulate. With a number of biocides there is a sharp drop in activity with a reduction in concentration, with activity in some cases falling logarithmically while biocide concentration drops only arithmetically. As a result, the effect of make-up rates in central systems can be critical.

**Physical Methods.** An advantage of physical methods (not involving chemicals) of controlling microbial growth in cutting fluids is that they have no residual effect. However, they are only active when being applied, and therefore require more frequent treatment. Such methods have not been widely used, primarily because of the need to introduce changes or additions to hardware. On an experimental level, however, some physical treatments have proven successful.

It has been shown that ionizing radiation, using an isotope of cesium, can be used to reduce the levels of spoilage microorganisms in cutting fluids without either the development of resistant survivors or negative effects on the fluid itself.

Thermopasteurization, using levels of heat that are less than sterilizing, is an inexpensive and safe method of control. A possible drawback is the need for recooling the fluid after heat treatment, but it should be possible to devise heat-exchanger units for this purpose.

Sonic oscillation is another physical method of controlling microbes that deserves more intensive investigation. Laboratory data shows that fairly short treatment with sonic oscillation does reduce microbial levels and increase emulsion stability. One shortcoming is a slight increase in temperature as the process proceeds. ■