Metalworking Fluids and Biological Contamination

By their very nature, metalworking fluids, whether water-miscible, straight oil, or parts washing fluids, tend to be subject to biological contamination. This contamination can come from a variety of sources including:

- The water it was mixed with.
- Bacteria and fungus in the air or on dirt carried into the system.
- Bacteria and fungus unintentionally introduced into the system from things like cigarette butts, part of a lunch sandwich, or the bottom of a cold cup of coffee.
- The operator's hands.

Bacteria need both water and a source of food (organic chemicals, tramp oil, etc.) to grow. It is interesting to note that one of the major differentiations between types of bacteria is that some grow and prosper in the presence of oxygen and others in its absence.

Bacteria present a series of problems in water-miscible MWFs (metalworking fluids). These problems include:

- Monday morning stink – a hydrogen sulfide odor that is particularly noticeable when the machine is first started.
- Brown or black staining as a result of the hydrogen sulfide reacting with the surface metal to produce corrosion.
- Corrosion – the bacteria “eat” some of the chemicals used as corrosion inhibitors and they produce organic acids and salts as metabolic by-products.
- Emulsion instability – the bacteria attacks both the oil (petroleum, vegetable, or synthetic) in the formula as well as the wetting agents, emulsifiers, and blending agents present in the fluid.
- The bacteria essentially uses all the components of the fluid as food sources.

Interestingly, synthetic (chemical) coolants tend to be more susceptible to mold infection than are emulsion coolants. Emulsions, on the other hand, are more susceptible to bacterial infections than are synthetic and semisynthetic fluids.

There are two broad classes of bacteria present in the MWF environment. The first is known as "facultative" aerobic bacteria. That is, they prefer air (oxygen) for best growth. In the absence of oxygen they stagnate or grow very slowly until oxygen is reintroduced, at which time they will assume normal rates of reproduction. (They reproduce by division approximately three times per hour.) This type of bacteria does most of the damage to the MWF in terms of actually destroying the fluid.

A second type known as anaerobic or sulfate reducers flourish in the absence of oxygen. While they don't do much damage to the fluid, they generate most of the odor and are therefore often the cause of the fluid being dumped. This type is the bacteria responsible for Monday morning stink associated with fluids. These bacteria grow much more slowly than the aerobic, dividing once every four hours.

These anaerobic bacteria will usually not grow until the fluid has been attacked by the aerobic bacteria. Because of this fact and the fact that testing for the aerobic bacteria is both faster (12 to 24 hours) and easier, more often than not they are the only bacteria tested for in normal laboratory sampling. It takes 120 to 160 hours to get accurate anaerobic results.

A special situation exists in the so called "bio mass". This is a situation where bacteria of both broad types, and sometimes fungus as well, "colonize" on machine tool or sump surfaces. In situations like this, as with fungus alone, it becomes necessary to "displace" and break up these colonies. It is sometimes possible to do this with special chemistry, but more often than not, they need to be physically removed during the machine cleaning process.

Fungus (mold) contamination can also be a problem. In general, there is a natural antagonism in nature between the various bacteria and fungi. In systems where all bacterial activity is suppressed, or where they are contaminated by outside sources of fungal spores (down wind of a bakery, brewery, distillery, or corn field) they are often subject to "problem" fungal growth. Fungus typically gives off the yeasty, damp, locker room smell and creates problems because it grows in "mats". These fungal mats can create problems both for machine function and filtration.

While the use of biocides, or more officially, fungicides or rodenticides are sometimes appropriate in managing the growth of bacteria and/ or fungus in MWFs, a much better solution is to have clean machine sumps, good quality MWFs, proper concentration control, good quality water, and tramp oil control.

In general, the control of bacterial contamination in MWF is a function of good fluid management and preventative maintenance.

NOTES:

1. Biological activity is normally reported as an exponential number (because the numbers are so large) per unit of volume, e.g. 10^6/ml or 10^6 with the volume understood or 1,000,000 bacteria per milliliter of solution.
2. Typical drinking water as it comes from your tap at home contains in excess of 10^3 bacteria.

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