

## BUGS

### Overview

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Metalworking fluids are subject to attack by micro-organisms. Many people refer to these micro-organisms as "bugs." While these tiny organisms are not insects, they do "bug" people who have them in their fluids. Microbiology is a specialized field but understanding some basics about these organisms can help to avoid problems.

### Definition

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The term "micro-organism" applies to both bacteria and fungi. Fungi are both yeast and mold. The singular for each is bacterium and fungus. Bacteria are single-celled organisms while fungi can be single-celled or multi-celled.

### Bacteria

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Bacteria are found in the air, soil, and water. They have been on earth millions of years prior to human beings and will be around long after we are gone. Living bacteria have been found in both poles of the world as well as the ocean floors where steaming hot water spews from volcanic vents. Bacteria can also be found in human intestines. Bacteria cannot be seen by the naked eye, as they are typically less than 2.0 microns in size. However, their impact can be seen and smelled.

Bacteria live in the metalworking fluid and can consume portions of the fluid in their growth. Consumption of specific alkanolamines can convert the amines to alcohol, water and ammonia. When the ammonia is emitted from the fluid, you will smell it right away. The human nose can detect levels of ammonia far lower than the TLV (threshold limit value) of 50 PPM.

"Monday morning odor," that rotten egg smell, is hydrogen sulfide ( $H_2S$ ) created by sulfate reducing bacteria (SRBs). SRBs grow in areas where there is no oxygen. When the machine tool pump is activated Monday morning, after the fluid sat stagnant over the weekend, the fluid is mixed. The SRBs begin to die as they are exposed to the oxygen and give off their  $H_2S$ .

### Fungi

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The by products of some growth are often acidic which decrease the pH of the fluid. As the pH decreases, the potential for corrosion increases. Unless the bacteria are killed, they will continue to grow. An entire population of some common metalworking fluid bacteria can double approximately every 20 minutes. So, if you start with 1000 bacteria at time zero, in 8 hours you would have  $1.68 \times 10^{10}$  bacteria, which equals 1,680,000,000,000 bacteria!

Fungus tends to live around the fluid and not so much in it. If fungus shows up in your fluid, you can bet that it exists somewhere else. Fungus tends to proliferate in splash areas where the coolant sits without agitation. Fungus can be found in the soil and in the air. If your customer's manufacturing plant is located near a farm, the customer probably has fungal problems every Spring when the new crops are planted and in the Fall BUGS at harvest time. This is because the soil is churned and a lot of micro-organisms get into the air.

Fungus is more of a physical problem creating films and mats of growth. These forms of growth can plug coolant nozzles and fluid lines. Given enough time, they will coat the walls of coolant flumes in the trenches, which are below the ground, as well as plug filters. Common odors used to describe fungal growth are a "wet dog" or a "musty locker room."

### Biostability

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This term has, at times, created some controversy. The reason behind this is that different companies have different beliefs in terms of just exactly what biostability is or means. It is "generally accepted" that biostability means that "uncontrolled" growth does not occur. This can mean no growth at all or small levels of growth to the point where the fluid is not disrupted by the organisms. Quaker Houghton understands this term to mean, "a usually nonbiocidal material that creates an environment in which the micro-organisms will not grow in an out of control fashion." Sometimes this is handled by maintaining a specific pH range. Other times it might be related to using components that are not easily digested by the organisms. Sometimes, proprietary chemistry is utilized to create a biostable condition.



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## Biocides

The Federal Insecticide Fungicide & Rodenticide Act (FIFRA) requires suppliers to register their fluids with the US government. The US government, the EPA to be more specific, guarantees that the biocides are checked for safety levels and general efficacy against the "typical" organisms encountered. At the end of the day, only Federally approved biocides can be used at the concentrations dictated by the suppliers. Misuse can lead to chemical burns or chemical sensitization.

Biocides are also industry specific. This means you cannot take a biocide used for cooling towers and use it in a metalworking application or vice versa. Biocides are contained in many fluid concentrates so that every time you add make up fluid to the system or sump, you are adding additional biocide to help protect the fluid. Some biocides can be post added in situations where the microbiological growth has gotten out of control for whatever reasons. This is typically impractical for smaller sumps as measuring and adding the biocide could easily lead to situations where overdosing could occur or it may be more cost effective to do a DCR (i.e. dump, clean & recharge).

Biocide types are broken down into full spectrum biocides, bactericides, and fungicides. As implied by their names, they either kill both bacteria and fungi, just bacteria or just fungi. Recognize however, that both bacteria and fungi often compete for the same food sources. If you suddenly remove all of the bacteria, the fungi could grow and vice versa. It is important to keep both under control.

The supplier, in coordination with FIFRA, determines specific dosage rates. These are the safe limits per dose. Some situations require treatment with multiple doses. As long as sufficient time is provided to permit the biocide/bactericide/fungicide to do its job, additional doses can be used to kill the organisms.

## Detection

There are methods available to detect the presence of micro-organisms other than smell. Most are determined by applying the suspect fluid onto a surface containing some type of agar. The agar can be treated so that only bacteria or fungi will grow. This keeps detection and counting the colonies simpler.

Standard plate counts have been used for a long time. This method requires a laboratory with controlled conditions to avoid or eliminate contamination of the samples. Serial dilutions of the suspect fluid are applied to individual petri dishes commonly referred to as "plates." With each dilution, you can obtain a more accurate count of the colonies. Specific time periods of growth

are applied to grow fungi and bacteria separately. After the organisms grow, the colonies on the plates are counted under a magnifying glass. The appropriate unit is CFU/ml, which stands for colony forming units/milliliter.

There are several suppliers that offer a type of "dip slide" that is a self-contained unit. This unit is usually a small plastic bottle with a screw cap that holds a wand or paddle that is typically two-sided. Each side of the wand contains agar so that one side permits growth of fungi and the other growth of bacteria. The unit is extremely simple to use but only offers ranges of response rather than the more accurate value obtained in a plate count. The wand is dipped into the metalworking fluid, excess fluid is shaken off, and then the wand is placed back into the container and screwed tightly to seal. After 24-48 hours for bacteria, or 72+ hours for fungi, the wand is examined and compared to a chart, which translates the appearance to a level of growth. The counts are expressed exponentially because this method is easier than writing large numbers. For example,  $1 \times 10^7$  is equal to 1 followed by 7 zeros or 10 million CFU/ml. Please refer to the table for a better understanding of the exponential readings.

## Terminology

Quaker Houghton leads many other companies in using clear and concise English in our SDS's. For a more complete list, request a Quaker Houghton Pocket SDS Dictionary.

READING	VALUE	MEANING	ACTION REQUIRED
$10^1$	10	Low value	No concern
$10^2$	100	Low value	No concern
$10^3$	1,000	Low value	No concern
$10^4$	10,000	Medium value	Some concern
$10^5$	100,000	Medium value	Some concern; investigate
$10^6$	1,000,000	High value	Concern; action required
$10^7$	10,000,000	Very high value	Concern; action required

Recognize that some customers prefer to "take action" at different values. Some customers might treat their fluid with a post-additive biocide at 100,000 CFU/ml. The majority of current customers treat somewhere between  $10^6$  and  $10^7$ . These values are used only for bacteria,



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as fungal results are much smaller with a maximum count of 200 CFU/ml. Fungal values in the 10–50 CFU/ml range are considered low value with no concern.

## Bacterial Characteristics

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The majority of micro-organisms found in metalworking environments are referred to as "Gram-negative" organisms. This has to do with the type of stain that is employed to identify the bacterium. It is named after a Danish doctor, Hans Christian Gram. In essence, Gram-negative bacteria are different from Gram-positive bacteria because of the cell wall structure. It is also this cell wall structure that impacts how the bacterium reacts to other chemicals. It is difficult to culture some Gram-positive bacteria in laboratory conditions.

In the last 10 years there has been more attention paid to certain slightly Gram-positive bacteria called mycobacteria, or "myco" for short. Myco have been linked to health problems in other industries, such as pigeon breeders and mushroom growers, just to name a few, as well as in the metalworking industry. Myco are slow growers taking anywhere from a few days to 6 weeks to grow. Specialized media and a longer incubation period are required to grow them in labs in comparison to other commonly found metalworking fluid contaminants. The faster growing mycobacteria that have been isolated from metalworking fluids can be detected on growth media in two weeks or less. These organisms have waxy cell walls that make them resistant to most biocides. There is a condition referred to as HP, which stands for hypersensitivity pneumonitis. HP has been linked to the inhalation of the mycobacteria that can inflame tissue in the lungs. HP is actually an allergic reaction and not a disease. You cannot "catch" HP from someone who has it.

Another method to determine and classify types of bacteria is called acid fast staining. Special stains are used to identify and classify bacterial organisms based on their cell wall composition. Acid fast stain, used for microscopy, stains the cell wall of mycobacteria clear red. The stain is not decolorized with acidified alcohol. All non acid-fast organisms (which include Gram negative bacteria, most gram positive bacteria, yeast and mold) will decolorize the dye and stain blue.

Gram negative organisms are ubiquitous in air, water, soil and metalworking fluids. The majority have minimal health risk. Gram positive organisms are more likely to be clinical pathogens. However, the vast majority of bacteria found in metalworking fluids are not harmful. Of course there is always the potential for an individual to be more sensitive to

certain bacteria and/or yeast and mold. While more work continues, it is believed that proprietary metalworking "chemistry" can negate the growth of mycobacteria and other metalworking fluid microbiological contaminants.

## Preventive Actions

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There are many simple things that can be done to minimize microbiological growth in the fluids. They are:

**Maintain Proper Concentration** - Concentration control is perhaps the number one concern in using water-soluble metalworking fluids. The concentration dictates just about all of the positive attributes of the fluid. Also, keeping the concentration at the right level guarantees the correct level of biocide.

**Maintain Proper pH Control** - This starts with the proper concentration as described in the above paragraph. The proper concentration should be sufficient to maintain the proper pH. However, if the pH continues to be a problem, there are pH-enhancing additives that will provide help.

**Minimize Contamination** - Contamination can be deliberate or accidental. The deliberate contamination is a matter of education. Deliberate contamination can come from food, drinks, spit, chewing tobacco, shop towels, cigarette butts, and just about anything else that gets tossed into the fluid without thought. This can also include dirty mop buckets and other spent process fluids.

Accidental is mostly related to tramp oil situations. Any non-water-soluble fluid that can get into the metalworking fluid is called tramp oil. Mostly these sources are hydraulic fluids, way lubricants, greases, gear oils, spindle lubricants or even process fluids carried in by the part. Minimizing these fluids minimizes food sources. Devices designed to remove tramp oils go a long way to help reduce their impact.

**Sustain Good Maintenance Practices** - Maintenance can be very simple. It can start with the machine operator hosing down his/her machine tool at the end of their shift. They should use only coolant to flush all of the chips into the filter and off of the machine surfaces. Most machine tools have automatic conveyors to remove chips and fines from the coolant sump. Make sure the filtration system is in place and functioning properly. Keep the volume of the machine at the proper level and at the proper concentration. If the machine tool gets too dirty, then it should be properly DCR'ed (dumped, cleaned, recharged).



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## Conclusion

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Defending any metalworking fluid from microbiological attack requires preventive actions. There are specific actions/reminders you can use to alert your customers so that they can prevent or minimize biological attacks. Minimizing the biological issues lengthens the life of the fluid, keeps problems from occurring, promotes more "up time" for the operation and saves the customer money. Make sure your customers are doing what is best to maximize the benefits of their fluids.

