Technical Bulletin

Master Fluid SOLUTIONS®

Metal Removal Fluids and Corrosion – Frequent Sources of the Problem

After more than seventy years in the industry, Master Fluid Soltuions (founded in 1951) has found that the cause of a corrosion problem can frequently be traced to a relatively short list of reasons. Note: the source of corrosion can be quite complex and is rooted in the nature of the material (metals) being machined – once freshly cut metal is exposed to the air, it oxidizes and corrodes. However, more often than not, when corrosion moves from a "theoretical inevitability" level to "problem" the condition that is pushing the level up is one of these conditions:

- **pH control** - pH is one of key indicators of fluid health, but like so many indicators it is only valid when understood in the broader context of the situation. Most metalworking fluids are maintained on the alkaline side (having a pH above 7) because alkalis put a protective layer on most ferrous metals (the machine tool, steel work piece, etc.) which prevents corrosion. Higher pHs do a better job of preventing ferrous corrosion; however pHs above the mid 10s often cause dermatitis.

  The inevitable is that most nonferrous materials, such as zinc (Zn), copper (Cu), aluminum (Al), and magnesium (Mg) are amphoteric; that is, they are attacked by acids or alkalis. Therefore, the pH of working solutions for these nonferrous metal need to be kept as near 7.0 as possible to provide the corrosion protection on the machine tool. If we are looking at ferrous corrosion situations and the working pH is less than approximately 9.0, there may be cause for concern. On nonferrous metal a pH level above 8.5 would be a cause for concern. The important thing here is not the pH at the moment, but whether it is higher or lower than it was when it was working most effectively.
- **Salts** - The addition of any salt, from the mixing water, the atmosphere, heat-treating, plating, etc., to an aqueous (water- based) solution will increase its ability to conduct electricity. As a fluid becomes a better electrolyte it is more likely to facilitate corrosion. Salts from minerals in hard and even those in "softened" water can cause corrosion problems. The chloride ion (Cl-) present in softened water is a particularly "bad actor" in many corrosion processes.
- **Environmental factors** - The air in some areas may be high in acid fumes from sources like the plating process, near a battery recharge station, or the atmosphere where the burning of coal, oil, or gas can produce significant quantities of sulfur dioxide. Depending on geographical environment the atmosphere itself may be high in salt content, particularly in areas near the ocean or sea.
- **Galvanic** - If two dissimilar metals (e.g. iron and aluminum) are paired together, a current will flow from the most noble (most cathodic) to the least noble (most anodic) metal any time a conductor is present. This will cause corrosion unless special precautions are taken with specific inhibitors. This situation happens, for example, when large pieces of aluminum aircraft alloys are worked on a cast iron or steel machine bed for a number of days.
- **Grounding** - Machines that are poorly grounded or have no ground may be subject to corrosion. The magnitude of the corrosion will depend on the amount of "stray" electricity flowing. One big clue to this phenomenon is when you notice corrosion on the machine but the parts are corrosion free.
- **Bacteria** - As part of their metabolic process, bacteria generate acids and salts. Because these acids and salts are corrosive, they will turn the machine tool and parts brown. The gas (hydrogen sulfide – H_2S) produced by the sulfate reducer bacteria may turn the coolant black and produce a black stain on machines and parts.
- **Wood, paper, and tote boxes** - Unless paper and wood are specially treated, they are acidic and may cause corrosion when they come in contact with a wet part or moisture laden air. If the wood is "green", e.g. contains a lot of moisture, the parts don’t even need to be wet to cause corrosion.

  Pieces stacked together in tote boxes will often rust, particularly if the boxes are extremely deep. The atmosphere at the bottom (unless the boxes are well ventilated) will be at practically 100% humidity. Parts should not be stacked flat against each other but should be separated by plastic or plastic covered open metal separators.
- **Use of air hoses** - Sometimes operators will use an air hose to blow off wet parts after machining or grinding. If the compressed air has

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any entrapped moisture, the combination of blowing off the rust inhibiting coolant and the depositing of water from the air line onto the part will result in rust.

- **"Mating" parts on machine tools or work pieces** - This type of corrosion is most often a mixture of different types of corrosion and occurs so frequently that it has its own name. It occurs when two or more materials come together or "mate". The two typical causes of mating corrosion are galvanic and bacterial. The galvanic cell is created in the presence of an electrolyte – coolant that has been carried in by capillary action and/or minerals deposited when that fluid evaporates. As these mating interfaces are often "warm, wet, and stagnant", the bacteria thrive there. With the growth of the bacteria comes organic acids and salts which facilitate the galvanic corrosion and cause the dark staining so typical of this type of corrosion.
- **Undesirable cutting oils** - The presence of active sulfur and/or chlorine in some straight oil products react with moisture from either coolant or moisture in the air to cause staining and corrosion of machine tools and machined parts.
- **Poor coolant concentration control** - The amount of corrosion inhibitor present in any coolant is directly related to the concentration of that fluid so concentration control is critical. It is important to understand that some rust inhibitors can just be "used up" by exposure to oxygen in the air, bacterial degradation, and on the very finely divided chips left to soak in the sump. This material is designed to be replaced by make-up product added to maintain concentration.
- **Germicides, additives, or contaminants** - Many of the fluid maintenance chemicals used tank-side can cause or contribute to corrosion if improperly handled. Add materials to your systems only after understanding all the ramifications and consulting with your fluid supplier.

NOTES:

1. Lack of concentration control is implicated at least in part in nearly all metalworking fluid problems.
2. Metals (alloys) are not necessarily homogeneous and it is therefore possible to set up a galvanic cell within a single piece of metal.
3. Corrosion occurs more easily and moves faster on a rough surface than on smooth, because there is more surface area.
4. To provide effective corrosion prevention on a surface, it must be wetted so fluids with very low surface tension are best on porous materials like cast iron or powdered metal, etc.

REFERENCES:

1. Joseph R. Davis, James D. Destefani, ed., ASM Handbook Volume 13, "Corrosion", ISBN: 0-87170-007-7
2. Stephen D. Cramer and Bernard S. Covino, Jr., ed., ASM Hand- book Volume 13A, "Corrosion: Fundamentals, Testing, and Protection", ISBN: 0-78170-705-5
3. J.R. Davis, ed., "Corrosion Un- derstanding The Basics" (ASM International Materials Park, Ohio; 2000), ISBN: 0-87170-641-5

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