WATER QUALITY AND METALWORKING FLUIDS

BACKGROUND

On average, 90% of the water-soluble cutting fluid in use at your customer is composed of locally sourced water. This document in intended to educate you on the water used in metalworking fluid applications.

TYPICAL IMPURITIES

Generally, city water quality is adequate to mix with cutting and grinding fluid concentrate for the initial charge and in small pumps as make-up. However, if you want to extend the life of the metalworking fluid sump, or plan to recycle the fluid, the quality of the water used for make-up must be considered. Understanding water impurities and how these impurities impact the metalworking fluid is important. The following are some typical impurities.

Hardness is a common quality of water which contains dissolved compounds of calcium and magnesium. Dissolved calcium and magnesium salts are primarily responsible for most scaling in pipes and water heaters. In metalworking fluids, hardness can cause the development of an insoluble curdy precipitate referred to as hard water soaps. Hardness is usually expressed in grains per gallon (or ppm) as calcium carbonate equivalent. Hardness builds due to the ‘distillation effect’ as water evaporates from the sump. As hardness increases emulsion stability, corrosion protection and bioresistance are negatively impacted.

Dissolved salts such as chlorides and sulfates increase the risk of corrosion on machines and parts. Chlorides are very corrosive to metals. As fluid pools evaporate, chlorides concentrate and can result in localized corrosion on parts and machine surfaces. Sulfates are more associated with staining of metals, particularly yellow metals. Sulfates promote the growth of sulfate-reducing bacteria that produce a ‘rotten egg’ odor.

Bacteria and fungi may be found in any water source. Deionized, reverse osmosis, process water, wells, lakes, rivers and even municipal water sources can have bacteria and fungi in them. If bacteria is allowed to increase over time, corrosion protection, coolant stability and coolant sump life can be negatively impacted. Fugus can lead to equipment malfunction, off-odors and degradation of the fluid.

THE CONCERN WITH CONTMINANTS

Water extended coolants lose 5-20% water per day through evaporation, depending on fluid type, agitation and severity of the operation. This water is replaced with make-up to maintain coolant concentration. Dissolved contaminants from the initial charge increase through additions of make-up water. They do not evaporate with the water, remaining in the system and resulting in a gradual buildup in the system. This process is known as the distillation effect. Hardness and salt levels can increase three to four times in a month. As ionic concentrations increase over time, corrosion protection, coolant stability and coolant sump life can be degraded.

Castrol Technology Deployment, 150 W Warrenville Rd., Naperville IL 60563

WATER TYPES

Tap water is the initial water source or supply to a facility. This source will vary depending on geographic location, source (reservoir, well, lake, etc.) and treatment. Chemical additives can be added to tap water that will temporarily eliminate the symptoms of hardness by chelating the calcium and magnesium. Some additives increase sodium and/or alkalinity, causing other problems; all add dissolved solids to the water.

Deionized water (DI water) is a chemical process where the dissolved ionic salts are removed from the water. The deionizing unit uses two ion exchange resins to remove both cations (positively charged ions) and anions (negatively charged ions) and replaces them with hydronium (H^+) and hydroxyl (OH^-) ions respectively. This process can provide water quality equivalent to laboratory distilled water: less than one part per million in hardness. Bacteria and fungi can contaminate resin beds and filters but can be corrected using ultraviolet (UV) light.

Water softeners utilize exchange resins which exchange one ionic species for another. In water treatment, the hard water mineral ions calcium (Ca^{+2}) and magnesium (Mg^{+2}) are exchanged for sodium (Na^+) ions. As this is an exchange, the ionic activity or total dissolved solids (conductivity) remains nearly constant.

Reverse osmosis (RO) utilizes a membrane that allows water to cross freely but significantly retards charged ions. This reduces the ionic content and ionic activity of the water by 90 to 95 percent. RO units use water softeners as a pretreatment to remove hard water minerals, reducing hardness and dissolved salts by 90 to 95 percent. This extends the life and performance of the RO membrane. RO units filter out bacteria and fungi, but these organisms may grow on the membrane so the RO membrane should be sanitized every 6 to 12 months.

WATER FOR SYSTEM CHARGE

Water softeners exchange calcium and magnesium for sodium, which will reduce scaling, but tends to increase foam and reduce corrosion protection. A fluid system charged with DI or RO water may experience foam problems as well. We recommend that fresh charges be made with tap water if it is not excessively hard, and make-up additions be made with DI or RO water. The levels of calcium, magnesium, chlorides and sulfates should be well below tolerances, yet still provide good metalworking fluid foam break characteristics. Charging a system with DI or RO water is typically not feasible or economical because the usual industrial DI or RO units do not have the capacity needed to charge a large fluid system.

TESTING YOUR WATER

Conductivity is a measurement of dissolved minerals and salts in water. The higher the conductivity, the poorer the water quality. Conductivity does not, however, distinguish between hardness and salts.

Hardness is measurable via several tests:

- Hardness test strips are not completely accurate, provide a general measure of water hardness.
- “Hach” hardness test kits are convenient for field use.
- ICP hardness tests are completed in our lab, report hardness based on Calcium and Magnesium.

Chlorides are determined via titration.

Bacteria and fungi can be measured by an agar dip slide method, which is also used for metalworking fluids.