WATER QUALITY

Overview

Cutting and grinding coolants, diluted for use, are mostly water (95% water at a typical concentration). Water plays an important role in coolant performance. Life would be simpler if every customer's water was the same; however, water quality varies across the United States. We need to understand how water affects metalworking coolants. This "Skill Builder" makes water crystal clear.

Introduction

Water is two parts hydrogen atom and one part oxygen atom. The water molecule is a polar compound and is described in several technical guides as "the most universal solvent." Water is often taken for granted, however, water quality varies depending upon the source and how the local processing plant treats it.

- Water expands upon freezing (most liquids contract)
- 97.5% of water on earth is salt water, 70% of the Earth's fresh water is frozen in the polar caps
- Once evaporated, a water molecule spends 10 days in the air
- Water conducts heat 2.5 times faster than oil
- Kentucky bluegrass uses 18 gallons of water per square foot per year
- Ice, formed when a supercooled liquid contacts a freezing surface, is called "Rime."
- It takes 2,072 gallons of water to make 4 new tires
- 1 billion people walk 3 hours each day to obtain safe drinking water
- In the US, 500,000 tons of pollutants pour into lakes and rivers each day
- A chicken is about 3/4ths water
- One inch of rain is equivalent to 17.5 million gallons per square mile

In metalworking, we rely on water to transfer heat away from the tool and part. Water also serves as a carrier for additives that enhance corrosion protection, lubricity, cleanliness and resistance to bacterial attack. In cutting fluid applications, the important parameters for water are hardness, conductivity, pH, alkalinity, temperature and purity.

As systems age, these parameters change and finally reach equilibrium. The equilibrium level is dependent upon the degree of evaporation in the system. Overflows, spills, carry-out on parts, heat, and coolant makeup rates all affect how high these parameters will go.

Hardness

Hardness is the measure of calcium (Ca) and magnesium (Mg) ions in the water expressed as calcium carbonate (CaCO3). These are naturally occurring positive ions that are derived from the minerals in the ground. You can express the value as grains of hardness or as ppm (parts per million) of hardness. One ppm is the same as one milligram per liter (mg/L).

One grain of hardness is equivalent to about 17 ppm as CaCO3. In the continental U.S., hardness can vary from a low of 2-5 ppm in the Southeast to 1200-1500 ppm in the desert areas of the Southwest.

The biggest concern about hardness is that too high of a hardness can create emulsion instability. "Hard water" soaps can be formed in the presence of too much calcium and magnesium. These soaps are generally insoluble and can lead

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to sticky residues. At times, it is possible to chelate the hardness by using an additive called a chelating agent. Chelation means that the calcium and magnesium become chemically bound to the agent so that they cannot react with other components in the coolant.

There are analytical methods for determining the total hardness of solutions. We can use one of two simple methods in the field: test strips and titration ampoules. Ask your Quaker Houghton representative for details.

Conductivity

Conductivity is a measure of electrical "activity" of an aqueous fluid in which the total dissolved solids (i.e. TDS) are examined. The conductivity is measured via a small electronic bridge in units of either microSiemens (µS) or micromhos (a mho is one divided by ohm, hence the name "mho"). One microSiemen is equivalent to one µ mho. The primary ions contributing to the TDS are calcium, magnesium, chloride, sulfate, and iron.

Ion-specific electrodes exist for measuring these ions. There is a Volhard procedure for determining chlorides in emulsions and solutions. This procedure is typically a lab procedure. While these are naturally occurring ions, you can also have chlorides and sulfates carried in from other fluids and compounds (see section on Chlorides & Sulfates). Iron can come from the ferrous machining and grinding process of steel and cast iron.

Like high hardness, high conductivity can disrupt the emulsion. This is actually part of the waste treatment process. Concentrated aluminum sulfate (alum) or ferric chloride is used to split emulsions.

pH

In general, most water sources have a pH range of about 5.7 to 8.0. The pH is really not too much of a concern, unless it has a correspondingly high alkalinity.

Alkalinity

The alkalinity of water is usually attributed to carbonates in general. However, the main concern about alkalinity is when it becomes high enough to affect an alkaline titration. At this point we must make sure that we subtract the alkalinity of the water from the total titration.

Chlorides and Sulfates

High conductivity, especially chlorides and sulfates, can also lead to increased corrosion . Unfortunately, the only way to minimize high chlorides and sulfates is through partial dumps. You either have to remove the source of these ions as contaminants or not allow them to remain in the water when it enters the plant. Chlorides and sulfates contribute to the TDS/conductivity. Ion specific electrodes exist for measuring these. There is also a laboratory procedure called the Volhard method for determining chloride ions in fluids. Chlorides and sulfates are naturally occurring ions, but you can also have these ions carried in from other sources. Heat treat salts can be a signifigant source for chlorides as well as certain cleaners.

Temperature and Mixablity

Cold water usually makes emulsification more difficult. In some cases, some products will not mix at all in cold water. Cold water is obviously a problem in the winter, when water temperatures can run as low as 40-50°F.

Some customers and processes require that the metal- working fluid be chilled to a temperature lower than ambient. This is typically done in order to maintain a more consistent temperature of the workpiece. You will find this in some aerospace

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applications as well as those having very tight tolerances for finish.

Processes

There are different processes used to improve water quality. Some of our customers use these processes. By far, the most common is deionization. Deionized (DI) water is water that has had all ions removed through a deionization column process. This water is typically less than 5 ppm in hardness and contains no ions detrimental to emulsion characteristics. The downside of DI water is that some products can foam easily in it.

Another type of conditioning process is called softening. As its name implies, the hard water ions are removed. However, in the ion exchange process, sodium ions (Na) are substituted for the calcium and magnesium ions. So, while you may wind up with soft water, you will also have increased your conductivity because each calcium or magnesium is replaced by two sodium ions.

The last type of process is called reverse osmosis (RO). RO water is a physical process that "blocks" ions from passing through a special type of membrane. RO water is very close in quality to DI water.

Conclusion

As you can see, we are highly dependent upon something over which we have very little control. However, if we properly arm ourselves with a working knowledge of the variables discussed above, we can forewarn our customers about the impact of their water on their processes. Once again, thorough knowledge of the customer's process is important for product selection.

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