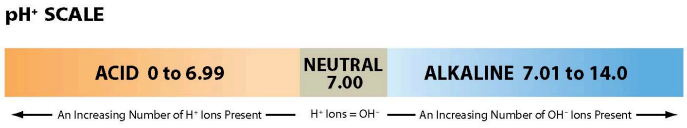
Technical Bulletin

Characteristics of Metalworking Fluids - The Importance of pH+ and Reserve Alkalinity



Typical metalworking fluids range is 8.5 pH^+ to 10.5 pH^+

The working pH of any given metalworking fluid is a key indicator of the fluid's health – whether a coolant, washing compound, or water-based corrosion preventative. While the "optimal" pH for any given fluid or situation differs, there is a pH for your fluid, mixed at your concentration, and used in your machines where the pH of the fluid will stabilize. Typically, this is within a relatively narrow range. Most metal removal fluids (MWF's) are alkaline, meaning they have a pH above 7.0. For a variety of necessary compromises, a MWF typically has a pH between 8.5 and 10.5. It should be noted that there are a few specialized fluids which are more nearly neutral (with a working pH between 7.0 and 8.0), and a very few that are acidic. The specific pH desirable for your situation should be worked out with your fluid supplier. What is important is that if the pH of your fluid changes significantly, you need to find the reason.

pH and alkalinity have an affect on many different fluid characteristics and we will look at some of them later; meanwhile, it is important to understand that alkalinity, either reserve alkalinity* or useful reserve alkalinity** is a critical parameter. Characteristics of Metalworking Fluids – The Importance of pH+ and Reserve Alkalinity If pH is thought of as how "strong" (how acid or basic) the fluid is, alkalinity is a measure of a fluid's ability to maintain that particular pH level over time. So, pH and alkalinity work hand in hand to dictate some fluid characteristics. Some of these fluid characteristics include:

1. Corrosion – Ferrous metals are protected from corrosion by a higher pH. The closer to pH 14.0, the less likely to have corrosion on ferrous materials. White and yellow metals tend to be amphoteric, meaning as the pH is raised or lowered from 7.0, the probability of corrosion increases; the exception to this is that magnesium (Mg), which does better at a higher pH. The responses of materials like nickel (Ni), chrome (Cr), and cobalt (Co) to pH are very alloy-specific.

2. Metal solubility – The solubility of materials into MWFs follows much the same rule as does corrosion, except that the amount of alkalinity very much controls the amount of metal that can be put into solution. It is important to have reserve alkalinity, but only at the pH that is appropriate to the fluid and the specific situation.

3. Emulsion stability – With traditional soluble oils, increasing the pH of the working solution tends to "tighten up" the emulsion, while reducing it makes the emulsion more course and likely to split. Tighter emulsions wet better, and have lower carryoff; those that are more course usually provide better hydrodynamic (mechanical) lubricity and much more carryoff. Depending on the nature of the tramp oil, changing the pH can either reject it or emulsify it.

4. Dermatitis – The farther the pH of a working solution moves from 7.0, the more likely dermatitis results. In general, a working pH of less than 10.5 is well tolerated. When skin is exposed to alkaline situations, the alkalinity in the fluid can "saponify" the oil in the skin causing it to dry out ("dish pan" hands) and even crack.

5. Bacterial and fungal growth – Bacteria and fungus can grow at any pH and in nearly any situation. The growth rate of bacteria typically present in metalworking fluids is reduced as the pH is increased. So, raising the pH reduces (though does not eliminate) bacterial growth. The fungus typically associated with metalworking fluids tends to prefer highly alkaline solutions.

6. Machine tool compatibility – Extremes of pH, either very alkaline or acidic, can cause machine tool maintenance problems, such as corrosion, where different materials meet (as when aluminum or brass are attached or in contact with steel or cast iron). At either pH extreme, elastimers (seals and such) tend to loose their flexibility and plastic "glazing" can become quite brittle. As you can see, there is no easy answer to the question "What is the proper pH for a metalworking fluid?" Rather the question should be, "At what pH can I expect this fluid to function best?"

* Reserve alkalinity is the amount of a specific acid that is necessary to supress the pH to 4.5.

** Useful reserve alkalinity is the amount of a specific acid that is necessary to suppress the pH of a solution to 7.5.