SKILL BUILDER

CONCENTRATION

Overview

The term "water-soluble metalworking fluid" means that the fluid is mixed with water prior to use in the machine tool. However, unlike straight oils, water-soluble products must be monitored for appropriate concentration. What exactly is being monitored or measured? There are a number of different variables involved. Many people ask, "What is the REAL concentration?" The answer is, "it depends!"

Methods

The concentration of any product is dependent upon the type of product and the test method(s) employed. Not all test methods are applicable for all products. Common test methods can be grouped into six different categories, without getting into intensive analytical procedures. They are described in the table below:

Test Method Categories

GENERIC METHOD NAME	BRIEF DESCRIPTION
Acid Split	Best for oil-containing products
Dry-down (solids)	Generally for low actives products
Refractometer	Works for all technologies
Saponification	Only for fats & esters
Titration	Dependent upon the component

Each of these is described in greater detail in the sections below along with their interferences. Each method can be negatively affected by contaminants that will generate false positives and lead us to believe that more "product" is present when it is not. Laboratory conditions are used to determine the factors for these procedures. This means that each product will respond differently to each test and its "factor" reflects to what degree it is affected. Also, each written procedure describes exactly how much fluid is required for the test, what reagents are required, and the apparatus necessary to complete the method.

Ratio Versus Percentage

A concentration is best expressed as a percentage, meaning parts of concentrate per parts of total dilution. If 5 parts of X are added into 95 parts water, then the concentration of X is 5%. This is because the total is 5 parts of X plus 95 parts of water for a total of 100 parts. Five divided by 100 yields 0.05. As a percentage, this equals 5.0%. Some people refer to dilutions in terms of a ratio. For that same 5% dilution from above, the calculation is to simply divide that number into 100. In this example the dilution is referred to as 20:1. Regardless, it is always best to confirm exactly what is being stated to make sure everyone understands how much of the product concentrate was added into how much water.

The table below demonstrates the relationship:

Ratio And Concentration

RATIO AND CONCENTRATION						
Ratio (typical)	100:1	50:1	33:1	25:1	20:1	10:1
Ratio (actual)	99:1	49:1	32:1	24:1	19:1	9:1
Concentration (%)	1.0	2.0	3.0	4.0	5.0	10.0

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Dry-Down

A dry down is exactly what it sounds like. A dilution is dried down in an oven to remove all of the water. Like the acid split, it is necessary to remove the tramp oil first. Of course, other contaminants, likes chips and other debris, must also be removed first via filtration. This is typically a very "quick & dirty" method when other methods are not available. Products that tend to have a small amount of active ingredients can be ashed by taking the temperature above 1100°F in small crucibles. This causes all organic material to burn off leaving only inorganic materials behind. Obviously, this only works for products containing inorganic compounds in the formulation. This should only be run under tightly controlled laboratory conditions.

Refractometer

The optical refractometer was originally designed to measure the percentage of sugar, expressed as sucrose (% Brix), in solution for wine making. Today, this same device is used to monitor a wide range of "solids" in solution. A refractometer, in essence, measures the total actives of a product. A few drops of the dilution are placed on a small glass slide, covered by a prism, and then pointed at a bright light. The light is refracted through the prism. When viewed through the eyepiece, a linear scale is read to determine the % Brix. That reading is then translated into concentration based on the factor for the product.

There are many different manufacturers of refractometers with different scale readings. The most common are the 0-10 scale and 0-32. As long as you expect to run concentrations below a reading of "10," a 0-10 scale unit should work fine. If a product has a reading of 4 on a 0-10, it should also read 4 on the 0-32 unit. However, just recognize that there will be fewer graduations on the 0-32 scale. This will affect accuracy of the reading. This device is also thrown off by the presence of tramp oil so, like the other methods, the tramp oil should be removed from the dilution prior to testing. This device is standardized to read "0" against distilled water.

One thing that is absolutely critical to remember when using this method is that not all products read the same. Each product will have its own refractometer factor. The level of active ingredients (i.e. those that refract) in the concentrate dictates the factor. If a product contains 20% water in the concentrate, then a 10% dilution will read 8.0 at best. This can confuse some end users that are not aware of this issue. Some people believe that a reading of "5" means 5.0%. It does only if the product is 100% active. Other raw materials can impact the reading as well. The bottom line is that each supplier should provide a chart showing the refractometer readings over the normal concentration range.

Saponification

Only fats and esters can be saponified. Saponification occurs when a caustic material is heated with the solution. The end mixture is then titrated to an endpoint. Fat-containing and ester-based products work best for this method.

Titration

This is actually a simple acid/base titration. A titration can be conducted colorimetrically or potentiometrically. A colorimetric endpoint uses an indicator that changes color when the endpoint (i.e. specific pH) is reached. A potentiometric endpoint uses the pH meter. Potentiometric is more accurate than colorimetric. A titration can be based on the acidity or alkalinity of the product. There are titrations for total, free, and reserve alkalinity. There is also a boric acid titration. A titration is very accurate but will be interfered by similar compounds. If you are conducting an alkaline titration and an alkaline cleaner is the contaminant, you will read both.

Conclusion

When asked about concentration, you should now be able to handle this inquiry. Maybe your response should be, "The concentration of what?" By understanding the product and the process contaminants, you can choose the best method for monitoring. By understanding the product and the process contaminants, you can choose the method of monitoring concentration that will lead to higher customer satisfaction.

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