Technical Bulletin

Master Fluid Solutions

Mixing Water-miscible Metalworking Fluids

The typical water-miscible metalworking fluid (MWF) should be considered as a material that is mixed at typically less than 10% by volume with water. This means that not only is the quality of the MWF concentrate critical but the quality of the water and how it is added and mixed into the water is also critical.

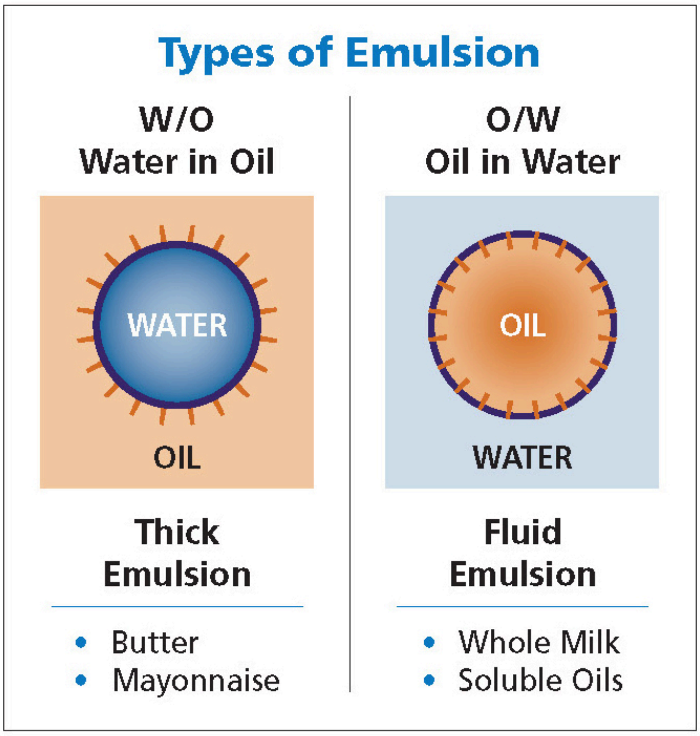
One of the most basic rules of design engineering is that to make a good product you must start with "good" raw materials. For the purposes of this technical bulletin, we will assume that the mixing will occur using the best possible water in the given situation and we will concentrate on the physical act of mixing the MWF concentrate with good quality water.

From a mixing point of view, there are two types of MWFs: those that form an emulsion, and those that go into a solution. Those that form emulsions should always be mixed by adding the concentration to the water! Oil in last (OIL). Those that go into solution can be mixed either by adding the concentrate to the water or the water to the concentrate.

As we all know, oil and water do not mix but we do it all the time when we formulate and mix MWFs. This is done by the addition of special surfactants called emulsifiers to the oil. These emulsifiers are a special form of surfactant where one end of the molecule is soluble in the oil and the other end in the water. This allows very small (less than colloidal size) oil droplets to be suspended in an immiscible liquid (water). The amount of emulsifier, the type of the oil, and how it is mixed will dictate the size of the emulsion droplet. Typically, with MWFs, it is desirable to generate the smallest possible oil droplet, as these small droplets will penetrate to the point of cut better and will reduce carryoff of the fluid system.

When the oil is added to the water (typically not greater than 1 part of oil in 3 parts of water) what is generated is an oil in water emulsion where the oil droplets are suspended within the water phase. If we add the water to the oil, at least part of the system will be a water-in-oil emulsion.

This phenomenon is most often seen in chemical emulsion or soluble oil products but can be observed in many semisynthetics as well (those where the emulsion portion of the product is created upon mixing). It is important to note that you have only one opportunity to properly "set" the emulsion and once it has formed it can not be modified.



Synthetic or chemical products and semisynthetic products, where the emulsion was "set" in the concentrate, do not experience this problem and can be safely mixed by either method.

To be safe, it is always best to add the MWF concentrate to the water, and because the makeup water is nearly always better than the water in the machine sump, it is best to pre-mix the fluid outside the sump and then add the premixed concentrate and the water to the sump.

To optimize fluid performance, it is good practice not to allow the MWF concentration to move up or down but rather to add the proper amount of concentrate each time water is added to the system.

In situations where manual mixing is being done, it is best to fill a container partway full and then generate a vortex in the center of the container by vigorous stirring while the concentrate is added to the vortex. With some difficult-to-mix products it is best to allow this pre-mixed material to "soak" for a few minutes to make sure that everything has been fully mixed.

Proper mixing techniques and equipment help insure that you get the maximum benefit from your coolant concentrate by reducing coolant concentrate purchases, and improve sump life and cutting performance.

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There are at least two types of "mechanical or automated" mixers that will help insure that the fluids are mixed properly.

1. The venturi style mixers, where the suction created by the water moving across an orifice creates a vacuum (Venturi Effect) to lift the concentrate out of the drum. The orifice size is variable to change the amount of lift created to control the concentration that is mixed. This type of mixer may have, as part of its design, a mixing chamber or one may be added externally.
2. The "positive piston proportioning" pump, where a water driven motor causes a variable volume piston to move. The piston pump sucks the concentrate out of the container and then expels it into the stream of water from the "water motor" in some type of mixing chamber. This type of pump is particularly useful because the percentage of concentrate mixed is not a function of flow rate.