



### Technical Topic

# Formulating ‘Multi-Functional’ Soluble Metalworking Fluids

## The Sweet Spot

Experienced users of soluble metal working fluids often ask for one successful multi-functional soluble cutting fluid – a single product that is capable of:

- machining a wide variety of different materials ranging from ferrous to non-ferrous metals
- performing in a spectrum of machining operations from boring and turning to milling and grinding
- exhibiting low foaming propensity even with increasing machine speeds
- offering low maintenance properties.

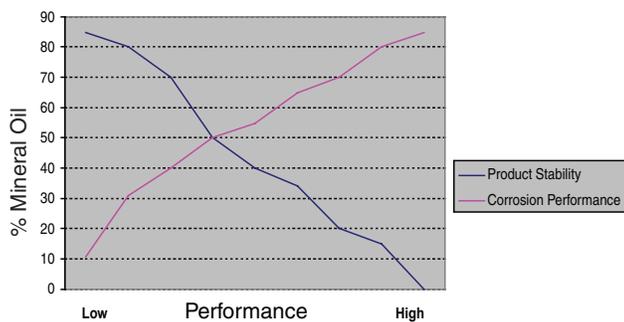
These requirements present the fluid formulator with a major challenge, which can be met by designing and developing a soluble oil product that contains just the right amount of mineral oil to hit the ‘Sweet Spot’ in emulsion performance.

## Emulsion Stability and Corrosion Protection

Take for example a synthetic soluble metalworking fluid that contains no mineral oil in the formulation. Typically this type of product has excellent solution stability while at the same time provides only a limited amount of residual corrosion protection for both machines and components.

On the other hand, a high oil-content product that contains approximately 80% mineral oil in the formulation forms a milky emulsion on dilution with water and will have relatively low emulsion stability, especially in poor quality water, but provides relatively strong residual corrosion protection in the form of a thin oily film.

Figure 1



By varying the mineral oil content from these two extremes, emulsion stability and corrosion performance exhibit the trends shown in Figure 1.

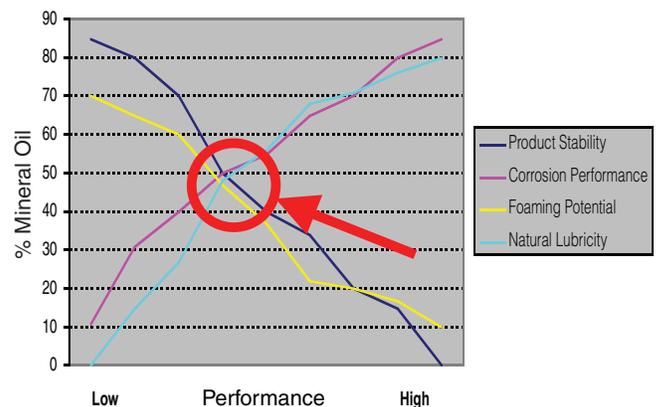


Although this is a simplification of various laboratory tests, it can be seen clearly that there is a point where the two trend lines cross (Figure 1). As both these criteria are critical to the success of a water-based metalworking fluid in customers’ machine shops, this area is the basis of the ‘Sweet Spot’ concept.

## Foaming and Lubricity

The theory of a sweet spot can be demonstrated even further by plotting foaming potential against the quantity of mineral oil in the formulation, as seen in Figure 2. High and persistent foam is detrimental to a soluble cutting fluid and its inherent fluid lubricity, which is necessary to aid cutting performance.

Figure 2

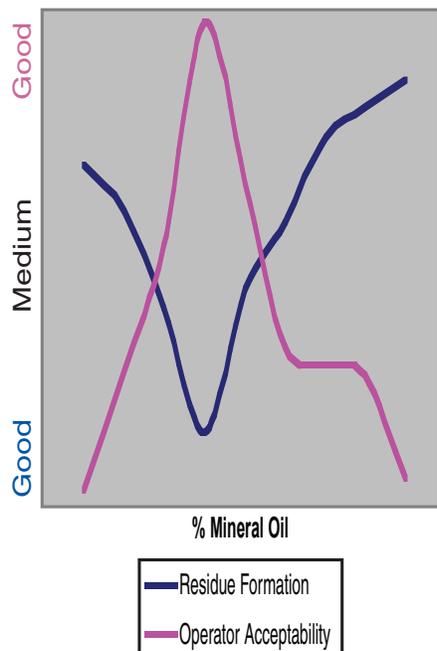


As you can see in Figure 2, a mineral oil content of between 40% and 55% in a soluble cutting fluid provides the optimum performance for low foaming and machining performance (lubricity).

### Fluid Residue and Operator Acceptability

Figure 3 shows the relationship between residue formation after water evaporation (undesirable) and operator acceptability (subjective but critical for product success) and the mineral oil content of the product. Poorly formulated low-oil content products can cause skin irritation. Once again, performance linking these two critical characteristics is optimized at the formulation 'Sweet Spot' - an oil content of between 40% and 50%.

Figure 3



### “The Sweet Spot” Concept

A mineral oil content of approximately 50% offers engineering professionals a balanced performance profile for today’s soluble metalworking fluids. The formulator is able to optimize corrosion protection, machining performance, foaming, and long-term stability with operator acceptability. Products of this type are typically called “semi-synthetic” because they contain a blend of oil and synthetic materials. A carefully developed metalworking fluid offers the long service life and versatility frequently requested by engineering managers.

Formulating to the ‘Sweet Spot’ can provide high performance and low-maintenance soluble metalworking fluids that can improve service life and enhance productivity. It should be no surprise that those global machine tool builders who approve soluble oil cutting fluids often recommend products that contain over 40% oil in their manuals.

A well-balanced metalworking fluid is the key to achieving peak performance in your machine. Each property must be carefully weighed against the others to develop a cutting fluid that performs in a wide variety of machining operations with a varied selection of metals.