



The basics of metalworking fluids

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These versatile players have more functions than a Swiss Army knife and come in four basic types.

The metalworking industry has undergone significant changes in the last 15 or 20 years. Originally the perception of metalworking plants was as one of those “Black Hole of Calcutta” places. While no offense is meant toward our friends from India or, for that matter, the metalworking industry, the perception of metalworking plants was of a dark, dingy, smelly, smoky place where oil of one kind or another was dripping all over the floor and...well, you get the idea. Today’s metalworking industry is very much different, if indeed it ever was quite as bad as that imagery.

While I’m hardly an expert in the metalworking industry, I have had the privilege of sitting in on numerous metalworking certification committee meetings and metalworking fluids certificate education courses. So I have just enough knowledge, with no real plant experience, to be truly dangerous. Nevertheless, undaunted, I have learned a few basic things to share.

Early in my career I had no idea of the very complex nature of metalworking fluids and the many functions that these fluids are required to fulfill. Metalworking fluids must pro-



For some, metalworking plants once suggested this kind of imagery.

vide tool life by removing heat (because heat kills) and lubricate the interface between tool and workpiece, carrying chips away and preventing in-process corrosion.

But these are the macro issues. Metalworking fluids also are expected to protect the workpiece from such problems as poor surface finish, chemical attacks, mechanical damage, metallurgical change, thermal damage and electrical changes. And these are just the operational parts.

However, metalworking fluids contribute to a number of negative things, all of which must be minimized: mist leading to respiratory problems, dermatitis and fungal and microbial growth, which can lead to employee health and safety issues as

well as plugging filters and other operational problems. As a chemist, this poses a formidable set of interrelated and interacting problems—talk about better living through chemistry!

If that were not enough, the term metalworking itself represents a complex set of operations: First, there are “big chip” operations like sawing, broaching, tapping, drilling and gunning and hobbing. Second, there are “small chip” operations like grinding and abrasive fine finishing. Finally, there are “no chip” operations like metalforming into a wide variety of shapes.

Clearly, no one fluid or material can be expected to operate successfully in all these applications and conditions while preventing or minimizing all the negative things that can happen. As near as I can tell, most metalworking fluid suppliers have literally hundreds and hundreds of formulations, often tailored to specific application requirements and plant environments.

Basic categories

Metalworking fluids fall into four basic categories based on their com-

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position: straight oils (often called cutting oils), soluble oils, semisynthetic oils and synthetic oils.

Straight oils are, for the most part, just like the name—a mineral oil and a number of additives. These materials do not contain water, nor are they water soluble. Straight oils are usually used for heavier duty applications requiring lots of lubricity and/or slower speed applications where cooling properties are not as critical.

Soluble oils are usually mineral oils and additives dispersed in water. These macro emulsions, relatively stable dispersions of oil droplets in water, result in a milky opaque appearance. They are sold as concentrates that, while diluted with water for the specific application, are still primarily oil. They are used where lubricity is important and the excellent cooling properties of water are required.

Semisynthetics are, by contrast, often primarily water. They can be translucent as the oil is a microemulsion (very small oil droplets in



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water), which also are diluted further in the plant. These materials contain a number of additives that augment the performance of the product. These versatile fluids are useful in most metal-removal applications, with excellent cooling, wetting and detergency, all of which are particularly useful in chip removal.

Finally, there are the synthetics (also called chemical solutions) where water is usually the main component. They appear as true solutions, as they are clear, with the oil

and additives dissolved. These tend to be used in lighter machining or grinding operations, often where higher speeds and excellent cooling are required.

Straight and soluble oils are typically made from minerals oils. Synthetics are usually made from polyalkylene glycols, esters, phosphate esters, polyalphaolefins, dialkylbenzenes, or polyisobutylenes. Semisynthetics can be made from synthetic oils or blends of synthetics and petroleum oils.

In future articles, we will take a look at some of the additives needed to make these remarkable fluids do their job. If you are interested in learning more about metalworking fluids, you might want to get a copy of the just-published book, *Metalworking Fluids, 2nd Edition* by Jerry Byers, now available on STLE's Web site. <<

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