Metalworking Fluids - Application

Cutting fluids are used in machining and grinding operations to: remove chips from the cutting zone, improve surface integrity of the finished work piece and promote or improve tool life. For any of these things to happen it is imperative that the fluid gets to the point of cut and that it gets there with sufficient volume and velocity to do the work required.

There are five application theories or techniques. Each one offers advantages and disadvantages. When engineering a specific job or machine, it is worth considering what kind of fluid is needed, how it will be delivered and what kind and how many chips will be produced. These applications techniques include:

1. **Dry Machining** – It uses no fluid at all. Dry machining has been around for years and until someone decided to drip water on a grinding stone, we even did a lot of dry grinding. Dry machining is still the process of choice in situations where the machine is not designed to deliver and contain the fluid within the machining envelope. Examples of this type of situation are seen every day in tool rooms all over the world. Dry machining also makes sense in situations were chips are easily made and broken: free machining brass, grey cast iron and where other mechanisms exist in the machine tools for moving the chips out of the cutting zone. In situations where “dry machining” is the Metalworking Fluids - Application selected alternative, the need for the process to run dry outweigh the cooling, lubricant and chip moving characteristics of a metal removal fluid.
2. **Minimum Quantity Lubrication (MQL)** – This method recognises that metal removal fluids can provide significant levels of lubricity to a machining operation without the issues generated by “flood coolant” if the lubricant can be directed to the tool face. MQL is a viable alternative to flood coolant. It is an improvement over dry machining when the mixture of tools and work piece generate a situation where the flow of fluid to the point of cut is periodically interrupted (this is a coolant application problem) and substantial drag is created at the tool work piece interface. In this situation, heat builds up in the tool and the flood coolant periodically quenches it causing thermal shock to the tool. MQL treats this problem by spraying small quantities of highly concentrated lubricant directly onto the tool. The typical scenario would have about one ounce of lubricant per hour sprayed directly onto the tool with the nozzle normally located less than two inches from the point where the fluid is needed. The requirement of having the fluid nozzle in close and constant proximity to the cutting tool, along with an MQL’s inability to move chips, limits its usefulness in high volume production.
3. **Spray misting** – This process generates maximum cooling without the need to circulate coolant. Misting takes advantage of water’s very high heat of vaporisation (966.6 BTUs) to take heat out of the tool and the work piece without moving or recycling large volumes of fluid. The classic use of this technique is in the manual cutter grinder where it is nearly impossible to capture and direct flood coolant and relatively small qualities of swarf are generated. The key to maximising success with spray misting is to adjust the spray mist head so the droplets are very finely dispersed, but large enough to “carry” to the point of cut without generating an objectionable “mist.” Spray misting does not effectively address the issues of lubricating the cutting tool work piece interface and moving chips from the cutting zone.
4. **Flood coolant** – This has been the standard method of fluid application for most of the “machine tool age.” It relies on the fact that if you put enough fluid into the cutting zone, some of it is bound to get to where it is needed. It does a good job of delivering fluid to the right place in most situations and does a very good job of flushing chips if sufficient volume is applied. However, two major problems exist for this process: in situations where the tools are moving very rapidly, the fluid may not consistently reach the tool work piece interface; in other situations, because of tool geometry, nozzle placement or chip formation, the tool may run wet and then dry, leading to thermal shocking and catastrophic (unplanned and or irregular) tool failure.

Metalworking Fluids - Application

5. **High-pressure coolant** – High velocity or high volume coolant means more than simply delivering fluid in high volume, high velocity or high pressure. In its best form, it is about delivering sufficient fluid to the tool work piece interface so that it does the most good. The problem of getting fluid to the point of cut are not new. Over the years we have dealt with tools such as the oil hole drill, even using the high-pressure fluid in conjunction with special coolant feed tools in operations like gun drilling. What is different about the new generation of machine and cutting tools is that now there are whole families of tools designed to get fluid to the point of cut.

Each of these different applications, methods or techniques places special demands on the amount and type of fluid used. These constraints or demands apply to both cutting and non-cutting functions. Part of all fluid application and problem solving work is to determine and understand how the fluid is best applied for the particular situation.

NOTES:

1. BTU or British Thermal Unit is a measure of energy equal to the amount of energy necessary to raise the temperature of one pound of water 1o F (the metric equivalent of BTU is one calorie (1C) = the amount of energy necessary to raise 1kg of water 1o C).
2. 1 HP/min. is the equivalent of 42.44 BTUs /per min.