HIGH PRESSURE / HIGH FLUID DELIVERY OF METALWORKING FLUIDS

Metalworking fluids have typically been applied to the working cut zones at pressures well below 100 psi. Conventional delivery systems used relatively low pressure to "flood" the work area with fluid. Recently, newer high-pressure metalworking fluid delivery systems provide "through-the-tool" fluids that range from several hundred to several thousand psi of pressure. In addition, these new delivery systems provide significantly higher coolant volumes delivered to the workpiece, while utilizing smaller sump sizes. This results in significantly higher turnover rates.

Benefits

Many basic functions of metalworking fluids, such as cooling, lubricating and chip removal, can be improved with the use of high-pressure fluids. The metalworking tool can be cooled more effectively when the fluid is able to completely flood the work zone. The theory behind high pressure lubrication is that coolant delivered at high pressures is able to break through the vapor pressure barrier to provide better lubrication. This allows the chip to be thinner and more easily broken and removed from the cut zone. Fluid delivered in a "through-the-tool" fashion provides coolant into areas that may otherwise be unreachable. The high kinetic energy applied to the fluid can force chips out of the cut zone and prevent chip re-cutting.

High pressure fluid delivery overcomes the static resistance of the metal allowing the fluid to completely "wet" or plate-out onto the metal at the tool-part interface. The ability to keep the work zone cool allows tooling to last longer, allows for better chip size control and chip evacuation. A cool chip breaks easier than a hot chip. A shorter, "less stringy" chip can be removed more efficiently. Keeping the work zone cool allows for other process changes such as increased feeds and speeds that can provide longer tool life.

Process Considerations

Using high-pressure delivery systems with metalworking fluids will require certain process changes. The machine needs to be enclosed to protect the operator and contain the fluid. High pressure coolant delivery can literally cut skin or even amputate fingers. Serious injury can occur if proper precautions are not taken. Additional guarding may be required to keep fluid away from hydraulic and electrical components. Extra precautions need to be taken to provide for operator safety, due to the high energy levels applied to the fluid. Safety interlocks are necessary to automatically shut down the high-pressure pump, whenever the enclosure is opened. You should always consult with the manufacturer of the system to insure that they have proper safety warnings for use. Seal materials that can withstand high pressures should also receive consideration.

Metalworking Fluid Considerations

Extra demands are placed on metalworking fluids that are used in high-pressure systems. Fluids used for these applications must possess strong properties in the following key areas:

Foam

A high-pressure pump with rapid circulation of fluid can cause extreme agitation with no "rest" time. Metalworking fluids designed for high pressure applications must be inherently low foaming. Fluid reservoirs consistent with the horsepower of the machines are also needed, so that pump cavitation cannot occur. Historical "ideal" fluid turnover/retention times of >10 minutes were recommended to minimize turbulence and foam, and

maximize filtration. (For example, a 50 GPM delivery rate system would require a 500 gallon tank to achieve a 10 minute retention time.) However, in newer designs, it is not uncommon to see retention times of 3 minutes or less. In these cases, it is critical that the coolant have excellent foam control and chip settling. It is recommended to put an automatic shutoff on the system to prevent pump cavitation.

Since metalworking fluids are usually designed to provide lubrication and good cleanliness, it is not surprising that foam can be a "side effect". Lubricants and detergents are often foamy. Fluids that generate large foam bubbles tend to break more easily. Smaller bubbles can form stable foam that is more of a problem. Antifoams or artificially hardening the water (with an additive like CIMCOOL® Foam Depressant) may be temporary fixes, but long term use or overuse can lead to mix instability and ultimately more foam. (See Mix Stability below)

Air entrainment, or the "cola" effect, is due to mechanical agitation (such as pumps, grinding wheels, and waterfalls) dissolving air into the fluid. Generally it quickly dissipates, though it can cause the mix to become cloudy and/or misty. Air is not a good lubricant.

Mix Stability

The high energy imparted to the fluid by a high-pressure pump is rapidly dissipated when the fluid strikes the tooling fixtures and workpiece. This type of impact requires a chemically stable fluid that can withstand this rough physical treatment. Good water quality and minimizing fluid contamination is also important to maintain mix stability.

Thermal Resistance

During the operation of high-pressure equipment, the fluid absorbs thermal energy from the pump, in addition to the operation itself. The fluid must be resistant to reasonable levels of thermal fluctuations. Temperature variations must be minimized in order to prevent dimensional changes in the workpiece. Rapid removal of cut chips from the work zone is needed to reduce the amount of heat that the fluid will absorb. The high-pressure pump should only be run when needed, in order to minimize unnecessary thermal input into the fluid. Primary and auxiliary fluid pumps should be off, when not in use. A larger fluid reservoir can also help to dissipate the thermal energy load. A fluid chiller may be necessary, for continuous operations and high metal removal rates.

Shear Stability

Metalworking fluids need to be tolerant to the shearing action of a high-pressure pump. Lubricants used in the fluids need to withstand the mechanical action of the pump. The high-pressure pump should also be cycled to run only when needed, and should not be deadheaded, when it is not in use.

Equipment Considerations

High pressure is generally achieved through the use of highly rated pumps combined with the through-the-tool coolant delivery. The nozzle or orifice size of through-the-tool delivery systems greatly affects the pressure at which the fluid is delivered. This through-the-tool design also greatly enhances the chip breakage and removal process.

The installation of high-pressure fluid delivery equipment introduces a tremendous amount of thermal energy into the metalworking operation. The performance of the application begins with the selection of the equipment which establishes the key operating parameters of pressure and flow rate. Supporting equipment is also required for the continuous removal of chips from the operation. Next, it is necessary to operate the system in a way that minimizes thermal buildup. Run the high-pressure coolant pump only as needed. A chiller may be required to control metalworking fluid temperature for continuous operation. Since fluid make-up rates could be higher in a high-pressure application, it is important to control the water quality to avoid excessive mineral buildup. Also, monitor the metalworking fluid for proper mix concentration in order to maintain optimum performance.

Metalworking Fluid Recommendations

The selection of the proper metalworking fluid for any operation must be based upon a review of all aspects of the process. Operations using high-pressure fluids are no exception. CIMCOOL FLUID TECHNOLOGY recommends the use of one of the CIMCOOL® HFP with FACT™ fluids designed specifically for high pressure/high volume applications or other fluids designed for low foaming properties. These include:

CIMTECH® 320 HFP with FACT™
CIMTECH® 510Z HFP with FACT™
CIMSTAR® 70 HFP with FACT™
CIMSTAR® 60C HFP with FACT™
CIMPERIAL® 16EP HFP with FACT™
CIMPERIAL® 1060CF HFP with FACT™
CIMTECH 610 HFP with INSOL™ and MSL® Technology
CIMFREE VG991M

Consult your regional CIMCOOL® Technical Service Engineer for specific recommendations, or call CIMCOOL® at 513-458-8199.