Technical Bulletin

Master Fluid SOLUTIONS

Fluid Application - System Sizing and Design

Metalworking fluids (MWFs) improve machining efficiency (longer tool life, etc.), surface integrity, transporting chips or swarf from the cutting zone, and provide in-process corrosion protection on parts and chips. Yet to achieve these benefits the fluid must get to the point of cut. So, a pertinent question is “how much coolant is needed to keep from being coolant application limited and what should the system look like?”

Most system sizing and design is based on good common sense with some guidance provided by a set of tried and true basic rules. These rules tend to be very conservative, but using them as a starting point can produce very reliable results. The rules for system sizing are:

1. For “big chip machining” you need to plan on having 1 to 1.5 gp/Hp (gallons per minute per horsepower) used at the point of cut.

2. To move big chips from the cutting zone to the disposal point (primarily an issue in central system design, but a very real consideration in some larger machines), you need to plan on 1.5 to 2 gp/Hp for every 10 feet you need to move the chips.

3. For grinding, the planning number is 1.5 to 2 gp/Hp used at the point of cut.

4. To move grinding swarf (typically small and more uniform in size than big chips), plan on 1 to 1.5 gp/Hp per 10 feet that the swarf needs to move.

Once you have decided how much fluid you need, it is time to look at the fluid delivery system. The system is made up of several parts, some of which serve multiple functions. These parts include:

1. The pump – The pump is the heart of the coolant delivery system. In many ways all decisions flow from decisions about the pump. In general, the pump should not be bigger than necessary. “usher” style pumps are best for flood-type coolant, and “piston” pumps best for high-pressure, high-volume operations. In some situations, multi-stage “turbine” pumps work very well, while gear and vane pumps should be used only with straight oils (they are subject to maintenance issues when used with water-based systems). The pump should be set as low as possible in the tank to reduce the possibility of cavitation, but it should not rest on the bottom of the tank as it then can pick up and re-circulate chips and swarf. To facilitate cleaning and service, the pump should be easy to remove from the tank. The pump should be located as far as possible from the return line to allow maximum time for tramp oil rejection, foam breakage and chip settling.

2. The return line – The line returning fluid from the machine tool to the sump should be large enough to allow unrestricted flow of fluid and chips to the tank. The return line should discharge below the level of fluid in the tank to reduce foaming and facilitate chip settling.

3. The delivery plumbing – Make sure the diameter of delivery plumbing is as large as possible. If it is necessary to reduce pipe diameter, do it as far down stream as possible. The system should be smooth inside with as few couplings, elbows, and valves as possible. This plumbing needs to be supported and insulated against shocks caused by starting and stopping the fluid flow.

4. On/off and “throttle” valves – If possible, fluid flow should not be restricted with a “throttle valve,” but when using a throttle valve use a separate on/off valve to start and stop fluid flow. The entire fluid system works much better if the pump starts and stops when the fluid flow needs to be started or stopped, rather than “dead heading” a pump against an on/off valve. Remember to include a check valve to prevent the system siphoning itself dry each time the pump is shut off.

5. Wash down hoses and pumps – It is often highly desirable to use coolant to periodically wash down the machine tool to flush chips off parts and machine ways. Additionally, it is sometimes desirable to have a steady flow of fluid into the machine bed to flush out chips. This is best done with coolant working solution rather than water or fluid from another source. If you are going to start and stop fluid flow with a valve, it is appropriate to tap the coolant supply line for fluid to do these operations. However, it is often better to install a small pump in the dirty side of the tank for the sole purpose of supplying the wash down hose for moving chips from the base of the machine back to the tank.

6. Filtration – Without question clean coolant works better than dirty coolant, so removing chips and swarf from the fluid and system should be a design priority. If positive media filtration is going to be used, sizing and location are critical. If separation is going to be done by settling, the system needs to be properly designed both in terms of size and system “geography” to allow sufficient quiescent time for the necessary settling to occur to allow chip removal.

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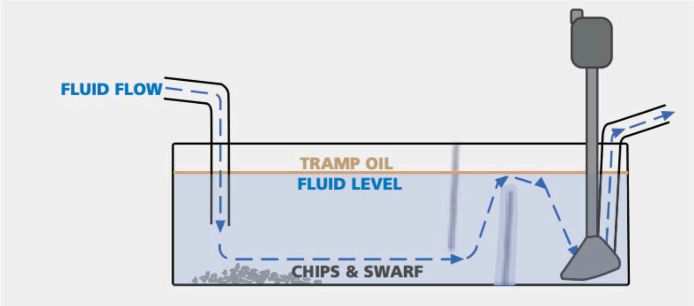

ILLUSTRATION OF TANK WITH COOLANT SUMP

7. Tank design – Typical tank sizes are three to ten times the capacity of the pump. The tank is divided (approximately 25%/75%) with the supply pump located in the small side and the dirty fluid return line in the larger portion. The dirty fluid return line needs to be as far from the clean fluid intake as possible. The two tanks are separated by baffles. The baffle nearest the pump rises from the bottom of the tank to about 70% of fluid depth. This baffle forces the fluid to change direction and keeps chips from getting to the pump. A second baffle, close to the first but further upstream from the pump, descends from the top of the tank to about 70% of tank depth. This baffle helps change fluid direction and captures free-floating tramp oil before it is re-circulated.
When planning sump design, it is crucial to design the tank for ease of service, system cleaning, and installation of tramp oil removal devices.

8. Temperature control – The coolant system in a machine tool facilitates not only material removal, but also serves as a heat sink and energy (heat) removal system. The fluid makes all parts of the machine tool a temperature similar to the temperature of the fluid. The fluid then gives up that heat (energy) through radiation and evaporation. The question of “to chill or not to chill” is largely a question of floor space. Chilling allows a much smaller tank, both in volume and surface area. Fluids generally work best when they “track ambient temperature,” as they are maintained at a temperature similar to the temperature that the machine, parts and the gauging see.

It is essential to remember that the reason for using the fluid is to assist in the metal removal process and that the design and maintenance of the coolant delivery system is critical to the success of your operation.

NOTES:

1. Machinability of materials is often expressed in the number of cubic inches of material that can be removed per Hp per minute (as in3 /Hp/min).
2. While “swarf” can be used interchangeably with terms like “turnings,” “borings,” and “chips,” in common North American usage it typically refers to the chips and grit generated in grinding operations.