

The basics of hydraulic flow control



By Dr. Robert M. Gresham
Contributing Editor

In previous articles we have discussed most of the fundamental aspects of fluid flow of the hydraulic fluid. In addition, we have discussed many of the basic pieces of equipment in a hydraulic system: the pump, actuator, accumulator, reservoir, etc. Now, we are ready to begin exploring how to control this thing once we turn the pump on.

Controlling fluid flow is at the heart of our system. It impacts whether we perform the desired work, minimize wear and tear on the system and operate safely. There are three aspects of hydraulic system fluid flow that we must control: flow rate, direction and pressure (relief).

The primary purpose of flow control is to regulate the speed that the rod in linear actuators moves or the speed that rotor turns in a hydraulic motor.

When discussing pumps, we mentioned that flow can be controlled by varying the speed or displacement of the pump. Flow also can be controlled by use of flow control valves. These can be quite simple, such as an orifice, or more complex pressure-compensating flow control valves. There are numerous designs of flow control valves, so a rigorous examination is not possible here. Instead, we'll just touch on the basics.

The simplest flow control is an orifice of fixed cross-section or area. These are used in conjunction with a check valve, which is a one-way flow control valve. In this case, the system is plumbed such that flow in one direction goes through the orifice at a controlled rate. When the direction is reversed, flow bypasses the orifice and flows freely out through the check valve.

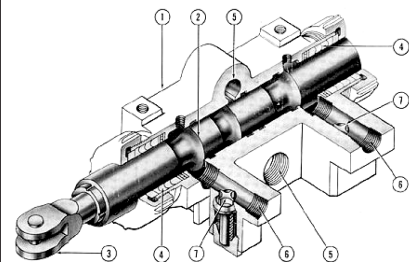
The next step up in design is a variable area orifice, so flow can be increased by changing the area of the orifice. These kinds of system designs are fine when precise flow control is not a critical issue.

In our earlier discussion of pressure and

Figure 1. Hydraulic flow control valve.



Figure 2. Cutaway of rigging interlock.



(1.) Valve body; (2.) spool valve; (3.) shackle; (4.) packing; (5.) ports to tilting lines; (6.) ports to rigging lines and (7.) check valves.

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fluid flow, we noted that pressure drops when passing a restriction, like the orifice. Thus, where more precise flow control is needed, we use a compensated flow control valve. This valve compensates for this pressure drop so that flow remains more constant.

Next, we must control the direction of flow. When hydraulic fluid flow is in one direction, fluid is pumped into one of two ports on the actuator, and the actuator (whether linear or rotary) moves in one direction. When flow is reversed, fluid then

Figure 3. Open center, sliding spool directional control valve.

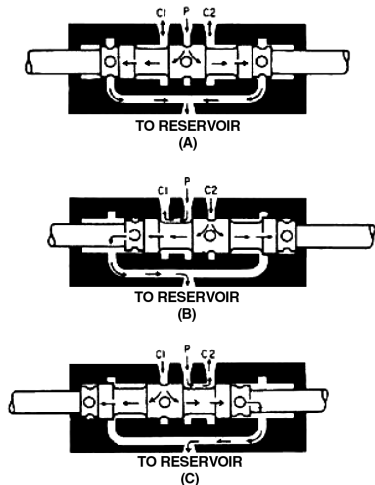


Figure 4. (Need cutline from Bob.)

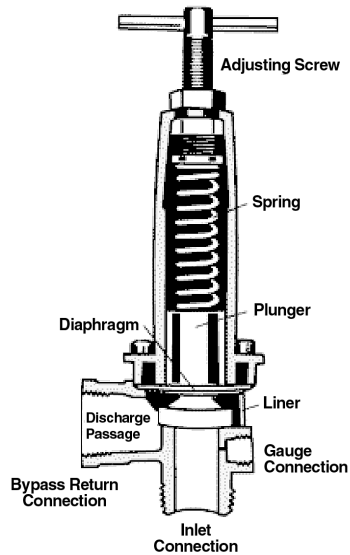
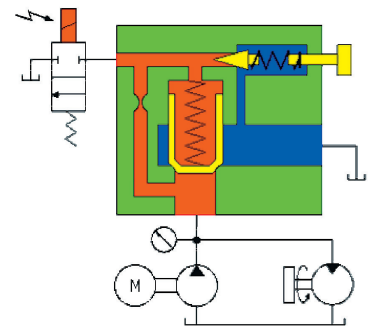


Figure 5. (Need cutline from Bob.)



flows into the other port and the actuator moves in the opposite direction. The best way of accomplishing this change is by using a sliding spool type directional control valve (see Figure 2).

These valves consist of a cylindrical shaft called the spool that slides in a machined bore in the valve housing. The housing has ports to the hydraulic pump, a return line to the tank and lines to the actuator.

While the four-port valve is probably the most common, other arrangements are available for certain system designs. The spool valve can be designed to operate as a two-position or three-position valve as well. The two-position valve can only be shifted fully to the right or left. This would result in the actuator extending or retracting to its fullest positions. The more common three-position valve also can be stopped in a third position or neutral position in which there is no flow to the actuator (see Figure 3).

A wide variety of flow paths are possible with these valves to accom-

modate system design. These valves can be operated manually, as is common in earthmoving equipment such as excavators, backhoes and the like. Or they can be operated electrically through use of a solenoid connected to the spool shaft.

Finally, we must consider pressure relief valves. Pressure relief valves are the primary method for controlling overall pressure in the system, and they help to insure safe operation. There are two major types: direct acting and pilot operated.

In the direct acting type valves, fluid enters the valve as pressure increases the fluid presses against ball, piston or diaphragm, usually loaded by a spring (which may or may not be adjustable). As pressure builds to the point that the diaphragm (see Figure 4) moves, it allows fluid to pass through to a return (discharge) line back to the reservoir.

The pilot-operated relief valve operates in a similar fashion but with increased sensitivity to pressure changes. In this valve the fluid acts

on both sides of the piston, but as the pressure increases the poppet at the top of the diagram moves, allowing fluid to flow to the return line. At the same time, the pressure behind the piston drops and the piston moves, allowing even more fluid to the return line.

More complex systems may involve multiple-pressure or flow control valves to accommodate multiple actuators operating at differing speeds and or pressures. Nevertheless, they all operate under the same set of principles. Through adroit use of these valving techniques, we can control our system to accomplish safe, efficient work.

While these admittedly are just the basics, the final thing we have to explore is the proper sizing and location of piping, hydraulic hose, and fittings. We'll examine those next time. Then we will be ready to turn the pump on! <<

Bob Gresham is STLE's director of professional development. You can reach him at rgresham@stle.org.