VALVE SIZING...Use of Performance Charts

ENGINEERING DATA

FULFLO GUIDED PISTON VALVES

The trademark FULFLO expresses the basic principle that the relief valve must have flow capacity equal to that of the pipe lines to which it is connected. The sliding piston concept and internal design contours of FULFLO valves provide unique flow and stability characteristics for reliable performance without chatter.

FULFLO valves are designed to operate reliably at pressures as low as 2 PSI and as high as 1000 PSI. The FULFLO valve reduces velocities through all but the controlling interface of the valve thereby minimizing system power loss.

Unlike ordinary direct acting relief valves, FULFLO guided piston valves are less responsive to transient pressure surges thereby eliminating the tendency to pound, squeal or chatter. Quiet, stable, efficient performance is assured in both load regulation and system protection applications.

FULFLO valves operate effectively with all types of liquids in the full range of viscosities including hydraulic oils, water, solvents and chemicals.

FULFLO valves are not designed to be positive shut off, and will pass a minimal amount of leakage before the set pressure.

FULFLO valves are NOT designed for use with air, gas or steam.

Since the FULFLO relief valve is a flow-modulating device, pressure flow characteristics are completely different from spring loaded poppet or ball check valves. Both types remain substantially tight up to *cracking pressure*. When this pressure is exceeded, the "conventional" valve pops open with a pressure drop at very low flow and an exponential pressure rise as the flow increases.

In contrast the FULFLO valve causes a pressure rise, *over-pressure*, as soon as flow starts; pressure increases almost proportionally with flow. Springs and areas on FULFLO valves are carefully designed to minimize this over-pressure.

Both pressures are important in sizing a valve. *Cracking pressure* must be selected high enough to permit system operation at its maximum rated pressure and flow. *Over-pressure* is limited by the system's capability to withstand the additional pressure and the motor's ability to sustain the pump output at the increased pressure for the required time interval.

The over-pressure to produce a certain flow is a function of valve size and spring constant and can be determined with the aid of the over-pressure charts given for the different valve sizes. The valve performance charts are based on tests made with oil of 150 SSU viscosity at 100˚ F and may be used with reasonable accuracy within the conventional range of oil viscosities from 30 to 500 SSU. For operation with high viscosity fluids, consult FULFLO's engineering department.

In sizing a valve, the first attempt should be to select a valve equal in size to the pipe to which it is connected. A larger or smaller valve may be used to suit individual requirements, depending on the permissible amount of over-pressure. Assume we have selected a 3/4" valve for 17 GPM flow and a cracking pressure of 325 PSI. By referring to the pressure range chart, we find that we may use either a "YS" or a "ZS" spring.

Assuming a "YS" spring, draw a line horizontally at 17 GPM in the 3/4" valve chart, to intersect the slanted line marked "YS" and drop a vertical line to the over-pressure scale to read an over-pressure of 44 PSI. The 17 GPM will be discharged at a pressure of 325 + 44 or 369 PSI. The percentage of over-pressure would be 44/325 X 100 or 13.5%.

If a "ZS" spring is used, extend the horizontal line to the "ZS" slope and the over-pressure is 70 PSU. The pressure to pass 17 GPM would be 325 + 70 or 395 PSI and the over-pressure would be 21.5%. If the over-pressure is higher than desired for the particular application, the procedure may be repeated for the next larger size valve.

In some cases, maximum flow through a valve at a given pressure is specified. To determine the cracking pressure, assume a 3/4" valve is to pass 12 GPM at 50 PSI. A horizontal line drawn from the 12 GPM capacity to the intersection with the "WS" spring line results in an over-pressure of 14 PSI, therefore the cracking pressure must be 50 – 14 or 36 PSI, and the percentage of over-pressure of only 9 PSI, but the cracking pressure would be 14/36 x 100 or 38.8%. The use of a "US" spring would produce an over pressure of only 9 PSI but the cracking pressure would then be 50 – 9 or 41 PSI, which would exceed the rating of the "US" spring.

For sizing valves for higher viscosity than 500 SSU, the following formula is used:

$$\sqrt[4]{\frac{V2}{V1}} \text{ x area of valve for 150 SSU}$$

V1 = 150 SSU

V2 = higher viscosity

Assume we have the following application,

GPM = 10

Viscosity = 12,000 SSU

Normally for 10 GPM a 1/2" valve would be used. Referring to the orifice area chart on page 9, to find the area of a 1/2" valve. The area is .305.

$$\sqrt[4]{\frac{12000}{150}} = \sqrt[4]{80} = 2.99$$

2.99 x .305=.9120 area needed to pass 10 GPM

Again referring to the orifice area chart, we find that the area of $1^1/_4$" valve is 1.224. Therefore a $1^1/_4$" valve would be used. To find the over-pressure refer to the performance chart for a $1^1/_4$" valve.

Performance charts based on actual test results are available on request. For additional information contact THE FULFLO SPECIALTIES CO.

PIPE SIZING...Use of the Nomograph

The flow velocity, which must first be determined, is dependent on the viscosity of the fluid and the permissible flow resistance in the piping. Lower velocities are for higher viscosity fluids and/or lower pressure drops; higher velocities are for less viscous fluids and cases where higher pressure drops can be tolerated. In all cases, allowable suction velocities are much lower and the lowest velocities should be used for the more viscous fluids and/or higher suction lifts.

Suction velocities are much more critical than discharge velocities. Too high a discharge velocity may only result in excessive power loss but an excessive suction velocity may make the system inoperative or cause damage to the pump and system.

After the velocity has been selected, the nomograph chart is used to determine the inside diameter of the pipe at a given flow rate. For example, assume a flow of 17 gpm and a velocity of 12 fps for the discharge pipe is required. Draw a line from the 12 fps point on the velocity scale through the 17 gpm point on the flow rate scale and the extended line intersects the pipe inside diameter scale at 0.76 inches. This inside diameter applies to either pipe or tubing.

The correct pipe or tube size also depends on the pressure it must carry. The conversion chart for pipe sizes and schedules facilitates this section.

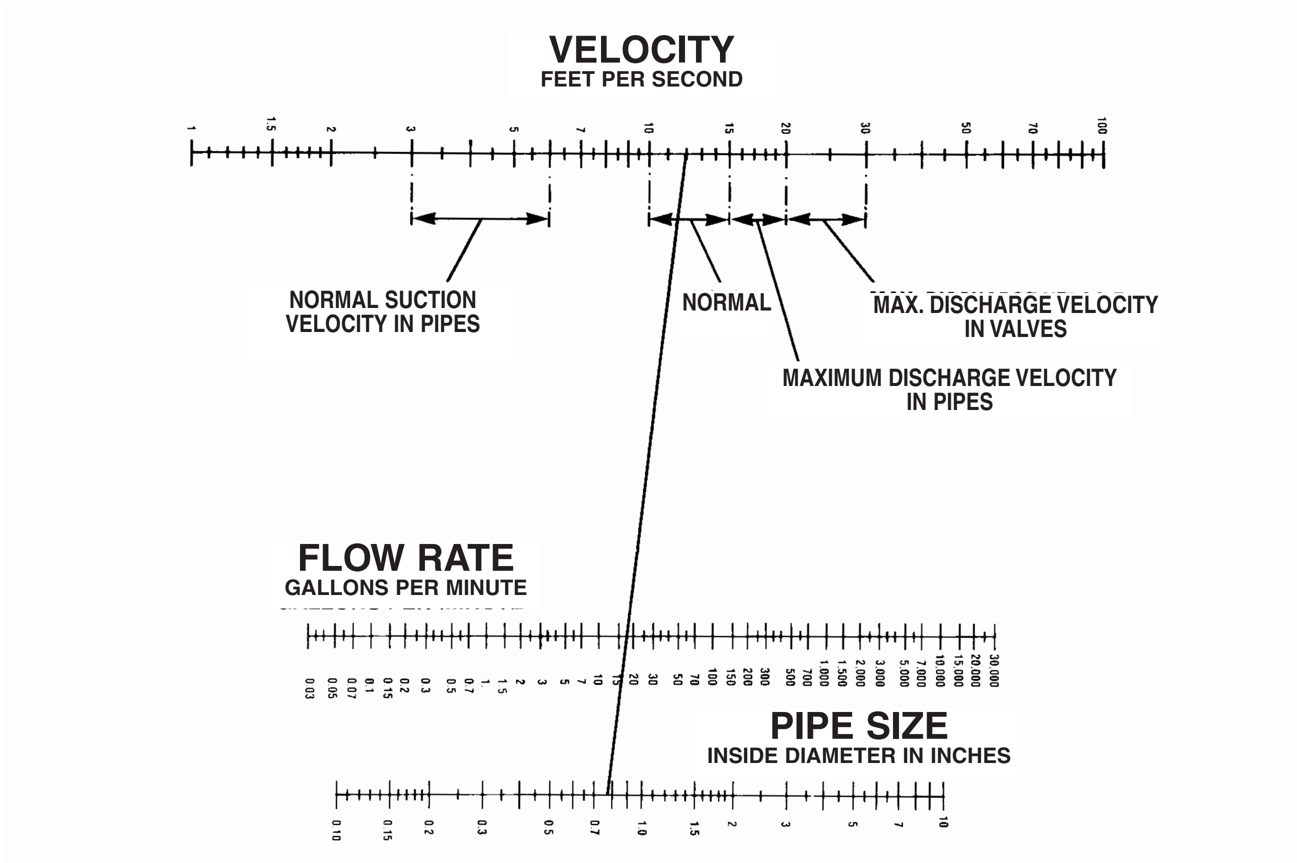
Note the different weights or piping are grouped under various schedule numbers. Approximate pressure for each schedule number may be computed from the formula.

$$\text{Pressure} = \frac{S}{1000} \times \text{schedule number}$$

S is the permissible stress to which the pipe is subjected. Thus, for a stress of 10,000 psi, the allowable pressure is equal to ten times the schedule number. Higher pressures may be carried if higher stresses are allowed.

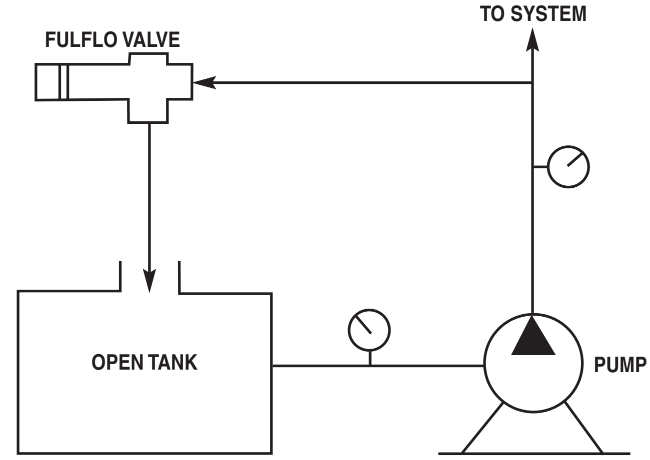
In the example, a schedule 40 pipe is more than adequate for 250 psi. Twice the wall thickness of a 3/4" schedule 40 pipe of 0.226 or 0.976". Since the actual outside diameter of a 3/4" schedule 40 pipe is 1.05", the selection of a 3/4" pipe is adequate.

A 3/4" Fulflo relief valve should be selected. Operational characteristics of this valve, that is cracking pressure and overpressure, may be determined from the performance chart precisely in the manner explained in the example. The maximum discharge pressure of 285 psi is still well below the safe carrying capacity of the pipe. The design of the Fulflo valves is such that if used within their rating and with properly selected springs, the overpressure is not sufficient to endanger system or system components.



APPLICATIONS

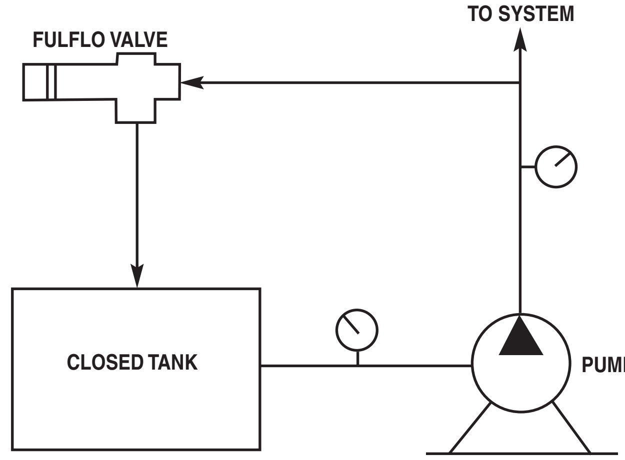
SYSTEM 1



OPEN TANK

VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

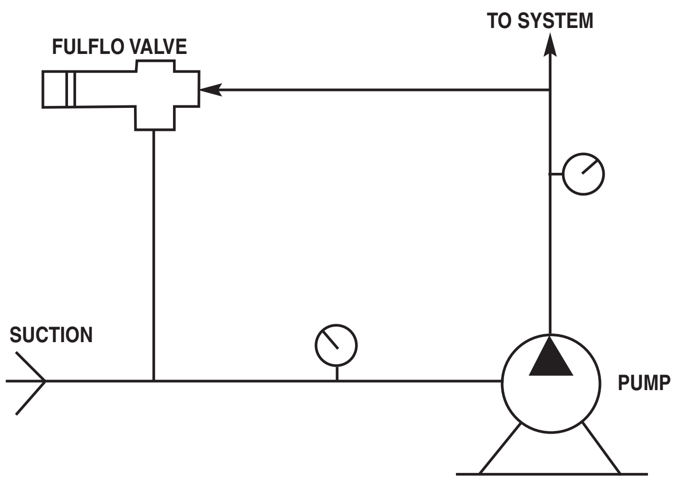
SYSTEM 2



CLOSED TANK

TANK PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

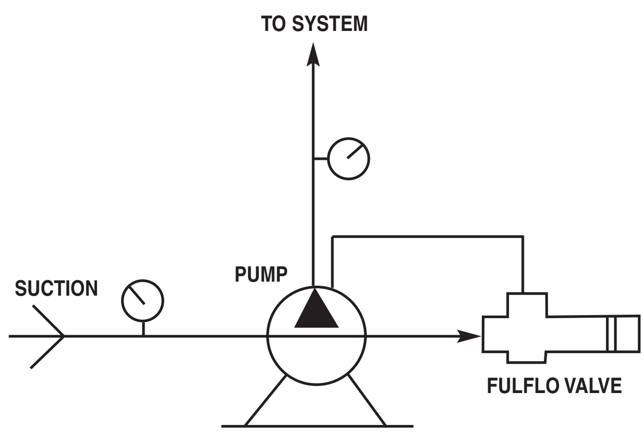
SYSTEM 3



CLOSED LOOP

SUCTION PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

SYSTEM 4



PUMP INTERNAL RELIEF

FOR PUMPS WITH (2) SUCTION PORTS AND (2) DISCHARGE PORTS

SUCTION PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

TYPICAL APPLICATIONS

Combustion Equipment
- Circulating Oil Systems
- Heating Equipment on Railroad Cars
- Package and Industrial Boilers
- Oil Burning Equipment

Machine Tools
- Valves are used for:
  - Regulation of Lubricating System Pressure
  - Regulation of Pressure for Hydraulic Feeds
  - Regulation of Coolant Pressure
- Boring Machines
- Drills (Radial, Single or Multiple Spindle)
- Grinders (Surface, Cylindrical, Centerless and Universal)
- Lathes (Engine, Turret, Automatic)
- Milling Machines
- Hydraulic Tracing Units

Hydraulic Manufacturing and Processing Equipment
- Stamping Presses
- Press Brakes
- Molding Presses
- Rams
- Crushers
- Bending and Forming Equipment

Hydraulic Test Stands
- To Maintain Specific Pressures
- As Safety Relief Valve to Protect Pumps, Gauges, etc.
- Aircraft Test Equipment and Ground Support Equipment
- Equipment Test Racks
- Pressure Test Racks

Hydraulic Power Units
- Used in Basic Tank, Pump and Motor Systems

Material Handling Equipment
- Hydraulic Hoists
- Hydraulic Elevators
- Hydraulic Platforms

Special Equipment
- Fire Equipment
- Laundry Equipment
- Coal Mining Equipment
- Road Spraying Machinery
- Car Washing Machinery
- Cleaning Machinery (Steam or Solution)
- Industrial Sewing Machines
- Dairy Machinery
- Special and Custom Engineered Industrial Machinery
- Equipment for Oxygen and Industrial Gasses

Industrial Air Conditioning Equipment
- Pumps - Filters

Engines and Turbines, Lubrication and Control System
- Diesel Engines
- Steam Turbines
- Hydraulic Turbines
- Gas Turbines

Mobile Equipment
Industrial Compressors

Processing Systems
- Public Utilities
  - Maintaining City Water System Pressures
  - Protection and Control of Fire Hydrant Pressures
- Oil Refineries
- Chemical Plants
- Distilleries
- Irrigation Systems
- Steel Mill and Processing Plants
- Food Processing Plants
- Papermill and Pulp Processing Plants

Liquids Handled
- Hydraulic Oils
- Water (Treated, Purified and Salt Water)
- Dry Cleaning Solvent
- Heated Tar (Pumped)
- Heated Molasses (Pumped)
- Anhydrous Ammonia
- Edible Fats and Oils
- Processed Liquid Foods
- Processed Petroleum Products