## LIQUID REGULATOR APPLICATION GUIDE

To control fluid pressure, system designers use regulators in many liquid applications. The purpose of this application guide is to familiarize you with the common product applications and system considerations. Most liquid regulators fall into three categories: pressure reducing, differential/bias, or backpressure/relief.

Regulators and backpressure/relief valves used for liquid applications are available in many sizes and materials. Your Fisher Sales Representative is available to assist you in the proper regulator selection and sizing for your liquid applications.

### Pressure Reducing Regulators

In a liquid application, the pressure may need to be reduced for a process or equipment. Depending upon the accuracy required by the application, a direct-operated or pilot-operated regulator can be used to reduce the fluid pressure.

Direct-operated regulators are used for lower flow rates. Pilot-operated regulators are used for high flow rates or where precise pressure control is required.

### Differential/Bias Regulators

A differential or bias regulator maintains a pressure difference between two locations in the system.

### Relief Valves/Backpressure Regulators

Relief valves or backpressure regulators open when the upstream controlled pressure increases above the setpoint. These relief valves and backpressure regulators are the same devices that are used for different applications.

Overpressure protection is provided by relieving pressure, usually to atmosphere, when it rises above the setpoint. When upstream pressure rises above the setpoint, the relief valve/backpressure regulator opens to allow excess upstream pressure to flow downstream, typically into a pressurized system.

## LIQUID REGULATORS

Liquid regulators are called on to handle all kinds of fluids, pressures, and temperatures. When selecting a liquid regulator, choose a regulator that offers the best construction for the intended application.

Usually sizing a regulator is as simple as finding a regulator that meets your pressure and flow requirements. Other requirements, such as viscosity and presence of cavitation, can also influence the type and size of a regulator. The following discusses the special considerations pertaining to liquid applications.

Note: The capacities in this section are given in gallons (liters) of water per minute. When sizing a regulator for a different liquid, use the $C_v$, when provided, from the regulating flow coefficient table and one of the following formulas to calculate the capacity.

$$Q = C_v \sqrt{\frac{P_1 - P_2}{G}}$$

or

$$C_v = \frac{Q}{\sqrt{\frac{P_1 - P_2}{G}}}$$

where:
$Q$ = Flow in gallons per minute
$C_v$ = Liquid sizing coefficient
$P_1$ = Inlet pressure, psig
$P_2$ = Outlet pressure, psig
$G$ = Specific gravity of the liquid (water = 1.00 at 60°F)

### Viscosity

A fluid is a substance which undergoes continuous deformation when subjected to a shear stress of flow. Viscosity is the measure of a fluid's resistance to flow. The viscosity of a liquid decreases with increasing temperature.

Viscous conditions can result in significant sizing errors when using the basic liquid sizing equation, since published $C_v$ values are based on test data using water as the flow medium. Although the majority of applications will involve fluids where viscosity corrections can be ignored or where the corrections are relatively small, fluid viscosity should be considered in each regulator selection. For example, a common fluid such as corn syrup has a relatively high viscosity. Therefore, corn syrup has resistance to flow, or in other words its flowing velocity is much slower than water at the same pressure and temperature. This resistance to flow will require a larger regulator. Fisher has developed a nomograph and procedure that provides a viscosity correction factor (refer to the Technical Reference section). Apply the correction factor to the $C_v$ coefficient to determine a corrected coefficient.

Viscosity also affects the regulator's speed of response. Just as the velocity is slower through the pipe, so is the flow through the registration ports of the regulator. The larger the port, the easier the fluid flows through the port and therefore, better speed of response.

High viscosity fluids can cause very slow response in pilot-operated regulators merely because of the small ports in the pilot. A common rule of thumb is that a pilot-operated regulator should not be used on liquids with a higher viscosity than No. 2 fuel oil.

For assistance with the viscosity sizing procedure, contact your Fisher Sales Representative.

### Cavitation

The occurrence of either flashing or cavitation within a regulator can have an effect on the regulator sizing procedure. These two related physical phenomena tend to limit flow through the regulator.

Cavitation can cause structural damage to the regulator and adjacent piping. A regulator's design simplicity limits the capability to add anticavitation trim. Hardened trim material may be the only precaution available. Also, limit the pressure drop across the regulator or use a control valve when cavitation or flashing presents a problem. $K_m$ values are shown in the product pages of this section. These are used to predict choked flow. Refer to the Technical Reference section for an explanation on how to use these values. If there is a potential problem in your system, contact your Fisher Sales Representative for a recommendation.

### Incompressible Flow

Since liquids are incompressible, the system design requires special consideration. Shutoff valves, especially snapacting valves, can cause pressure problems with a regulator. Pressure surges from water hammer can feed back to the regulator causing damage to parts, such as the diaphragm. If a rapid closing valve is required, it should be upstream of the regulator.

Liquids will also slow down the response of a regulator, especially a pilot-operated regulator. The liquid is not able to quickly pass through the small ports in the pilot, delaying the response time.

### Regulator Construction Materials

Liquid applications require the regulator or relief valve/backpressure regulator wetted parts to be compatible with the fluid in the system to prevent corrosion in the system. Both elastomeric and metal components need to be compatible with the system. An abbreviated fluid compatibility chart is shown below, or refer to the Technical Reference section for a complete chart.

Material selection is usually based on the pressure, temperature, corrosive properties, and erosive properties of the flow media. Some service conditions require the use of special materials to withstand particular corrosive properties of the flowing fluid.

### Fluid Temperature

Diaphragms and all other parts must meet temperature requirements of the

**FLUID COMPATIBILITY OF ELASTOMERS**

| FLUID | MATERIAL | | | | |
|---|---|---|---|---|---|
| | Neoprene (CR) | Nitrile (NBR) | Fluoroelastomer (FKM) | Ethylenepropylene (EPDM) | Perfluoroelastomer (FFKM) |
| Acetic Acid Vapors (30%) | B | C | C | A | A |
| Acetone | C | C | C | A | A |
| Air, Ambient | A | A | A | A | A |
| Air, Hot (200°F (93°C)) | C | B | A | A | A |
| Alcohol (Ethyl) | A | C | C | A | A |
| Alcohol (Methyl) | A | A | C | A | A |
| Ammonia (Anhydrous) (Cold) | A | A | C | A | A |
| Ammonia (Gas, Hot) | B | C | C | B | A |
| Beer | A | A | A | A | A |
| Benzene | C | C | B | C | A |
| Brine (Calcium Chloride) | A | A | B | A | A |
| Butadiene Gas | C | C | B | C | A |
| Butane (Gas) | A | A | A | C | A |
| Butane (Liquid) | C | A | A | C | A |
| Carbon Tetrachloride | C | C | A | C | A |
| Chlorine (Dry) | C | C | A | C | A |
| Chlorine (Wet) | C | C | B | C | A |
| Coke Oven Gas | C | C | A | C | A |
| Ethyl Acetate | C | C | C | B | A |
| Ethylene Glycol | A | A | A | A | A |
| Freon 11 | C | B | A | C | A |
| Freon 12 | A | A | B | B | A |
| Freon 22 | A | C | C | A | A |
| Freon 114 | A | A | B | A | A |
| Gasoline (Automotive) | C | B | A | C | A |
| Hydrogen Gas | A | A | A | A | A |
| Hydrogen Sulfide (Dry) | A | A[1] | C | A | A |
| Hydrogen Sulfide (Wet) | B | C | C | A | A |
| Jet Fuel (JP-4) | B | A | A | C | A |
| Methyl Ethyl Ketone (MEK) | C | C | C | A | A |
| MTBE | C | C | C | C | A |
| Natural Gas | A | A | A | C | A |
| Nitric Acid (50 to 100%) | C | C | B | C | A |
| Nitrogen | A | A | A | A | A |
| Oil (Fuel) | C | A | A | C | A |
| Propane | B | A | A | C | A |
| Sulfur Dioxide | C | C | C | A | A |
| Sulfuric Acid (up to 50%) | C | C | A | B | A |
| Sulfuric Acid (50% to 100%) | B | C | A | B | A |
| Water (Ambient) | A | A | A | A | A |
| Water (at 200°F/93°C) | C | C | C | A | A |

1– Performance worsens with hot tempurature
A– Recommended
B– Minor to moderate effect. Proceed with caution.
C– Unsatisfactory
N/A–Information Not Available

system. Special elastomers and metal trim constructions are available for high and/or low temperature applications.

## Liquid Purity

Particles and other debris in the fluid can cause clogging or erosion inside the regulator. Consider installing filters and strainers upstream of regulators.

## Accuracy and Speed of Response

It is important to analyze the needs of the application to determine the accuracy and speed of response. Direct-operated regulators offer faster speed of response at a lower cost; however, they are not as accurate as pilot-operated regulators at high flow rates. Take care not to over- specify the accuracy of a regulator to avoid unnecessary expense.

## TIPS

- **Do not oversize regulators. Pick the smallest orifice size or regulator that will work. Keep in mind when sizing a station that most restricted trims that do not reduce the main port size do not help with improved low flow control.**

**CORROSION INFORMATION**

| FLUID | MATERIAL | | | | | | |
|---|---|---|---|---|---|---|---|
| | WCB Steel | Cast Iron or Ductile Iron | 302 or 304 Stainless Steel | CF8M or 316 Stainless Steel | 416 Stainless Steel | Monel | Hastelloy C |
| Acetic Acid Vapors (<150˚F (65˚C))(2/3) | C | C | A (304 only) | A | C | A | A |
| Acetone | A | A | A | A | A | A | A |
| Acetylene | A | A | A | A | A | A | A |
| Ammonia | A | A | A | A | A | A | A |
| Benzene (Benzol) | A | A | A | A | A | A | A |
| Butane | A | A | A | A | A | A | A |
| Carbon Dioxide (Dry) | A | A | A | A | A | A | A |
| Carbon Dioxide (Wet) | C | C | A | A | C | A | A |
| Carbon Disulfide | A | A | A | A | B | B | A |
| Carbon Tetrachloride | B | B | B | B | C | A | A |
| Chlorine Gas (Dry) | A | A | A | B | B | A | A |
| Chlorine (Wet) | C | C | C | C | C | C | A |
| Coke Oven Gas | A | A | A | A | A | B | A |
| Ether | B | B | A | A | A | A | A |
| Ethyl Chloride | C | C | B | B | C | A | A |
| Ethylene | A | A | A | A | A | A | A |
| Formaldehyde | B | B | A | A | A | A | A |
| Freon (Wet) | B | B | B | A | C | A | A |
| Freon (Dry) | B | B | A | A | A | A | A |
| Helium | A | A | A | A | A | A | A |
| Hydrogen | A | A | A | A | A | A | A |
| Methane | A | A | A | A | A | A | A |
| Natural Gas | A | A | A | A | A | A | A |
| Nitrogen | A | A | A | A | A | A | A |
| Phosphoric Acid Vapors | C | C | B | A | C | B | A |
| Propane | A | A | A | A | A | A | A |
| Sulfur Dioxide (Dry) | C | C | C | B | C | C | A |
| Sulfur Trioxide (Dry) | C | C | C | B | C | B | A |

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A– Recommended
B– Minor to moderate effect. Proceed with caution.
C– Unsatisfactory
N/A–Information Not Available

# Liquids Applications

| ELASTOMER INFORMATION | | | | | | |
|---|---|---|---|---|---|---|
| FLUID | MATERIAL | | | | | |
| | Neoprene (CR) | Nitrile (NBR) | Fluoroelastomer (FKM) | Ethylenepropylene (EPDM) | Perfluoroelastomer (FFKM) | Teflon (TFE) |
| Ammonia (Anhydrous) (<140˚F (60˚C)) | A | A | C | A | A | A |
| Ammonia (Gas, Hot) | B | C | C | B | A | A |
| Benzene | C | C | B | C | A | A |
| Butadiene Gas | C | C | B | C | A | A |
| Butane Gas | B | A | A | C | A | A |
| Carbon Tetrachloride | C | C | A | C | A | A |
| Chlorine (Dry) | C | C | A | C | A | A |
| Chlorine (Wet) | C | C | B | C | A | A |
| Coke Oven Gas | C | C | A | C | A | A |
| Ethyl Acetate | C | C | C | B | A | A |
| Hydrogen Gas | A | A | A | A | A | A |
| Hydrogen Sulfide (Dry) | A | A(1) | C | A | A | A |
| Hydrogen Sulfide (Wet) | B | C | C | A | A | A |
| Nitrogen | A | A | A | A | A | A |
| Propane | A | A | A | C | A | A |
| Sulfur Dioxide | C | C | C | A | A | A |

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| AVAILABLE CONSTRUCTION MATERIALS | BODY | | | | | | INTERNAL METAL PARTS | | | | | | | DIAPHRAGMS | | | | | | | | O-RINGS & OTHER COMPOSITION PARTS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TYPE | Brass/Bronze | Hastelloy C | Iron (Cast or Dulcite) | Monel | Stainless Steel | Steel | Alloy 20 | Aluminum | Brass/Bronze | Hastelloy C | Monel | Stainless Steel | Steel | Ethylenepropylene (EPDM) | Fluoroelastomer (FKM) | Hastelloy C | Monel | Neoprene | Nitrile | Stainless Steel | TFE Protector | Ethylenepropylene (EPDM) | Fluoroelastomer (FKM) | Neoprene | Nitrile | Nylon | Perfluoroelastomer (FFKM) | Teflon (TFE) |
| 63EG-98HM | | • | • | • | • | • | | | | • | • | • | • | • | • | • | • | | | • | • | • | • | | • | | • | |
| 67CS Series | | | | | • | | | | | | | • | | | • | | | | • | | | | • | | • | | | |
| 75A | • | | | | | | | | • | | | | | | | | | | • | | | | | | • | | | |
| 92C | | | • | | • | • | | | • | | | • | | • | • | | | • | | • | | • | • | | • | | • | |
| 92W | | | • | | • | • | | | | | | • | | | | | | | | • | | | | | | | | • |
| 95 Series | | • | • | • | • | • | • | • | • | • | • | • | | • | • | • | • | • | | • | • | • | • | • | • | | • | • |
| 98 Series | | • | • | • | • | • | • | | • | • | • | • | | • | • | • | • | • | | • | • | • | • | • | • | | • | • |
| 627W Series | | | • | | • | • | | | | | | • | | • | • | | | • | • | | • | • | • | | • | • | • | |
| 1098-EGR | | | | | • | • | | | | | | • | • | • | • | | | | • | | | • | • | | • | | | • |
| 1301 Series | • | | • | | • | | | | • | | | • | | | | | | | | • | | | • | • | | • | | • |

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