## Valve Selection Essentials
## written for Flow Control Magazine with Modifications

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May 9, 1997

Valve Selection Essentials as titled in Flow Control Magazine

Valve failures, replacements, repairs, downtime and lost product can be greatly minimized by selecting the right valve, the first time. Great. So how do you assure you are selecting the right valve? There are basically 3 avenues:

1. Evaluate your system criteria relative to each valve type.
2. Utilize the expertise of a consultant or the factory Technical Sales Representative.
3. Utilize one of the new Valve Selection Software Programs provided by various valve manufacturers.

No matter which avenue you take, the following criteria should be considered to assure you select the right valve, the first time:

- Process Parameters:
  - Flow
  - Pressure
  - Temperature

- Chemical Compatibility:
  - Media
  - Concentration
  - % of Solids
  - Specific Gravity (sg)

- Process Requirements:
  - On/Off versus control service
  - Allowable leakage rate
  - Cleanliness
  - Emissions Control
  - Available space and structural considerations
  - Industry Regulations: FDA, 3A, OSHA, EPA, ASME/ANSI, MSS
  - Cost of Ownership

- Failure Mode of Previous Valve

Whether you are an end user selecting a valve, a consultant, A&E, or Technical Sales Representative recommending a valve, or a valve manufacturer writing a Valve Selection Software Program, the aforementioned criteria should be evaluated prior to making a recommendation. Following is a comparison of some common valve types, how they relate in general to each criterion and some common industries in which each is used.

# Valve Selection Essentials

***written for Flow Control Magazine (cont'd)***

### *Butterfly Valves*

Butterfly valves are typically utilized in large line sizes in chemical services, waste and water treatment applications and fire protection systems.

Butterfly Valve

Due to the valve design, incorporating a small face-to-face dimension and lower weight than most valve types, the butterfly valve is an economical choice for larger line sizes (i.e. 8" and above). Additional advantages of the butterfly valve are standard face to face dimensions, relatively high coefficient of flow (Cv) and their availability in chemically resistant materials.

As with the ball valve, the butterfly valve complies with ASME face-to-face dimensions and pressure ratings. This enables the valve to be easily retrofitted in line regardless of the manufacturer. In addition, the small face-to-face dimension facilitates piping design. The ASME pressure classes adhered to by most manufacturers include 150, 300 and 600# allowing a maximum pressure of 1500 psi.

The butterfly valve is considered a high recovery valve, since only the disc obstructs the valve flow path. The Cv is relatively high; the pressure drop across the valve is relatively low. Hence the pump size is minimized and system wear reduced compared to that of low recovery valves (i.e. globe valves).

Applicable U.S. standards are AWWA C504 for rubber-seated butterfly valves, API 609 for lug and wafer type butterfly valves, MSS SP-69 for general butterfly valves and UL 1091 for safety butterfly valves for fire protection services. There are also various international standards, however the aforementioned standards are the most common governing valve design, dimensions and test criteria.

Available in a wide variety of plastic and rubber linings and solid metal bodies and discs, the butterfly valve is a good choice for chemical lines.

Disadvantages of the butterfly valve are lack of cleanliness and inability to handle slurry applications. Butterfly valves are generally not rated as bubble tight, although some high-performance butterfly valves may meet ASME class VI leakage ratings. As with ball valves, the cavities and leak paths around the disc stem where the stem attaches to the body are potential entrapments for fluids and slurries. The result is unwanted contamination in high purity systems and increased operating torque in slurry services.

For an economical valve choice in larger chemical process lines and waste and water treatment lines, the butterfly valve is hard to beat. General sizes available are 2 - 48", although sizes up to 96" are available from certain manufacturers.

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***written for Flow Control Magazine (cont'd)***

### *Ball Valves*

Ball valves are excellent in chemical applications, including the most challenging services (e.g., dry chlorine, hydrofluoric acid, oxygen). Readily available in a wide variety of configurations, 3-piece, end entry and top entry, these valves range from commodity type valves to high performance valves.

Advantages of ball valves include ease of operation, standard face-to-face dimensions, high flow capacity, high pressure/temperature capabilities and ability to handle severe service chemicals. The quarter turn operation is desirable to most operators and fairly easy to automate. The face-to-face dimensions comply with ASME, making the ball valve easy to retrofit and replace in line with most other ball valves and plug valves. Also compliant with ASME is the flange rating, either 150, 300, 600, 900 # or occasionally higher classes, enabling high performance ball valves to withstand up to 2250 psi. The ball valve temperature which is primarily dependent on seats and seals may be rated as high as 550° F. Higher temperatures are permitted when using metal seats.

*Standard Port Ball Valve*

Ball valves, available in reduced port and full port designs are considered high recovery valves, meaning a low pressure drop and relatively high Cv, [coefficient of flow (gpm per 1 psi pressure drop)]. The benefits of these desirable flow parameters are reduced pump size and less system wear due to lower velocity.

The ability to provide fire safe protection and handle severe service chemicals are two of the significant advantages of the ball valve. The Chlorine Institute of America recommends properly prepared ball valves for use in dry chlorine in accordance with the Chlorine Institute Pamphlet 6. Hence, chlorine manufacturers and users in North America utilize these specially prepared and vented valves. Other severe services using ball valves are anhydrous hydrofluoric acid, anhydrous hydrochloric acid, phosgene, ammonia and oxygen. When selecting a valve for any of these services, be sure to specify the specific service to the manufacturer to assure the valve is properly prepared.

Disadvantages of the ball valve design are its inability to handle slurry applications and the lack of cleanliness that can lead to contamination. Due to cavities around the ball and seats, ball valves are typically not suitable for slurry applications. Slurries tend to solidify or clog inside the cavities, greatly increasing the operating torque of the valve and in some cases rendering the valve inoperable. Therefore, most manufacturers do not recommend exceeding trace amounts of solids (e.g. 3% in ball valve applications).

As for cleanliness, the cavities mentioned above are also areas for fluid to become entrapped and stagnant, which can promote micro-organism or contamination growth. For industries striving to eliminate contamination, -- pharmaceutical, bioprocessing, electronics and some beverage industries for example -- ball valves are not recommended for use except for on chemical or non-sterile applications.

For chemical services, especially severe chemical services, ball valves are an excellent easy to operate choice. General sizes available are 1/2 - 12".

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### *Diaphragm Valves*

*Straightway Type Diaphragm Valve*

Diaphragm Valves are typically utilized in applications where cleanliness, bubble-tight shut-off, and chemical compatibility are paramount. Available in two general designs, the weir style diaphragm valve is utilized for higher pressure applications. The straightway diaphragm valve, having no flow path obstructions, is well suited for higher flow and slurry applications. Due to the diaphragm valve's streamlined flow path, absence of cavities and minimal contact surfaces, the valve is considered the "cleanest" valve or the valve least likely to cause contamination. For this reason, the diaphragm valve is the workhorse of the pharmaceutical, bioprocessing and electronics industry in high-purity water systems.

The diaphragm valve is also a frequent choice of the chemical processing industry, water treatment industry, power industry, mining industry and pulp and paper industries. A key advantage of the diaphragm valve is the wide variety of wetted materials providing an economical chemically compatible solution for almost any service. Typical body materials available are plastic lined, rubber lined, glass lined, various solid metals and alloys, and solid plastic. The only other wetted part is the diaphragm, which is typically available in multiple elastomer materials as well as Teflon®. This enables chemically compatible materials to be selected for almost any process media without the expense of upgrading the valve working parts, which are sealed from the process media by the diaphragm.

*Weir Type Diaphragm Valve*

Bubble-tight shut-off in accordance with MSS SP-88 (Manufacturers Standardization Society for the Valves & Fittings Industry, Standard Practice - 88, Diaphragm Type Valves) is also an advantage for services requiring zero leakage. In addition, leakage to the atmosphere (fugitive emissions) is minimized with the use of a diaphragm valve.

Diaphragm Valves may also be effectively used as control valves or in full vacuum applications. Although the controllability is not equal to that of the globe valve, recognized as the leader in valve control, the diaphragm valve provides a less expensive and cleaner solution when the precise control of a globe valve is not warranted. The control characteristics of the weir style diaphragm valve best emulate those of a linear control line, as opposed to an equal percentage or quick opening characteristic.

Disadvantages of the diaphragm valve are no industry standard face-to-face dimensions, multi-turn operation and a lower pressure/temperature limitation relative to most other valve types. The typical industry standard governing face-to-face dimensions, ASME (American Society of Mechanical Engineers) does not include diaphragm valve face-to-face dimensions. Although some diaphragm valve manufacturers have established the same face-to-face dimensions, in general these valves can not be easily retrofitted or replace other valve types.

Regarding operation, diaphragm valves are frequently automated with long lasting (1 million cycles in some case) pneumatic diaphragm driven actuators.

Where cleanliness, bubble tight shut off, and expense are the priorities, the diaphragm valve is a good choice. General sizes available are 1/4" - 12".

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### *Globe Valves*

The Globe Valve's complex flow path makes this configuration excellent for control. The valve operation is a linear rising-stem with multi-turn handwheel. The sealing device is a plug that offers limited shut-off capabilities, not always meeting bubble tight requirements. Depending on the specific construction and application, the globe valve may comply with ASME class II, III, IV, V or VI shut-off requirements.

*Globe Valve*

Easily automated and available with positioners, limit switches and other accessories, the globe valve is known for precise throttling and control. Most control valve manufacturers either supply control valve sizing software programs or will size the valve for you. Control valve sizing is significantly more complex than on/off sizing, hence the software programs available can be of real benefit.

Disadvantages include lack of cleanliness, relatively low coefficient of flow (Cv), and an inability to handle slurries. For these reasons, the typical globe valve is not typically specified for control in high purity services or slurry services. The inherent cavities in this valve tend to promote contamination and allow slurries to become entrapped disabling the valve operation. Moreover, the relatively low coefficient of flow, causes a relatively high pressure drop across the valve, resulting in increased pump and system wear.

Pressure limitations are relatively high, ranging from 1480 to 1500 psi, dependent on materials of construction, size and temperature. Minimum and maximum temperatures are also very broad ranging from -425° F to 1100° F, depending again on the materials of construction.

Simply stated, the main purpose of a globe valve is to provide precise throttling and control. General sizes available are 1/2 - 8".

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### *Knife Gate Valves*

Knife gate valves are used in three primary applications: non-abrasive slurry services such as in the pulp & paper industry, abrasive slurry applications as found in mining applications, and for large diameter water services as found in waste water systems.

Special knife gate valves configurations are used for handling abrasive slurries. These range from hardened components to the use of polyurethane seats and liners to combat the abrasion. The most recent development for abrasive slurries is the double seated slide gate valve which uses two opposing elastomer seats that provide an elastomer conduit through the valve. This type does best in the most difficult high solids and scaling applications.

Advantages of the Knife Gate Valve include the ability to cut through slurries, scale and surface build ups, unobstructed flow paths, small face-to-face dimensions and large line size availability. The unobstructed flow path not only provides high flow capacity (Cv), but even allows large objects, rocks and items routinely found in mining processes to safely pass through the valve. Similar to a butterfly valve, the knife gate valve has a small face-to-face dimension, greatly reducing the weight of this valve and facilitating piping design.

*Knife Gate Valve*

Sizes available range from standard cast configurations as small as 2" to special fabricated valves exceeding 100". Standard cast configurations have ASME 125/150 bolting patterns and are rated at 150 psi. Fabricated valves can address higher pressures and are often manufactured to match specific service requirements.

Disadvantages of a knife gate valve are the relatively low pressure limitation, lack of cleanliness and general inability to provide bubble-tight shut-off. As mentioned above, general pressure limitations are 150 psi maximum. Relative to cleanliness, the knife gate valve contains cavities which promote contamination. Hence this valve is not recommended for high purity applications. With regards to bubble tight shut-off, most knife gate valves due to the uni-directional flow path and metal seats are not capable of achieving ASME Class VI ratings. However some bi-directional knife gates valves utilizing an elastomer perimeter seal do comply with ASME Class VI shut-offs.

For abrasive and slurry applications, the knife gate valve is an excellent choice. For proper selection the Technical Sales Representative should be consulted since the application is key to developing the proper valve configuration particularly in larger line sizes. Many users are not aware of the recent design developments and capabilities.

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### *Pinch Valves*

Pinch valves typically perform well in low-pressure slurry applications. Popular applications are found in the mining, pulp and paper and food industries. The valve design is similar to that of a garden hose, in which the hose is pinched to stop the flow. The pinch valve operates by using an elastomeric sleeve which is "pinched" closed by a roller pin attached to a threaded stem. Operation is linear with a multi-turn handwheel.

Advantages of the pinch valve are streamlined flow, high flow coefficients and isolated working parts. The elastomeric sleeve contains essentially no cavities, meaning the valve is well suited for handling slurries that can become entrapped in such cavities. In addition, the sleeve isolates the working parts of the valve from the process media. Internals do not need to be specified in corrosion resistant materials. Due to no obstructions in the valve flow path, the coefficient of flow, Cv is relatively high. This reduces the head loss across the valve, decreasing the overall wear on the pump and system. Standard face-to-face dimensions are compliant with ASME B16.10, enabling the pinch valve to be easily interchanged with ASME compliant ball and plug valves.

Disadvantages are limited materials of construction, shut-off capabilities, increased maintenance time and relatively low maximum operating pressure. Due to the valve design and operation, a sleeve material with elastic resilient properties is required. The elastomers typically available to meet this criterion limit chemical compatibility and increase the potential for contamination. Although some manufacturers do offer Teflon® PTFE sleeves with an elastomeric sleeve reinforcement, the cycle life is most likely decreased with a less flexible material.

Pinch valves in most cases are not rated bubble tight per ASME or MSS. Another limitation due to the elastomeric construction is a relatively low pressure limitation, generally not exceeding 150 psi.

General sizes available are 1" - 24", however some manufacturers offer up to 70".

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### *Plug Valves*

Plug valves are typically utilized in chemical processing applications, including such severe service chemicals as chlorine and anhydrous hydrofluoric acid. The quarter turn design is most similar to a ball valve design, with the ball replaced by a plug. In contrasts to the ball valve, the plug valve typically requires higher operating torques, meaning larger and more expensive automation packages.

The valve is typically categorized into one of the three following designs: lubricated, nonlubricated or eccentric. The advantage of the nonlubricated design is elimination of periodic lubrication and assurance that valve lubrication will not contaminate the process media or adversely affect downstream instrumentation. The eccentric plug valve is essentially a plug valve with the plug cut in half. The advantage of this design is a higher achieved seating force with minimal friction encountered from the open to closed position. Shut-off capabilities are improved without a significant increase in operating torque.

General advantages of a plug valve are quarter turn design, chemical compatibility and standard face-to-face dimensions.

Disadvantages of this valve are limited shut-off capability, relatively high operational torques and cavities that may promote contamination or entrap solids.

Typical maximum operating pressures are 750 psi. Temperatures can range up to 400° F. Both aforementioned parameters are dependent on materials of construction, size and design.

For corrosive or severe service chemical applications, plug valves are a worthwhile consideration. General sizes available are 1/2" - 36".