Control Valve Basics - Sizing and Selection

An Online Continuing Education Course for Engineers

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Control Valve Basics – Sizing and Selection

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Introduction

A control valve is a power operated device capable of modulating flow at varying degrees between minimal flow and full capacity in response to a signal from the controlling system. Control valves may be broadly classified by their function as “on-off” type or “flow regulating” type.

A control valve is comprised of an actuator mechanism that is capable of changing the position of the flow controlling element in the valve. The valve modulates flow through movement of a valve plug in relation to the port(s) located within the valve body. The valve plug is attached to a valve stem, which, in turn, is connected to the actuator. The actuator, which can be pneumatically or electrically operated, directs the movement of the stem as dictated by the external control device. The actuator responds to an external signal, which usually comes from a controller. The controller and valve together form a basic control loop.

There are many types of valves available – each having their advantages and limitations. The basic requirements and selection depend on their ability to perform specific functions such as:

1. Ability to throttle or control the rate of flow;
2. Lack of turbulence or resistance to flow when fully open. Turbulence reduces head pressure;
3. Quick opening and closing mechanism. Rapid response is many times needed in emergency/safety;
4. Tight shut off. Prevent leaks against high pressure;
5. Ability to allow flow in one direction only - prevent return;
6. Opening at a pre-set pressure. Procedure control to prevent equipment damage;
7. Ability to handle abrasive fluids. Hardened material prevents rapid wear.

This course will discuss the selection process and provide the basic principles of sizing control valves.

BASIC VALVE TYPES

Valves are available with a wide variety of valve bodies in various styles, materials, connections and sizes. Selection is primarily dependent upon on the service conditions, the task and the load characteristics of the application. The most common types are ball valves, butterfly valves, globe valves and gate valves.

Ball Valves:

Ball valves are a quick opening valve that gives a tight shutoff. When fully open, the valve creates little turbulence or resistance to flow. The valve stem rotates a ball which contains an opening. The ball opening can be positioned in the fully open or fully closed position but must not be used to throttle flow as any abrasive wear to the ball will cause leakage when the valve is closed.

Ball valves are considered high recovery valves, meaning a low pressure drop and relatively high flow capacity.

Best Suited Control: Quick opening, linear

Recommended Uses:

- Fully open/closed, limited-throttling
- Higher temperature fluids

Applications:

- Ball valves are excellent in chemical applications, including the most challenging services (e.g. dry chlorine, hydrofluoric acid, oxygen).
- General sizes available are 1/2 - 12".

- 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 operating temperature which is primarily dependent on seats and seals may be rated as high as 550°F.
- Standard valves comply with ASME face-to-face dimensions, making the ball valve easy to retrofit and replace.

Advantages:

- Low cost
- High flow capacity
- High pressure/temperature capabilities
- Low leakage and maintenance
- Tight sealing with low torque
- Easy quarter turn operation- desirable to most operators
- Fairly easy to automate.

Disadvantages:

- Limited throttling characteristics
- Prone to cavitation
- Not suitable for slurry applications due to cavities around the ball and seats. 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.

Butterfly Valves:

Butterfly valves consist of a disc attached to a shaft with bearings used to facilitate rotation. These are considered high recovery valves, since only the disc obstructs the valve flow path. The flow capacity is relatively high and the pressure drop across the valve is relatively low.

The butterfly valves are used for limited throttling where a tight shut off is not required. When fully open, the butterfly creates little turbulence or resistance to flow.

Best Suited Control: Linear, Equal percentage

Recommended Uses:

- Fully open/closed or throttling services
- Frequent operation
- Minimal fluid trapping in line
- Applications where small pressure drop is desired

Applications:

- Most economical for large lines in chemical services, water treatment and fire protection systems. General sizes available are 2 - 48", although sizes up to 96" are available from certain manufacturers.
- 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).
- 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
- The ASME pressure classes adhered to by most manufacturers include 150, 300 and 600# allowing a maximum pressure of 1500 psi.

Applicable Standards:

- AWWA C504 for rubber-seated butterfly valves
- API 609 for lug and wafer type butterfly valves

- MSS SP-69 for general butterfly valves
- UL 1091 for safety butterfly valves for fire protection services

Advantages:

- Low cost and maintenance
- High capacity
- Good flow control
- Low pre

Disadvantages:

- High torq
- Prone to c
- Lack of cle
- Generally r paths around the disc stem are pc igh performance butterfly val wever available on demand.

Globe Valves:

Globe valves consis ement and a stationary ring seat in a generally spherical body. The valve stem moves a globe plug relative to the valve seat. The globe plug can be at any position between fully opened and fully closed to control flow through the valve. The globe and seat construction gives the valve good flow regulation characteristics. Turbulent flow past the seat and plug when the valve is open results in a relatively high pressure drop, limited flow capacity and low recovery.