



Valves

Continuing Education from the
American Society of Plumbing Engineers

October 2015

ASPE.ORG/ReadLearnEarn

CEU 228



Note: In determining your answers to the CE questions, use only the material presented in the corresponding continuing education article. Using information from other materials may result in a wrong answer.

Valves perform an important and vital role in almost every industry. They are critical in piping systems because of their basic function: controlling the flow of liquids or gases by on/off service, throttling service, or backflow prevention.

VALVE SELECTION

The selection of the correct type of valve for a specific installation is dictated by the purpose for which it will be used. For example, for starting/stopping service, a gate, butterfly, ball, or plug valve should be used. Where the service requirement is flow regulation or throttling, the choice should be a globe, butterfly, or ball valve. For backflow prevention, the selection is a check valve.

A valve's primary function is to control the flow of liquids or gases, so selection also depends on the characteristics of the fluid to be controlled. The following factors must be evaluated for satisfactory valve selection:

- Is the fluid a liquid or a gas?
- What is the fluid's viscosity (free-flowing characteristics)?
- Does the fluid contain abrasive, granular, or fibrous particles?
- Is the fluid corrosive?
- What is the fluid's temperature (normal, elevated, or cryogenic)?
- What is the fluid's pressure?
- What degree of leak tightness is required?
- What is the maximum pressure drop that can be tolerated through the valve?

Valve Styles

The three main styles of valves are multi-turn, quarter-turn, and check.

Multi-turn valves are considered linear stroke valves. A handwheel turns, causing the stem to rise, which pulls the wedge or disc off the seat and out of the flow path.

Quarter-turn valves are rotary-type valves. Rotary force applied to a lever turns the closure member 90 degrees for either full open or full closed; however, the closure member stays within the waterway.

Check valves require no manual operation. Operation of the valve depends completely on the flow through the piping system. A check valve is a unidirectional valve that opens by flow in one direction and closes automatically if the flow reverses.

Materials

The following materials are used in the manufacture of valves for commercial and industrial applications:

- Bronze, cast alloy (ASTM B61, ASTM B62, ASTM B584)
- Cast iron (ASTM A126)
- Ductile iron (ASTM A395)
- Forged steel (ASTM A105)
- Cast steel (ASTM A216 WCB)
- Cast stainless steel (ASTM A351 CF8 or CF8M)
- Forged stainless steel (ASTM A182, ASTM F304, ASTM F316)

Material selection is related to the actual application. The material must be compatible with the fluid running through the valve. Valve manufacturers supply chemical resistance charts to help make these determinations.

Many applications are water or water-based, and in these cases bronze and iron are the most cost-effective choices. However, if the fluid is a low-density gas like Freon, a cast material is too porous, so in this case a forged material is the right choice. If the fluid is volatile, like gasoline, then a brittle (low yield and elongation) material such as cast iron is not recommended. Brittle materials also should not be used where thermal or physical shock conditions may occur, such as with severe water hammer or where condensate may flash to steam.

Valves used in potable water systems must conform with the requirements of The Reduction of Lead in Drinking Water Act, which limits the lead content in plumbing products to a weighted average of 0.025 percent.

Dezincification occurs in valve bodies with more than 15 percent zinc. The leeching of the zinc from the brass alloy

creates porous copper and subjects the valve body to potential failure. This is no longer a problem with U.S.-made valves, but it may still be a problem with some valves manufactured outside of the United States.

Smooth or electro-polished finishes are typically specified for pharmaceutical, biotech, and food and beverage processes, as standard cast surface finishes promote the growth of bacteria and contaminants, which can lead to unsanitary conditions.

Pressures and Temperatures

Pressure and temperature are critical in selecting the right valve. The valve body is a pressure vessel—the valve’s walls must be thick enough to contain the pressure of the fluid passing through it. As temperature increases, materials weaken, and pressure ratings drop. A cast iron gate valve, for example, may be rated at 200 pounds per square inch (psi) for water up to 150°F, but the rating would drop to 125 psi at 353°F. A similar cast steel gate valve would be rated at 125 psi up to 650°F.

Pressure symbols commonly used throughout the industry include the following:

- SP: Steam pressure
- SWP: Steam working pressure
- WOG: Water, oil, gas pressure
- WWP: Working water pressure
- CWP: Cold working pressure

Each material has a temperature limitation, such as:

- Bronze ASTM B62: 450°F
- Cast iron ASTM A126: 450°F
- Cast steel ASTM A216 WCB: 1,000°F

Following are three common examples of ratings:

- 125 lb. SWP, 250 lb. WOG
- 150 lb. SWP, 300 lb. WOG
- 300 lb. SWP, 600 lb. WOG

The number refers to the specific amount of pressure in pounds per square inch gauge (psig) for which the valve is rated. The temperature of saturated steam at 150 psig is 366°F. This is the maximum temperature at which a 150 lb. WSP-rated valve can operate. Above 150 psig, the allowable temperature decreases as the pressure increases.

All valves manufactured to industry standards are classified as to their pressure/temperature limitations. For example, ASME B16.34 covers valves with flanged, threaded, and welding ends and outlines specific pressure/temperature limits for the valves’ pressure-containing parts. MSS SP-80, published by the Manufacturers Standardization Society, covers bronze gate, globe, angle, and check valves. Bronze is categorized by material type, pressure by class (i.e., 125, 150, 200, 300, and 350), and temperature.

Cv Factor

A valve’s Cv factor is the flow in gallons per minute (gpm) through the valve that will produce a 1-psi pressure drop (2.3 feet of water). Cv factors are listed by valve manufacturers to help determine the actual pressure drop through a valve since pressure varies with flow. (Equivalent lengths do not take this into account.) It can be calculated using the following equations:

Equation 6-1

$$\text{gpm} = \text{Cv} \sqrt{\frac{\Delta P}{\text{SG}}}$$

Equation 6-2

$$\Delta P = \left(\frac{\text{gpm}}{\text{Cv}} \right)^2 \text{SG}$$

where

ΔP = Pressure drop through the valve or fitting, psi

SG = Specific gravity (1.00 for water)

Trim Materials (Wetted Parts)

The term *trim* as applied to valves encompasses the elements of a valve relative to seating, such as the stem, disc, and seats in gate and globe valves, the stem, ball, and seats in ball valves, and the disc and liner in butterfly valves. The correct trim material is also a critical choice that depends on the actual application and the type of fluid in the body (abrasive, corrosive, etc.).

VALVE COMPONENTS

Bonnets

A bonnet is a cover for the valve and acts as the pressure boundary. Not all valves have bonnets depending on their design.

Screwed Bonnet

This is the simplest, least expensive, and probably most common design for small valves. However, for the internal threaded connection to be leak-tight, the mating threads must be accurate. Screwed-in bonnets are used for low-pressures and where shock and vibration are not present. They should not be used where frequent disassembly of the valve is required.

Union Bonnet

This design utilizes a separate union ring that mates with external threads on the body and pulls the bonnet and body into a close, pressure-tight relationship. The three-piece construction is the preferred choice over the screwed bonnet for rugged service and where frequent dismantling for replacement or maintenance is anticipated. It is stronger and safer than the two-piece screwed configuration. It is used for pressure ratings of 125 psi and higher.

Bolted Bonnet

In this type, the bonnet and body are cast with mating flanges that are machined and drilled. The flanges can be flat faced, male-female, or ring joint. Bolted bonnets are suitable for rugged service and all pressures and temperatures. They are practical for small and large valves, whereas the screwed and union bonnets are generally found on small valves only.

U-Bolt

The U-bolt bonnet is a modified version of the bolted bonnet and is used where moderate pressures are encountered. This type of bonnet is usually found in the oil and chemical industries because of its relative ease of disassembly for cleaning and repair, ruggedness, and economy.

Pressure Sealed

Pressure-sealed bonnets are not removable. They are used in high-pressure and high-temperature applications where seals providing compact and safe body-to-bonnet connections are required.

Seals

Simple Packing Nut

In this design, the packing is placed around the stem and forced down against the body with a packing nut. Maintenance is very easy, but the design is only suitable for use in low-pressure and small-size valves.

Packing Nut and Gland

In this design the stress is taken off the packing nut through the use of a loose gland that rides inside and is pressed against the packing as the nut is tightened. This permits more and tighter adjustments and consequently longer life with less maintenance.

Bolted Gland

Bolted glands are most commonly used in bolted bonnet valves and for valves operating at high pressures and temperatures. The stuffing box is usually much deeper than can be accommodated with a standard packing nut or even with the loose single-piece gland. Good designs prevent scoring of the stem by the gland.

Lantern Ring Design

On larger valves and those exposed to extremely high pressures and temperatures, additional sealing safety is built in through the use of a lantern ring in conjunction with the bolted gland. In effect, this design incorporates a double stuffing box, with the first taking the wear and pressure off of the second. Between the two stuffing box areas, space is provided for the introduction of a lubricant or sealant as further protection against leakage.

End Connections

Threaded End

Threaded ends are tapped with American National Standard female taper pipe threads. Threaded end valves are the least expensive and can be easily installed. Threaded ends are generally used for valves 2 inches and smaller, are suitable for all pressures, and are found in brass, iron, steel, and alloy steel valves.

Flanged End

Flanged ends make a strong, tight joint and are generally used for lines greater than 2½ inches that are frequently disassembled and assembled. Iron valves are typically provided with flanged ends. Flanged-end valves are installed between adjoining pipe flanges and made up with a gasket between the flanges for a tight joint. Cast iron valves come with flat-face flanges, and ductile iron and steel valves come with raised-face flanges.

Weld End

Welded-end steel valves are recommended where high temperatures and pressures will be encountered and absolutely tight, leak-proof connections must be maintained over a long period. Valves are furnished in either butt-weld or socket-weld ends.

Solder End

Solder end valves are used with copper tubing for many low-pressure services. The use of solder joints is limited to a maximum of 250°F because of the low melting point of the solder. Instead of solder, a higher temperature brazing material can be used. Flared ends are also available in small sizes for use with copper tubing.

Operators

Some of the most common valve operators follow:

- Wheel handle: In some cases the wheel on a large valve has a gearbox (6 to 8 inches); where it is 8 feet or more above the floor it may have a chain fall, and it could also be electric motor operated. If a large valve has high pressure on one side, it should have a small bypass valve that can relieve the pressure before opening.
- Horizontal lever: These come in various shapes. The butterfly valve should have a locking lever and should be opened slowly; otherwise, due to pressure on one side, the disc could open very rapidly and cause an injury.
- Vertical lever: These are either hand-operated or operated with an air or hydraulic piston.

GATE VALVES

Valve Stem

The sole function of the stem in a gate valve is to raise and lower the disc. The stem should not be subject to corollary stresses and strains of service conditions on the disc. For this reason, a relatively loose disc-stem connection is required. If the disc-stem connection were rigid, side thrust on the disc by pressure and flow would be transmitted to the stem, with possible straining and bending of the stem.

The most common stem configurations follow (see Figure 6-1):

- Rising stem, outside screw and yoke (OS&Y)
- Rising stem, inside screw
- Non-rising stem, inside screw

For the OS&Y construction, the stem threads are outside the valve. When the handwheel is rotated to open the valve, the stem's threading mechanism causes the stem to rise while the handwheel remains in the same location. The OS&Y construction is especially recommended for high temperatures, corrosive liquids, and where the liquid contains solids that might damage stem threads located inside the valve. Lubrication is a simple and easy procedure with external threads, but since the threads are exposed, care must be exercised to protect them from damage.

The rising stem, inside screw construction is generally employed with bronze gate valves. The handwheel and stem both rise as the valve is opened, so it is important to provide adequate clearance for valve operation.

The non-rising stem, inside screw construction requires minimum clearance for its operation. The disc moves on the stem as the handwheel is turned. Heat, corrosion, erosion, and solids in the fluid could damage the stem threads due to their constant exposure to the line fluid. In addition, the position of the disc (open or closed) cannot be determined by the position of the handwheel or stem as it can be with the rising stem types.

Disc

The control mechanism in a gate valve is a sliding disc (wedge) that is moved in and out of the flow passage of the body. The disc is restrained by guides in the valve body. In the fully opened position, the disc is completely out of the flow passage and thus allows a straight-through flow of the fluid through the passageway. The diameter of the passageway is nominally equal to the pipe diameter, which results in a pressure loss through the valve that is lower than through a valve that has a restricted flow passage or a design that changes the direction of flow.

Four main types of discs are available in gate valves: solid wedge; double disc, parallel faced; split wedge; and flexible wedge.

The solid wedge disc is the most widely used type in gate valves. It is noted for its simplicity of design and versatility.

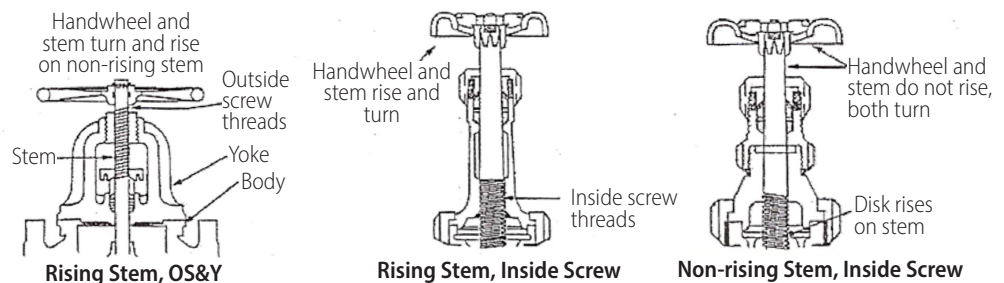


Figure 6-1 Common Valve Stem Configurations

The solid wedge closes by descending between two tapered seats in the valve body. Solid wedge disc seating is available in brass, iron, and steel gate valves.

The double disc should be selected where the application requires a tight seal to ensure leak-proof shutoff. The double disc closes by descending between two parallel or tapered seats in the valve body. After parallel-faced double discs are lowered into position, they are seated by being spread against the body seats. A disc spreader makes contact with a stop in the bottom of the valve and forces the discs apart. Valves with double discs are widely used in the water-works and sewage fields and in the oil and gas industries.

The split wedge is a two-piece disc that seats between matching tapered seats in the body. The spreader device that presses the discs against the body seats is simple and integral with the disc halves. As the valve is opened, pressure on the disc is relieved before the disc is raised, thus preventing friction and scoring of the seat. Another type of split wedge is one with a ball and socket joint that forces each disc to align itself against the body seat for tight closure.

Flexible discs were developed especially to overcome sticking in high-temperature service with extreme temperature changes. It is solid through the center but not around the outer portion, where it is flexible. This type finds little application in plumbing work.

Materials

A wide selection of materials is available for gate valves. In the selection procedure, the valve body and bonnet should be considered first, and then the valve trim. Factors to be considered in the selection of materials are pressure, temperature, corrosion resistance, thermal shock, line stresses, and fire hazard.

The most commonly used materials for the majority of gate valves in plumbing applications are bronze and iron. These materials are the most economical, are readily available, and generally satisfy most requirements of pressure, temperature, and corrosion resistance.

Carbon steel and various alloy steels are used when greater strength is required or where high temperatures, cryogenic temperatures, or special corrosive conditions are encountered.

Valve bodies and bonnets are available in cast, forged, or fabricated construction. For greater strength, forged and fabricated steel bodies are preferred over cast steel. The forged steel bodies are available only in a limited size range.

Many material options are available for seat rings, stems, discs, and backseat bushings. For instance, an iron body, bronze mounted (IBBM) gate valve has bronze seat rings, disc rings, stem, backseat bushing, and packing gland. When used within their pressure/temperature ratings, IBBM gate valves offer excellent service for most plumbing systems. Bronze gate valves are available with the body seats machined in the body. However, bronze is a relatively soft metal, and if grit or dirt is present in the fluid, the valve seats on the body or disc can be easily scored or scratched, causing subsequent leakage of the valve. In this case, a bronze gate valve with seats of stainless steel, copper-nickel, or Monel would be preferable. Of course, optional trim material increases the initial cost of a valve, but the extended valve life and lower maintenance costs often justify their selection.

Gate valves are now generally available in nonmetallic materials such as polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), and polypropylene (PP). When these materials are selected, their temperature limitations should be carefully checked.

Packing

Packing is one of the most important and often overlooked features of a valve. Valve manufacturers furnish gate valves with a general-purpose packing, which may not be satisfactory for a particular service.

Most gate valves employ stuffing boxes with packing glands that can be tightened with open-end or adjustable wrenches. Glands that are not sufficiently tightened will allow leakage. Over-tightening can squeeze out the lubricant in the packing.

Other packings for specialized applications include pure graphite, cotton filament, nitrile rubber, and rubber in combination with a cotton jacket.

The proper selection, care, and maintenance of valve stem packing can make a significant difference in the efficiency of a piping system.

Application

Gate valves are used to start or stop flow. The advantage of a gate valve is full flow with minimal pressure drop. The limitation is that a gate valve is not recommended for throttling applications. To throttle, the wedge would be left partially in the waterway, increasing velocity and eroding the wedge. The valve would also be damaged due to the wedge banging against the seats. Wire-drawing (erosion) with subsequent seat leakage is also a danger.

Gate valves should not be used where frequent operation is required. A closed 6-inch gate valve with a 300-psi inlet pressure and atmospheric outlet pressure is subjected to a load of more than 4 tons on the disc. While the valve is

tightly seated, no wear or undue stress occurs on the disc or seats, but at each start of the opening or end of the closing cycle is the ever-present danger of erosion of the seating surfaces due to the high velocity of flow. Repeated movement of the disc near the point of closure can cause a drag on the seating surfaces and subsequent galling and scoring on the downstream side.

A major market for gate valves is in commercial, industrial, and institutional construction. They are widely used by water utilities and conform to American Water Works Association (AWWA) requirements for this application. Other major markets are the petroleum, gas, chemical, shipbuilding, pulp, metal, and food and beverage industries. Power generation is another area where gate valves (mainly cast steel and stainless steel) are specified.

Additional types of gate valves for specialized service include:

- Knife gate valves, widely used in the pulp and paper industry where a slab-type valve is desired, as well as in chemical and petroleum plants for fire and explosion protection
- Slide valves, for low-pressure liquids and gases where absolute shutoff is not generally required
- Cryogenic gate valves, for use with liquefied gases requiring a stainless steel extended bonnet and stem to keep the packing out of the freeze area and allow gasification in the bonnet chamber

Operation and Maintenance

Before the piping system is placed in operation, the system should be thoroughly flushed to remove any chips, dirt, and scale that may have entered the lines during construction. No valve should be operated before this is done to prevent damage to the seating surfaces.

Gate valves should be closed slowly as the disc approaches the seat. The increased velocity of flow, caused by the reduced open area, will tend to flush out any solids that may have been trapped between the disc and seat. After opening the valve, the handwheel should be turned back one-quarter turn to ensure that the valve does not jam in the open position. The packing nut should be tightened at the first sign of packing leakage. Leaks around the stem could cause corrosion, and a loose stem could vibrate and damage the disc or seat.

Exposed valve stem threads should be kept clean and lubricated for ease of operation and to prevent wear from dirt or rust.

GLOBE VALVES

Globe valves (Figure 6-2) derive their name from the globular shape of the body. Flow through a globe valve follows a changing course; the fluid enters the valve parallel to the valve port and, after two 90-degree turns, leaves the valve again parallel to the valve port. Globe valves are designed for start and stop service and are ideally suited for throttling service.

Globe valves are available in a wide range of materials: bronze, all-iron, cast iron, cast steel, forged steel, and corrosion-resistant alloys. Body end connections are the same as for gate valves: screwed, soldered, flanged and welded.

The following bonnet types are generally available: screwed-in and screwed-on, union, flanged (bolted), pressure sealed, lip sealed, and breech lock.

The following types of stem configurations are available: inside screw, rising stem, OS&Y, and sliding stem.

Globe valves are specified for the following applications:

- Frequent operation
- Throttling (flow regulation)
- Positive shutoff for gases and air
- Where a high pressure drop across the valve can be tolerated

Seating

Unlike the perpendicular seating in gate valves, globe valve seating is parallel to the line of flow. The flow is controlled by a plug (disc) that moves perpendicular to the axis of flow.

The seat of the valve is a machined ring insert fitted in the port opening of the valve. The disc and seat can be quickly and conveniently reseated or replaced, which makes the use of globe valves ideal for applications where frequent maintenance is required.

The disc closes directly into the flow, unlike the gate valve where the disc moves across the flow. In the globe valve, the disc and seat do not come in contact until the actual seating takes place.

The travel distance of the stem is much shorter in a globe valve than in a gate valve. Since the pressure is directly under or over the disc, the globe valve is much easier to operate.

A major disadvantage of a globe valve is that the flow must change directions inside the valve, thus causing signifi-

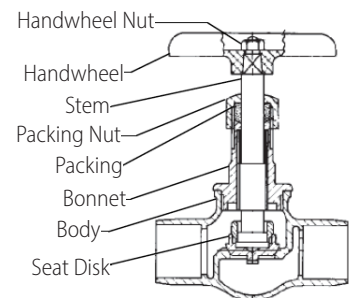


Figure 6-2 Globe Valve

cant pressure drop. For better flow control, the globe valve is installed with the flow under the seat. In higher pressure applications, the globe may be installed in the reverse position to prevent the disc from lifting off of the seat.

For general service, such as water, low-temperature fluids, gas, and low-pressure steam, a soft seat is usually recommended. This type of seat is available in bronze and sometimes iron valves.

Where scale, lime, or other buildup is present, a semi-plug is recommended. The disc and seat are usually of a harder alloy, such as copper-nickel. For severe throttling service like steam or particularly dirty fluids, a tapered plug disc is recommended because it provides a wider seating surface. The full plug is provided in a hard alloy, such as 420 stainless steel that is heat treated to 500 Brinell hardness. This design provides maximum resistance to galling, erosion, abrasion, and corrosion.

Globe valves should be installed with the disc closed to prevent seat damage during installation. Most globe valve leakage is due to foreign matter settling on the area between the disc and seat. When this occurs, it can often be corrected by opening the valve slightly and then closing it.

Discs

Globe valves regulate fluid flow by varying the size of the port opening through which the fluid flows. This is achieved by varying the position of the disc. All contact between the seat and the disc ends when flow begins. This is a distinct advantage for throttling flow with a minimum of wire-drawing and seat erosion.

Tapered Plug Disc

This type of flow control element has a wide seating contact with the tapered seat. This configuration results in a directly proportionate relation of size of seat opening to the number of turns of the handwheel and permits close flow regulation. Because of this feature, it is possible to gauge the rate of flow by the number of turns of the handwheel (e.g., if it takes four turns to open fully, then one turn permits 25 percent flow).

Conventional Disc

This disc is constructed of metal and has a line contact between its tapered or spherical seating surface and a conical seat. This particular flow control element is recommended for positive shutoff of liquids but is not recommended for throttling service.

Composition Disc

This disc has a flat face that is pressed against a flat, annular metal seating surface. The disc unit consists of a metal disc holder, composition disc, and retaining nut. Composition discs are available in materials suitable for hot and cold water, steam, oil, air, gas, gasoline, and many other fluids. This disc type is highly regarded for dependable, tight seating for hard-to-hold fluids such as gas and compressed air. It can usually tolerate the embedding of dirt without leaking. A composition disc is not recommended for throttling service.

Sealing

Sealing generally is required in four places in a globe valve. The sealing of three places prevents leakage of the fluid to the outside, and the sealing of the fourth prevents flow of the fluid within the system when the valve is closed. Leakage to the outside is stopped at the valve end connections, the body-to-bonnet joint, and the stem. Valve seats are usually provided as integrally cast or replaceable seat rings that are screwed or pressed into the valve body. Tightness against leakage when the valve is closed depends on the fit-up tolerance, material, fluid characteristics, pressure, and temperature.

Stem and bonnet-to-body seals are the same as for gate valves.

ANGLE VALVES

Angle valves (Figure 6-3) are a form of globe valve and have the same operating characteristics as globe valves. They are used when making a 90-degree turn in the piping to reduce the number of joints and save installation time. An angle valve offers less restriction to flow (less pressure drop) than the globe valve and elbow it replaces.

A valve that has a renewable composition disc should preferably have the pressure below the disc to ensure longer disc life. Where continuous flow is a requirement, it is safer to have the pressure below the disc. It is possible for a disc to become separated from the stem and automatically shut off the flow if pressure is above the disc. If this results in a dangerous condition for a particular service, then the pressure should be below the disc.

Another factor to be considered is the temperature variation. With pressure under the disc, cooling of the stem when the valve is in the closed position may cause sufficient contraction that will unseat the valve and cause leakage. Pressure and temperature above the disc help ensure tight seating.

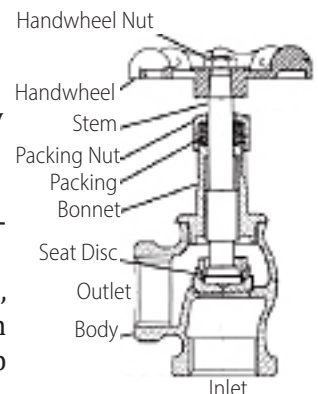


Figure 6-3 Angle Valve

CHECK VALVES

Check valves are the original truly automatic valve; they are actuated by the line fluid. Check valves are designed to perform the single function of preventing the reversal of flow in a piping system. Flow opens these valves (and keeps them open), and reversal of flow plus gravity (or an applied force) causes them to close automatically.

Check valves conform in operating principle to either of the two basic valve types: swing or lift check (Figure 6-4). The flow resistance (head loss) through swing checks is less than through the lift type. The pattern of flow through swing checks is in a straight-through line without restriction at the seat, similar to a gate valve.

Check valves are available in all the materials, end connections, body closures, and seats as for gate and globe valves.

Types of Check Valves

Swing Check Valve

Closure of swing checks depends on gravity (the weight of the disc) and reversal of flow. The pivot point of the disc is outside the periphery of the disc, increasing the possibility that the fluid will flow back through the valve (backflow) before the disc can seat itself. The disc must travel through an arc of approximately 90 degrees from the open position to the valve seat to achieve complete shutoff. Since there is no opposing force to the downward movement of the disc, the speed of the disc, impelled by the force of the reverse flow, results in slamming and possible water hammer on shutoff.

To prevent the dangers of water hammer and to eliminate slamming, swing checks are available with an outside lever and weight or spring. By adjusting the lever arm or spring tension, it is possible to cause valve closure at the moment of zero flow velocity (just as flow reversal is about to begin) and thus eliminate slamming and water hammer.

Double-Disc Check Valve

In the double-disc (double-door) swing check, an improved version of the conventional swing check, the disc is split into two separate discs, resulting in a reduction of the mass of the single disc as well as a shortened travel distance from the open to the closed position. A further improvement is achieved by the torsion springs that cause closure of the double discs on minimal flow reversal.

The characteristics of this valve minimize the slam potential as compared to the conventional swing check. They also reduce the potential for water hammer, but do not eliminate it.

The hinge pin in double-disc check valves is stationary, and each disc swings freely when opening or closing. Multiple springs are incorporated in the design of larger-size valves to compensate for the heavier discs and increase the speed of closure.

Slanting-Disc Check Valve

The slanting-disc check valve is a swing check valve that incorporates features for lower head loss and non-slam operation. The main body, constructed of two pieces, provides a 50 percent greater flow area through the disc and seat section. The disc pivots off center, with 30 percent of the disc area above the pivot point to impose resistance against the 70 percent area below the pivot point. Thus, this construction has a built-in non-slam characteristic, but it does not eliminate the possibility of water hammer.

The seat of the valve is placed at a 55-degree angle. The disc swings from this 55-degree closed position (rather than the 90-degree position in a conventional swing check), traveling a short distance to the open position of 15 degrees off the horizontal. The short distance of disc travel allows only minimal flow reversal before closure and provides a non-slam shutoff.

Lift Check Valve

The conventional lift check valve resembles a globe valve in construction and thus has the same characteristics relative to flow and head loss. The disc is equipped with a short guide, usually above and below, which moves vertically in integral guides in the cap and bridge wall. The disc is seated by backflow or by gravity in no-flow conditions. This valve operates in horizontal lines only, so the disc is free to rise and fall depending on the pressure under it.

In addition to the conventional lift check, other available types are the horizontal ball lift, vertical ball lift, and foot valve.

Silent Check Valve

The design principle of the silent check valve is that it is silent when it closes (non-slam). Silent check valves (sometimes called spring-loaded check valves) are available in the globe or wafer style. Both styles operate in an identical manner, but the wafer style has a higher head loss than the globe type.

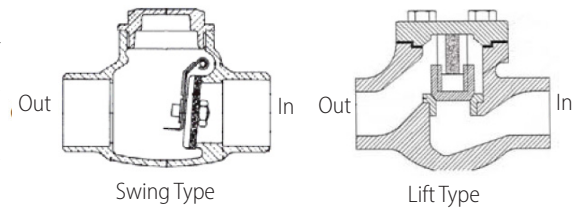


Figure 6-4 Check Valves

The center-guided poppet is spring loaded to be normally closed. The short distance between the poppet and the seat during flow conditions results in silent shutoff. This short distance is approximately one-fourth of the valve size (e.g., a 4-inch valve has a 1-inch distance from fully open to fully closed). This short poppet travel distance coupled with the spring force accomplishes the silent shutoff. The range of shutoff time is approximately one-tenth to one-twentieth of a second.

Silent check valves are furnished with helical or conical springs and are available in sizes to suit the specific design pressure conditions of the piping system. Both types of springs perform equally well. Unlike swing checks that require a flow reversal to cause closure, the silent check is designed to close at the instant of zero flow velocity before flow reversal occurs, thus eliminating any possibility of water hammer and slam.

It is important to differentiate between a non-slam check valve and a silent check valve. Although non-slam checks, as the name implies, eliminate slam, they do not eliminate the possibility of water hammer. Silent checks eliminate both slam and water hammer.

Installation

Swing checks can be installed in either the horizontal or vertical position. When installed in the vertical, the direction of flow must be up. Lift checks (except the vertical type) must be installed in the horizontal position only. Silent check valves can be installed in any position, and when vertical, the flow can be either up or down.

Sizing

The discs and any associated moving parts of a check valve may be in a state of constant movement if the velocity head is not sufficient to maintain the disc in the wide-open position. The size of the check valve should be selected on the basis of flow conditions to prevent premature wear, noisy operation, and vibration.

The following formulas can be utilized to determine the minimum velocity required to hold the discs in the wide-open and stable position.

Equation 6-3a: Bronze Valve, Swing Check

$$V = 35V_s^{1/2}$$

Equation 6-3b: Bronze Valve, Lift Check

$$V = 40V_s^{1/2}$$

Equation 6-3c: Cast Iron Valve, Swing Check

$$V = 48V_s^{1/2}$$

Equation 6-3d: Cast Iron Valve, Tilting-Disc Check

$$V = 30V_s^{1/2}$$

Equation 6-3e: Cast Iron Valve, Lift Check

$$V = 25V_s^{1/2}$$

where

V = Velocity of flow, feet per second (fps)

V_s = Specific volume of fluid, ft³/lb

Sizing check valves on this basis often results in valves smaller than the pipe in which they are installed. The pressure drop through the valve will be no greater than that of a larger valve that operates partially open.

ASPE Read, Learn, Earn Continuing Education

You may submit your answers to the following questions online at aspe.org/readlearnearn. If you score 90 percent or higher on the test, you will be notified that you have earned 0.1 CEU, which can be applied toward CPD renewal or numerous regulatory-agency CE programs. (Please note that it is your responsibility to determine the acceptance policy of a particular agency.) CEU information will be kept on file at the ASPE office for three years.

Notice for North Carolina Professional Engineers: State regulations for registered PEs in North Carolina now require you to complete ASPE's online CEU validation form to be eligible for continuing education credits. After successfully completing this quiz, just visit ASPE's CEU Validation Center at aspe.org/CEUValidationCenter.

Expiration date: Continuing education credit will be given for this examination through **October 31, 2016**.

CE Questions — "Valves" (CEU 228)

1. A check valve is a _____ type of valve.
 - a. rotary
 - b. unidirectional
 - c. linear stroke
 - d. multi-turn
2. Which of the following valve materials would be the most cost-effective for a water-based application?
 - a. bronze
 - b. forged steel
 - c. iron
 - d. both a and c
3. Cv factors are used to help determine the actual _____ through a valve.
 - a. friction loss
 - b. flow rate
 - c. pressure drop
 - d. pressure rise
4. Which of the following types of bonnets should not be used where frequent disassembly is required?
 - a. screwed
 - b. union
 - c. bolted
 - d. U-bolt
5. Which of the following end connections is recommended where absolutely tight, leak-proof connections must be maintained?
 - a. threaded
 - b. flanged
 - c. weld
 - d. solder
6. Which of the following is the control mechanism in a gate valve?
 - a. stem
 - b. handwheel
 - c. yoke
 - d. disc
7. Where high or cryogenic temperatures are expected to be encountered, the recommended material used for a gate valve is _____.
 - a. PVC
 - b. carbon steel
 - c. iron
 - d. bronze
8. In which of the following applications should a gate valve be used?
 - a. for throttling
 - b. where frequent operation is required
 - c. where full flow with minimal pressure drop is required
 - d. both a and b
9. In which of the following applications should a globe valve be used?
 - a. for throttling
 - b. where frequent operation is required
 - c. where a high pressure drop can be tolerated
 - d. all of the above
10. Which of the following globe valve discs is recommended for severe throttling service?
 - a. tapered plug
 - b. semi-plug
 - c. conventional
 - d. composition
11. The _____ valve is designed to perform the single function of preventing the reversal of flow.
 - a. globe
 - b. check
 - c. angle
 - d. gate
12. Which type of check valve eliminates the possibility of water hammer?
 - a. non-slam
 - b. swing
 - c. silent
 - d. slanting-disc