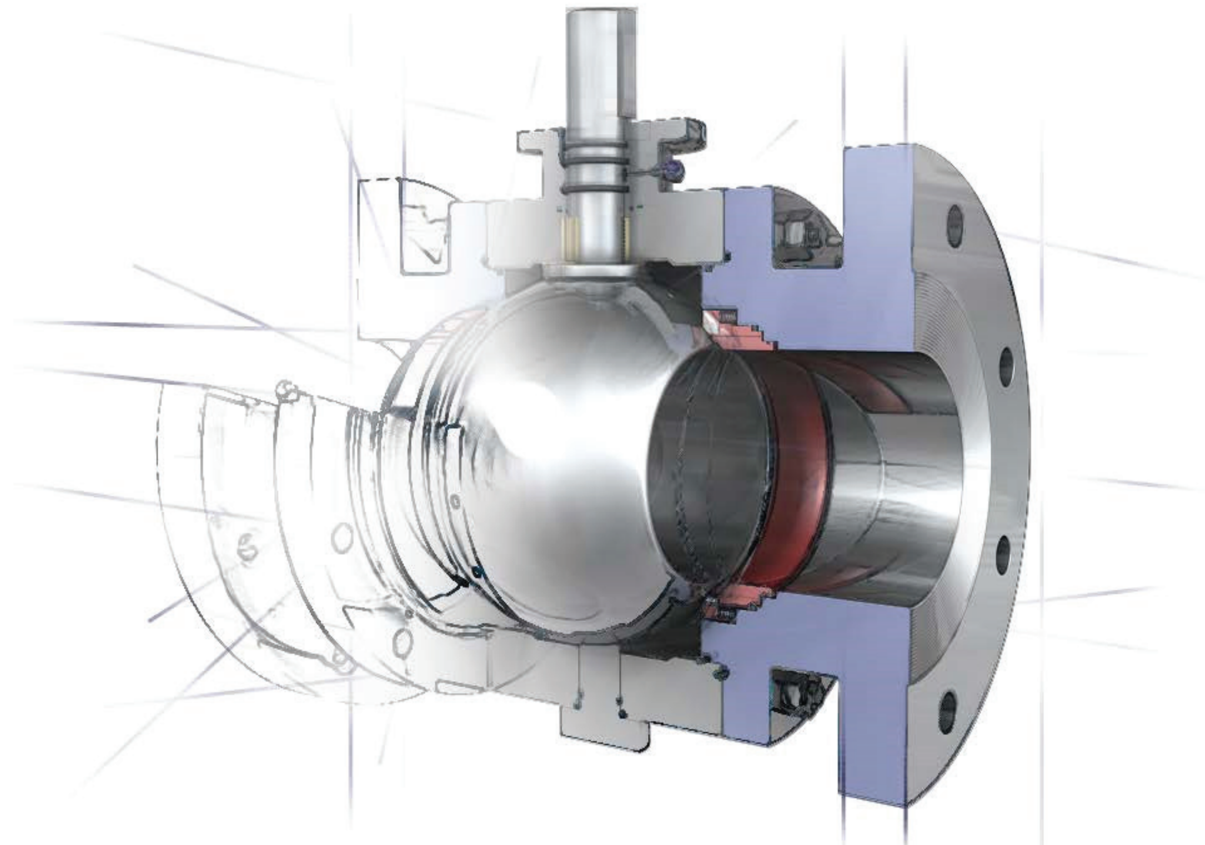
OFFSHORE NORGE

VALVE TECHNOLOGY



Handbook

February 2020/Rev. 04

With contributions from Ingolf from Holmslet

Table of Contents

Background

Offshore Norge has developed a handbook for working on valves on hydrocarbon systems. The handbook can be downloaded from www.offshorenorge.no.

The handbook covers the typical valves used in the petroleum industry and includes information about valve types, seals, sealing surfaces and applications. The handbook is the basis for a training curriculum for valves on hydrocarbon systems also developed by Offshore Norge. This training curriculum can also be downloaded from www.offshorenorge.no.

HSE Precautions

1. Always maintain a good overview of the work site and who is involved in the work.
2. Do not use solutions that can harm people or tools.
3. Use proper personal protective equipment such as safety shoes, gloves, goggles, etc.
4. Check that there is an approved and signed work permit for the job before starting.
5. For work at heights, the working area must be secured against falling objects (tools, bolts, gaskets, etc.)

1. Basic Theory

Static pressure forces

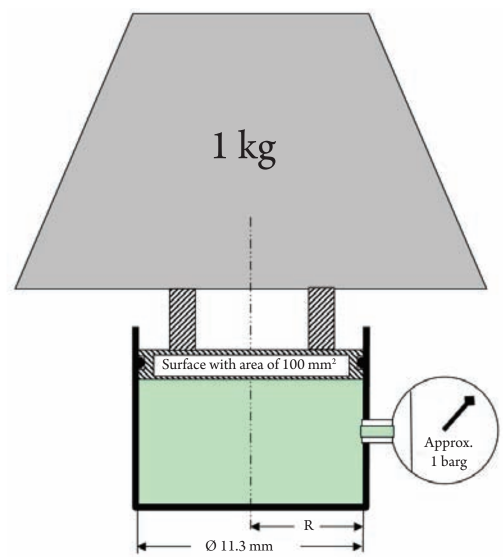
The fluid pressure inside the valve affects the function of the parts that make up the valve. The pressure acting on a surface will push the surface until the pressure on the other side is offset by the same pressurized fluid, or the force is absorbed by the valve.

The force created by the pressure on a surface is expressed in Newtons [N] and can be calculated as the pressure multiplied by the size of the area upon which the pressure acts.

The normal unit for pressure is bar. 1 bar is equivalent to 0.1 N/mm^2. When the pressure is expressed as overpressure in relation to the outside atmosphere, a g is added so that it is written "barg".

If 1 barg (0.1 N/mm^2) acts on a surface of 100 mm^2, this will produce a force of 10 N.
To easily get a feeling for the size of a force, it is not uncommon to compare with how many kilograms it can hold. 10 N can hold a mass of approximately 1 kg.

The pressure area for a 10" closed ball valve is usually 50,000 mm^2. With a differential pressure across the ball of 100 bar, this gives a force of 500,000 N.

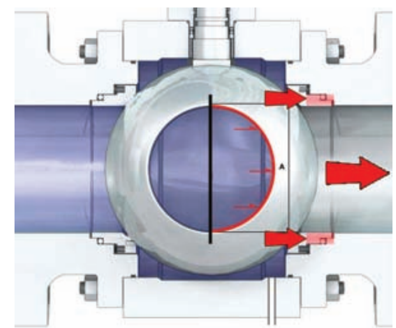


The area of a circular surface is calculated by the radius squared, multiplied by Pi (Π = 3.14).

$$A = R^2 \times \Pi = R^2 \times 3.14$$

This force must be absorbed by the valve. If one allows the sealing surfaces alone to absorb this force, this will provide a good sealing force which makes it easy to get the valve sealed.

However, if the valve is moved with this force present, this same force causes significant friction that must be overcome in order to create movement.

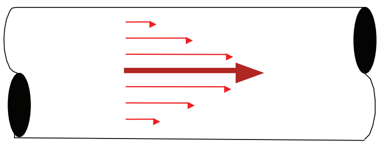


The figure shows the pressure forces in a ball valve with floating ball.

Even if one is able to move the valve with such strong friction, this friction would also cause excessive wear on the seal surface.

Flow

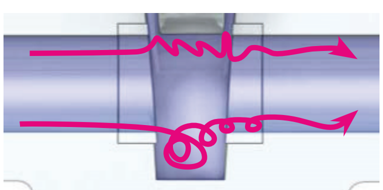
The flow of gas or liquid is referred to as either turbulent or laminar. Laminar flow is steady over time and cross-section. In a circular cross section, a laminar flow will have high velocity in the center, which then decreases towards the edges.



Turbulent flow is characterized by the fluid constantly changing velocity and direction of flow across the cross section.
See for example: www.youtube.com/watch?v=KqqtOb30jWs

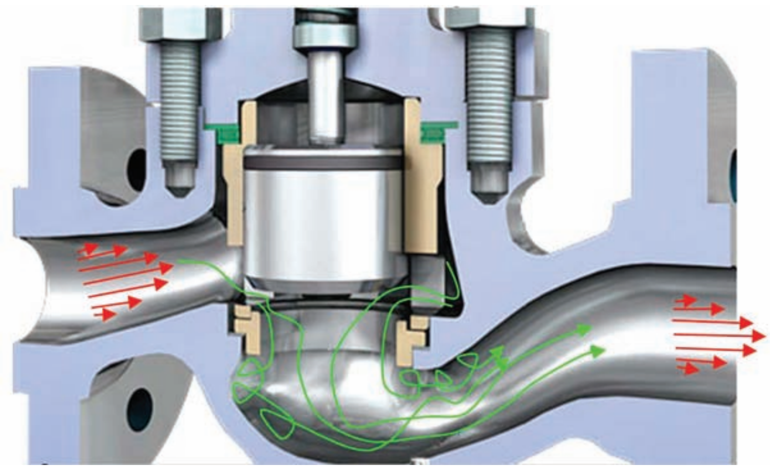
www.youtube.com/watch?v=NplrDarMDF8

Turbulent flow typically occurs at high velocities, abrupt changes in flow direction and/or changes in cross section, as a result of both geometry and increased velocity.

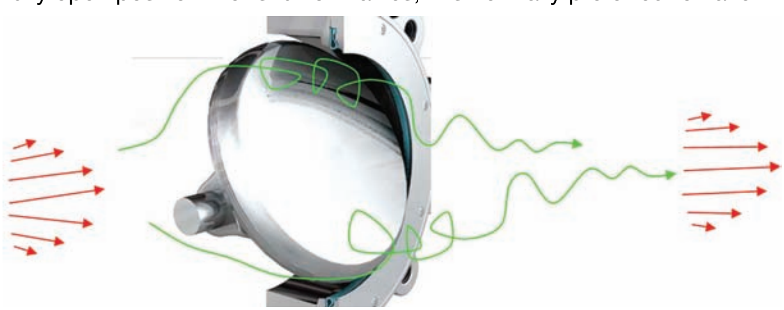


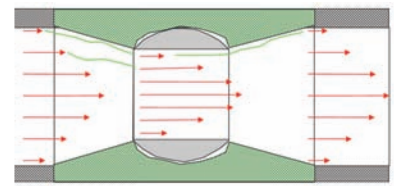
Laminar flow gives a lower pressure drop and erosion than turbulent flow. Turbulence can also break down corrosion prevention layers in low alloy or corrosion-resistant materials. With turbulence, a corrosion inhibitor has little or no effect.

The different types of valves handle flow in different ways. A regulating valve should provide a certain pressure drop, which is achieved by reduced cross-section and subsequent increase in velocity. This often causes turbulent flow. Because the pressure loss associated with turbulence is not constant, it can be difficult to achieve a smooth adjustment.



A butterfly valve used for regulation will usually produce high turbulence at a small opening. This type of valve is therefore used primarily as a control valve for applications, where the valve normally operates in a fully open position. For shut-off valves, it is normally preferred to have the least possible loss of pressure in the open position. These are therefore largely designed to ensure laminar flow. This also applies to valves with reduced throughput, where the geometric design is even, so that turbulence does not normally arise, even though the velocity is increased locally in the valve's smallest cross-section. If the valve is mounted immediately downstream of equipment or elbows that generate turbulence, this can create conditions that alter the characteristics of the valve. For example, a wedge-gate valve will be able to operate satisfactorily with moderate velocities if the flow upstream is laminar.



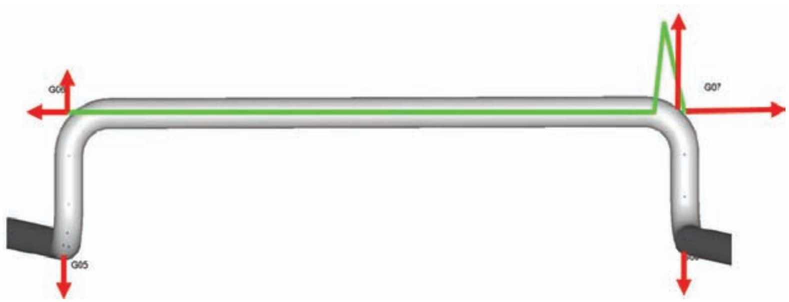


This is because the velocity is low at the outer edge, where the open design of the valve type can generate turbulence. However, if this valve is located immediately downstream of a control valve, the open design of the valve type can amplify the turbulence so that it causes adverse effects.

Dynamic pressure forces

In a pipe system with continuous flow, the pressure forces in the system are balanced. This means that the pressure acts with equal force on both ends of a straight section. The system is therefore stable and will not move.

Quick opening and closing of valves can cause pressure pulses caused by positive or negative acceleration of the fluid. The pressure pulses may reflect, for example, when they encounter shut-off ends, T-pieces, phase changes in the fluid or large expansions in a cross-section. If several of these reflections meet each other, they could reinforce each other and produce a pressure which is several times greater than the original system pressure. Such a pulse can move with sonic velocity.



Even though such a pulse may only act for milliseconds, it can cause major damage since it is an unbalanced force in the pipe system. Systems in which such pulses are expected to occur are braced with pipe supports that absorb the forces. For example, in the flare system, where there are quick-opening valves, the system will have strong pipe supports and a slope on the lines so that a slug of liquid does not form. For systems where such pressure pulses are not expected, the result can be fatal, because the pipe supports may be crushed and in worst cases, the pipe may fail.

To avoid such occurrences, therefore, it is important that valves with large pressure differences are not opened too quickly. Furthermore, valves with high flow velocity must not be closed too quickly. For valves controlled by actuators, it is particularly important to ensure that valves that may have a large differential pressure are limited in their hydraulic influx, since opening speed with incorrect operation can be too fast.

Seal surfaces

Seal surfaces are usually divided into two categories: soft and hard. The function of soft seal surfaces is achieved primarily by a soft material such as a polymer or graphite being pressed against a metal surface. The softness means that it does not require as much force or evenness of the metal surface to achieve an acceptable seal.

The function of hard seal surfaces is achieved primarily by two surfaces with good fitting being pressed against each other. In addition to a good fit, a strong force is also required to create an acceptable seal. Hard seal surfaces can consist of two metal-to-metal surfaces or a hard polymer surface against a metallic surface.

In the context of valves, the concepts of static and dynamic seals are often used. Typical dynamic seals are stem seals, whereas the static seals will often be valve housing seals, where there is no movement and the seal must remain tight.

Hard seal surfaces

Hard seal surfaces are used primarily on immobile surfaces or where sealing only needs to be maintained at a clearly defined point. This may be a seal between two flanges, or back seat sealing between the stem and housing or between the seat and the sealing body. The high sealing force required for a hard seal to be effective means that there are also higher levels of friction over the sealing surfaces caused by movement.

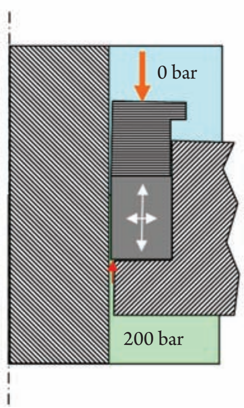
Metal-to-metal seals that are subject to motion while the sealing force is also at a maximum must therefore be coated with hard metal in order to avoid abrasion to the metal surface.

Metal-to-metal seals of the same material/alloy may also be subjected to cold welding due to the high sealing force. This problem is particularly relevant to rotating parts, such as a plug. Coating with hard metal on one or both surfaces will also counteract this.

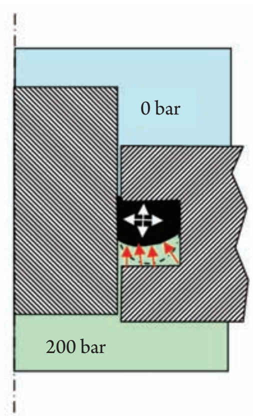
Soft seal surfaces

Soft seal surfaces are primarily used as seals where there is some movement, therefore requiring that good sealing be maintained during movement. This may be a seal between a stem and housing, between seat and housing or between seat and the sealing body. Soft seals can be sealed as a result of a mechanical pre-tensioning which ensures sufficient sealing force, and/or by the gasket being pressurized by the process.

A stuffing box typically with graphite is mechanically pre-tensioned by the pressure from the gland flange.



Although the gland force acts parallel to the gap to be sealed, this force will produce pressure in the graphite so that a sealing force is created normally on the stem and valve housing. The size of this force in relation to the gland force depends on the consistency of the graphite. To maximize the sealing force, it would be optimal if the gasket was so soft that it was almost fluid. The sealing force would then be equal to the gland force, but with the disadvantage that it would be extruded out of the gap that it should seal. The graphite typically used in stuffing boxes is relatively hard in order to avoid extrusion. Therefore, only a small part of the gland force provides effective sealing force. This will be further reduced over time because the graphite becomes harder as it ages. The hardness of the graphite also increases with the pressure to which it is exposed. This means that the more the gland flange is tightened, the less the force increase will result in increased sealing force.



Soft seals have limited strength, so that if the pressure area is too large, the material is unable to hold the pressure forces. The result then is often an extrusion of the gasket material into the gap it is intended to seal. In the worst case, this could result in a full blowout of the gasket. A typical O-ring can have a tensile strength of 10 N/mm^2 and a softness that makes it extremely easy to compress. This means that the gap it can seal without extrusion at high differential pressures is typically as low as 1/100 of the thickness of the O-ring (in the unpressurized state). Apart from the risk of extrusion, the O-ring is optimal because its softness provides a high sealing force, which is enhanced with increasing pressure difference.

Correct geometric design of the O-ring groove is important for the functionality and longevity of the O-ring. It is equally important that the cross section of the O-ring does not fill the entire O-ring groove, but allows the O-ring to move. Normally, an O-ring should not fill more than approximately 85% of the available volume of the O-ring groove. If this is exceeded, the O-ring may be permanently deformed if, for example, it produces a vacuum.

Soft sealing materials generally have temperature limitations, both maximum and minimum. At low temperatures, the material may become too hard and rigid, so that satisfactory sealing cannot be achieved. At higher temperatures, they lose strength and become susceptible to extrusion. General degradation of the material is also increased by increased temperature. It is therefore common to operate valves with soft seals within the following temperature range (may vary in relation to the pressure):

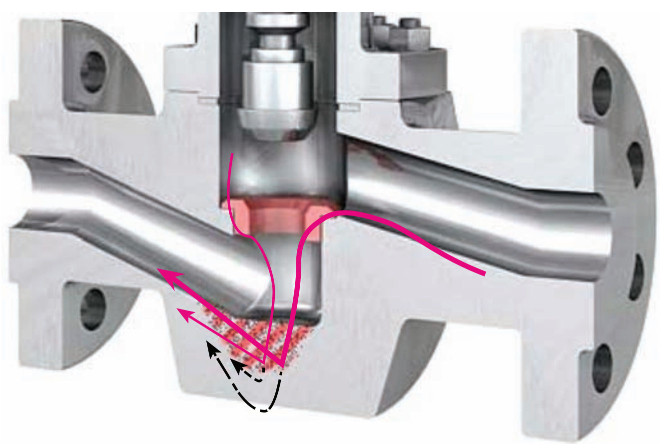
A valve can be used outside the temperature range for soft seals if the design is such that the seal is not exposed to the fluid's temperature, or where care is taken that the seal is not exposed to differential pressure at the same time that it is at the same temperature as the fluid. Usually, valves that are exposed to very low temperatures will have an extended bonnet where the stuffing box has a larger distance to the fluid.

Otherwise, soft seals in seats may be exposed to a higher or lower temperature when the valve is only open.

Fluid
A valve is affected by the fluid flowing through it. The fluid can cause erosion, corrosion and cavitation on the metal surfaces, degradation of soft seals, wear on seal surfaces and clogging of fittings with subsequent locking of motion.

Erosion
For valves with fluids containing particles, there will be a risk of erosion damage if these particles strike the metal surfaces with high velocity. Particles will normally have higher net-weight than the fluid they are in. Where a change of direction occurs, they will be concentrated at the periphery of the change. Erosion is not normally a problem for valves without changes of direction or with large pressure reduction, as long as the velocity in the system is moderate. For valves with pressure reduction, it is difficult to avoid local high velocities and turbulence. It is then important that the valve is used such that the area with the highest velocity is kept farthest away from critical areas of the valve. For a traditional seat valve, where the flow runs from the top side of the plug and down, there will be a concentrated flow on the lower side with a high velocity. This also coincides with a change of direction. This can result in a small area with concentrated erosion.

The solution is to mount the valve in the opposite direction, so that the flow comes from the underside and provides a more distributed flow in the area with the highest velocity and large change of direction. This will not necessarily eliminate the erosion completely, but it will distribute it over a larger area, so it will take longer before a dangerous reduction of the valve material occurs.



Corrosion
The materials selected for the valve must have an acceptable corrosion resistance against the fluid the valve is exposed to. For seal surfaces, corrosion is totally unacceptable, though it may be acceptable to have some general corrosion in the housing over the lifetime of the valve. For valves selected made of precious metals because of a corrosive and wet fluid, it is particularly important that the smaller valve parts have at least as good resistance as the valve housing and obturator. There are many examples where bearing rings of 316 stainless quality have lost function due to galvanic corrosion when they have been inside the duplex valves.

Cavitation
Liquids have a vapor pressure at all temperatures. If the pressure is lower than this pressure, the liquid turns to vapor (gas). For valves where there is a drop in pressure, this pressure drop will be slightly different inside the valve. In some places, there can be a risk of reaching a level below the liquid’s vapor pressure. This results in gas precipitating locally. If the surrounding system is not below the vapor pressure, the system will quickly equalize. This results in the gas returning to liquid form again. This happens quickly, and the large volume difference between gas and liquid means that this causes an implosion. Implosions near metal surfaces can cause metal pieces to be sucked out. Paradoxically, the damage to hard metal surfaces is just as large as for soft surfaces. This physical mechanism is called cavitation. Similar problems typically occur in pumps and boat propellers.

Degradation of soft seals

Soft seals can be degraded by the fluid we have in our facilities. Usually, the additives used in a well stream to ensure hydrate-free transportation and optimal separation represent a challenge for some of the soft seals used. The temperature itself also affects the degradation process.

Chemical degradation of soft seals is a common problem in connection with the specification of such sealing elements. Seals in the fluorocarbon group (rubber) are often more susceptible to chemical degradation than seals made of polymer (plastic). Although there are many types of rubber compounds which are specially adapted to various chemicals that are present in the fluid, this is often a design challenge. It is particularly chemicals such as methanol that pose the greatest challenges. Plastic materials, however, are normally very resistant to chemicals and therefore lip gaskets are often used to a greater extent than O-rings, where it is known that these chemicals will be present. Rubber sealing rings will normally also be more susceptible to mechanical damage in gas service. This is caused by gas that penetrates into the core of the O-ring and which is not released naturally during rapid decompressions. When the O-ring's ambient pressure drops rapidly, the confined pressure is released into the surrounding volume. If the O-ring's natural pores are unable to release the trapped pressure quickly enough, the O-ring will "explode" and thereby lose its functionality. This phenomenon is often referred to as "explosive gas decompression failure". Plastic gaskets are not prone to this damage mechanism and lip seals are therefore often preferred instead of O-rings in gas service.

Some soft seals have an extensive network of pores and micro-cracks. This can lead to the penetration of liquid, causing the sealing material to swell. Such swelling can result in increased friction, and therefore cause operational problems or increased wear.

Clogging

Cavities in valves can be filled up with both particles and deposits from the fluid. This can prevent movement of floating seats or prevent a gate from closing. Deposits may also form on the seal surfaces that prevent them from meeting.

Hydrates can assume various forms, such as a "sludge" in oil pipelines or more solid matter in gas systems. Hydrates occur in a hydrocarbon gas/water mixture. Hydrates form under relatively high pressure and low temperature (below 20-30 °C). For a fluid where there is a potential for hydrate precipitation, there will usually be a risk of this occurring on parts of the valve where there is a lower temperature than inside of the main flow. This can apply to a cavity on a gate valve, for example.

In oil and gas production, the well stream also carries a number of different salt compounds. These compounds can precipitate inside the valves, producing a relatively hard coating. On the seal surfaces, this can prevent the desired quality of seal being achieved. In the worst case, the hardest forms of precipitation can also result in scratching of softer seal surfaces. For fluid seats, this precipitation can prevent movement and, in the worst case, result in full wedging of the seat.

Threaded connections

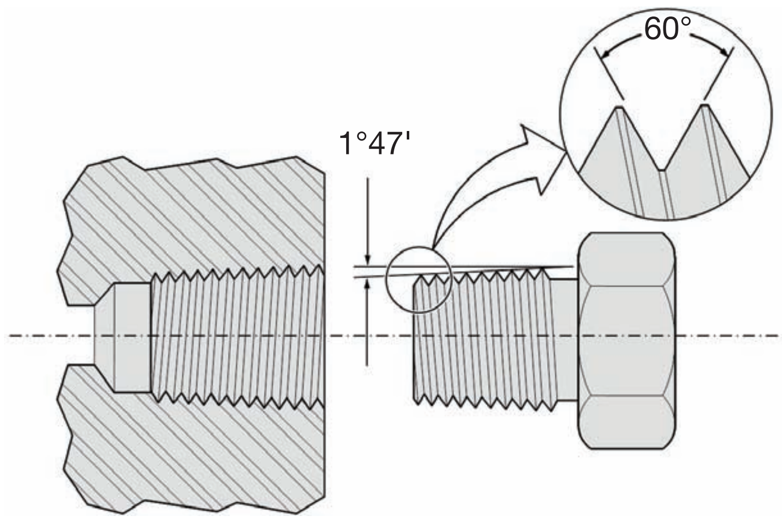
Detailed knowledge about threads is covered in the Offshore Norge handbook on fittings and small bore pipework that can be downloaded from www.offshorenorge.no.

Working with valves requires that the principles should be understood so that personnel are able to safely remove and install threaded plugs in a valve housing.

The minium number of threads engaged should be in accordance with the suppliers recommendations and company procedures.

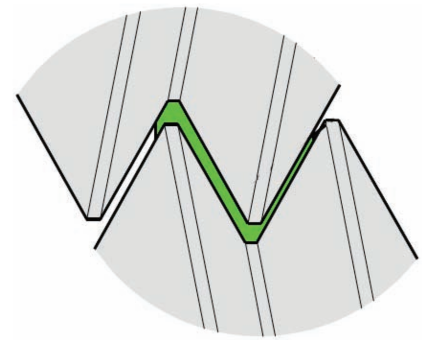
Tapered threads

For tapered threads, sealing must be achieved in the threads. However, there is a misunderstanding in the market that this is achieved by creating metal-to-metal contact between the threads.



There would have to be very large deformation to achieve a continuous metal contact around the entire cross-section so that it can create a satisfactory seal. Instead, there must be a sealant that fills the gap between the threads. This could be Teflon tape or a lock-tight fluid.

In addition to creating the seal itself, this will also provide lubrication during tightening so that friction is reduced, while the risk of cold welding between similar materials is reduced. Lock-tight fluids will also lock the plug so that the risk of unscrewing, due to vibration, for example, is reduced. Teflon tape is prohibited in many facilities because of the danger of unscrewing. Teflon tape and lock-tight fluid used must be specified for the correct temperature range. The lock-tight fluid specified for the facility must then be used in accordance with applicable procedures. This also applies to the cure time for the fluid.

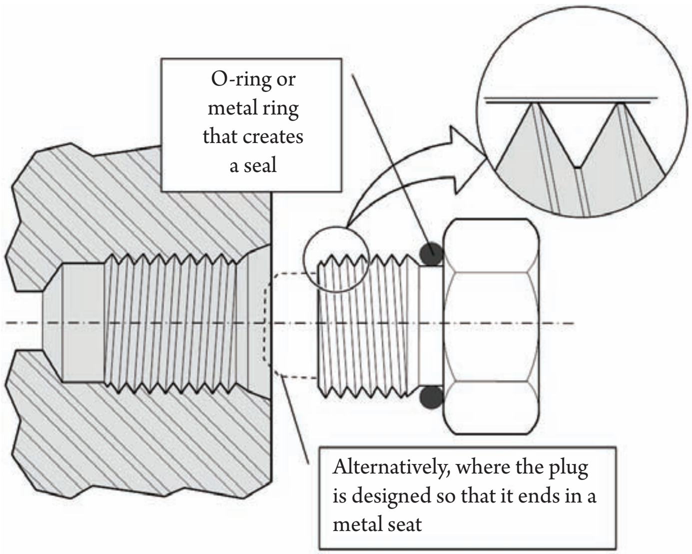


When removing plugs with tapered threads, it is difficult to control when the plug loses contact with the threads and can be shot out. The sealant will also be destroyed by unscrewing, so that it will not be possible to achieve sealing again if it is discovered that the valve seats, for example, are not tight. Therefore, plugs with tapered threads should not be unscrewed when they are pressurized. Regardless, always ensure that no person is in front of a plug when it is unscrewed.

Parallel threads

For parallel threads, the gap between the threads is too large to be filled up and provide a full pressure seal. For parallel threads, therefore, sealing must be obtained somewhere other than in the threaded surface. A gasket is normally used. Alternatively, the plug can have a tip that ends in a metal seat.

Unscrewing parallel threads will result in immediate leakage, but is nevertheless poorly suited as a means to bleed off pressure. Therefore, plugs with parallel threads should not be unscrewed when they are pressurized. Regardless, always ensure that no person is in front of a plug when it is unscrewed.



Threaded bleed-off plugs

There are many different designs of bleed-off valves that allow controlled release of pressure, while also allowing satisfactory sealing to be obtained again at any time. All these plugs have an outer portion with parallel or tapered threads that are screwed into the valve. This section must always be static. Inside this there is a new element that is used to bleed off pressure. This can either be operated by a threaded arrangement directly, or it may require a special tool to be able to loosen a spring-loaded sealing body. Some bleed-off plugs must be opened by screwing to the right, while others must be turned to the left to open.

It is extremely important to find the proper procedure for the plug in question and to follow it.

Whatever the design, it must always be ensured that the bleed-off plug's outer part is locked in the valve with lock-tight fluid or a locking bolt. During bleed-off, it is important not to use excessive force without a counterbalance on the outer part of the plug.

2. General Principles

Design criteria

All valves are designed to control pressure forces, flow and different fluids.

A perfect valve would handle all this without wear. But in a commercial world, we have ended up with different valve types with prioritized properties on the basis of function and operating parameters. For example, a soft seated ball valve can function well as an on/off-valve in a clean fluid, where it is not operated with a differential pressure.

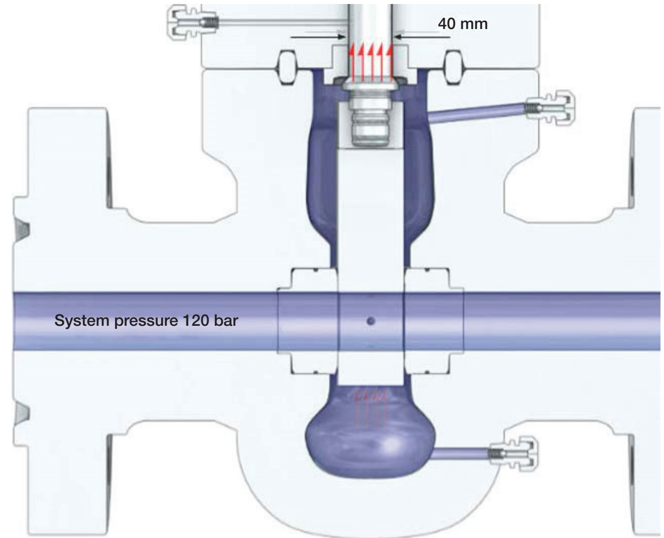
Under other conditions, the same valve would be far less robust. Therefore, it is important to know each valve's characteristics and peculiarities and to be able to evaluate them with respect to the function the valve must serve.

Pressure forces

All valves are affected by the pressure forces in the system and they are designed for a given pressure rating – the maximum permitted working pressure.
The system pressure is expressed in bar or PSI. Pressure acts across a surface and produces force.
A 40 mm stem on a 4" gate valve at 120 bar must be closed.

This means that a gate valve with rising stem is quite heavy to close, but correspondingly easy to open. An 8" valve has a differential pressure of 60 bar.

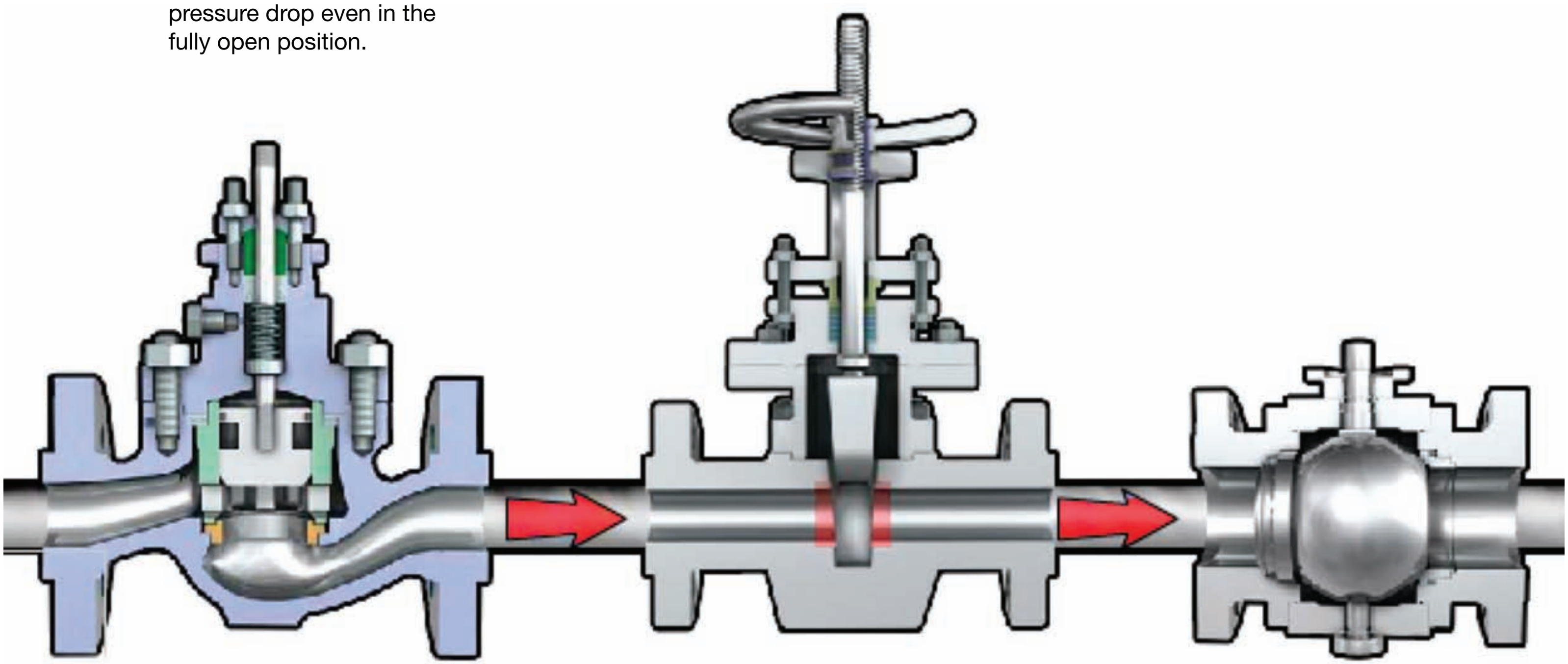
With a fluid's system pressure, the sealing force is equivalent to the weight of a large truck.



Control valve
The pressure drop generates noise, the valve causes a pressure drop even in the fully open position.

Wedge gate
Turbulence in a body.

Soft seated ball valve
Tearing out of seats in partially open position.

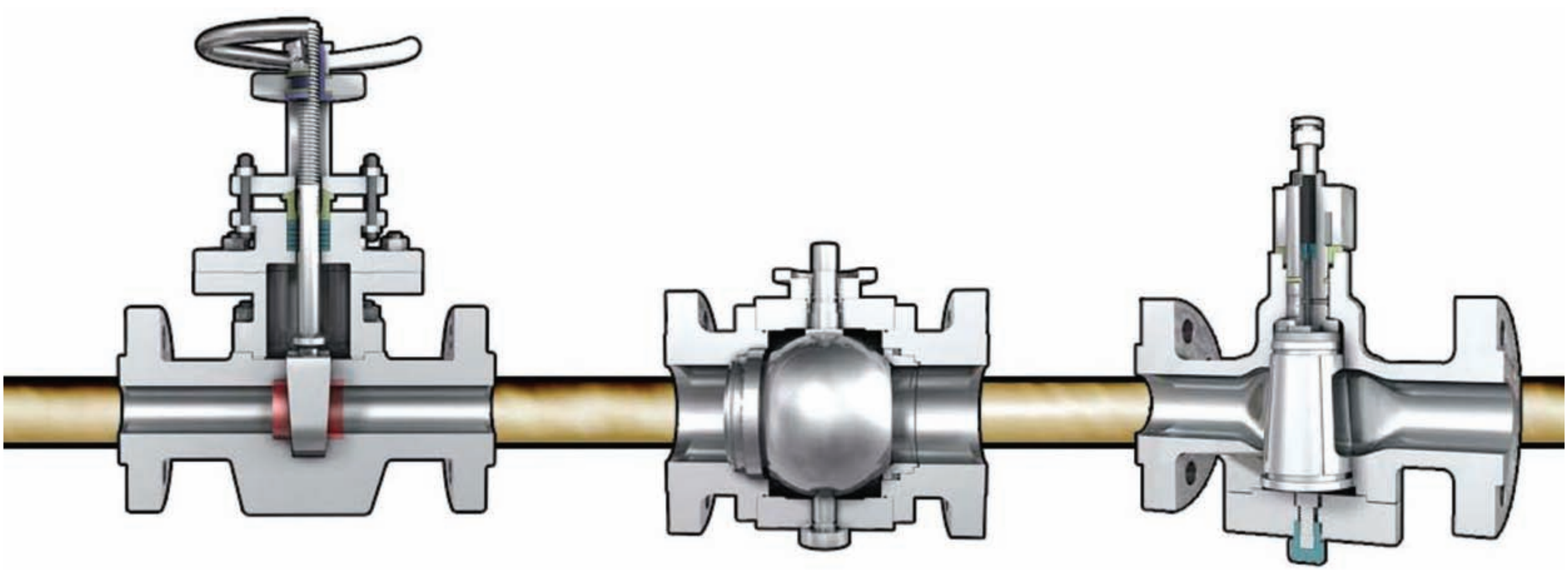


This is a line with an open wedge gate, a control valve and a soft seated ball valve.
Gas passes through the line at high speed.
Important characteristics or challenges are described for each type of valve.

Wedge gate
Precipitation of foreign bodies can prevent complete closure, large seal surfaces provide resistance to abrasion.

Ball valve
Poor methanol resistance in O-rings, deposits can prevent seat movement.

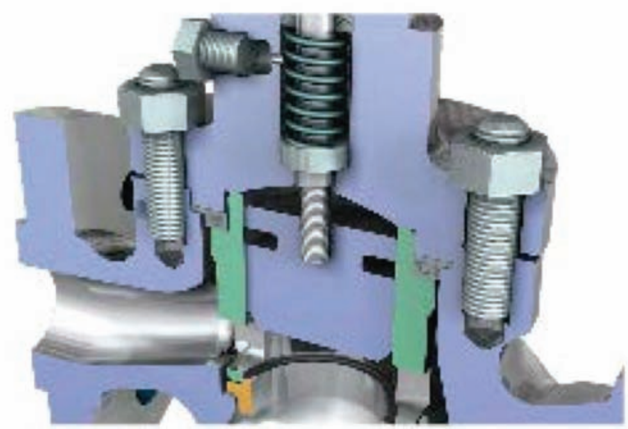
Plug valve
Large seal surfaces provide resistance to abrasion from foreign bodies.



This is a line with an open wedge gate, a plug valve and a soft seated ball valve.
A dirty well stream flows through a line which has been given a methanol injection to prevent hydrate formation.
Important characteristics or challenges are described for each type of valve.

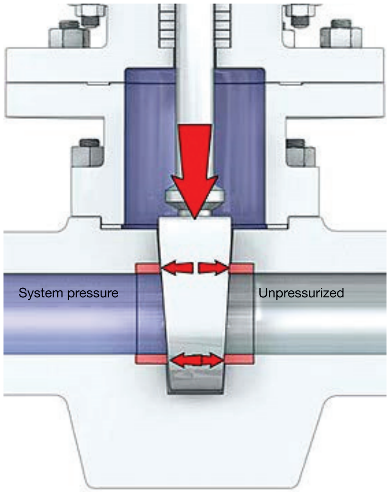
Sealing mechanisms

Various types of valves are designed to use and control the pressure forces in certain ways. These properties affect the possibility to operate the valve and the size of any actuator.

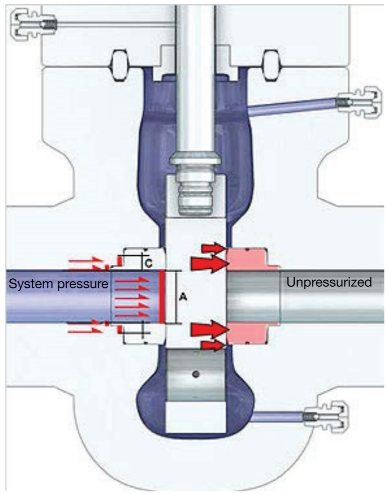


Mechanical versus pressure-induced

A wedge gate valve has both a mechanical force component and a pressure component.

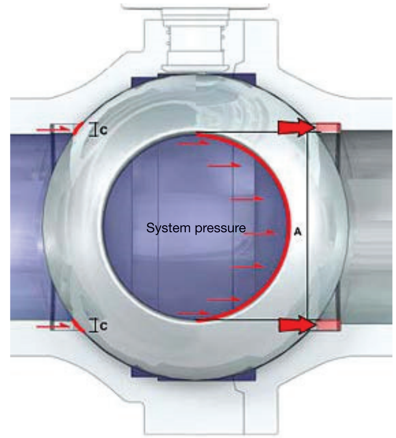


A solid gate valve with fixed seats has pressure forces that are absorbed by the downstream seat.

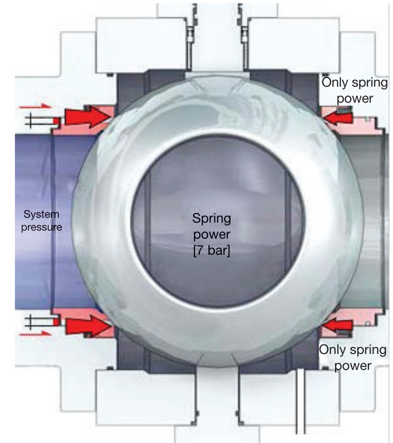


Supported versus floating

For a floating ball with fixed seat, the pressure forces on the ball will be absorbed by the downstream seat.

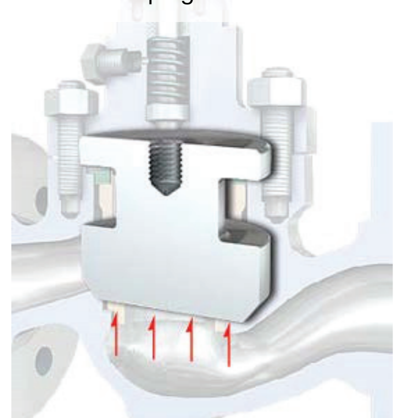


On a mounted ball valve, only the pressure forces on the seat provide sealing force. Pressure force on the ball is absorbed by the housing around the stem and therefore does not affect the seal.

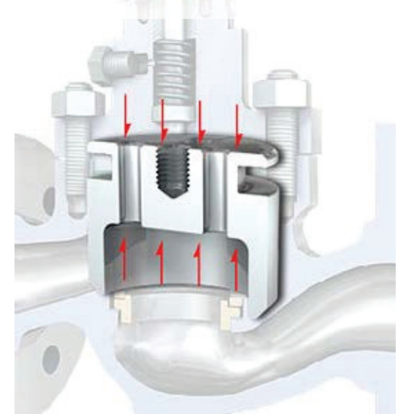


Balanced versus unbalanced

In our example, mechanical force and pressure will give a negative contribution on a globe valve with unbalanced plug.



A balanced globe valve has the same pressure above and below the plug and a sealing cage, which provides only mechanical sealing force.



Hard versus soft seals

The quality of the seal surfaces that meet is critical for achieving the required seal.

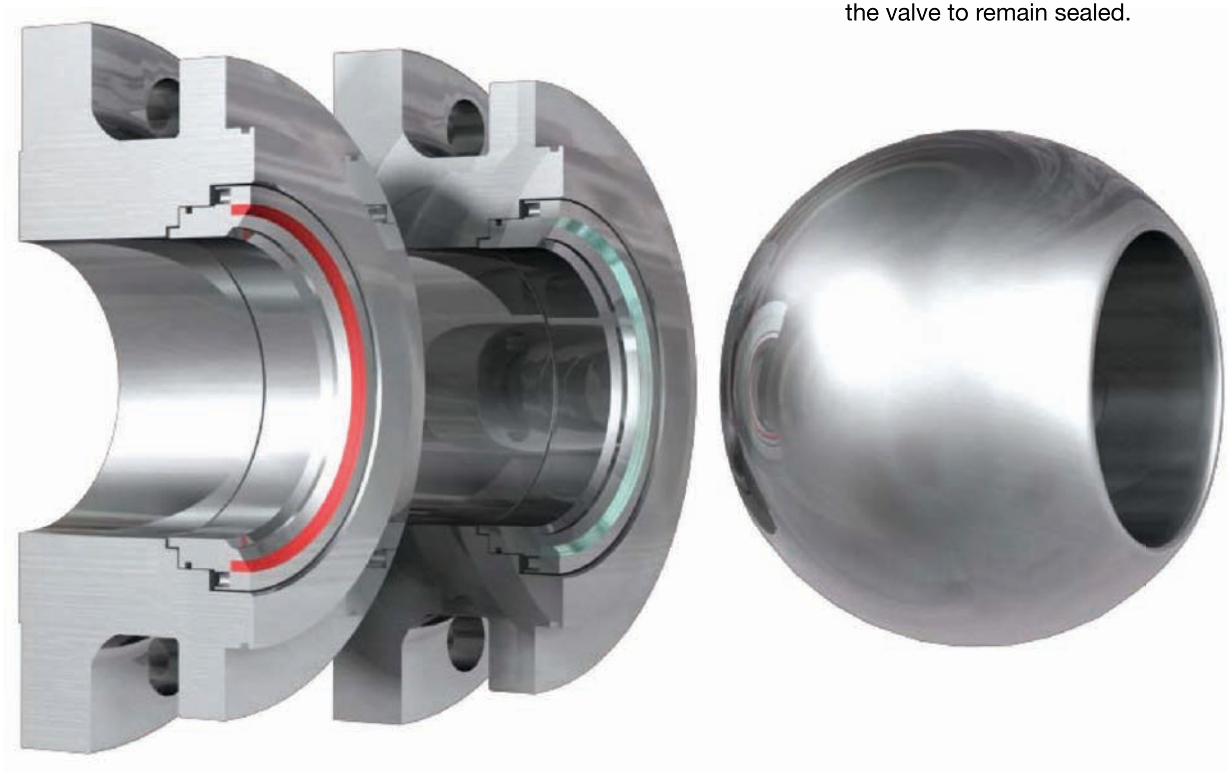
These surfaces are often comprised of hard metal or of polymers, plastic compounds which may be hard or soft.

Tungsten carbide is widely used for metal seats, while Peek is common for hard polymers. PTFE is often used as soft polymer.

Hard seals withstand greater forces and wear than soft seals, but in order to form a seal, they are more difficult to fabricate.

Metal seals are often used in valves which must withstand being operated with high pressure differential and/or high temperature.

On certain ball valves with metal-to-metal seals, each seat is adapted to each side of the ball. The ball must then be mounted so that the correct side of the ball meets the right seat in order for the valve to remain sealed.



O-ring versus lip seal

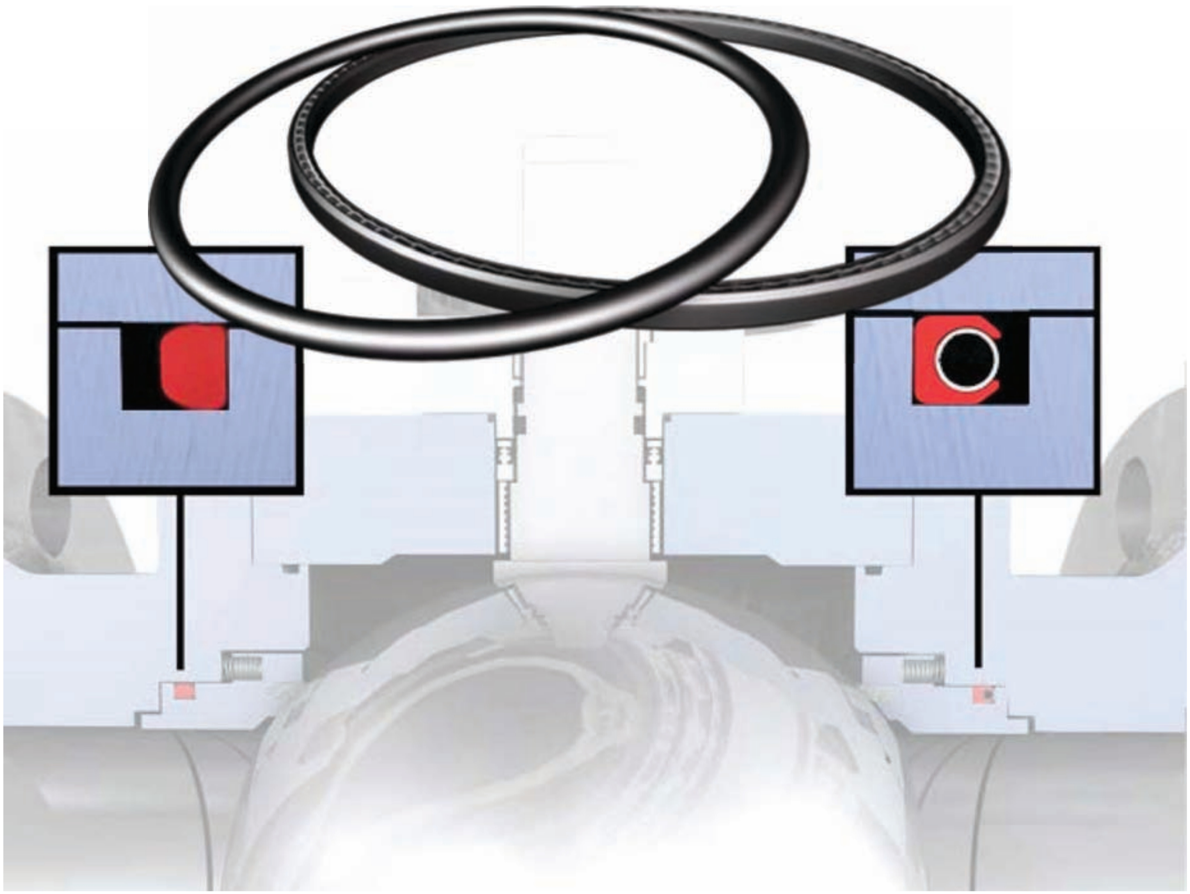
In valves with a floating seat, a seal must be established between the seat and the valve housing.

Normally, this is achieved with O-rings or lip seals. In addition, a secondary seal of graphite or metal can be used to satisfy any fire requirements.

The lip seal has better chemical durability and aging properties than the O-ring.

The O-ring has lower fabrication costs and better availability than a lip seal.

Today, lip seals are increasingly used for hydrocarbons in gaseous form, particularly in flows which may contain methanol. This is because O-rings can have problems with absorbing gas, which then expands during rapid depressurization and results in cracked rings. This is also referred to as explosive gas decompression.



One of the Offshore Norge goals is to prevent hydrocarbon emissions. The areas described here have the highest leakage risk for valves.

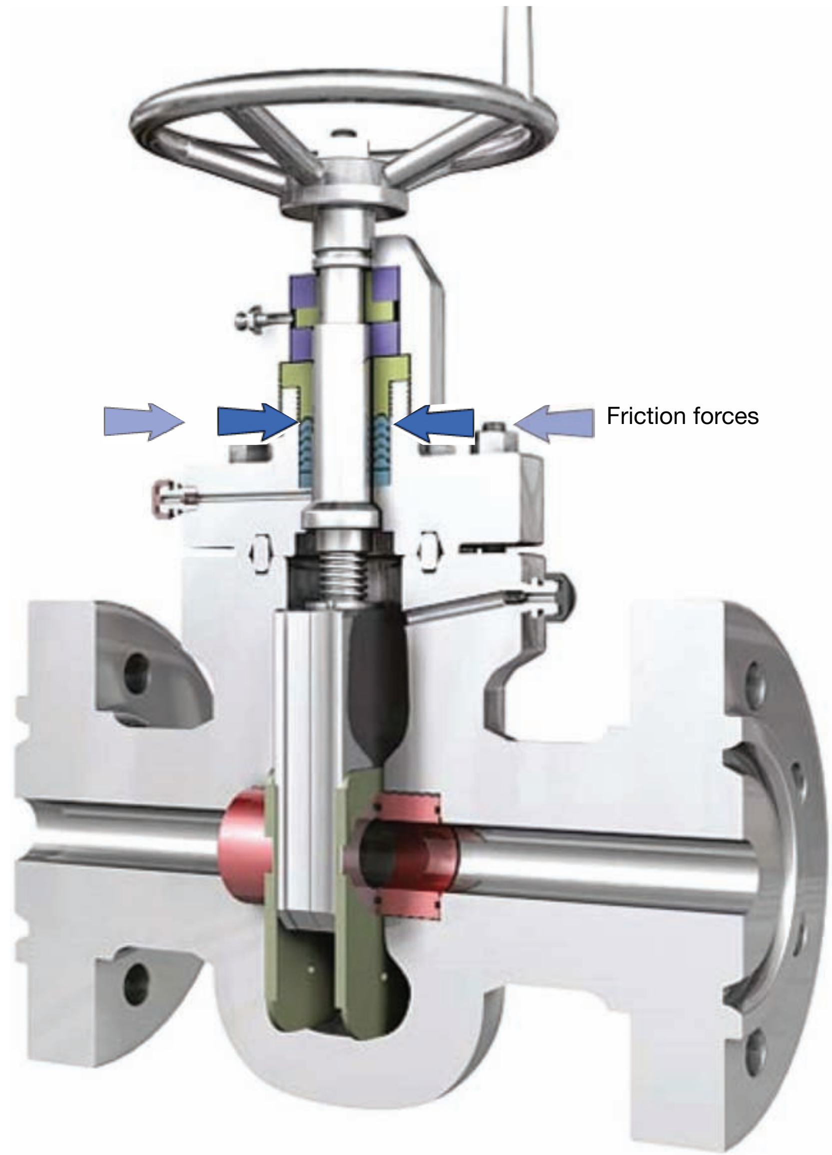
Stem sealing

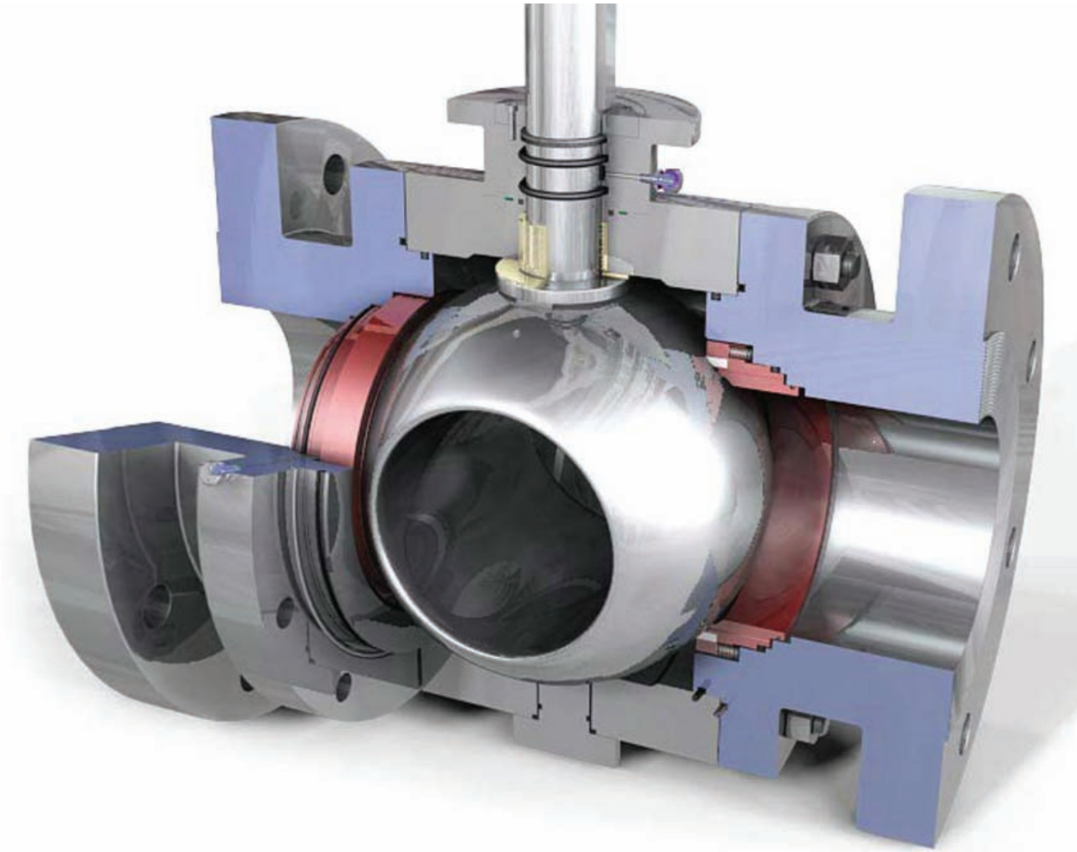
Most hydrocarbon leaks associated with valves can be linked to the stem seal. It is important to follow the relevant procedures when assembling and tightening the stuffing box.
The procedures consist of specially adapted materials, construction and pressure ratings.

Valves can have “rising, rotating”, “rising, non-rotating” or “stationary, rotating” stems.

The stem seal must be designed to withstand the movement it is exposed to during normal operation of the valve.

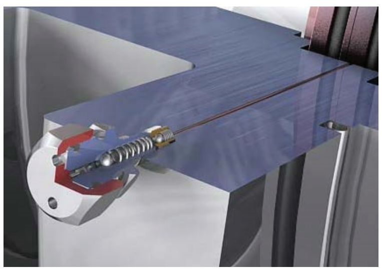
It is also important that the frictional forces are kept as constant as possible throughout the lifetime of the valve. An actuator, for example, is designed for a given level of stuffing box friction. Excessive friction in a stuffing box can, in a worst case, result in the valve not working as intended.





Thread connection

Threaded connections are usually used for blind plugs, injection nipples and instrumentation. Such connections may be directly connected with the system pressure in the line and are therefore associated with the consequent risk of leakage.



So how should a threaded connection be assembled properly?

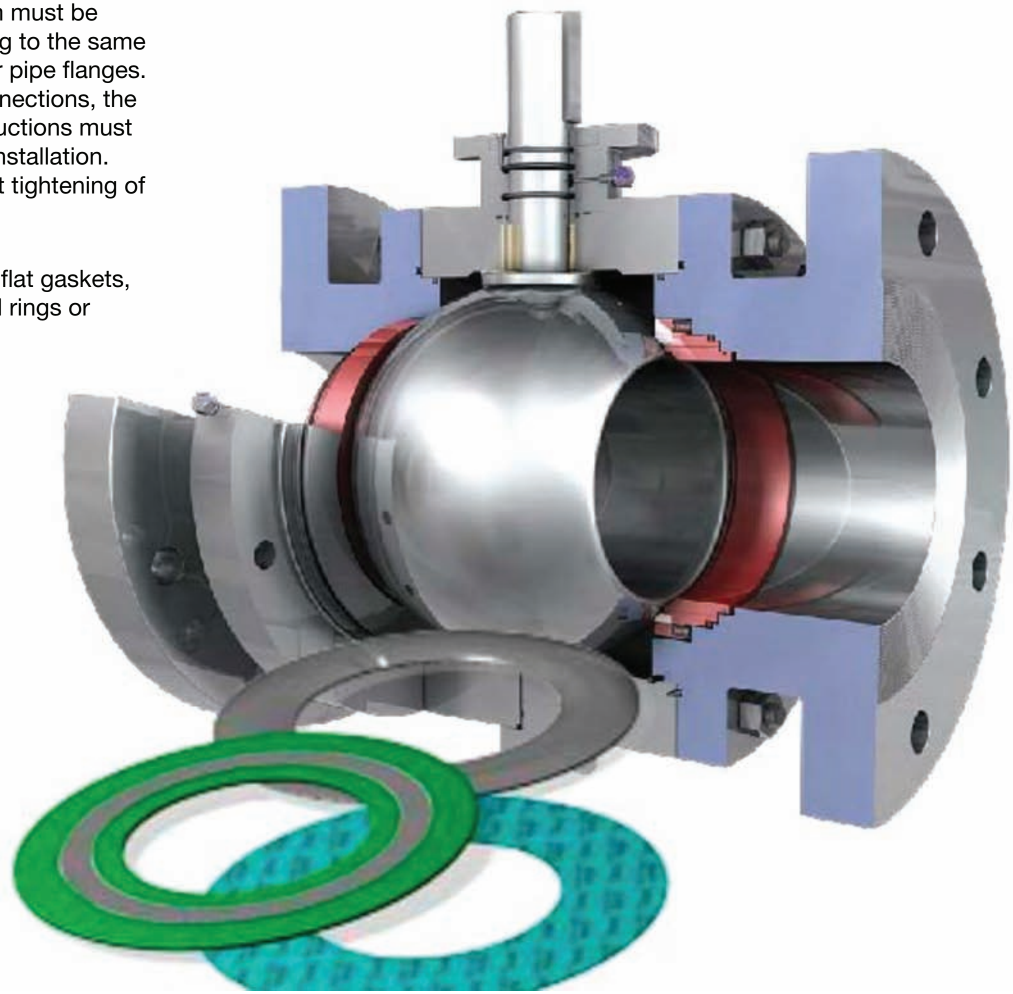
For connections with tapered threads (NPT), the thread lubrication and sealing must be achieved by using the installation's specified lock-tight fluid.

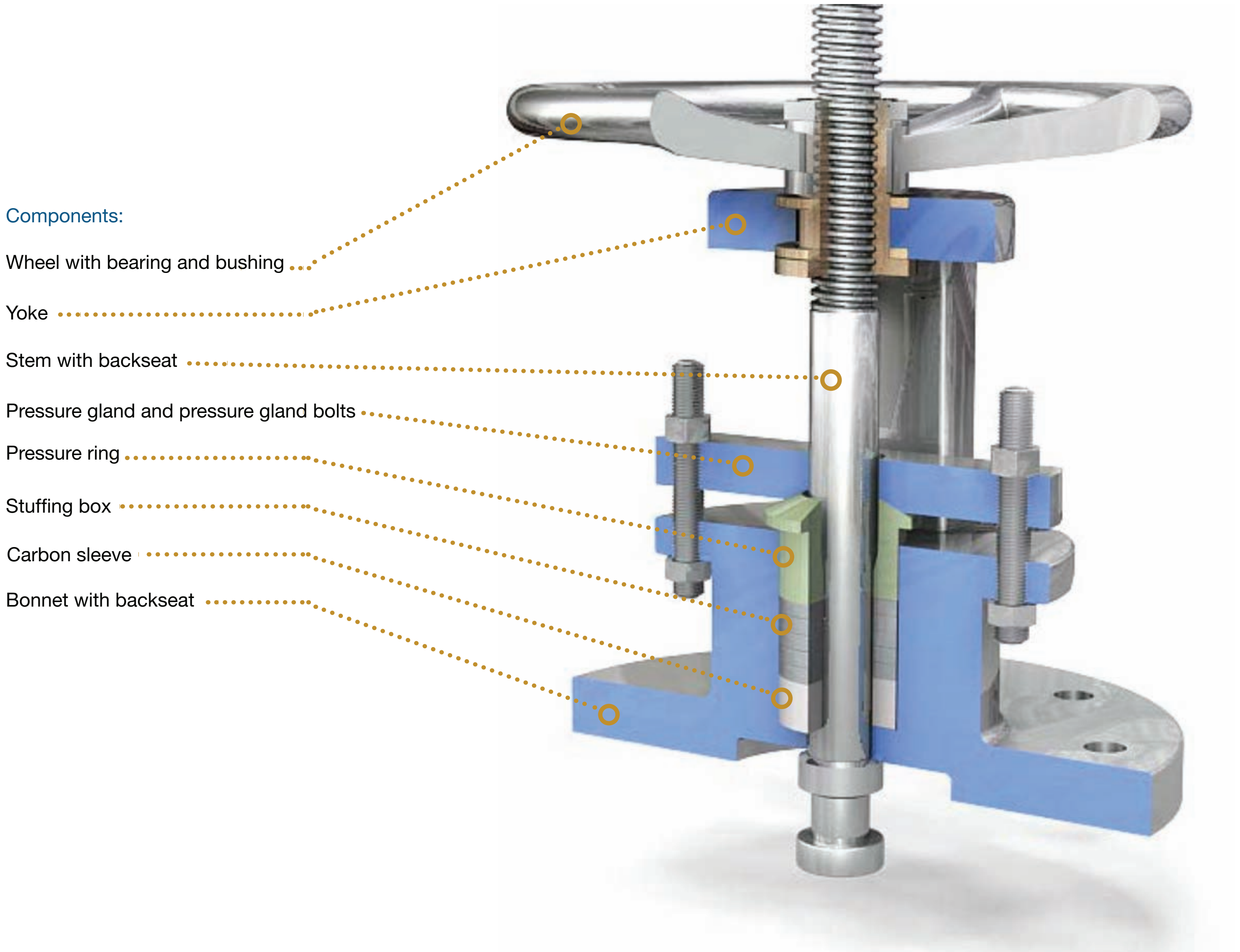
For connections with parallel threads, sealing must be achieved with a separate metal seat or sealing ring. These connections must be locked with a locking pin, or by using the lock-tight fluid specified for the installation.

Flange gaskets

The valve's flange connections with the pipe system must be assembled according to the same guidelines as regular pipe flanges. For other flange connections, the manufacturer's instructions must be followed during installation. This includes correct tightening of the bolts.

It is common to use flat gaskets, spiral gaskets, metal rings or O-rings.

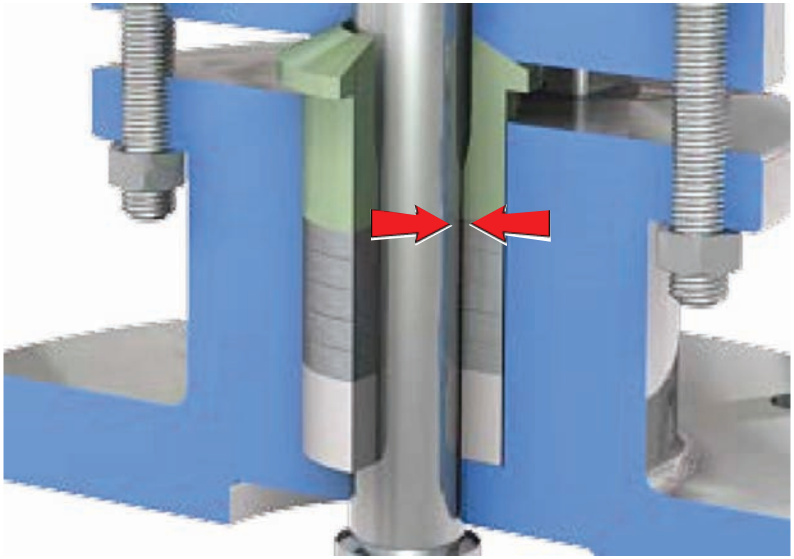



Components:
Wheel with bearing and bushing
Yoke
Stem with backseat
Pressure gland and pressure gland bolts
Pressure ring
Stuffing box
Carbon sleeve
Bonnet with backseat

Stuffing box

The role of the stuffing box is to form a seal between the bonnet and the stem and to prevent any leakage through the gasket rings. There are a number of alternative stuffing boxes used on these type of valve tops.

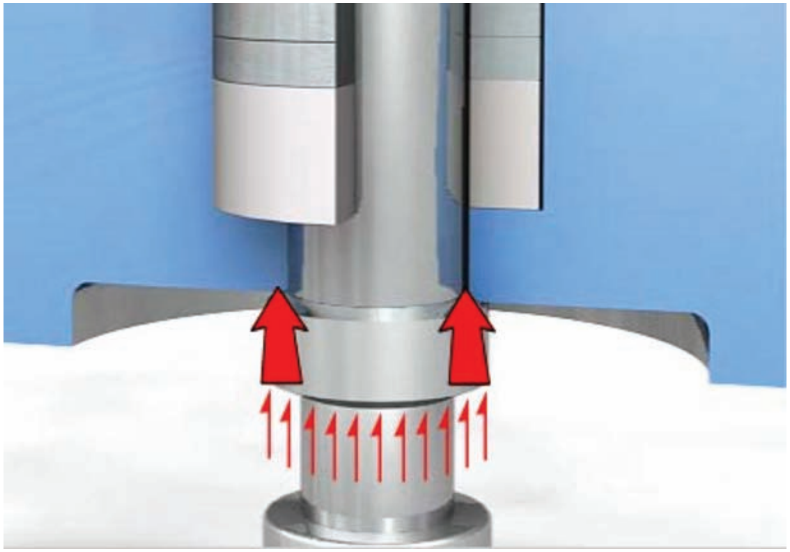
The type shown in the figure is low density braided graphite with 5 sealing rings. It is recommended to use 4 - 7 sealing rings in graphite stuffing boxes. In this example, a carbon sleeve has been inserted at the bottom, adapted to fill in the extra distance beyond 5 rings.



Backseat

The backseat is a mechanical seal drawn up with the wheel, which is achieved by the stem being pressed fully up. In addition, the pressure in the valve housing helps to further increase the sealing force.

It is important to note that this is an extra safety feature in the valve that can be used to stop any stem leakage until necessary maintenance can be performed.



Valve data sheet

VDS stands for valve data sheet. The data sheet, drawings and numbering will have different formats depending on which company you work for, but it is important that you can locate and understand these documents. The following are some examples of VDS numbers according to NORSOK and with explanations.

GTFC40C

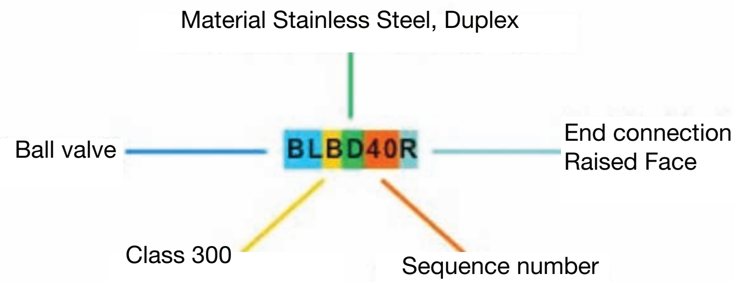
Gate valve
ASME-class 1500
Strong carbon steel
Clamp connection

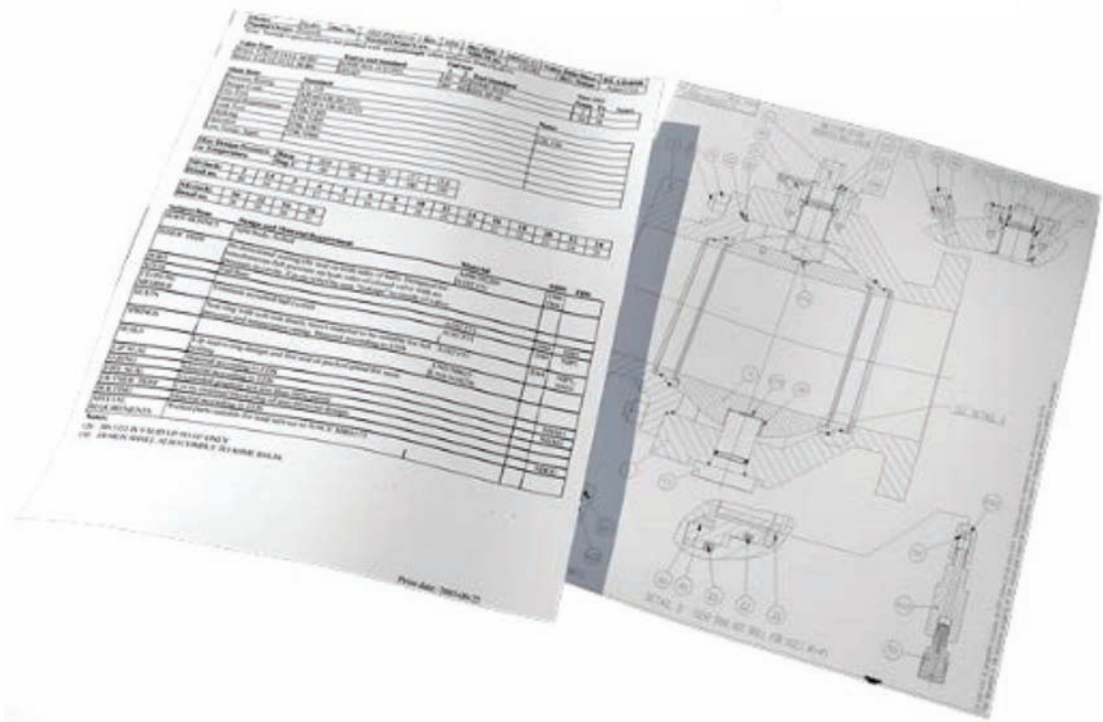
BLBD40R

Ball valve
ASME-class 300
Stainless steel, DUPLEX
Raised face-flange

PGES40J

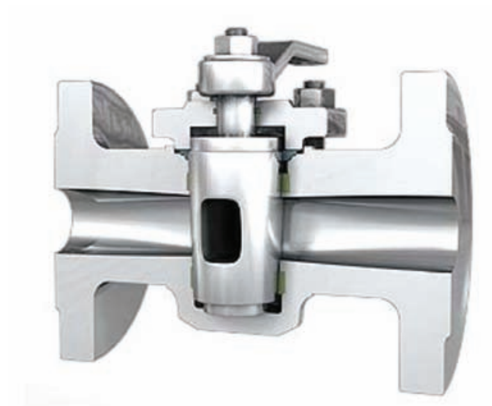
Plug valve
Class 900
Austenitic stainless steel type 316
Ring type joint flange



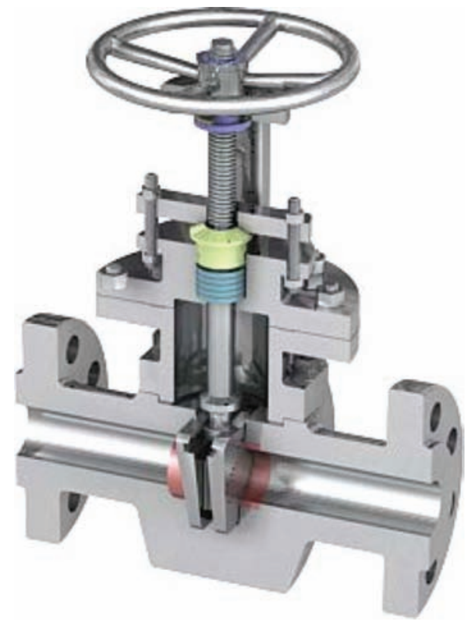


3. Valve Operation

Wheels and handles should always be marked with the direction for opening and closing.



Valves with levers must always be closed when the lever is perpendicular to the pipe.



A valve should always be closed by turning clockwise. On normally operated valves, the stem will go down to close.
If the valve is reverse operated, the stem will go up to close.

If it is not possible to operate the valve by normal operation, this is often a symptom that something is wrong with the valve.

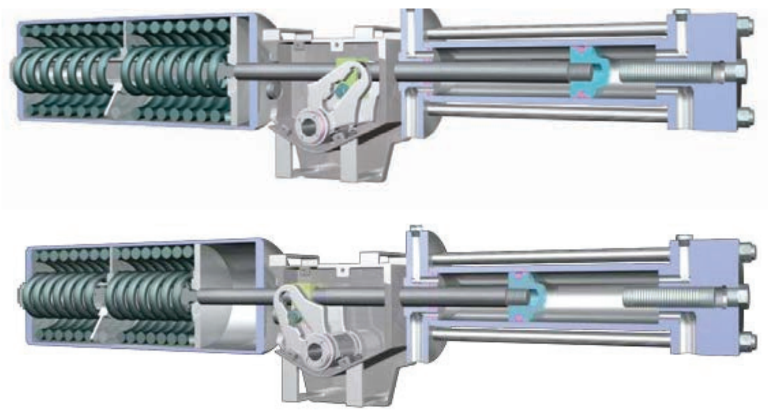
This may be due to high pressure differential, locked-in pressure in the valve housing or over-pressure in the stuffing box.

Other causes may be inadequate lubrication, jamming or corrosion.

Excessive force should not be applied! Corrective maintenance must be initiated to avoid incidents that could result in leakage.

General

All actuators are adapted to be able to operate a given valve at defined operating parameters. Actuators and gears must always be adjusted according to the valve's normal operating mode. It is especially important that the end positions are adjusted correctly. Hydraulic and pneumatic actuators should be able to operate the valve safely at the lowest instrument pressure, while not damaging the valve if it is operated at maximum instrument pressure.

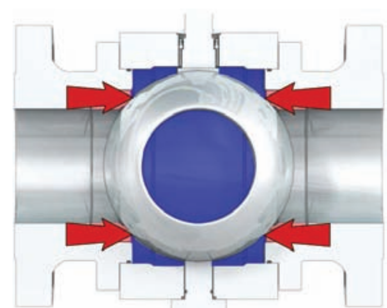


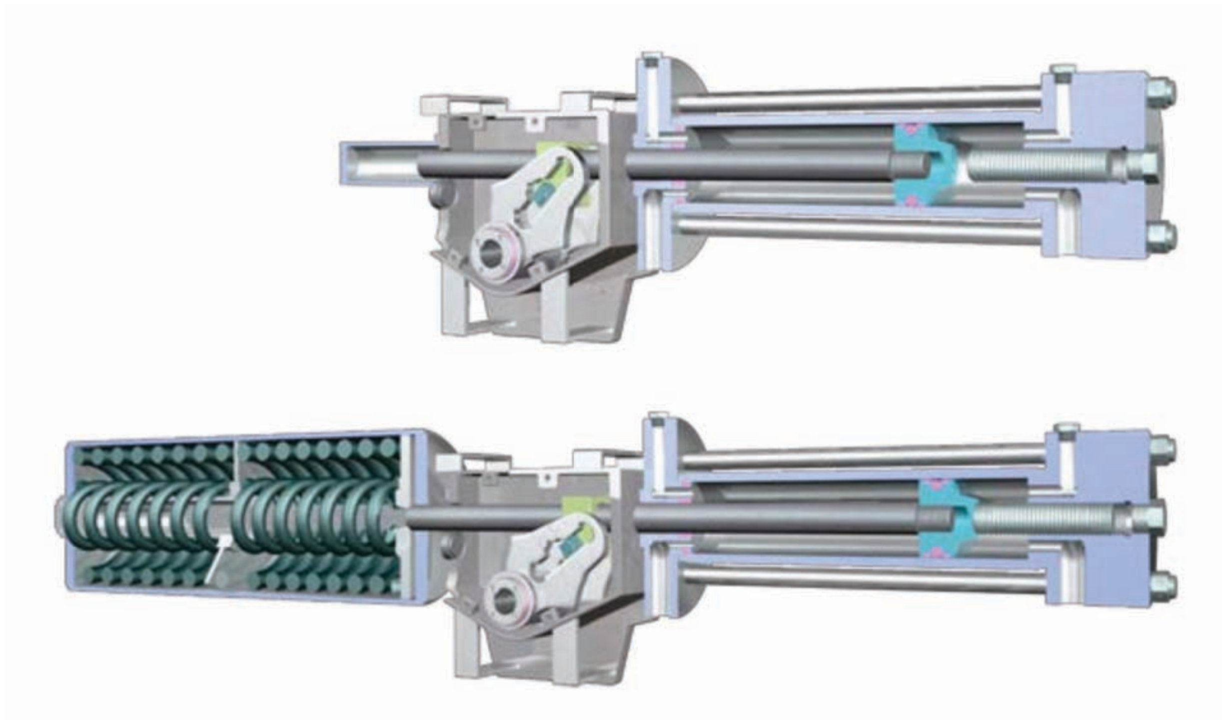
Lack of maintenance and infrequent usage can make the valve far heavier to operate. The actuator is usually designed to operate the valve under normal operating conditions. Requirements for oversizing of the actuator are common in order to increase the reliability of both the valve and the actuator.

When a valve cannot be operated, there are several possible sources of malfunction. It is therefore important to carefully study the valve's mode of operation when investigating a malfunction. It is also important that the operation force is not increased to force the operation of the valve.

The pressure regime in the valve can be a source of malfunction in terms of a lack of pressure or pressure lock.

Other possible sources of malfunction may be the formation of deposits in the valve, a fault in the hydraulic system, internal corrosion in the actuator cylinder or a defective spring.





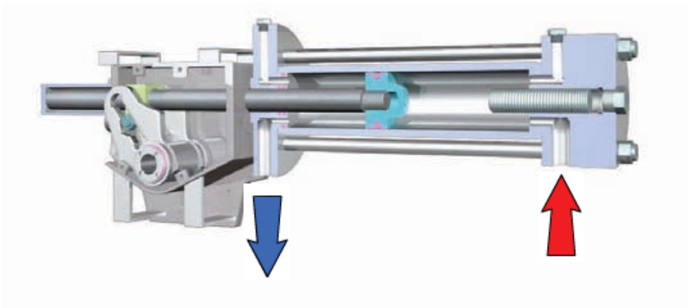
The majority of 90 degree-operated actuators turn about 100 degrees in order to align the correct rotation in the fully open and fully closed position.

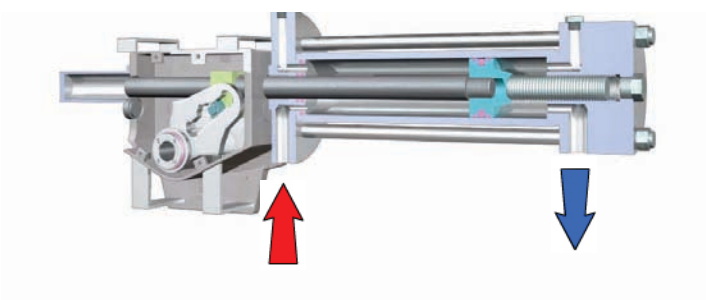
The end-stops on the actuator ensure the correct start and stop position. If the movement is too short or too long, the valve may be exposed to flow wear in the open position and it may then begin to leak when closed.

Hydraulic double-acting in 90 degrees

Hydraulic double-acting actuators can be pressurized on both sides.

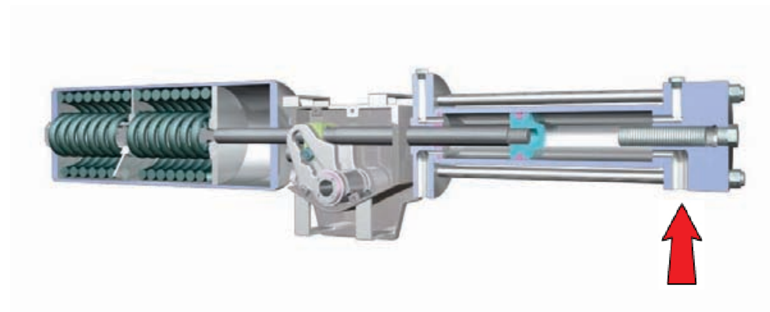
The vent on the actuator must not be clogged. This prevents the feature from functioning.





Single-acting with spring return

When using valves as barriers during downstream maintenance work, it is important to safeguard against inadvertent valve operation.



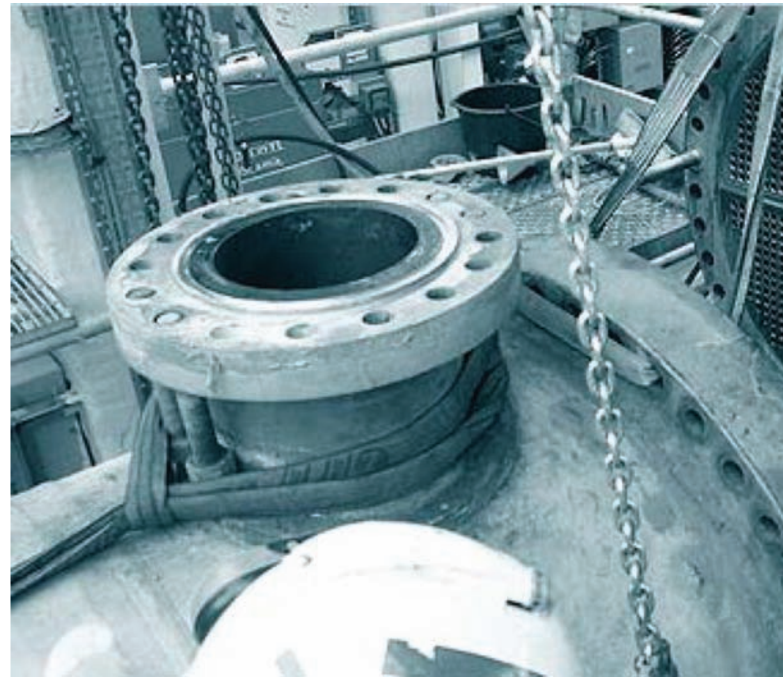
On certain valves that are critical for safety, there is a backup system to ensure that the valve can be opened and closed a certain number of times. For safety-critical maintenance operations, the hydraulic system, including the backup system, must be disconnected and have a drainage point against the actuator. This is done to prevent pressure buildup in the hydraulic system that could cause undesired valve operation.

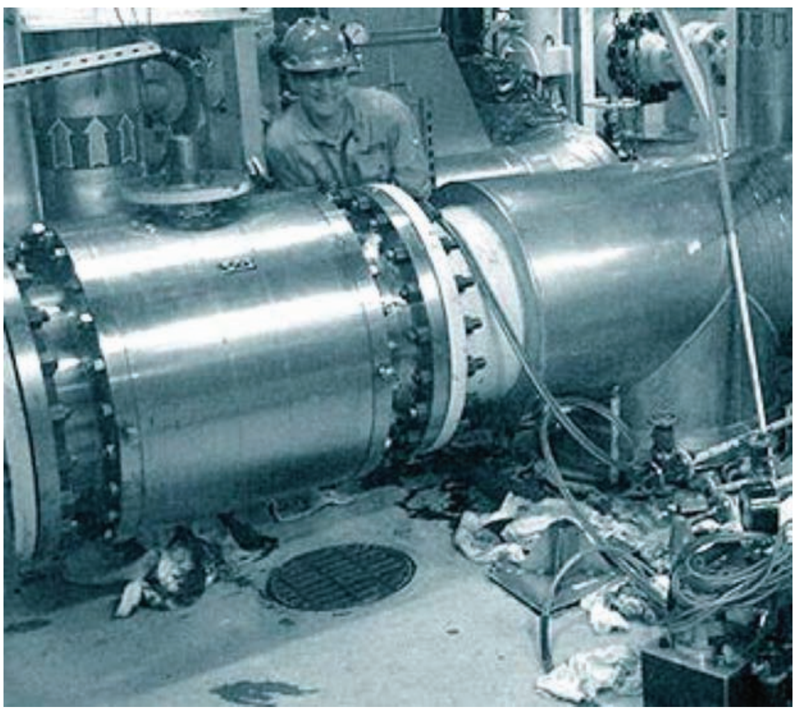
Unintentional valve operation can also occur as a result of pneumatic leakage or internal leakage. For actuators with spring return, it is important that safety-critical maintenance operations are only carried out in a position where the spring is not tense.

Hazards

When using valves as barriers during downstream maintenance work, it is important to safeguard against inadvertent valve operation. On certain valves that are critical for safety, there is a backup system to ensure that the valve can be opened and closed a certain number of times.

For safety-critical maintenance operations, the hydraulic system, including the backup system, must be disconnected and have a drainage point against the actuator.





This is done to prevent pressure buildup in the hydraulic system that could cause undesired valve operation.

Unintentional valve operation can also occur as a result of pneumatic leakage or internal leakage.

For actuators with spring return, it is important that safety-critical maintenance operations are only carried out in a position where the spring is not tense.

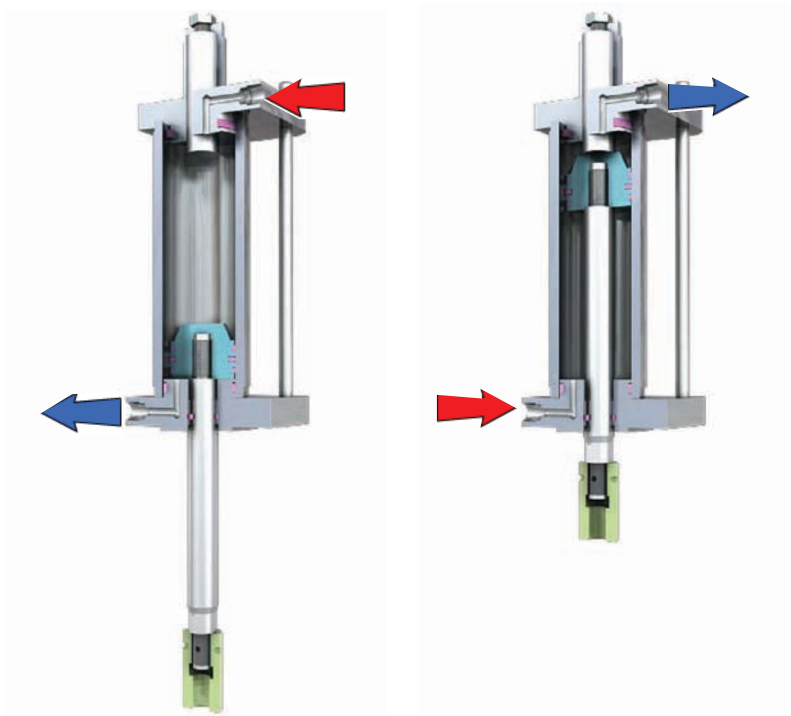
Linear

The movement on linear actuators can vary between valve types of the same dimension.

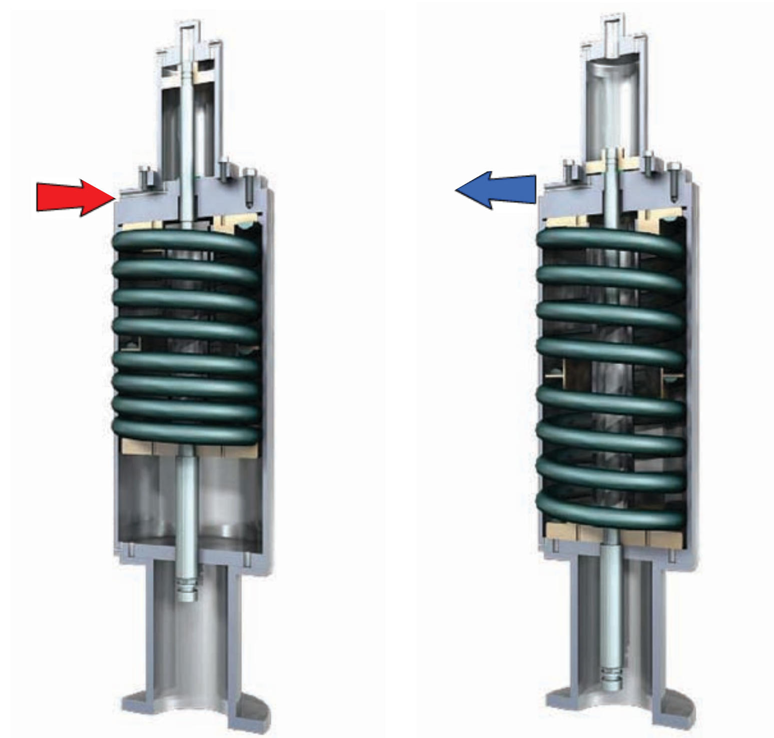
It is important that the valves are in the correct open position, and the hole in the gate must be flush with the flow. In the closed position, some valves are dependent on expanding and therefore require slightly longer movement. This type stops for a given force.

Other valves, such as slab valves, must stop before the gate meets the bottom of the valve housing. These must stop at a given point.

Hydraulic double-acting linear

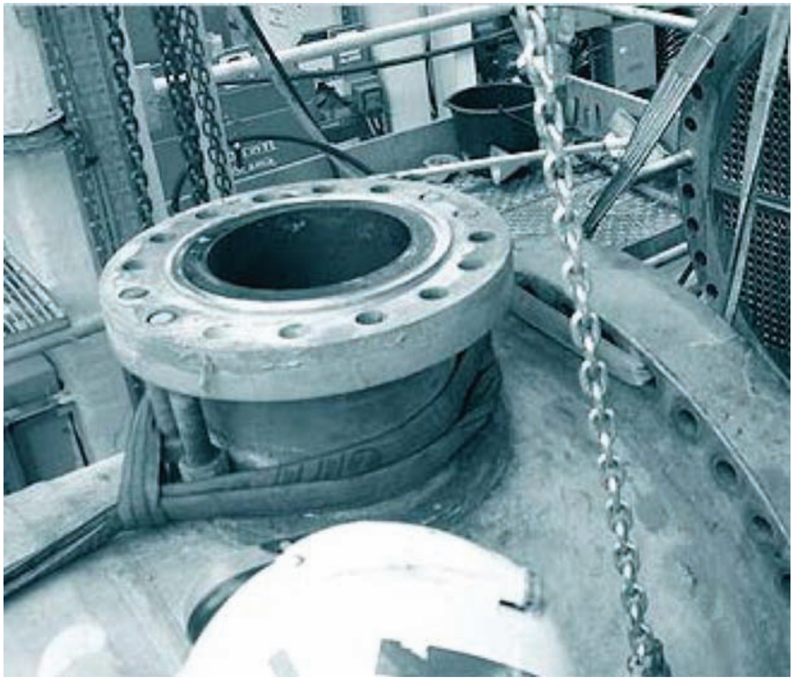


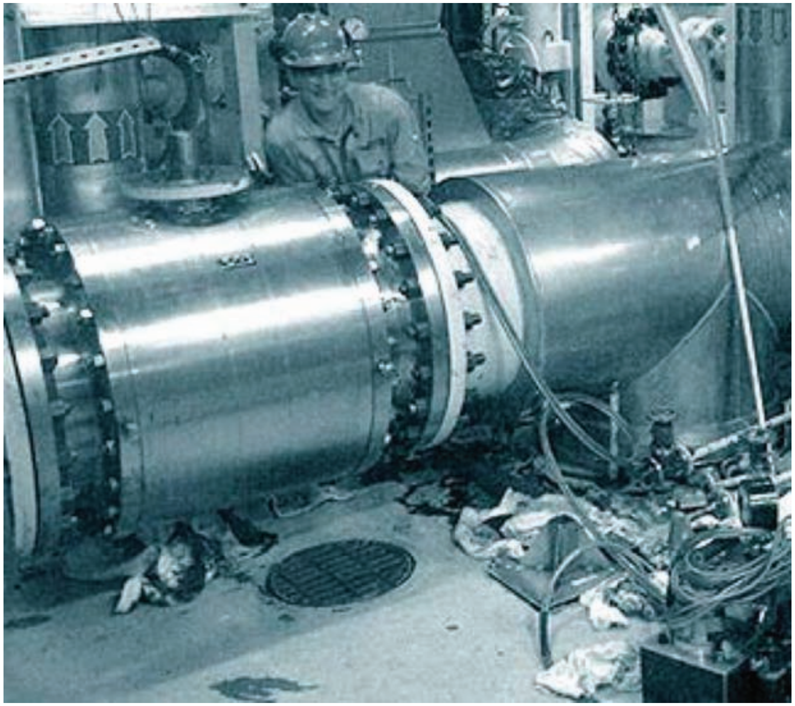
Hydraulic linear with spring return



Hazards

When working downstream, the same hazards exists as for 90 degree operated valves. When using linear actuators, there is a particular risk of inadvertent valve operation caused by the gate's dead weight.



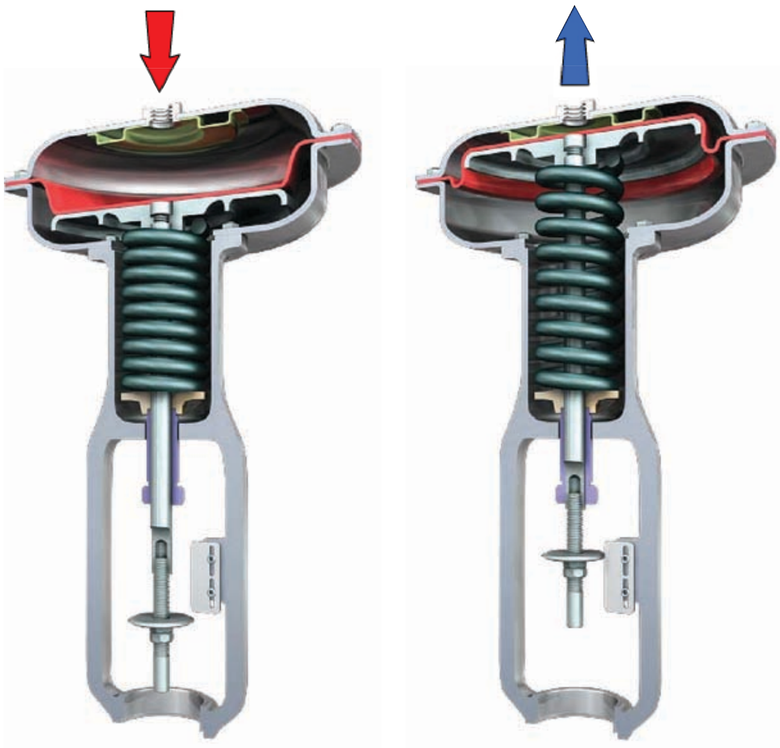


When pressure is not acting on both sides of the piston, there is a danger that the force of gravity will operate the valve in a depressurized system.

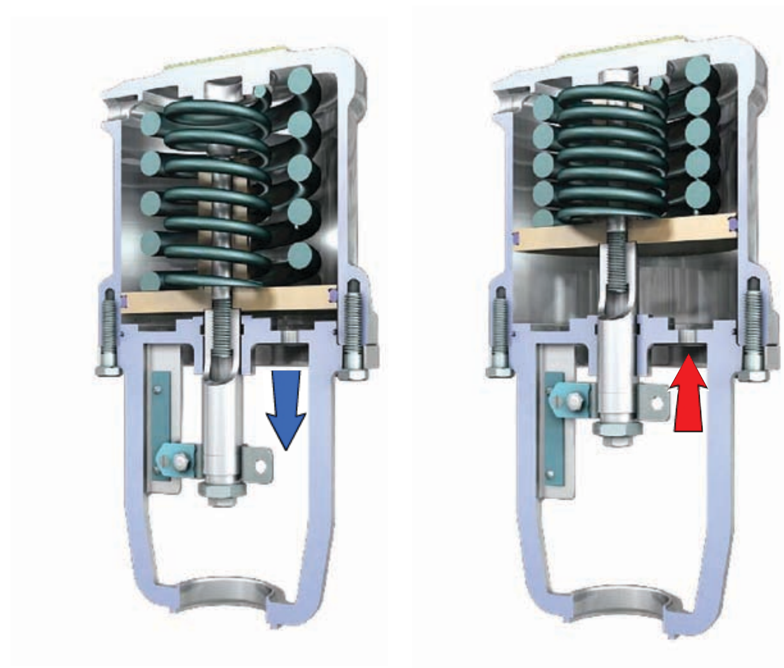
Use locking plates if you are unsure about whether physics ensures the desired position on the valve. This also applies to pressure forces on the stem.

A control valve may be fail open or fail closed by applying pressure above or below the actuator's diaphragm or piston.

Pneumatic direct-acting with diaphragm



Pneumatic piston actuator with spring return (reverse acting)



Electric actuators are used for on/off valves that do not have a safety-critical function. They do not require supply tubes for hydraulic or air pressure and require little space. Maintenance of EX-fuses is important for these actuators.

General

Gears are used to reduce the power required to operate the valve.

The quality of the gear does not always correspond to the quality of the valve. Rust and drying out of gears often causes problems for valve operation.

It is recommended to perform regular maintenance in order to preserve the gears in good condition.

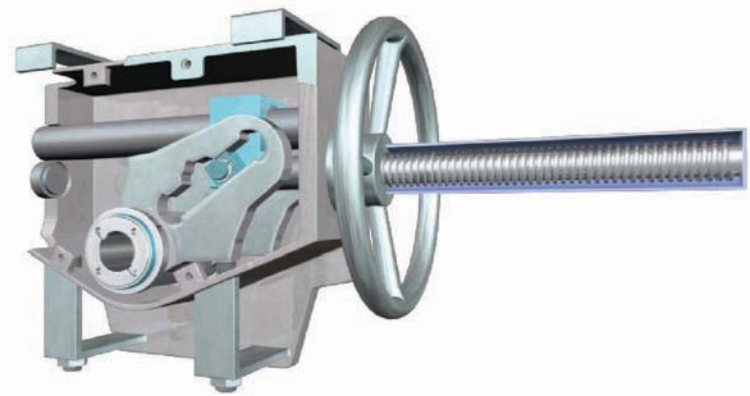
The following is an example of a procedure for aligning the end-stops on a ball valve with a floating seat:

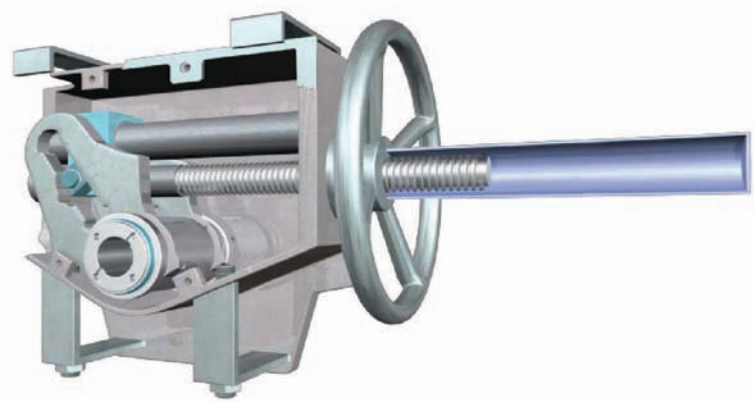
1. Unscrew the end-stops completely (open and closed).
2. Set the valve at closed.
3. Pressurize with N2 in the valve housing (approx. 3-7 bar).
4. Turn the valve past closed until it leaks.
5. Mark the point on the indicator and gear/actuator.
6. Turn the valve back and apply pressure in the valve housing again.
7. Turn the valve towards open until it leaks.
8. Mark the point on the gear/actuator.
9. Turn it back towards closed until the indicator mark is midway between the marks on the gear/actuator.
10. Align the closed end-stop.

The valve's alignment in the open position can be controlled at exactly 90 degrees of rotation using an angle.

The procedure can also be repeated in the open position if the valve does not have balance holes.

If the valve has a balance hole, the valve in the open position must be exactly 90 degrees from the closed position.





Karmøy winch should not be the first choice for valve operation. When it is used, it is important to be aware of the hazards.

- This applies particularly when valves move into the closed or open position.
- The final stage of the opening and closing process must always be performed by manual operation in order to avoid personal injury and damage to the valve.
- The winch must not be strapped on or left unattended during operation. This can cause significant personal injury or damage to equipment.
- If the Karmøy winch has adjustable torque, this should be used to reduce the force when necessary.

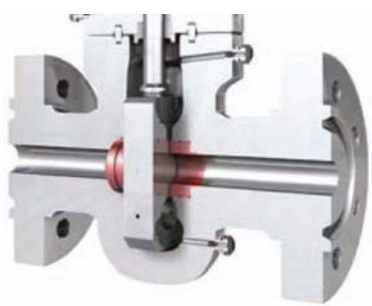
4. Gate Valves

Type
- A shut-off valve (on/off)
- Floating seats
- Normally operated
- Rising non-rotating stem

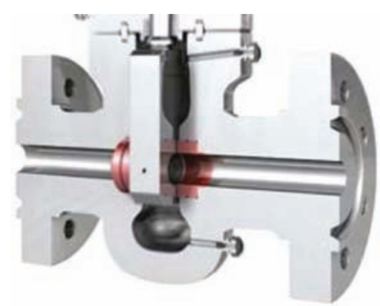
Operation
- Can be opened with differential pressure and closed during flow, when the seat and gate have a durable coating applied.
- Is not dependent on a given flow direction (bi-directional).

Seal
- The valve housing can be depressurized in order to obtain a double-action seal, where the valve then seals against both the upstream and downstream seat.

When the valve is closed, it is a good practice to turn the hand-wheel slightly towards the open position to prevent the gate locking at the bottom of the valve housing. The manufacturer's instructions should always be followed in this respect.

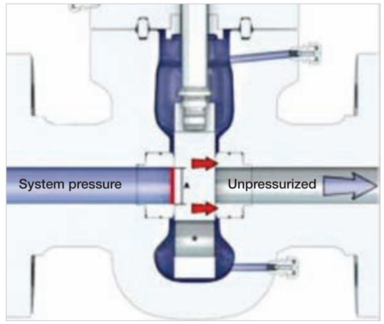


When the valve is fully opened, it is good practice to turn the hand-wheel slightly toward the closed position to prevent damage to the backseat. The manufacturer's instructions should always be followed in this respect.



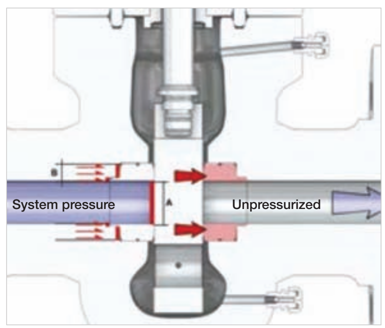
Single seal

The system pressure acts on the gate over area A and provides a force that presses the gate against the downstream seat so that the valve seals.



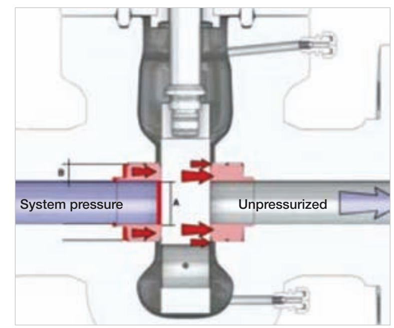
Double sealing

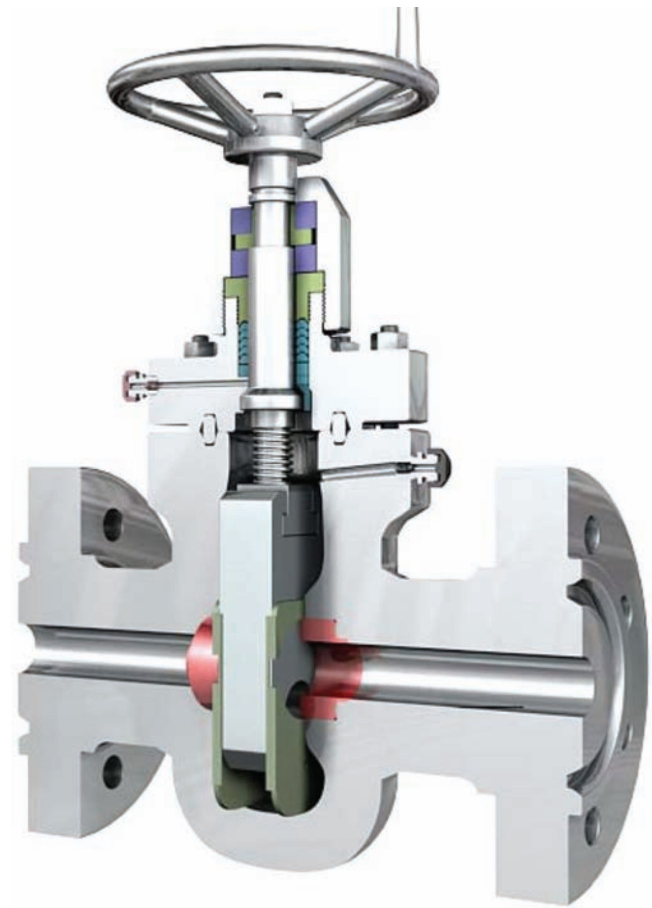
The pressure in the valve housing is now reduced to atmospheric pressure. For the downstream seat, the sealing force will be provided by the system pressure acting on the gate over area A, and the system pressure behind the upstream seat, area B.



For the upstream seat, the sealing force will be provided by the system pressure acting behind the upstream seat, area B.

Sealing is now established on both the upstream and downstream seat – a double seal.



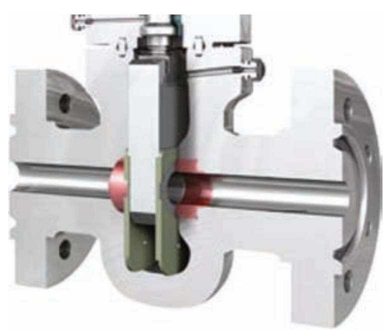


Type
- A shut-off valve (on/off)
- Floating seats
- Stationary rotating stem

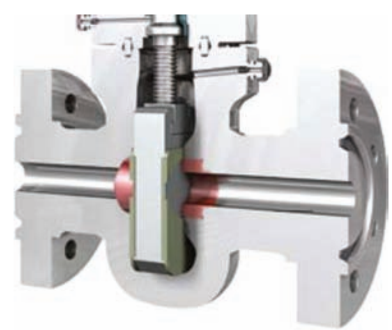
Operation
- Can be opened with differential pressure and closed during flow, when the seat and gate have a durable coating applied.
- Is not dependent on a given flow direction (bi-directional).

Seal
- The valve housing cannot be depressurized to create dual-action sealing.
- Seals only in the downstream seat

When the stem is operated to the upper end position, it is good practice to turn the hand-wheel back slightly to avoid any damage to the backseat. The manufacturer's instructions should always be followed in this respect.



When the valve is closed, it is a good practice to turn the hand-wheel slightly towards the open position to prevent the gate locking at the bottom of the valve housing. The manufacturer's instructions should always be followed in this respect.

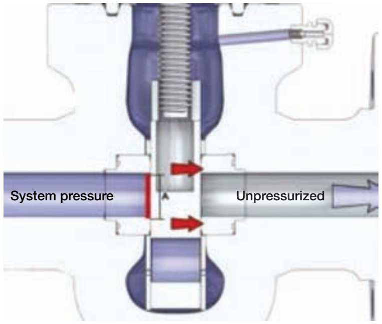


Single seal

The system pressure acts on the gate over area A and provides a force that presses the gate against the downstream seat so that the valve seals.

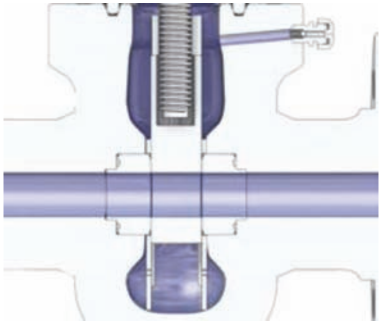
In addition, the system pressure will go in behind the upstream seat, area B, and push it against the gate.

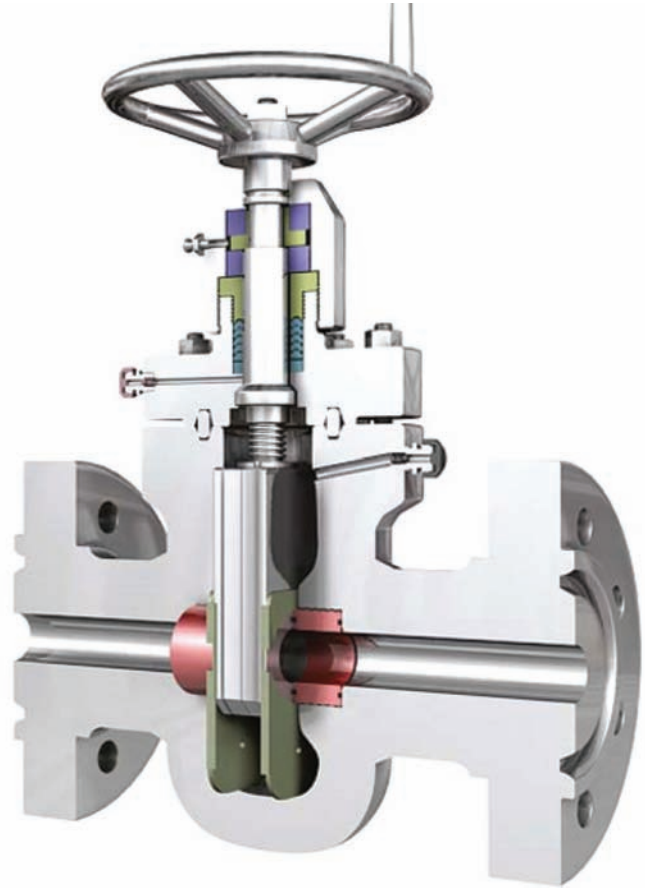
The pressure in the valve housing acts such that it is area C that provides additional sealing force on the downstream seat.



Double sealing

This valve alone cannot form a double seal because the valve housing cannot be depressurized due to location and operation of the soft seal.





Type
- A shut-off valve (on/off)
- Stationary rotating stem

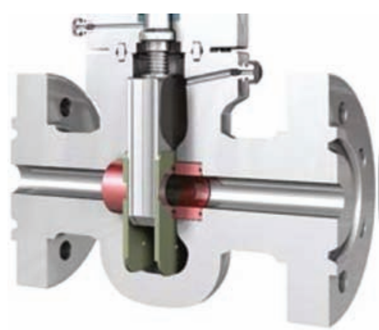
Operation
- Can be opened with differential pressure and closed during flow, when the seat and gate have a durable coating applied.
- Is not dependent on a given flow direction (bi-directional).

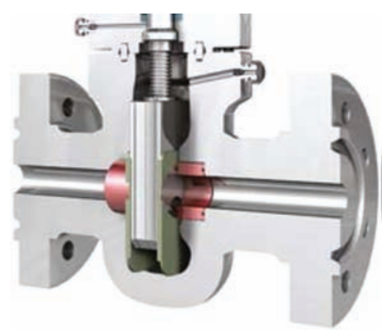
Seal
- Seals only on the downstream seat, since the valve housing cannot be depressurized to create a dual-action seal.

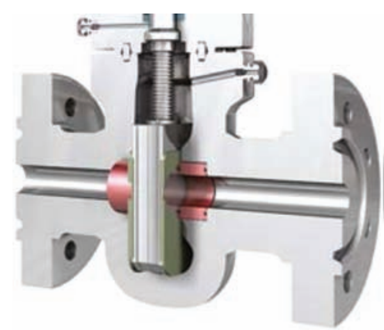
Note! Avoid a pressure lock by reducing the pressure on both sides of the valve.

This valve must not be tightly screwed to a closed position. This is because the gate parts should be able to 'float'.

In the open position, the stem should be slightly unscrewed. This is to prevent the drive nut becoming locked in the stem threads. This also prevents the stem going into back seat.

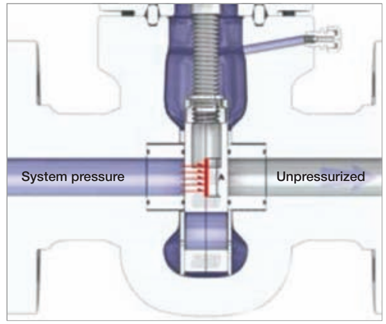




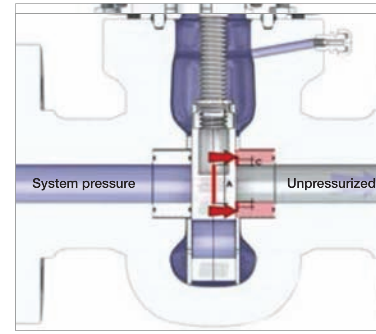


Single seal

The system pressure will leak past the upstream seat and into the valve housing. The system pressure acts on the downstream half of the gate over area A and provides a force that presses it against the downstream seat so that the valve seals.

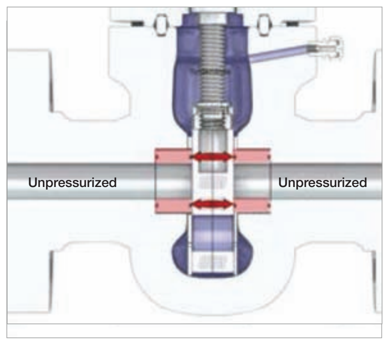


Because of the seat's design, the pressure in the valve housing will also act on area C, which provides additional sealing force on the downstream seat.



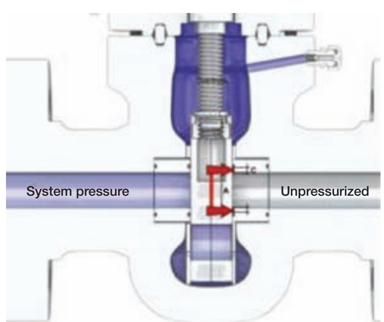
Locked-in pressure

In connection with pressure reduction on one or both sides, the valve housing will remain pressurized. When there are springs between the gate halves, the springs will push the gate halves against the seats.

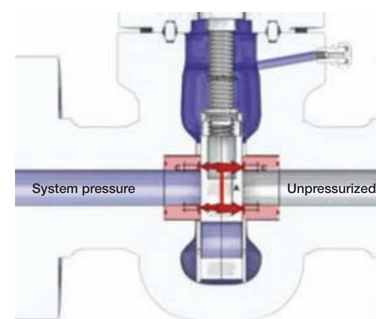


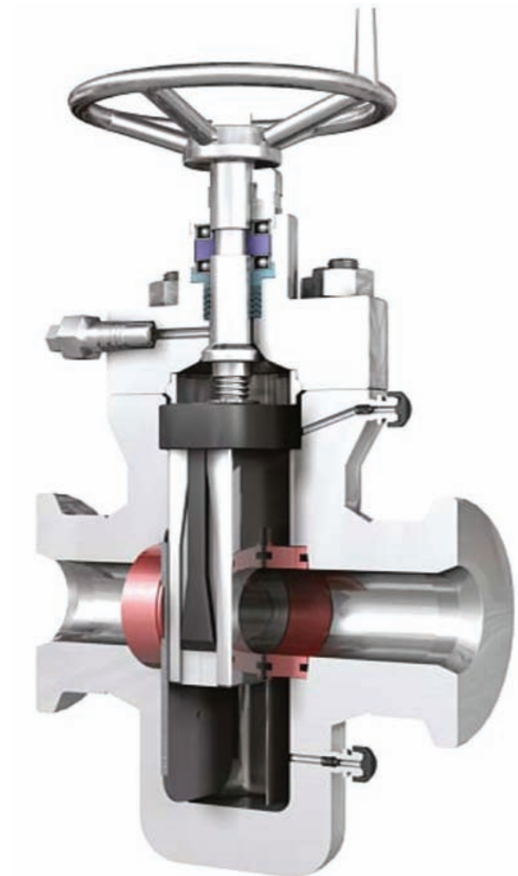
Double sealing

For the downstream seat, the sealing force will be provided by the pressure in the housing acting on the lower gate-half over area A and C. For the upstream seat, the sealing force will be provided by the differential pressure between the valve housing and the flow, which acts on the upper gate-half over area A and C.



Sealing is now established on both the upstream and downstream seat – a double seal. By reducing the pressure in the valve housing, the pressure lock is removed and the valve can be opened.





Type

- A shut-off valve (on/off)
- Stationary rotating stem

Operation

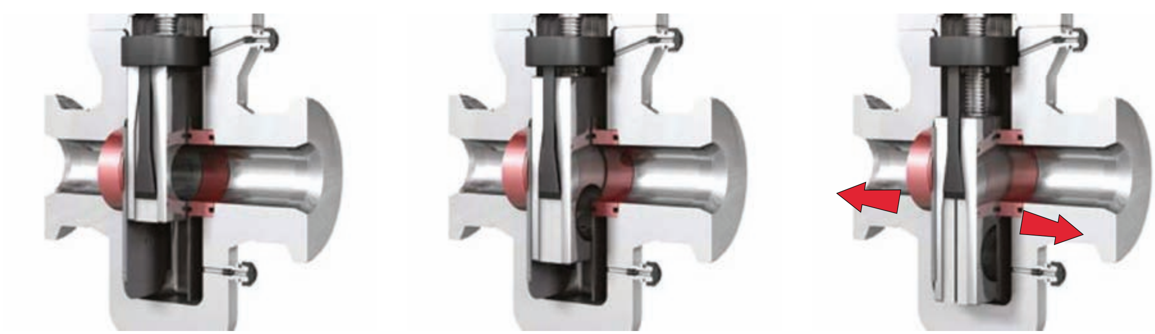
- Can be opened with differential pressure and closed during flow, when the seat and gate have a durable coating applied.
- Is not dependent on a given flow direction (bi-directional).
- Can be damaged by use of excessive force

Seal

- The valve housing can be depressurized to create dual-action sealing.
- The valve housing can be pressurized in the closed position in order to test the valve seals.
  NB Avoid pressure lock by reducing the pressure on both sides of the valve.

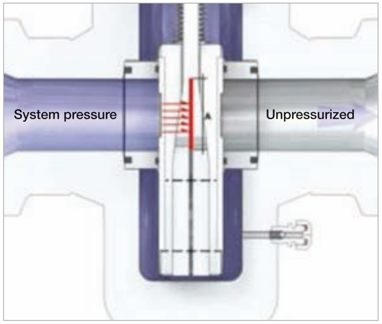
This valve must be tightly screwed in the closed position so that the gate will expand against the seats.

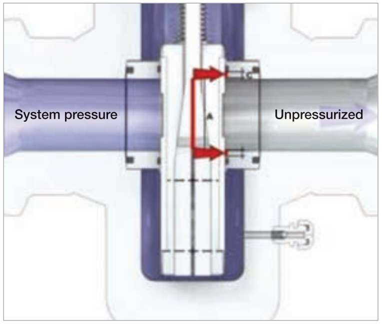
In the open position, the stem must be turned back slightly in order to prevent the drive nut from becoming locked in the stem threads.



Single seal

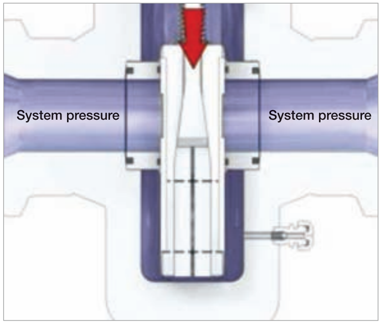
If the valve is not tightly screwed in the closed position, it will only seal against the downstream seat, due to the system pressure acting over area A and C on the downstream gate-half.

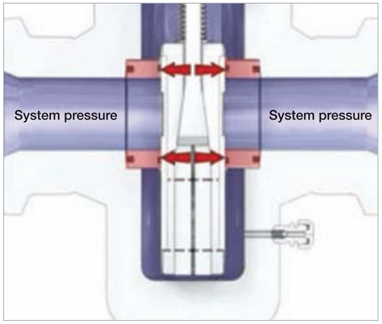




Mechanical seal

The force coming from the stem will press the gate halves against both the seats. This provides a mechanical seal, regardless of the pressure differential.

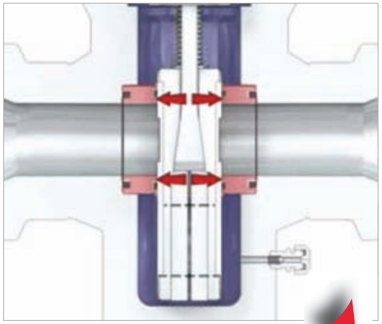




Locked-in pressure

Since this valve is mechanically sealed and seals against both seats, the system pressure may be locked into the valve housing. The valve then seals against the upstream and downstream seat, and the housing can be depressurized.

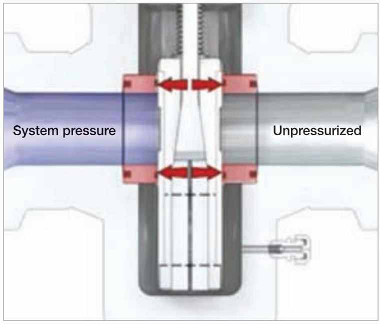
By reducing the pressure in the valve housing, the pressure lock is removed and the valve can be opened.



Double sealing

When the valve is tightly screwed into the closed position, the gate halves will be pressed against both the seats and form a mechanical seal. The valve now seals against the upstream side and the valve housing can be depressured. A double seal is now established.

Note! Avoid a pressure lock by reducing the pressure on both sides of the valve.



Type

- A shut-off valve (on/off)
- Stationary rotating stem

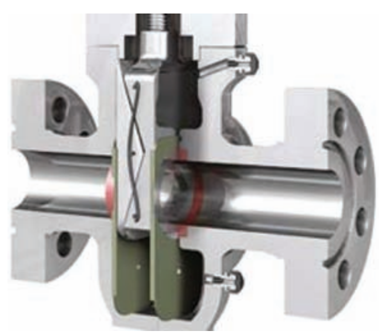
Operation

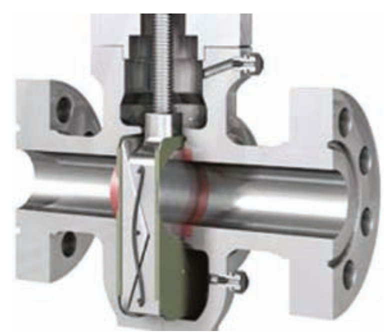
- Can be opened with differential pressure and closed during flow, when the seat and gate have a durable coating applied.
- Is not dependent on a given flow direction (bi-directional) for most valves.
- Can be damaged by use of excessive force.
  Note! Some double expanding valves are direction dependent for opening with differential pressure.

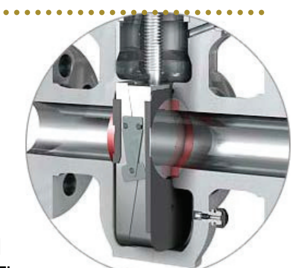
Seal

- The valve housing can be depressurized to create dual-action sealing.
- The valve housing can be pressurized in the closed position in order to test the valve seals.
- The valve housing can also be depressurized in the open position in order to test the valve seals.
- The sealing force is influenced by temperature changes Note! Avoid a pressure lock by reducing the pressure on both sides of the valve.

This valve must be tightly screwed in the closed position so that the gate will expand against the seats.
In the open position, the valve must also be screwed tightly. This is because the gate must expand against the seats.



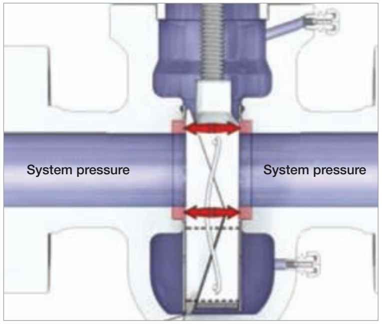




Lever arm
Normally used on valves with over 6" nominal diameter. The gate parts are forced to collapse when the valve opens.

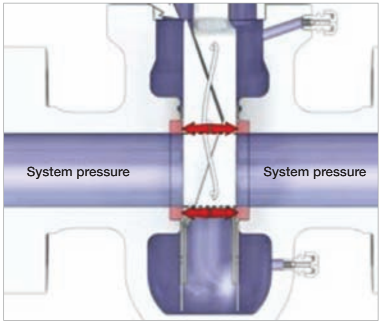
Mechanical seal – closed

The gate's design means that the halves are forced apart when it reaches the bottom of the valve housing. This provides a mechanical seal.

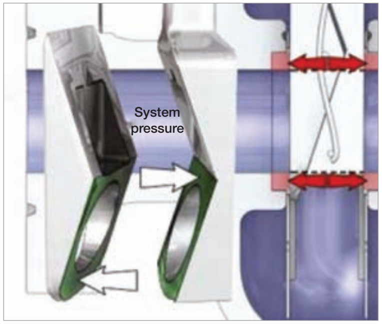


Mechanical seal – open

The gate's design means that the halves are forced apart when it meets the bonnet up in the valve housing. This provides a mechanical seal between the barrel and the valve housing.



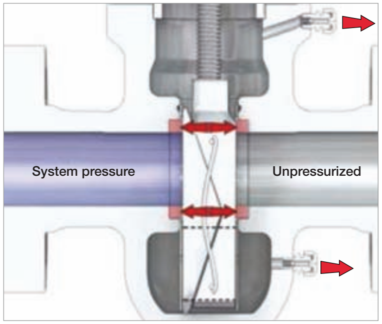
In order to create a seal between the housing and the barrel, both gate halves must have additional sealing surface, as shown in the figure. Valves without such additional sealing surfaces on the gate halves, will not have this sealing function.



Double sealing

When the valve is tightly screwed into the closed position, the gate halves will be pressed against both the seats and form a mechanical seal. The valve then seals against the upstream and downstream seat, and the housing can be depressurized.

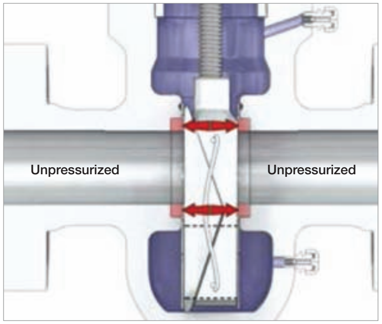
A double seal is now established.

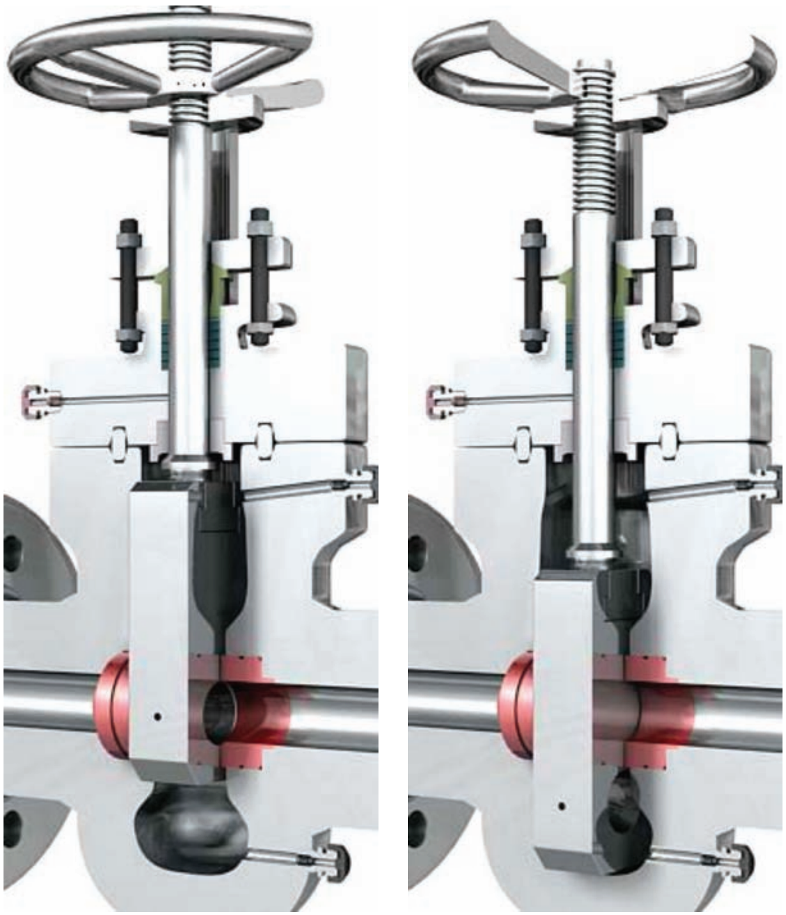


Locked-in Pressure

Since this valve is mechanically sealed and seals against both seats, the system pressure may be locked into the valve housing.

NB! Avoid pressure lock by reduction in pressure on both upstream and downstream sides of the valve.





Rising stem

- The wheel rotates and the stem moves up or down without rotating.
- The valve is attached to the stem and follows its movement.
- This should normally be slightly rotated back in the upper position in order to prevent excessive wear of the stem seats.
- The valve is normally easier to operate when the stem is screwed out of the valve housing.

Stationary stem

- The stem rotates with the wheel without the stem being moved up or down.
- The gate moves up or down by means of threads in the stem.
- Equal operating power is required to open or close the valve.

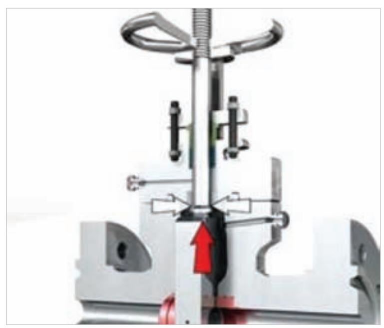
Rising stem

The following procedure can be followed when it is detected that the valve is leaking through the stem packing:

Stationary stem

This stem can be put in the backseat, regardless of position, as the stem does not move either up or down. The following procedure can be followed when it is detected that the valve is leaking through the stem packing:

A rising stem must be set in the upper position to go in backseat. Check the seal by placing a stinger on the lubricating nipple.

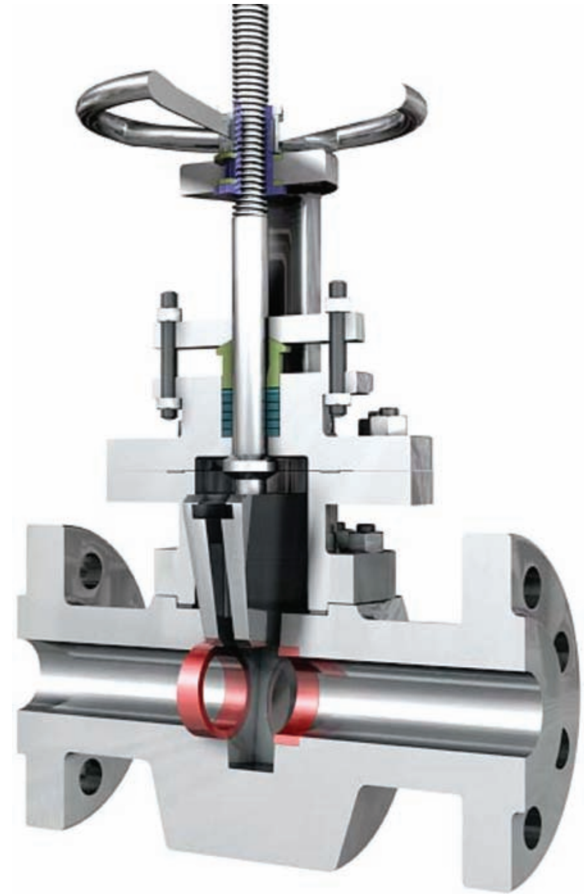


The first thing to do is to loosen the stem cup under the wheel. The stem is now pushed into the backseat position by the system pressure in the valve housing.

When the backseat seal has been checked, replacement of the stem gaskets can be carried out.

Check the seal by placing a stinger on the lubricating nipple. When the backseat seal has been checked, replacement of the stem gaskets can be carried out.

The use of a stinger should be in accordance with the manufacturers' instructions and company procedures.



Type
- A shut-off valve (on/off) that can be opened with differential pressure (dp)
- Usually has a rising non-rotating stem

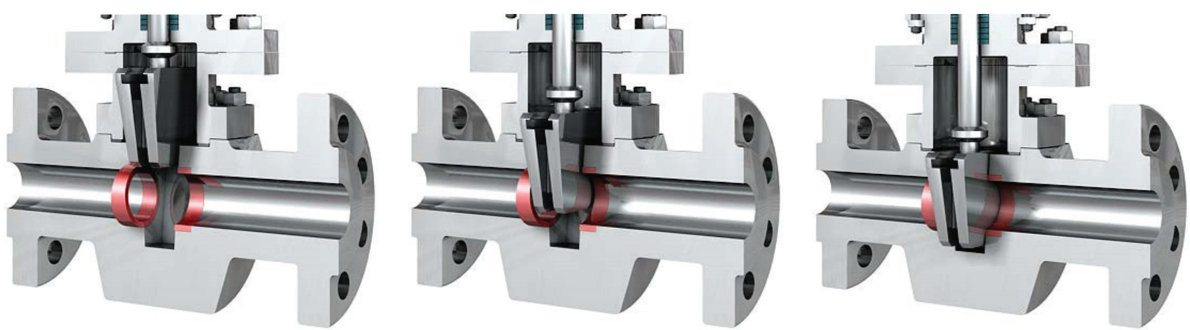
Operation
- Is designed to be able to close with flow in the pipe, but not to regulate the flow.
- Is not dependent on a given flow direction (bi-directional).

Seal
- Seals mechanically by the stem pressing the wedge down between the seats. The wedge seals against both the upstream and downstream seat.

Other
- Often larger valves (over 2")

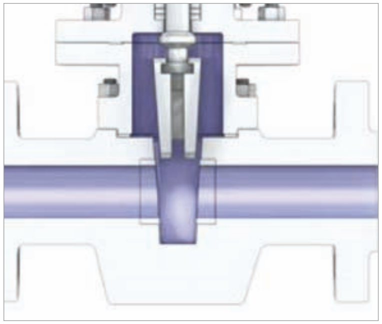
  Note! Remember that the valve can be damaged by excessive use of force.

In the open position, the stem must be unscrewed slightly so that the stem seat is not pressed into the bonnet seat (backseat). The valve should be screwed hard into the closed position.

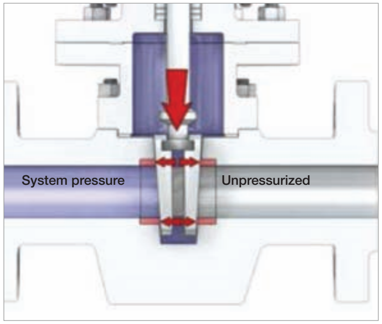


Mechanical seal

The force that comes from the stem will push the wedge between the seats.

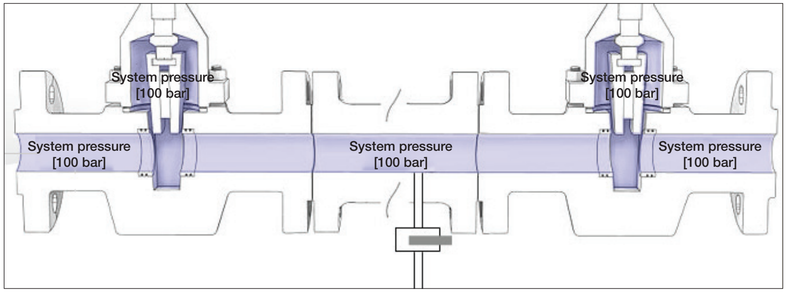


This provides a good mechanical seal with relatively little force. Although the valve seals on both seats, it is not an accepted double seal, because the valve housing cannot be depressurized.

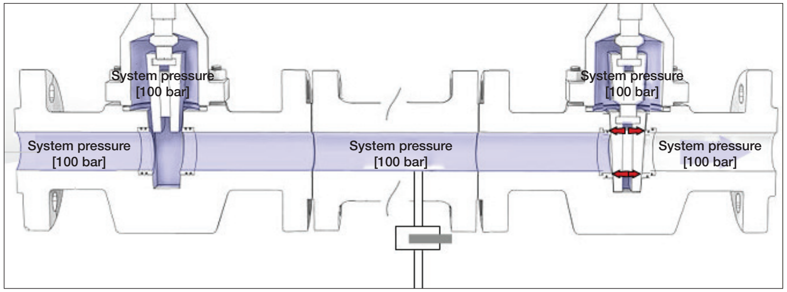


Double sealing

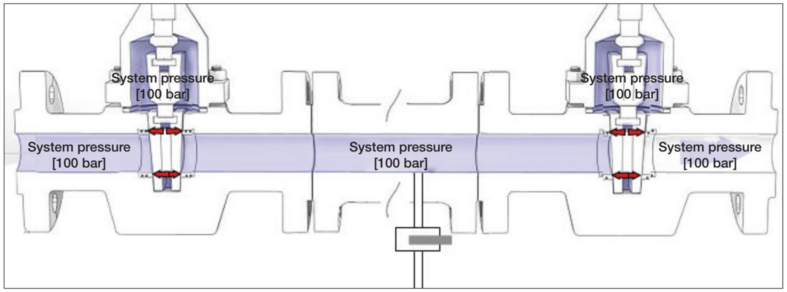
For safety reasons, the best possible seal should be achieved. This is achieved by a double seal with pressure monitoring.



By closing valve 2, we have a single mechanical seal.

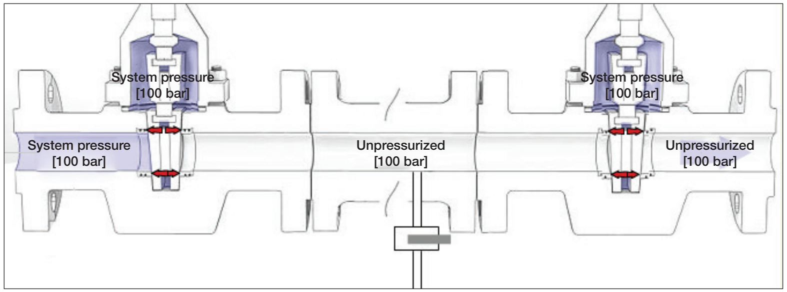


By closing valve 1, we have established another mechanical seal.

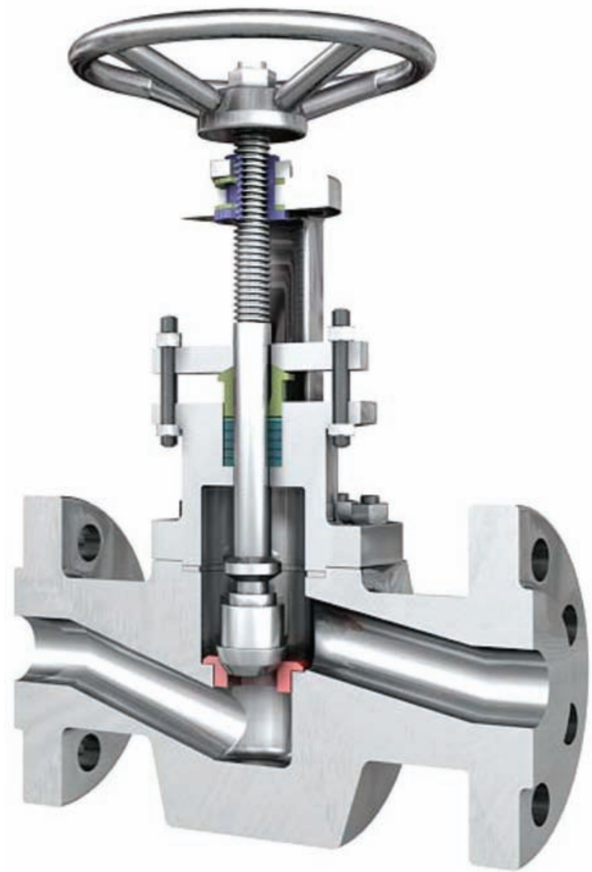


Remove the pressure between the valves by using the drain valve. Now we can check the upstream seal without losing the downstream seal.

We have now established a double seal.



5. Seat Valves



Type

- Is most often used as a manual control valve, but is also a shut-off valve (on/off)
- Usually has a rising rotating stem

Operation

- Is primarily designed for a given flow direction, where the flow enters under the seat and up.
- Can be affected by vibration. Important that stem and plug are correctly aligned.

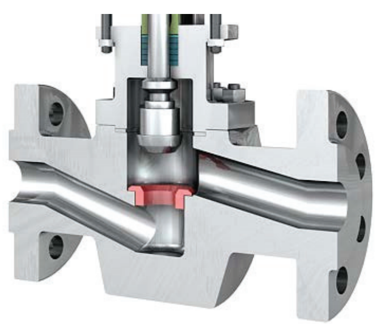
Seal

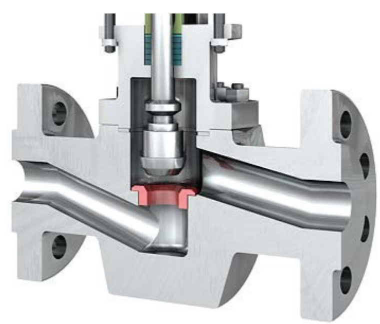
- Seals mechanically by the plug being pressed down against the seat by force from the stem.

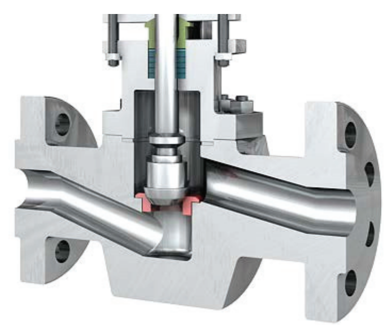
Other

- Often small valves (under 2")

This valve must be tightly screwed to the closed position. Exercise caution! Excessive use of force may cause damage. In the open position, the stem must be unscrewed slightly so that the stem seat is not pressed into the bonnet seat (backseat).

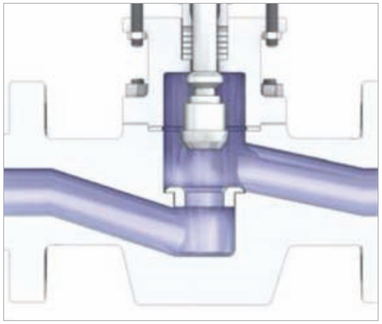


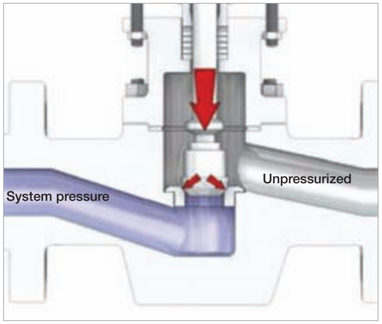




Mechanical seal

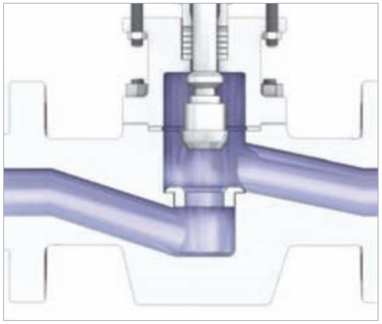
The force coming from the stem will push the plug down against the seat. This provides a good mechanical seal with relatively little force.





Double sealing

For safety reasons, the best possible seal should be achieved. This is achieved by a double seal with pressure monitoring. This valve alone cannot achieve a double seal. The procedure for this is similar to that shown for a wedge gate.

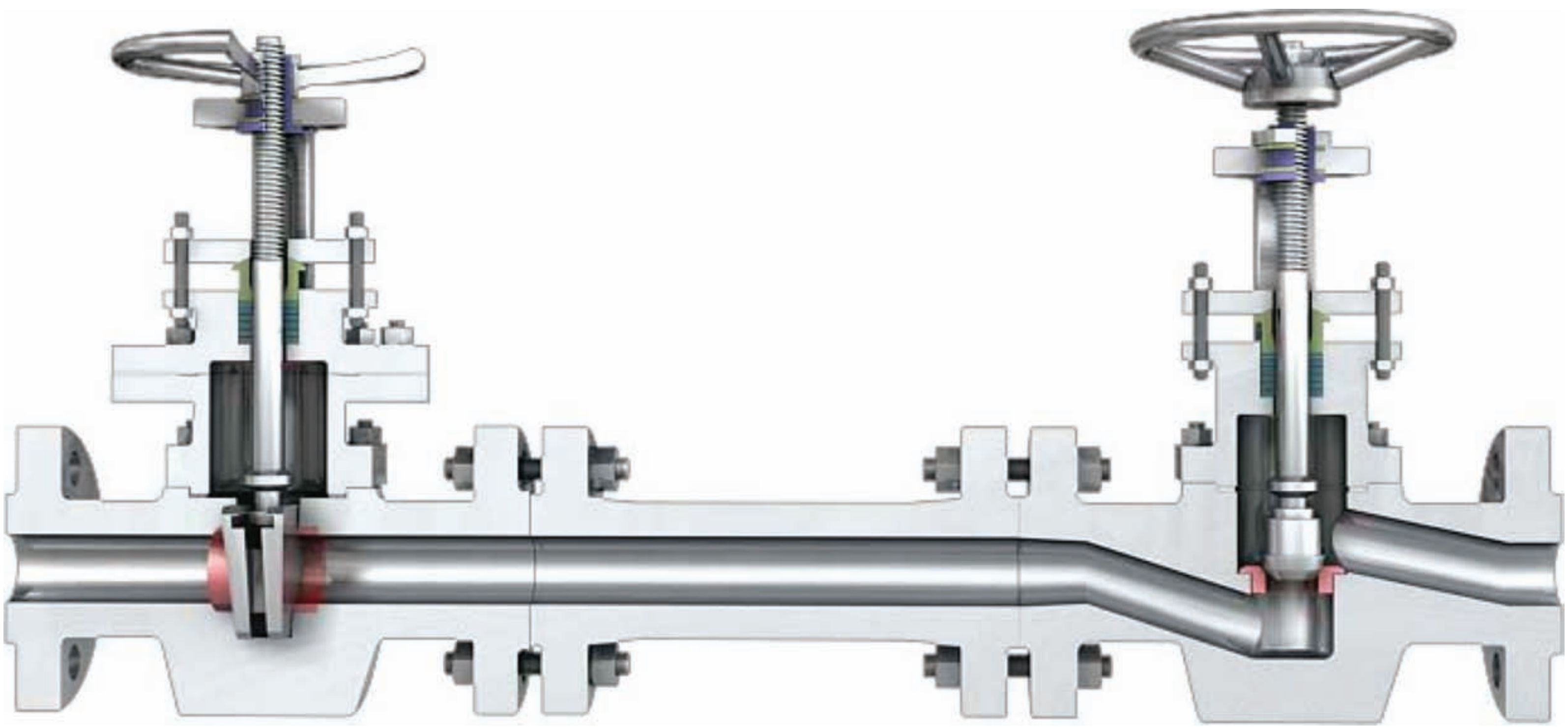


Wedge gate valve

- A shut-off valve (on/off)
- Can be used as a safety valve against a seat valve
- Normally has a rising, non-rotating stem

Seat valve

- Is a shut-off and control valve
- Normally has a rising, rotating stem

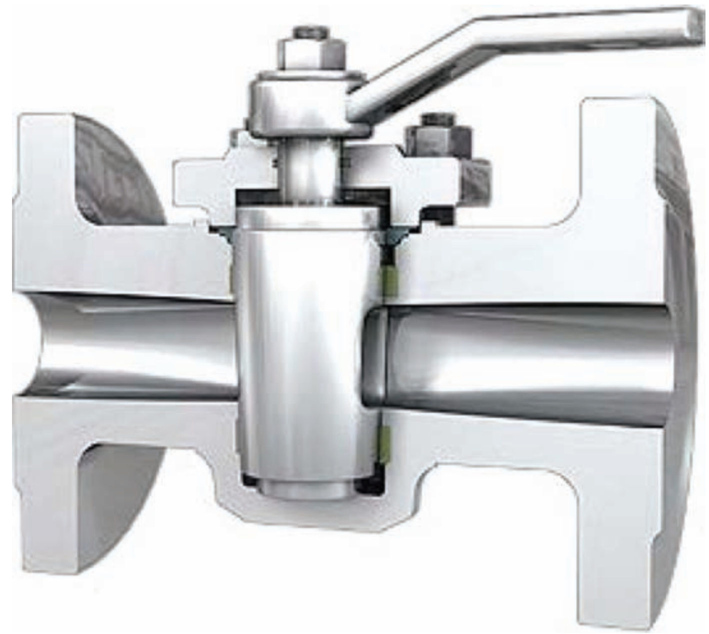


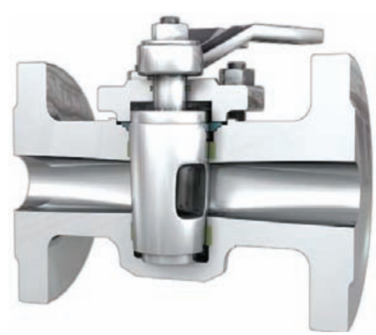
6. Plug Valves

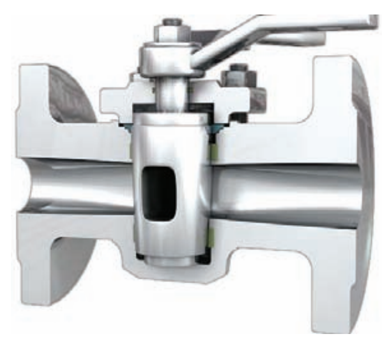
Type
- A shut-off valve (on/off)
- 90 degrees operated
- Floating valve plug (unbalanced)

Operation
- Can be opened with differential pressure and closed with flow in the pipe, but is not a throttle valve.
- Is not dependent on a given flow direction (bi-directional).

Seal
- The valve seals by the plug being compressed into the soft seal.

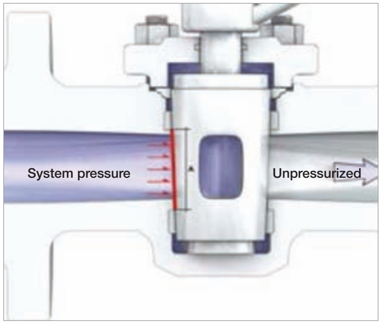




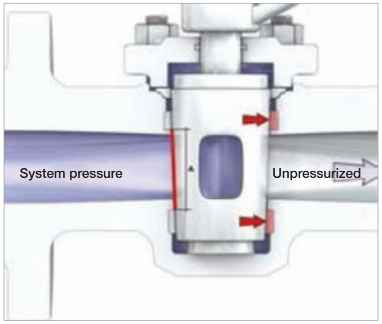


Single seal

The plug is pushed down into the Teflon sleeve in the valve housing. The system pressure acts on the plug over area A, which goes up to the Teflon sleeve and provides a force equal to the system pressure multiplied by the area.

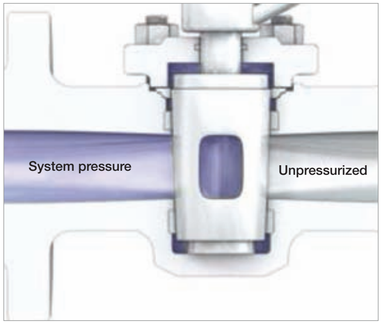


This force pushes the plug towards the downstream side and toward the Teflon sleeve so that the valve seals.



Dual-action seal

For safety reasons, the best possible seal should be achieved. This is achieved by a double seal with pressure monitoring. This valve alone cannot achieve a double seal.
The procedure for this is similar to that shown for a wedge gate.

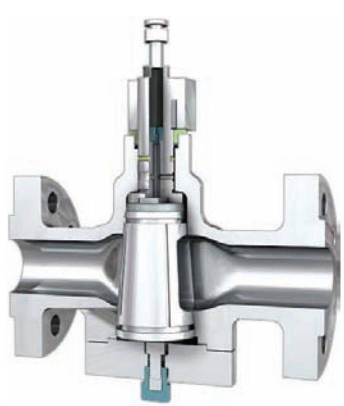


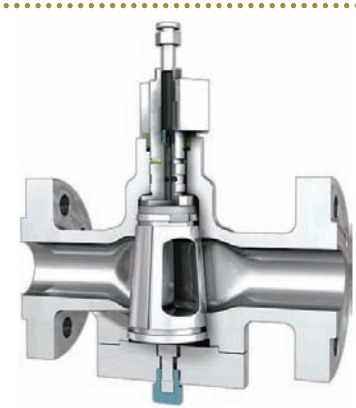
Type
- A shut-off valve (on/off)
- 90 degrees operated
- Mechanical balanced valve plug

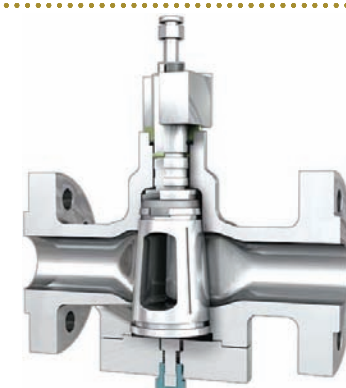
Operation
- Can be opened with differential pressure and closed with flow in the pipe, but is not a throttle valve.
- Is not dependent on a given flow direction (bi-directional).
- Heavier to operate with differential pressure (the plug is pressed toward the downstream side).

Seal
- The valve seals by the differential pressure pressing the plug against the downstream side.
- The sealant will also be compressed between the plug and the housing (on the downstream side).

The plug may be wedged into the valve housing by misalignment of the plug or if the valve is installed upside down. Follow the manufacturer's instructions for correct alignment.

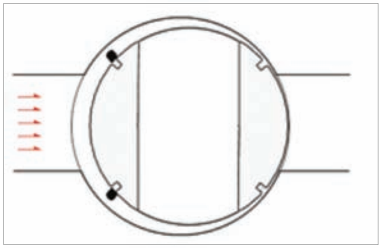




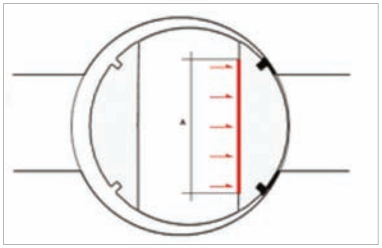


Single seal

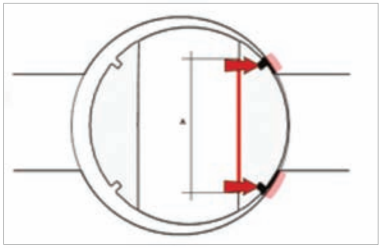
The sealant located in the grooves in the plug on the downstream side is compressed between the plug and the valve housing so that the valve seals.



The system pressure acts on the plug over area A and provides a force equal to the system pressure multiplied by the area.

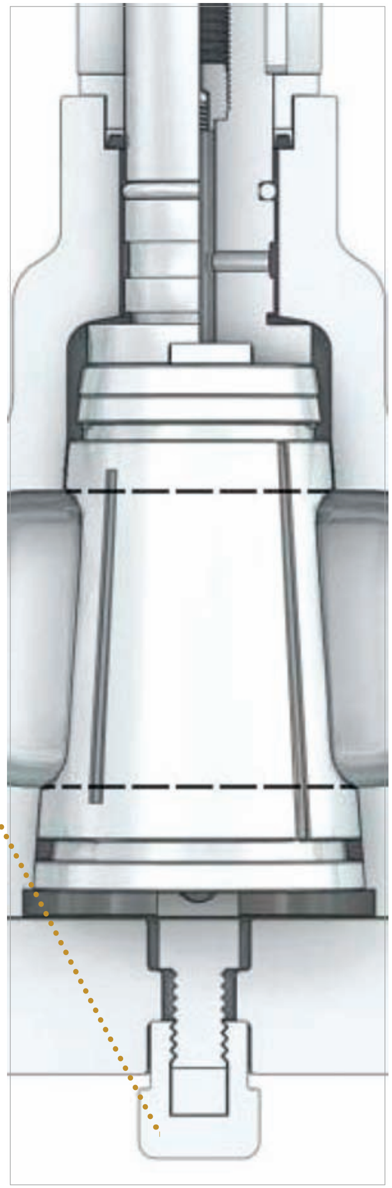


This force pushes the plug toward the downstream side.



Double sealing

For safety reasons, the best possible seal should be achieved. This is achieved by a double seal with pressure monitoring.



This valve alone cannot achieve a double sealing, but by using the adjusting screw at the bottom of the valve housing, it is possible to wedge the plug securely in the valve housing so that it seals both upstream and downstream.

Although the valve seals on both seats, it is not an accepted double seal, because the valve housing cannot be depressurized.

It is important to remember that the plug must be readjusted before it is put into operation.

Type

- A shut-off valve (on/off).
- The stem is rising and rotating (90 degrees rotation).
- Has two seats (slips) which are secured on the plug with dovetail grooves (slide track).

Operation

- Can be opened with differential pressure.
- Can be closed with flow in the pipe, but is not a throttle valve.
- Is not dependent on a given flow direction (bi-directional).

Seal

- The valve seals by the plug being rotated to the closed position. The stem then presses the plug down so that the slips are wedged against the housing on both sides.
- The slips have an integrated O-ring for sealing against the housing.

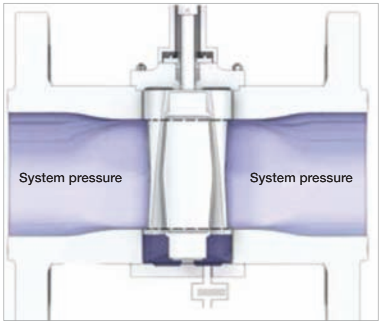
When the valve is closed, the slips are pushed against the housing on both sides, and there will be a locked-in pressure in the housing.

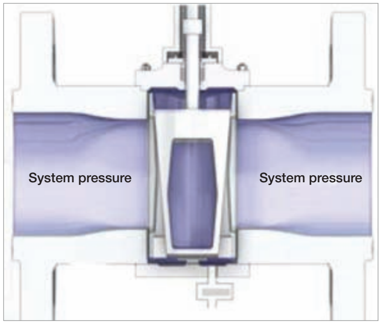
This pressure can create a pressure lock by reducing the pressure in the pipe (the system pressure).

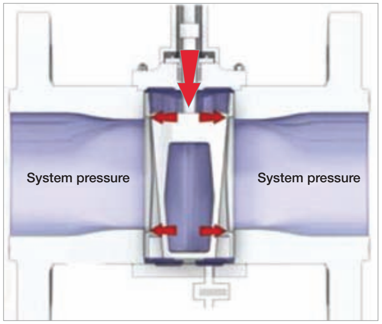
Mechanical seal

The plug is constructed as shown in the figure, where each of the slips has a vulcanized O-ring.

The plug wedges the slips against the valve housing and compresses the O-rings on both sides. This provides a mechanical seal on both sides.

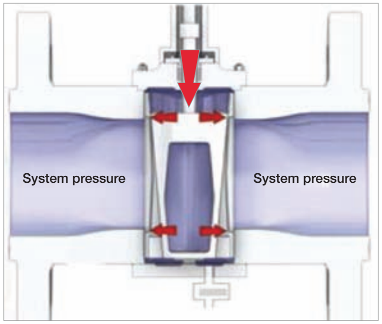


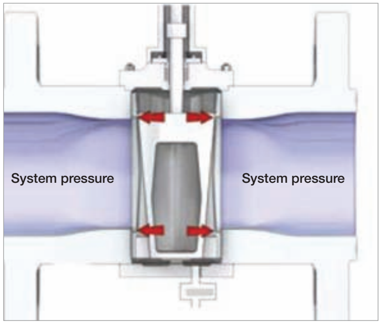




Double sealing

By turning this valve tightly to the closed position, a double seal can be established by reducing the pressure in the valve housing.



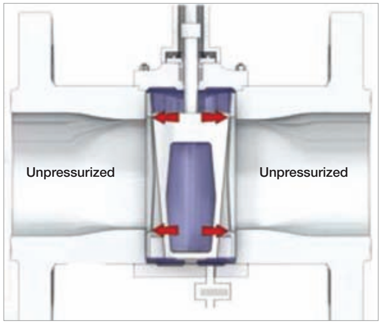


Open the drain valve to remove the pressure in the valve housing.

A double seal is now established.

Locked-in pressure

Since this valve is mechanically sealed and seals against both seats, the system pressure may be locked into the valve housing.



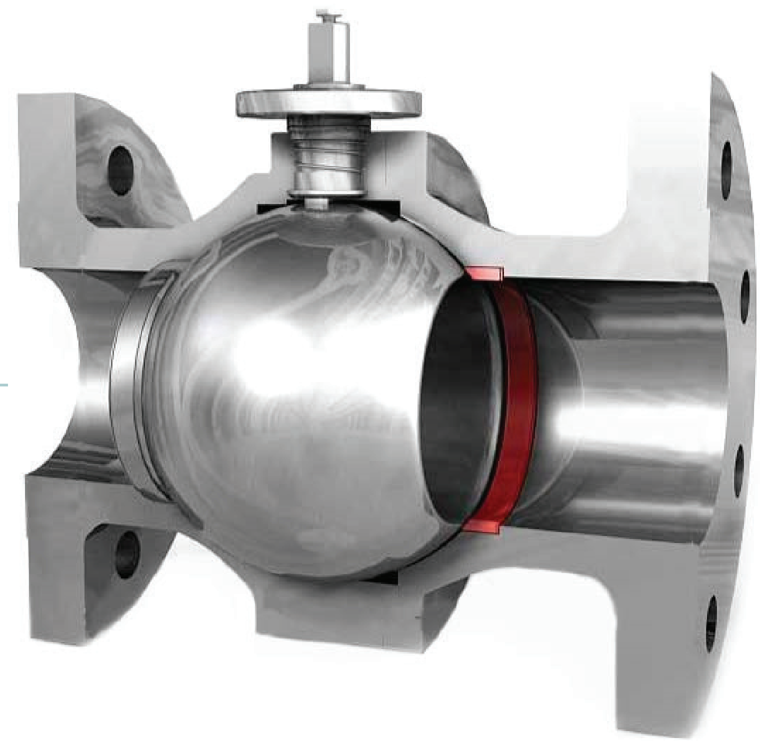
7. Ball Valves

This handbook does not cover Double Isolation and Bleed valves (DIB - 1 and DIB - 2). The use of these types of valve should be in accordance with the suppliers recommendations and company procedures.

Type
- A shut-off valve (on/off).
- The ball's rotation is 90 degrees.

Operation
- Can be opened with differential pressure and closes under flow.
- Conventional valve with soft seats should not usually be opened with a differential pressure exceeding 20 barg.
- Is not a throttle valve.
- Is not dependent on a given flow direction (bi-directional).

Seal
- Seals on only the downstream seat by the ball being pressed against the seat by the system pressure.



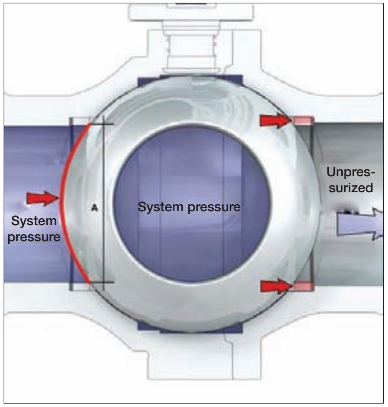
Conventional valve with soft seats should usually not be opened with a differential pressure exceeding 20 barg.

Note! The valve must be in a completely open or closed position.

Single seal

The system pressure acts on the ball over area A and provides a force equal to the system pressure multiplied by the area.

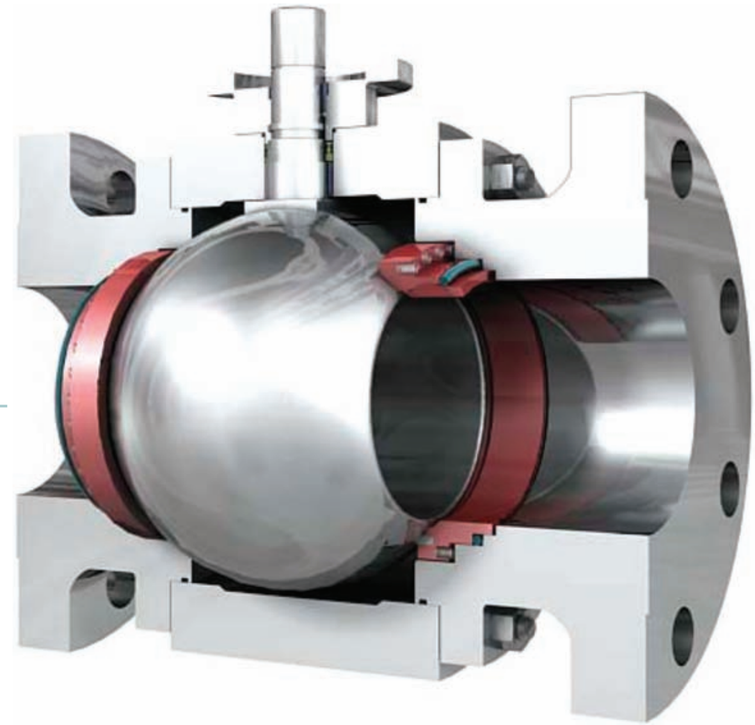
This is the force that seals the downstream seat.



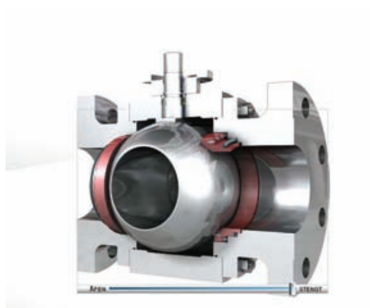
Type
- A shut-off valve (on/off).
- The ball's rotation is 90 degrees.

Operation
- Can be opened with differential pressure and closes under flow.
- Conventional valve with soft seats should not usually be opened with a differential pressure exceeding 20 barg.
- Is not a throttle valve.
- Is not dependent on a given flow direction (bi-directional).

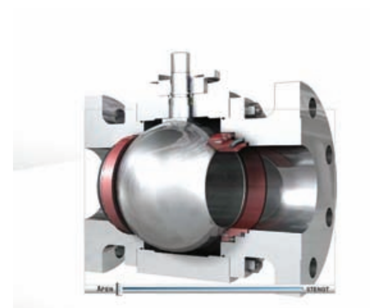
Seal
- The main seal is downstream of the seat, but additionally also seals the upstream seat.
- The valve seats can be tested by reducing the pressure in the valve housing.



The valve seats can be tested by reducing the pressure in the valve housing. Conventional valve with soft seats should usually not be opened with a differential pressure exceeding 20 barg.

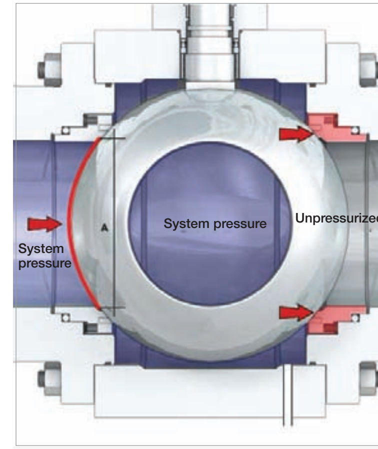


Note! The valve must be in a completely open or closed position.



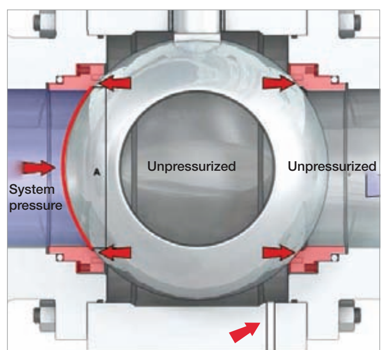
Single seal

The system pressure acts on the ball over area A and provides a force equal to the system pressure multiplied by the area. This is the force that seals the downstream seat.



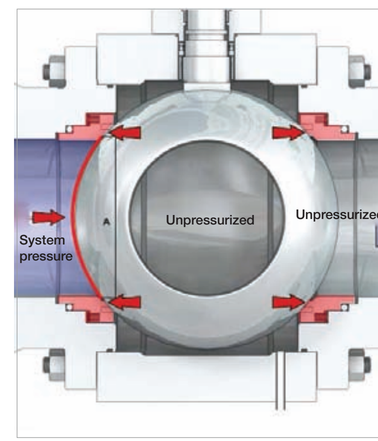
Double sealing

For safety reasons, the best possible seal should be achieved. This is achieved by a double seal with pressure monitoring.



Open the drainage line to depressurize the valve housing.

The differential pressure between the upstream and downstream side establishes a double seal by the ball being pressed against the downstream seat and the upstream seat is pushed against the ball.



Type

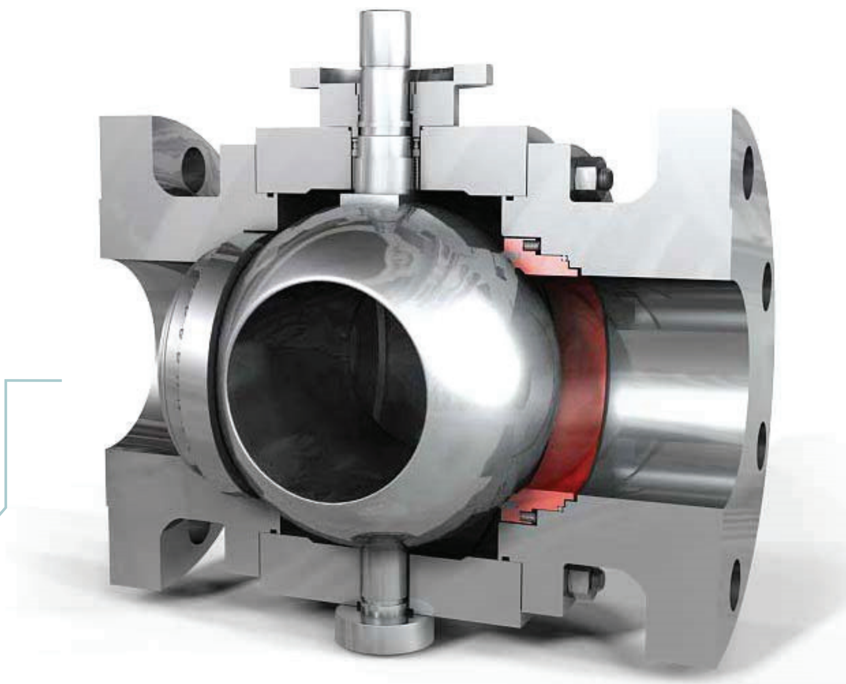
- A shut-off valve (on/off).
- The ball's rotation is 90 degrees.
- Supported ball.

Operation

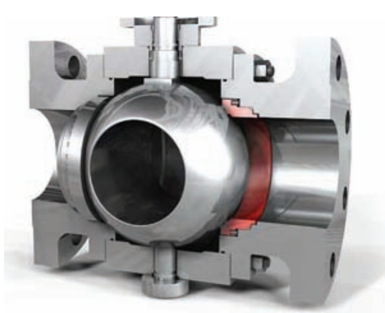
- Can be opened with differential pressure and closes under flow.
- Conventional valve with soft seats (PTFE, Nylon, etc.) should not be opened with a differential pressure exceeding 20 barg. The differential pressure limitations on valves with soft seats are dependent on several factors and can vary.
- Valves with hard seats (PEEK, Devlon, etc.) should not be opened with a differential pressure exceeding 60 barg.
- Is not dependent on a given flow direction (bi-directional).
- Some valves have one seat with DP and one with SP. The valve is then partially directional.

Seal

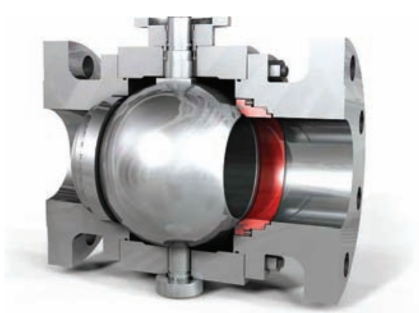
- Seals on the upstream seat.
- The valve seats can be tested by reducing the pressure in the valve housing.



Valves with hard seats (PEEK, Devlon, etc.) should not be opened with a differential pressure exceeding 60 barg.

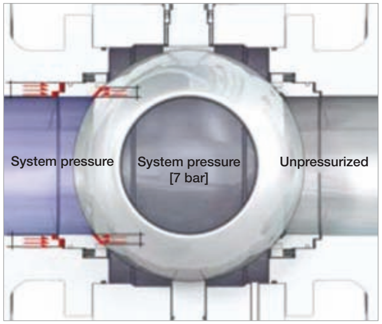


Note! The valve must be in a completely open or closed position.

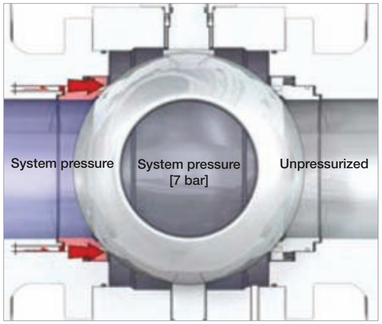


Single seal

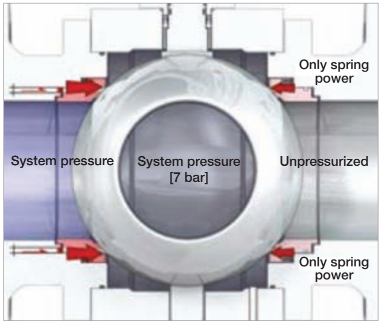
The system pressure enters behind the upstream seat and presses it against the ball. Some of the pressure will enter between the seat and the ball and press in the opposite direction. As we can see, the upstream positive area is greater than the upstream negative area.



The pressure acting on this active area provides the sealing force on the upstream seat.

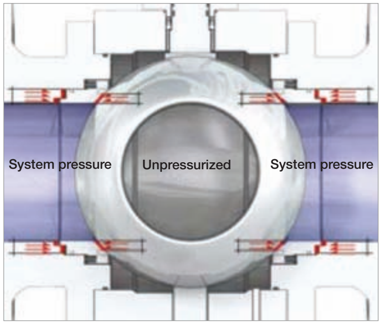


On the downstream side, it is only the spring forces that hold the seat against the ball, as it is depressurized behind the seat.

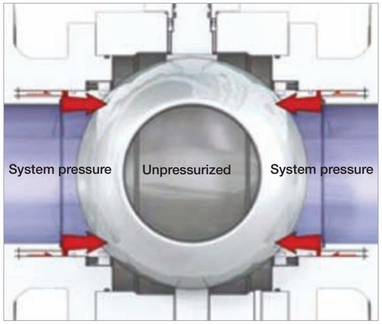


Double Block & Bleed

Now the pressure in the valve housing is removed through a lubricating nipple or an air vent.

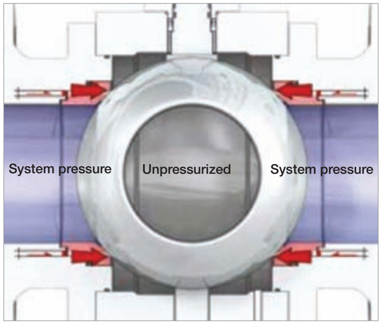


The system pressure enters behind the seats and presses them against the ball. Some of the pressure will enter between the seats and the ball and press in the opposite direction. As we can see, the upstream positive area is greater than the upstream negative area.



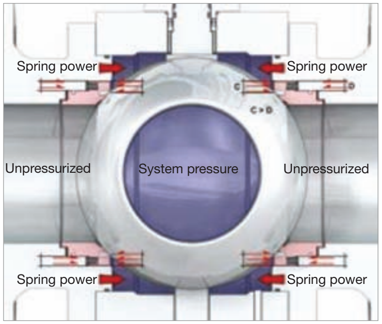
Both the seats now seal against the ball when the housing is depressurized, and we have system pressure on both sides.

This situation is described by valve manufacturers as “double block & bleed”, which is an API designation in this context. This is only to test whether both seats have seal surfaces that are in order. The test can also be performed in the open position, unless the ball has balance holes.

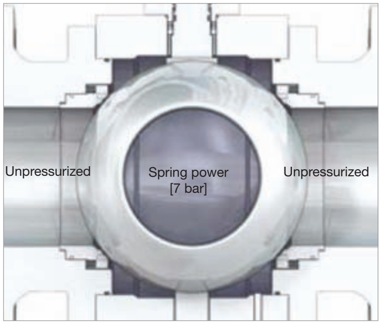


Self-relieving

When the pressure in the barrel is reduced to atmospheric pressure, the pressure in the valve housing will be reduced to spring power. This is called “self-relieving”.

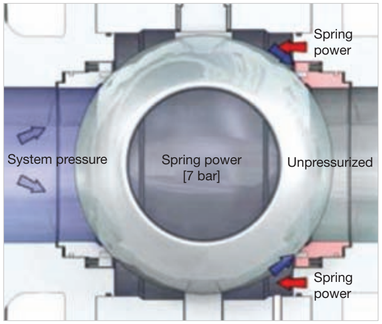


The pressure remaining in the housing, usually between 5 and 12 bar, will depend on the strength of the springs.

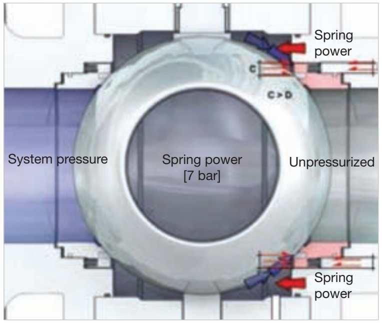


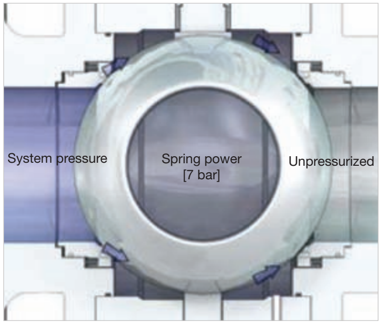
Over pressure relief

If the upstream seat is damaged and leaking, the pressure will go into the valve housing.



Since the downstream negative area is greater than the downstream positive area, the seat will release when the pressure in the housing exceeds the spring force.

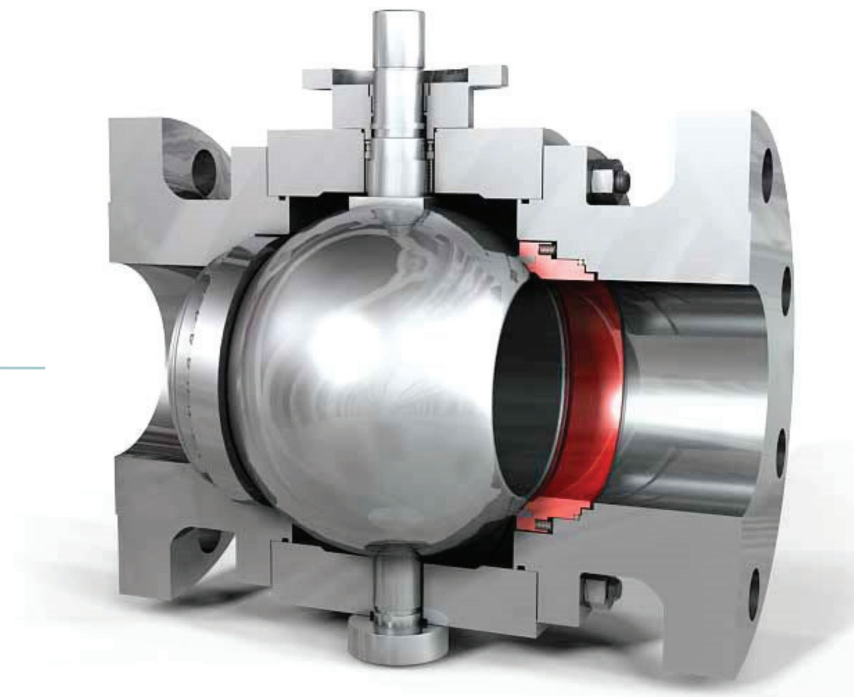




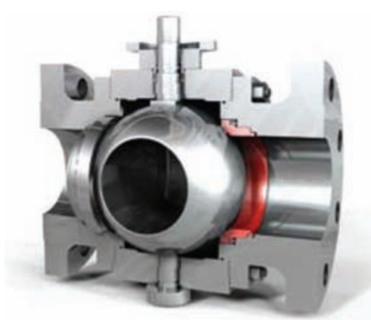
Type
- A shut-off valve (on/off).
- The ball's rotation is 90 degrees.
- Supported ball.

Operation
- Can be opened with differential pressure and closes under flow.
- Conventional valve with soft seats (PTFE, Nylon, etc.) should not be opened with a differential pressure exceeding 20 barg.
- Valves with hard seats (PEEK, Devlon, etc.) should not be opened with a differential pressure exceeding 60 barg.
- Is not dependent on a given flow direction (bi-directional).
- Some valves have one seat with DP and one with SP. The valve is then partially directional.

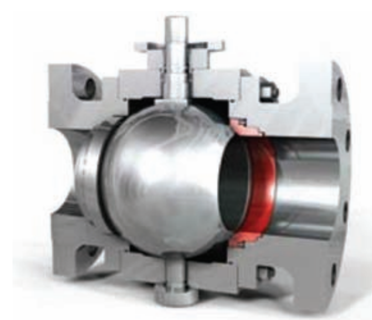
Seal
- The main seal is the downstream seat, but the upstream seat will also seal if the pressure drops in the valve housing.
- The valve seats can be tested by reducing the pressure in the valve housing.



Valves with hard seats (PEEK, Devlon, etc.) should not be opened with a differential pressure exceeding 60 barg.

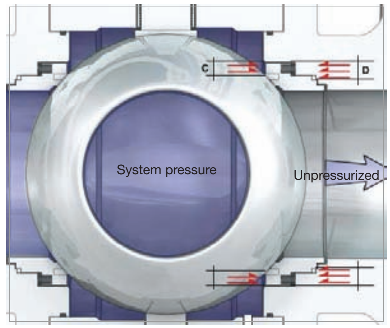


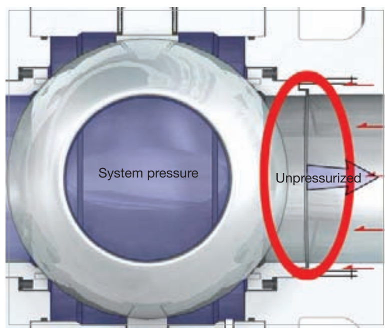
Note! The valve must be in a completely open or closed position.



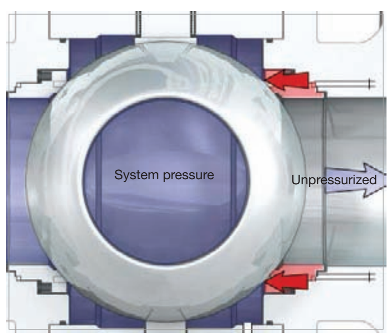
Single seal

The system pressure in the valve housing will go in behind the downstream seat. The positive area is greater than the negative.



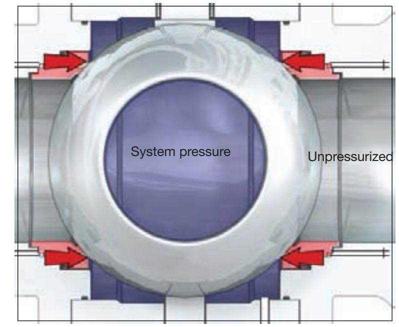


The pressure acting on this active area provides the sealing force on the downstream seat.

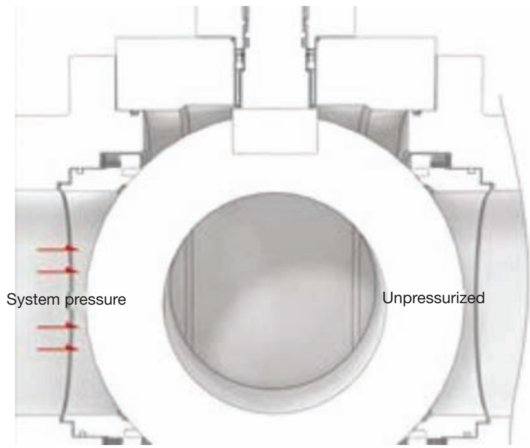


Locked-in pressure

If we reduce the pressure on both sides of the ball, the pressure in the valve housing will press both seats in against the ball.

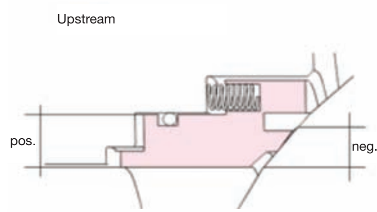


SR – SELF-RELIEVING



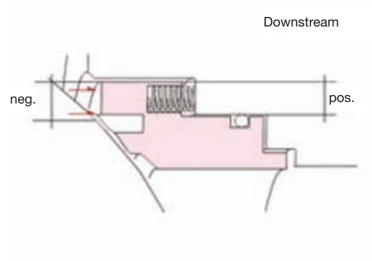
Upstream seat:

The system pressure presses the upstream seat in against the ball, because the upstream positive area is greater than the upstream negative area. This function is the same as for the DP.

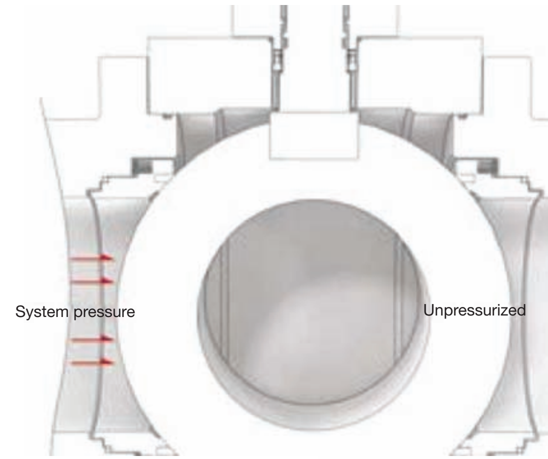


Downstream seat:

The system pressure presses the downstream seat away from the ball, because the downstream positive area is less than the downstream negative area.

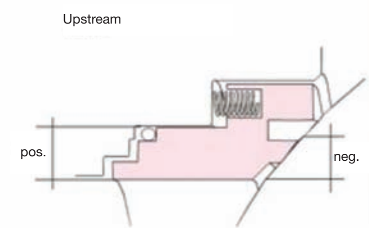


DP – DOUBLE PISTON



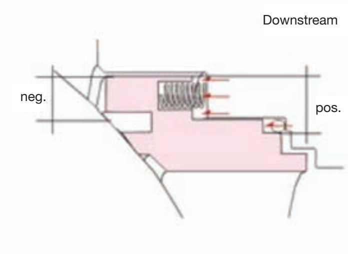
Upstream seat:

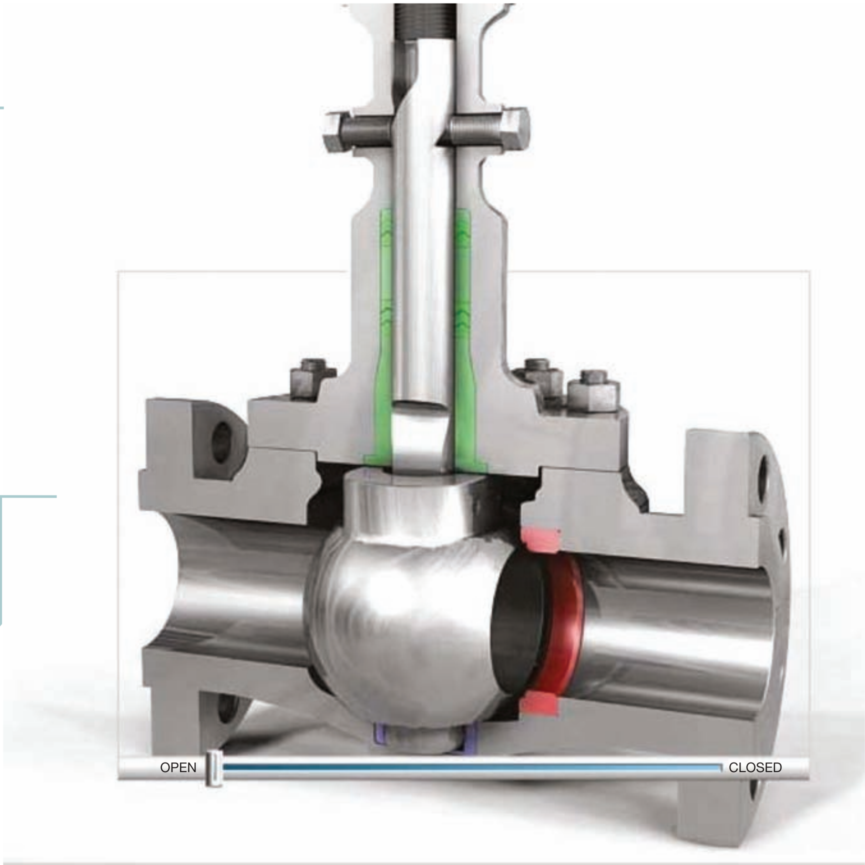
The system pressure presses the upstream seat in against the ball, because the upstream positive area is greater than the upstream negative area. This function is the same as for the SR – self-relieving.



Downstream seat:

The system pressure presses the downstream seat against the ball, because the downstream positive area is greater than the downstream negative area.





Type

- A shut-off valve (on/off).
- The stem is rising and rotating.
- The ball's rotation is 90 degrees.

Operation

- Can be opened with differential pressure and closed with flow in the pipe, but is not a throttle valve.
- Is not dependent on a given flow direction (bidirectional), but has a recommended flow direction depending on the application and the fluid.

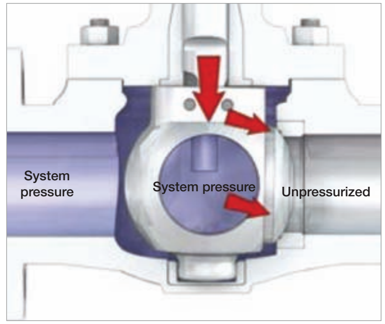
Seal

- Mechanically sealing by the stem wedging the ball and pressing it against the seat.

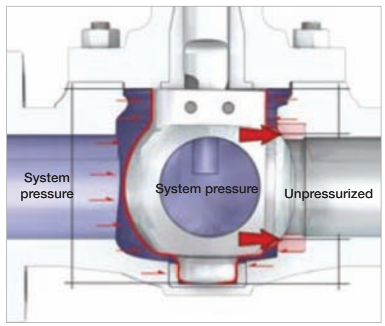
This valve must be tightly screwed to the closed position. This is because the ball must be pressed tightly against the seat and provide a good seal, especially when the seat is mounted in the upstream direction.

Single seal

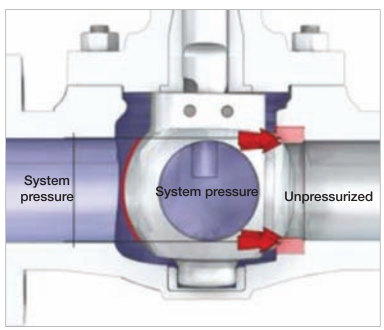
Because of its shape, the force that comes from the stem will push the ball in against the seat.



In addition, the system pressure will act with a force on the ball. Since there is pressure in the valve housing, this will press in the opposite direction on the ball.

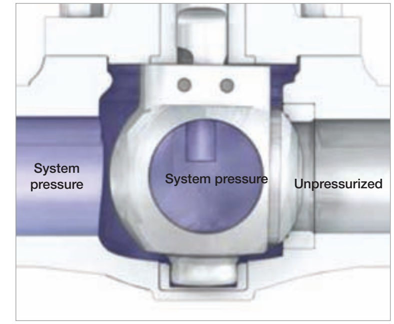


The pressure acting on the active area will increase the sealing force on the seat, since it helps to push the ball further in against the seat.



Double sealing

For safety reasons, the best possible seal should be achieved. This is achieved by a double seal with pressure monitoring. This valve alone cannot achieve a double seal. The procedure for this is similar to that shown for a wedge gate.



Type

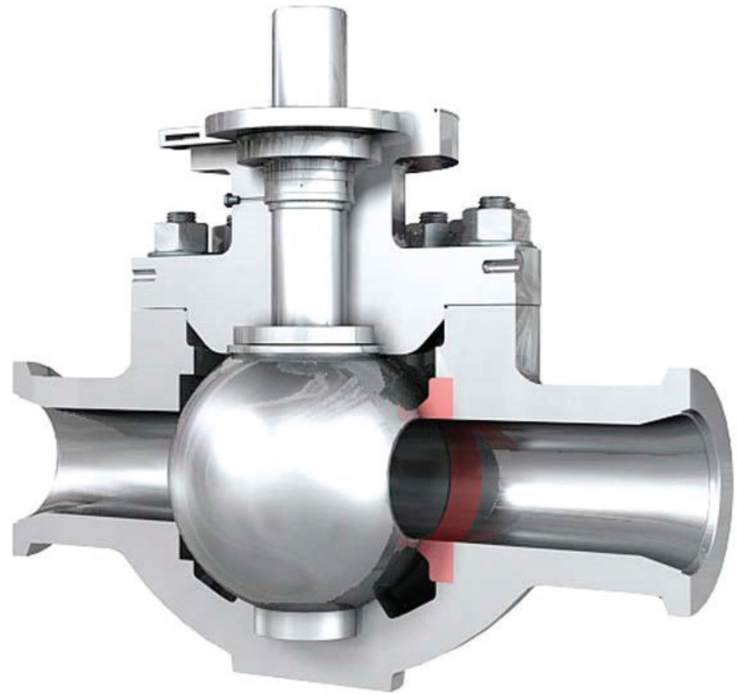
- A shut-off valve (on/off).
- The ball's rotation is 90 degrees.

Operation

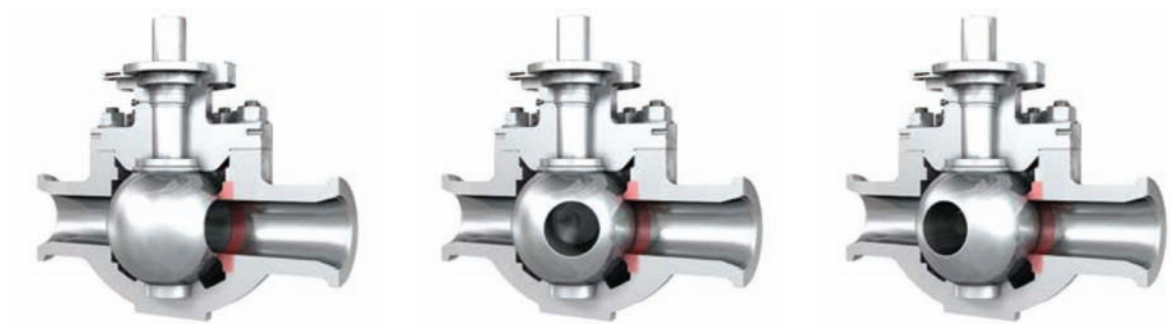
- Can be opened with differential pressure or closed with flow in the pipe, but is not a throttle valve.
- During rotation from the closed to the open position, there is no contact between the seats and the ball (non-contact).
- It is not dependent on a given flow direction (bi-directional). Valves with a single seat will normally have a recommended flow direction or seal direction.

Seal

- Mechanical sealing by the ball being wedged against the seat in the closed position.
- Valves with two seats seal on both the upstream and downstream seat.



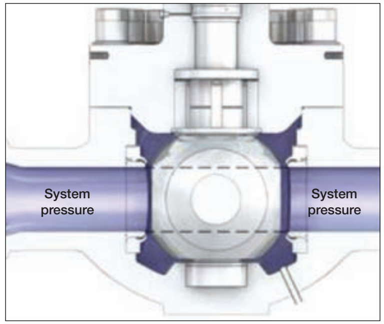
This valve must be tightly screwed to the closed position. This is because the ball must be wedged tightly against the seat and provide a good seal.

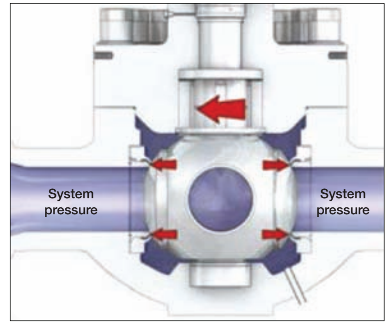


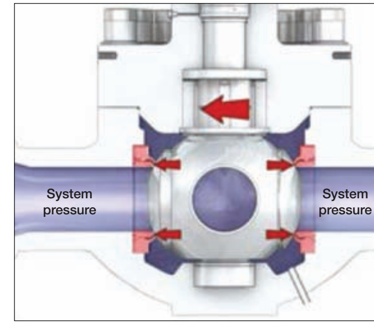
Mechanical seal

When the valve is closed, the force from the stem wedges both sides of the ball against the seats.

The ball first meets the spring-loaded seats that are compressed so that they are tightened up against the ball. Ball rotation stops in the fixed seat. The ball is now wedged between both seats and we have a mechanical seal.

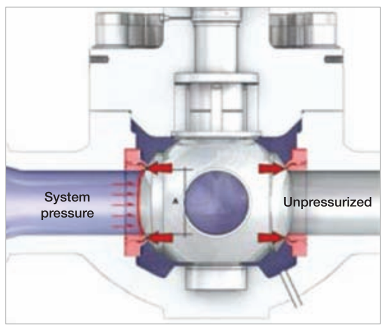






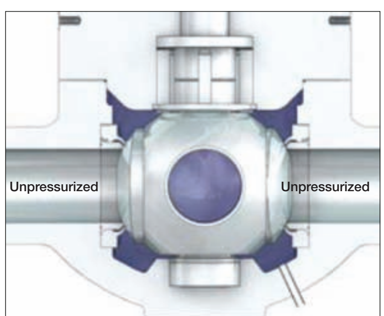
Seal – downstream seat

The system pressure acts on the ball over area A and provides a force equal to the system pressure multiplied by the area. This force pushes the ball against the downstream solid seat.

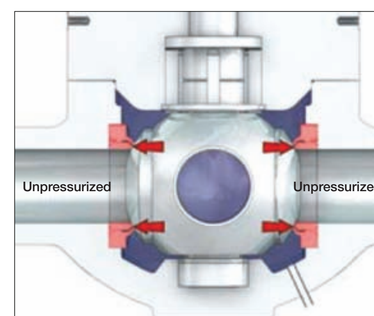


Locked-in pressure

If we reduce the pressure on both sides of the ball, the pressure in the valve housing will be locked-in.



The pressure will press the ball against the seats, but there is no danger of pressure lock, since the seats are fixed and the ball will move from the seats on both sides when the valve is opened. When the valve starts to open, it will be slightly heavier to operate.



Double sealing

For safety reasons, the best possible seal should be achieved. This is achieved by a double seal with pressure monitoring.

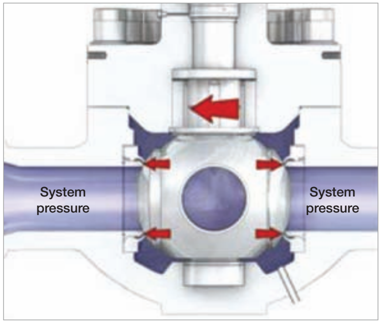
When the valve is closed, the force from the stem wedges both sides of the ball against the seats.

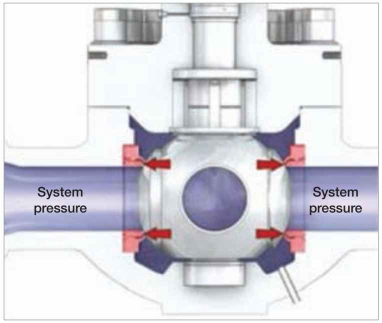
We will also obtain additional sealing force on the downstream seat because the system pressure acting on area A presses the ball against the seat.

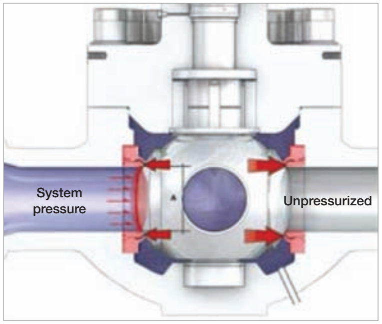
As can be seen, the sealing force on the upstream seat will be reduced as a result of this.

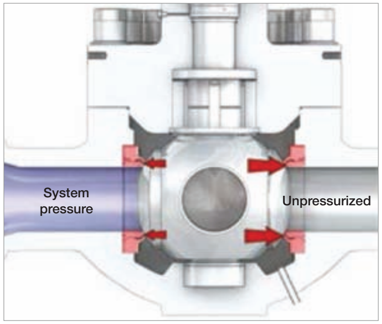
Remove the pressure from the housing to verify that the upstream seat is sealed.

We have now established a double seal.

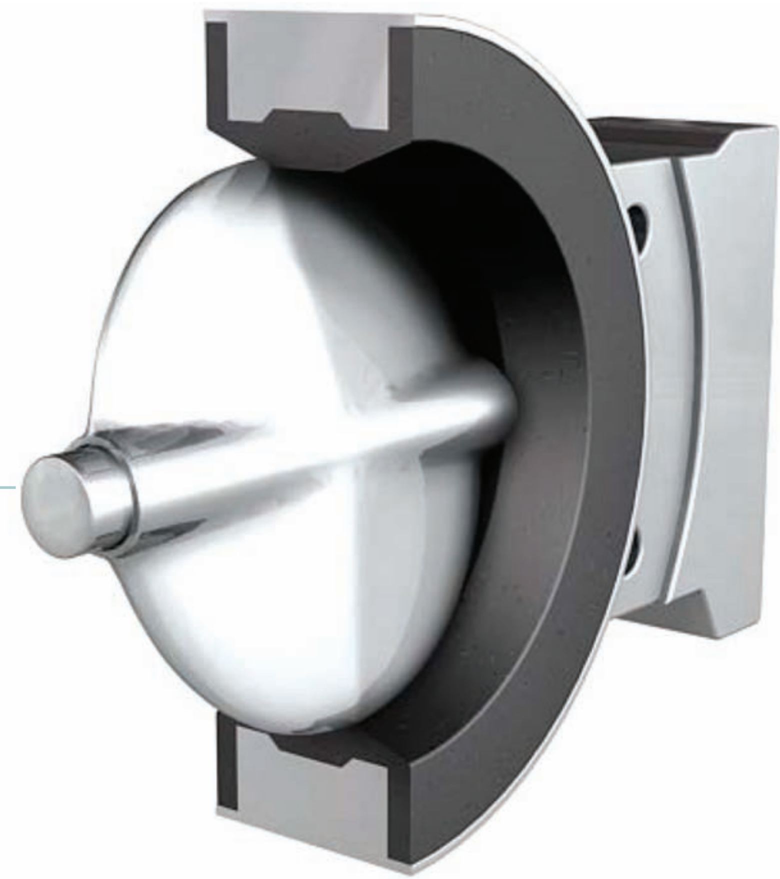








8. Butterfly Valves

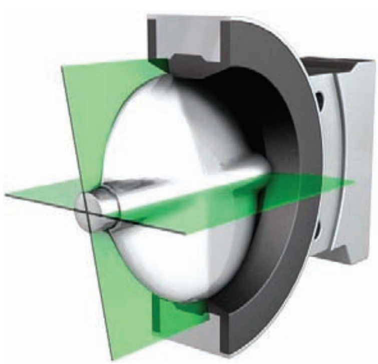


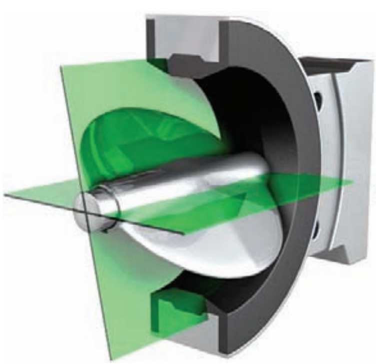
Type

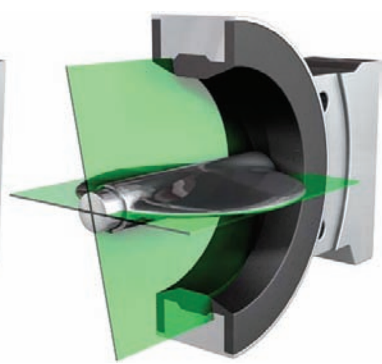
- Is a shut-off valve (on/off) and control valve.
- The stem in the center of the pipe and in the center of the damper.
- The damper rotation is 90 degrees.

Seal

- Seals by the damper pressing against the soft seal in the valve housing.







Type
- Is a shut-off valve (on/off) and control valve.
- Has the stem in the center of the pipe, but the damper is not centric. The damper is mounted on the side of the stem.
- The damper rotation is 90 degrees.

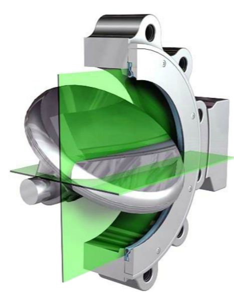
Seal
- Seals by the damper pressing against the soft seal in the valve housing.

Type

- Is a shut-off valve (on/off) and throttle valve.
- The stem is mounted off-centre on the valve housing. The damper is mounted on the side of the spindle.
- The damper rotation is 90 degrees.

Seal

- Seals by the damper pressing against the soft seal in the valve housing.
- The difference in the pressure area can be used to determine if the valve opens or closes in the event of a failure or fault with the stem mounting.

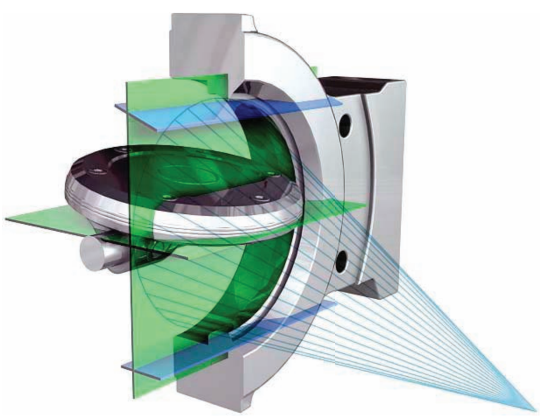


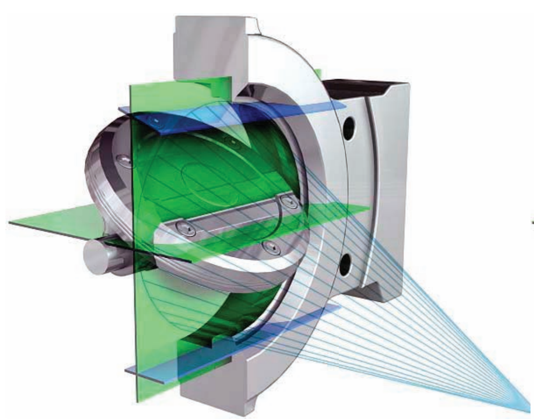
Type

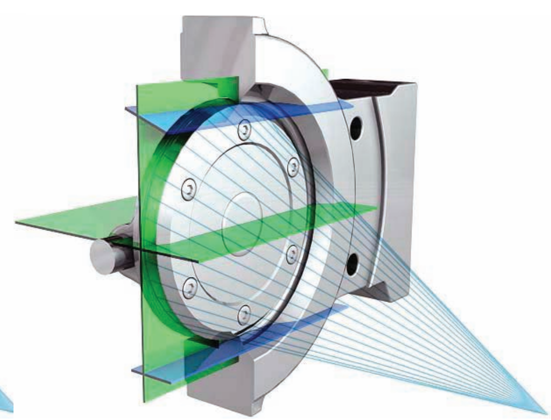
- Is a shut-off valve (on/off) and control valve.
- Has the stem mounted off-center in the pipe and off-center on the valve housing. In addition, the seat's conical design angle is also moved off-center on the pipe.
- The damper rotation is 90 degrees.

Seal

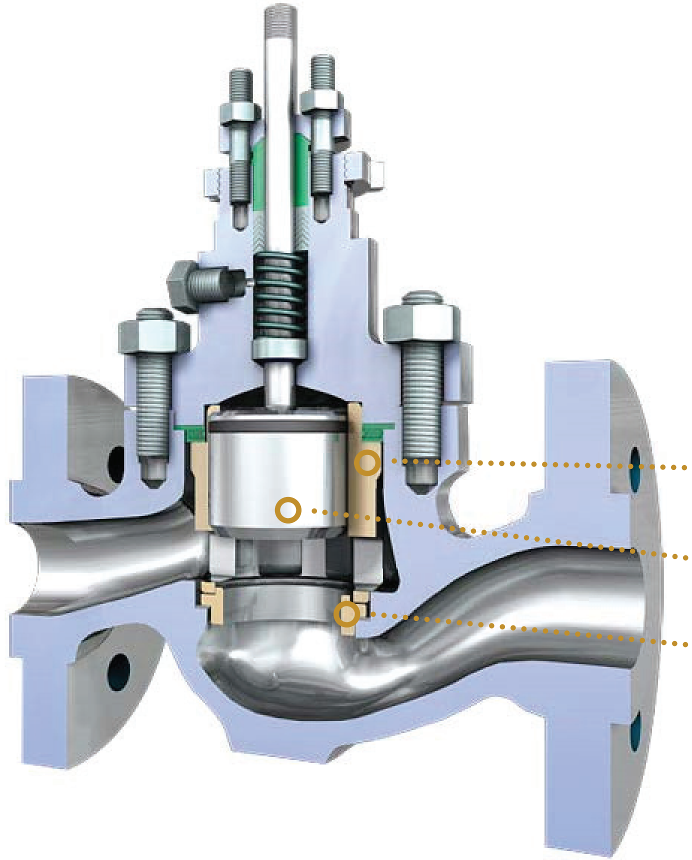
- Has only a metal seal.
- Sealing occurs when the damper is pressed against the seal in the housing.
- The difference in pressure area on the disk can be exploited to allow the valve to open or close in case of failure or defect on the stem fastening points.







9. Control Valves



Type

- Cage guided seat valve which is designed to regulate the flow conditions in the process.
- It is also available in an axial design based on the same principles as the balanced seat version.

Trim

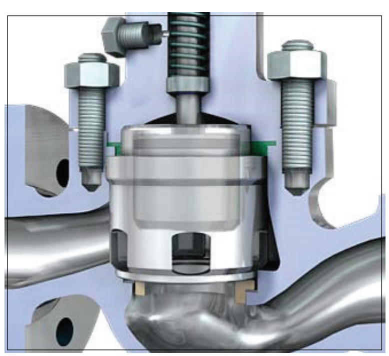
- A trim-set consists of a stem, cage, plug and seat.
- Different trim-sets are designed to operate within defined operating parameters.
- Incorrect use can cause damage to the trim.

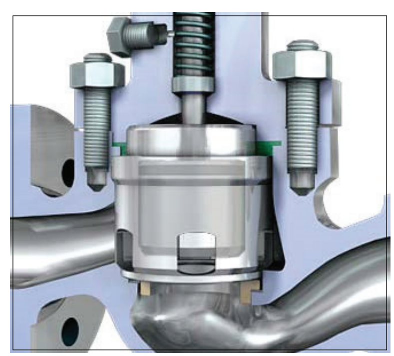
Operation

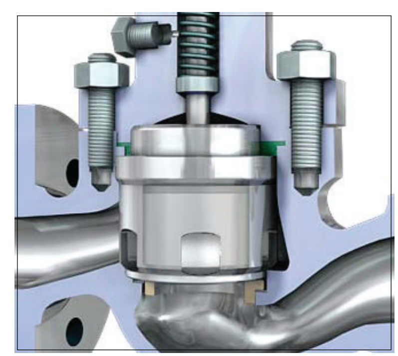
- Engineered for specific modulation functions.
- The cage guides the plug for controlling flow and velocity.
- The trim and fluid determine the flow direction.

There are three main types of control valves: seat, ball and butterfly. Seat and butterfly valves are the most common.

To reduce the risk of cavitation, cage guided valves should not have less than 20% real opening, including the dead band.







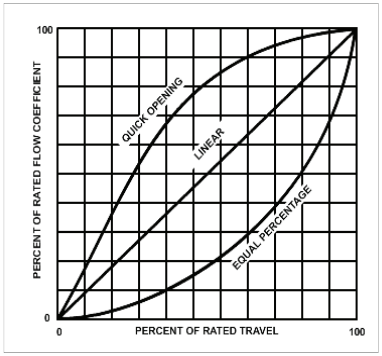
Cage
The cage and plug may have different main properties; quick open, linear and equal percentage/ logarithmic.

Quick open
A small stem movement at the start produces large flow.

Linear
Increased stem motion is approximately equal to the increase in the throughput.

Logarithmic/equal percentage
The stem movement at the start after opening produces a small increase in the throughput. Similarly, stem movement toward fully open produces a large increase in the throughput.

In terms of percentage, however, the change in throughput will be approximately the same.



There are cage variants that handle cavitation, high differential pressure and noise problems.

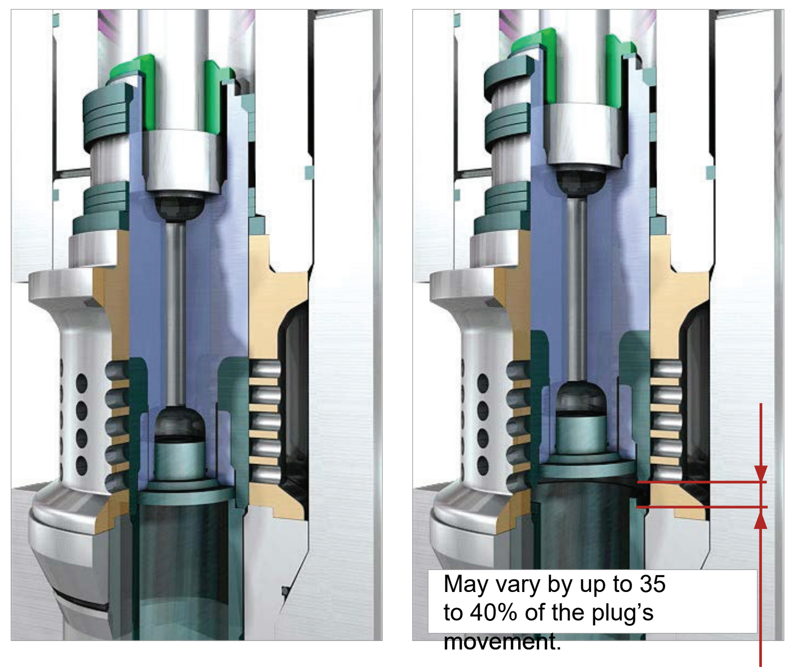
Control system

The control system receives continuous information about the stem position from the position indicator.

The actuator is adjusted by the control system based on signals from the process.
Based on data about the stem's position and flow values, the necessary degree of opening of the valve is calculated.

Dead band

Refers to the distance from the seat to the bottom row of holes/slots on the cage.
The dead band can vary by up to 35 to 40% of the plug's total movement. In this area, the trim is extremely susceptible to cavitation.

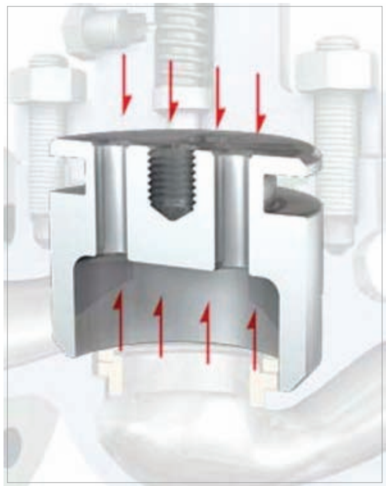


Control valves have sealing ratings ranging from I to VI ANSI FCI 70-2. This means that they range from having relatively large leakage rates to being approximately sealed.

Sealing class I has no requirements for sealing; this valve should leak.

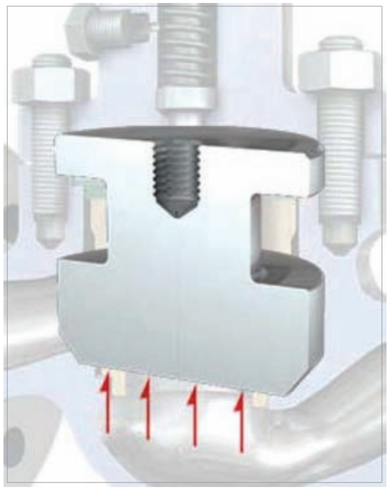
Balanced plug

- The hole means that the pressure is equalized.
- Balanced plug requires less force and actuator.
- Used for high differential pressure and for large valves.

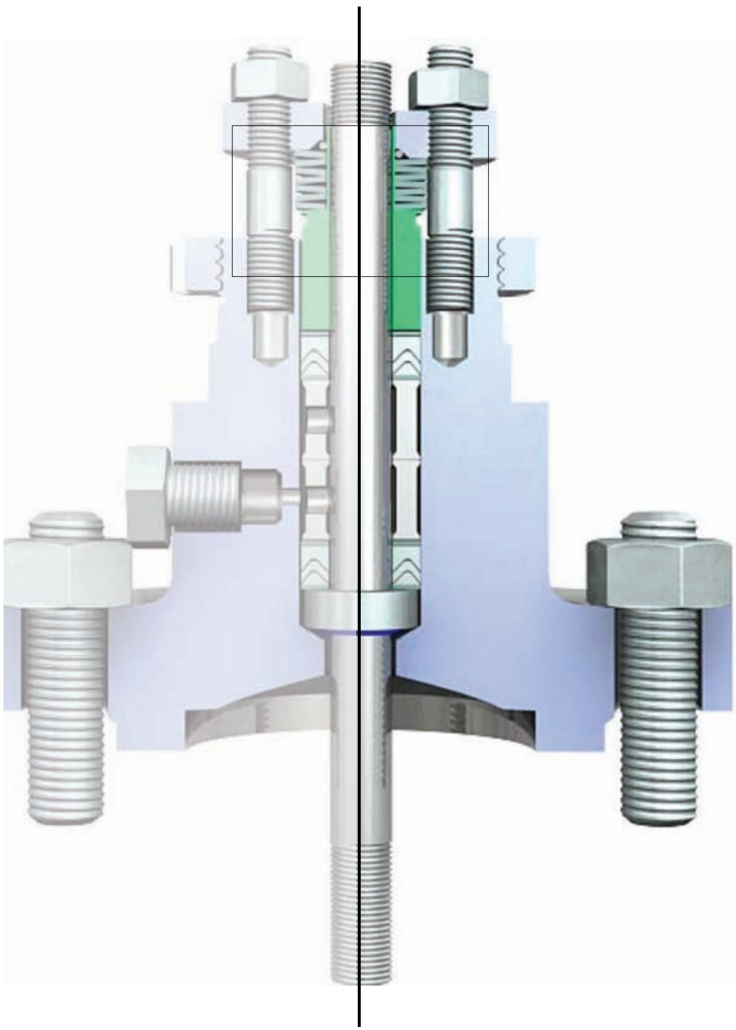


Unbalanced plug

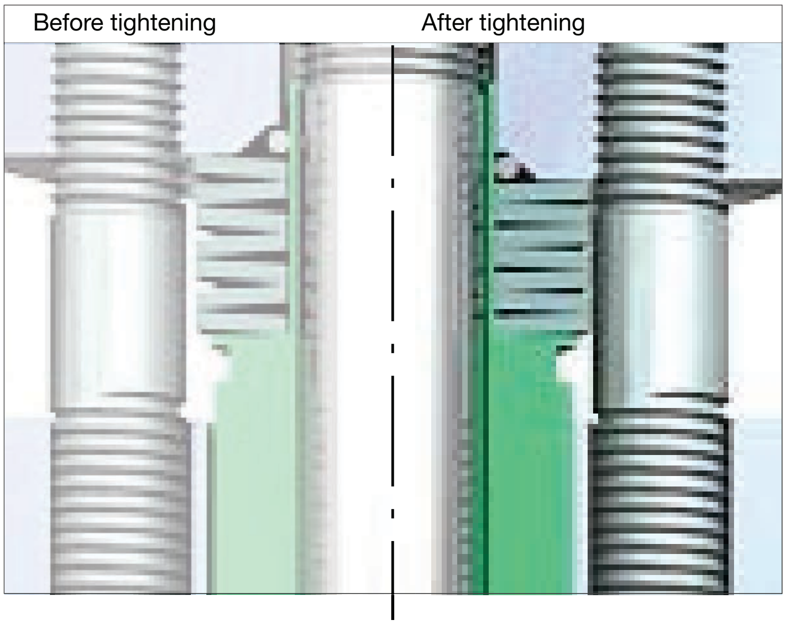
- Typically used on valves up to 2", but larger do exist. An unbalanced plug requires a large actuator to overcome the pressure forces.



There are two main types of stem seals for control valves – with and without spring load. When the valves arrive from the manufacturer, it is usually without a tightened stuffing box. Therefore, tightening should usually be performed before the valve is put into operation. The procedures for installing and tightening the stuffing box vary and are specially adapted to the materials, construction and pressure ratings.

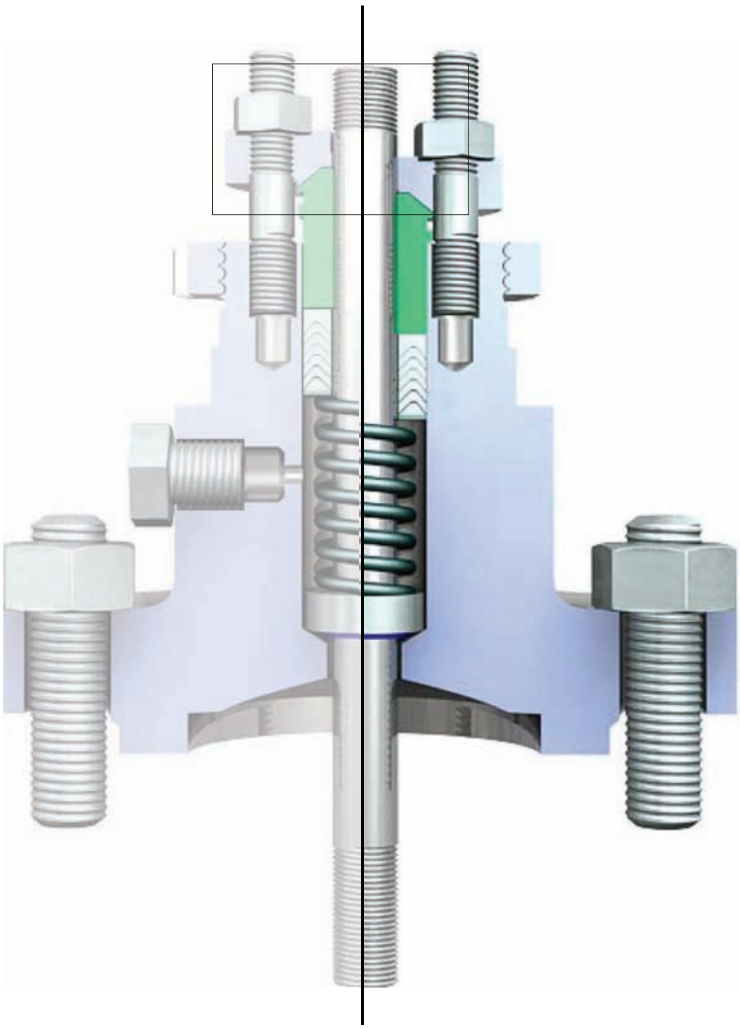


V-gaskets and spring assembly

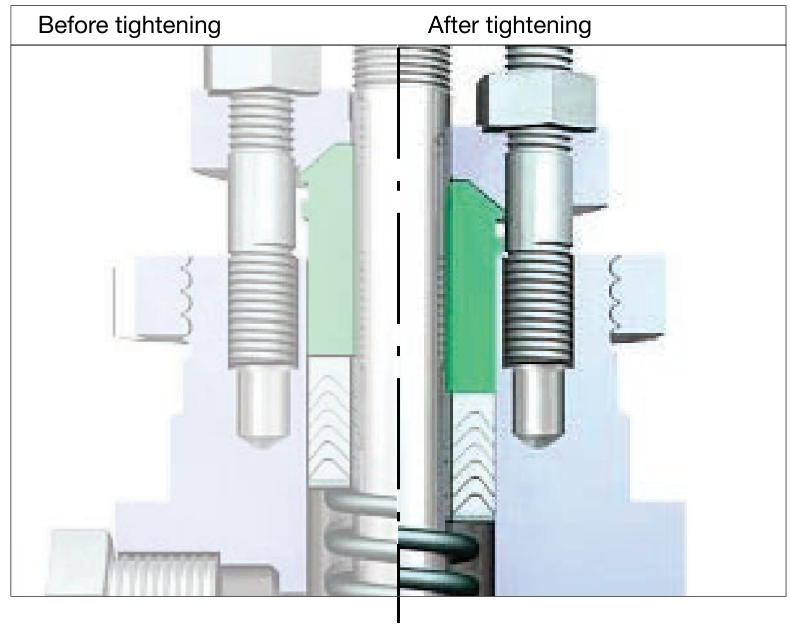


The stuffing box shown here consists of V-gaskets with a lantern ring between and a spring assembly above the pressing ring.

Always observe the manufacturer's procedures for tightening.
In this example, the springs are compressed so that there will be a small gap opening between every other spring.

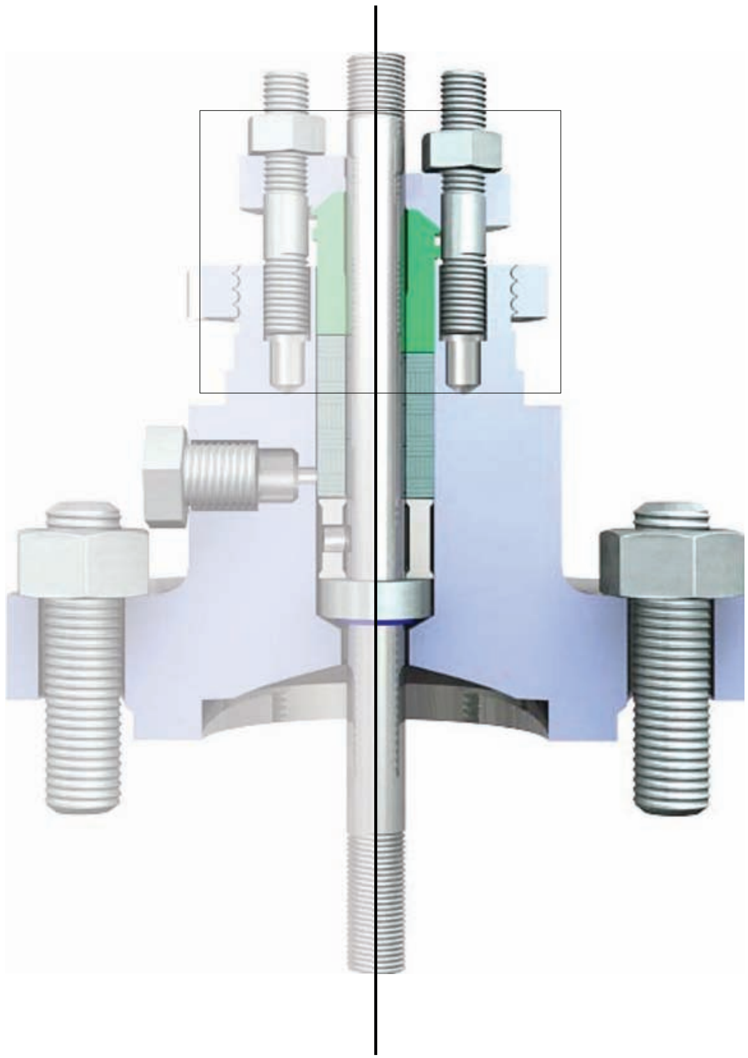


Coil spring

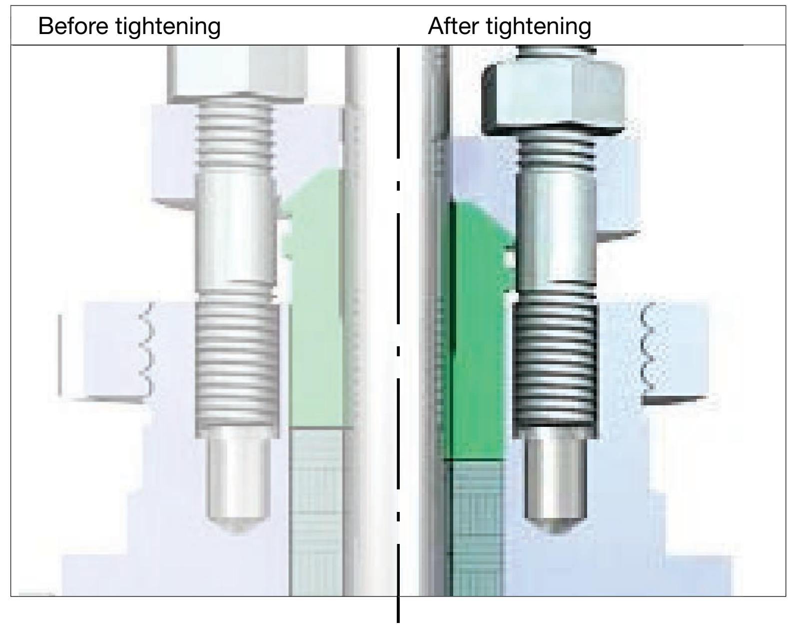


This stem seal has a coil spring between the lower scraper ring and the seat with PTFE V-gaskets.

In this example, the stop edge of the pressing ring must be screwed in completely until it is in contact with the bonnet.



Compressible graphite gaskets



This stem seal has a seat with compressible graphite gaskets and lantern ring.

Tightening of this stuffing box is dependent on graphite type – soft or hard.

Follow the manufacturer’s procedures.

Pipe insulation helps to reduce noise.

Thermal insulation provides 3-5 dbA noise reduction per inch, up to a maximum of 12-15 dbA.

Acoustic insulation provides 8-10 dbA noise reduction per inch, up to a maximum of 24-27 dbA.

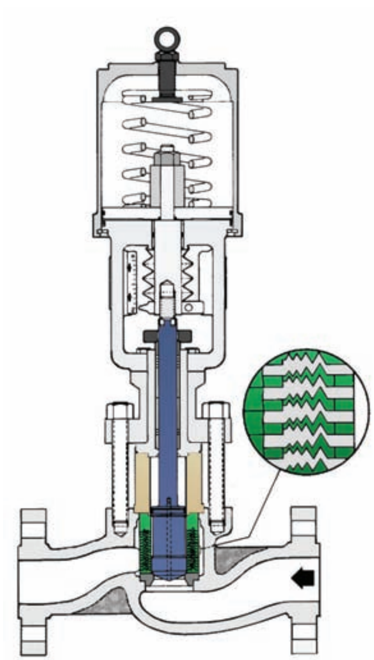
Control valves often produce a lot of noise and contribute greatly to the overall noise level at a facility.

It is important both to protect against noise and to reduce it as far as possible.

The authorities have also tightened the requirements for noise reduction.

There are also separate trims that can reduce noise.

Such trims have in common that they divide the flow and produce special passages for taking the pressure drop in several stages.

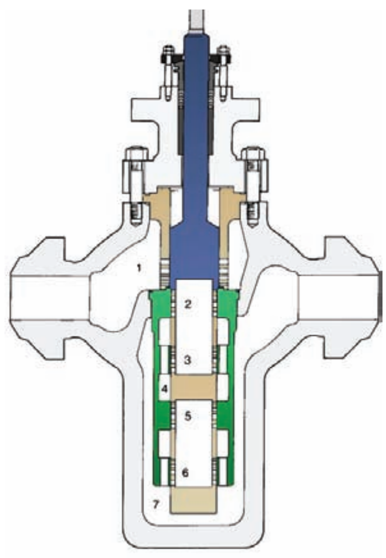


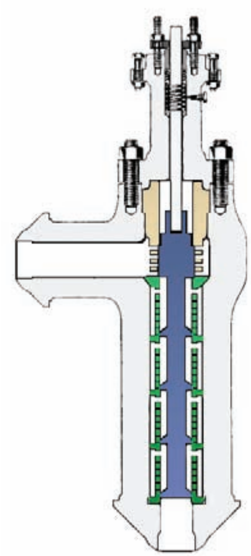
Liquid flows containing particles of sand, lime etc., result in wear. When you know you have a flow with sand, for example, it is important to note that high flow velocities will result in erosion damage.

This problem is greatest in the upstream separators for well stream. The inlet choke is therefore designed to cope with high flow velocities and possible subsequent erosion.

Cavitation

Cavitation occurs when a liquid phase that has changed to the vapor phase, also called flashing, returns to the liquid phase. This implosion can cause cavitation damage to steel. It is often possible to hear cavitation damage. It will then sound like gravel or pebbles passing through the pipe. One should especially guard against cavitation problems on valves that have small openings, especially below 20%.

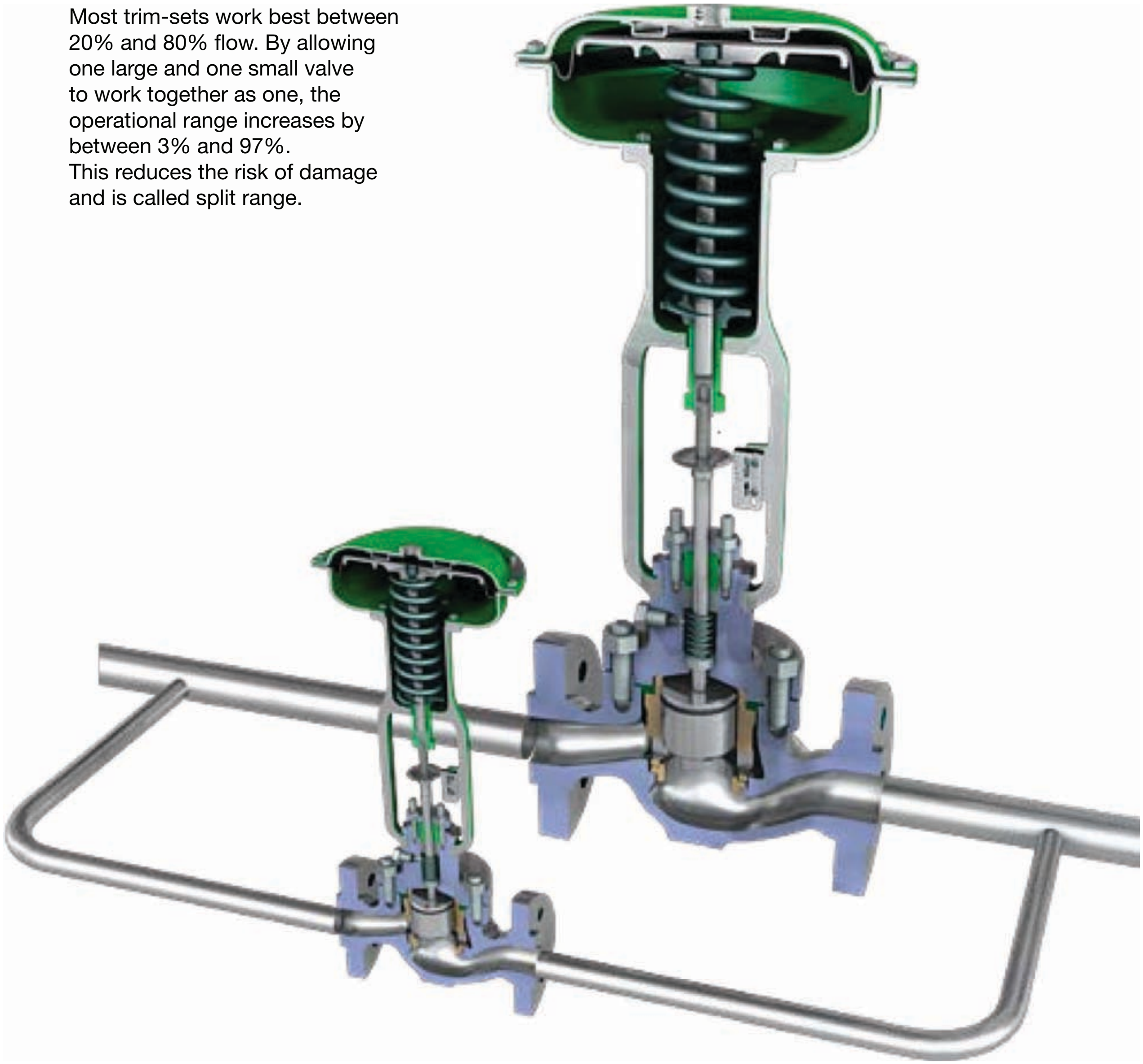




There are a number of trims especially designed to control the pressure drop across the valve so that it does not fall below vaporization pressure.

Multi-stage trims of various designs are a common choice for this purpose. Here are examples of how multi-stage trims can be constructed.

Most trim-sets work best between 20% and 80% flow. By allowing one large and one small valve to work together as one, the operational range increases by between 3% and 97%.
This reduces the risk of damage and is called split range.



10. Safety Valves

Type
- It is an unbalanced, spring operated safety valve.

Operation
- The pressure rating changes across the valve.

Set point
- 97% of the set point gives leakage past the seat in spring operated valves.

Pop pressure
- There should be a little fluid discharge in order to reduce system pressure.
- The fluid acts over a larger area, the disk gets an explosive lift and the valve opens completely. This produces increased power and the valve opens fully so that the spring can be pressed to give full opening. This occurs at approximately 102% opening and is called pop pressure.

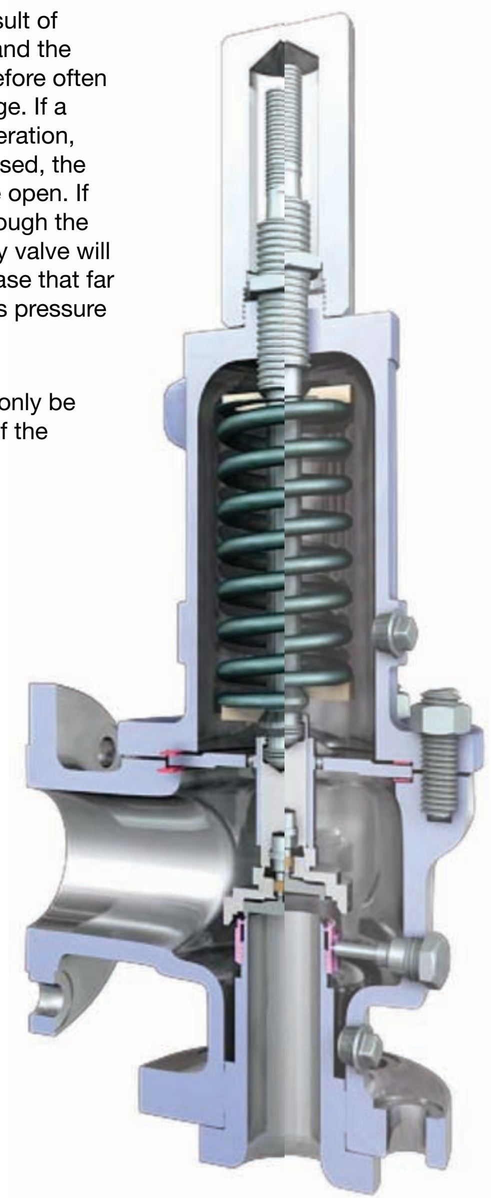
Closing pressure
- The pressure at the inlet decreases when the valve has opened. It is recommended that this pressure decrease should not exceed 3%. When the valve closes, the inlet pressure will increase again. If the pressure loss is too big, it will cause the valve to open by itself after closing and it will continue to close and open. This is called chatter.

  The valve's closure pressure must be set at approximately 7% lower than the valve's set point in order to avoid chatter. When the valve closes, the pressure increase will not be high enough to reopen the valve. The difference between the valve's set point and the closing pressure is called blowdown. Adjust the blowdown ring to provide the desired lifting pressure on the disk in the partially open position.

Back-pressure
- The outlet side is pressurized by opening.
- The back-pressure spreads to other safety valves. Safety valves must be adjusted with regard to back-pressure.

Gas will expand as a result of the pressure reduction and the discharge flange is therefore often larger than the inlet flange. If a safety valve is not in operation, and the inlet valve is closed, the outlet valve must still be open. If it is not open, a leak through the inlet valve and the safety valve will lead to a pressure increase that far exceed the outlet valve's pressure rating.

The outlet valve should only be closed for dismantling of the safety valve.

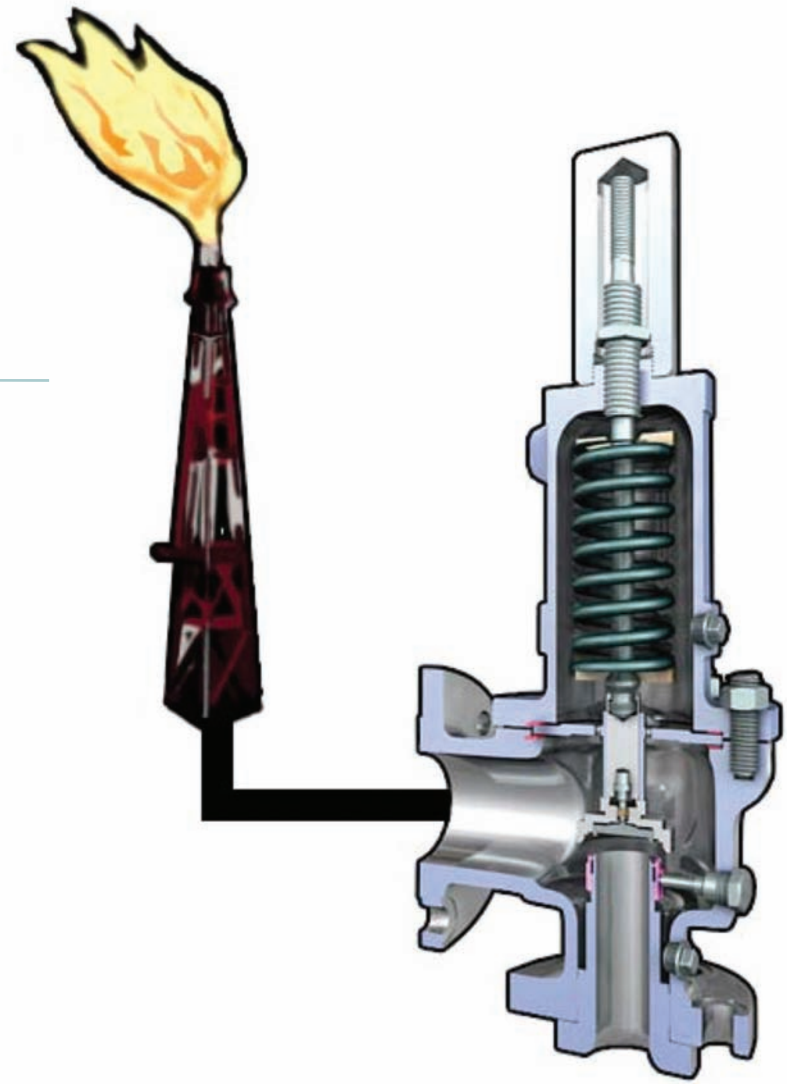


The safety valves are the last barrier against overpressure. The valves should open to a safe area for an appropriate pressure relief. They should open at a given pressure, even after not being operated over a longer period.

The valve must be tested regularly in order to ensure that it opens at the given pressure. This is also a regulatory requirement. Special courses are required in order to perform testing and maintenance of safety valves.
The valve must be overhauled in the event of any deviation from the specified opening requirements and leakage.

Safety valves do not necessarily maintain a seal, and downstream pressure build-up must therefore be prevented.

Pilot-operated valves may contain several potential leakage points, because they have many pipe connections between the pilot and the main valve. These should be tested for leaks at each recertification.

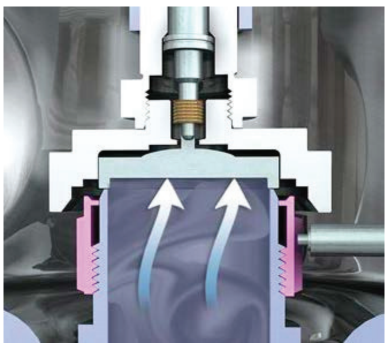


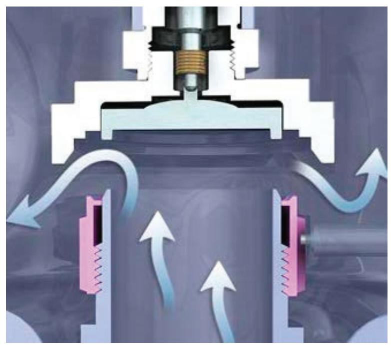
When the pressure on the disk's area produces an opening force that exceeds the spring pressure, the valve will open. When the valve has opened, the spring is compressed.

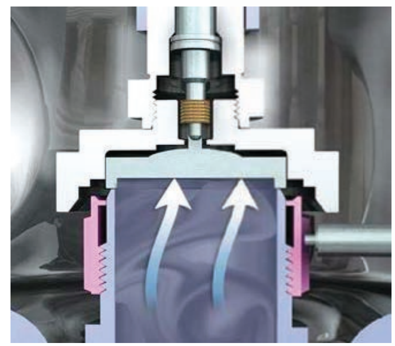
The valve relieves the pressure and the inlet pressure drops. The pressure goes into the valve's spring housing and outlet as back-pressure.

The pressure loss in the inlet allows the valve to return to the closed position. The blowdown ring is a ring screwed onto the valve's inlet nozzle. In order to prevent the valve closing prematurely, this ring must be adjusted so that it slows the outflow from the nozzle and acts on the valve's disk.

The blowdown ring then affects the disk so that it does not close until the pressure is approximately 7% lower than the inlet pressure. In case of misalignment of the blowdown ring, the valve can begin to chatter. The ring must be adjusted according to the manufacturer's guidelines.







A spring-operated safety valve that is balanced has no connection between the valve tube and the spring housing.

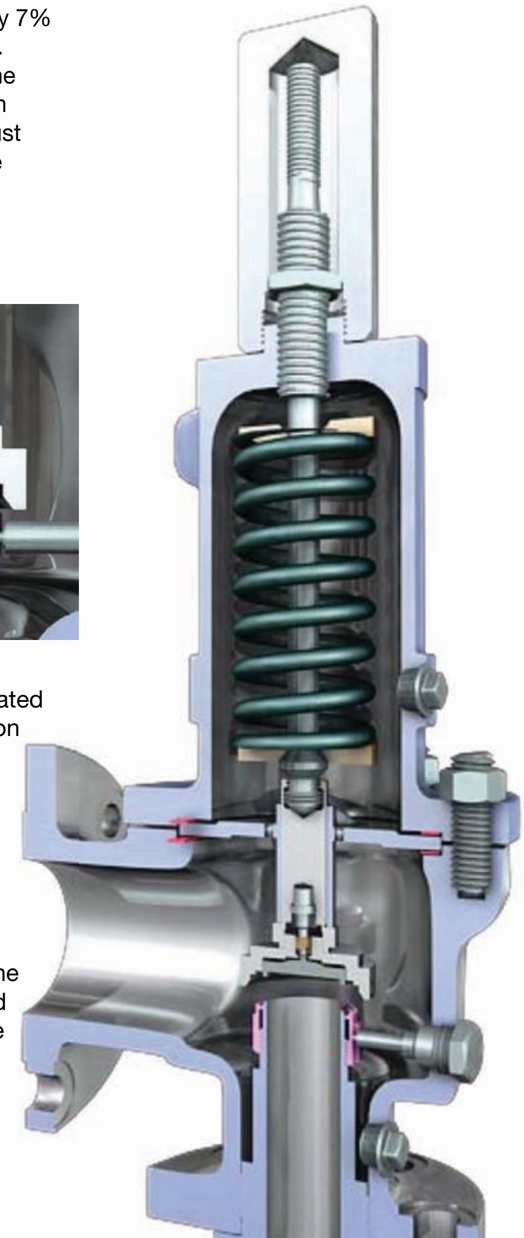
From the disk, a bellows extends along the stem and seals against the spring housing. This prevents back-pressure having any effect on the configured opening pressure.

Note that it is important to maintain aeration of the spring area.

An unbalanced spring-operated safety valve has a connection between the valve tube and the spring housing.

Here, the back-pressure works with the spring to close the valve.

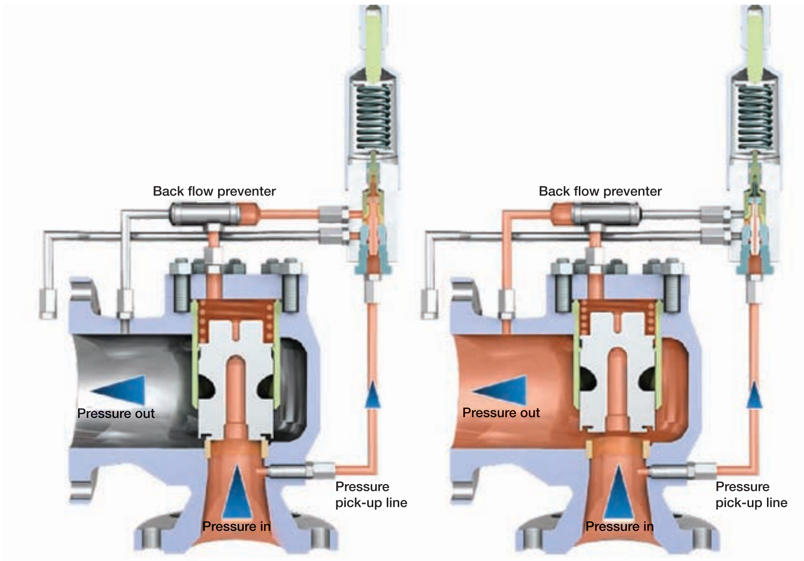
This is mainly used where the back-pressure is known and constant, or where there are no back-pressure.



Structure

While a spring-operated valve has weaker sealing with increasing pressure, a pilot-operated valve will achieve better sealing with rising pressure. The main valve on a pilot-operated valve will have inlet pressure both below and above the piston. The area under the piston is approximately 25% smaller than the area above the piston.

This means that the same pressure above and below the piston will provide a higher force toward closing than for opening. Thus, the valve cannot open until the pilot releases the pressure above the piston.



Hazards

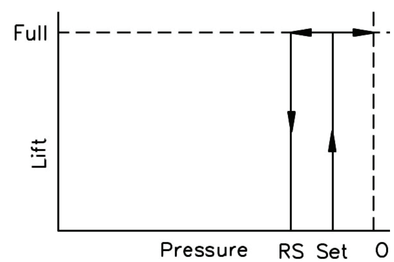
Impure fluids and fluids that entail a risk of hydrate formation mean that there are special risks associated with pilot-operated safety valves. Clogging of impulse tubes must be prevented, and this can be achieved by placing a filter on the valve's inlet.

Methanol injection has been used to prevent hydrate formation. An important measure against hydrate formation in gas streams is heating cables along the pipes.

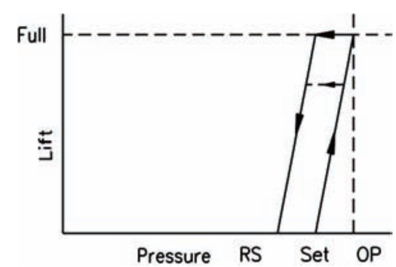
NB. Methanol can lead to degradation of seals.

Types

A pilot of type pop action, also called full-release, dumps the pressure from above the piston and opens quickly.



A pilot that is modulating, bleeds off the desired pressure above the piston to provide an opening adapted to the pressure increase in the system.

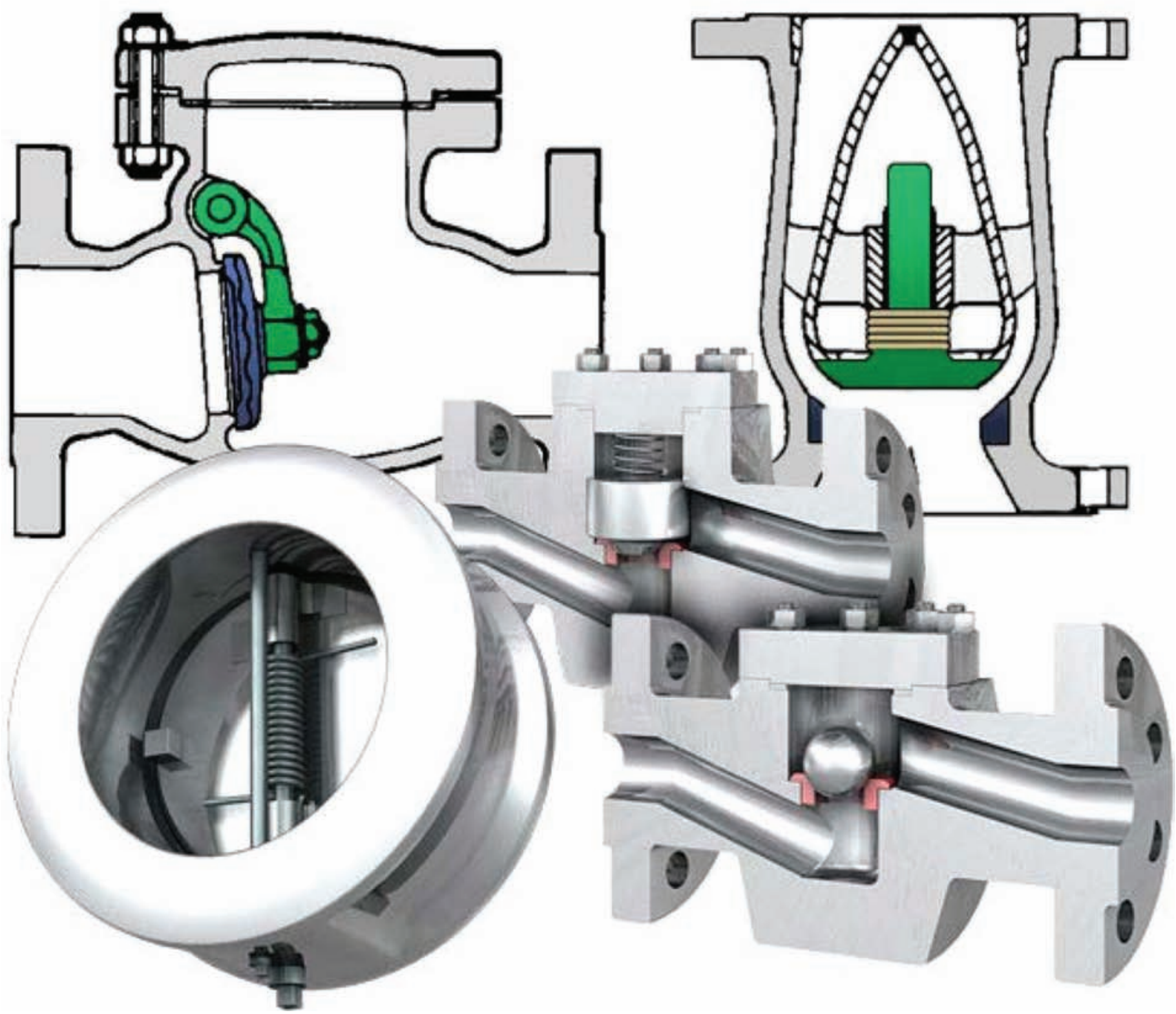


11. Check Valves

Function
The function of check valves is to stop massive backflow in case of the breakage of pipes and to prevent back-flow towards lower pressure.

Seal
Check valves normally have no maintenance and may not hold pressure when closed.
In some cases, it can be recommended that the valves leak in order to avoid locked-in pressure between the check valve and the block valve.

Locked-in pressure
Locked-in pressure can cause operational problems with neighboring block valves. The valves are not bi-directional and the direction of flow is therefore crucial to preserve function.



Duo check

The duo check valves are designed to be placed in a horizontal tube with the shaft vertical. Duo check can also be used in vertical pipes with the flow direction upwards. There are other check valves that can be placed in vertical tubes.

Duo check is normally used from 3" and above, and should be used in non-erosive fluids. This is because disks and shafts are exposed to the middle of the pipe.

Noises from the valve, such as clattering, may be due to damaged springs. Clacking flaps can gnaw apart the shaft that holds them in place.

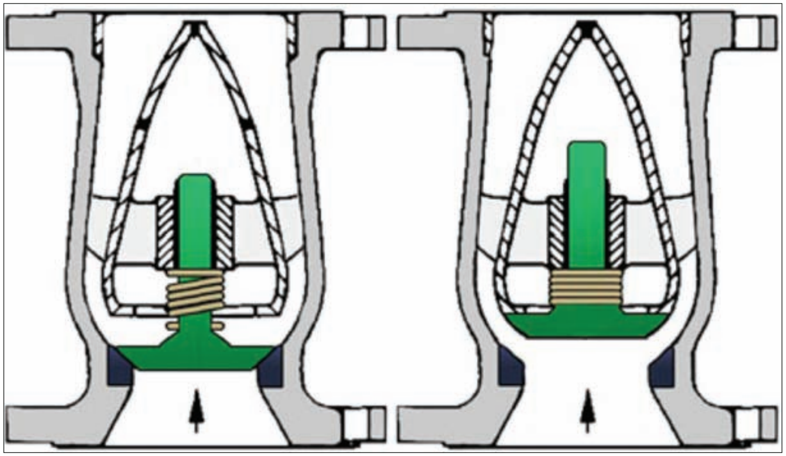
If the shaft breaks, both the shaft and the flaps will disappear in the pipe. A valve that makes a noise should therefore be checked at the first opportunity.

Nozzle check

Nozzle check valves that have short movements are therefore quick-closing. These valves close so quickly that the fluid is unable to flow back and they are referred to as “non-slam” check valves.

In order to provide the required opening and closing properties, the spring on the valve must be optimized based on the relevant flow, fluid and location.

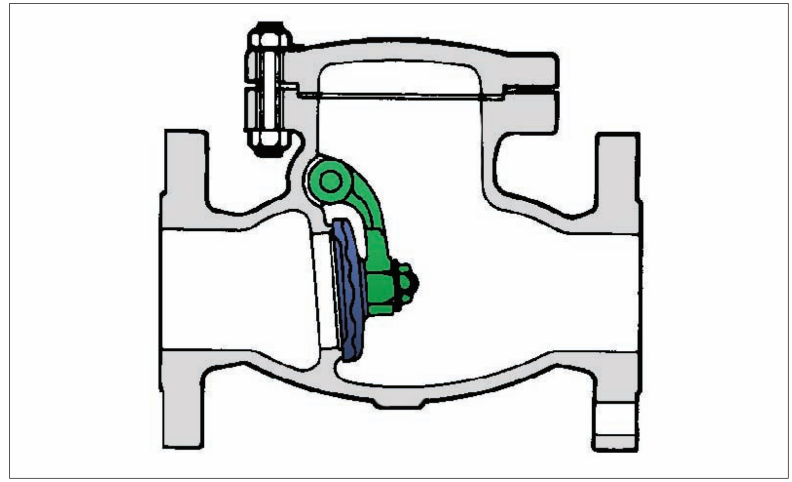
The valve is used primarily in systems with rotating compressors, where contra-rotation must be prevented.



Swing check

In a swing check valve, the obturator is tilted away and kept out of the flow, but this also produces large movement, which results in backflow before the valve closes.

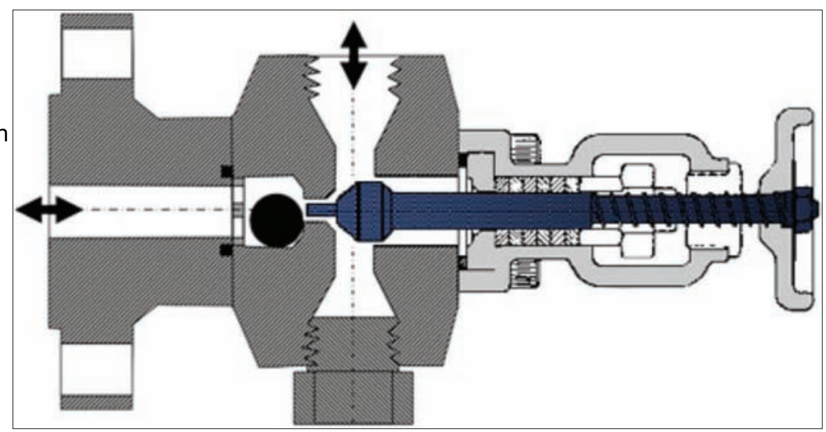
This makes the valve better suited to withstand erosive fluids, but can cause a pressure shock at closing.



Sight glass valves

Sight glass valves prevent leakage of fluids from a tank in case of breakage of the sight glass. The non-return ball in these valves has a tendency to hang in connection with level variations in the tank. The sight glass will then display an incorrect level.

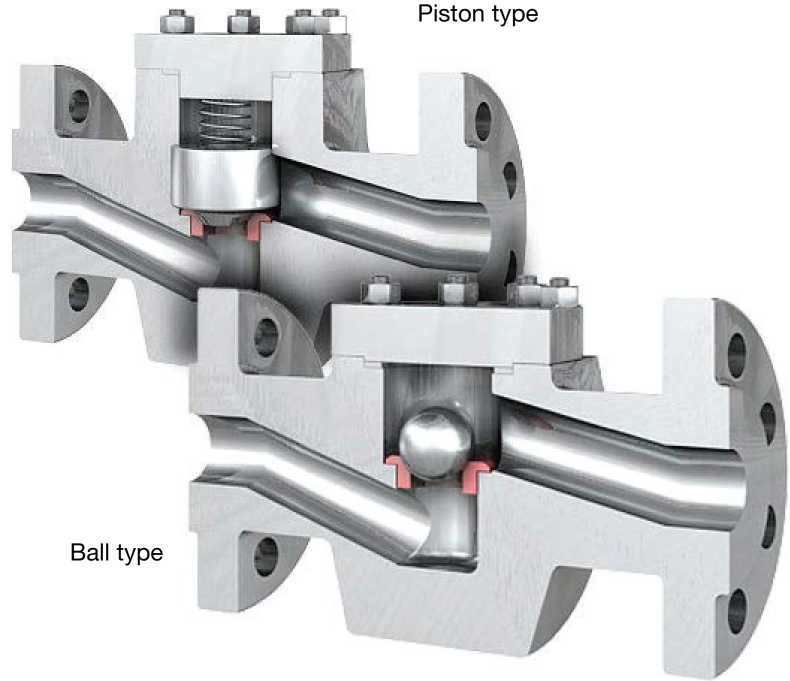
Restoring the correct level in the glass is achieved by putting the valves in the middle position. The valves must therefore not be left in this position, but in either the fully open or fully closed position.



Ball check

This is a check valve of ball-check type.

This is found in a variety of designs and is usually used for small dimensions.



12. Maintenance

Button-head without threads

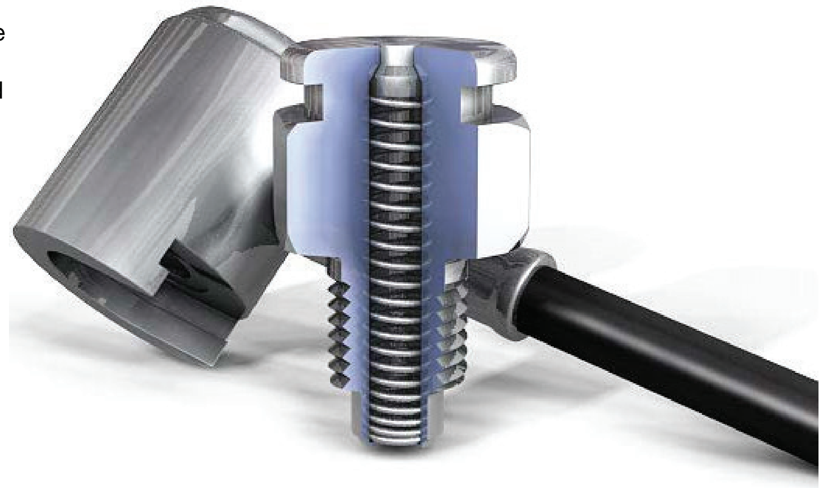
This lubricating nipple has no cap to protect the lubricating nipple's sealing surface against the caliper.

Before use, the top of the lubricating nipple must be thoroughly cleaned, as this is the fitting and sealing surface against the caliper for the lubricating pump.

Put on the caliper. When there is pressure in the system, the pump pressure must exceed the system pressure in order to provide lubricant or detergent.

Because of problems extending the springs, some lubricating nipples have an extra safety catch screwed in under the spring.

Check that the lubricating nipple is tight by bleeding off on the return to the pump before the caliper is removed.



Button-head with threads and cap

This lubricating nipple has a cap to protect the lubricating nipple's seal surface and in order to be able to block any leakage in the lubricating nipple.

NOTE! Before use, check that the holes in the cap are open. Loosen the cap one half to one revolution and check for leakage out of the holes in the top of the cap. Fit the caliper for the lubricating pump.

When there is pressure in the system, the pump pressure must exceed the system pressure in order to provide lubricant or detergent.

Check that the lubricating nipple is tight by bleeding off on the return to the pump before removing the caliper.

Split with two balls

This lubricating nipple is split in order to be able to block any leakage in the lubricating nipple.

Before use, the top of the lubricating nipple must be thoroughly cleaned, as this is the fitting and sealing surface against the caliper for the lubricating pump. This lubricating nipple has a mechanical seal between the two balls, which must be opened before pumping in.

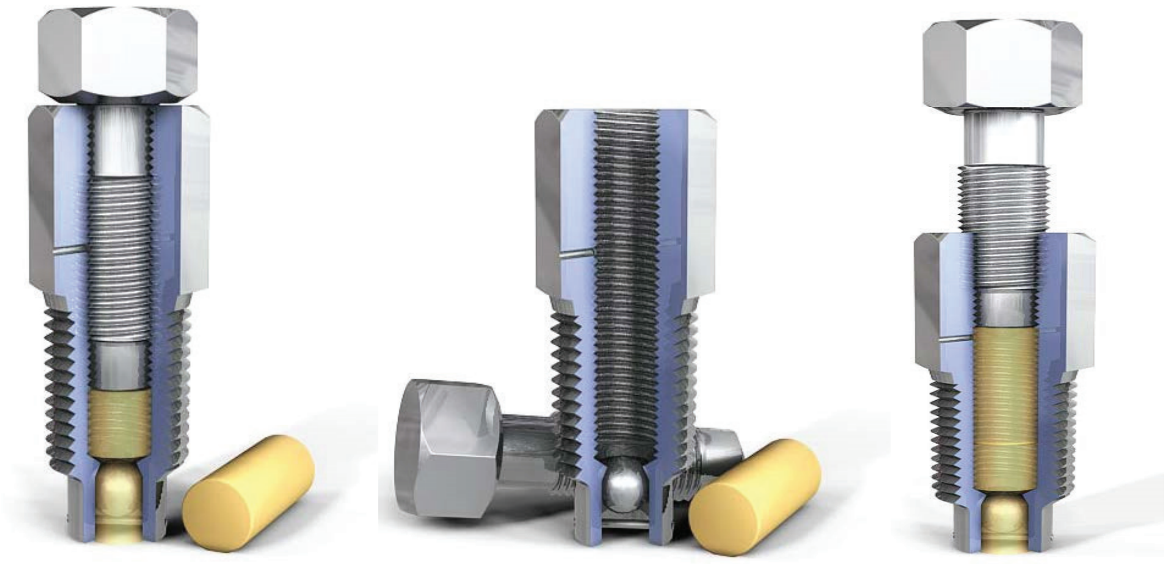
Unscrew the upper part one revolution and check for leakage. Fit the caliper for the lubricating pump. When there is pressure in the system, the pump pressure must exceed the system pressure in order to provide lubricant or detergent.
Check that the lubricating nipple is tight by bleeding off on the return to the pump before the caliper is removed.

A small amount of oil

This is a small lubricating nipple for oil for the stem.

Before use, the top of the lubricating nipple must be thoroughly cleaned, as this is the fitting and sealing surface for the lubricating pump. Attach the lubricating pump.

Pump the oil in carefully to avoid damage to the lubricating nipple.



Sealant injector
The sealant injector is placed on the stem for orbit valves and is used to activate the stem seals.

When the injector screw is screwed fully down, the sealant must be replenished.

Unscrew the injector screw gently. It should now go easily if the check valve is sealed. Otherwise it will feel heavy. Any leakage will also be detected when the screw has passed the leakage indicator hole.

Insert a new piece of sealant and screw in the outer part until you feel resistance, or until the leakage in the stem stops.

This valve top is usually used in wedge gate valves. The valve top has a rising, non-rotating stem.

Components: (for illustration only)

Wheel with bearing and bushing

Yoke

Stem with backseat

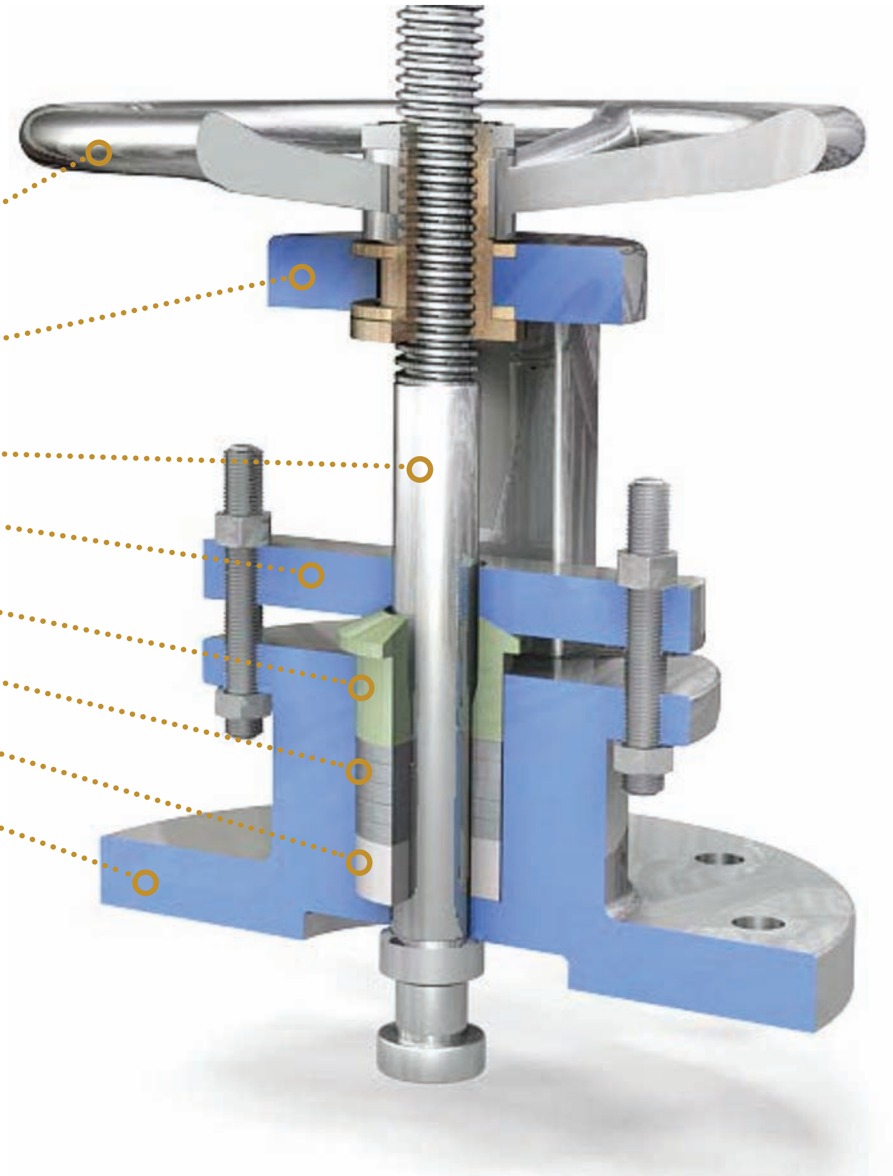
Pressure gland and pressure gland bolts

Pressure ring

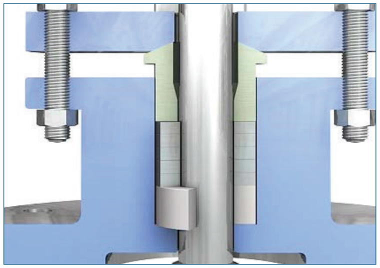
Stuffing box

Carbon sleeve

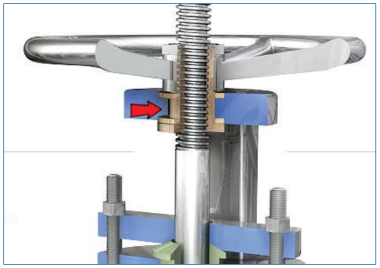
Bonnet with backseat



Troubleshooting in connection with valve tops as shown in the figure, is usually performed in connection with stem leaks or operational problems.

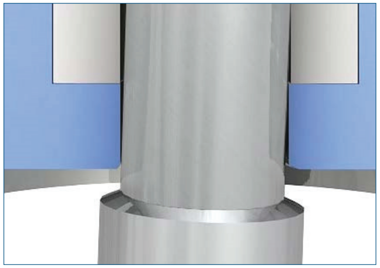


Note that for valves that have been screwed too tightly to close, the edge of the bushing under the yoke may be stretched. This may cause looseness and cause the valve knocks when it opens again. This may be an indication that the valve is in the process of being destroyed.

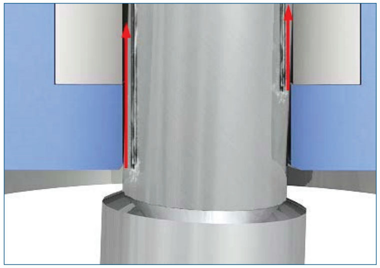


Scratches on the stem:

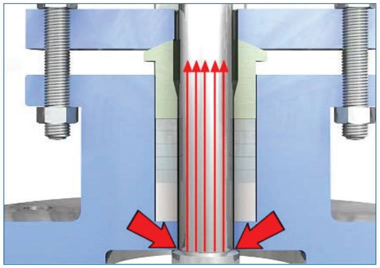
Skewed stem
An incorrect tightening procedure on the stuffing box can result in the stem being skewed and coming into contact with the bonnet as shown in the figure.



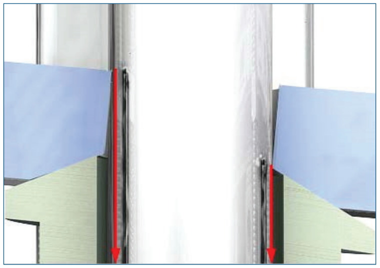
When the valve is operated, vertical scratches may occur on the stem. It is important that the stem is always in the backseat when the pressure gland is tightened. Rising non-rotating stem – vertical scratches. Ascending rotating stem – spiral stripes.



Deformed backseat
Excessively hard operation of the valve in the open position can deform the backseat. This will produce vertical stripes around the entire stem when it is operated.



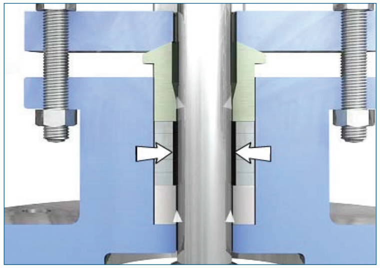
Skewed pressure gland
Skewed tightening of the pressure gland may cause the gland to come into contact with the stem as shown. When the valve is operated, vertical scratches may occur on the stem.



Loose stuffing box

Leakage can occur because the stuffing box is loose.

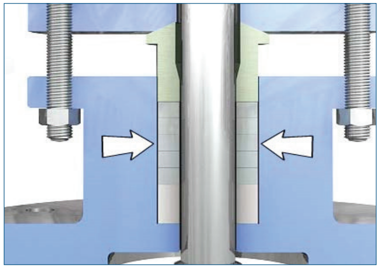
1) Wear on the gaskets



If the stuffing box is completely compressed and leaks, it must be replaced.

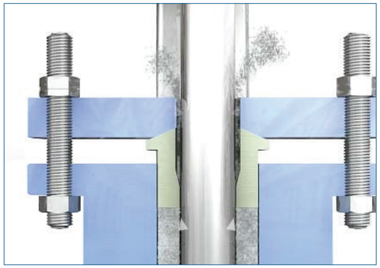
The maximum compression rating for low density graphite is between 25% and 40%.

2) Inadequate compression



In case of inadequate compression of the stuffing box, leakage can occur past both sides. The gland can be tightened in order to compress the stuffing box and stop the leak.

3) Over-compressed stuffing box

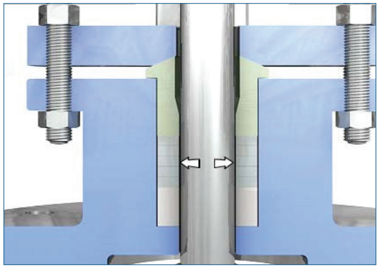


In case of excessive tightening of the pressure gland bolts, the graphite in the stuffing box may be pulverized. This can result in leakage and blow-out of the sealing material.

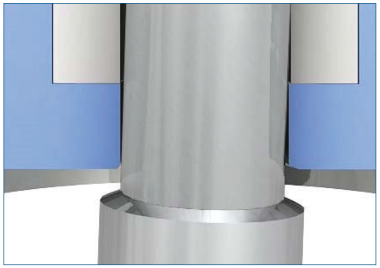
Note! This can only happen with the molded type (Grafoil), not with the reinforced braided.

Slow operation

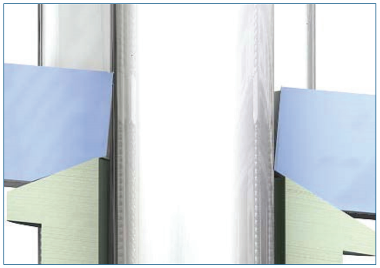
1) Excessive tightening
The stuffing box is tightened too hard. The stuffing box expands too much and presses against the stem, which results in high friction.



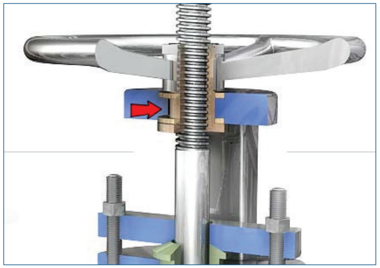
2) Skewed stem
Incorrect tightening procedure for the stuffing box. The valve is not in the backseat, which may result in a skewed stem.



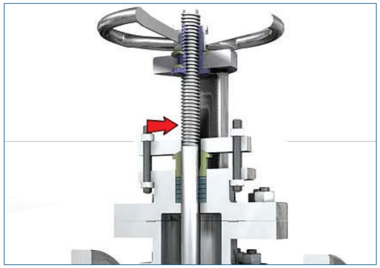
3) Skewed pressure gland
Skewed tightening of the pressure gland.



4) Corrosion in bearing/threads
Corrosion, inadequate lubrication or damage to the stem threads and stem bearing and bushing.



5) Fixed gate
Sluggish operation may be experienced at the start of operation in cases where the gate has become stuck between the seats.



The usual procedure is that it is replaced with original sealing according to the parts list or sealing of type low density braided 1% reinforced and 99% pure graphite.

The stuffing box should have 4 to 7 sealing rings in graphite based stuffing boxes. The upper and lower rings should be braided rings to prevent the stuffing box blowing out.

Recent research has shown that a stuffing box should not have more than five sealing rings. The recommended sealing type is low density braided 1% reinforced and 99% pure graphite.

Do not use corkscrew, hooks, screwdriver or similar to remove the seals. Such use may cause damage on the seal surfaces.

Removing the old stuffing box

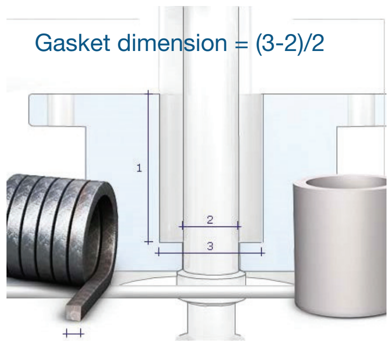
1) Insert the valve in the backseat. This should always be performed when the pressure gland shall be adjusted, including during tightening of the stuffing box.

2) Remove the gland nuts. Lift up the pressure gland and the pressure sleeve and bind them securely.

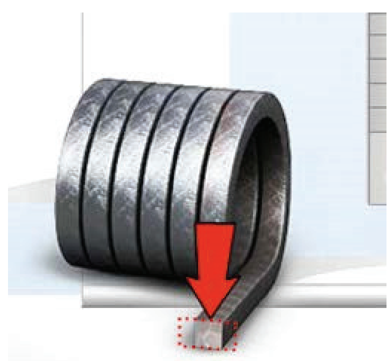
3) Use a gasket blower to remove the old stuffing box. Observe safety precautions during use. Personal protective equipment is required.
4) Clean the stuffing box groove with the gasket blower and inspect the stem and stuffing box groove for scratches or corrosion.

Prepare a new one

5) In order to calculate the gasket dimension and the size of the carbon sleeve, it is necessary to measure: the depth of the box 1, the diameter of the stem, 2, and finally the inner diameter of the box, 3.
6) The correct gasket dimension is found by: subtracting the diameter of the stem (2) from the diameter of the box (3) and dividing by 2.



7) To ensure good contact between the stem and the gasket before compression, the gasket dimension must be adjusted within tenths of a millimeter. This is done by rolling the gasket carefully out with a gasket roller.



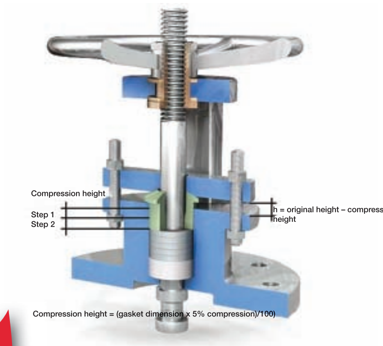
8) Adjust the carbon sleeve measurement to fill the extra distance beyond five rings.

Installation

9) Adjust the gasket rings. Always use a gasket cutter, as this cuts the gaskets with a 45 degree angle and also ensures the correct length is obtained.
10) The gaskets must be positioned with 120° between the seams so that the seam is squeezed together by the gland pressure.

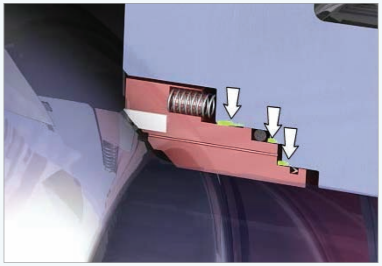
Compression

11) Calculate the correct compression of the gasket kit. The percentage by which the gasket height must be compressed can vary according to the pressure rating, and is specified by the gasket supplier.



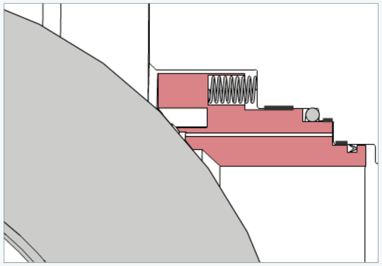
Note! Make sure the pressure gland is horizontal and does not scrape against the stem during compression.

When the fluid is liquid, check for leaks. When the fluid is gas, use soapy water, Snoopy or similar.

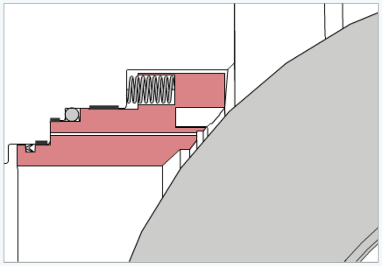


Why wash and lubricate

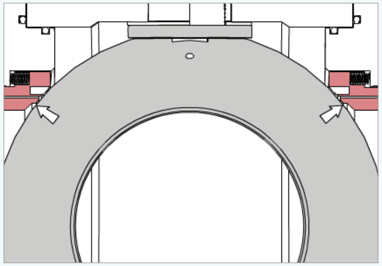
A common problem is that deposits form between the seat and the seat pockets. The figure shows where the deposits form.



When the downstream pressure decreases, the differential pressure over the ball could deform the ball and trunnion so that the downstream seat is pressed into the seat pocket.

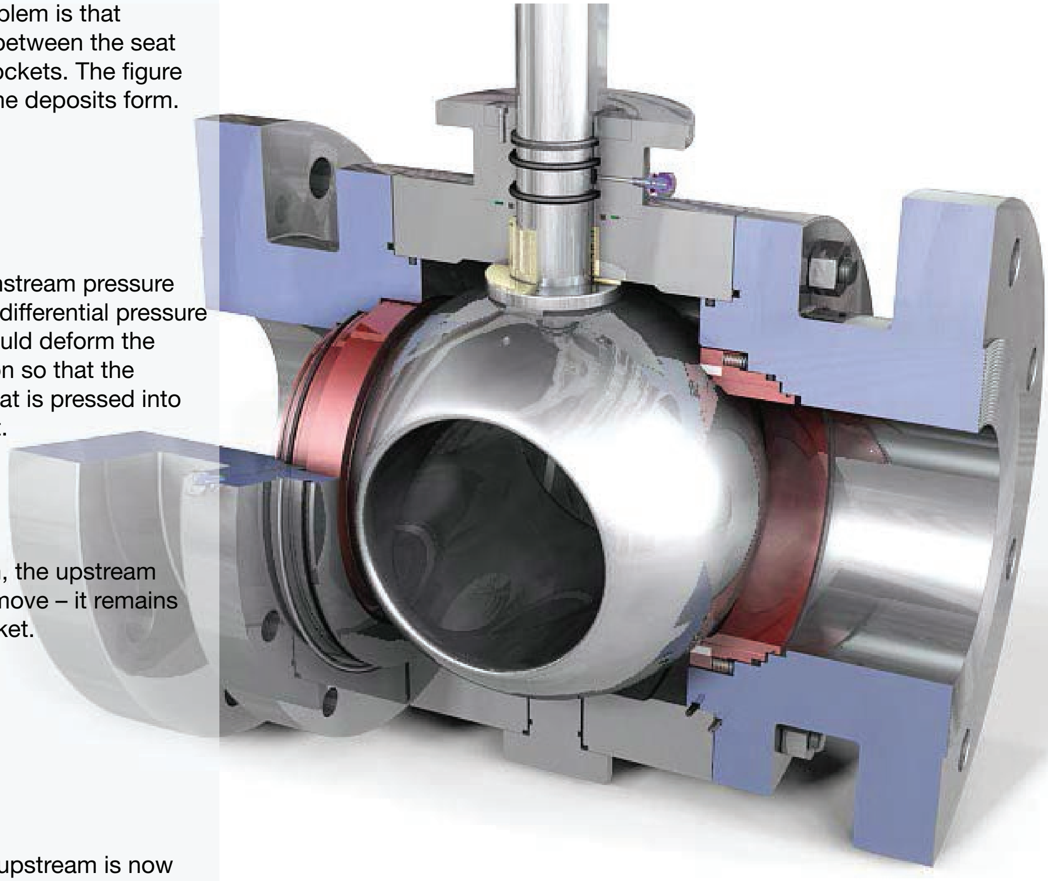


As can be seen, the upstream seat does not move – it remains in the seat pocket.



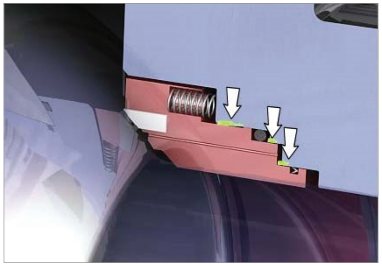
If the pressure upstream is now reduced, none of the seats are in contact with the ball and the valve will leak when the system is pressurized.

A solution to this problem is washing and lubrication of the seats.

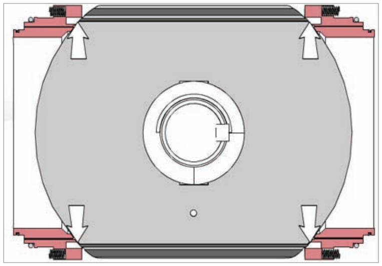


Why wash the ball

Valves that have been in the open position for longer periods tend to get deposits on the ball. These deposits form in a circle around the seal surface of the seat.

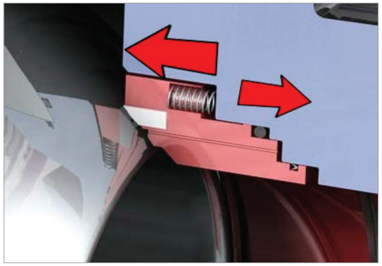


In the closed position, the deposits now come into contact with the seat's soft seals at the indicated points. At exactly these points, the soft seal will climb up on the deposits so that the seat no longer comes properly into contact with the ball. The valve will leak.



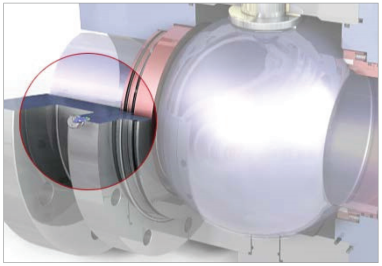
A solution to this problem is to wash the ball.

Why shock the valve? To shock the valve means quickly reducing the pressure in the valve housing using auxiliary valves. Shocking can loosen seats that are stuck in the seat pocket due to deposits, after both washing and lubrication have been performed.

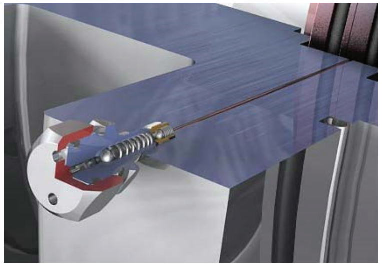


Procedure for washing seats and ball

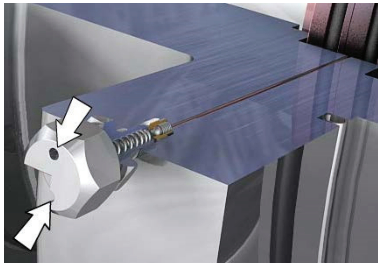
To perform washing, it is recommended to use a hand pump for liquid in order to achieve better control of the quantity and pressure. Diesel or kerosene are commonly used.



Verify that the lubricating nipple is free of leaks by loosening the cap half a revolution.

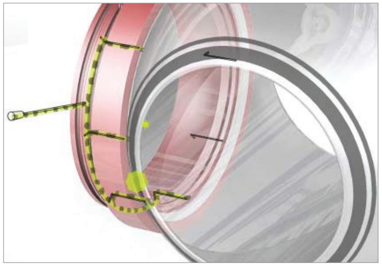


The holes in the cap can now be used to check for leaks, as the extra seal in the cap has gone.



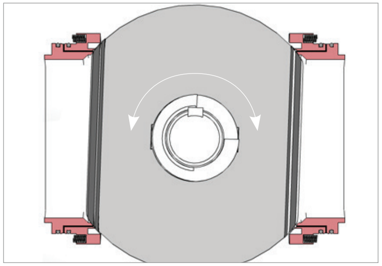
Once you are sure that the lubricating nipple is in order, screw off the cap and attach the caliper for the detergent.

Pump in some kind of detergent from the hand pump. The detergent dissolves the deposits and friction between the seat and the seat pocket is reduced.



When there is only one lubricating nipple on each seat, it will not be possible to wash off the valve seat for more than one side of the seat.

Remove deposits on the ball by rotating it 5-10 degrees back and forth 4-5 times in both the open and closed position. This applies in cases where there is both one and two lubricating nipples into each seat.

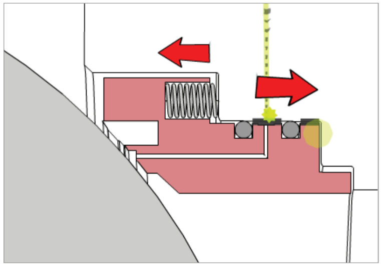


When the ball is operated in this way, the seats will work like scraper rings, and the dissolved deposits will disappear.

Procedure for lubrication

Pump in lubricant via the seat's lubricating nipples. Note! Grease must not be used.

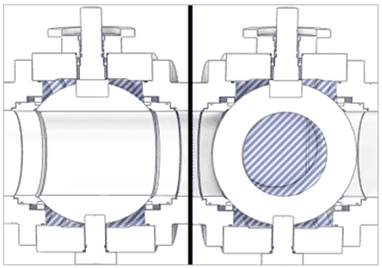
When pumping in lubricant, the friction that prevents movement of the seat will be reduced.



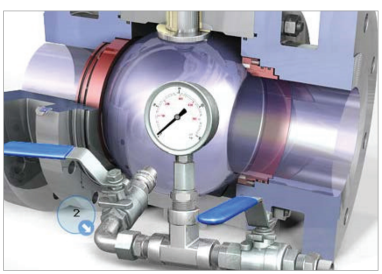
The lubricant will have a preventive effect over a period. This maintenance operation should therefore be repeated periodically, depending on the fluid, the temperature and operation of the valve, the so-called condition-based maintenance.

Procedure for shocking

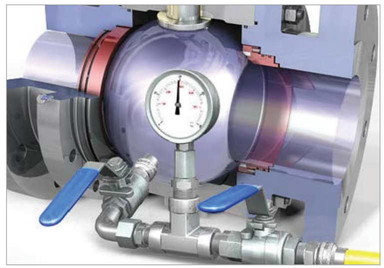
- The volume of a valve housing is smaller in the open position, so that the effect of shocking is enhanced.



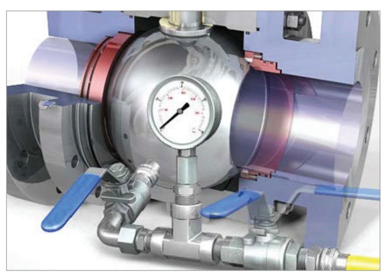
- Attach transversely – must be ball valves (for quick opening and closing) in the closed position.
- Connect to secure system.
- Open the innermost auxiliary valve and read off the system pressure.



- Open the outermost auxiliary valve quickly for 2-3 seconds for rapid pressure reduction in the valve housing.
- Close the outer auxiliary valve.



- Observe the pressure in the valve housing. If the pressure does not rise, the seat has released and the valve is in order.
- Repeat the opening and closing of the outermost auxiliary valve if the pressure rises to system pressure again.



- If the pressure continues to rise after a number of purges without improvement, it may be due to the balance hole in the ball. In this case, repeat the procedure, but with the ball in the closed position. The procedure will be the same, but larger volumes will need to be drained from the valve housing, so that a rapid depressurization is difficult.

The ball's rotation is 90 degrees. During rotation from the closed to the open position, there is no contact between the seats and the ball (non-contact).

The auxiliary valves must be ball valves – for quick opening and closing.

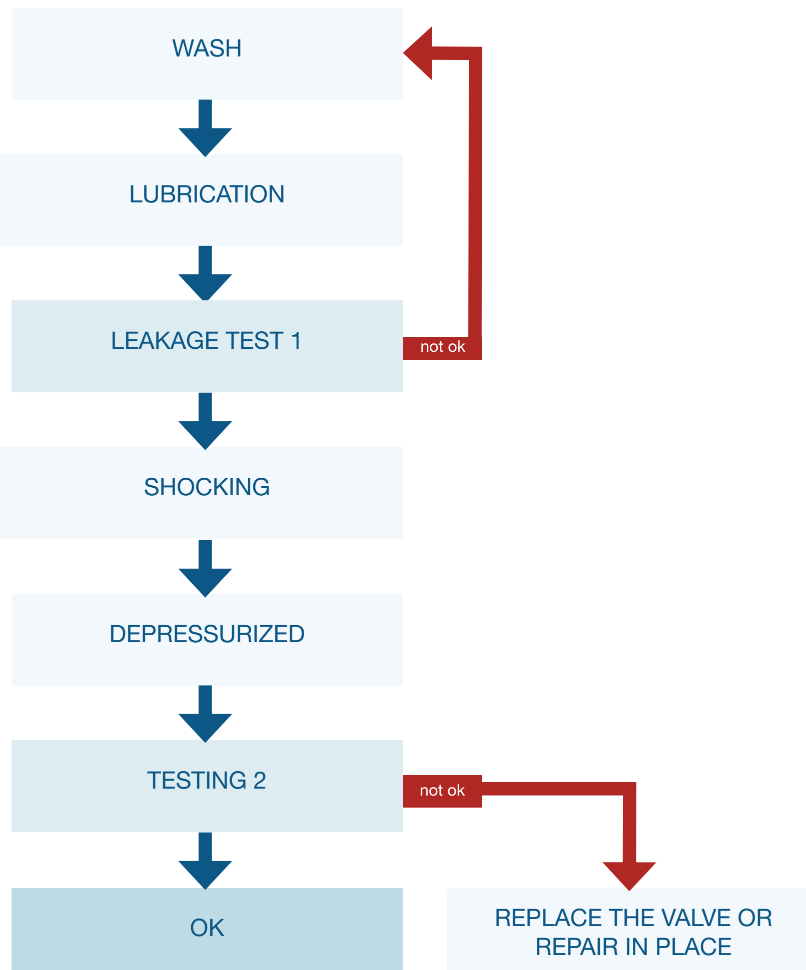
Shocking is most effective when the fluid is non-compressible, like liquids. When the fluid is compressible gas, shocking does not work on large valves (> 8") because the pressure reduction from the valve housing cannot be performed quickly enough.

On 6" and 8" valves, as well as on valves with high pressure, two outlets should be used for drainage if the valve has them.

Main causes of valve leakage:

- Deposits between the seat and the seat pocket (the seat is not in contact with the ball).
- Deposits behind the seat against the seat pocket (the seats may be warped or pushed completely away from the ball).
- Deposits on the ball (prevents contact between the seat and the ball).
- Scratches on the ball/seat or soft seals have been sucked out.

The valve leaks



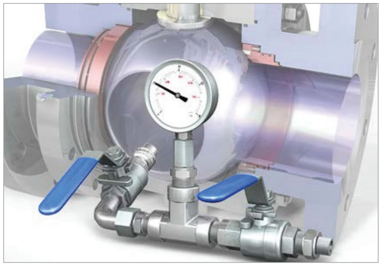
Perform washing, lubrication and leak test according to the specific procedures for this valve.

The shock valve according to own procedure (see maintenance DP).

However, if the deposits behind the seat are not dislodged by shocking the valve (when it is the system pressure that holds the seats away from the ball), the seat may return to its original position when the system is depressurized, because the springs now press the seats against the ball again. By pressing up the valve housing with N2, it can now be verified whether the seats have contact with the ball. NOTE! SR-seats will relieve pressure with spring pressure of 7-12 bar, for example.

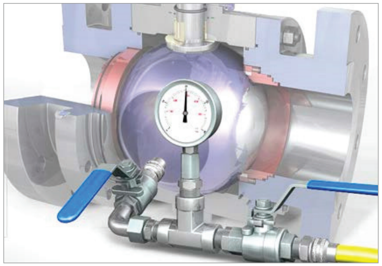
Testing pressurized system

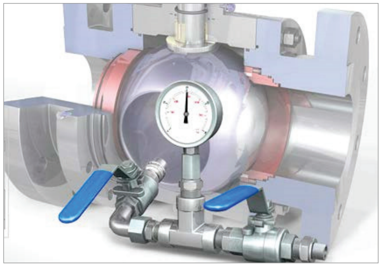
- Valves without a balance hole in the ball can be tested during operation in the open position.
- Install a T-pipe with pressure gauge and bleed valve in the closed position.
- Open the drain valve and read off the pressure in the valve housing from the pressure gauge.
- Carefully open the bleed valve and reduce the pressure in the valve housing to 50%. Shut the bleed valve.
- Check for a pressure increase after about 15 minutes.
- If the pressure has not increased, the seats are sealed and the valve is OK. However, if the pressure has increased, the valve is leaking.
- This leakage must be measured by emptying the valve housing completely and using a flow meter or mini-separator to verify whether the leakage rate is within acceptable limits.



Testing depressurized system

- In a depressurized system, the seats can be tested in the closed position. Then it is not necessary to take into account whether the valve has a balance hole in the ball.
- Install a T-pipe with pressure gauge and bleed valve.
- Attach the nitrogen bottle on the bleed valve.
- Open the bleed valve and drain valve and pressurize the valve housing to system pressure or the valve's pressure rating.
- Read off this pressure and close the nitrogen bottle and the bleed valve.





- Remove the hose for nitrogen supply.
- Check for a pressure decrease after about 15 minutes.
- If the pressure is stable, the seats are sealed and the valve is OK. However, if the pressure has decreased or disappeared, the valve is leaking.
- This leakage must be measured by maintaining the pressure in the valve housing. A flow meter can be used to verify whether the leakage rate is within acceptable limits.

13. Changes

1. Section 1.4 Minimum size for an 'O' ring
2. Section 1.6 Minimum number of engaged threads
3. Section 1.6 Temperature range for thread tape and sealing fluid
4. Section 2.2 Number of packing rings in graphite based stuffing boxes
5. Section 3.3 Ball valve with floating seat
6. Section 4.3 Prevention of stem going in backseat
7. Section 4.4 Excessive force on spindle
8. Section 4.4 Prevention of pressure locking
9. Section 4.4 Note on sealing to depressure housing
10. Section 4.5 Excessive force on spindle
11. Section 4.5 The effect of temperature changes
12. Section 4.5 Prevention of pressure lock
13. Section 4.6 Use of stinger in accordance with manufactures recommendations
14. Section 5.1 Effect of vibration
15. Section 6.1 Note on 'unbalanced'
16. Section 6.2 Use of check valve in vertical pipes
17. Section 7 Note on contents not including DIB-1 and DIB-2
18. Section 7.3 Note on the influence of differential pressure
19. Section 7.7 Sentence on double mechanical seal removed
20. Section 8.3 New illustrations and text
21. Section 9.1 Note on dead-band
22. Section 10.2 Note on use of methanol
23. Section 11.1 Note on maintenance of check valves
24. Section 11.1 Note on the use of duo check valves
25. Section 12.2 Note that illustration only for information
26. Section 12.2 Removal of sentence 'dependent on pressure class'
27. Section 12.2 Number of packing rings in graphite based stuffing boxes
28. Section 12.3 Removal of 'double piston' in the title
29. Section 13 New section for changes

OFFSHORE NORGE

If you have any questions, feedback or comments on the contents of the handbook, please contact Offshore Norge Technical Director through the switchboard at

(+47) 51 84 65 00.

www.offshorenorge.no