Sanitary Systems Design

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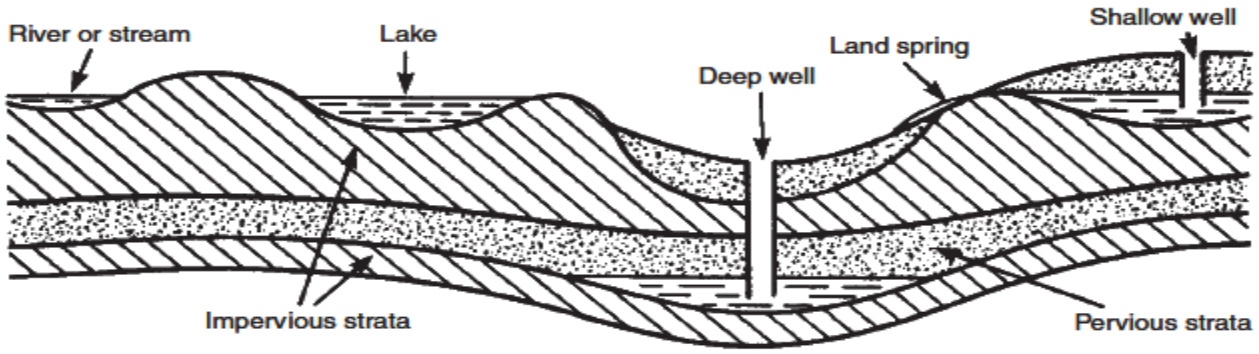
COLD WATER AND SUPPLY SYSTEMS

Surface sources : Lakes, streams, rivers, reservoirs, run off from roofs and paved areas.

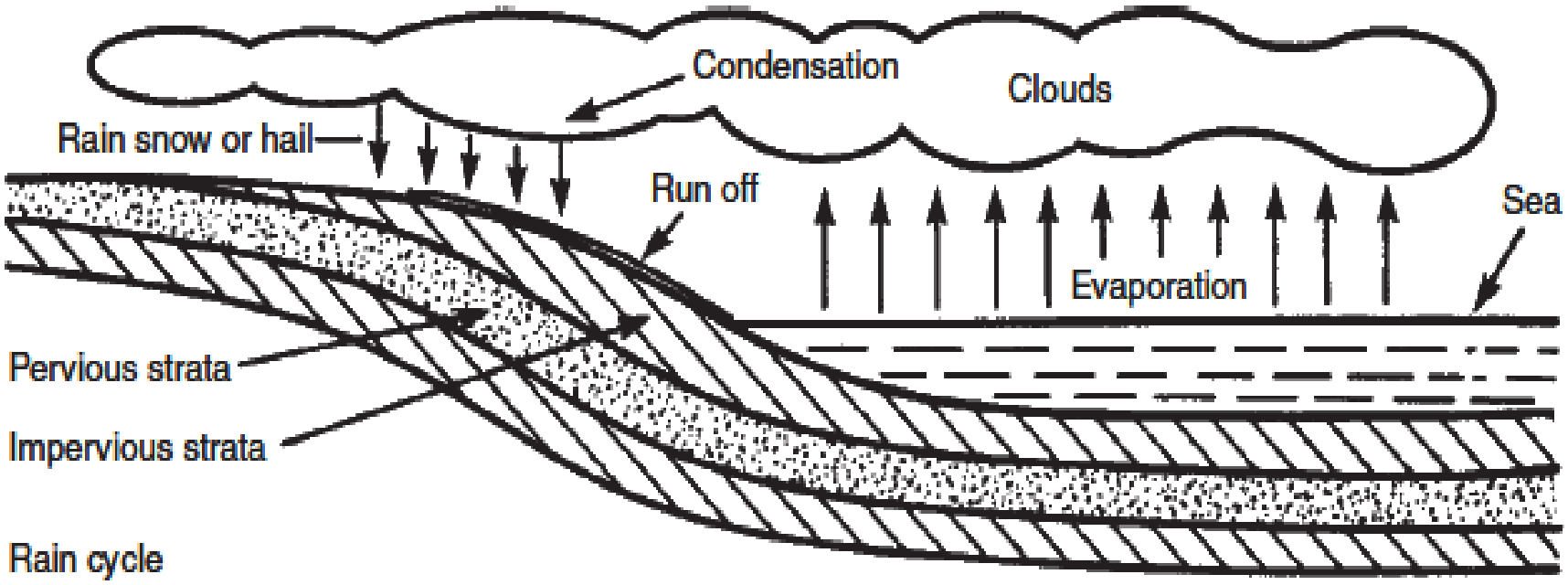
Underground sources : Shallow wells, deep wells, artesian wells,

artesian springs, land springs.

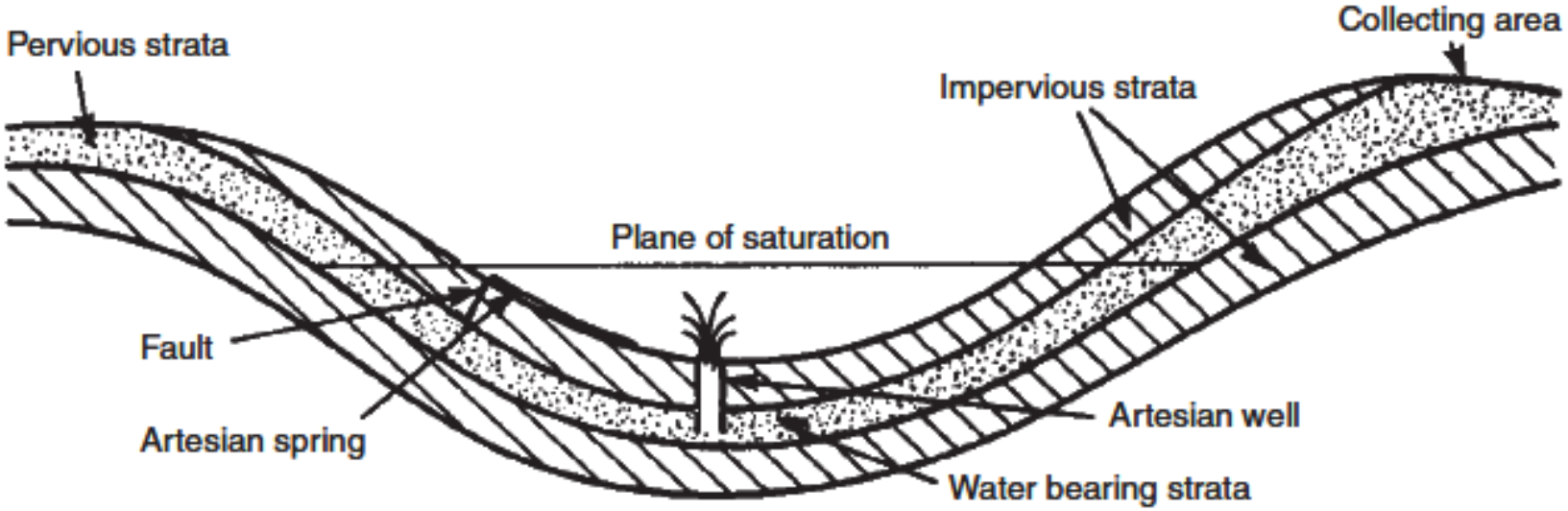


Surface and normal underground supplies

RAIN CYCLE


Condensation
Clouds
Rain snow or hail
Run off
Sea
Evaporation
Pervious strata
Impervious strata
Rain cycle

UNDERGROUND WATER SOURCES



Artesian wells and springs

ACIDITY AND ALKALINITY IN WATER

Acid : a substance containing hydrogen which can be replaced by other elements. Litmus paper in the presence of acidic water turns red.

Alkali : a substance which will neutralize acid by accepting its

hydrogen ions (H). Litmus paper in the presence of alkaline water turns blue.

More accurate definitions can be obtained by using hydro chemical electric meters. These measure the amount of hydrogen ions (H) in a relative proportion of water. This measure of acidity or alkalinity in solution is referred to numerically from 0 - 14 as the pH value.

- **pH 7 indicates acidity**
- **pH 7 indicates alkalinity**
- **pH 7 chemically pure**

WATER PURITY AND POLLUTION

Surface and substrata water sources : contaminated by dissolved inorganic materials such as calcium, magnesium and sodium. These are responsible for water hardness as described later. Organic matter from decaying vegetation, animals and untreated waste water can also contaminate ground water supplies. These are normally associated with ammonia compounds in the water or bacteria. Certain

Water purity and pollution

- **types of bacteria present in water can be responsible for outbreaks of typhoid, cholera and dysentery. Chlorination, as described later is applied to filtered water to destroy any remaining bacterial microbes before general distribution through service reservoirs and mains.**

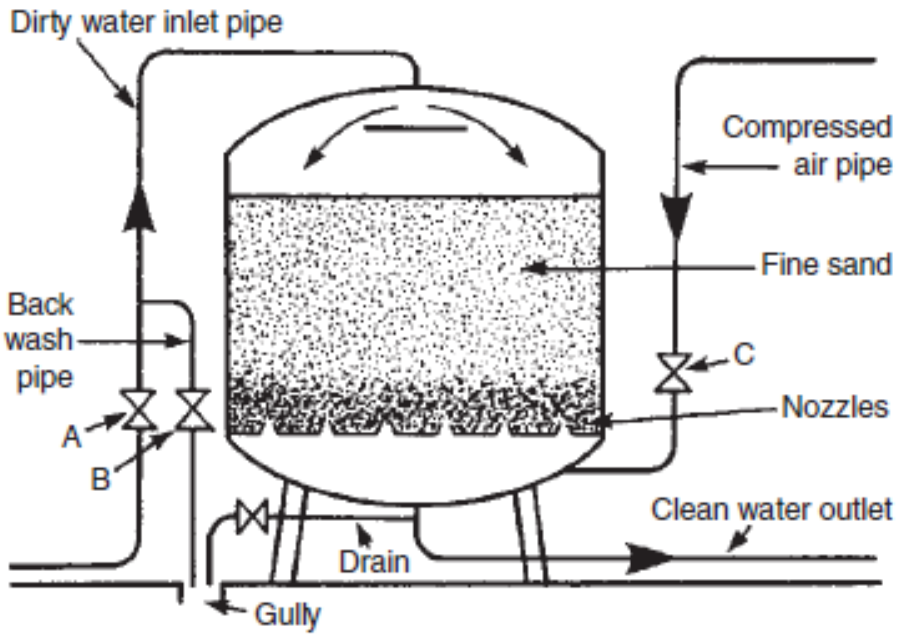
QUANTITY OF POLLUTANT MICROBES PRESENT DURING THE STAGES OF WATER PROCESSING

Source/process	Typical pollutant microbe count per litre
River	41000
Impounding reservoir	1500
Primary filter	500
Secondary filter	50
Chlorination	0
Service reservoir	0
Distribution main	0

FILTRATION OF WATER

Pressure filter : rate of filtration 4 to 12 m 3 per m 2 per hour.

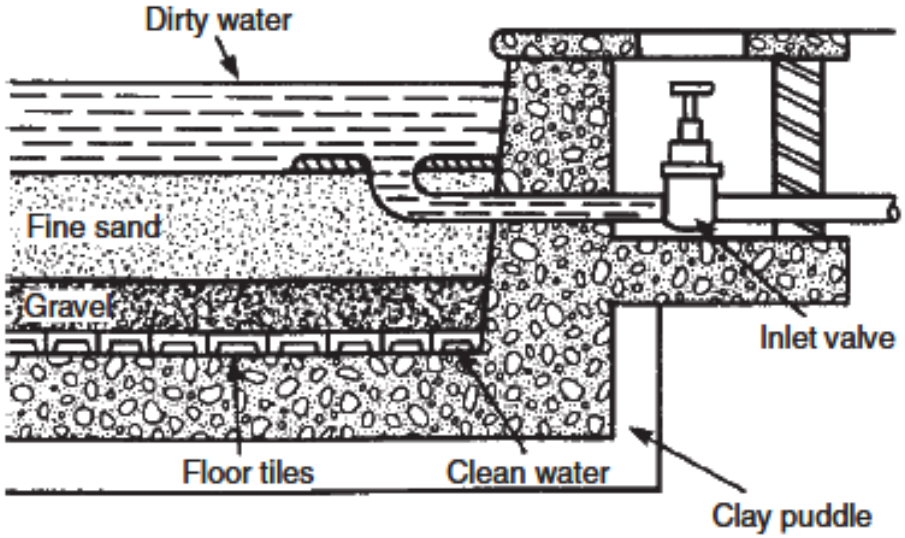
To backwash, valve A is closed and valves B and C opened. Compressed air clears the sand of dirt. Diameter = 2.4 m



SLOW SAND FILTER BED

Slow sand filter bed † rate of filtration 0.2 to 1.15 m per mper hour.

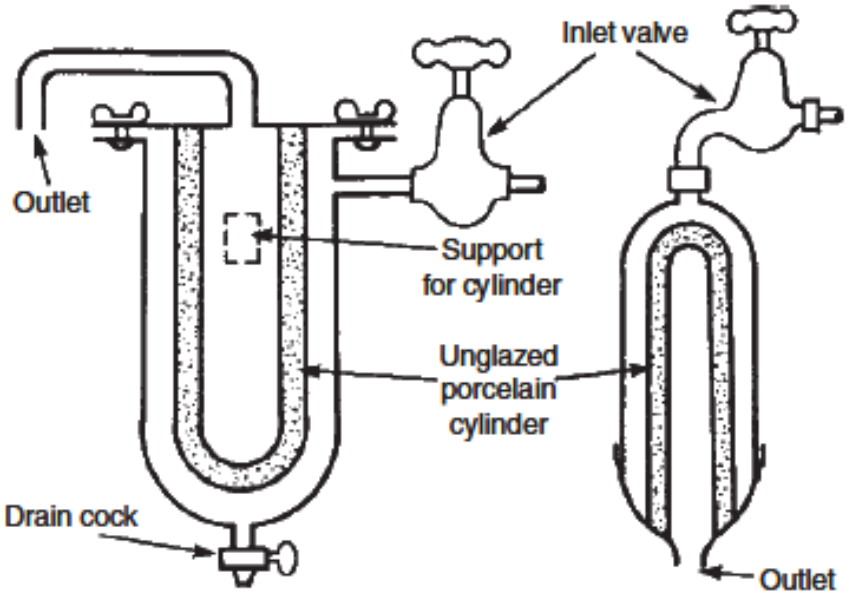
Filter beds can occupy large areas and the top layer of sand will require removal and cleaning at periodic intervals.



SMALL DOMESTIC FILTER

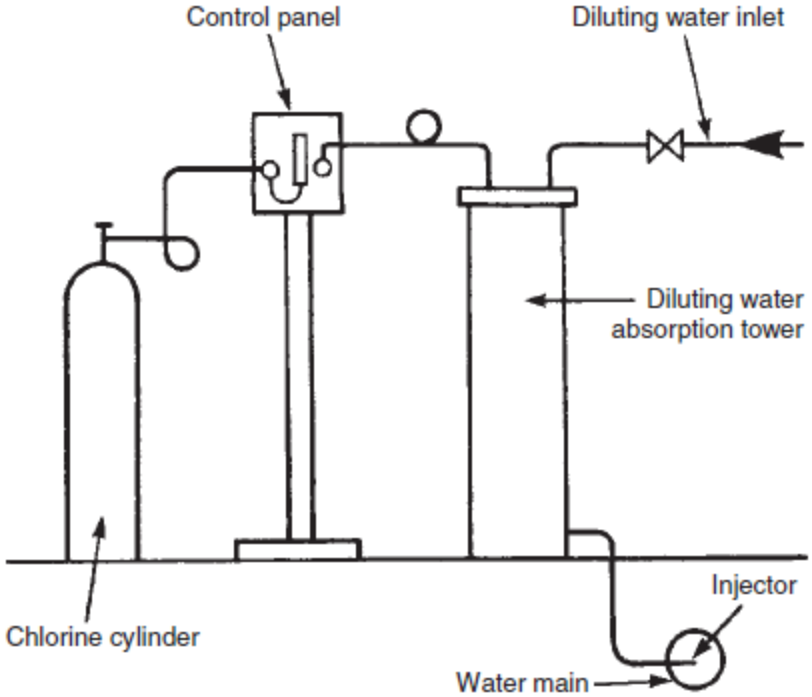
Small domestic filter : the unglazed porcelain cylinder will arrest very fine particles of dirt and even micro-organisms.

The cylinder can be removed and sterilized in boiling water for 10 minutes.



STERILISATION BY CHLORINE INJECTION

Sterilization by chlorine injection † water used for drinking must be sterilized. Chlorine is generally used for this purpose to destroy organic matter. Minute quantities (0.1 to 0.3 p.p.m.) are normally added after the filtration process.



HARD AND SOFT WATER

- Soft water contains little or no dissolved solids.
- It is often brownish or yellowish in colour.
- Hard water, on the other hand, will have a high calcium or magnesium salt content.

- Soft rainwater that percolates through certain types of rock strata e.g., chalk or limestone, will become "hardened" in this way. Hard waters do not form lather readily which has shaken with soap solution, whereas soft water lathers easily.
- The table below sub-divides hard and soft waters into several classes depending on the hardness.

Type of water	Hardness as calcium*	Hardness as calcium carbonate equivalent*
Soft	<20	<50
Moderately soft	20-40	50-100
Slightly hard	40-60	100-150
Moderately hard	60-80	150-200
Hard	80-120	200-300
Very hard	>120	>300

*Mg/l = 1 part per million.

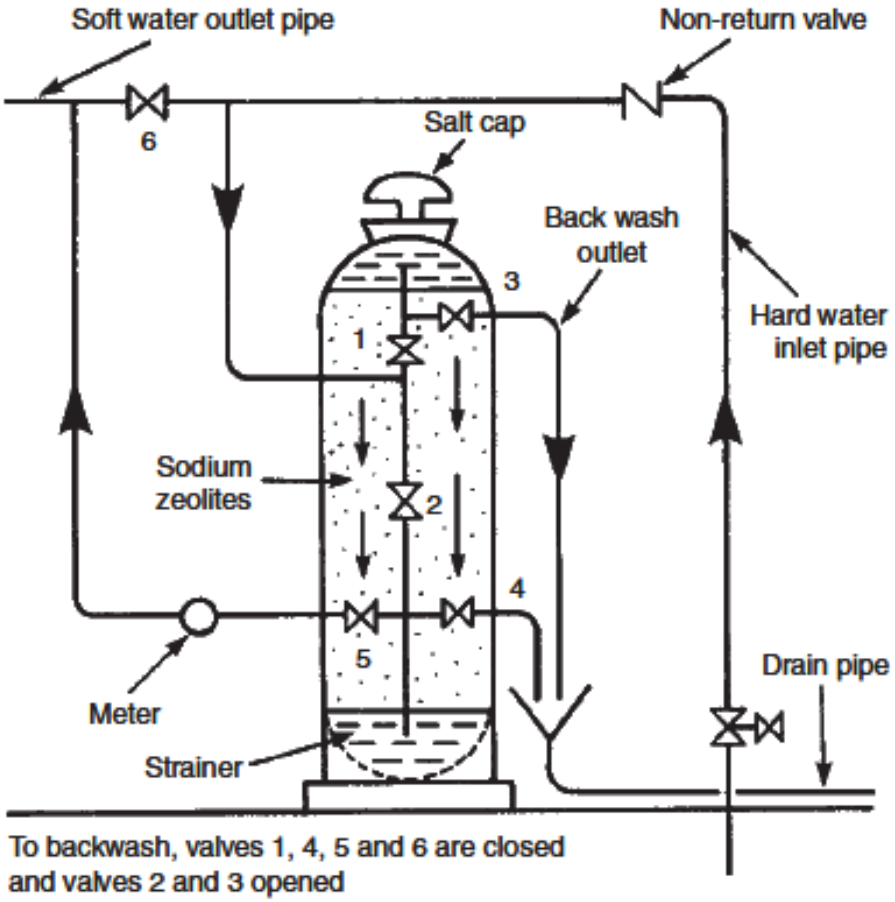
- Hard water can be further sub-divided into two types - **TEMPORARY** and **PERMANENT**.
- Temporary hardness can be removed by heating to temperatures above 60oC, whereas permanent hardness requires removal by chemical methods.
- Temporary hardness can lead to the formation of scale deposits on heating pipes, boilers, kettles, etc.

SOFTENING OF HARD WATER BY BASE EXCHANGE PROCESS

Softening of hard water by base exchange process : sodium zeolites exchange their sodium base for calcium (chalk) or magnesium bases in the water. Sodium zeolite plus calcium carbonate or sulphate becomes calcium zeolite plus sodium carbonate or sulphate.

To regenerate, salt is added; calcium zeolite plus sodium chloride (salt) becomes sodium zeolite plus calcium chloride which is flushed away.

SOFTENING OF HARD WATER BY BASE EXCHANGE PROCESS



- The water in treatment plants is **filtered** and **sterilised** with **'chlorine'** to reduce harmful effects of bacteria in water.
- The **pH value** of water should be considered i.e. its acidity or alkalinity. Soft acid waters are derived from hard insoluble rocks or from peaty uplands, they have a pH less than **7.0** and may corrode pipes and tanks unless passed through a cylinder packed with limestone to neutralise the acidity.

- Waters with a pH of more than 7.0 are alkaline and are not likely to attack metals.

Valve Definition

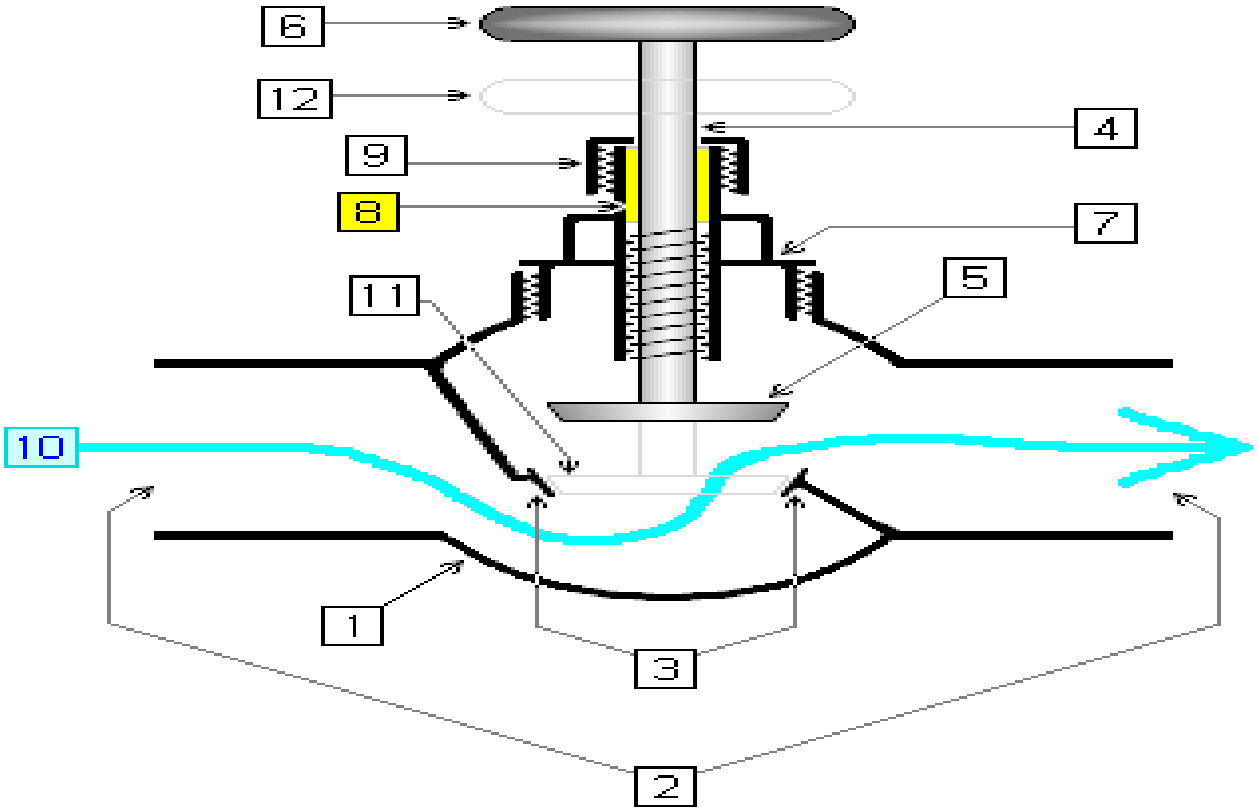
- A **valve** is a device that regulates, directs or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways. Valves are technically fittings, but are usually discussed as a separate category. In an open valve, fluid flows in a direction from higher pressure to lower pressure.

Classification of valves

- Valves are quite diverse and may be classified into a number of basic types. Valves may also be classified by how they are actuated:
- Hydraulic
- Pneumatic
- Manual
- Solenoid valve
- Motor

The globe valve

- The main parts of the most usual type of valve are the **body** and the **bonnet**. These two parts form the casing that holds the fluid going through the valve.



Cross-sectional diagram of an open **globe valve**.

1. **body**
2. **ports**
3. **seat**
4. **stem**
5. **disc** when valve is open
6. **handle** or **handwheel** when valve is open
7. **bonnet**

were shut

- 8. **packing**
  9. **gland nut**
  10. **fluid flow** when valve is open
  11. position of disc if valve were shut
  12. position of handle or handwheel if valve

Body

- The valve's **body** is the outer casing of most or all of the valve that contains the internal parts or *trim*. The bonnet is the part of the encasing through which the stem passes and that forms a guide and seal for the stem. The bonnet typically screws into or is bolted to the valve body.

- A **bonnet** acts as a cover on the valve body. It is commonly semi-permanently screwed into the valve body or bolted onto it. During manfacture of the valve, the internal parts are put into the body and then the bonnet is attached to hold everything together inside. To access internal parts of a valve, a user would take off the bonnet, usually for maintenance. body.

Introduction

Valves are primarily used in piping systems to interrupt, divert, or regulate the flow of fluids.

Depending on the valve function, its operation may be manually initiated or may be automatically initiated by a signal from a control device, or the valve may automatically respond to changing system conditions.

Valves are generally manufactured in standard pressure and temperature ratings in accordance with ANSI/ASME B16.1, B16.34, and B16.24 for cast-iron, steel and bronze materials, respectively.

Valves can be broadly categorized based on their function as:

- **Stop (Isolation) Valves**
- **Regulating Valves**
- **Back-Flow Prevention Valves**
- **Pressure-Relief Valves**

STOP (ISOLATION) VALVES:

These valves are used to stop the flow or isolate a portion of the system until it is desirable to achieve flow downstream of the valve. The basic design requirement of stop valves is to offer minimum resistance to flow in the fully open position and to exhibit tight shut-off characteristics when fully closed.

Valves commonly used as stop valves are gate, globe, ball, butterfly, plug, and diaphragm valves, which satisfy the above requirements in varying degrees. The actual type of valve selected is dictated by several parameters like pressure drop, seat leakage, fluid properties, initial cost, maintenance, etc.

PRESSURE RELIEF-VALVE

Pressure-relief valves are used to protect piping and equipment from being subjected to pressures that exceed their design pressures. Safety valves and relief valves primarily serve this requirement. Generally, the seating of these valves is accomplished by a compressed spring, which exerts a force on the valve disc, pressing it against the valve seat. When the force exerted by the fluid on the valve disc exceeds the spring force; the valve automatically opens to release the excess pressure.

BACK FLOW PREVENTION VALVES

Generally, check valves are used for the prevention of back-flow in piping systems. The valves are mostly self-actuating. The valve's disk is kept open by the forward flow of fluid and quickly closed by reverse flow. In certain applications, pneumatic actuators may be used to help in the rapid closure of the valves on flow reversal.

Types of Valves and Selection

- **Selection of valves**
- 1. Type of liquid, vapor, or gas
- 2. Pressure and temperature
- 3. Flow considerations

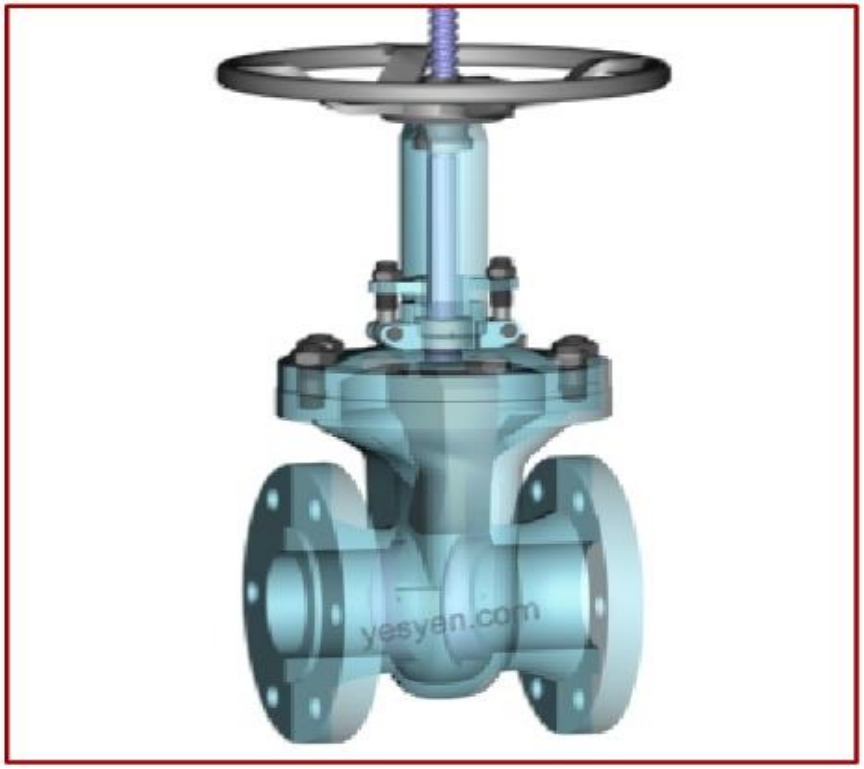
  4. Frequency of operation

TYPES OF VALVES

- ✓GATE VALVES
- ✓ GLOBE VALVES
- ✓ PLUG VALVES
- ✓ DIAPHRAGM VALVES
- ✓ BALL VALVES
- ✓ BUTTERFLY VALVES
- ✓ NEEDLE VALVES
- ✓ CHECK VALVES
- ✓ PRESSURE RELIEF VALVES
- ✓ CONTROL VALVES

STOP/ISOLATION VALVE

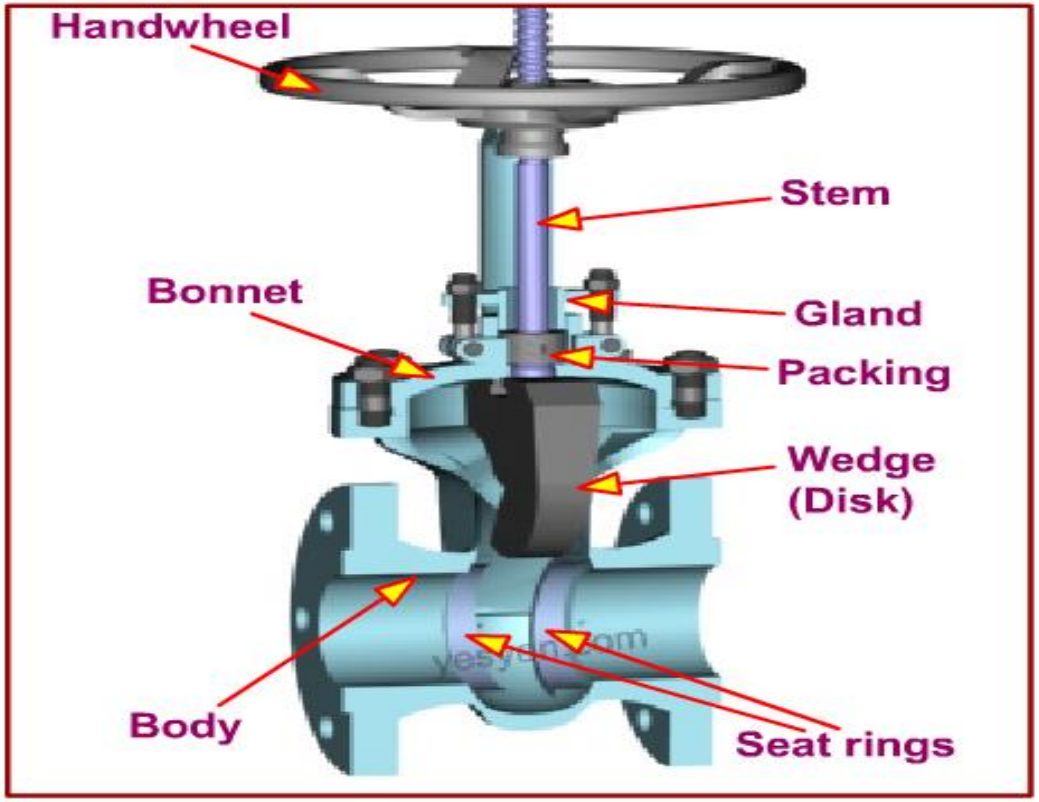
- TYPES OF GATE VALVES – RISING STEM GATE VALVE



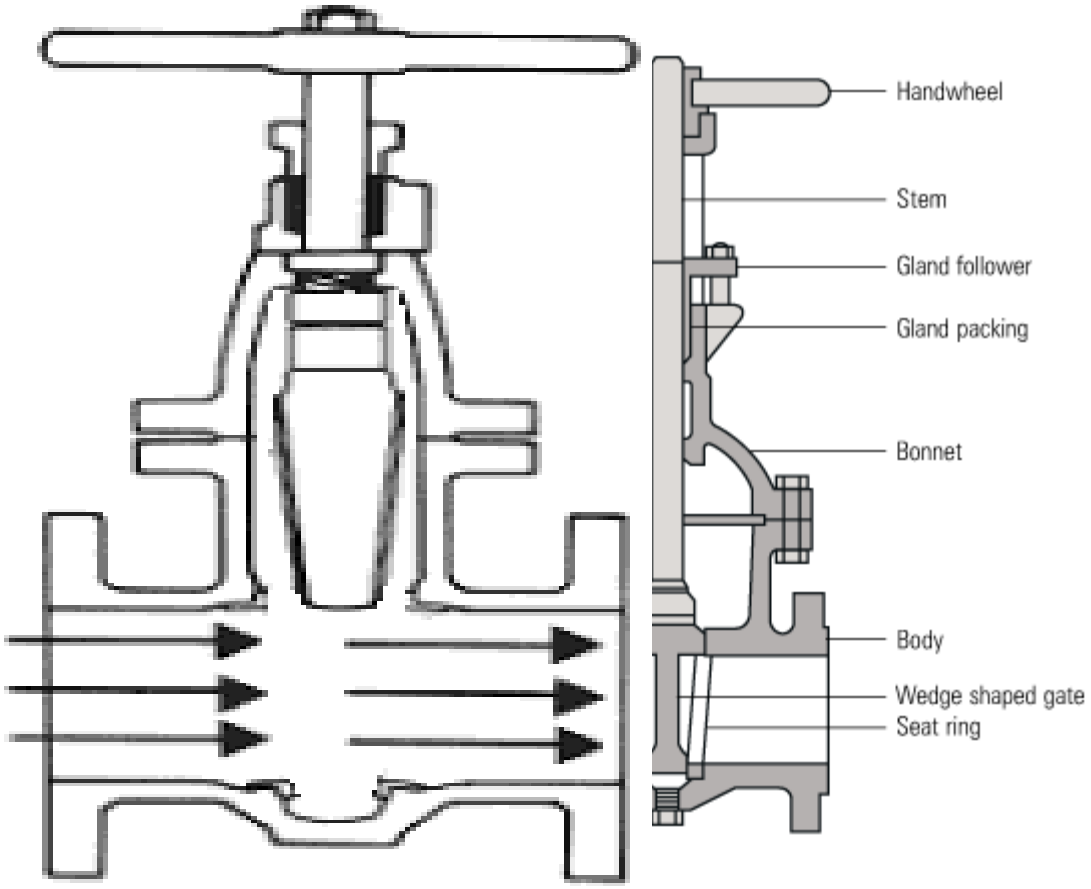
Gate Valves

Gate valves are primarily used as isolation valves.

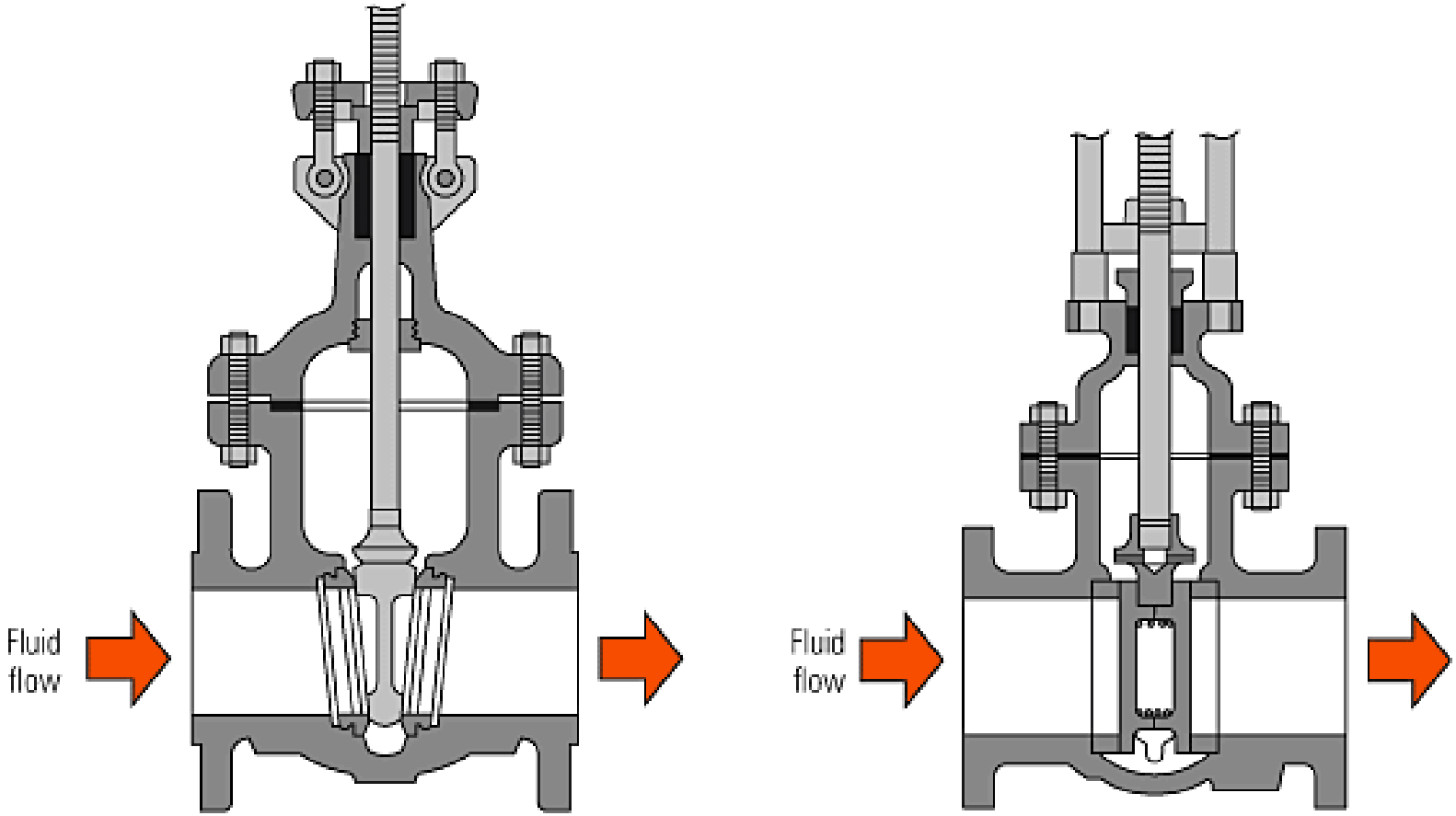
In the valve depicted, a tapered wedge is used to establish a firm contact against the valve seat in the closed condition. In the rising stem type the operating threads are out of direct contact with the fluid.



Gate Valve /Stop valve



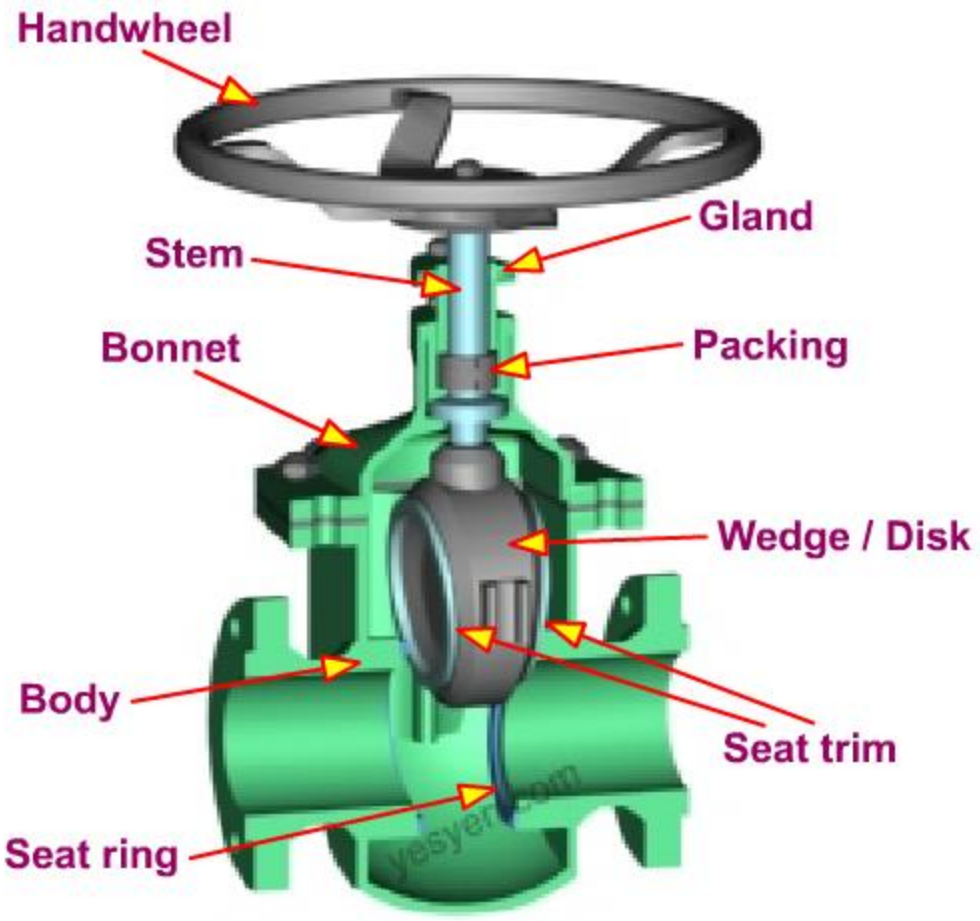
Wedge gate valve and parallel slide valve



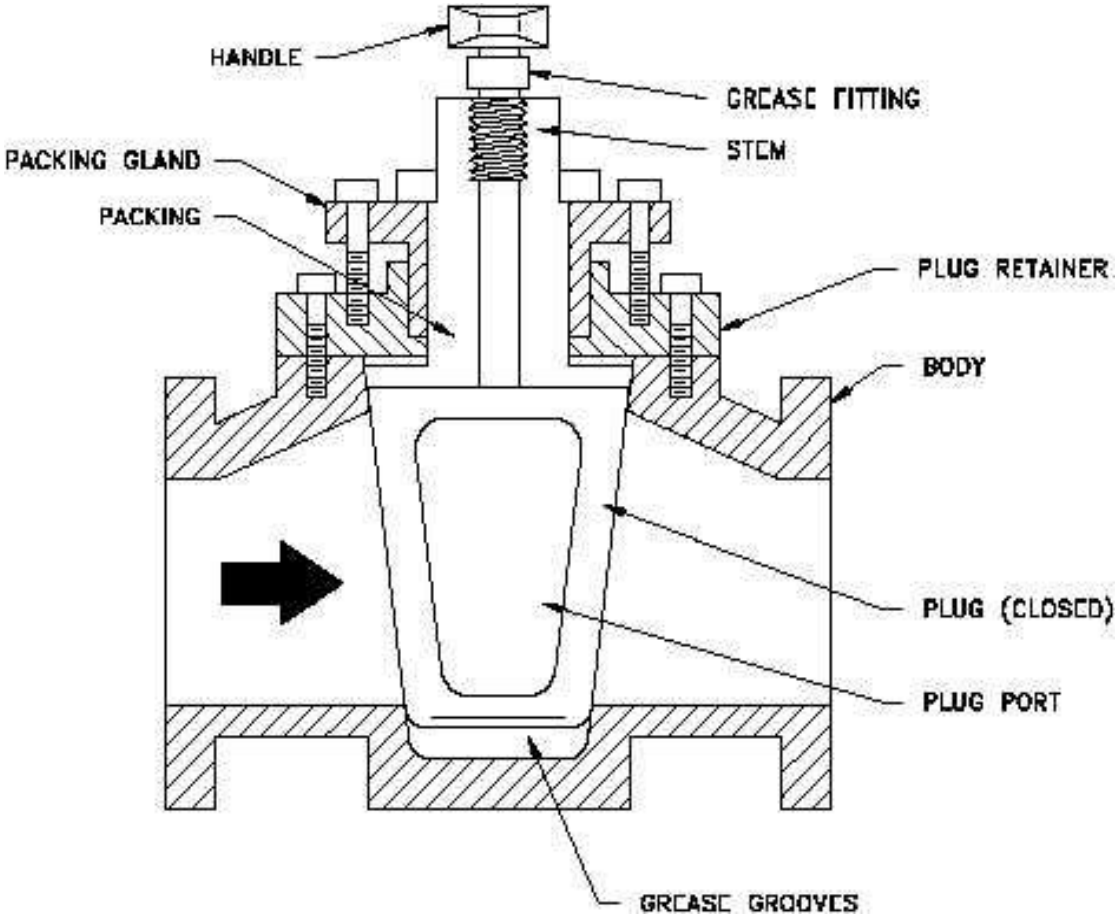
TYPES OF GATE VALVES – NON RISING STEM GATE VALVE

In the valve depicted, a tapered wedge is used to establish a firm contact against the valve seat in the closed condition. Non rising stem types are preferred where there is space limitation and if the fluid passing through the valve does not corrode, erode or leave deposits on the thread.

NON RISING STEM GATE VALVE



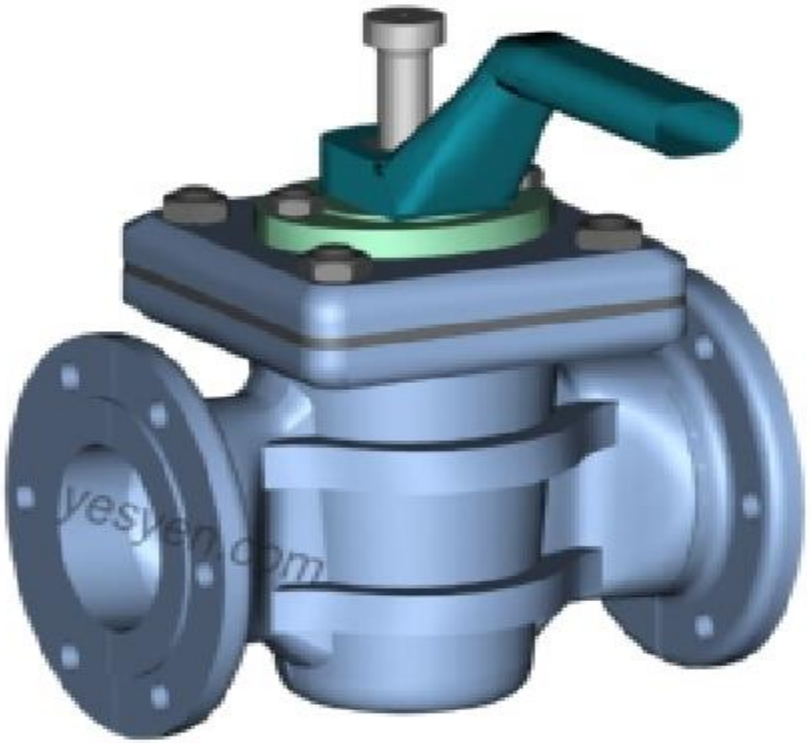
Plug valve (on-off) or Cock low-pressure



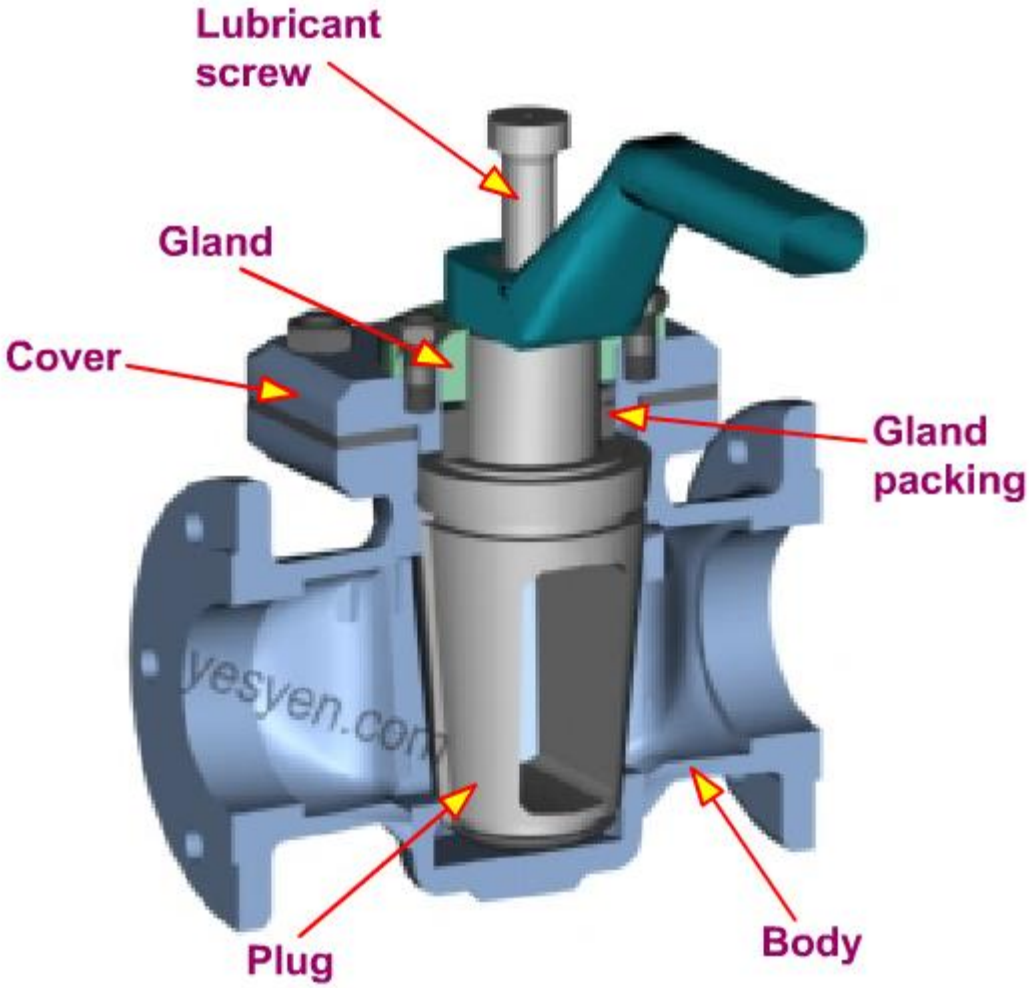
PLUG VALVES

Plug valves, also called cocks, are generally used for the same full flow service as gate valves, where quick shutoff is required.

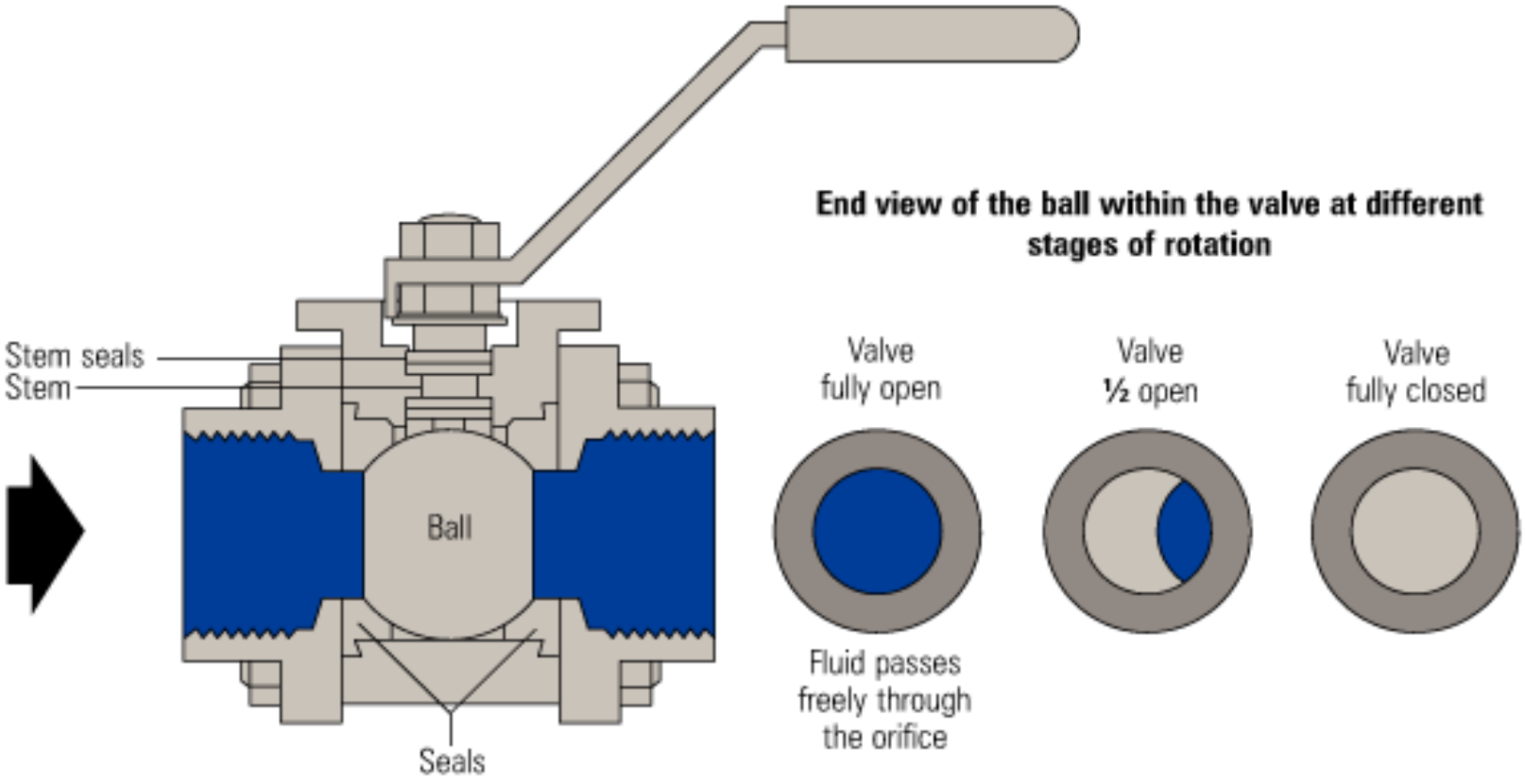
They are quarter turn valves and are operated by turning the plug a quarter turn in the clockwise (for closing) or anti-clockwise direction (for opening).



Plug Valve



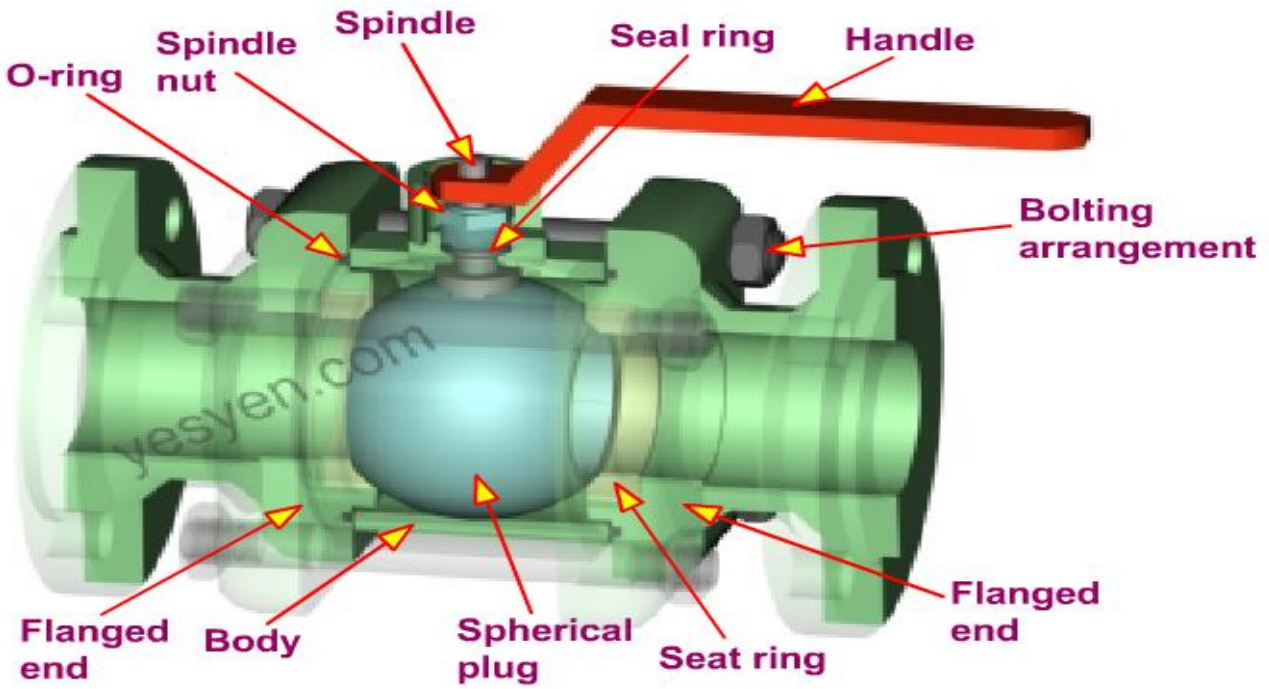
Ball Valve (on-off)



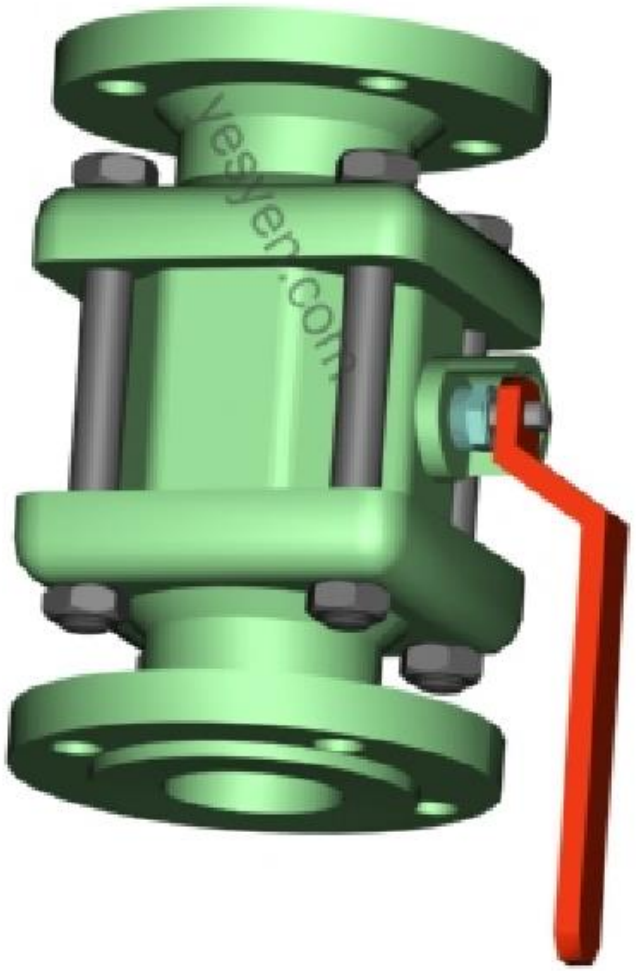
TYPES OF BALL VALVES – FLANGED END BALL VALVES

Ball valves are quarter-turn valves suitable for gas, compressed air, liquid and slurry service. They are commonly used for isolation services.

The valve shown has flanged end parts, which connect to the piping and are held to the main body by bolting arrangement. The valve is operated by turning the spherical plug (ball) a quarter turn in the clockwise (for closing) or anti-clockwise direction (for opening).



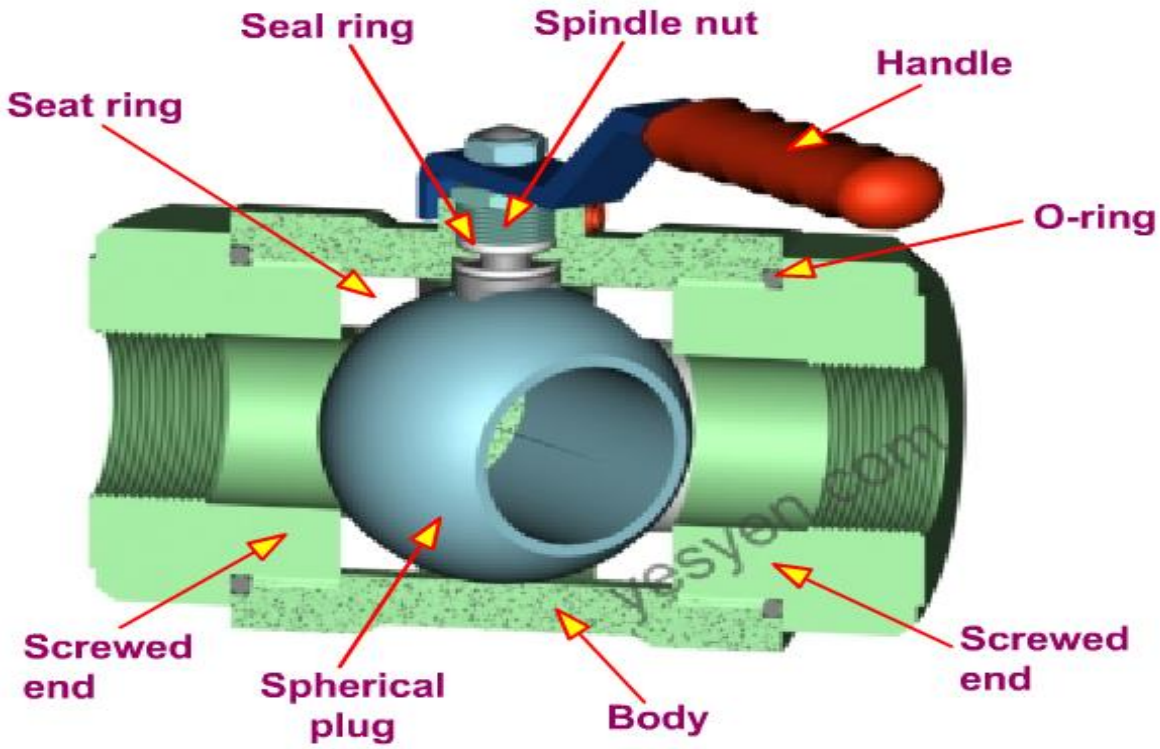
FLANGED END BALL VALVES



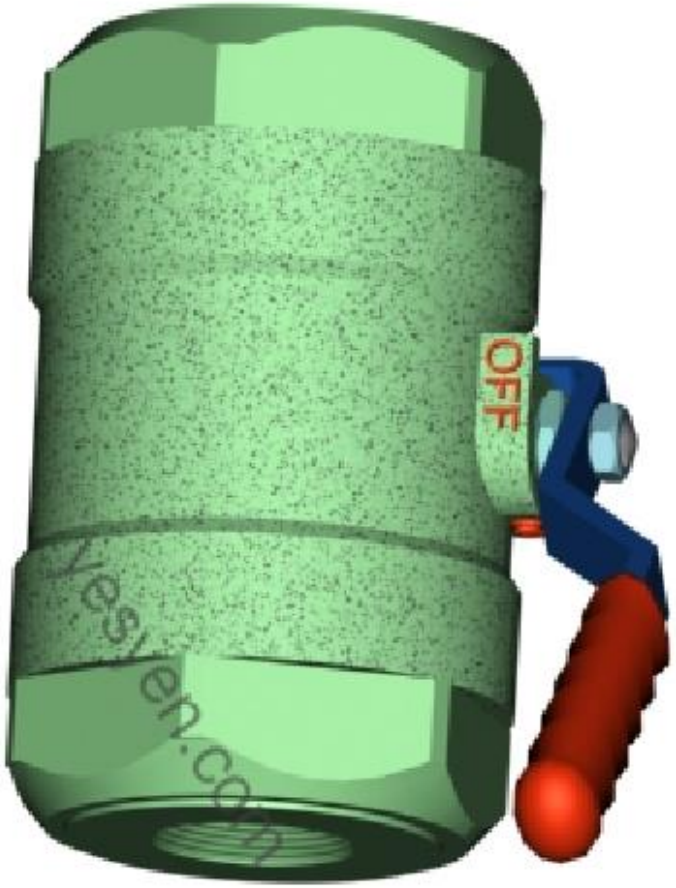
SCREWED END BALL VALVES

Ball valves are quarter-turn valves suitable for gas, compressed air, liquid and slurry service. They are commonly used for isolation services.

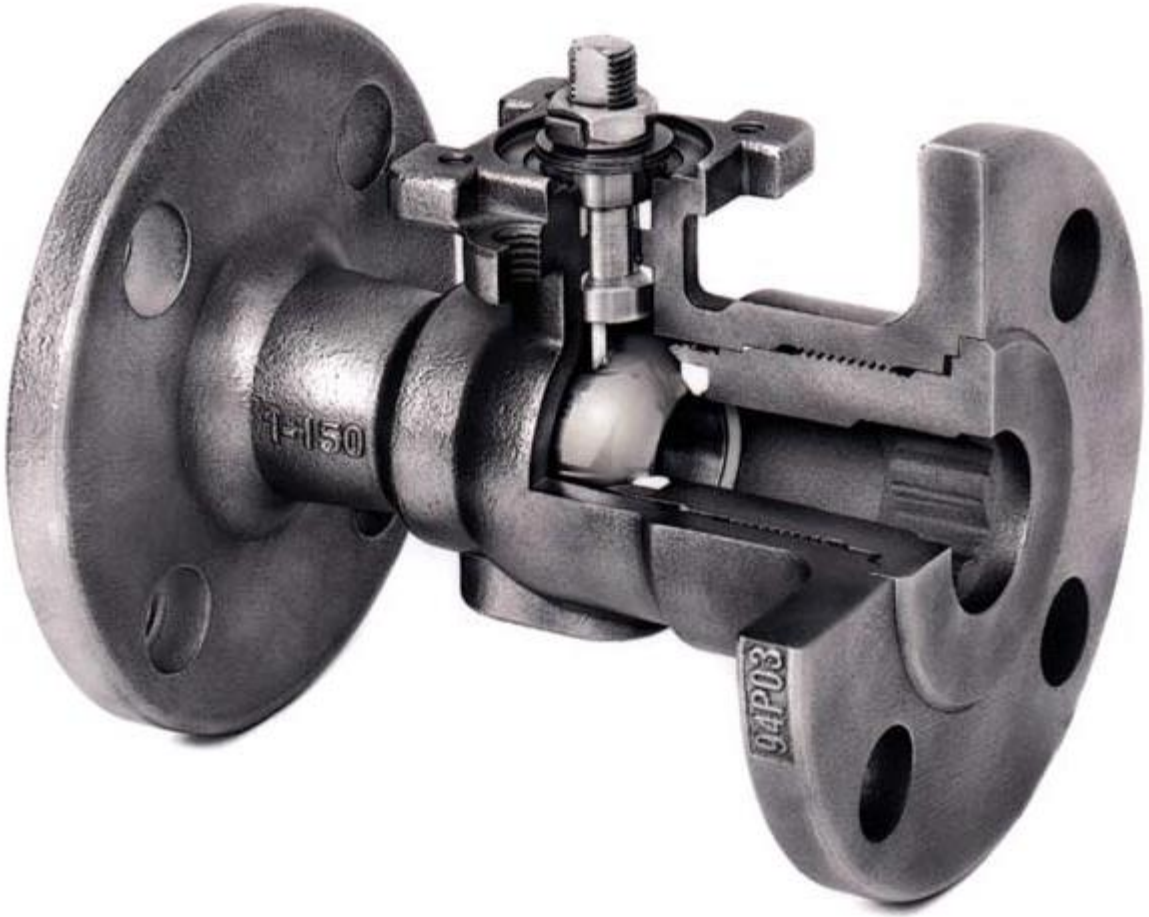
In the valve shown, the valve ends, which connect to the piping are screwed into the main body. The valve is operated by turning the spherical plug (ball) a quarter turn in the clockwise (for closing) or anti-clockwise direction (for opening).



SCREWED END BALL VALVES



Ball Valve (on-off)

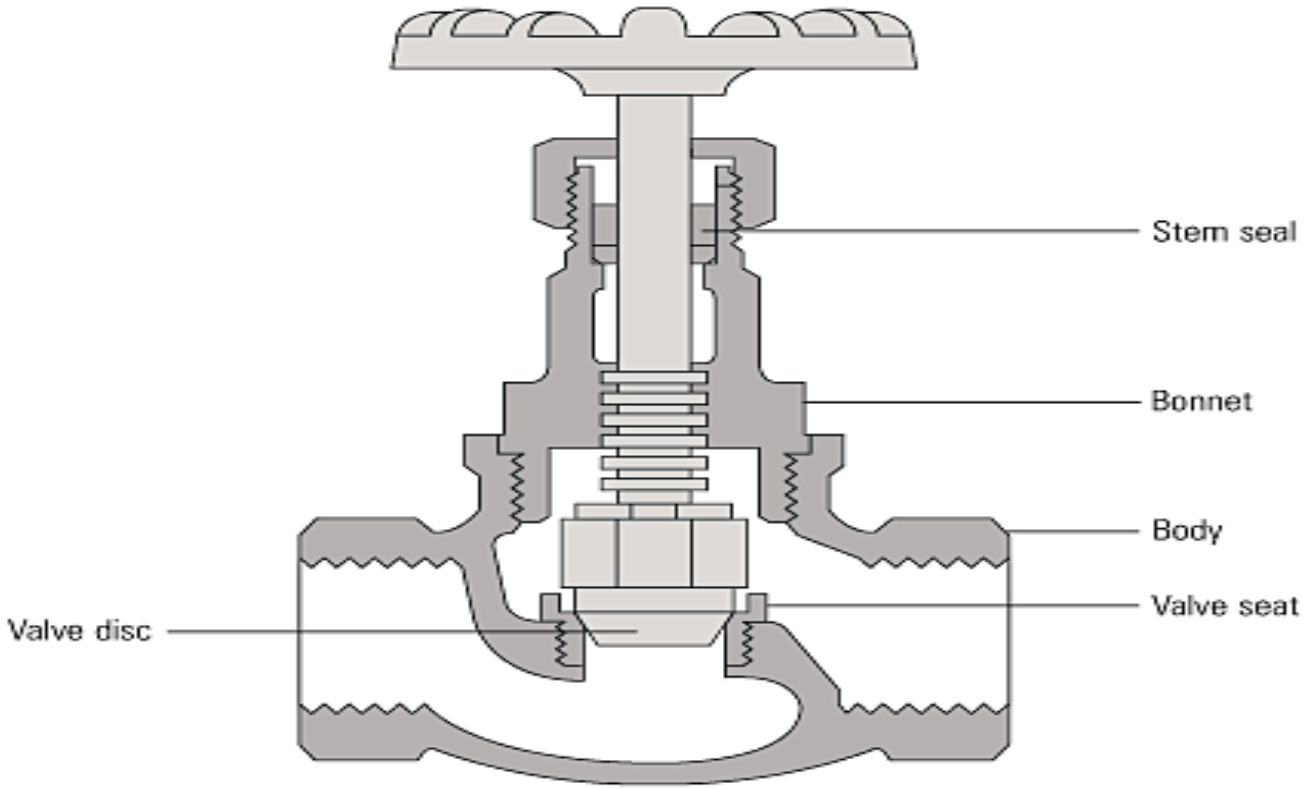


Ball Valve Quarter-Turn

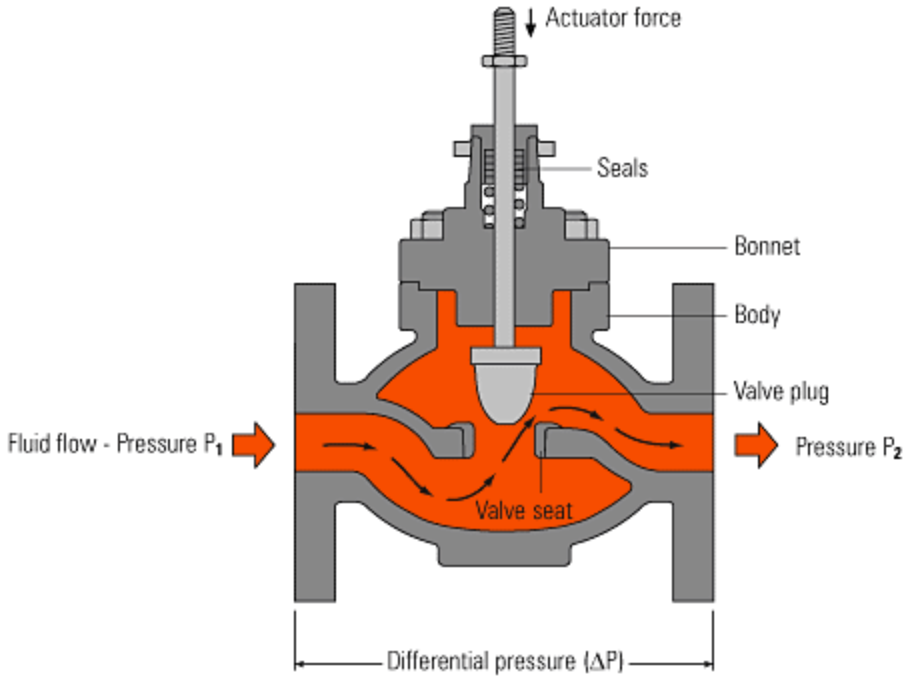
- Hydraulic systems .
- Water .
- Air.
- Oil .
- Petrochemical .
- High volume, high pressure and high temperature flow .

THROTTLING (Regulating)Valves

- Globe Valve
  (High pressure & value)



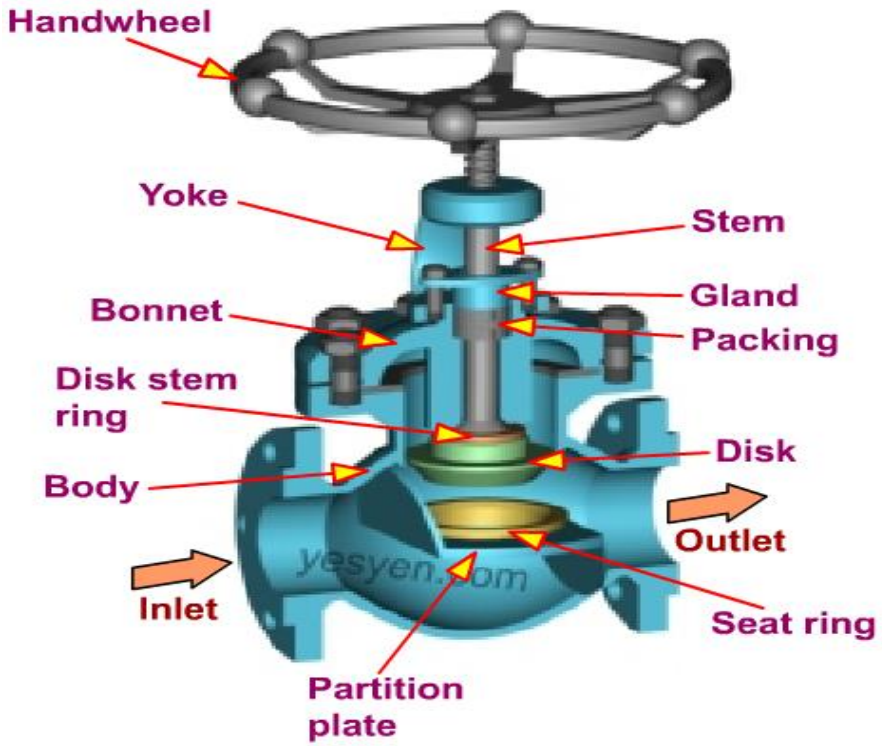
Globe Valve


Actuator force
Seals
Bonnet
Body
Valve plug
Fluid flow - Pressure P_1
Pressure P_2
Valve seat
Differential pressure (ΔP)

Globe Valve

Globe valves are extensively used to control flow. Conventional globe valves may be used for isolation service.

The inlet and outlet of the valve is separated by a partition plate, which is integral with the valve body casting. The flow in the valve takes a vertical path from down to top (through the seat ring), allowing for shorter disk travel, which enables easier effective flow control and convenient manual operation.

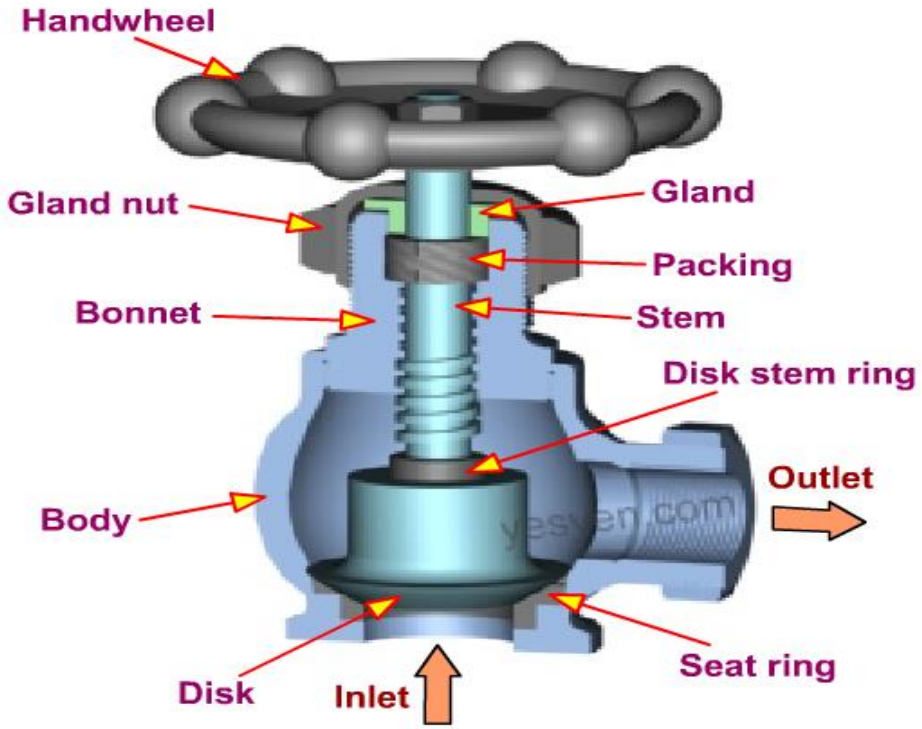


GLOBE VALVE – ANGLE PATTERN

GLOBE VALVES

Globe valves are extensively used to control flow. Conventional globe valves may be used for isolation service.

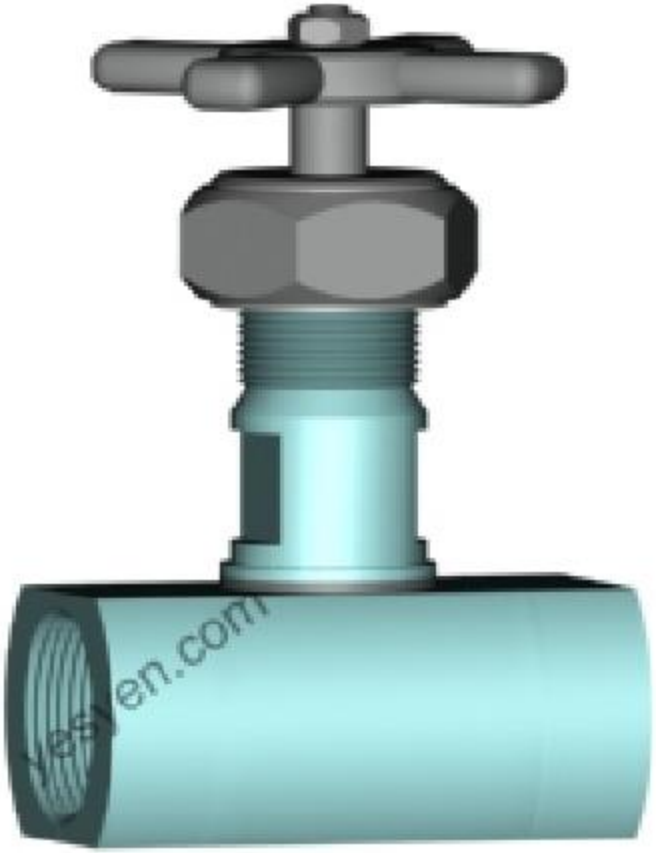
Angle-pattern globe valves exhibit improved flow characteristics over the tee-pattern globe valves. The flow in the valve takes a vertical path from down to top (through the seat ring), allowing for shorter disk travel, which enables easier effective flow control and convenient manual operation.

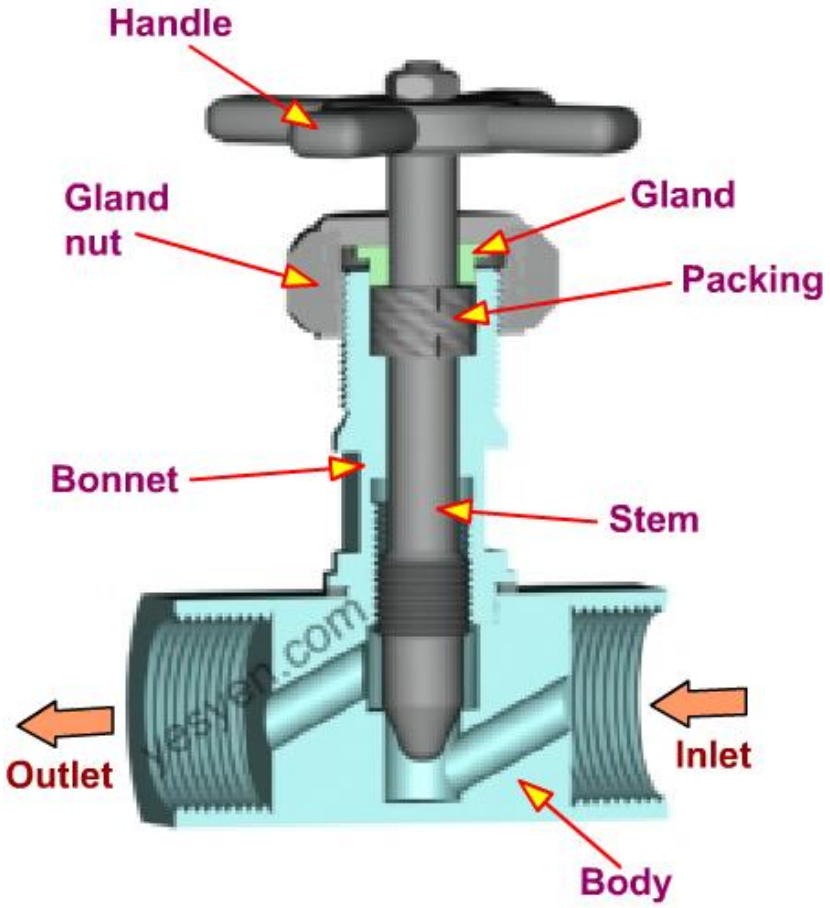


NEEDLE VALVES

Needle valves are generally used for instrument, gauge and meter line service.

The end of the stem is needle pointed and fits accurately into the seat thus providing tight closure with minimum effort. Because of the needle point of the stem very accurate throttling is possible. These valves are therefore used extensively in applications involving high pressures and temperatures.





Butterfly Valve

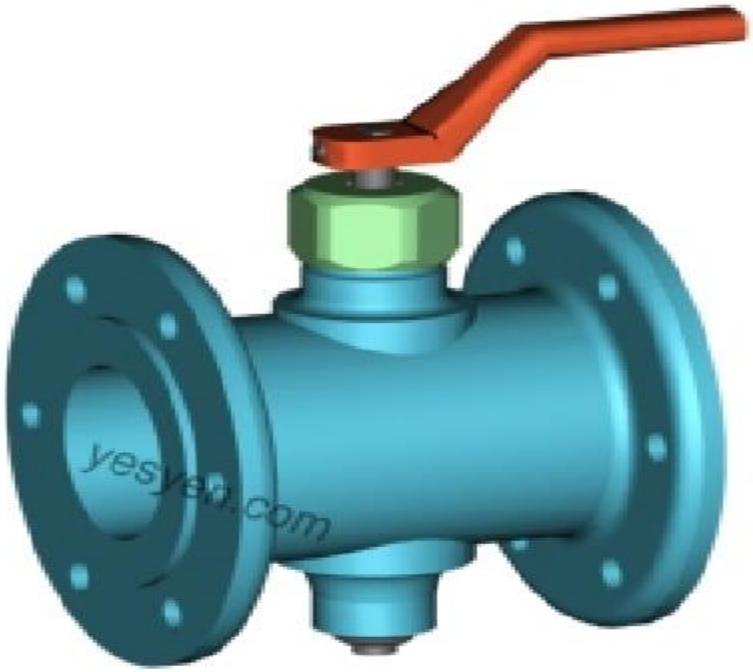
Xomox high performance butterfly valve with patented axially pliant seal.

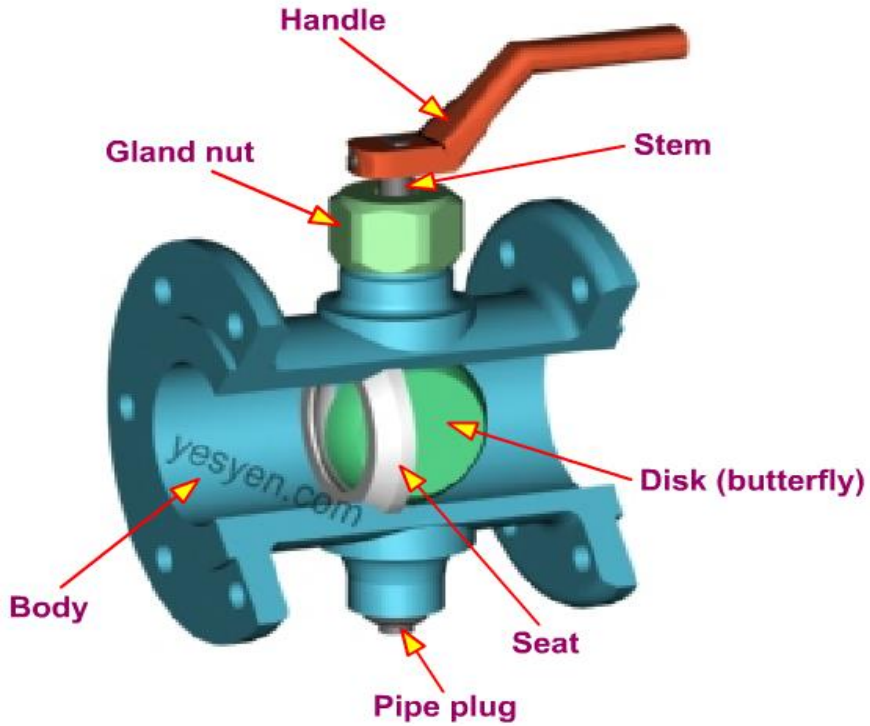
Flow Control
Low Speed
Both Side flow

TYPES OF BUTTERFLY VALVES – FLANGED-END BUTTERFLY VALVES

Butterfly valves are low pressure valves of efficient design, used to control and regulate flow.

The stem is positively locked with the disk and handle. The valve is operated by turning the stem/disk a quarter turn in the clockwise (for closing) or anti-clockwise direction (for opening).

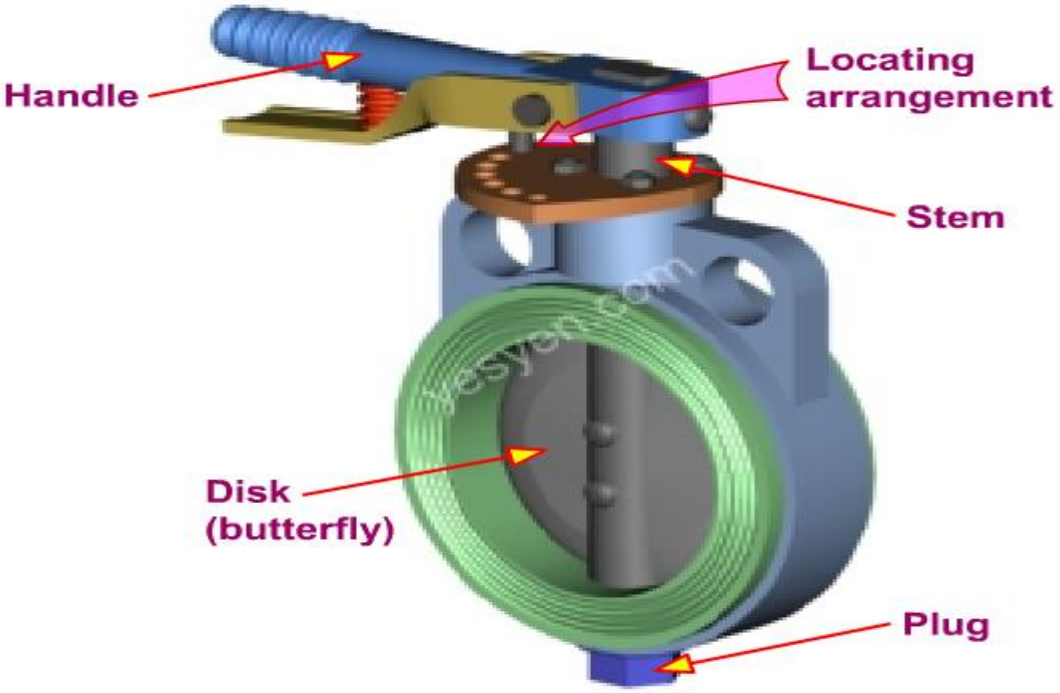


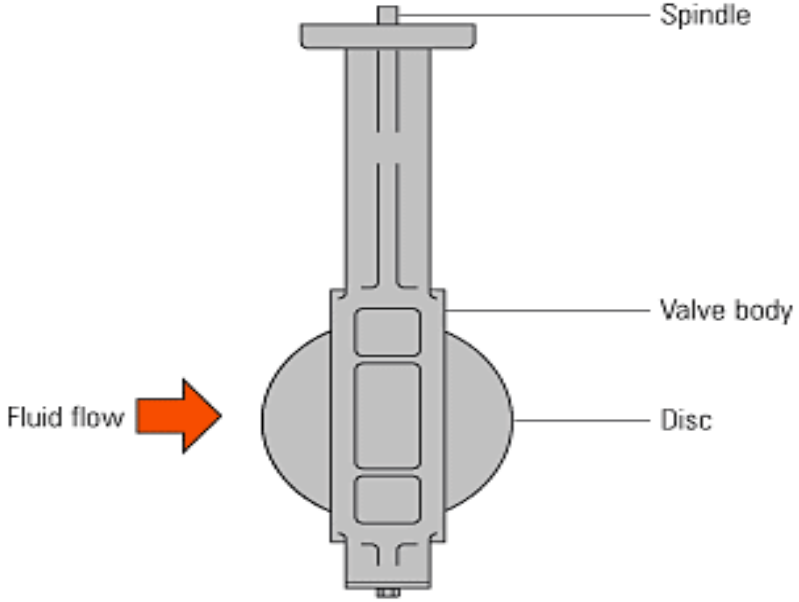


TYPES OF BUTTERFLY VALVES – BUTTERFLY VALVES

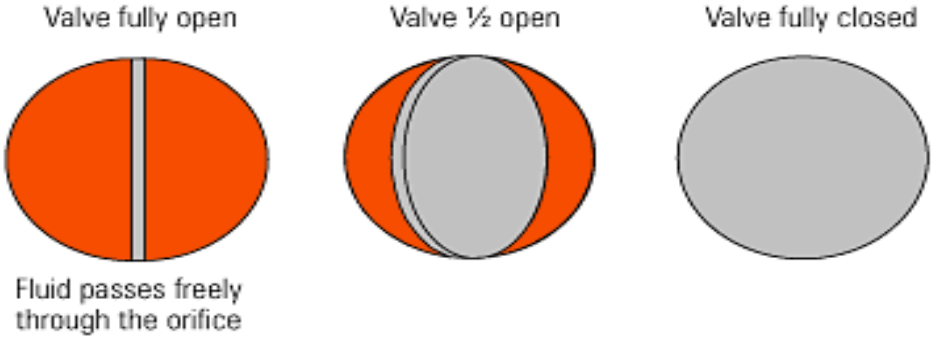
Butterfly valves are low pressure valves of efficient design, used to control and regulate flow.

The wafer type does not have flanges and is held in place by bolting arrangement between the pipe flanges. The stem is positively locked with the disk and handle. The valve is operated by turning the stem/disk a quarter turn in the clockwise (for closing) or anti-clockwise direction (for opening).





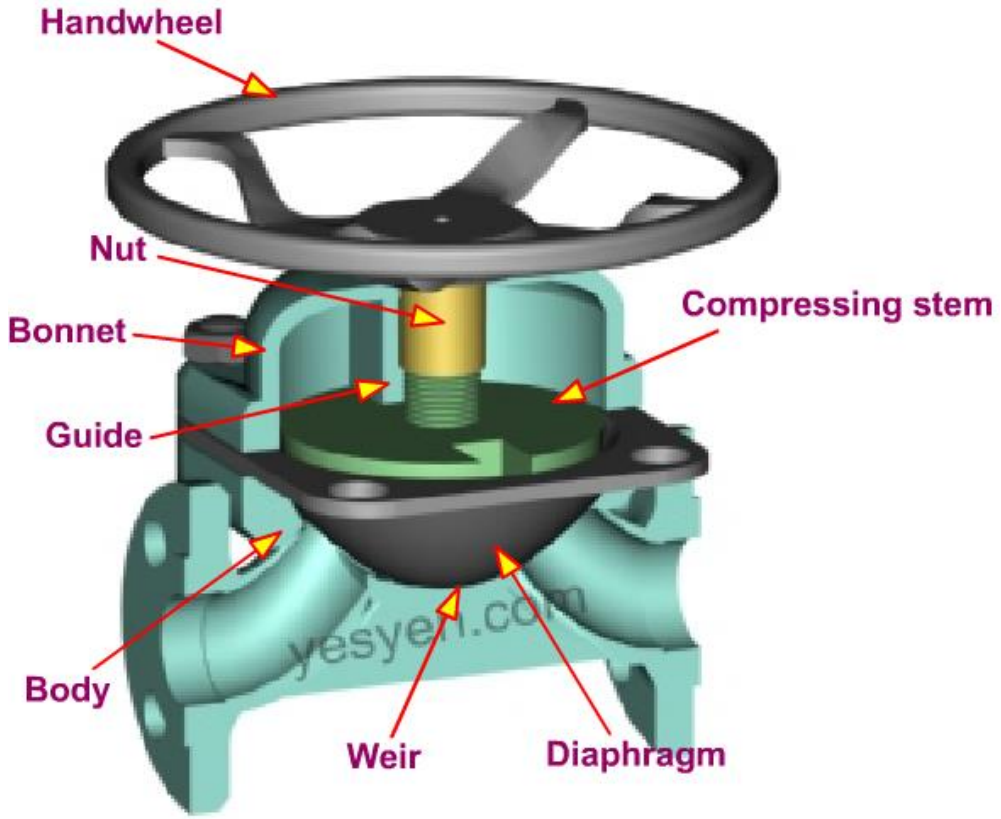
End view of the disc within the butterfly valve at different stages of rotation



DIAPHRAGM VALVES

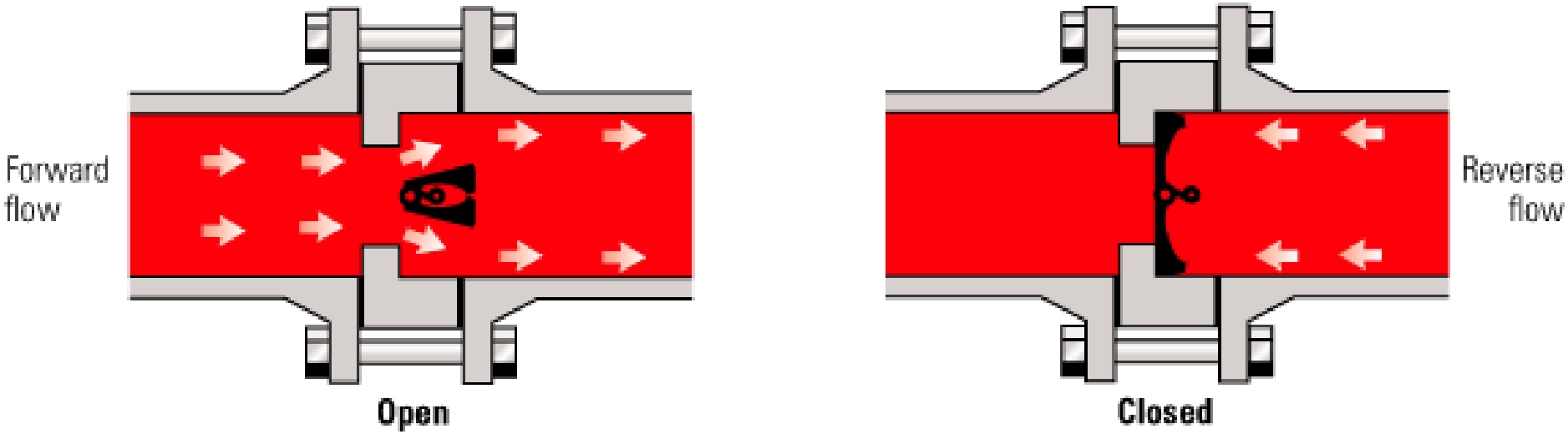
Diaphragm valves are suitable for moderate throttling applications and offer several advantages over other valves in low pressure applications.

The valve has a flexible diaphragm which forms the upper pressure boundary of the valve. This provides for excellent leak-tight properties, even when conveying liquids containing suspended solids.



Prevention of back flow

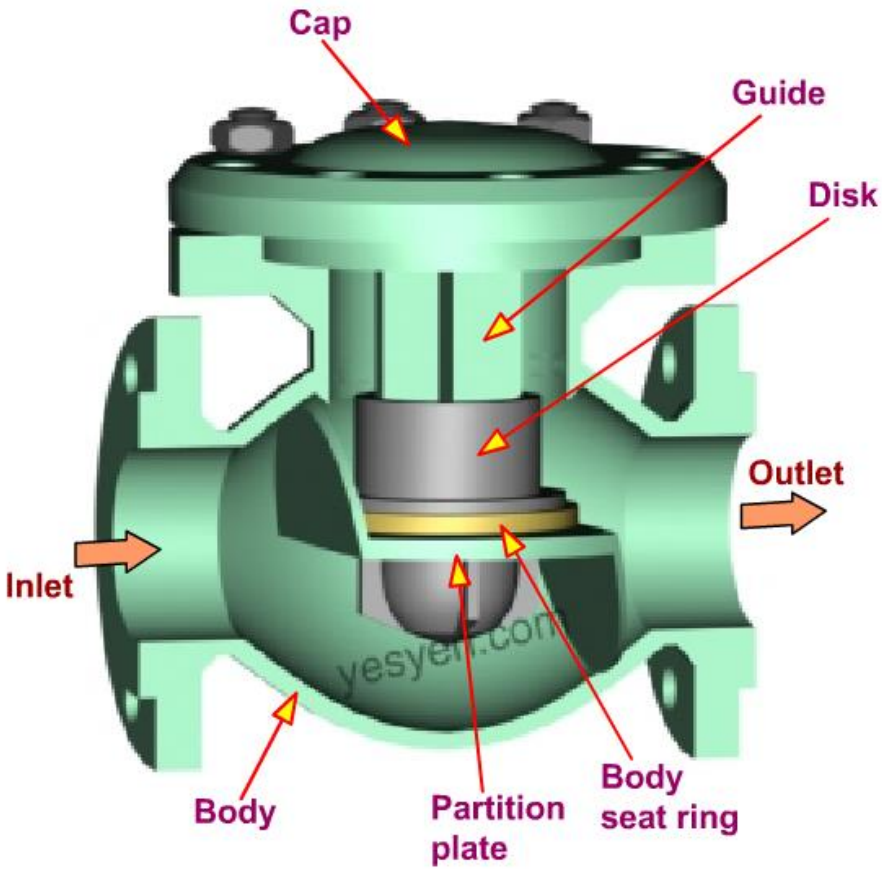
- Split disc check valve operation



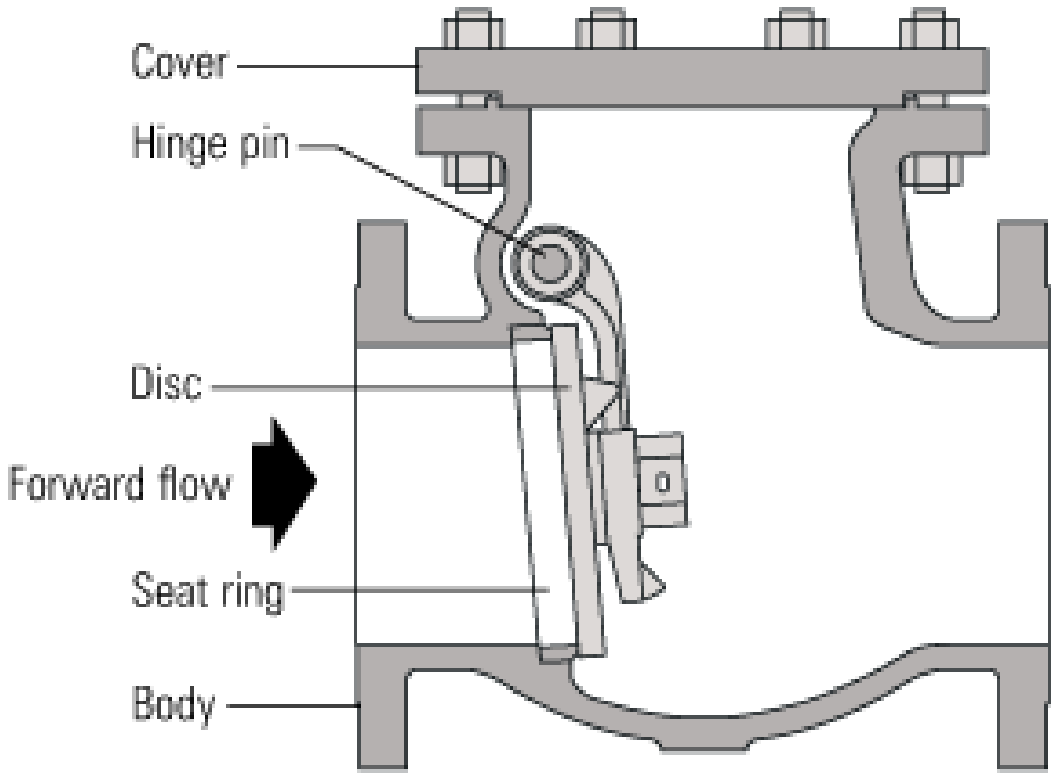
CHECK VALVES – LIFT CHECK VALVES

Check valves are designed to prevent backflow of fluid in lines.

In the lift check valve, the disk traverses along accurate guiding arrangement and provides a firm seating with the body seat ring. The valve must always be placed such that the direction of lift of the disk is vertical.



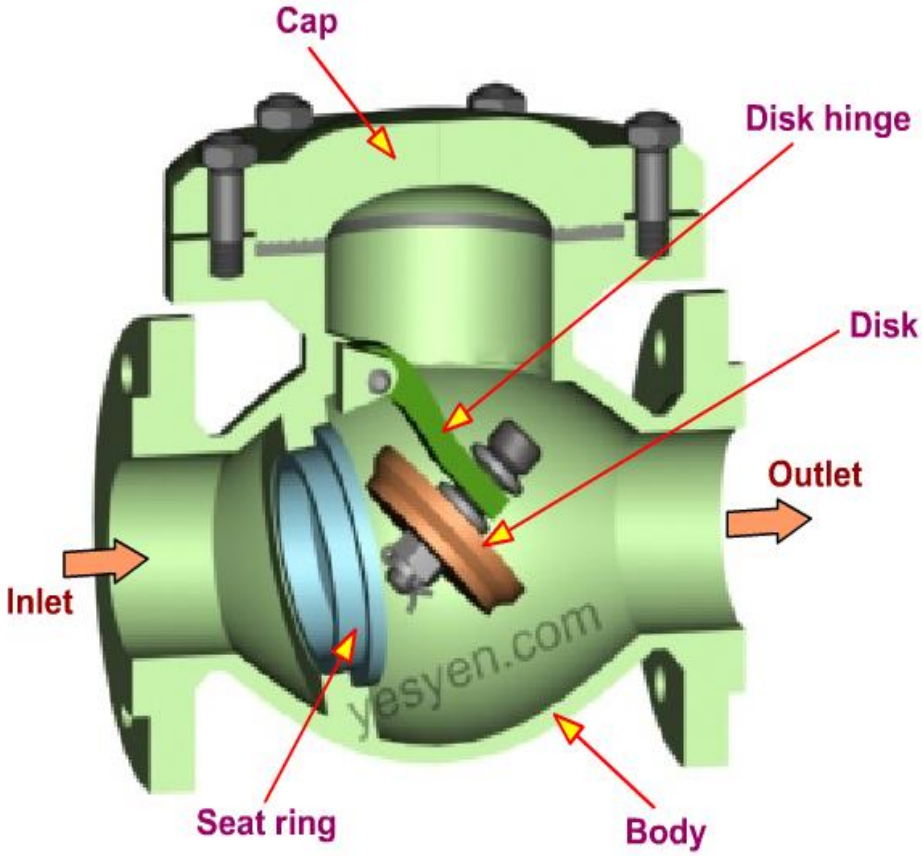
Swing check valve (liquids) installed horizontal & vertical



SWING CHECK VALVES

Check valves are designed to prevent backflow of fluid in lines.

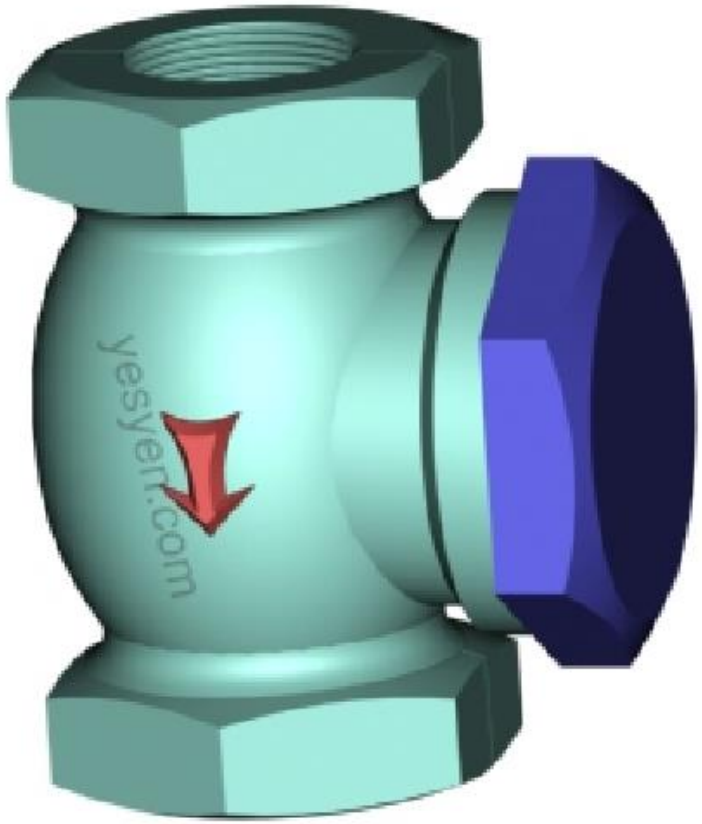
Of the various types of check valves, the swing check valve is more commonly used. In this valve, the disk is pivoted by means of the disk hinge from lugs cast integrally with the body.

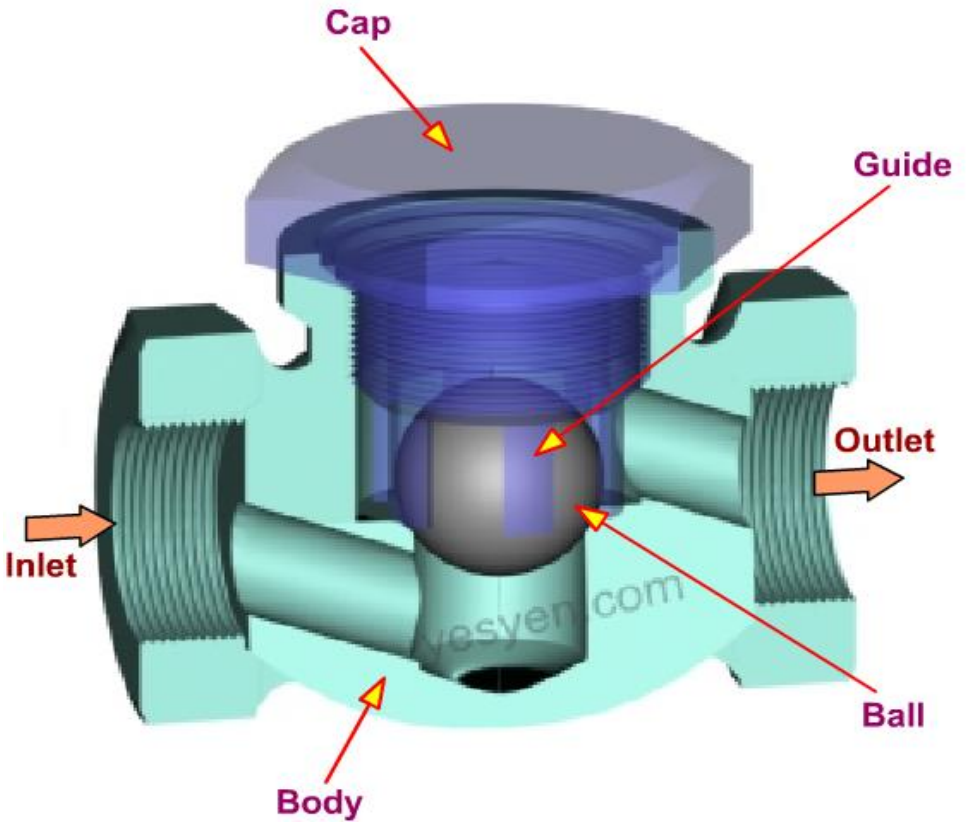


CHECK VALVES – BALL CHECK VALVES

Check valves are designed to prevent backflow of fluid in lines.

In the ball check valve, the ball traverses through suitable guiding arrangement and provides seating with the body. The valve must always be placed such that the direction of lift of the ball is vertical.





Check valve (Ball)

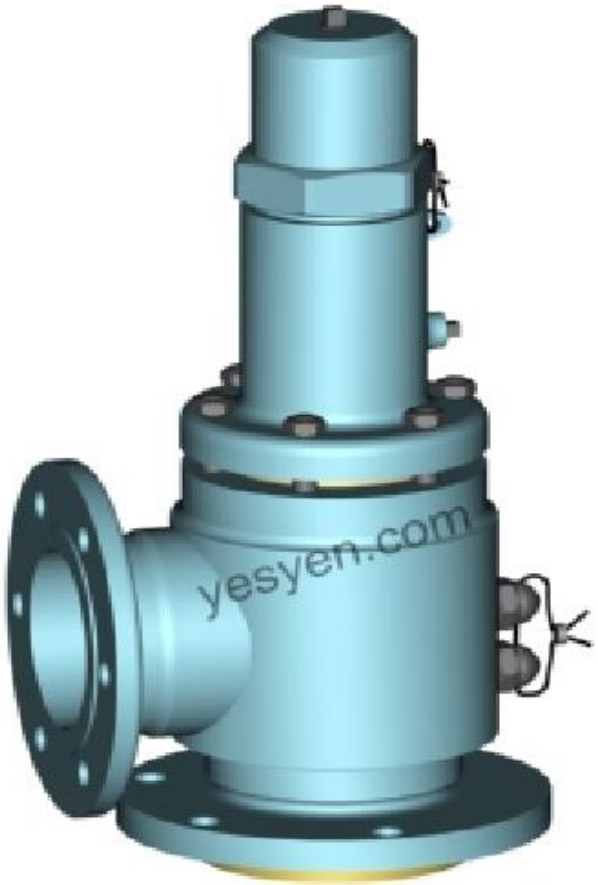
Pressure Relive valves

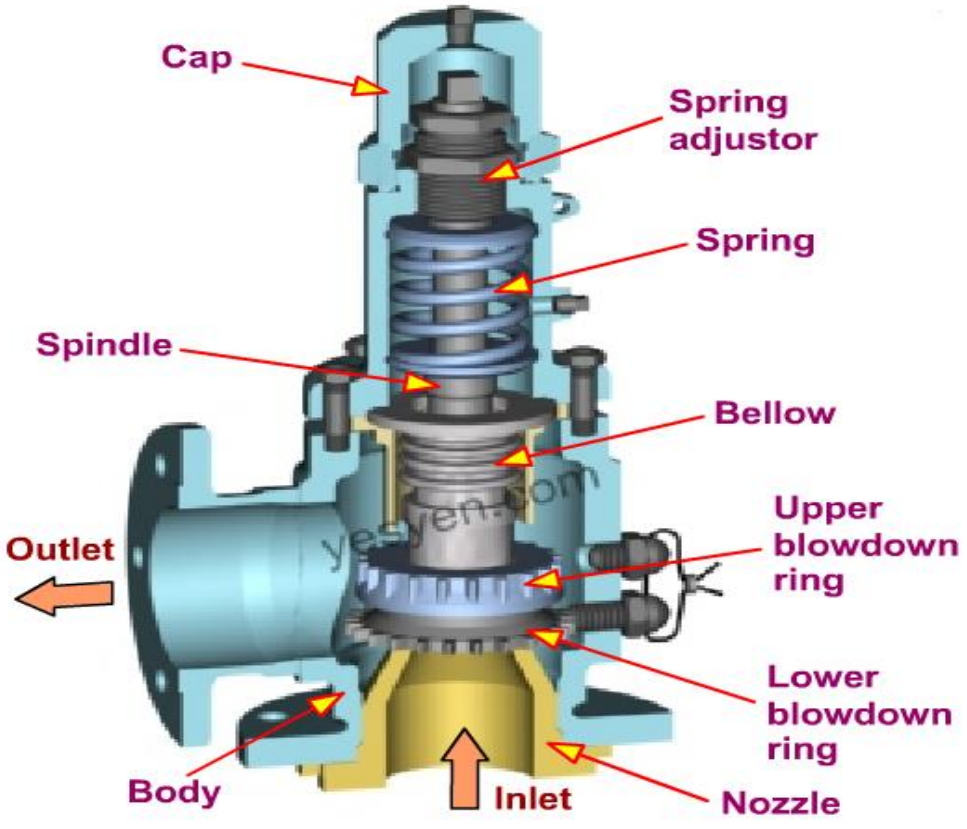
- safety valves and relief valves:
- Safety valves are primarily used with compressible gases and in particular for steam and air services .
- Relief valves are commonly used in liquid systems

SAFETY VALVE

The safety valve is a pressure-relief valve, used to protect piping and equipment from being subjected to pressures that exceed their design pressures.

The valve is actuated by inlet static pressure and is characterized by rapid opening or pop action. Safety valves are primarily used with compressible gases especially for steam and air services.





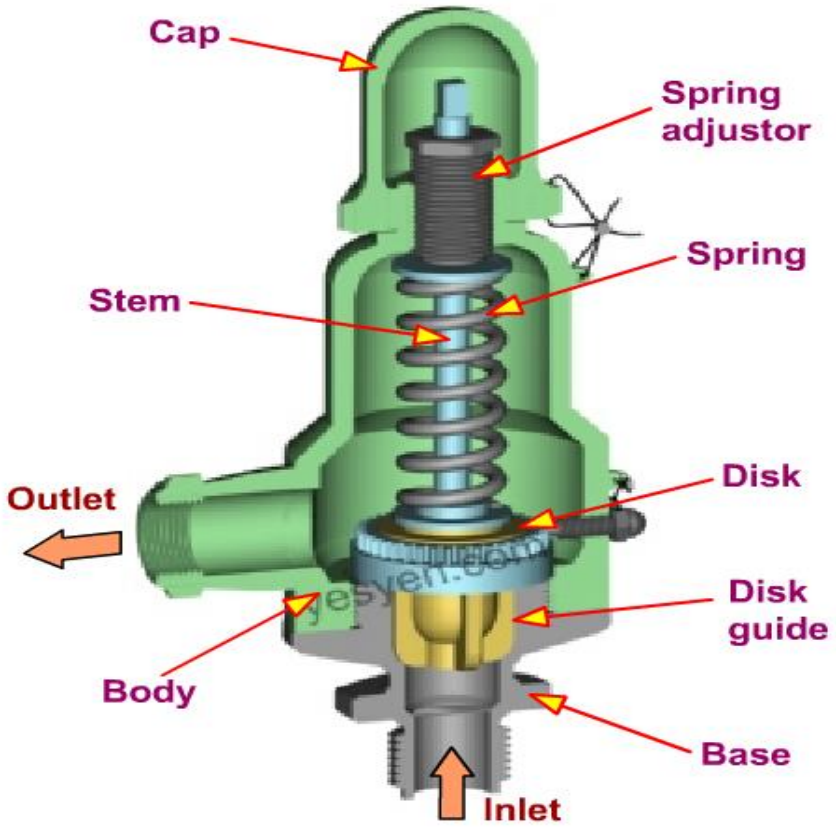
Pressure Relief Valves

- Releases excess pressure to protect system.
- Use with Gases & Vapors & liquid.
- Open Full at once at set pressure.
- Outlet port larger than inlet port.
- Never adjust whilst in service.

RELIEF VALVE

The relief valve is a pressure-relief device, used to protect piping and equipment from being subjected to pressures that exceed their design pressures.

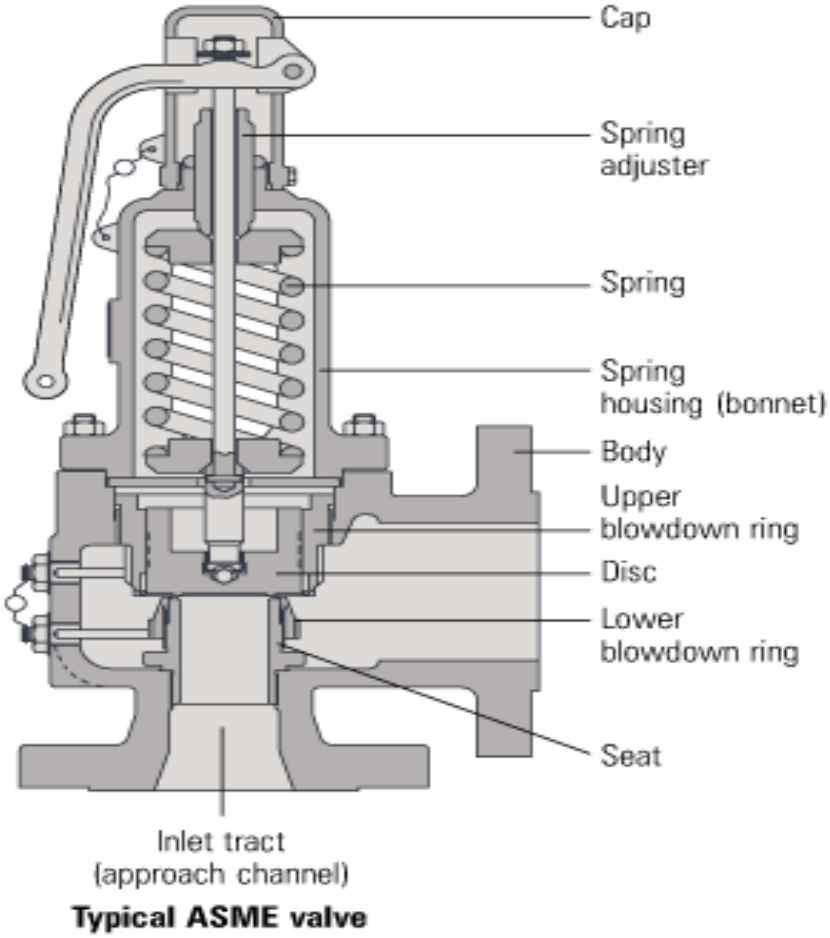
The valve is a actuated by inlet static pressure, having a gradual lift generally proportional to the increase in pressure over opening pressure. Relief valves are commonly used in liquid systems.



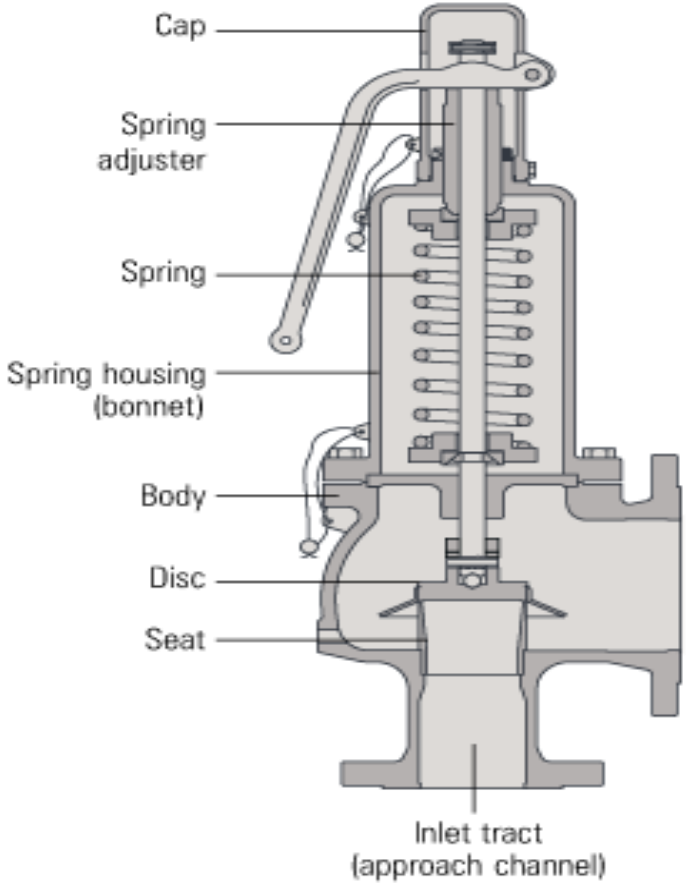
Type of Pressure Relief Valve

- ***Safety valve*** :***Used with compressible gases .steam and air services*** .
- ***Relief valve*** : ***Used in liquid systems. as pressure overspill devices*** .
- ***Safety relief valve*** : ***used either for liquid or compressible fluid.***

Safety valve - liquid applications, opens in proportion to the



Typical ASME valve



Typical DIN valve

Typical examples of safety valves used on steam & Air systems