

PIPING SYSTEM COMPONENT

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INTRODUCTION

- The piping or pipe is a network unit which transports a fluid from one type of equipment to another.

The various transported fluids:

- Incompressible fluids (liquid)
- Compressible fluids (gas)
- Fluids under high pressure
- Mixed fluids: liquid gas / slurries / solids

Flow principles

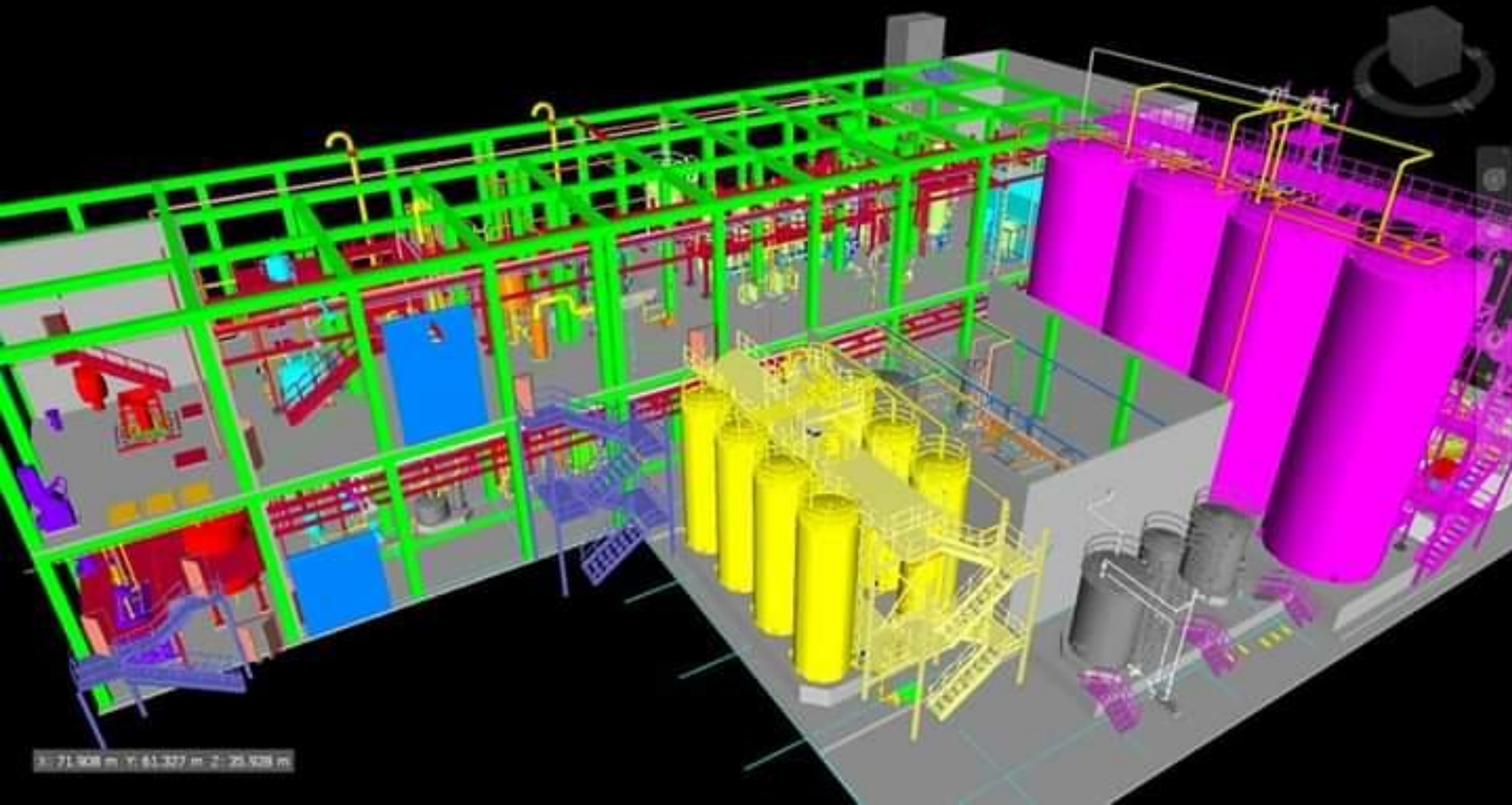
- Difference in pressure between an upstream and a downstream equipment
- Pump (liquid)
- Compressor (gas) (and) Gravity flow



PIPING NETWORK

- The piping network is a complete network (pipes, valves and other accessories which are connected to correctly perform a specific job.)
- A familiar example of a piping system is the network of water pipes in houses.
- This system includes all the components which are needed to bring the water to the house and distribute it to the various places within it.
- The piping systems are essential for the successful operation of any industrial plant. There are various systems, each with its own function.
- For example the gas oil storage tanks for boiler burners.





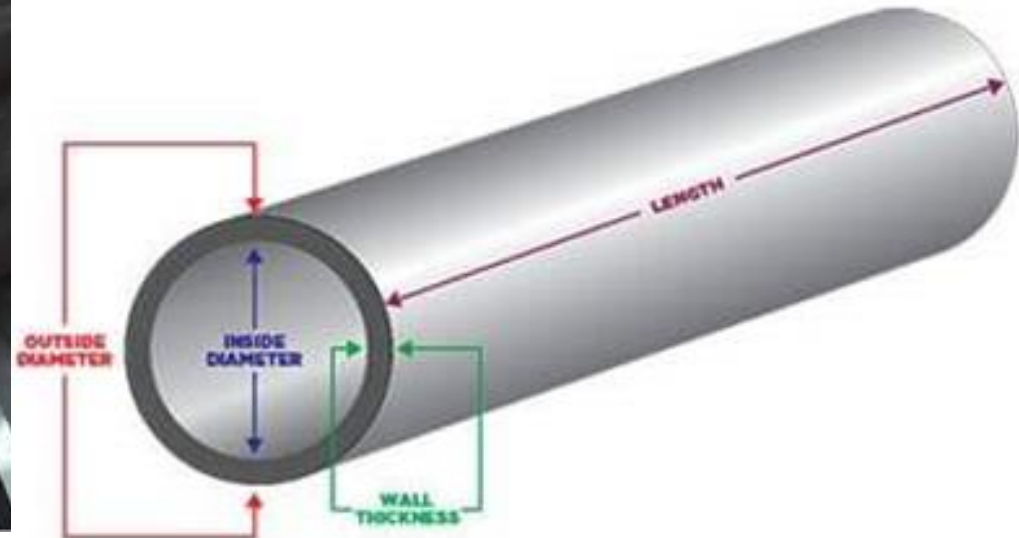
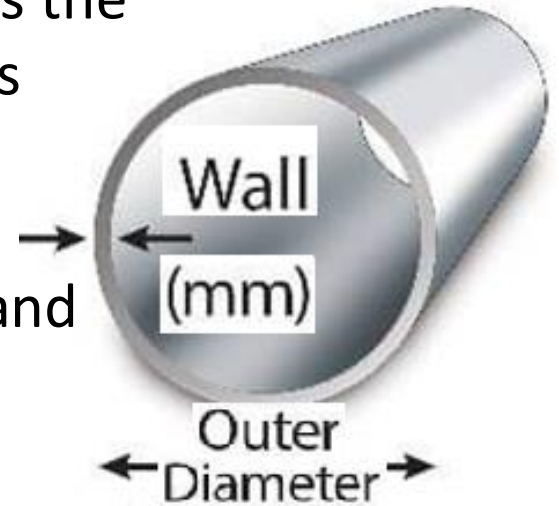
X: 71.908 m Y: 61.327 m Z: 25.928 m

1. PIPES

Pipes are used mostly to permit fluid flow and must support specifically determined pressure, compression and tensile stress. They must also resist buckling.



thickness is the differences between outside diameter and inside diameter



DIMENSIONING

The dimensioning of a pipe and of the associated elements is determined by what it will be used for (flow rate, velocity, pressure, location)

1. Dimensions of the pipes

Pipe dimensions are standardized in inches and also in the metric system

**$\frac{1}{2}$ " - $\frac{3}{4}$ " - 1" - 1½" - 2" - 3" - 4" - 6" - 8"-10" - 12" - 14" - 16" - 18"- 20" - 24"-30"
36"-42" - 48" – 56"-60"**

Example:

A pipe with a nominal pipe size of 4" (100 mm) is available in the thicknesses and diameters below:

Outer diameter in mm	Interior diameter in mm	Thickness in mm	Schedule
114.3	102.3	6.00	40
114.3	97.2	8.55	80
114.3	87.3	13.50	160

Various thicknesses of a 4" carbon steel pipe

PIPE FABRICATION

How to Calculate Any Pipe or Plate Weight ?

WEIGHT CALCULATION

Examples :

Shell :

$$W = V \times \text{Sp. Gravity}$$

$$V = \frac{1}{4} \pi \times (OD^2 - ID^2) \times \text{Length}$$

$$\text{Here } OD = 400 + 10 = 410\text{cm}$$

$$ID = 400\text{cm}$$

$$\text{Length} = 300\text{cm}$$

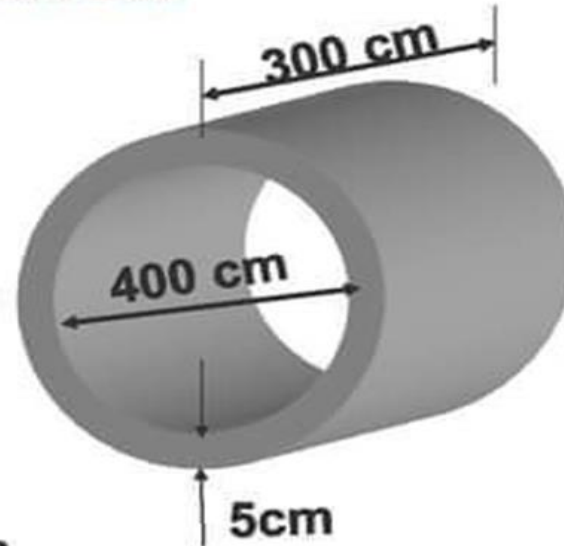
$$\begin{aligned}\text{So } V &= \frac{1}{4} \pi \times (410^2 - 400^2) \times 300\text{cm} \\ &= 1908517.54\text{cm}^3\end{aligned}$$

Now Weight

$$W = V \times \text{Sp. Gravity}$$

$$= 1908517.54 \times 7.86 = 15000947\text{gms}$$

$$= 15000.947\text{kgs} = @ 15 \text{ Ton}$$



PIPE FABRICATION

WEIGHT CALCULATION

Examples :

Circular sector :

Weight of Circular Plate Segment :

$W = \text{Volume} \times \text{Sp.Gravty.}$

Now Volume = Cross Sec.Area x Thk

$$= \frac{\pi \times (R1^2 - R2^2) \times \emptyset \times 2 \text{ cm}}{360}$$

$$= \frac{\pi \times (400^2 - 350^2) \times 120 \times 2}{360}$$

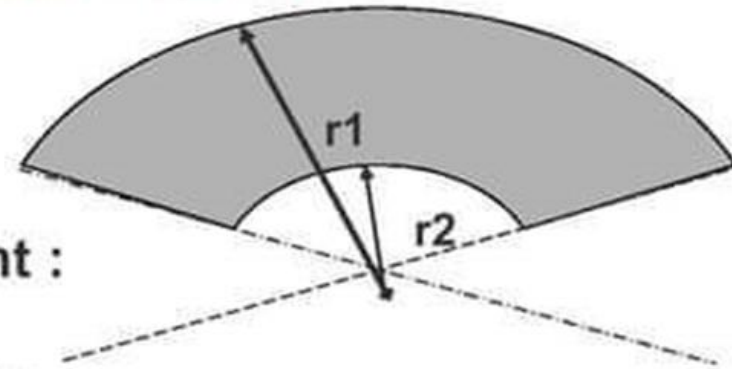
$$= 78539.81 \text{ cm}^3$$

Now Weight = $V \times \text{Sp. Gravity}$

$$= 78539.81 \times 7.86 \text{ gms/cc}$$

$$= 617322.95 \text{ gms}$$

$$= 617.323 \text{ kgs}$$



$$R1 = 400 \text{ cm}$$

$$R2 = 350 \text{ cm}$$

$$\text{THK} = 2 \text{ cm}$$

$$\emptyset = 120^\circ$$

PIPE FABRICATION

WEIGHT CALCULATION

Examples :

1. Rectangular plate :

Weight of This Plate 3.5 CM

= Volume X Sp.Gravity

= L X B X H X 7.86gm / CC

Here L = 200cm, B = Width = 100cm And H = Thk = 3.5 cm

So Volume = 200 X 100 X 3.5 cm³

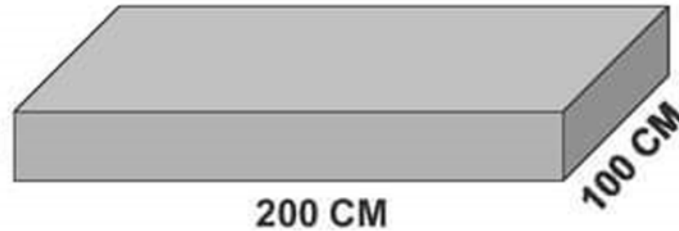
= 70000 cm³

Now Weight Of Plate = Volume X Sp .Gravity

= 70000 X 7.86 gm/cc

= 546000 gms

= 546 kgs



WEIGHT CALCULATION

Examples :

Weight calculation of different items:

- Rectangular plate
- Circular plate
- Circular plate with cutout
- Circular sector
- Shell course

Specific gravity for

(i) C.S.= 7.86 g/cm³

(ii) S.S.=8.00 g/cm³

PIPE FABRICATION

WEIGHT CALCULATION

Examples :

2. CIRCULAR PLATE :

Weight= V X Sp. Gravity

Volume V= Cross Section Area X Thk

$$= \frac{1}{4}\pi D^2 \times 4\text{cm}$$

$$= \frac{1}{4}\pi \times 300^2 \times 4\text{cm}$$

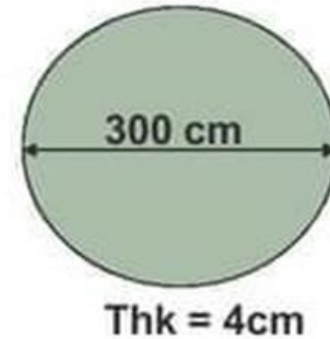
$$= \underline{282743.33 \text{ cm}^3}$$

So W = V X sp.Gravity

$$= 282743.33 \times 7.86 \text{ gms/cc}$$

$$= 2222362.5738 \text{ gms}$$

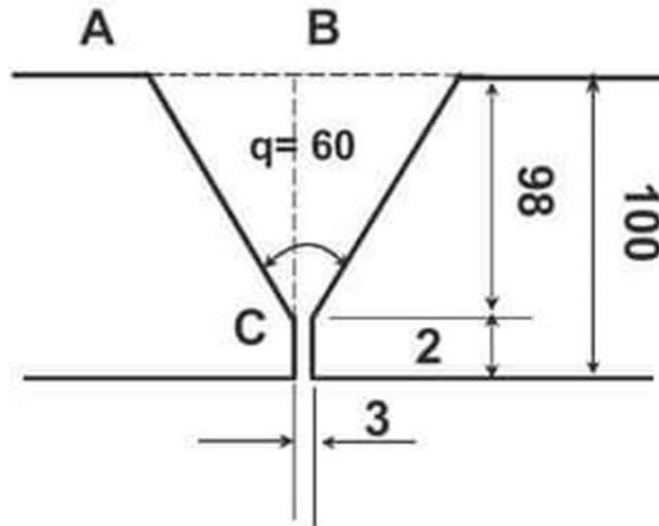
$$= \underline{2222.362 \text{ kgs}}$$



PIPE FABRICATION

WEP CALCULATION

SINGLE 'V'



In given figure, to find out

Distance, we will use

Trigonometric formula.

$$\tan Q / 2 = AB / BC$$

Here $AB = ?$, $BC = 98$, $Q / 2 = 30^\circ$

$$\therefore \tan 30 = AB / 98$$

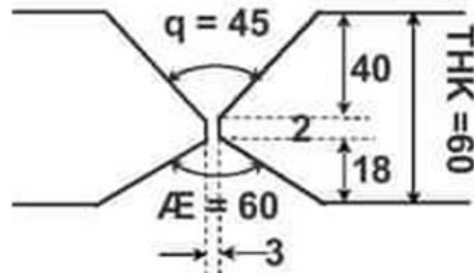
$$\therefore AB = \tan 30 \times 98 = 0.577 \times 98$$

$$= 56.54 \text{ mm}$$

PIPE FABRICATION

WEP CALCULATION

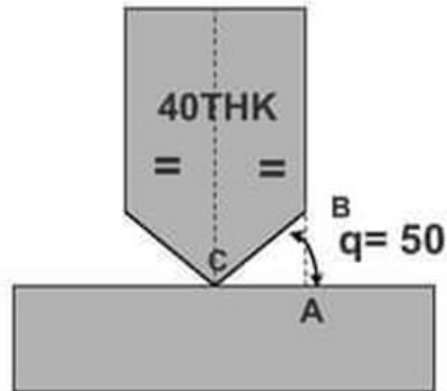
Double 'V'



For double v also we can calculate distance by same trigonometric formula. Double v are of two types:

1. Equal v
2. $2/3$ rd & $1/3$ rd.

T joint



• In t joint also by tan formula we can find WEP dimensions:

$$AC = 20, q = 50, AB = ?$$

$$\tan q = AB / AC$$

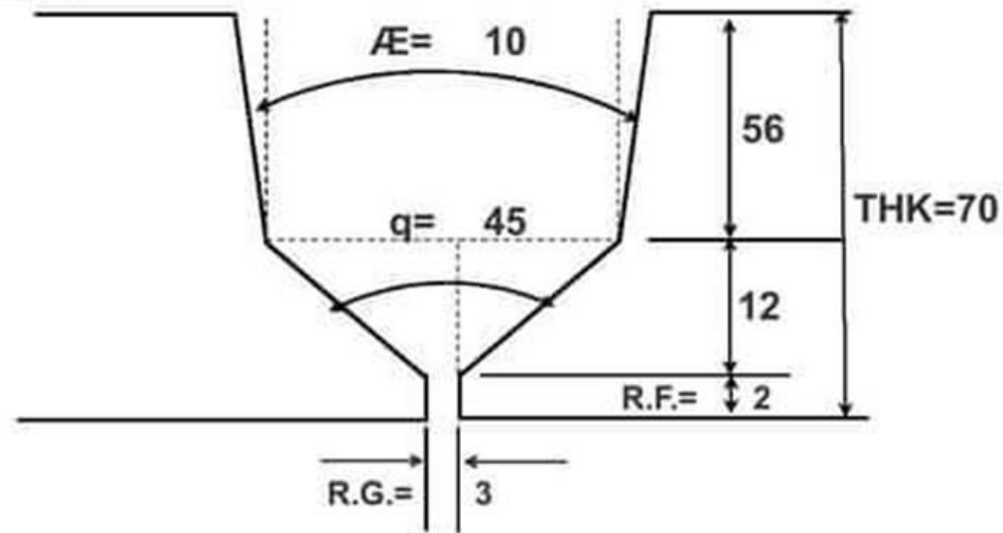
$$AB = 20 \times \tan 50$$

$$AB = 23.83$$

PIPE FABRICATION

WEP CALCULATION

COMPOUND 'V'



In such kind of compound "V", we always do machining to take care of all calculation.

As shown by dotted line, we can calculate WEP dimensions by sine or tangent formula.

PIPE FABRICATION

WELD METAL WEIGHT CALCULATION

Weld metal weight =

Cross section area of particular WEP x
length / circumference of seam x density

Basically weld metal weight calculation involves
Calculation of **volume**, **trigonometry** and
Weight calculation.

WELD METAL WEIGHT CALCULATION

For long seam weld weight

= Cross section area x Length of seam x density

= $14.9\text{cm}^2 \times 100\text{cm} \times 7.86\text{gm/cm}^3$

= 11711.4gms = 11.712kgs for 1 mtr long seam

For circ. seam

= Cross section area x Mean circ. x Density

For Circ. seam having OD = 4000 mm and Thk. = 50 mm

Weld Weight = $14.9\text{cm}^2 \times 1272.3\text{ cm} \times 7.86\text{ gms/cc}$

= 149009gms = 149.009kgs.

PIPE FABRICATION

WELD METAL WEIGHT CALCULATION

For long seam weld weight

= Cross section area x Length of seam x density

= $14.9\text{cm}^2 \times 100\text{cm} \times 7.86\text{gm/cm}^3$

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= 149009gms = 149.009kgs.

WELD METAL WEIGHT CALCULATION

Basic fundamentals of weld metal weight Calculation

1.Single v for long seam and circseam

- Long seam weld weight

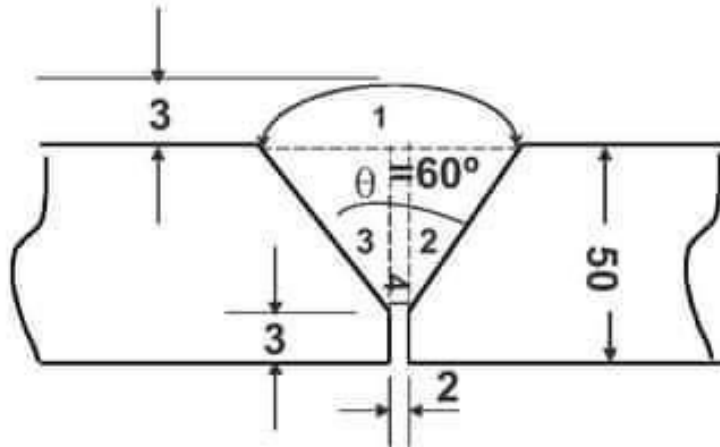
= Cross section area x length of seam x density

- Circ. seam weld weight

= Cross section area x mean circ. of seam x density

PIPE FABRICATION

WELD METAL WEIGHT CALCULATION



1. Cross-section Area Of Joint

$$A = A1 + A2 + A3 + A4$$

$$\text{Now } A = 1.2 + 6.38 + 6.38 + 0.94 \text{ cm}^2$$

$$A = 14.9 \text{ cm}^2$$

Now $A1 = \frac{2}{3} \times H \times \text{Bead Width}$

$$\therefore A1 = \frac{2}{3} \times 0.3 \times 6 \text{ cm}^2 = 1.2 \text{ cm}^2$$

Now $A2 = A3$

$$A2 = \frac{1}{2} \times B \times h = 0.5 \times B \times 4.7 \text{ cm}^2$$

$$\text{Here } B = 47 \tan 30^\circ = 2.713 \text{ cm}$$

$$\therefore A2 = 0.5 \times 2.713 \times 4.7 \text{ cm}^2$$

$$= 6.38 \text{ cm}^2$$

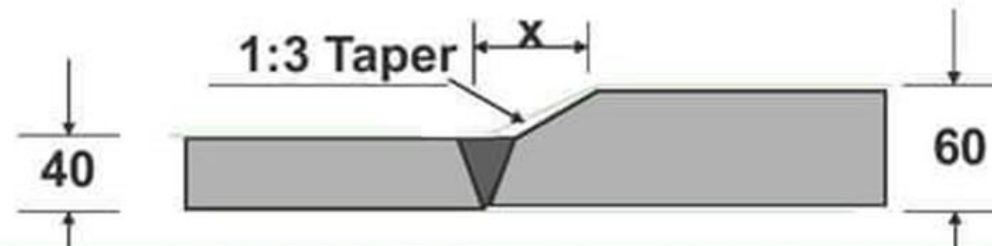
$$A3 = 6.38 \text{ cm}^2$$

$$A4 = 0.2 \times 4.7 \text{ cm}^2$$

PIPE FABRICATION

TAPER CALCULATIONS

- Whenever a Butt joint is to be made between two plates of different thickness, a taper is generally provided on thicker plate to avoid mainly stress concentration.



Thickness Difference = $60 - 40 = 20\text{mm}$.

$$X = 20 \times 3 = 60\text{mm}.$$

Instead of 1:3 taper, if 1: 5 Taper is required;

$$X = 20 \times 5 = 100 \text{ mm}.$$

3. PIPING COMPONENTS

The main fittings used

Fitting A male and female fitting which connects two straight pipes

3.1. **Elbow** (angle of 45° or 90°): Used to change the direction of a pipe

3.2. **Union** A female fitting which can be unscrewed

3.3. **Sleeve**(smaller pipe) With a different internal and external thread. It joins one pipe to another

3.4. **Tee (T)** Joins 3 pipes together in a T

3.5. **Y gasket** Joins 3 pipes together in a Y

3.6. **Cross / + gasket** Joins 4 pipes together in a +

3.7. **Plug** Solid male thread to temporarily(un)plug a pipe

3.8. **Cap** Solid plug with internal thread to temporarily (un)plug a pipe

3.9. **Nipple** A male fitting of a small section often used to fit other fittings

3.10. **Reducing sleeve** Serves to reduce the diameters of a pipe



What is Flanges?

Flanges are the second most reliable method which is used for joining after welding.

The most reliable method is obviously the valves system.

The usage of flanges adds a high level of flexibility in order to maintain a proper systems by allowing the easier disassembly and an improved access to the components of a system. Coming to the categories of a flanged connection, there are three parts which are mentioned below:

- Pipe Flanges
- Gasket
- Bolting



Threaded Flange



Socket Weld Flange



Slip On Flange



Blind Flange



Weld Neck Flange



Lap Joint Flange



Reducing Flange



Elbow Flange



Weldo Flange



Weldo Flange



Expander Flange



Swivel Ring Flange

Common Types of Flanges

Flanges are of various types which can be selected according to the site requirement. In order to match the design of an ideal flange, reliable operations must be ensured along with this long service life and an optimal pricing should be taken c the most common flange types which are usually availab

1. Threaded Flanges:

These are the flanges which are also referred to as a screwed flange and is found having a thread inside the flange bore that gets fit with the matching male thread on the fitting.

The threaded connection here refers to as avoiding the welding in various cases. It is mostly connected by matching the threading to the pipes which is to be installed.



1. Threaded Flanges:

2. Socket Weld Flanges:

This type of flanges are usually used for smaller pipe wherein the diameters in low-temperature and low-pressure areas feature a connection in which the pipe is placed inside the flange in order to secure the connection with a single or multi-pass fillet weld. This is responsible for making the style simple in installing as compared to other welded flange types by avoiding the limitations that are associated with the threaded ends.

3. lap joint flange

is the one which requires a butt welding of the stub end to that of a fitting in order to use it with a backing flange and to create the flanged connection. This design is responsible for making this style popular for use in various systems which are found having a limited physical space or systems that requires a frequent dismantling or high maintenance.



Socket Weld Flanges



lap joint flange

4. Slip On Flanges

Slip-on flanges are found to be very common and also available in a wide range of sizes in order to accommodate the systems with high rate of flow and throughput. It is quite easy to install it by simply matching the flange with the outer diameter of the pipe in order to connect it. Installing these flanges is bit technical as there is a need of fillet weld on the both side in order to secure the flange to the pipe



Slip On Flanges

5. Blind Flanges

These type of flanges are highly used for terminating the piping system.

The blind flanges are found to be shaped like a bolt able blank disc. Once these are installed properly and combined with the correct gaskets, it can achieve an outstanding seal which is easy to remove whenever required



Blind Flanges

6. Weld Neck Flanges

Weld neck flanges are quite similar to lap joint flanges but require a butt welding for installation. Whereas the integrity in the performance of this system along with the multiple repeat bends and the ability to use them in high-pressure and high-temperature systems makes them a leading choice for process piping.

- Elbow Flanges And Latro Flanges

Elboflange is referred to as a combination of a flange and an Elbolet and Latroflange is referred to as the combination of a flange with a Latrolet. Elboflanges are used to branch a pipeline at an angle of 45 degrees.

- Expander Flange

The expanding flange is commonly referred to as a welding neck flange with a highly large bore on the non-flanged end. It can be used to increase the run pipe bore only by one or two sizes strictly or maximum 4 inches. These type of flanges are preferred more as they are cheaper and lighter as compared to the combination of a butt-



Weld Neck Flanges



2.1. GASKETS

What is gasket?

Component which acts as a mechanical seal between two mating surfaces to prevent leakage.

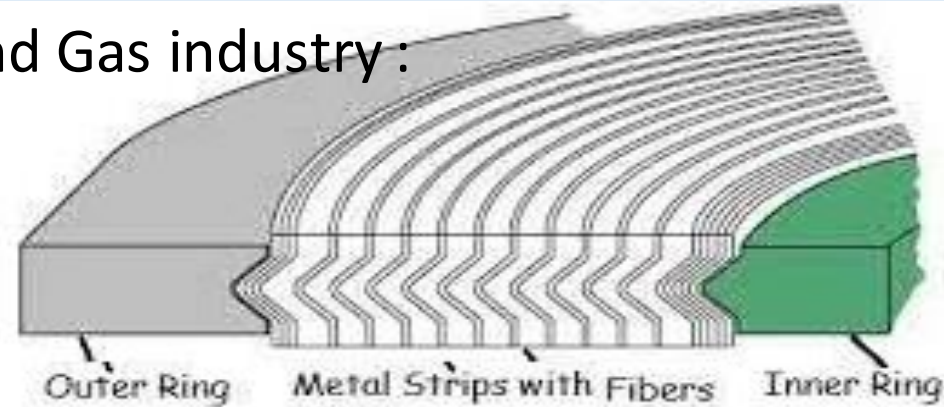
There 3 types of gasket used in Oil and Gas industry :

1. Semi metallic gasket
2. Non metallic gasket
3. Metallic gasket

Semi-metallic gaskets

are made from a combination of metallic and nonmetallic components. The metallic element is intended to give strength and elasticity, whilst the non-metallic part provides formability and sealing qualities. Commonly used are spiral-wound, Kamprofile (grooved) and metal jacketed gasket.

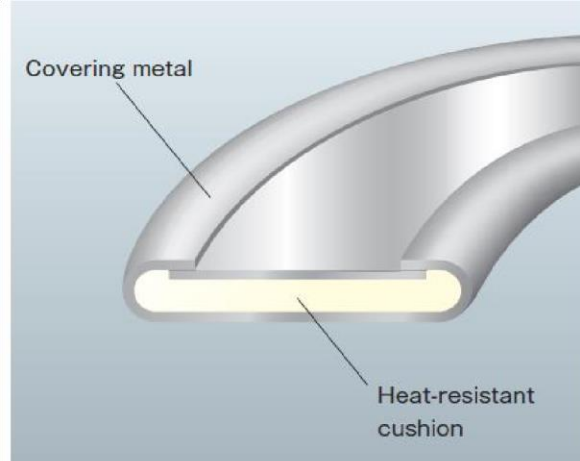
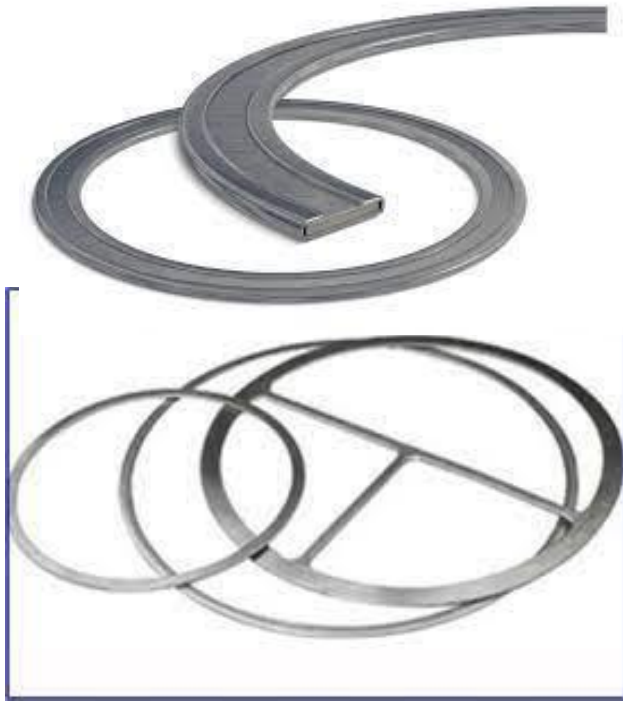
Spiral wound are widely used at standard flange in piping system while Kamprofile, metal jacketed can be found at nonstandard flange ie mechanical equipment such as heat exchanger



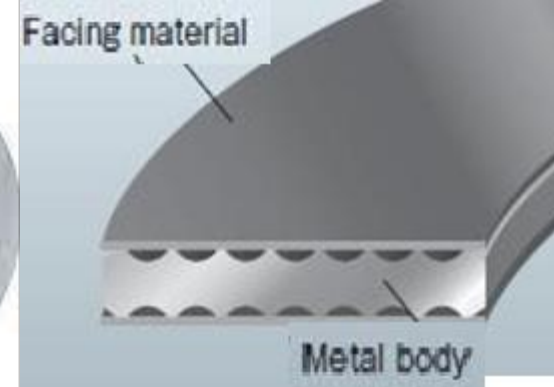
spiral-wound



Semi Metallic Gasket

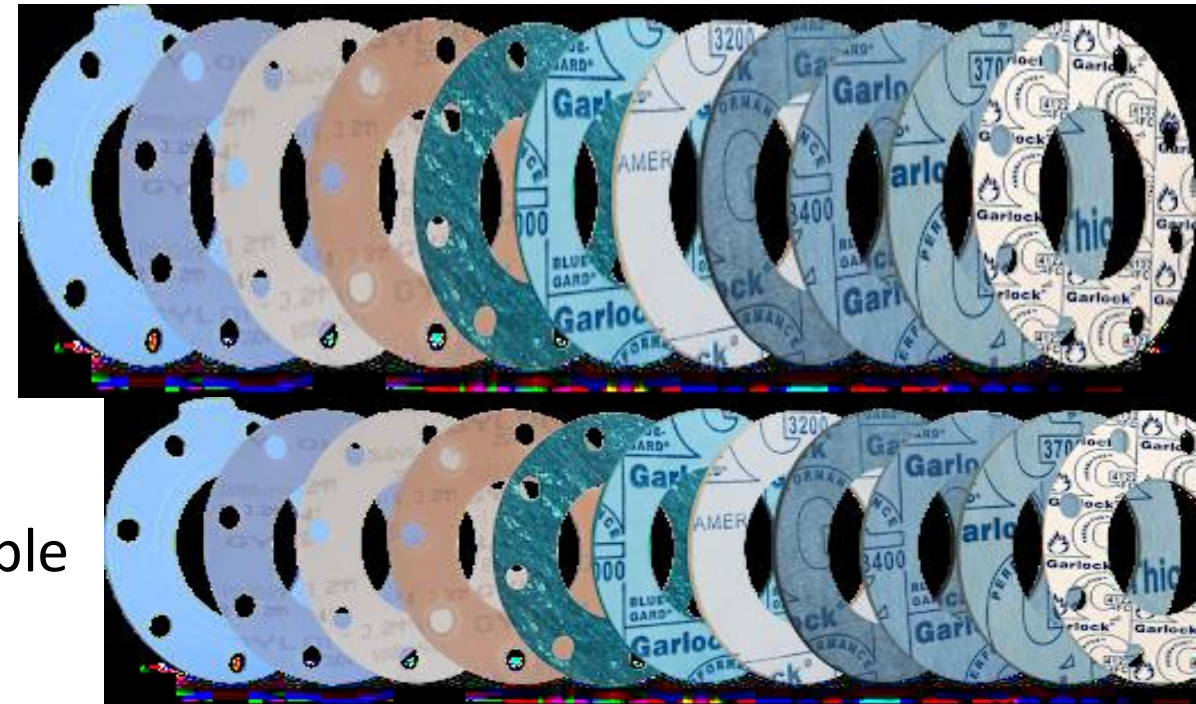


Metal Jacketed Gasket



Metal Grooved (Kammprofile)

- Non-metallic gasket relates to a gasket material that is easily compressed under bolt load. These Non- Metallic Gasket (know as soft gasket) material can be chosen from a large variety of elastomers, compressed non-asbestos, PTFE, flexible graphite and high temperature sheet products.

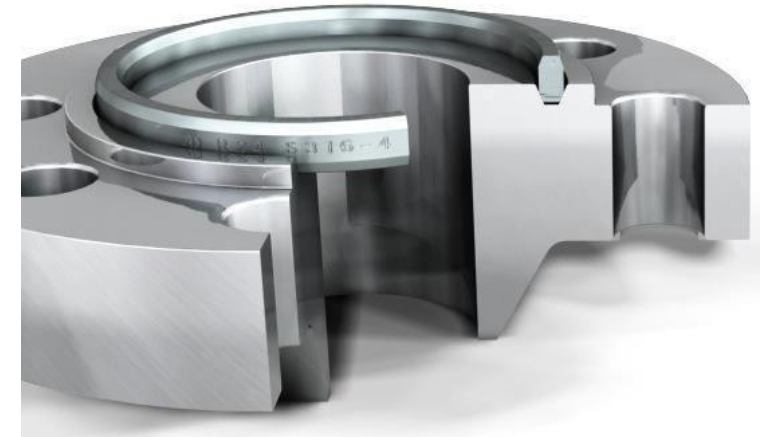
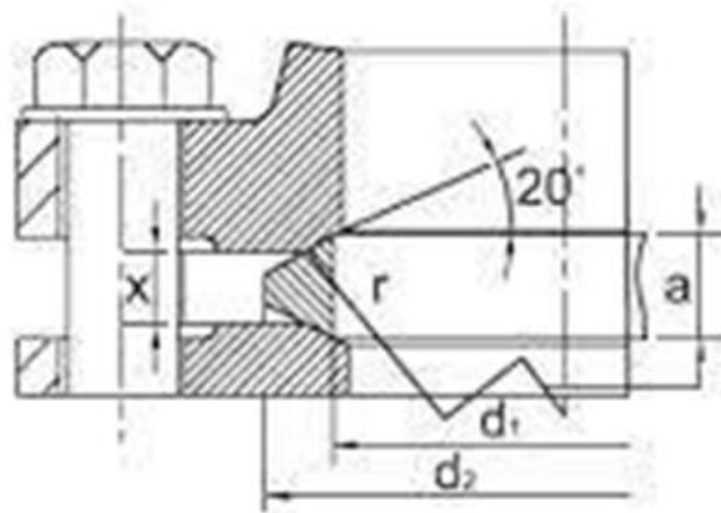


Metallic Gasket

- The gasket is made of solid metal. This gasket is suitable for high pressure and temperature application.
- Most common used is Ring Type Joint (RTJ) gasket. Other type of metallic gasket which typically found is Lens Ring.
- Lens ring gaskets have spherical sealing faces designed to fit mating flanged recesses, providing a high pressure/temperature metal to metal seal. Available in standard RTJ gasket materials and made to DIN standards, the lens ring, as with all RTJ type gaskets, should be softer than the flange material.



Lens Ring



Ring Type Joint (RTJ)



BOLTS



Anchor Bolt



Carriage Bolt



Eye Bolt



Hanger Bolt



Hex Bolt



Square Head Bolt



U-Bolt



Lag bolt

Studs with Nuts

Stud Bolts

- The all thread stud bolt is a threaded rod with 2 heavy hex nuts,
- In a flanged connection the size, length, diameter and number of bolt holes is dependent of flange type and pressure class of flange.
- Stud Bolt grades and sizes are defined by industry standards in ASTM A193 and ASME B16.5 standards.
- Stud bolt length is commonly measured end to end or first to first. The length of stud bolt, measured parallel to the axis, is the distance from first thread to first thread.
- First thread is defined as the intersection of the major diameter of the thread with the base of the point. Stud bolts are normally available in 1/4 in. length increments.



F x F = Fixed x Fixed

F x R = Fixed x Rotatable

R x R = Rotatable x Rotatable

ANSI Class 150 bolt and stud length requirements							Bolt Size
Flange Size	Stud Length			Bolt Length			
	F x F	F x R	R x R	F x F	F x R	R x R	
1"	3"	3¼"	3¼"	2½"	2¾"	2¾"	½-13
1½"	3¼"	3½"	3½"	2¾"	3"	3"	½-13
2"	4"	4"	4¼"	3¼"	3¼"	3½"	⅝-11
2½"	4¼"	4½"	4½"	3½"	3¾"	4"	⅝-11
3"	4¼"	4½"	4½"	3½"	3¾"	4"	⅝-11
4"	4¼"	4½"	4½"	3½"	3¾"	4"	⅝-11
6"	5"	5"	5¼"	4¼"	4¼"	4½"	¾-10
8"	5"	5¼"	5½"	4¼"	4½"	4¾"	¾-10
10"	5½"	5¾"	6"	4½"	4¾"	5¼"	⅞-9
12"	5½"	5¾"	6¼"	4¾"	5"	5½"	⅞-9

Valves

ملحقات

The distribution pipes are provided with various pipe appurtenances or accessories so as to make the distribution of water easy and effective.

Types of valves

- | | | | | |
|------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|
| ☐ Air valve | ☐ Reflux valve | ☐ Sluice valve | ☐ Stop cock | ☐ Fire hydrants |
| ☐ Bib cock | ☐ Relief valve | ☐ Scour valve | ☐ Water meters | |

There are fourteen types of valves for water pipes

- | | | |
|---|---|--|
| ☐ Stop valve | ☐ Air relief valve | ☐ Sluice valve or Globe valve |
| ☐ Fancy stop valve | ☐ Pressure relief valve | ☐ Butterfly valve |
| ☐ Angle stop valve | ☐ Scour valve or washout valve | ☐ Float valve or Ball cock |
| ☐ Concealed stop valve | ☐ Ball valve | ☐ Bib cock / tap |
| ☐ Gate valve | ☐ Foot valve | |

1. Air valve

- ☐ The air valve should be located at point which are close to or above the hydraulic gradient

TYPES OF VALVES



Gate Valve



Globe Valve



Y- Globe Valve



Ball Valve



Plug Valve



Diaphragm Valve



Reducing Valve



Pinch Valve



Butterfly-valve



Swing Check Valve



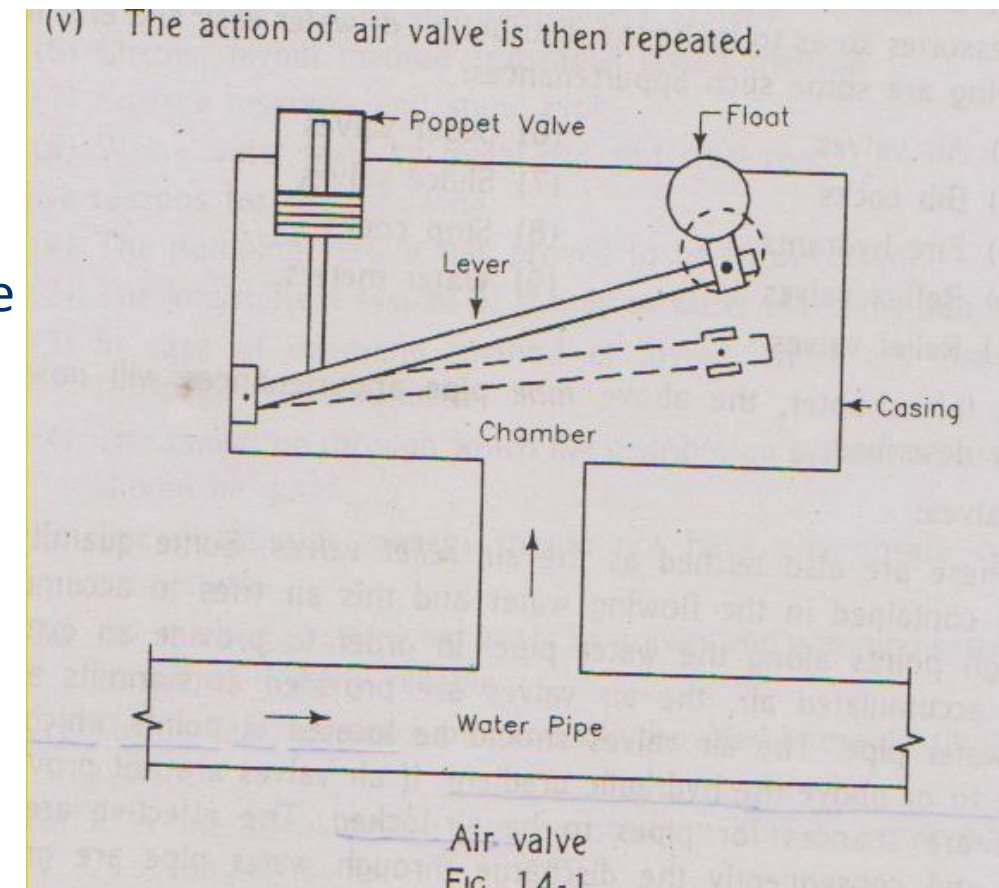
Lift Check Valve



Safety Valve

Why air valves are installed?

- ❑ If air valve are not provided there are chances for pipes to be air locked. The effective area of flow and consequently the discharged through water pipe are greatly reduced due to air locking.
- ❑ The provision of air valve along water pipe also helps in admitting air quickly when vacuum occurs in water pipe due to sudden break down at water pipe at low point.
- ❑ Air valves consist of a cast iron chamber, float, lever, and poppet valve. The chamber may be circular or rectangular in shape. A poppet valve is lifted bodily.
- ❑ Working
- ❑ The chamber is full of water drawn from water pipe. The float therefore touches the roof of chamber and poppet valve is in a closed position. When air from water pipe enters the chamber it starts accumulating just below the roof of chamber. This accumulation of air makes the lever to work and to bring down the float



- ❑ The pulling down of float by lever operates the poppet valve which is then opened. The air is thus allowed to escape through the poppet valve.

2. Reflux Valve

- Reflux valve are also known as check valve or non return valves (NRV).
- A reflux valve is an automatic device which allows water moves in one direction only

Working

When water moves in the direction the valve swing or rotates around the pivot and it is kept in an open position due to the pressure of water. When flow of water in this direction cease. The water tries to flow in a backward direction, but in this case the valve occupies its seat and thus prevents the passage of water in the reverse direction.

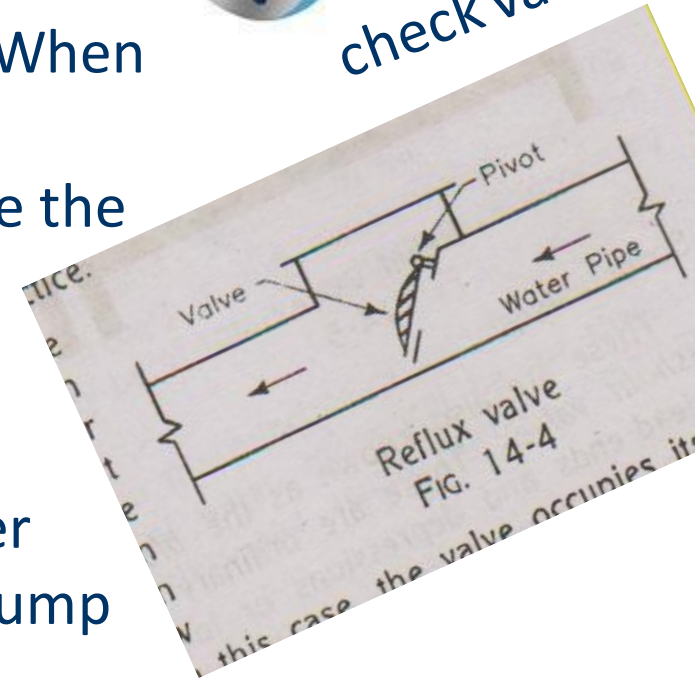
Location

The reflux valve is invariably placed in water pipe which obtains water directly from pump fails or stop. The water will not run back to the pump and thus the pumping equipment will be saved from damage.

Similarly at inter connection between a polluted water system and a potable water system, the provision of reflux valve will prevent the entry of polluted water into pure water.



check valve



3. Water Meter

- Water meters are installed on pipes to measure the quantity of water flowing at a particular point along the pipe.

Types Meters

The water meters can be classified into the following 2 categories.

1. Positive displacement type meters.
2. Velocity meters

- The positive displacement type meters records the number of times a container of known volume is filled and emptied with water, depending upon the motion of a moving part in the measuring device. The positive displacement device may be rotary, oscillating, reciprocating or rotating disc type meters.
- The velocity meters work on the principle of velocity of entering water and higher the velocity more will be the discharge through meter.
- Thus turbine meters and venturi meters come under this category.

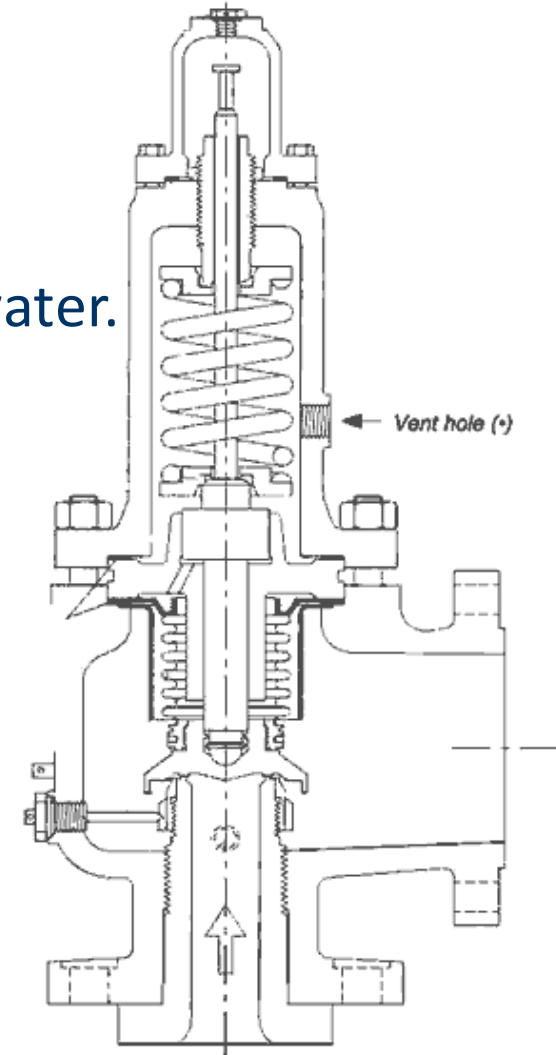


The Requirements Of Good Water Meters

1. It should accurately measure the discharge of water to the permissible tolerance of about 2%
2. It should be capable of registering even small quantity of flow of water
3. It should be easy to repair and to maintain in a good working condition
4. It should not be too costly
5. It should contain an arrangement in the form of a screen at the inlet so that the entry of grit is prohibited.
6. It should not offer any resistance or obstruction to the natural flow of water.
7. The entire assembly of the meter should be non corrosive

4. Relief Valve (Globe Valve)

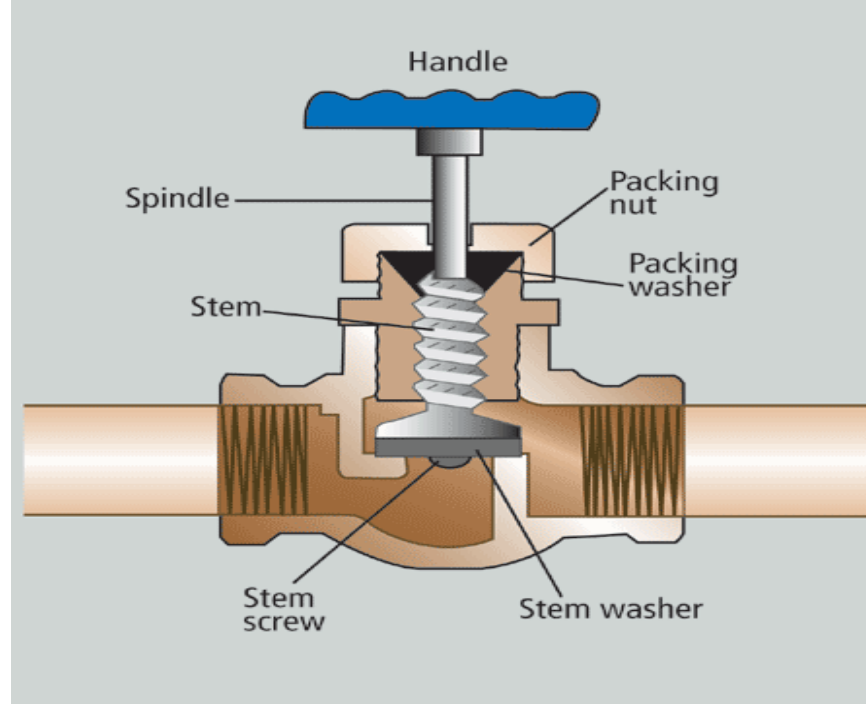
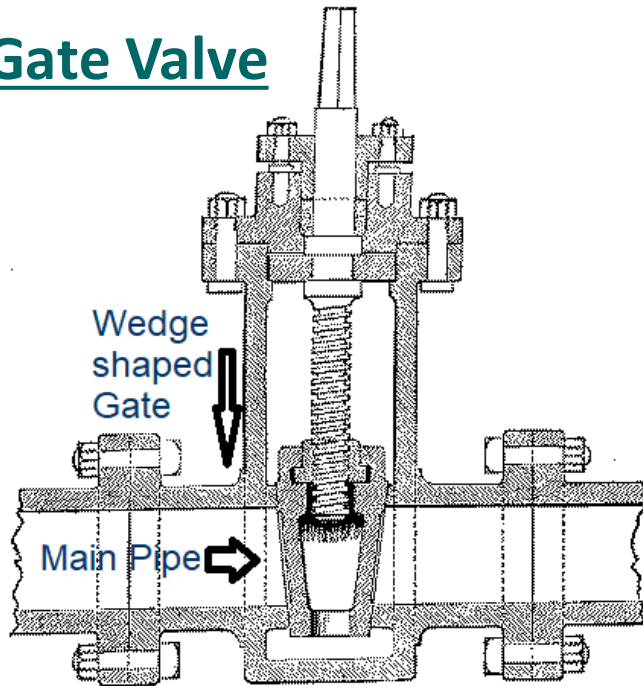
- ❑ The **relief valve** (RV) is a type of valve used to control or limit the pressure in a system or vessel which can build up by a process upset, instrument or equipment failure, or fire
- ❑ Pressure relief valves perform the vital role of limiting the air or fluid pressure or vacuum in a system. Designed to open at a predetermined pressure, relief valves protect your system from over or under pressurization



Working

- ❑ When the safe pressure of a system is exceeded, the relief valve opens and air or fluid is diverted through this auxiliary route – thus protecting your system from pressure that has exceeded the safe pressure range.
- ❑ Once the pressure reaches safe levels the relief valve will close allowing normal operation of the system to continue, with the relief valve ready to operate again.
- ❑ Pressure relief valves are also known as vacuum relief valves, blow-off valves, pop-off valves, pressure regulating valves, safety valves, and purge valve

5. Gate Valve

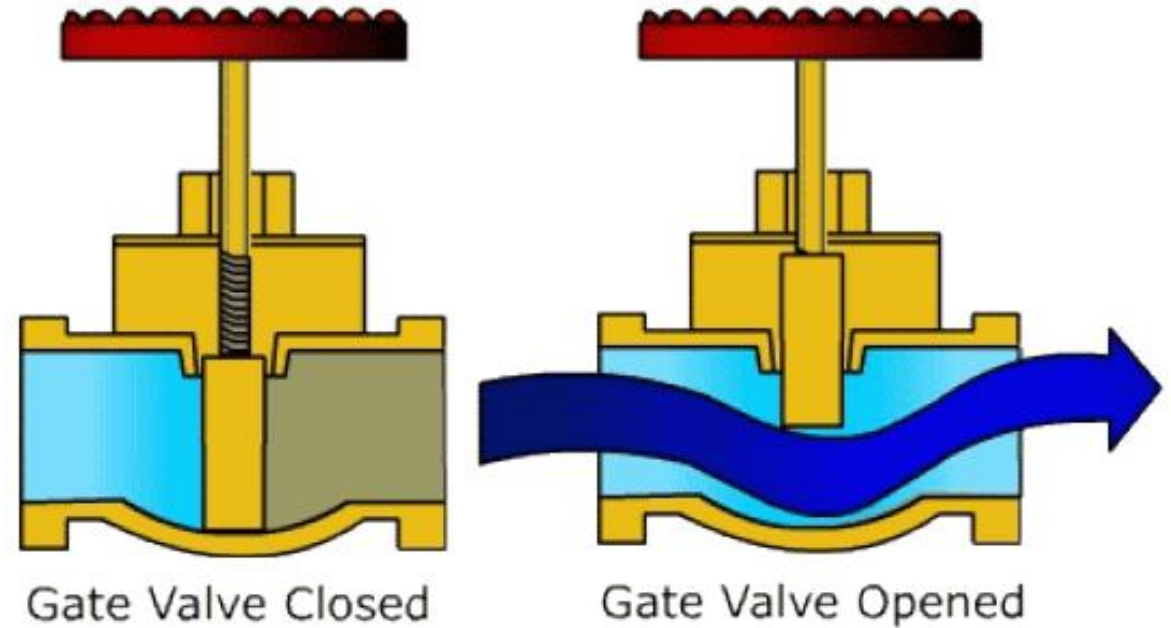


Gate valve

is a full way valve which is inserted in a pipeline for controlling or stopping the flow of water. It offers lesser resistance to the flow of water.

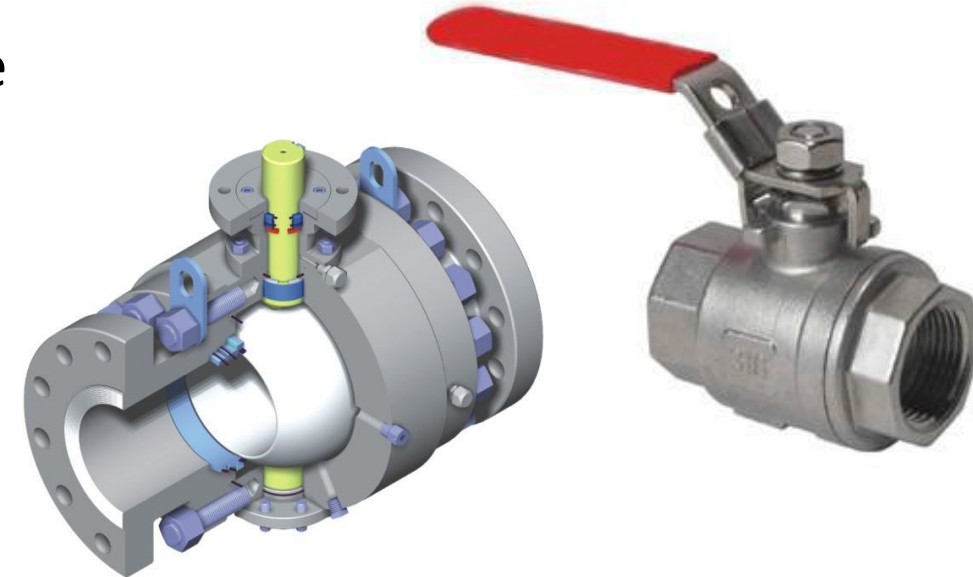
Hand wheel closes the valve by turning it in clockwise direction.

Its nominal sizes are 15 mm to 100mm



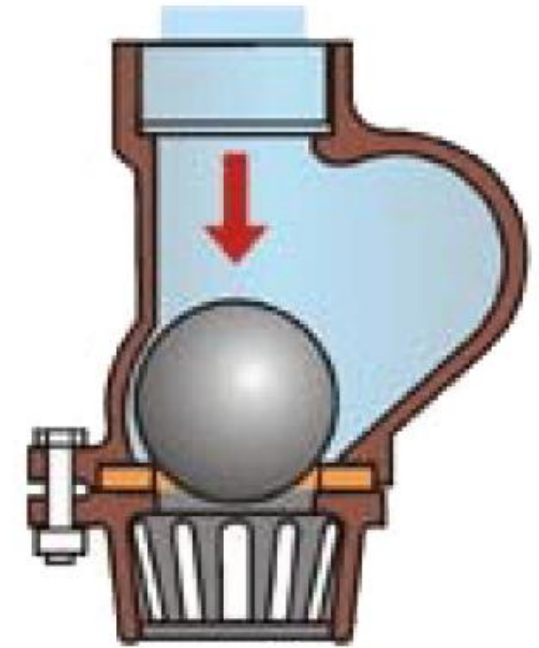
6. Ball Valve

- Ball valve or float is an automatic flow control device.
- in this valve the regulating principle is the level of some free water surface.
- Ball valves are used in the underground storage tank, flushing cistern etc. to regulate the flow of water automatically.
- The ball valves are of nominal sizes 15 mm, 20 mm, 25 mm, 32 mm, 40 mm and 50 mm.



7. Float Valve Or Ball Cock

- These valves are used in water tanks and in the cisterns to maintain constant water level and prevent overflow.
- It is activated by means of a lever and float (ball).
- The rise and fall of the ball controls the flow of the water.
- They are generally made for high pressure, medium pressure and for low pressure.



8. Butterfly Valve

- The valve contains a circular disc which rotates to the direction of flow in the pipe.
- A butterfly valve is a type of flow control device used to regulate the fluid flowing through a section of pipe.
- The valve is similar in operation to a Ball Valve.
- A flat circular plate is positioned in the center of the pipe.

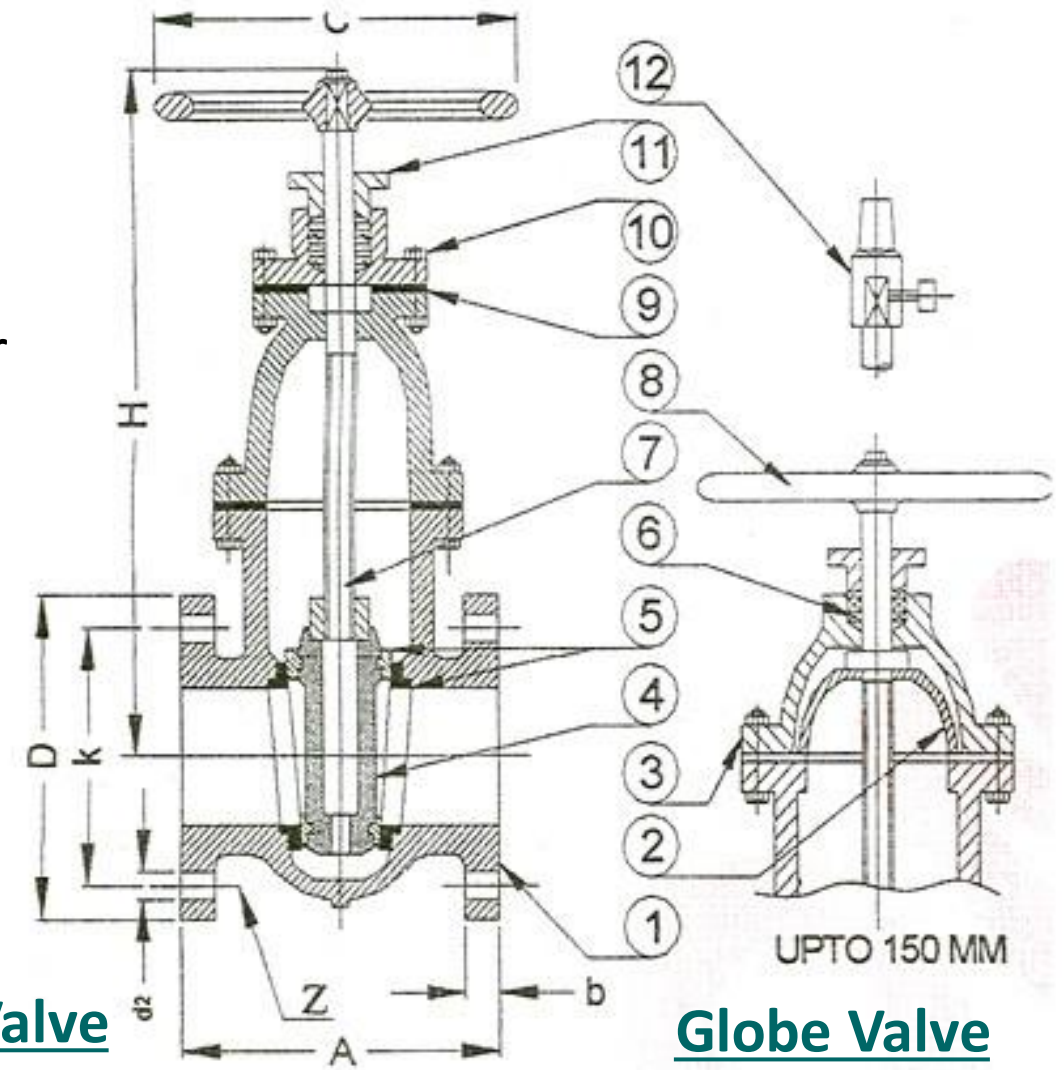
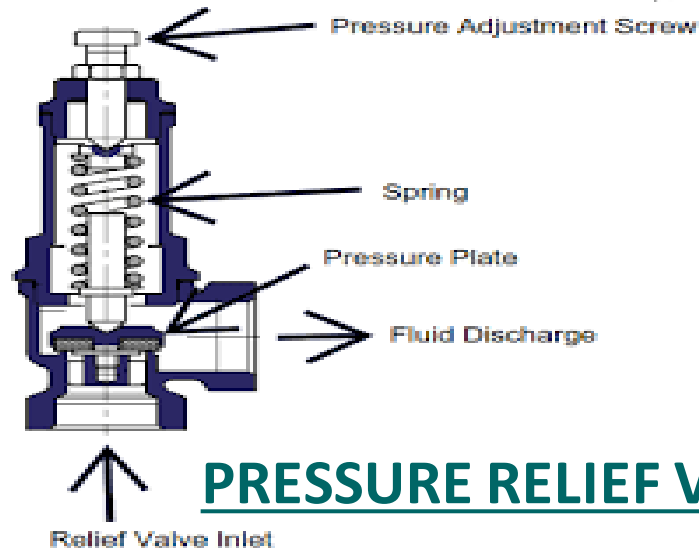


9. Sluice Valve Or Globe Valve

- These valves are used to control the flow.
- Globe valves are used for the control and frequent operation

10. PRESSURE RELIEF VALVE

- It is used to protect pipe from sudden increase in the pressure due to water hammer (beat) because of closing the valves.
- It is a device attached to a boiler or other vessel for relieving the pressure of steam automatically before it becomes great enough to cause bursting.



CONTROL VALVES

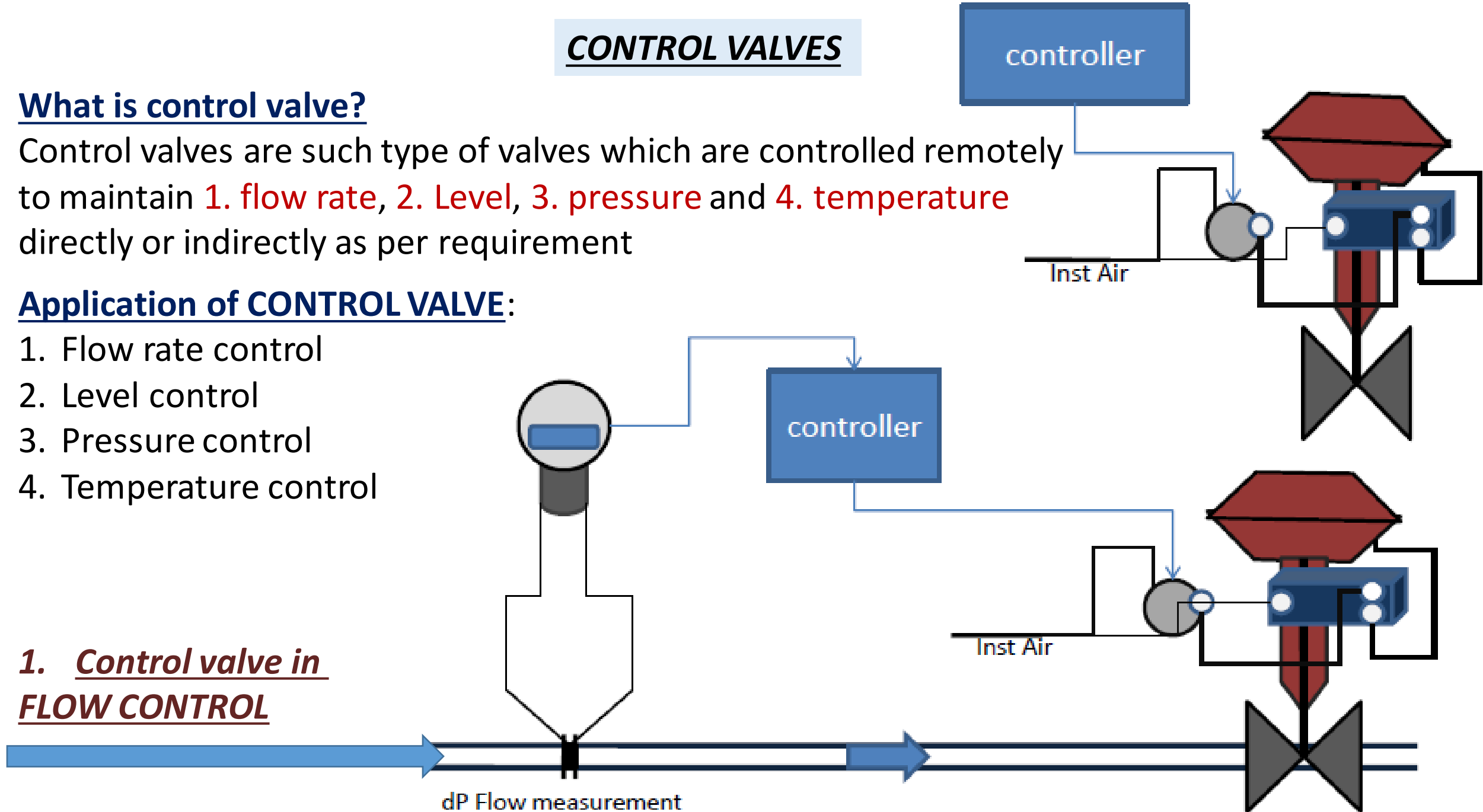
What is control valve?

Control valves are such type of valves which are controlled remotely to maintain **1. flow rate**, **2. Level**, **3. pressure** and **4. temperature** directly or indirectly as per requirement

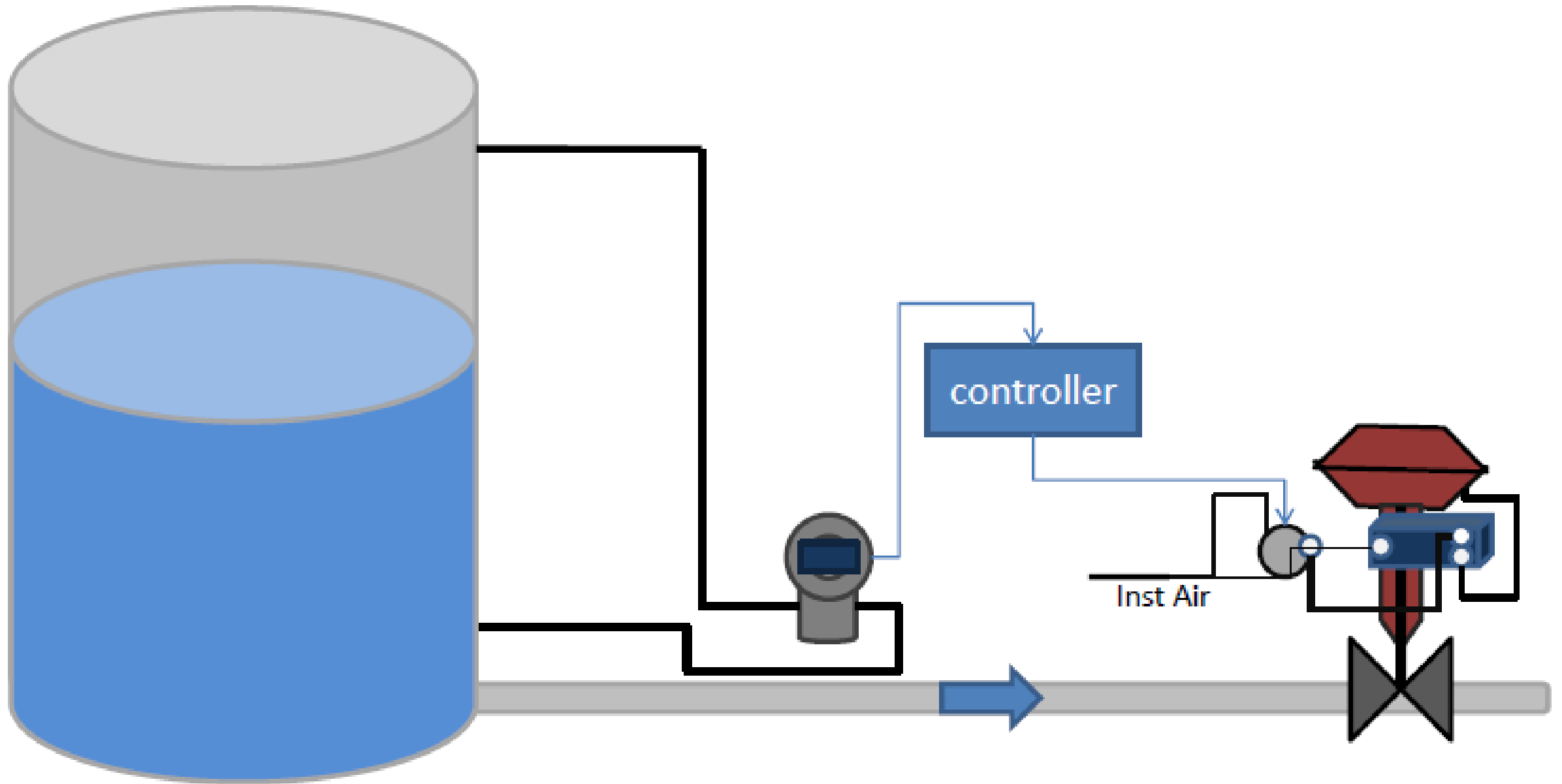
Application of CONTROL VALVE:

1. Flow rate control
2. Level control
3. Pressure control
4. Temperature control

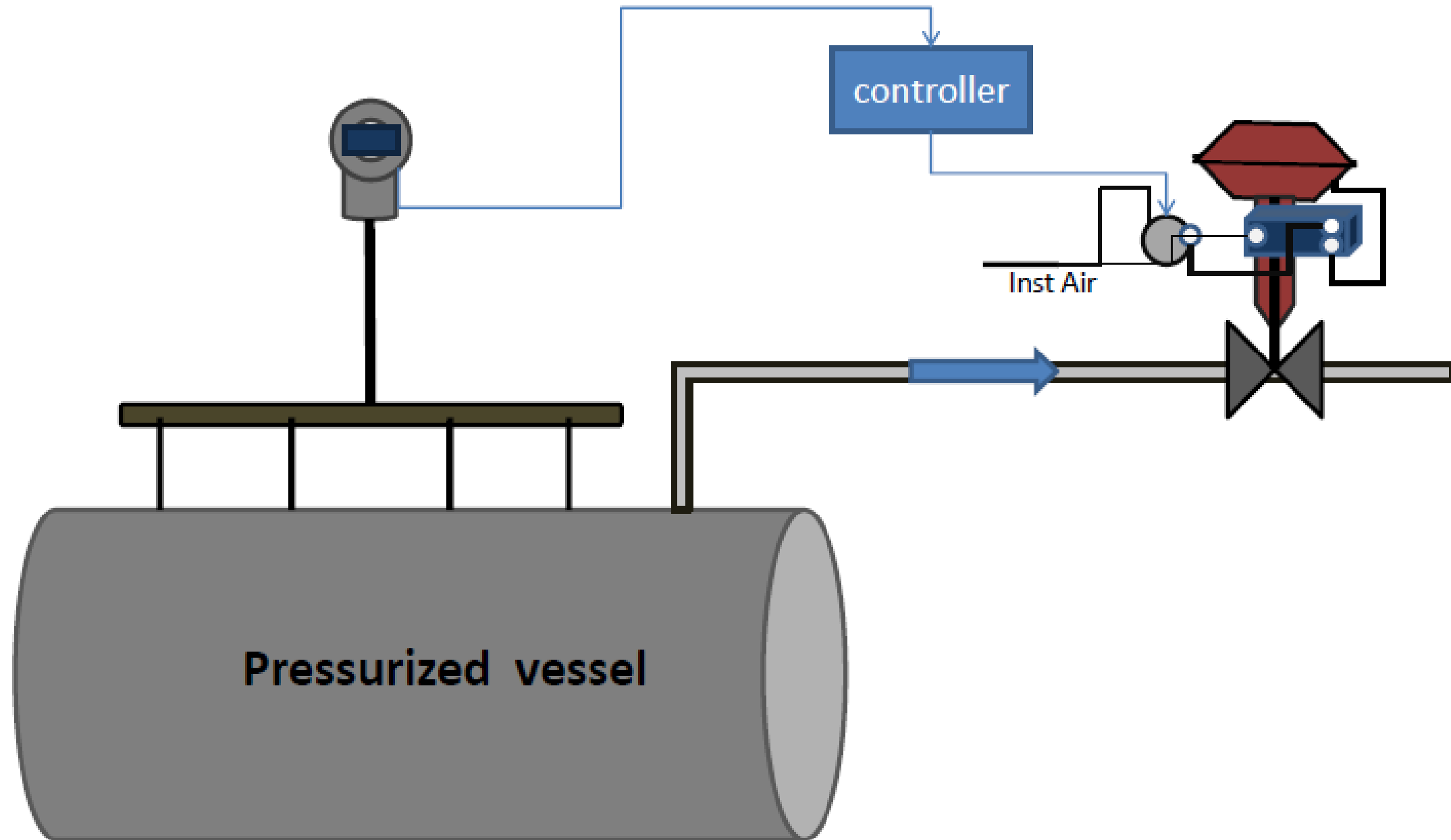
1. Control valve in FLOW CONTROL



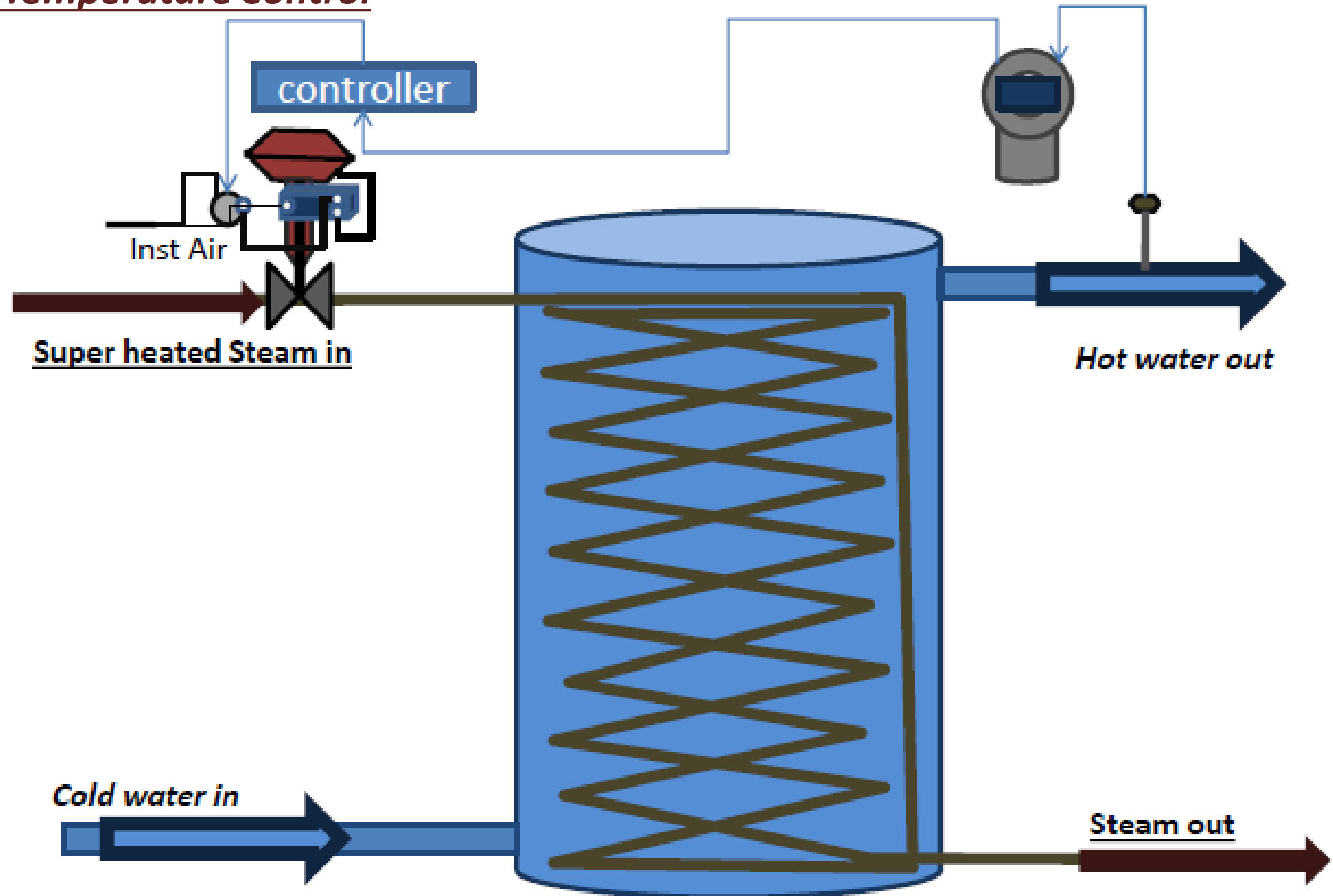
2. Control valve in LEVEL CONTROL



3. Control valve in PRESSURE CONTROL

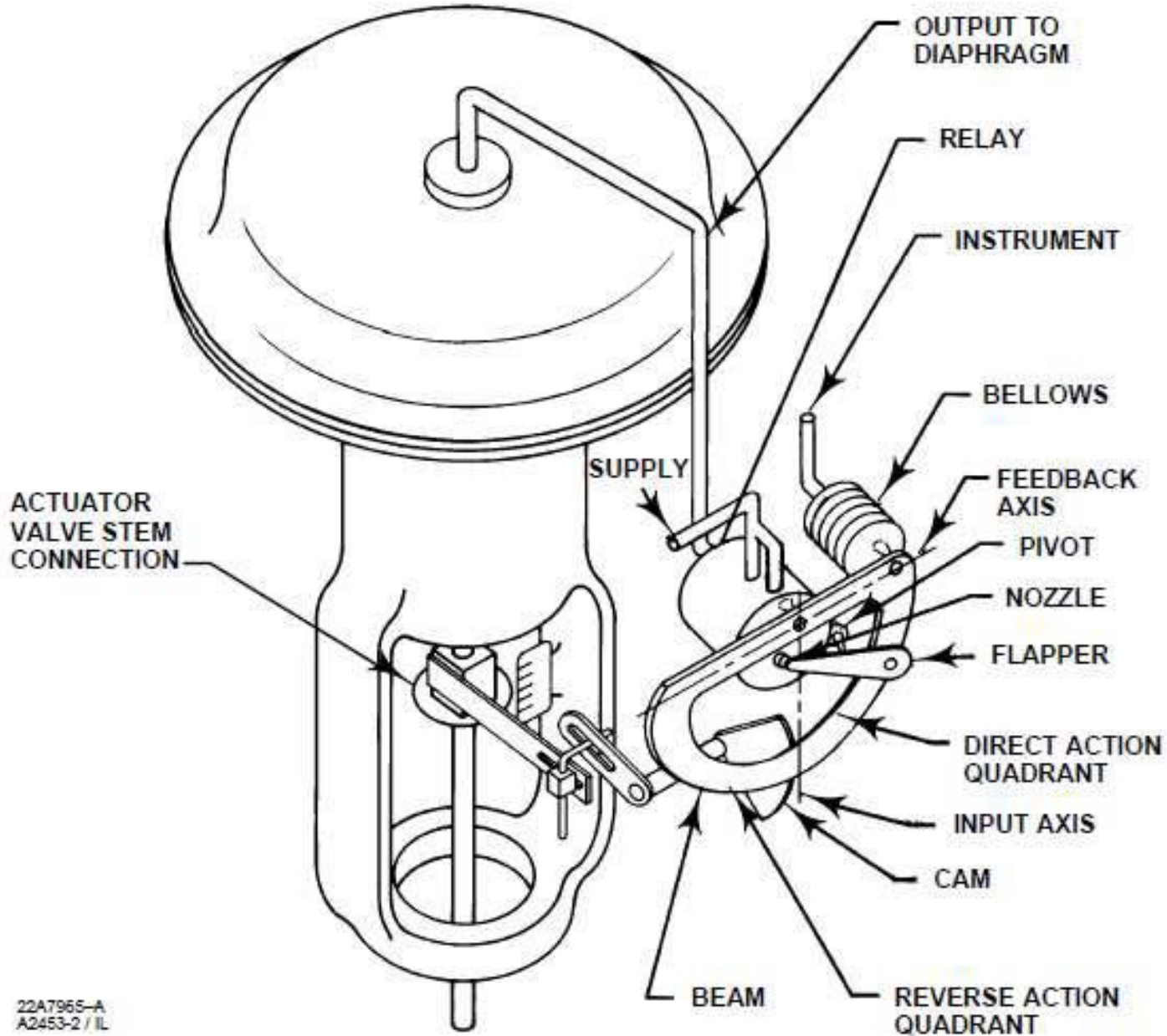
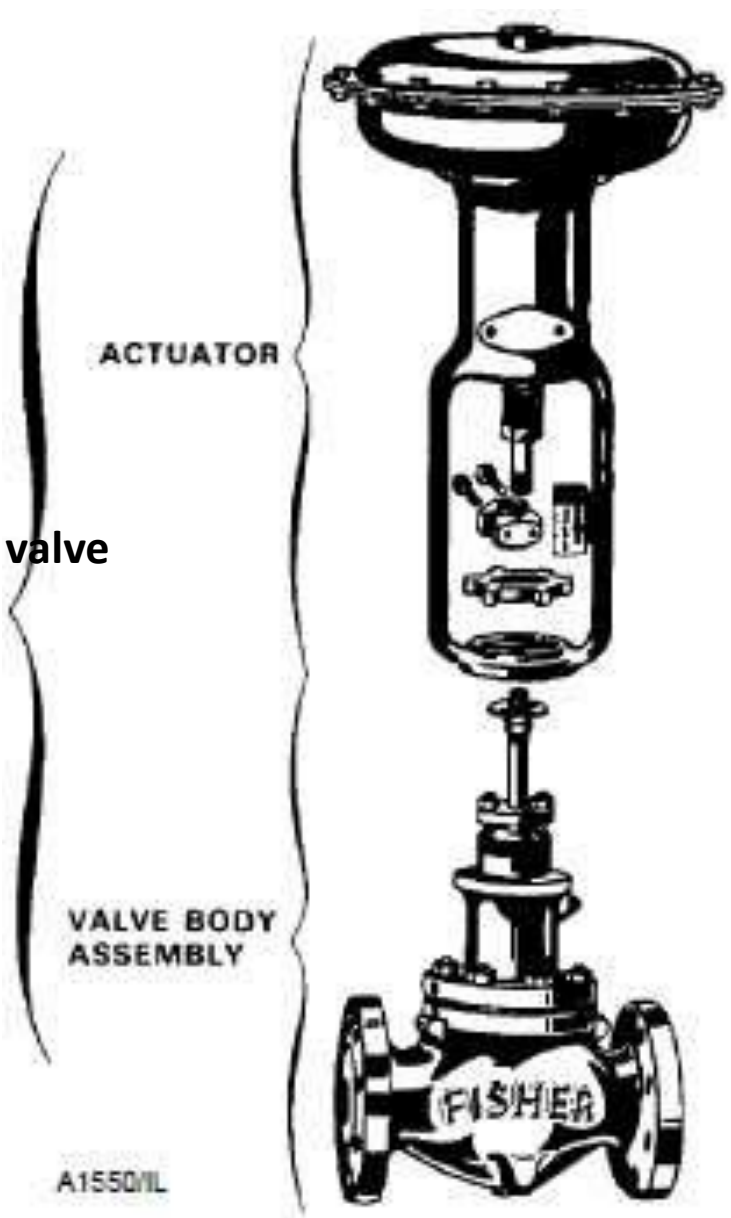


4. Control valve in Temperature Control



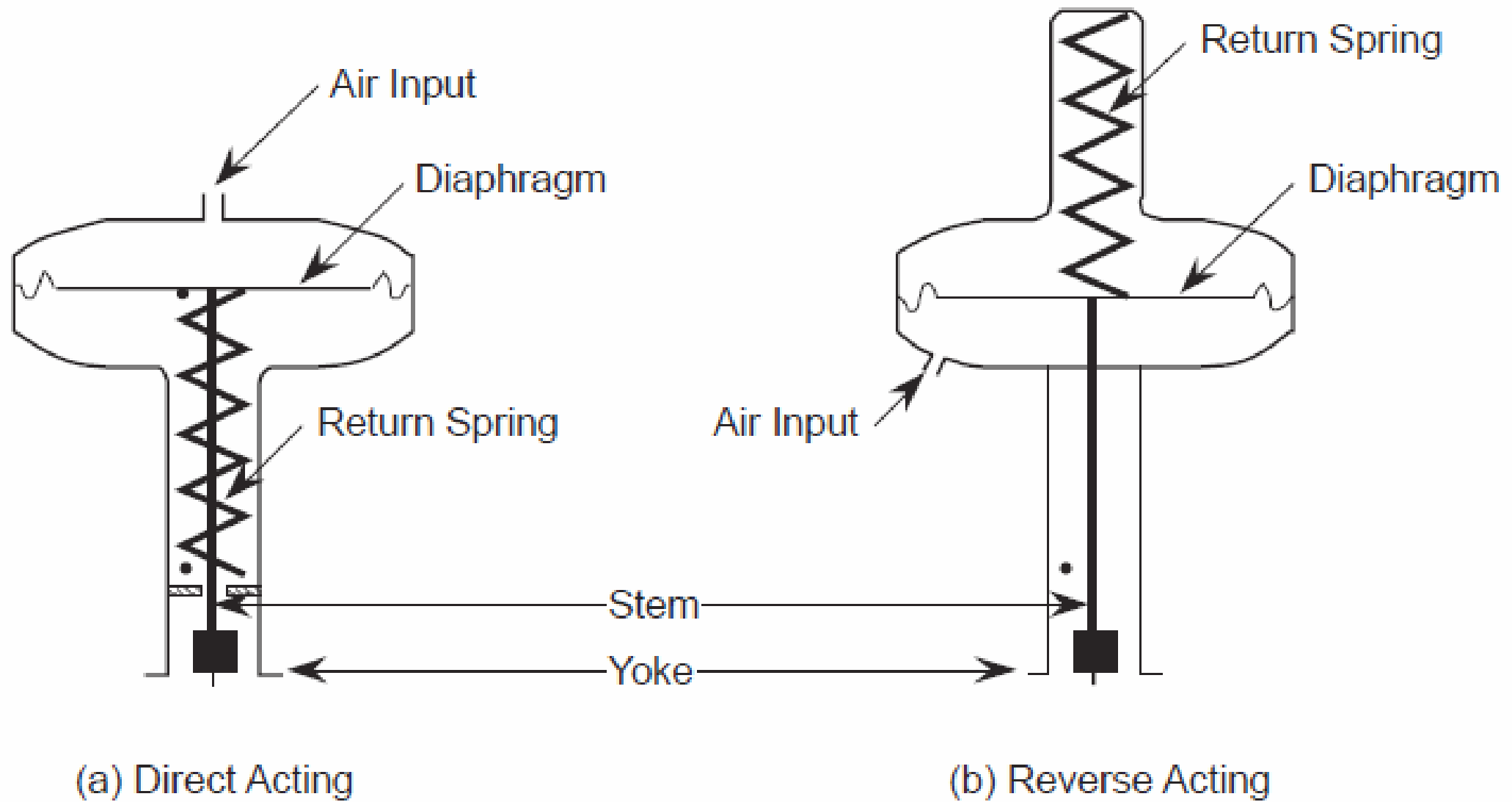
Relationship of major components of a control valve

Control valve

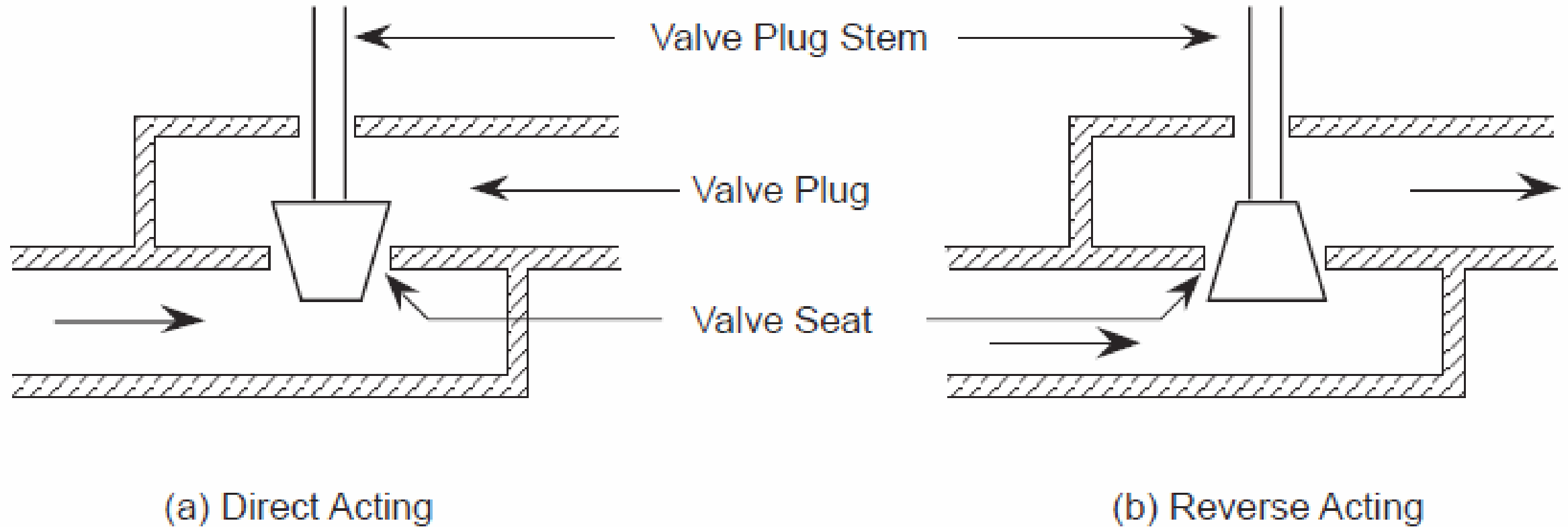


22A7965-A
A2453-2 / IL

Classification of control valve on the basis of actuator action



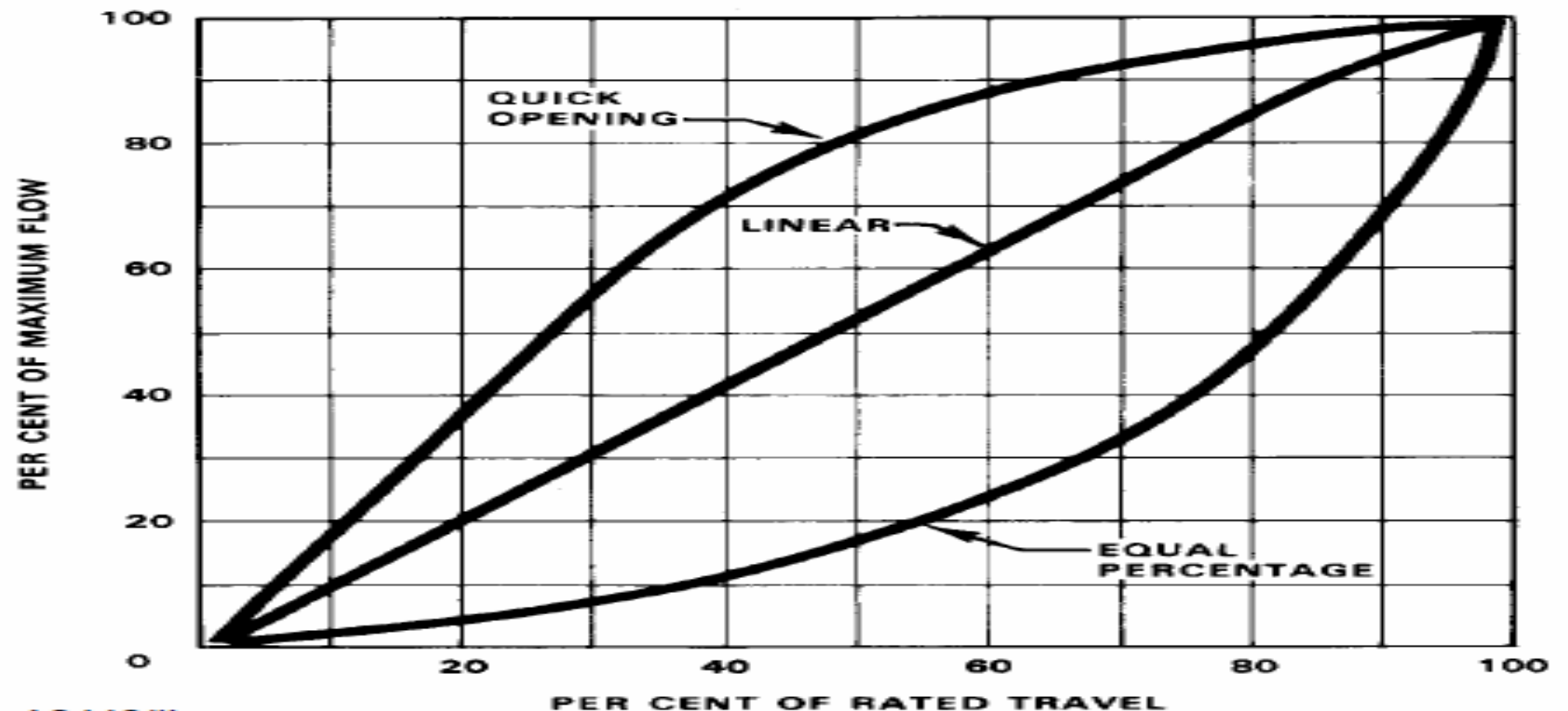
Classification of control valve on the basis of valve action



Failure mode

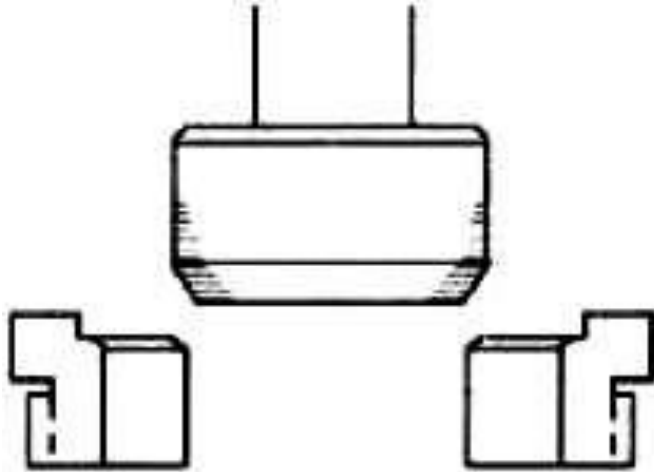
Actuator action	Valve body action	Control valve action	Failure mode	Valve Color
Direct	Direct	Air to close	FAIL OPEN	Green
Direct	Reverse	Air to open	FAIL CLOSE	Red
Reverse	Direct	Air to open	FAIL CLOSE	Red
Reverse	Reverse	Air to close	FAIL OPEN	Green

Characteristic of control valve

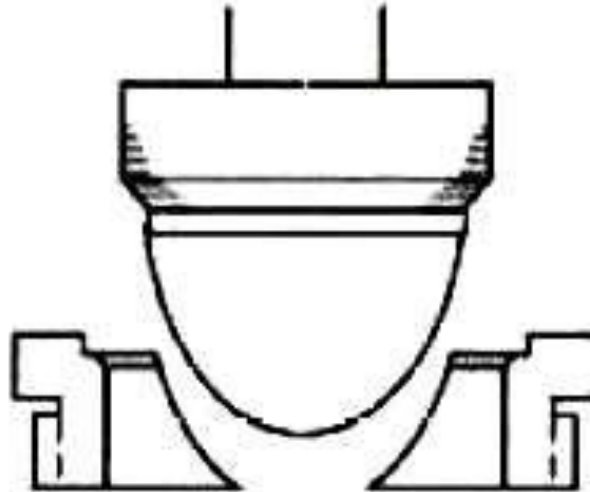


Characterized
valve plugs

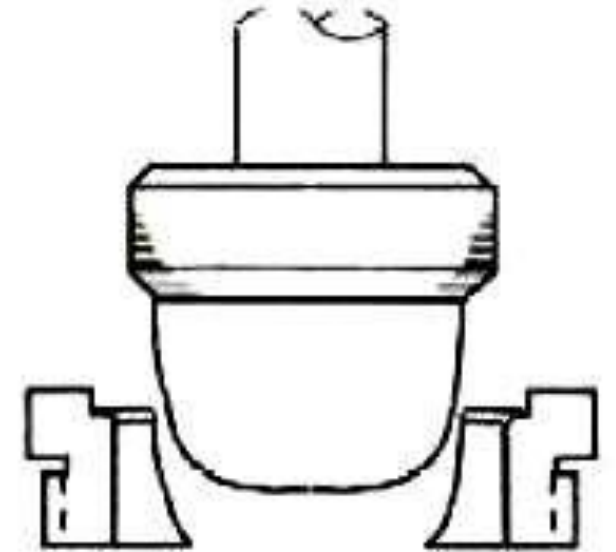
a) Quick Opening



b) Linear



c) Equal Percentage



Characterized cages
for glove style valve bodies



W0958/1L

QUICK OPENING



W0959/1L

LINEAR



W0957/1L

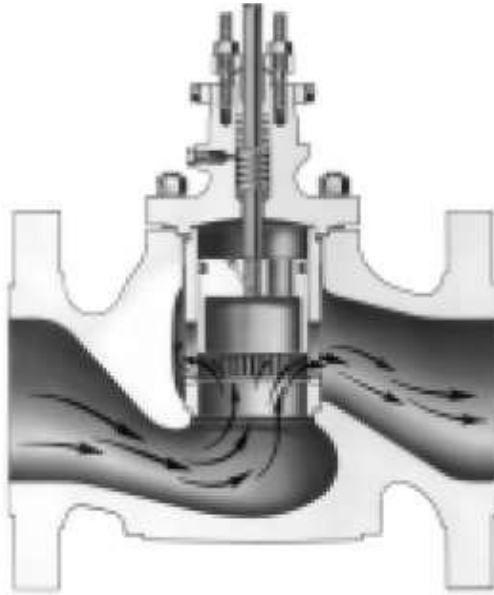
EQUAL PERCENTAGE

Pictures of Few typical valves

1. Cage valve and aerodynamic noise reduction



W1257/L

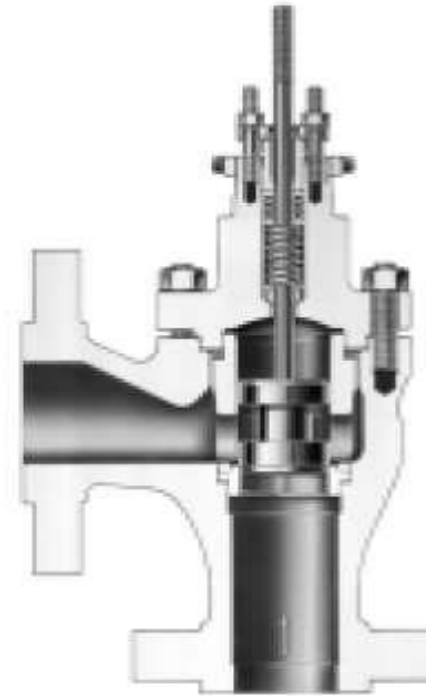


W598Q/L

2. Glove valve

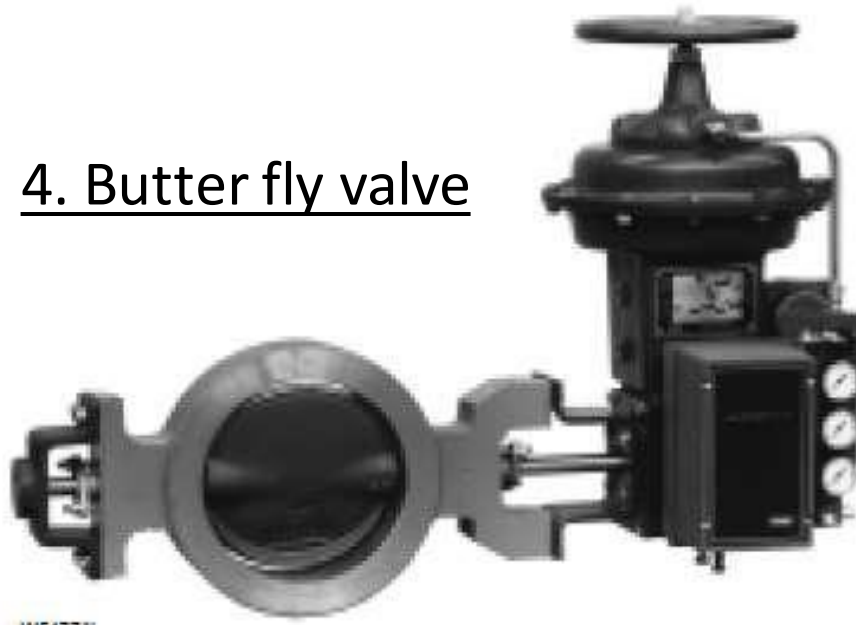


3. Angle valve and two port valve





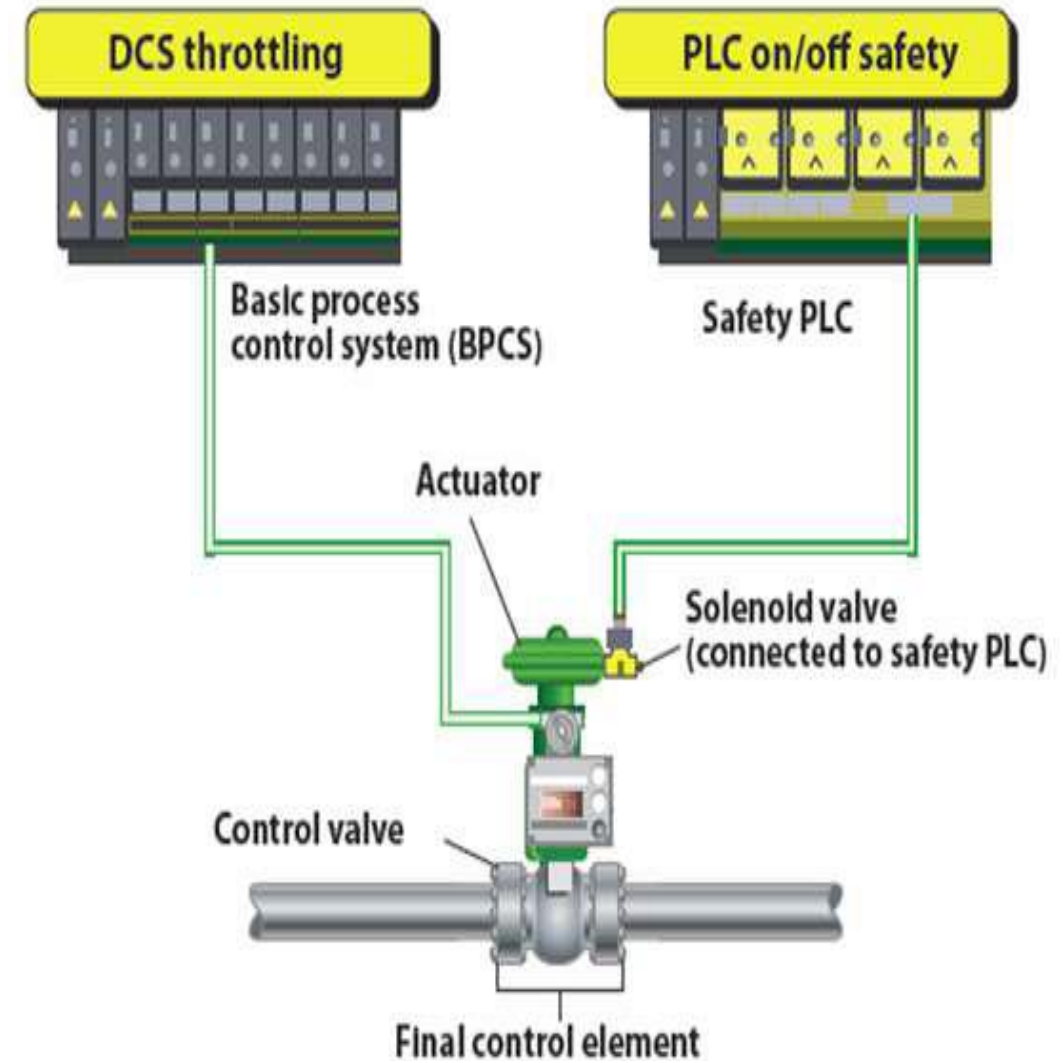
4. Butter fly valve



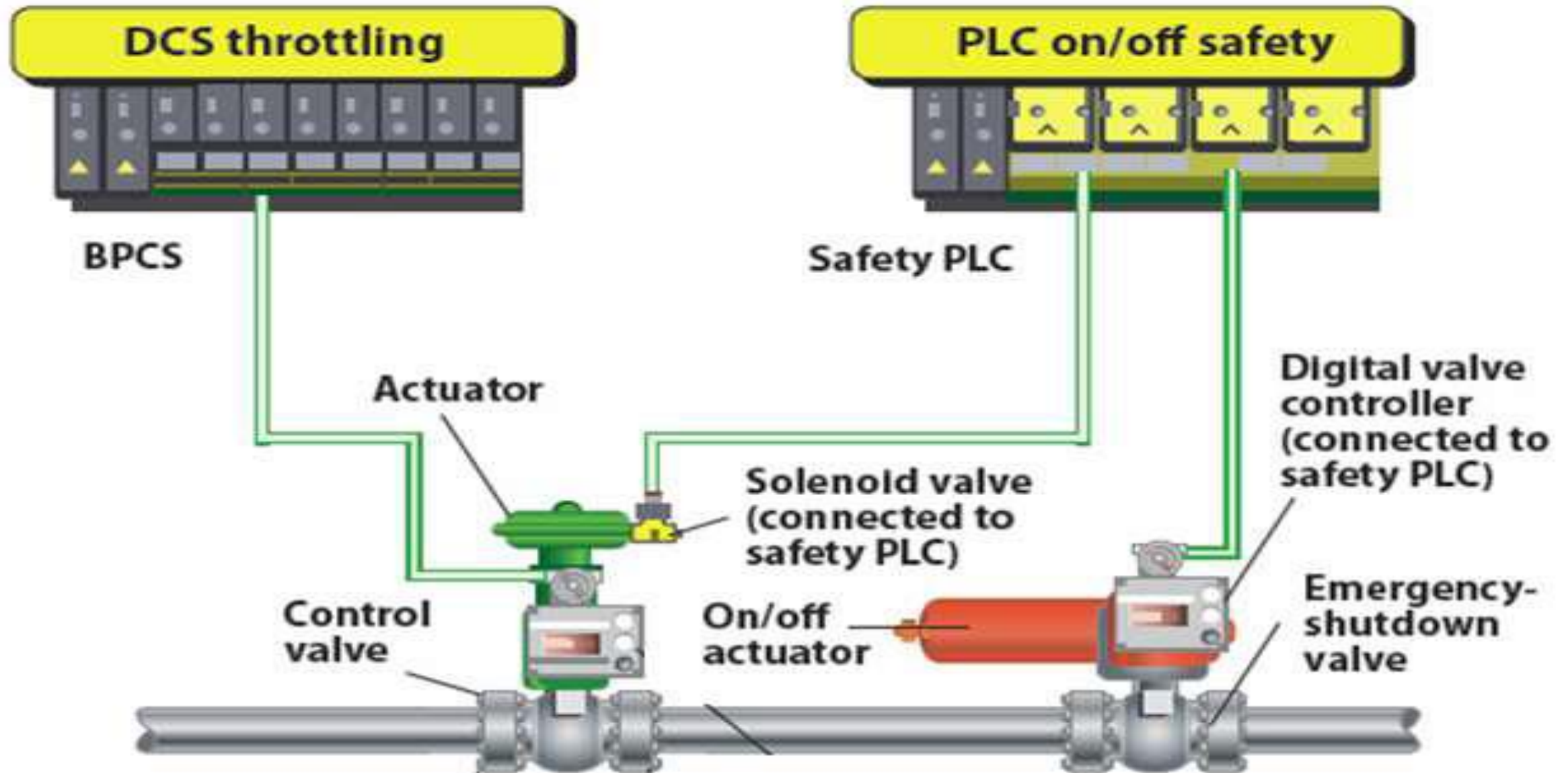
5. Ball valve



6. Control valve used as a shutdown valve



....and same arrangement with redundant.



Instrumentation

Flow Measurement

We will consider only a so-called ideal fluid, that is, a liquid that is incompressible and has no internal friction or viscosity.

The techniques used to measure flow fall into four general classes:

1. Differential pressure technique
2. Velocity technique
3. Volumetric technique
4. Mass technique

➤ Differential-Pressure Flowmeters

We use the relationship between the pressure drop and the rate of flow

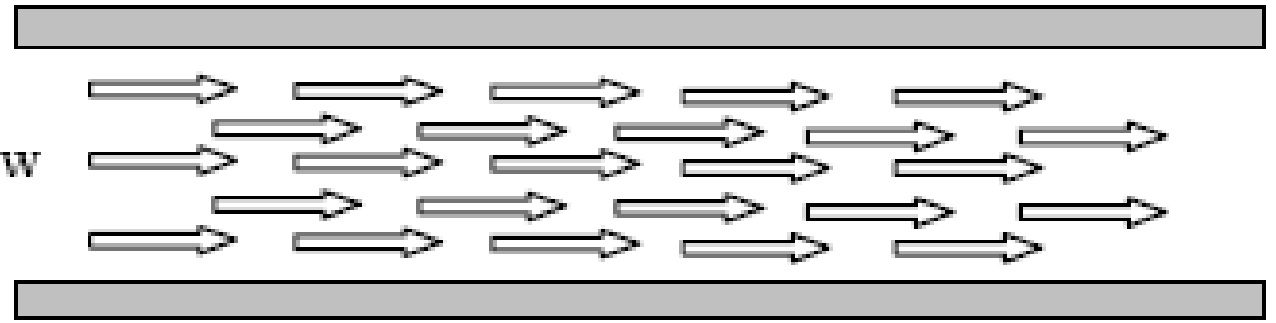
$$Q = K \sqrt{\Delta P}$$

Q = the volumetric flow rate

K = a constant for the pipe and liquid type

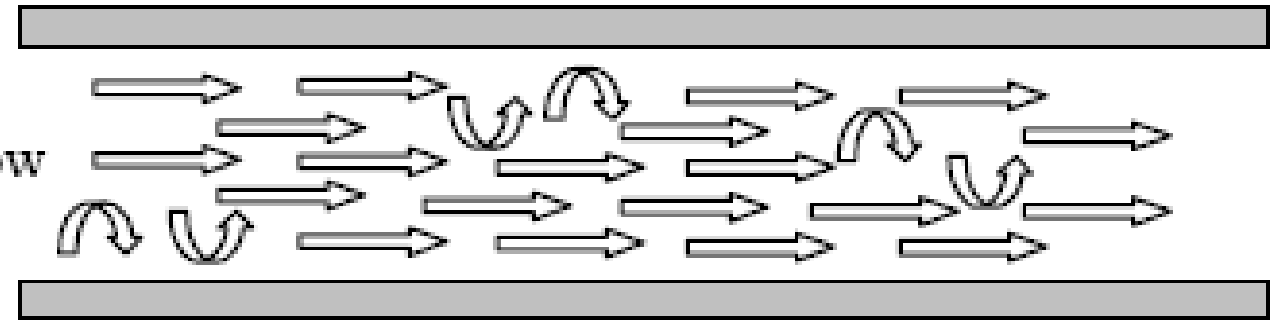
ΔP = the differential pressure drop across the restriction to measure the flow

→ Flow



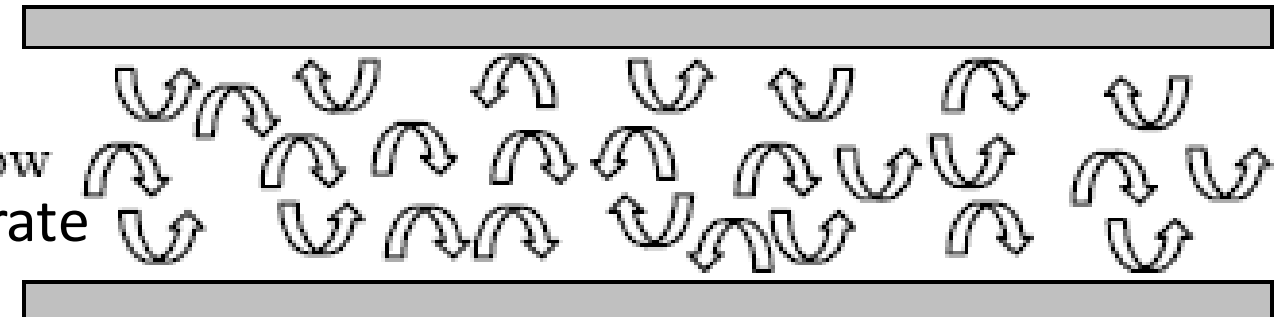
a) Laminar Flow

→ Flow



b) Transitional Flow

→ Flow



c) Turbulent Flow

Flow Detectors

To measure the rate of flow by the differential pressure method, some form of restriction is placed in the pipeline to create a pressure drop.

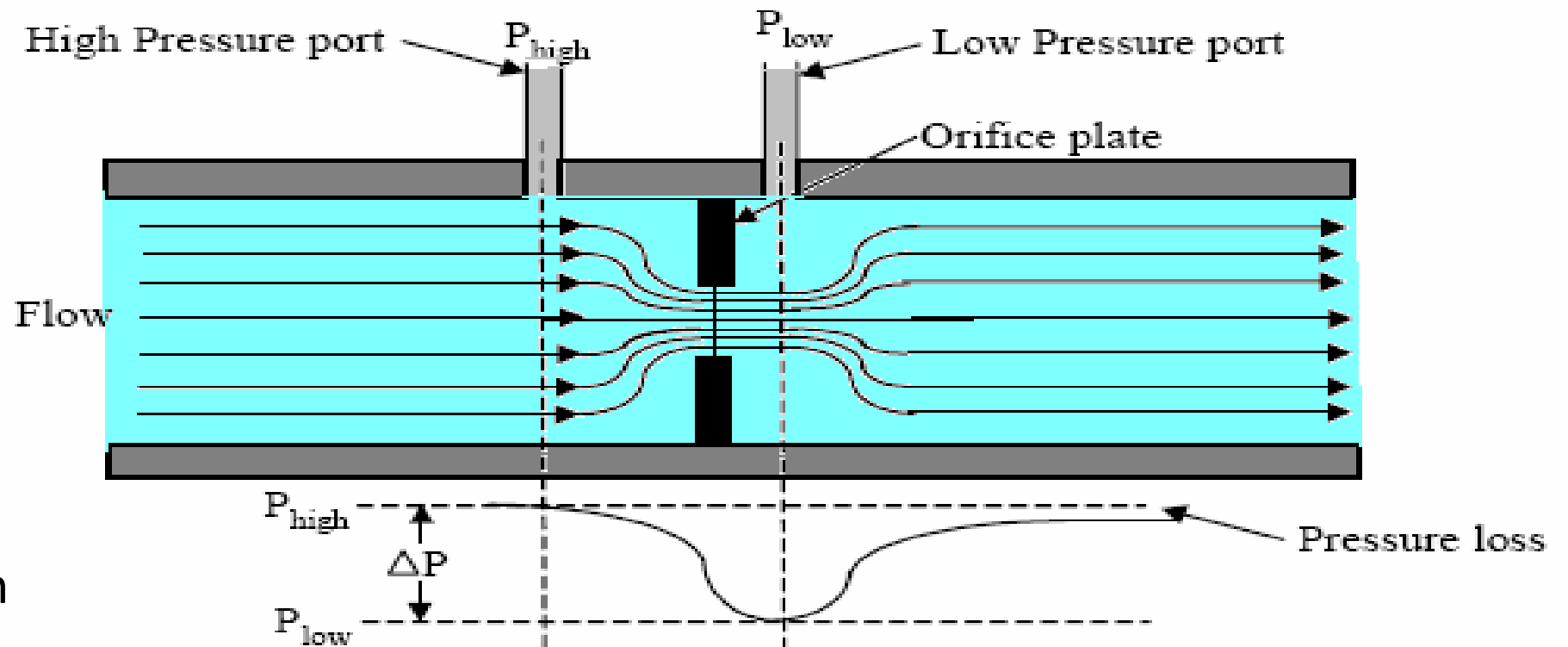
Since flow in the pipe must pass through a reduced area, the pressure before the restriction is higher than after or downstream.

So by measuring the differential pressure across a restriction, one can measure the rate of flow.

Using DP transmitter in a square mode of operation can detect the flow

Orifice Plate

- An orifice plate is basically a thin metal plate with a hole bored in the center.
- Usually clamped between a pair of flanges. suitable for liquid, gas, and steam

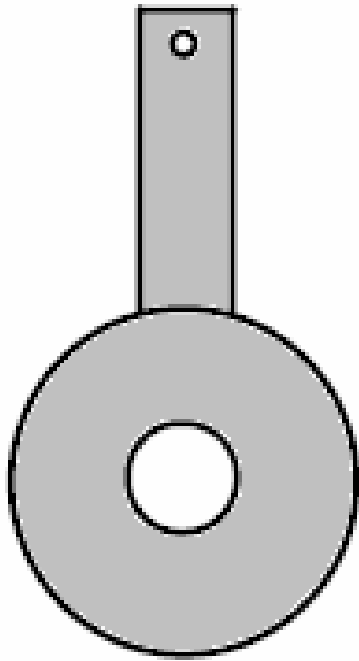


Orifice Plate

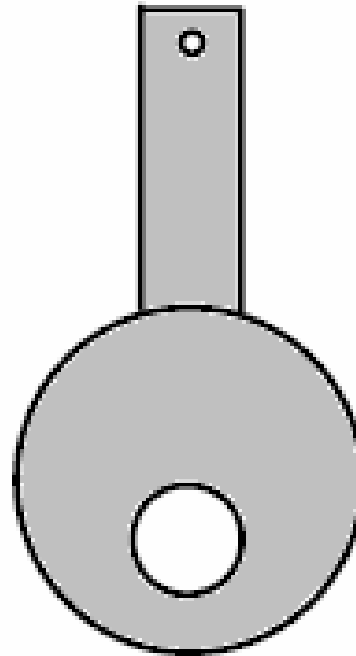
The **concentric orifice plate** is the most widely used type.

Eccentric and **segmental orifices** are preferable to concentric orifices for measuring dirty liquids as well as gas or vapor where liquids may be present, especially large slugs of liquid.

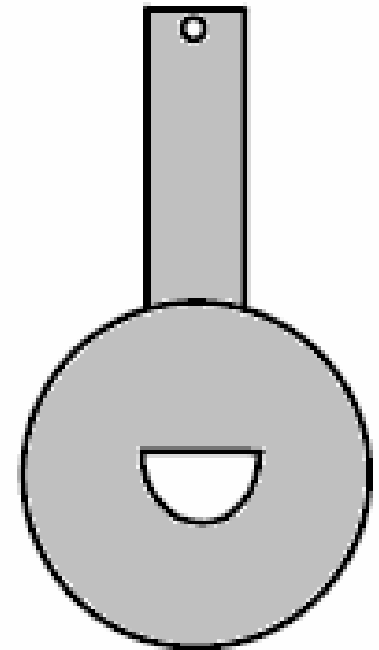
Where the stream contains particulate matter, the segmental orifice may be preferable because it provides an open path at the bottom of the pipe.



a) Concentric



b) Eccentric



c) Segmental

