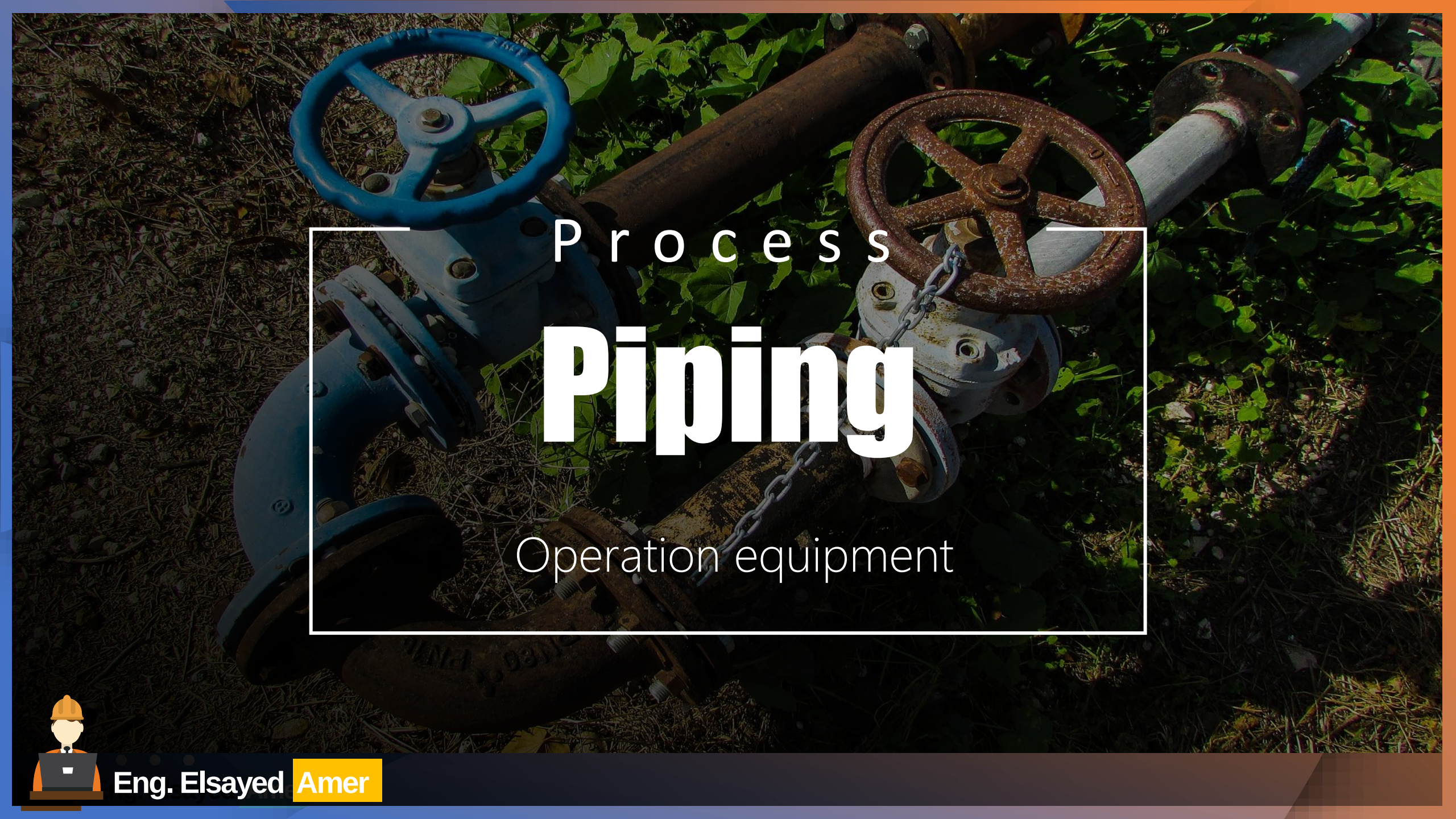




Process Piping

Operation equipment



Eng. Elsayed Amer



El Sayed Amer



01065860658



Eng20072007@gmail.com



/elsayedameer



- Bachelor's degree of Petroleum & Natural Gas Engineering 2012.
- Current Senior Process and Production Engineer at Suez Oil Co “SUCO” since 2014.
- Worked for Weatherford drilling international for 2 years as well drilling and completion engineer.
- Instructor for Oil & Gas Upstream and downstream courses at MTC Egypt, Egyptian syndicates of engineers, OGS & OPA.
- Member of SPE, AAPG, AACE, NACE, Environmental Geoscience.
- IWCF , HYSYS process modeling, Eclipse certified.



<https://bit.ly/2UFSgpn>



01

Stationary
equipment

Piping components

What is *pip*ing?

Piping includes pipe, flanges, fittings, bolting, gaskets, valves, and the pressure containing portions of other piping components.



PIPE



FLANGE



FITTING



BOLTING



GASKET



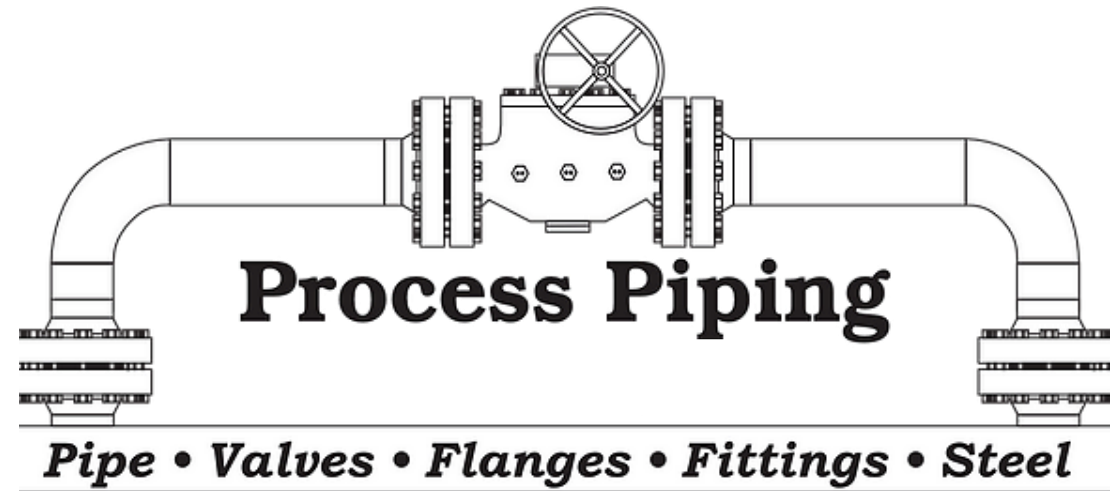
VALVE



What is piping?

Piping system include:

- **Pipes**—to carry the fluid
- **Fittings**—to join sections of pipe and direct the flow of the fluid
- **Flanges**—to temporarily join sections of pipe and connect pipes to valves and equipment
- **valves**—to control the flow of fluid through pipes
- **supports** and hangers—to fix piping in position



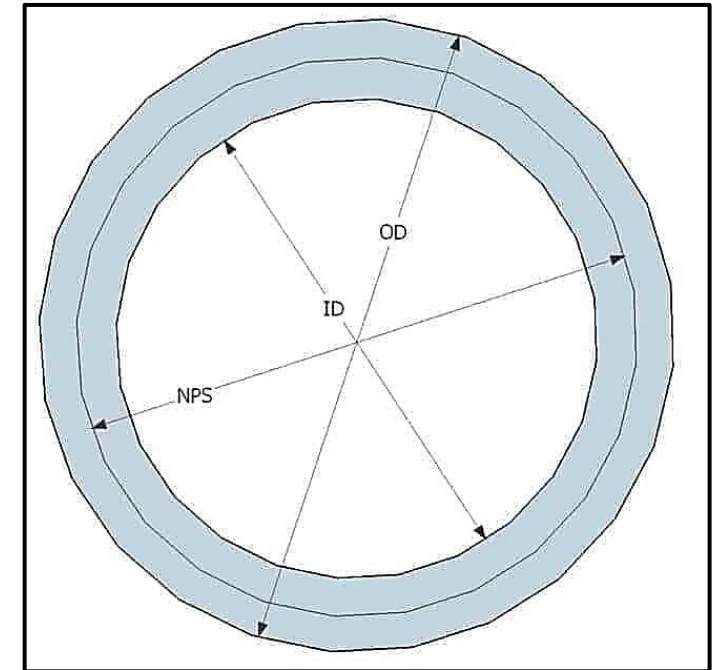
PIPE Dimensions

Pipe dimensions are given in :

- Nominal pipe size
- Pipe schedule (the wall thickness)

Three different terms are used to define the size of the pipes.

- NPS – Nominal Pipe Size
- NB – Nominal Bore
- DN – Diameter Nominal



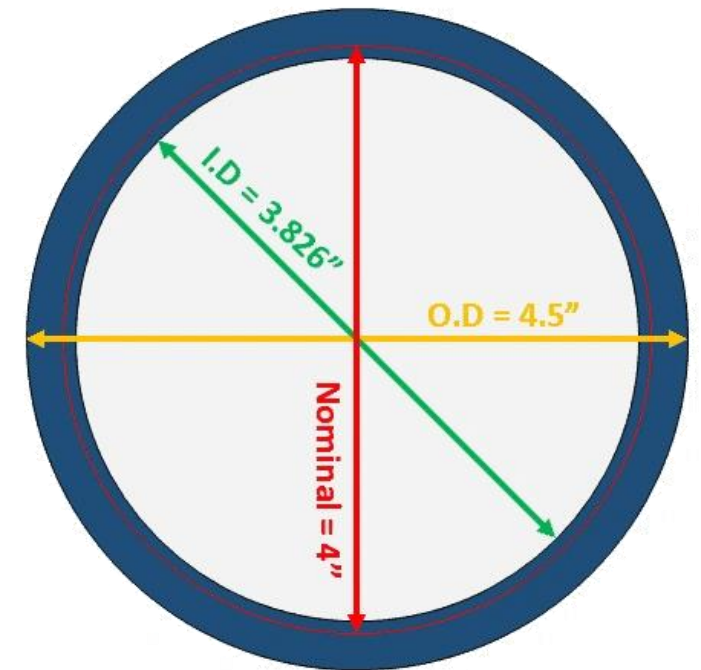
PIPE Dimensions

Pipe dimensions are given in :

- Nominal pipe size
- Pipe schedule (the wall thickness)

- Nominal pipe size (NPS) is A number to represent the outside diameter of pipe.
- For example, when you say 6" pipe, the 6" is the nominal size of that pipe.

4" Schedule 80 Pipe Size & Thickness

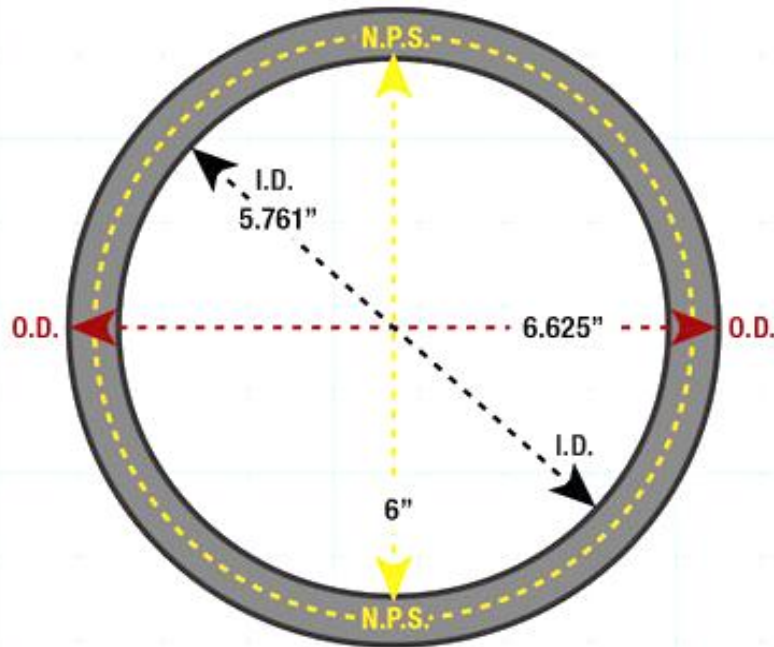


PIPE Dimensions

For Nominal Pipe Sizes (N.P.S.) 1/8" to 12"
the N.P.S. and O.D. Values are Different

$$(O.D. > N.P.S. > I.D.)$$

6" SCHEDULE 80 PIPE SIZE & THICKNESS

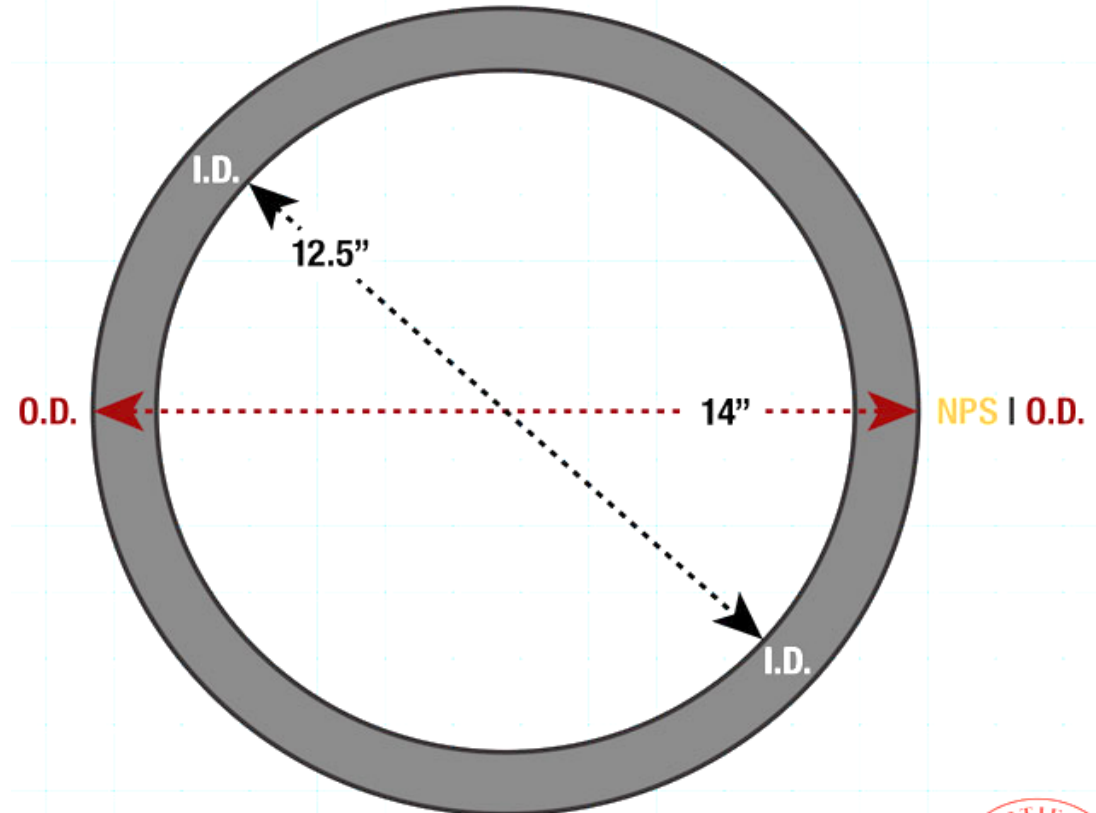


$$\text{Wall Thickness: } 6" - 5.761" = .864 / 2 = .432"$$

For NPS 14" and Above the N.P.S.
and O.D. Values are Equal

$$(O.D. = N.P.S.)$$

14" SCHEDULE 80 PIPE SIZE & THICKNESS



$$\text{Wall Thickness: } 14" - 12.5" = 1.5 / 2 = .750"$$



PIPE Dimensions

Pipe dimensions are given in :

- Nominal pipe size
- Pipe schedule (the wall thickness)

Schedules: for higher-pressure, pipes were produced having thicker walls, which came to be known as :

- extra strong (XS)
- extra heavy (XH).
- Double extra strong (XXS)
- double extra heavy (XXH).

Schedule number = $1000 * P/S$

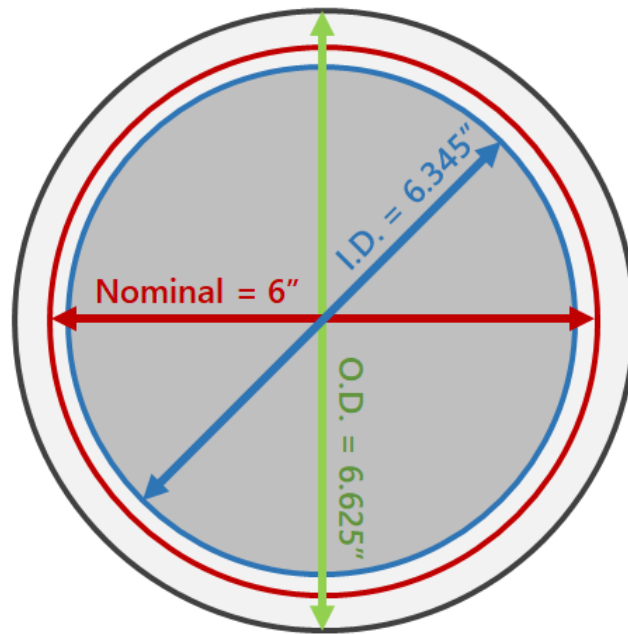
- P is the service pressure in (psi)
- S is the allowable stress in (psi)



PIPE Dimensions

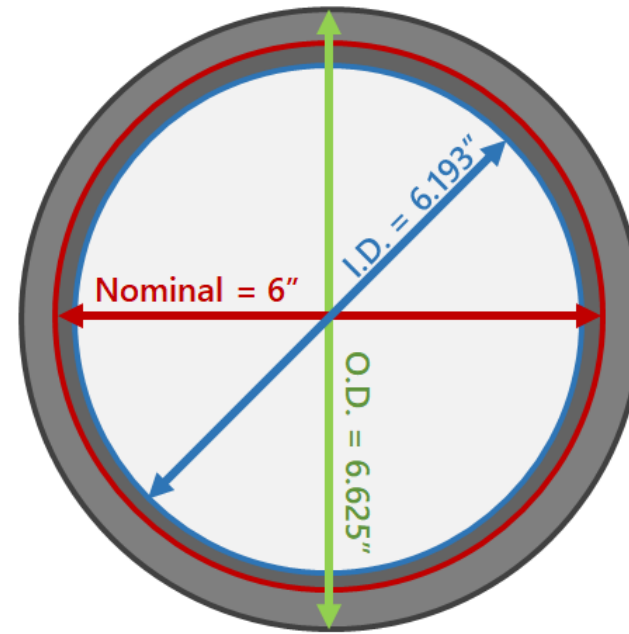
- All pipes of one nominal size have the same OD but they come in different schedules.
- The ID depends on the nominal size and the wall thickness.

6" NPS Schedule 40 Thickness



0.280" Pipe Wall Thickness

6" NPS Schedule 80 Thickness



0.432" Pipe Wall Thickness



PIPE Dimensions

PIPE SCHEDULES & WEIGHTS					
NOMINAL PIPE SIZE	OUTSIDE DIAMETER	SCHEDULE 40		SCHEDULE 80	
		Wall Thick.	Wt. Per Ft.	Wall Thick.	Weight Per Ft.
1/8	0.405	0.068	0.245	0.095	0.315
1/4	0.540	0.088	0.425	0.119	0.535
3/8	0.675	0.091	0.568	0.126	0.739
1/2	0.840	0.109	0.851	0.147	1.088
3/4	1.050	0.113	1.131	0.154	1.474
1	1.315	0.133	1.679	0.179	2.172
1-1/4	1.660	0.140	2.273	0.191	2.997
1-1/2	1.900	0.145	2.718	0.200	3.631
2	2.375	0.154	3.653	0.218	5.022
2-1/2	2.875	0.203	5.793	0.275	7.661
3	3.500	0.216	7.576	0.300	10.250
3-1/2	4.000	0.226	9.109	0.318	12.510
4	4.500	0.237	10.790	0.337	14.980
5	5.563	0.258	14.620	0.375	20.780
6	6.625	0.280	18.970	0.432	28.570
8	8.625	0.322	28.550	0.500	43.390
10	10.750	0.365	40.480	0.500	54.740
12	12.750	0.375	49.560	0.500	65.420



		DIMENSIONS OF SEAM LESS & WELDED STEEL PIPE ACCORDANCE WITH ANSI B36.10 & B36.19															
NOM. PIPE SIZE	OUT SIDE DIAM.	NOMINAL WALL THICKNESS															
		Sche.	Sche.	Sche.	Sche.	Sche.	Standard	Sche.	Sche.	Extra	Sche.	Sche.	Sche.	Sche.	Sche.	XX	
		5*S	10*S	10	20	30		40	60	Strong	80	100	120	140	160	Strong	
20 mm	26.670	1.651	2.108	----	----	----	2.870	2.870	----	3.912	3.912	----	----	----	5.563	7.823	
25 mm	33.401	1.651	2.769	----	----	----	3.378	3.378	----	4.547	4.547	----	----	----	6.350	9.093	
32 mm	42.164	1.651	2.769	----	----	----	3.558	3.558	----	4.851	4.851	----	----	----	6.350	9.703	
40 mm	48.260	1.651	2.769	----	----	----	3.683	3.683	----	5.080	5.080	----	----	----	7.137	10.160	
50 mm	60.325	1.651	2.769	----	----	----	3.912	3.912	----	5.537	5.537	----	----	----	8.738	11.074	
65 mm	73.025	2.108	3.048	----	----	----	5.158	5.158	----	7.010	7.010	----	----	----	9.525	14.021	
80 mm	88.900	2.108	3.048	----	----	----	5.486	5.486	----	7.620	7.620	----	----	----	11.125	15.240	
90 mm	101.600	2.108	3.048	----	----	----	5.740	5.740	----	8.077	8.077	----	----	----	-----	-----	
100 mm	114.300	2.108	3.048	----	----	----	6.020	6.020	----	8.560	8.560	----	11.125	----	13.487	17.12	
125 mm	141.300	2.769	3.404	----	----	----	6.553	6.553	----	9.525	9.525	----	12.700	----	15.875	19.050	
150 mm	168.275	2.769	3.404	----	----	----	7.112	7.112	----	10.973	10.973	----	14.275	----	18.263	21.946	
200 mm	219.075	2.769	3.759		6.350	7.036	8.179	8.179	10312	12.700	12.700	15.088	18.263	20.625	23.012	22.225	
250 mm	273.050	3.404	4.191	----	6.350	7.798	9.271	9.271	12.700	12.700	15.088	18.263	21.438	25.400	28.575	25.400	
300 mm	323.850	3.962	4.572	----	6.350	8.382	9.525	10.312	14.275	12.700	17.475	21.438	25.400	28.575	33.325	25.400	
350 mm	355.600	3.962	4.775	6.350	7.925	9.525	9.525	11.125	15.088	12.700	19.050	23.925	27.788	31.750	35.712	-----	
400 mm	406.400	4.191	4.775	6.350	7.925	9.525	9.525	12.700	16.662	12.700	21.438	26.187	30.963	36.525	40.488	-----	
450 mm	457.200	4.191	4.775	6.350	7.925	11.125	9.525	14.275	19.050	12.700	23.825	29.362	34.925	39.675	45.237	-----	
500 mm	508.000	4.775	5.537	6.350	9.525	12.700	9.525	15.088	20.625	12.700	26.187	32.537	38.100	44.450	50.013	-----	
550 mm	558.000	5.537	5.537	6.350	9.525	12.700	9.525	-----	22.225	12.700	28.575	34.925	41.275	47.625	53.975	-----	
600 mm	609.600	5.537	6.350	6.350	9.525	14.275	9.525	17.475	24.613	12.700	30.963	38.887	46.025	52.375	59.538	-----	
650 mm	660.400	-----	-----	7.925	12.700	-----	9.525	-----	-----	12.700	-----	-----	-----	-----	-----	-----	
750 mm	762.000	6.35	7.925	7.925	12.700	15.875	9.525	-----	-----	12.700	-----	-----	-----	-----	-----	-----	
850 mm	863.600	-----	-----	7.925	12.700	15.875	9.525	-----	-----	12.700	-----	-----	-----	-----	-----	-----	
900 mm	914.400	-----	-----	7.925	12.700	15.875	9.525	-----	-----	12.700	-----	-----	-----	-----	-----	-----	
Note:- All dimensions are given in decimals of and inch of the nominal pipe sizes. Thickness may vary due to mil tolerance.* Corrosion resistance																	

Note:- All dimensions are given in decimals of and inch of the nominal pipe sizes. Thickness may vary due to mil tolerance.* Corrosion resistance



		DIMENSIONS OF SEAM LESS & WELDED STEEL PIPE ACCORDANCE WITH ANSI B36.10 & B36.19														
NOM. PIPE SIZE	OUT SIDE Diameter	NOMINAL WALL THICKNESS														XX
		Sche.	Sche.	Sche.	Sche.	Standard	Sche.	Sche.	Extra	Sche.	Sche.	Sche.	Sche.	Sche.	Sche.	
		5	10	20	30		40	60	Strong	80	100	120	140	160	Strong	
3/4	1.050	0.065	0.083	----	----	.0113	.0113	----	0.154	0.154	----	----	----	0.219	0.308	
1	1.315	0.065	0.109	----	----	.0133	.0133	----	0.179	0.179	----	----	----	0.250	0.358	
1 1/4	1.660	0.065	0.109	----	----	0.140	0.140	----	0.191	0.191	----	----	----	0.250	0.382	
1 1/2	1.900	0.065	0.109	----	----	0.145	0.145	----	0.200	0.200	----	----	----	0.281	0.400	
2	2.375	0.065	0.109	----	----	0.154	0.154	----	0.218	0.218	----	----	----	0.343	0.436	
2 1/2	2.875	0.083	0.120	----	----	0.203	0.203	----	0.276	0.276	----	----	----	0.375	0.552	
3	3.500	0.083	0.120	----	----	0.216	0.216	----	0.300	0.300	----	----	----	0.438	0.600	
3 1/2	4.000	0.083	0.120	----	----	0.226	0.226	----	0.318	0.318	----	----	----	----	----	
4	4.500	0.083	0.120	----	----	0.237	0.237	----	0.337	0.337	----	0.438	----	0.531	0.674	
5	5.563	0.109	0.134	----	----	0.258	0.258	----	0.375	0.375	----	0.500	----	0.625	0.750	
6	6.625	0.109	0.134	----	----	0.280	0.280	----	0.432	0.432	----	0.562	----	0.718	0.864	
8	8.625	0.109	0.148	0.250	0.277	0.322	0.322	0.406	0.500	0.500	0.593	0.718	0.812	0.906	0.875	
10	10.75	0.134	0.165	0.250	0.307	0.365	0.365	0.500	0.500	0.593	0.718	0.843	1.000	1.125	----	
12	12.75	0.156	0.180	0.250	0.330	0.375	0.406	0.562	0.500	0.750	0.843	1.000	1.125	1.312	----	
14 OD	14	----	0.250	0.312	0.375	0.375	0.438	0.593	0.500	0.750	0.937	1.093	1.250	1.406	----	
16 OD	16	----	0.250	0.312	0.375	0.375	0.500	0.656	0.500	0.843	1.031	1.218	1.438	1.593	----	
18 OD	18	----	0.250	0.312	0.438	0.375	0.562	0.750	0.500	0.937	1.156	1.375	1.562	1.781	----	
20 OD	20	----	0.250	0.375	0.500	0.375	0.593	0.812	0.500	1.031	1.281	1.500	1.750	1.968	----	
22 OD	22	----	0.250	----	----	0.375	----	----	0.500	----	----	----	----	----	----	
24 OD	24	----	0.250	0.375	0.562	0.375	0.687	0.968	0.500	1.218	1.531	1.812	2.062	2.343	----	
26 OD	26	----	----	----	----	0.375	----	----	0.500	----	----	----	----	----	----	
30 OD	30	----	0.312	0.500	0.625	0.375	----	----	0.500	----	----	----	----	----	----	
34 OD	34	----	----	----	----	0.375	----	----	0.500	----	----	----	----	----	----	
36 OD	36	----	----	----	----	0.375	----	19.050	0.500	----	----	----	----	----	----	

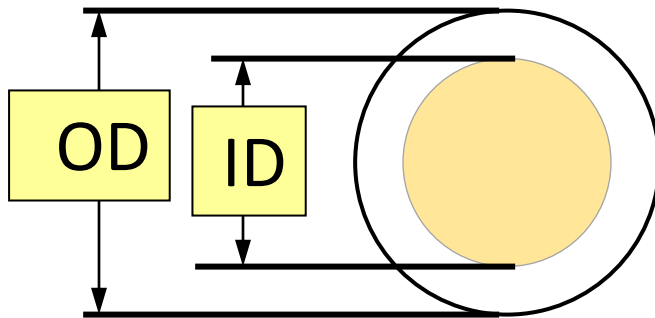
Note:- All dimensions are given in decimals of and inch of the nominal pipe sizes. Thickness may vary due to mil tolerance.

Prepared By:- Syed Aftab Ahmed



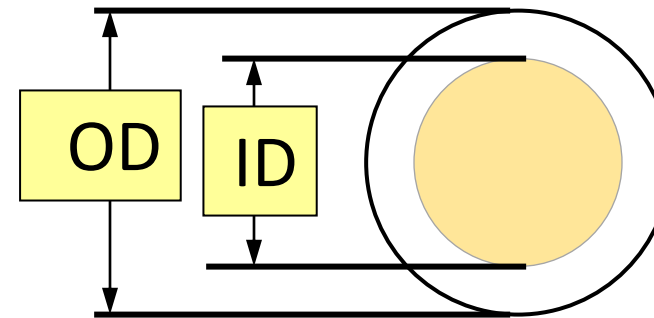
Pipe

Pipe is specified
by **NPS**

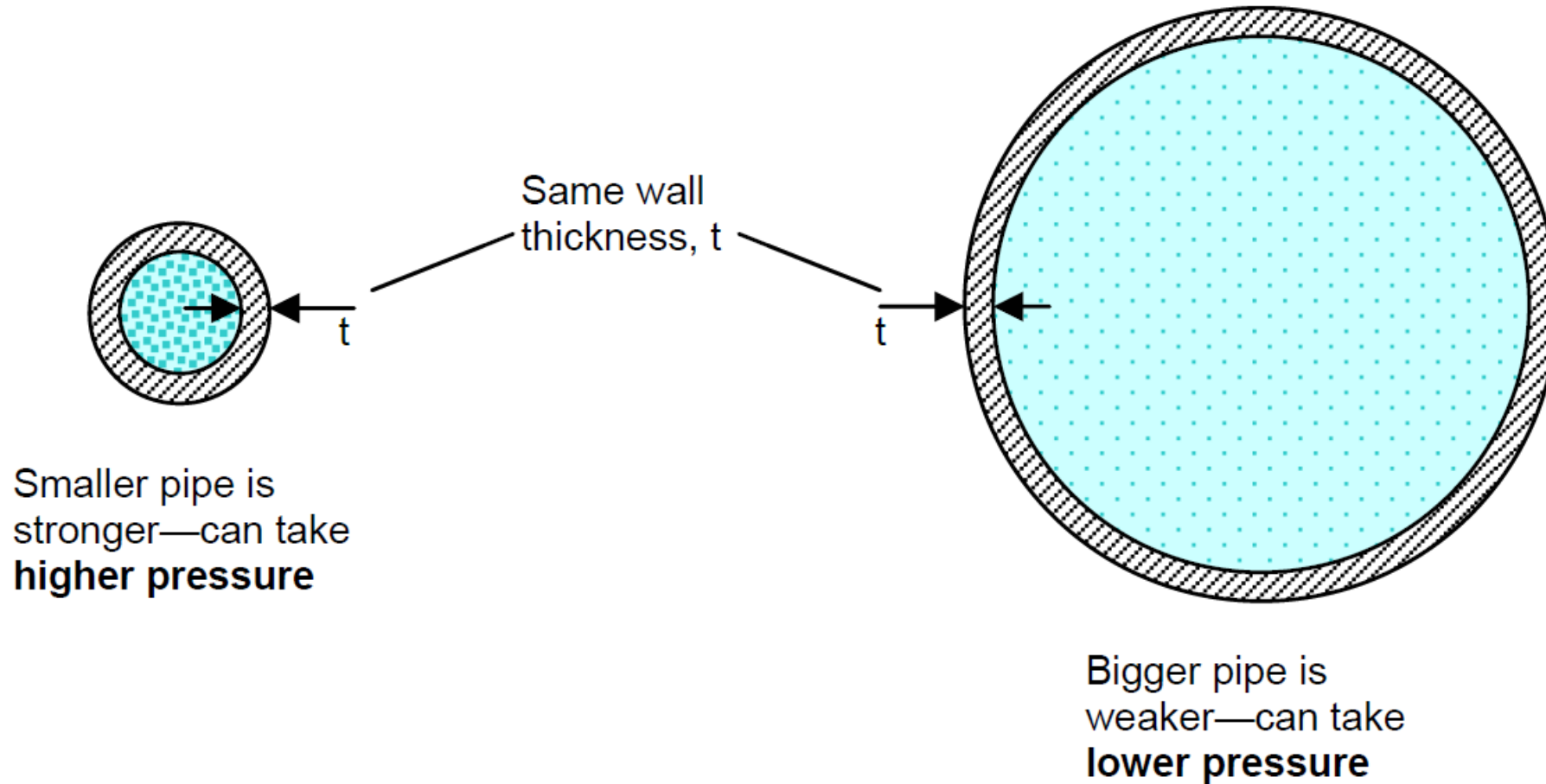


Tube

Tube is specified
by **OD**



Pipe and tube



(a) Equal Wall Thickness



PIPE Color code



Yellow ochre	Gases (other than air) including liquefied gases
--------------	--

Light blue	Air
------------	-----

Green	Water
-------	-------

Red	Fire extinguishing materials
-----	------------------------------

Silver grey	Steam
-------------	-------

Violet	Acids and alkalis
--------	-------------------

Black	Trapped solids
-------	----------------

Yellow	Used for chemicals in ADGAS
--------	-----------------------------



PIPE materials

Piping material selection mainly depends on process conditions such as:

- I. Types of fluid
- II. Service temperature
- III. Operating pressure

carbon steel

Low alloy steel

Stainless steel

Titanium, Copper, Nickel

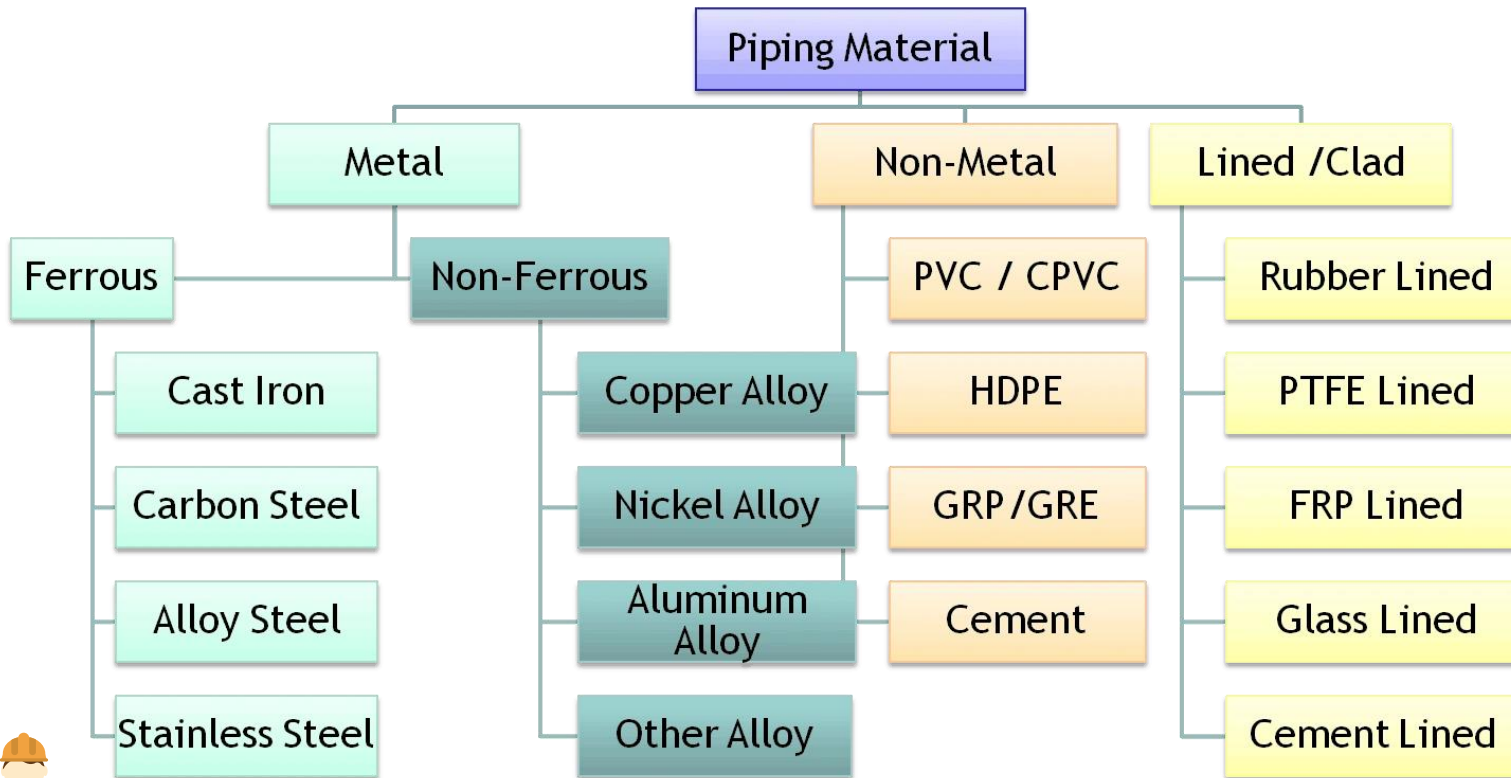
PVC, HDPE, GRE/GRP

- **Corrosive fluids** such as – crude oil, Sea Water, H₂S, Ammonia, Acids, etc. required high corrosion resistance material. On the other hand, **normal carbon steel** is enough for Non-Corrosive fluids such as – Lube oil, Air, Nitrogen, etc.
- 2nd **Process condition** that will impact the selection of material is the Temperature of fluids
 - Cryogenic
 - Low temperature
 - Medium temperature
 - High temperature



PIPE materials

An increase or decrease in the service fluid temperature will greatly affect mechanical properties of the pipe material such as impact resistance, elongation, and tensile strength; hence, you required special material for both high temperature & Cryogenic services.





02

Static Equipment

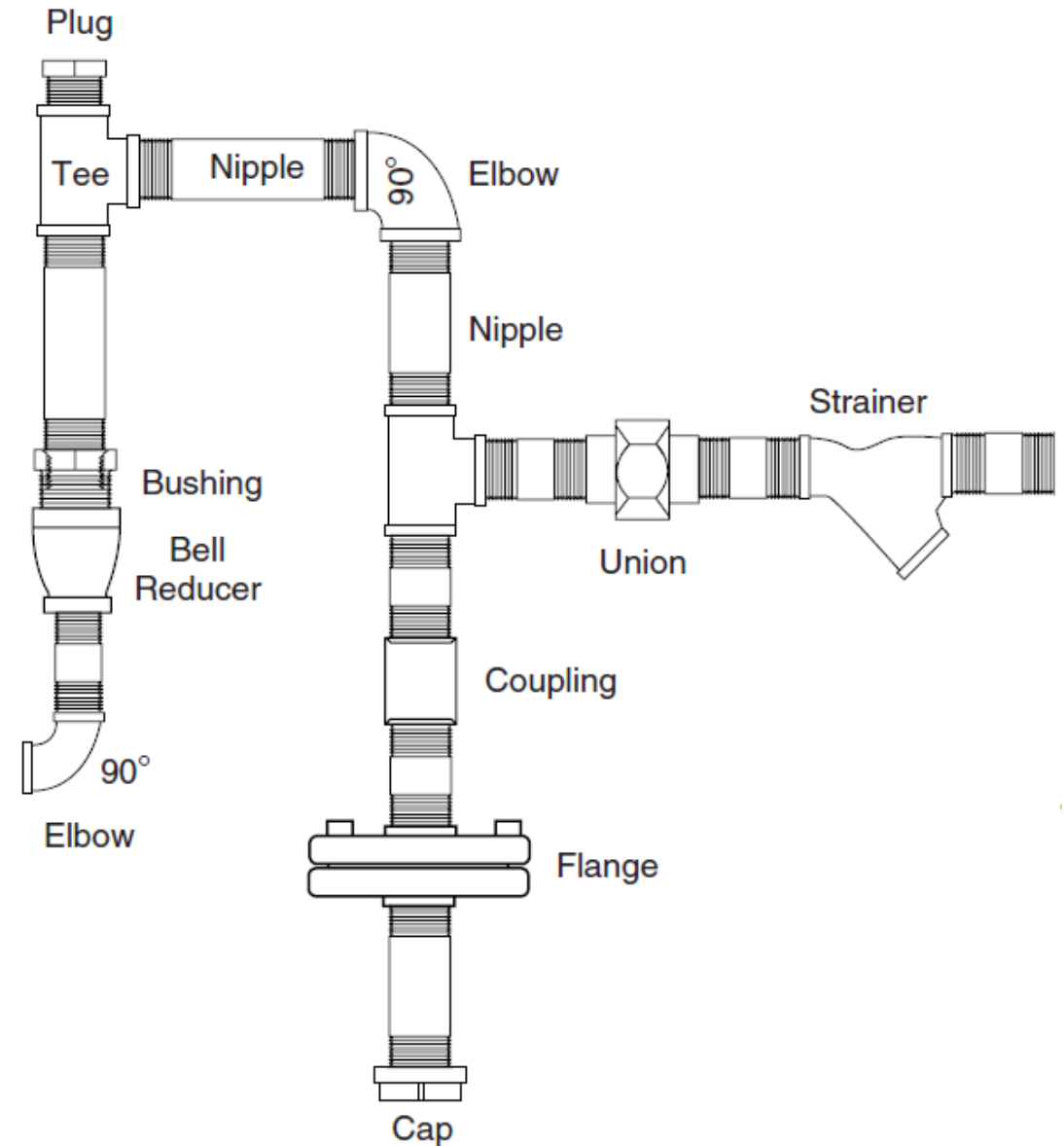
Pipe Fittings

- couplings,
- unions,
- nipples,
- reducers,
- bushings,
- elbows,
- tee,
- crosses,

PIPE Fittings

What is Pipe Fittings?

Fittings are Piping component which helps in Changes the direction of the flow such as elbows, tee. Changes the size of the pipe such as reducers, reducing tees. Connect to components together such as couplings and stop the flows such as Caps.





Fittings are used for:

- join together lengths of pipe — **couplings, unions, nipples**
- change the pipe size -- **reducers, bushings.**
- change the direction of a pipe run -- **elbows**
- join or separate flows of fluid (branch the pipe) — **tees and crosses**
- Control flow through pipes — **valves,**
- Stop flow through pipes - **Spade**

PIPE Fittings

join together lengths of pipe — couplings, unions, nipples



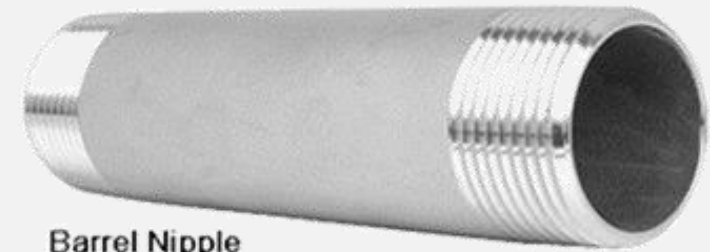
Coupling



Union



nipples



Barrel Nipple



Close Nipple



Hose Nipple



Hex Nipple



Welding Nipple



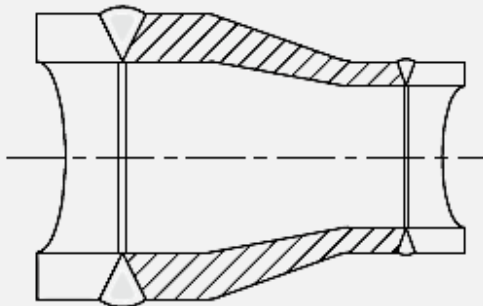
PIPE Fittings

change the pipe size

Concentric reducer



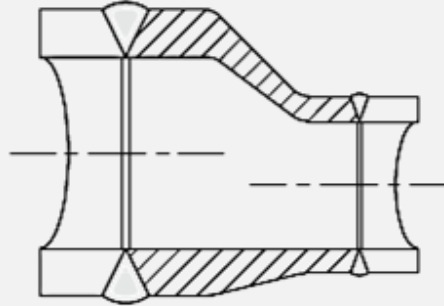
Concentric



Eccentric reducer

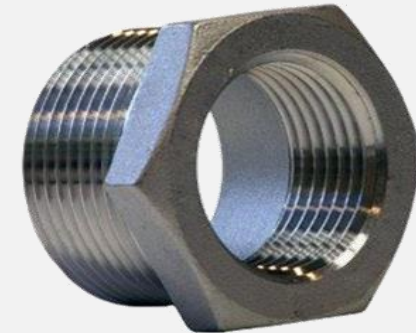


Eccentric



Bushings

Pipe bushings are used to join pipes of different sizes



PIPE Fittings

change the direction of a pipe run

Elbows

Threaded or socket weld pipe elbows are commonly used if you need to change the direction of flow.



45° Ell



90° Ell



PIPE Fittings

join or separate flows of fluid (branch the pipe)

tees and crosses



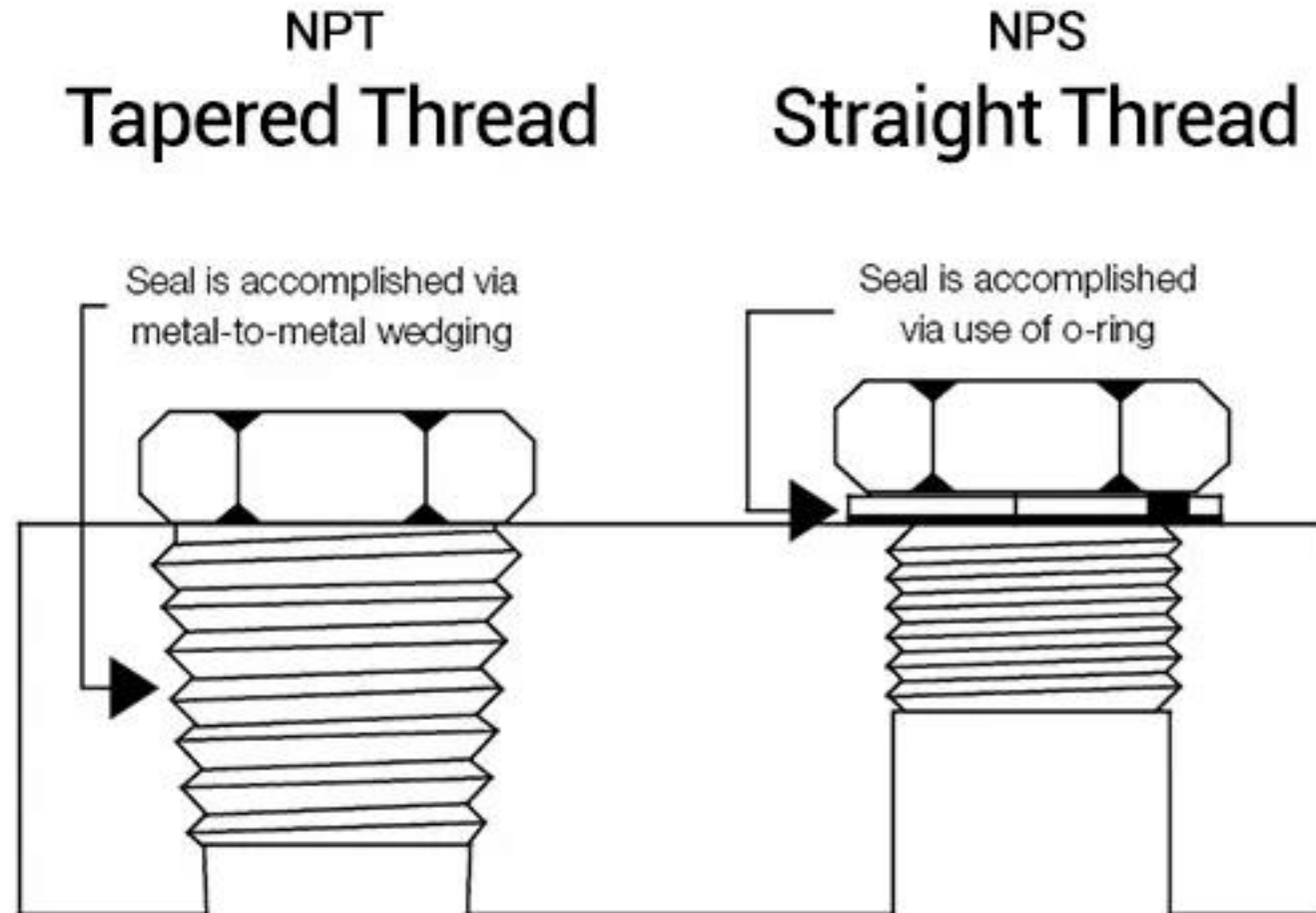
tee



Cross

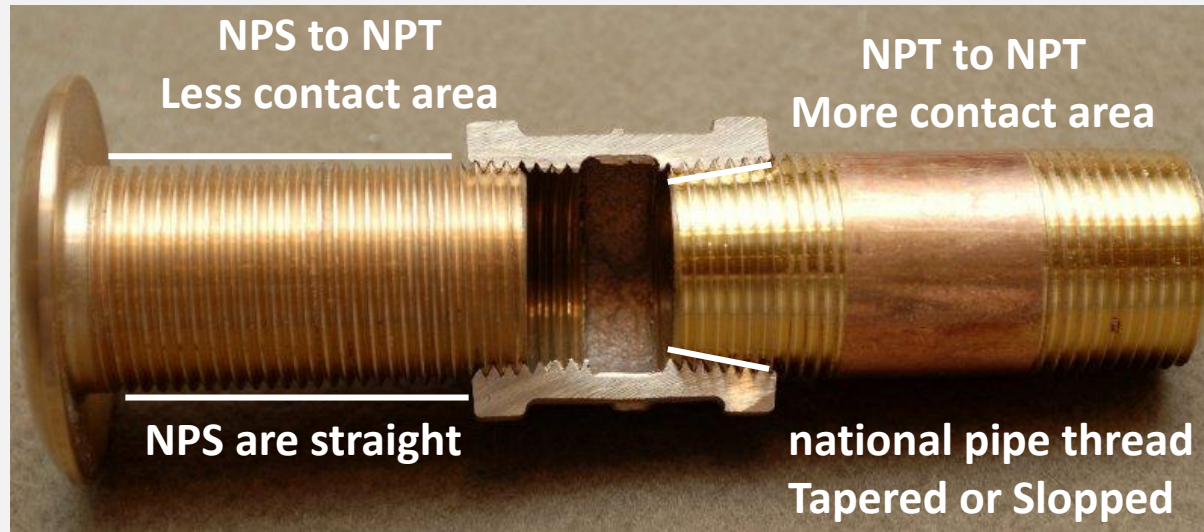


PIPE Thread



PIPE Thread

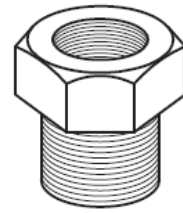
NPT : stands for National Pipe Tapered
NPS : stands for National Pipe straight



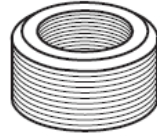
NPT Thread



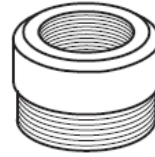
PIPE Fittings



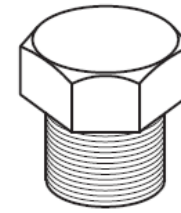
Hexagon bushing



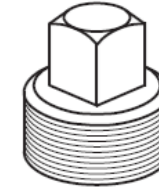
Flush bushing



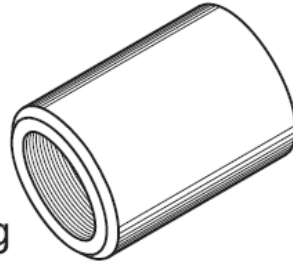
Round head bushing



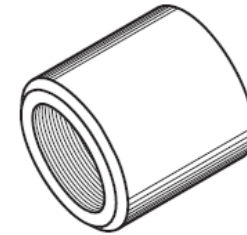
Hexagon head plug



Square head plug



Coupling



Half coupling



45°
Elbow



90°
Street elbow



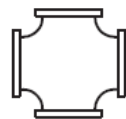
45°
Street elbow



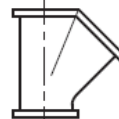
Tee



Street tee



Cross



Y branch



Cap



Return bend



PIPE Fittings

Control flow through pipes — valves,



Needle valve



Ball valve



PIPE Fittings

control flow through pipes

plugs



Pipe cap

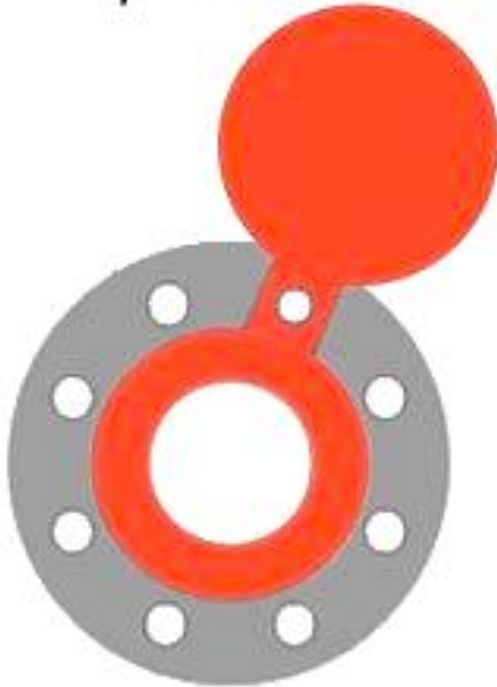
For closing the end of a male pipe.



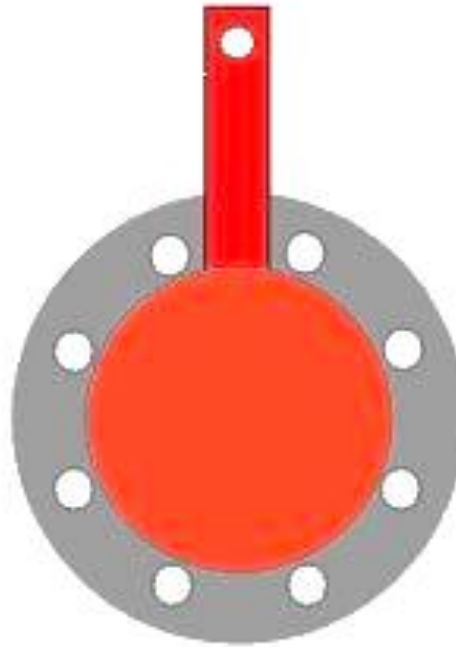
PIPE Fittings

control flow through pipes

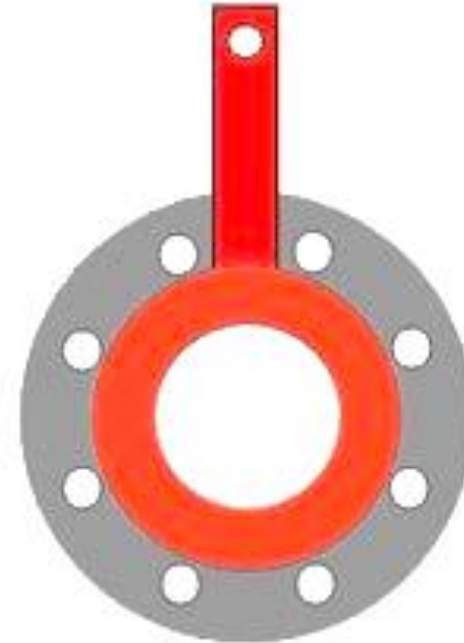
Spectacle Blind



Spade



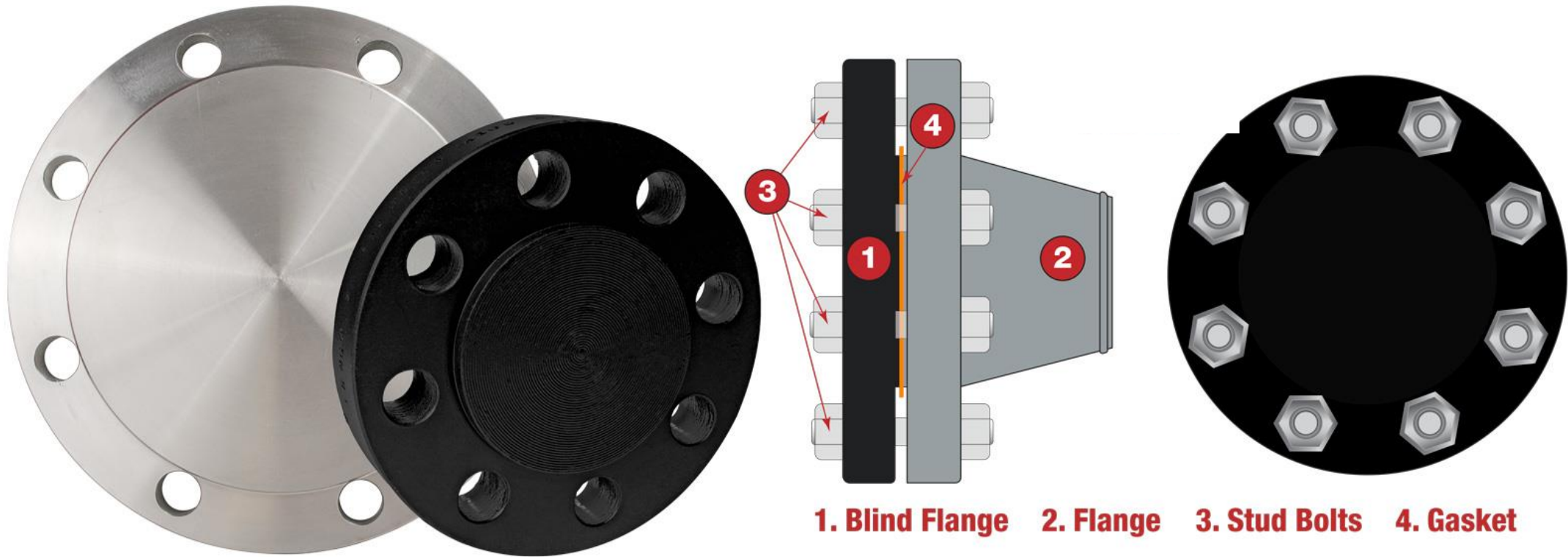
Spacer



PIPE Fittings

control flow through pipes

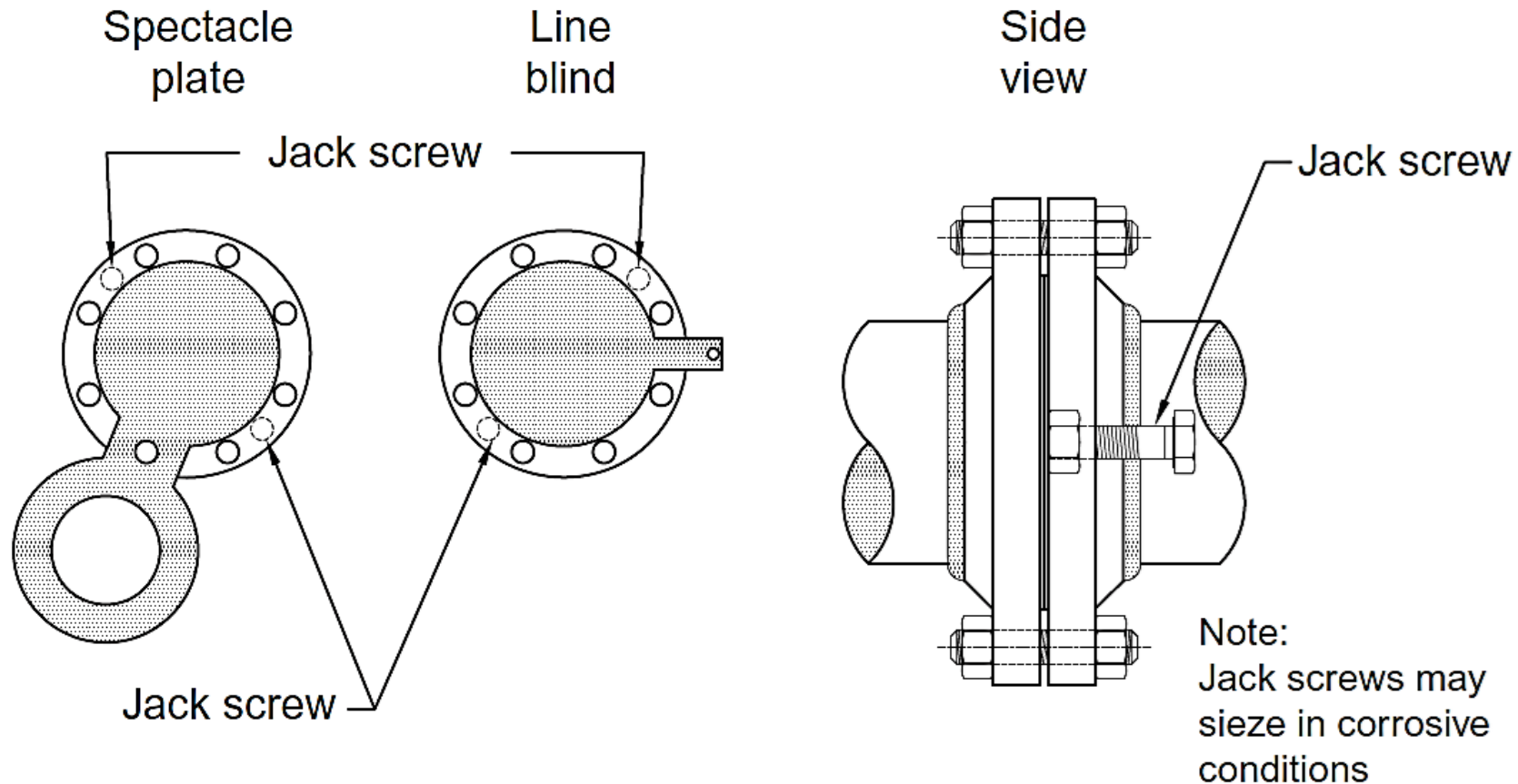
Blind flanges



PIPE Fittings

control flow through pipes

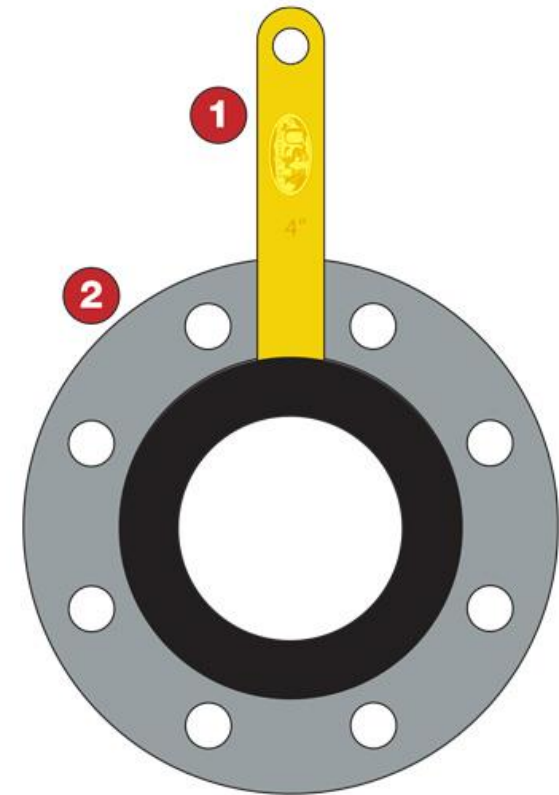
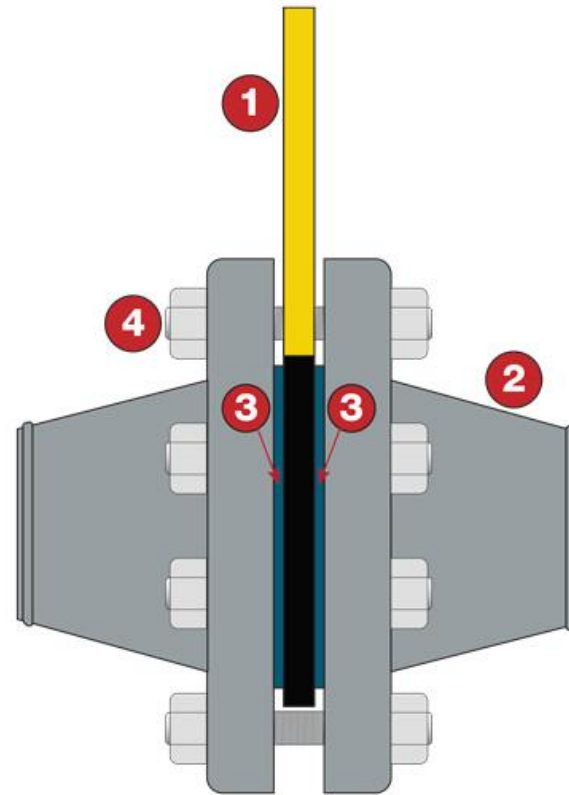
Spectacle Blinds



PIPE Fittings

control flow through pipes

Spacer



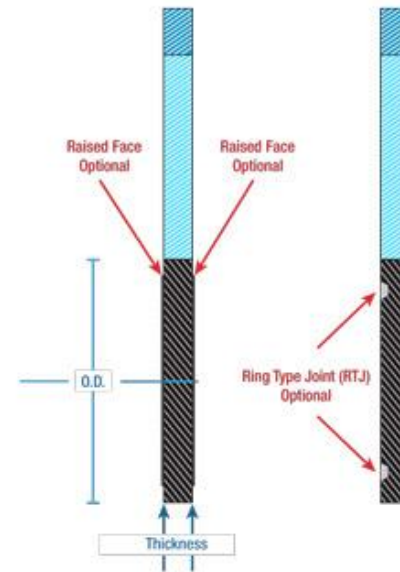
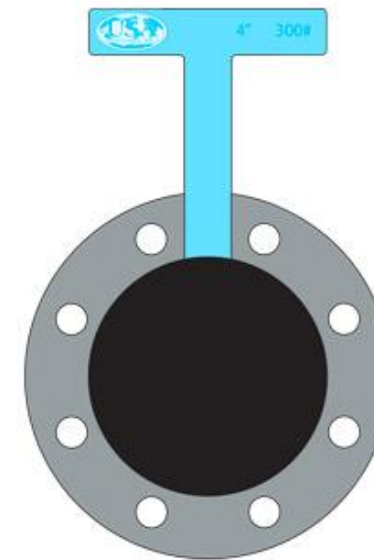
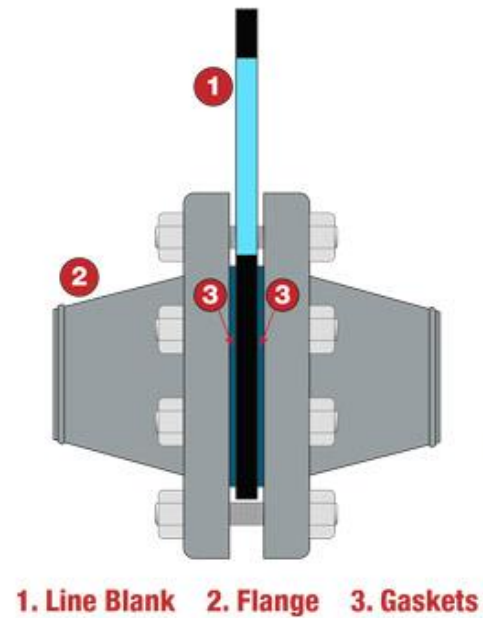
1. Paddle Blind/Blank **2. Flange** **3. Gaskets** **4. Stud Bolts**



PIPE Fittings

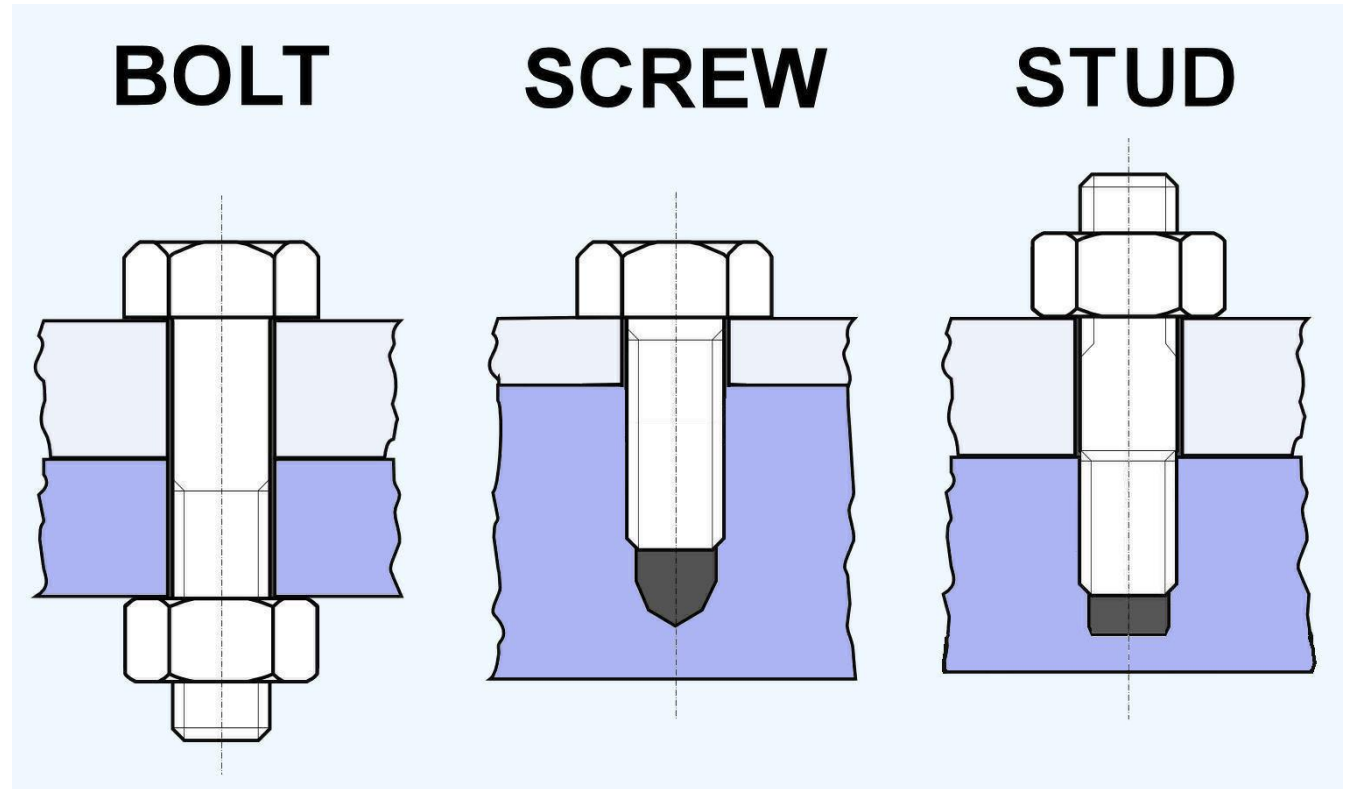
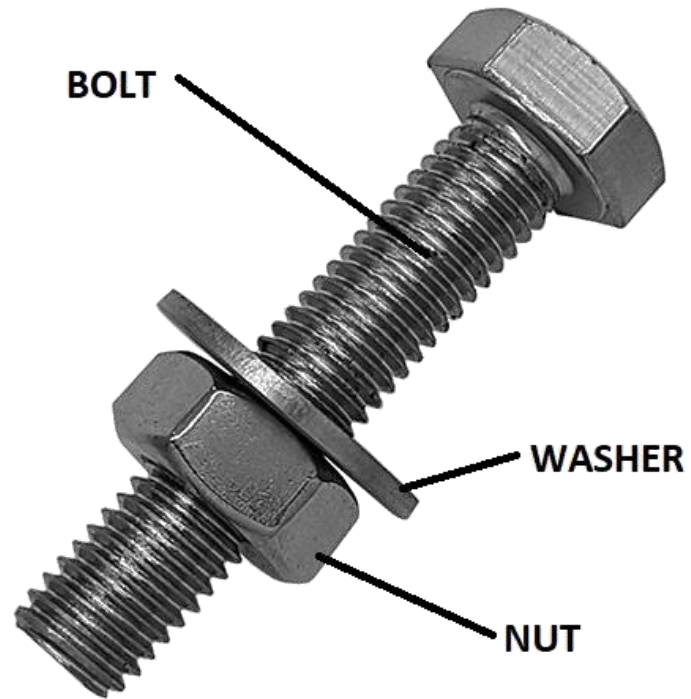
control flow through pipes

Spade



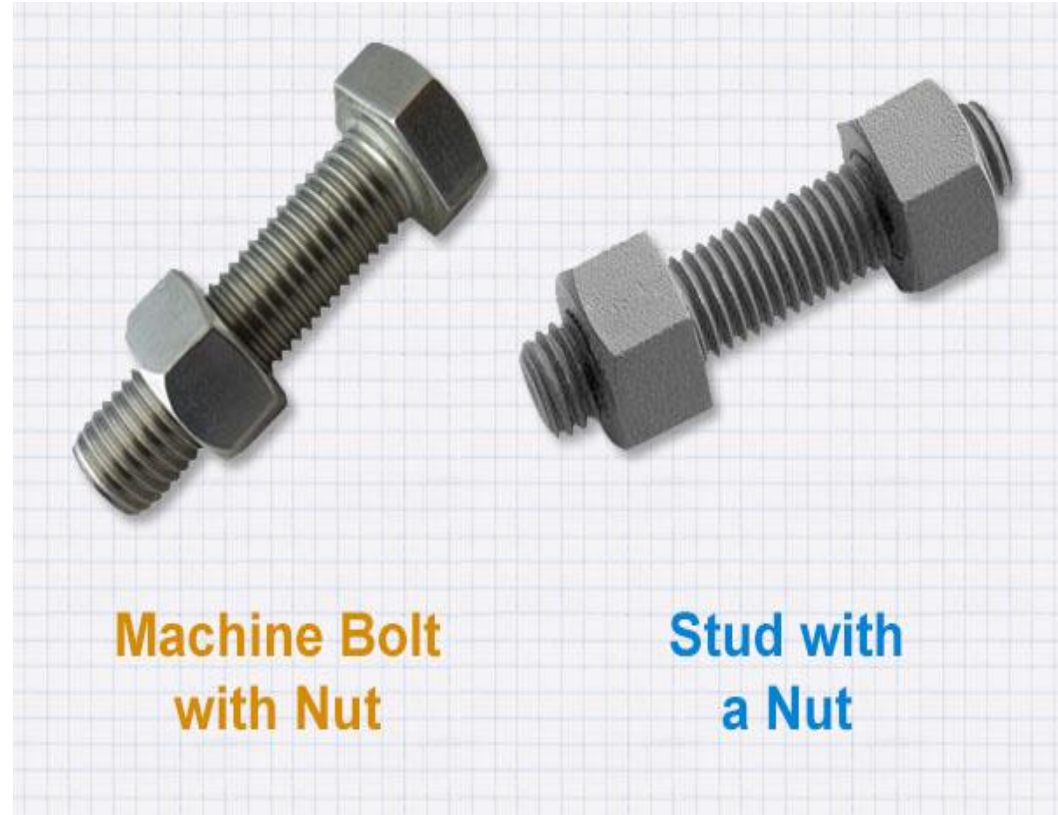
PIPE Fittings

STUDS BOLTS & HEX BOLTS



PIPE Fittings

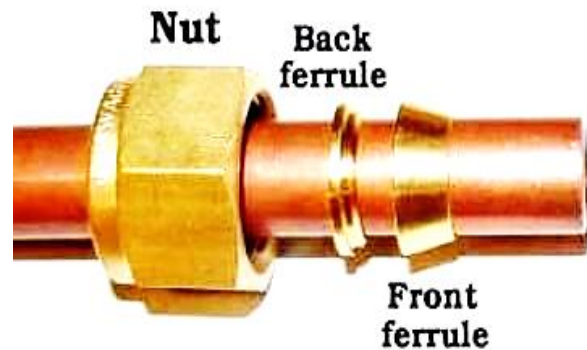
STUDS BOLTS & HEX BOLTS



PIPE Fittings

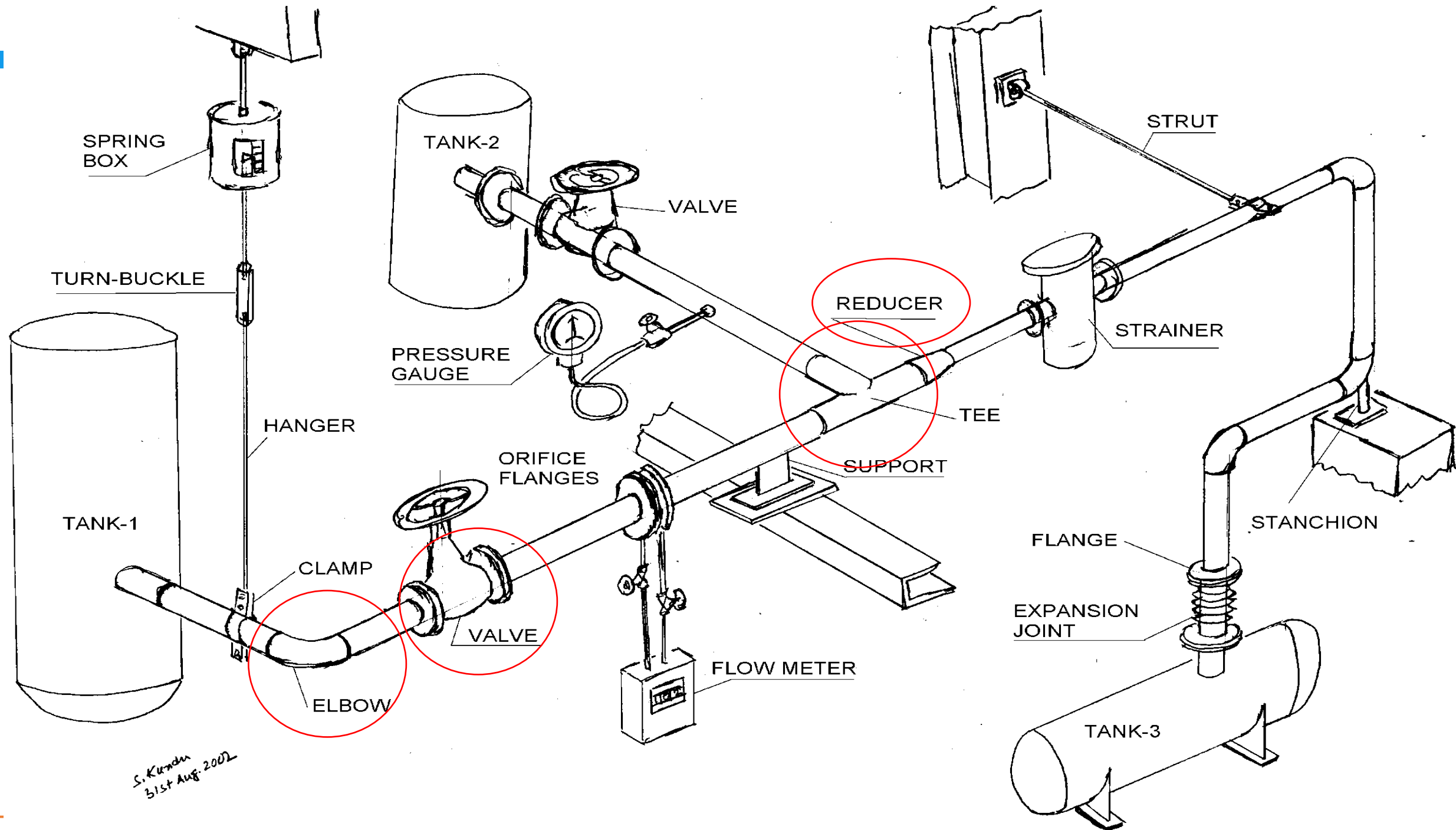
Compression fittings are used on small-diameter stainless steel, brass or copper tubing. They are only used on the plant for instrumentation hydraulic and air lines.

- **Compression Fittings**

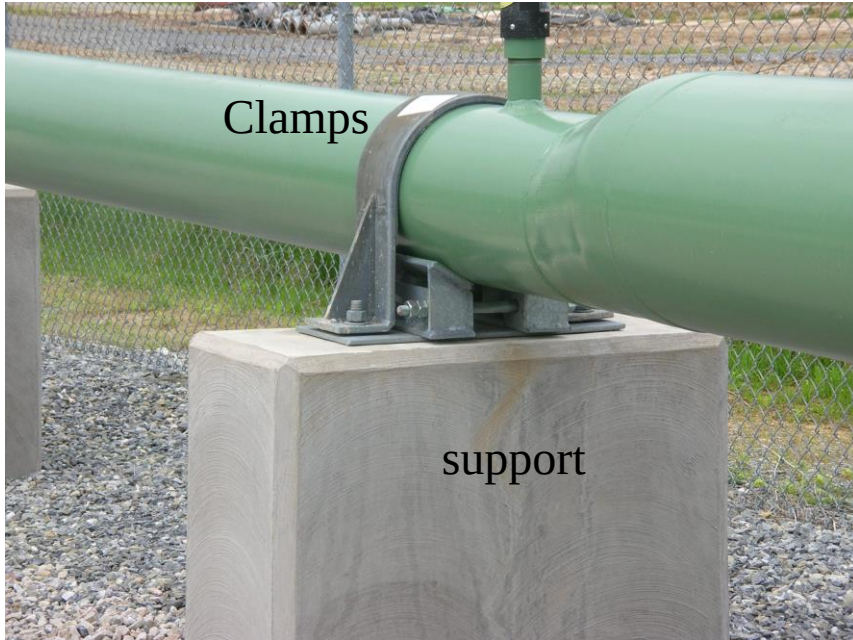


5/16" or 8mm OD Tube





PIPE Supports



A concrete block supports



A clamped pipe support



Clamped Shoe



100%





03

Static Equipment

Pipe Flanges



PIPE End

A pipe end is the description of how the section of pipe ends



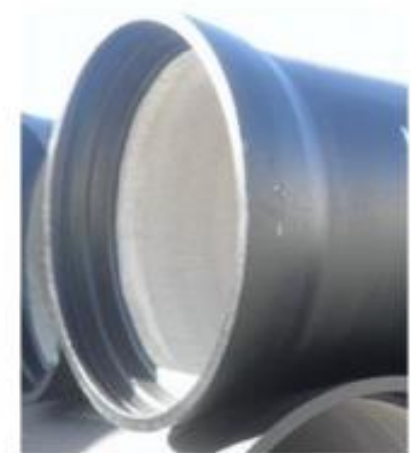
Plain End



Bevel End



Threaded End



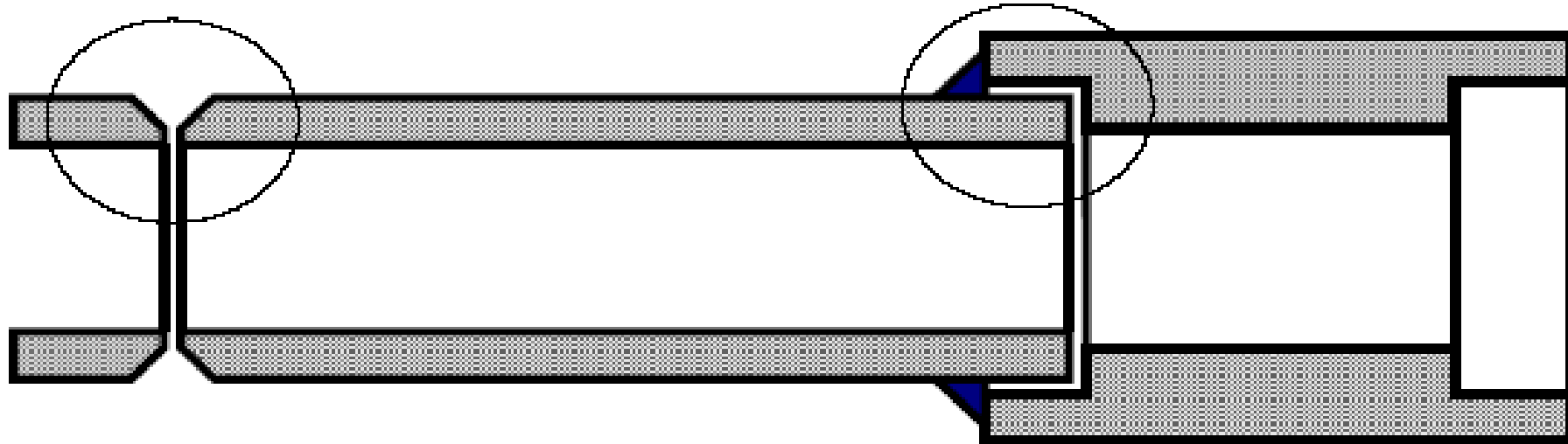
Socket –spigot End



PIPE End

Beveled End

Plain End



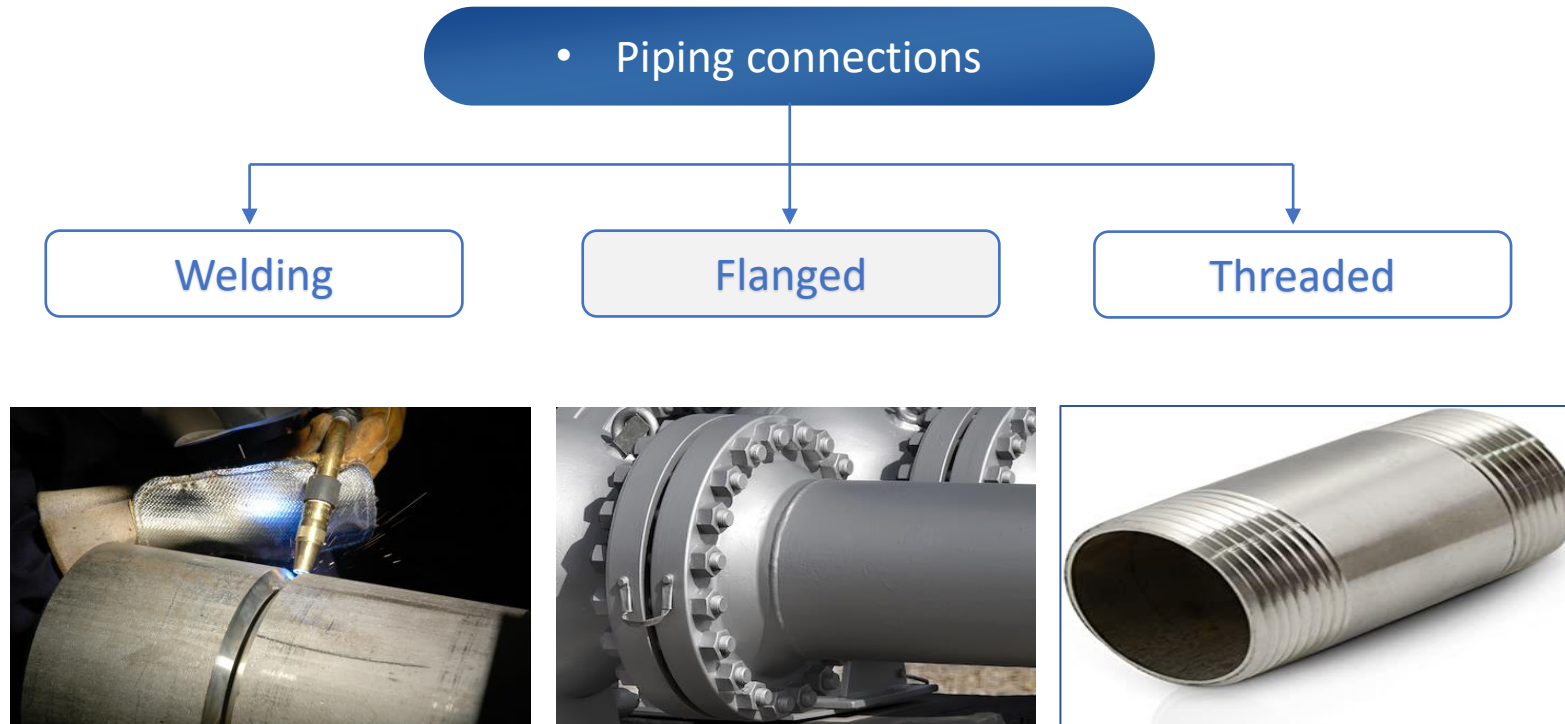
Bevel weld

Socket weld



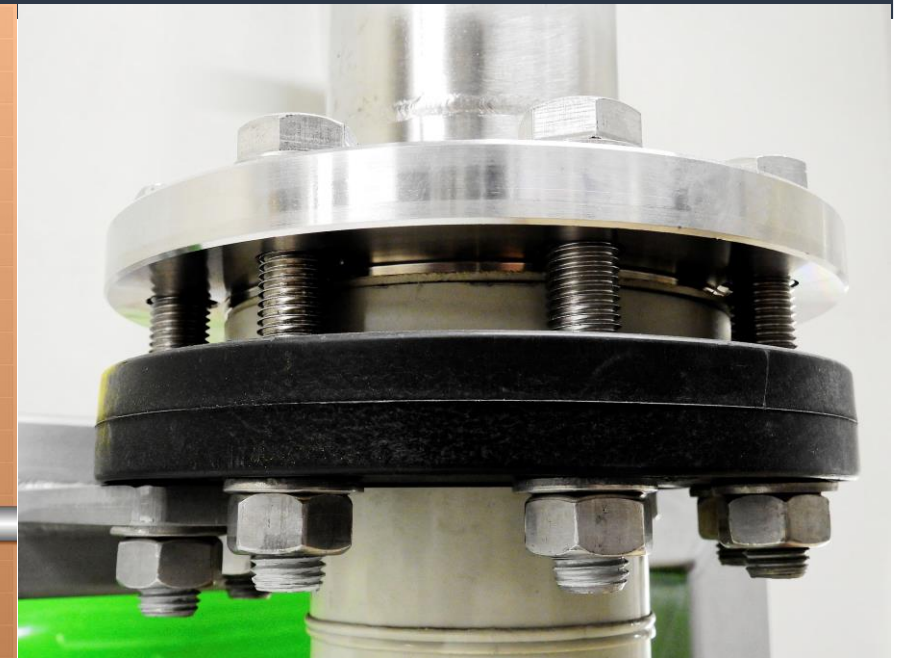
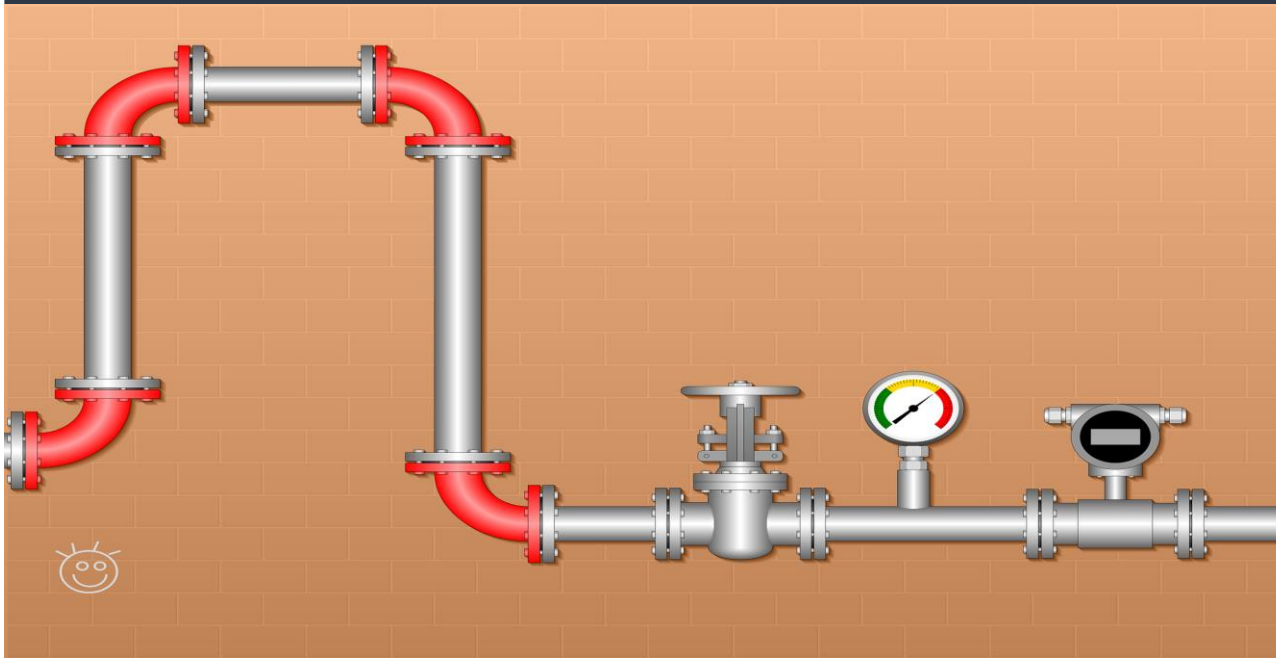
PIPE Connection

Flanges provide a bolted, separable joint in piping. Most piping connections to equipment are flanged for ease of installation and maintenance



PIPE Connection

- A flange is a method of connecting pipes, valves, pumps and other equipment to form a piping system, It also provides easy access for cleaning, inspection or modification.
- Flanges are usually welded or screwed.
- Flanged joints are made by bolting together two flanges with a gasket to provide a seal.



PIPE Flanges

A flange is specified by the following information:

- **Flange Specification and Identification**
 - **Type and Facing** i.e. whether the flange is for example “Weld Neck, RTJ” or “Socket Weld, RF”.
 - **Nominal Pipe Size** usually in inches.
 - **Pressure rating** e.g. Class 150, 300, 600, 900, 1500, 2500 etc.
 - **Standard** i.e. ANSI B16.5, BS 1560, API 6A, API 605 or ASME B16.47.
 - **Pipe Schedule.** A pipe’s wall thickness 10, 30, 40, ,80, 120, 160, etc



PIPE Class - Grade

Pipe Class

- This word refers to ANSI class.
- ASME/ANSI B16.5 and B16.34 define the pressure/temperature relationships for steel flanges and fittings. Pressure ranges are defined by the classes.
- The class number (150, 300, 600, 900, 1500, 2500 for flanges)

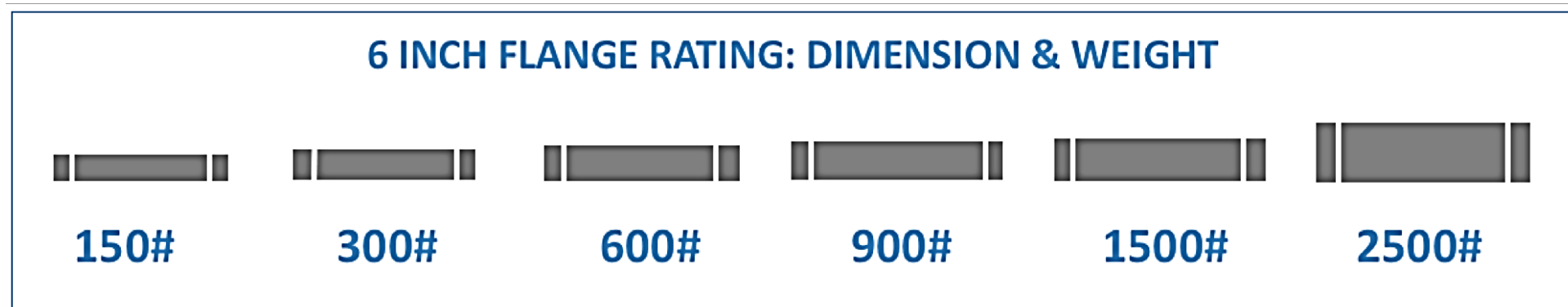
RATINGS COLOR GUIDE

150#
300#
600#
900#
1500#
2500#



Pressure Rating

- **working pressure**
- **Pressure rating** is the maximum allowed pressure that a flange can withstand According to the ANSI/ASME B16.5 specification, there are 6 flange pressure ratings: 150, 300, 600, 900, 1500, and 2500.



Pipe *Flanges*

- **Pressure rating working pressure**

Some piping components have a specific pressure rating and others do not:

- I. **Pipe** has no specific pressure rating. It must be calculated on the basis of wall thickness and allowable stress value.
- II. **Fittings** have no specific pressure rating, but it is generally the same as the pressure rating of straight pipe of the same material and schedule.
- III. **Flanges** and valves have specific pressure ratings, which are listed in ASME/ANSI B16.5 and B16.34 respectively.

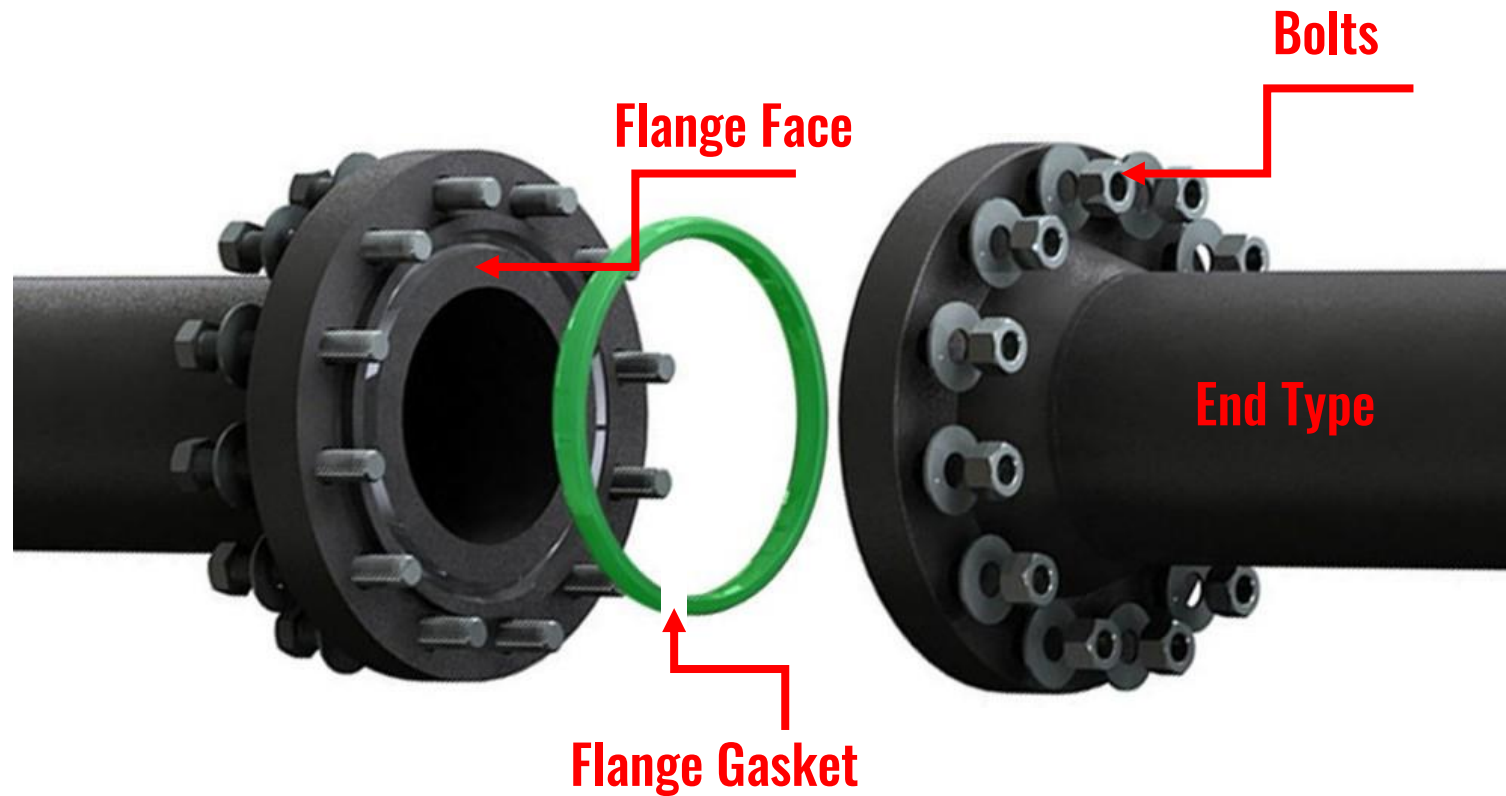


Pipe *Flanges*

- Pressure rating working pressure

TABLE 2. WORKING PRESSURES BY CLASSES, PSIG							
Temp., °F	Class						
	150	300	400	600	900	1,500	2,500
-20 to 100	285	740	990	1,480	2,220	3,705	6,170
200	260	675	900	1,350	2,025	3,375	5,625
300	230	655	875	1,315	1,970	3,280	5,470
400	200	635	845	1,270	1,900	3,170	5,280
500	170	600	800	1,200	1,795	2,995	4,990
600	140	550	730	1,095	1,640	2,735	4,560
650	125	535	715	1,075	1,610	2,685	4,475
700	110	535	710	1,065	1,600	2,665	4,440
750	95	505	670	1,010	1,510	2,520	4,200
800	80	410	550	825	1,235	2,060	3,430
850	65	270	355	535	805	1,340	2,230
900	50	170	230	345	515	860	1,430
950	35	105	140	205	310	515	860
1,000	20	50	70	105	155	260	430





- **Gasket – Compressible material providing the seal**
- **Bolts – Provide the force to compress the gasket and form the seal**
- **Flange – Transmit the force from the bolts to the gasket (must not distort or deflect)**



Pipe Flanges

• Types of Flanges

End Type

1. Threaded Flanges
2. Welding Neck Flanges
3. Socket Weld Flanges
4. Lap-joint Flanges with Stub-end
5. Slip-on Flanges
6. Blind Flanges

Flange Face

1. Flat Face (FF)
2. Raised Face (RF)
3. Ring Joint (RTJ)
4. Tongue and groove (T&G)
5. Male and Female type



Pipe Flanges

A. Types of Flanges



Welded neck flange



Slip on flange



Lap joint flange



Screwed flange



Blind flanges



Spectacle blind flange

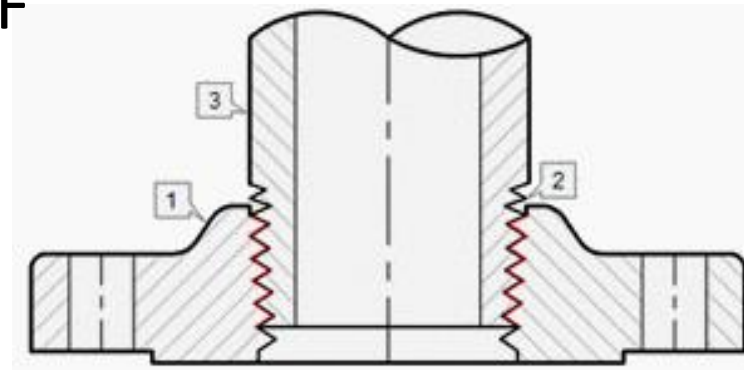


Pipe Flanges

A. Flange End

1. Threaded Flanges

- Threaded Flange mostly used in utility services such as air and water
- It is not suitable for high pressure and temperature applications
- It also available in limited Size of NPS 4" and below
- Threaded Flanges can be FF or RF
- It is a Low-cost flange.

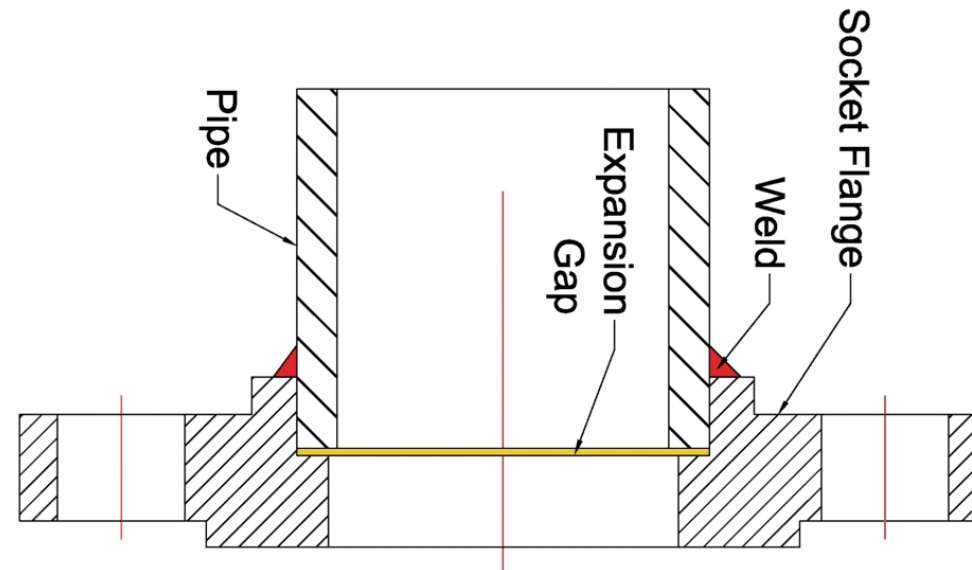


Pipe Flanges

A. Flange End

2. Socket-Weld Flanges

- Has a female socket in which the pipe is fitted.
- Used in small bore piping and only suitable for low pressure and temperature application.
- The cost of flange and fabrication is moderate.

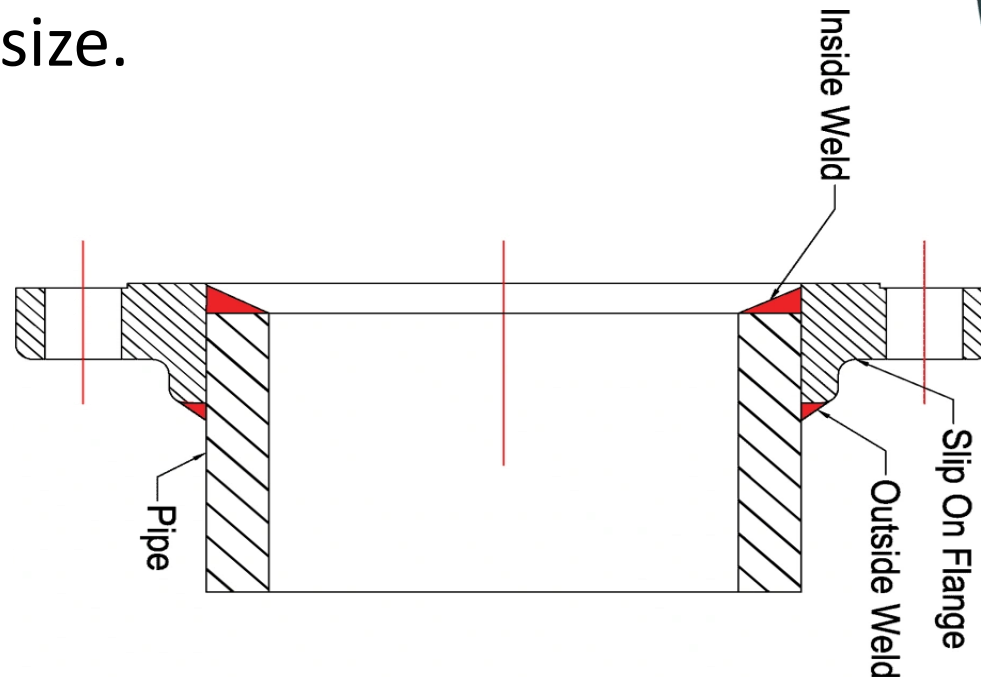


Pipe Flanges

A. Flange End

3. Slip-On Flanges

- Has a hole with matching outside diameter of pipe from which pipe can pass.
- welded from both inside and outside.
- Available in large size.
- It can be FF or RF.

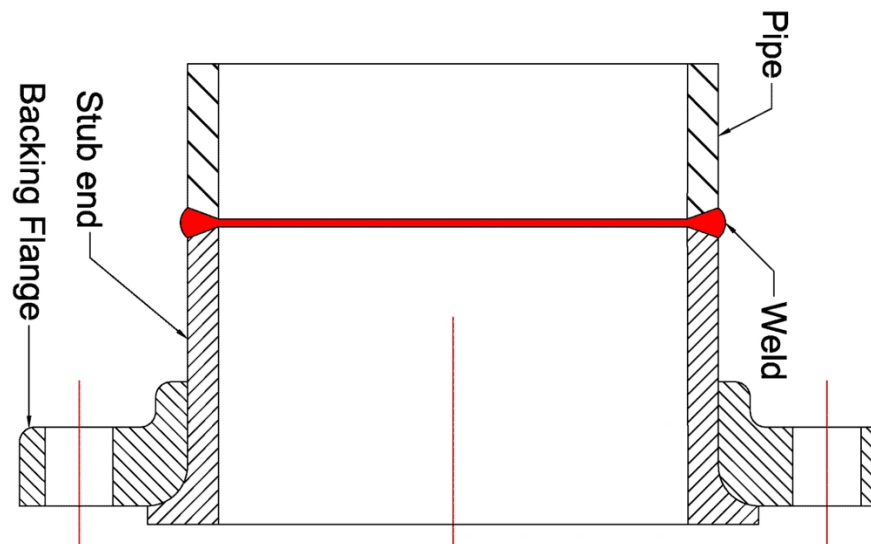


Pipe Flanges

A. Flange End

4. Lap Joint Flanges

- The lap flange is having two components, a stub end, and a Lap joint flange. The stub end is butt-welded to the pipe, and the backing flange freely moves over the pipe

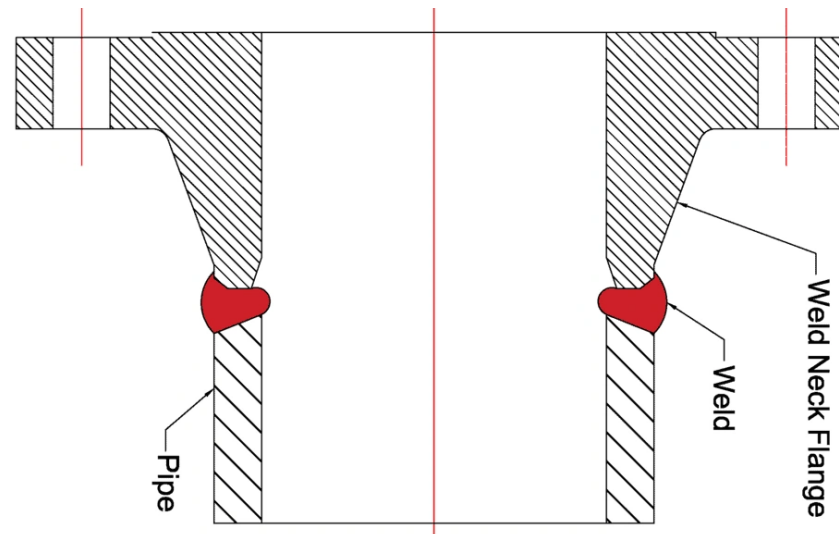


Pipe Flanges

A. Flange End

5. Weld Neck Flanges

- The most widely used type in process piping.
- It gives the highest level of joint integrity due to Butt-welded with a pipe.
- Used in high pressure and temperature application.



Pipe Flanges

A. Flange End

6. Blind Flanges

- The blind flange is a blank disc with a bolt hole.
- These types of flanges are used with another type of flange to isolate the piping system or to terminate the piping as an end.
- Blind flanges are also used as a ***manhole*** cover in the vessel.

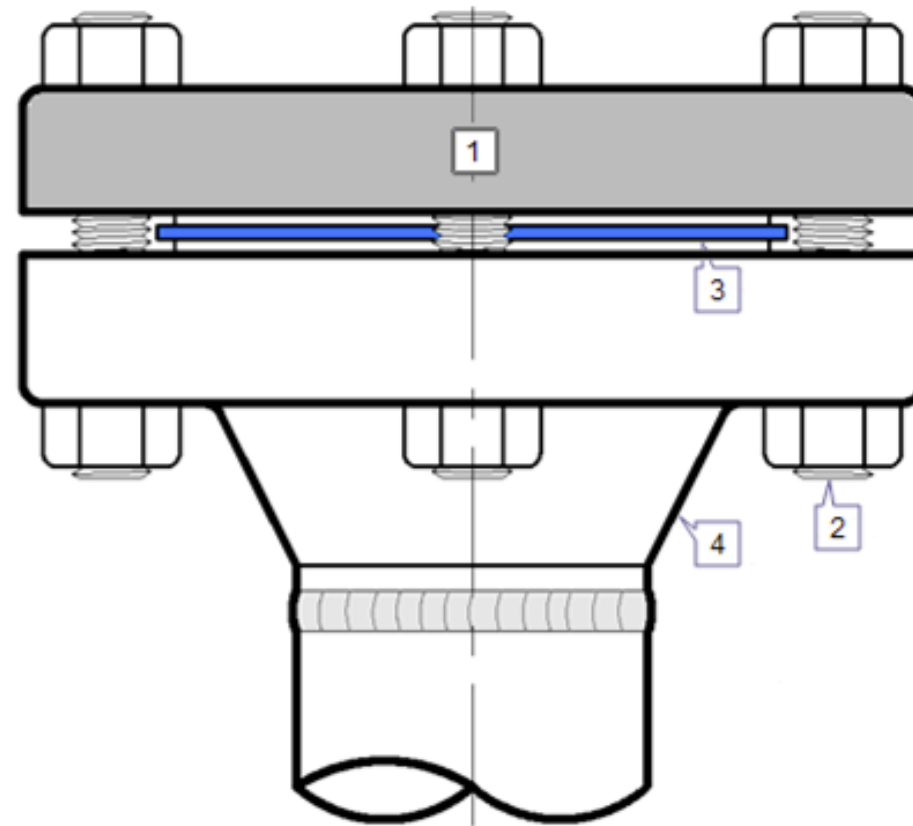


Pipe Flanges

A. Flange End

6. Blind Flanges

DETAILS OF BLIND FLANGE



1. Blind flange 2. Stud Bolt 3. Gasket 4. Other flange



Pipe Flanges

A. Flange End

7. Reducing Flange

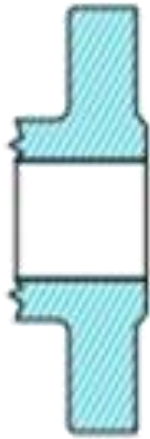
- Reducing flange is used in place of a standard flange to allow for a change in pipe size.



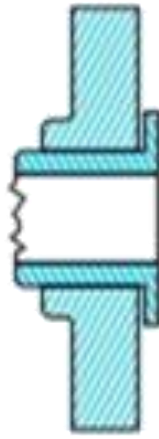
B. Flange Face



FLAT
FACE



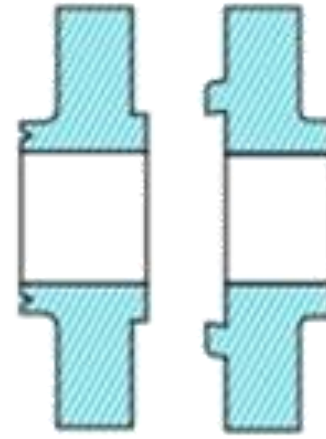
RAISED
FACE



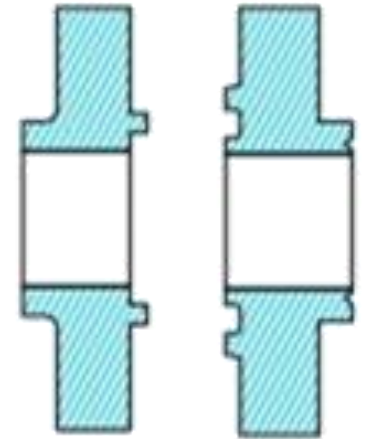
LAP
JOINT



RING
JOINT



MALE AND
FEMALE



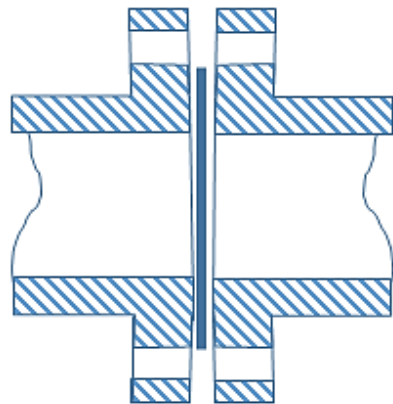
TONGUE AND
GROOVE



B. Flange Face



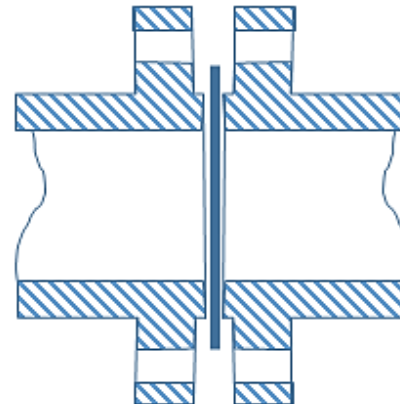
Flat Face



Flat Face



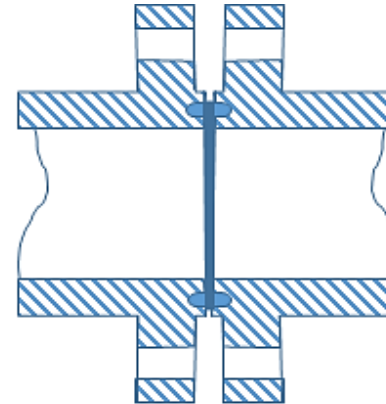
Raised Face



Raised Face



RTJ Face



Ring Type Joint



B. Flange Face

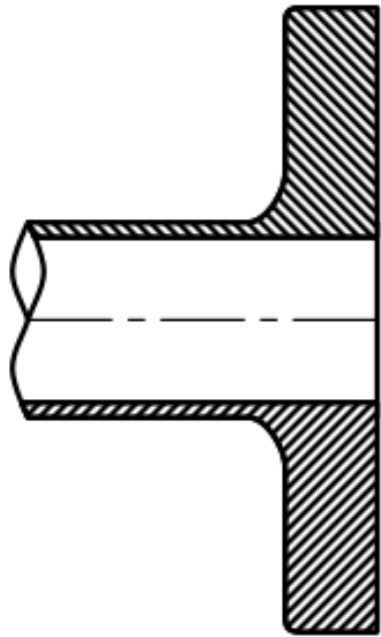
1. Flat Face

- Has a flat face.
- Flat face flanges are used when the counter-flanges are flat face.
- This condition occurs mainly in connection to Cast Iron equipment, valves, and specialties. Full face gasket is used when a flat face flange is used.



B. Flange Face

Flat Face



2. Raised Face Flanges

- Raised Face pipe flanges are the most commonly used flanges.
- Used for a wide range of pressure and temperature ratings.
- RF flanges are the **most common** type of flange employed in the Oil and Gas and chemical engineering industries.



B. Flange Face

2. Raised Face Flanges

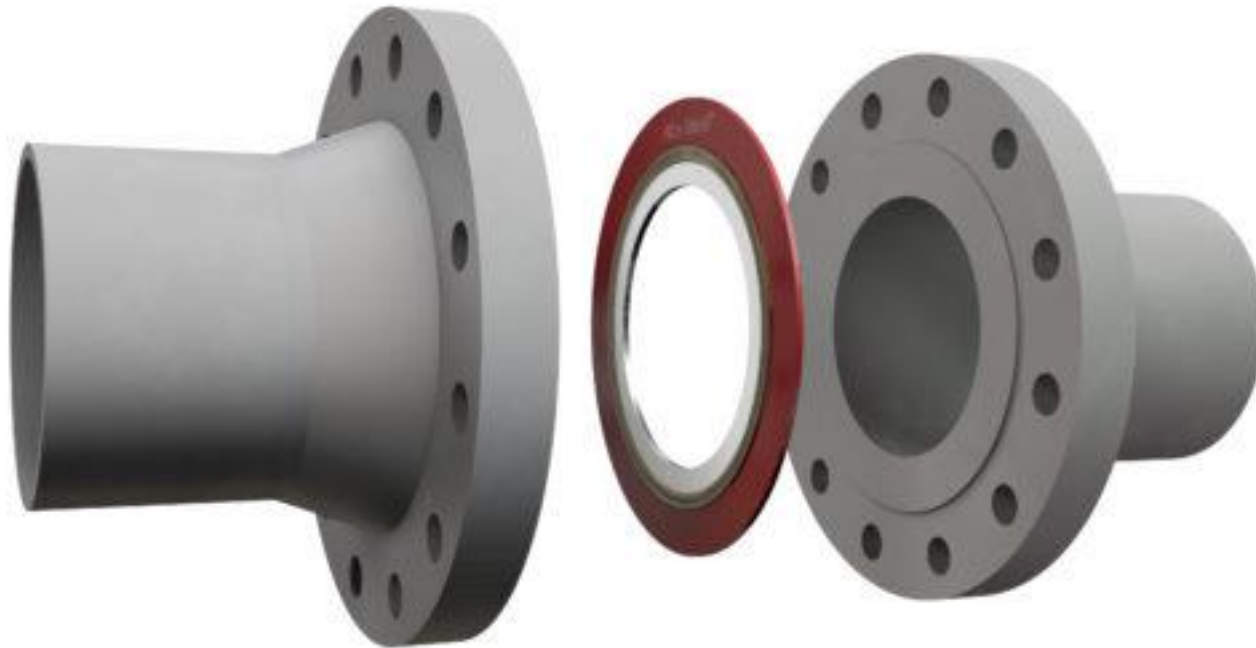
The **height of the raised face** is dictated by the **flange's class**

- **classes 150 and 300** have a raised face height of **1/16 inch (1.6mm)**
- **flanges exceeding class 300** use a **1/4 inch (6.4mm)** raised face.



B. Flange Face

2. Raised Face Flanges



B. Flange Face

3. Ring-Type Joint (RTJ)

The difference between an RTJ flange and a raised face flange is the way a seal is obtained. **Metal gaskets (hard)** are used with RTJ flanges, whilst raised face gaskets use soft or semi-metallic gaskets



Pipe gaskets

- Pipe gaskets are manufactured in many different materials.

Types Of Gasket by Material

- 1.Non-metallic
- 2.Metallic
- 3.Composite



non-metallic gasket



metallic gasket



semi-metallic gasket



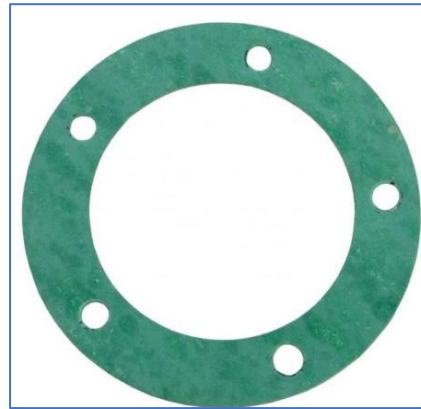
Types of Gasket: Materials

1. Non-metallic

These can be made from CNAF (Compresses non-asbestos fibre), PTFE, Rubber, Teflon or Graphite. Non-metallic gaskets can compress easily with low tension bolting. They're generally used for low pressure applications and low temperatures.

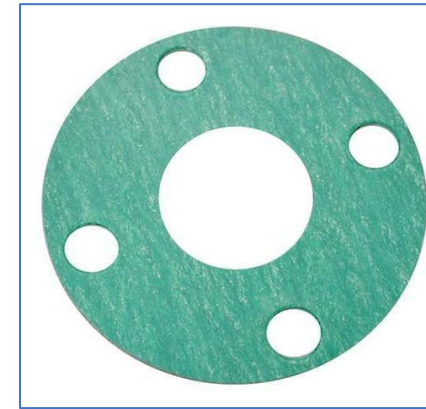


Rubber



PTFE

PTFE (Polytetrafluoroethylene)

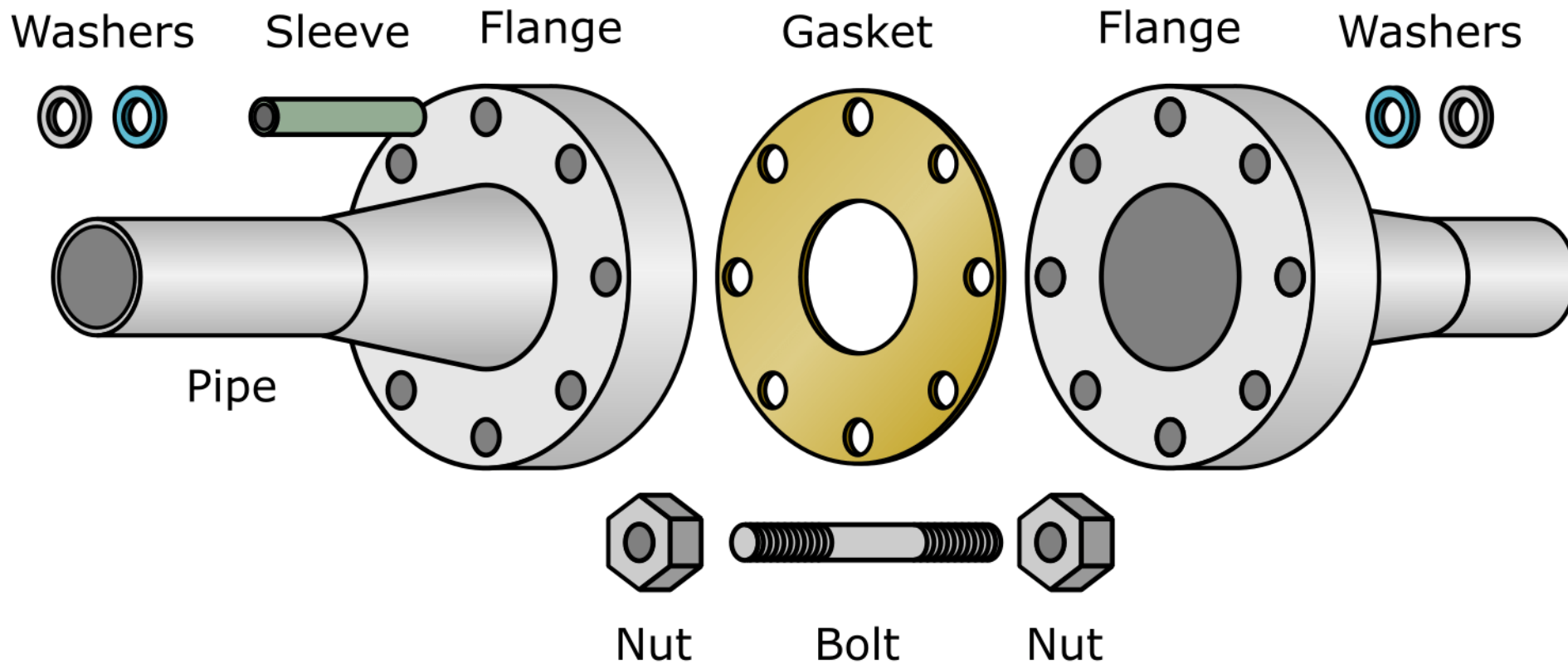


Asbestos



Types of Gasket: Materials

1. Non-metallic



Types of Gasket: Materials

1. non-metallic



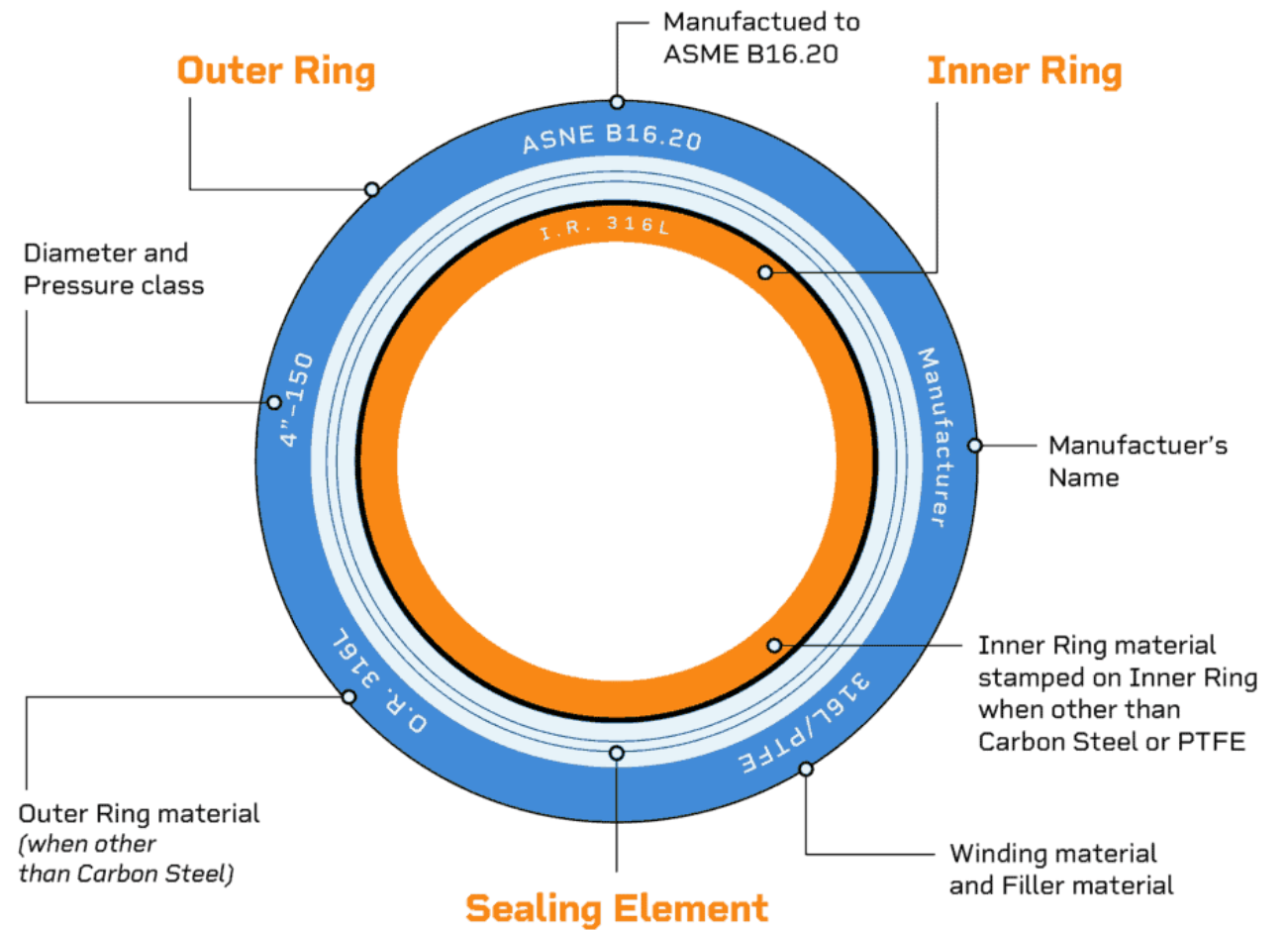
2. Semi-metallic gaskets

- **Spiral wound** : Spiral wound gaskets are semi-metallic gaskets that are used for high temperature and high-pressure applications. The main parts of spiral wound gasket are metallic windings and **filler** material.



Types of Gasket: Materials

- Spiral wound :



Semi-metallic gaskets



Ring-Type Joint

3. Ring-Type Joint (RTJ)

- The Ring Type Joint flanges are typically used in **high pressure** (Class 600 and higher rating) and/or high temperature services above 800°F (427°C).



BX TYPE RING



R TYPE RING



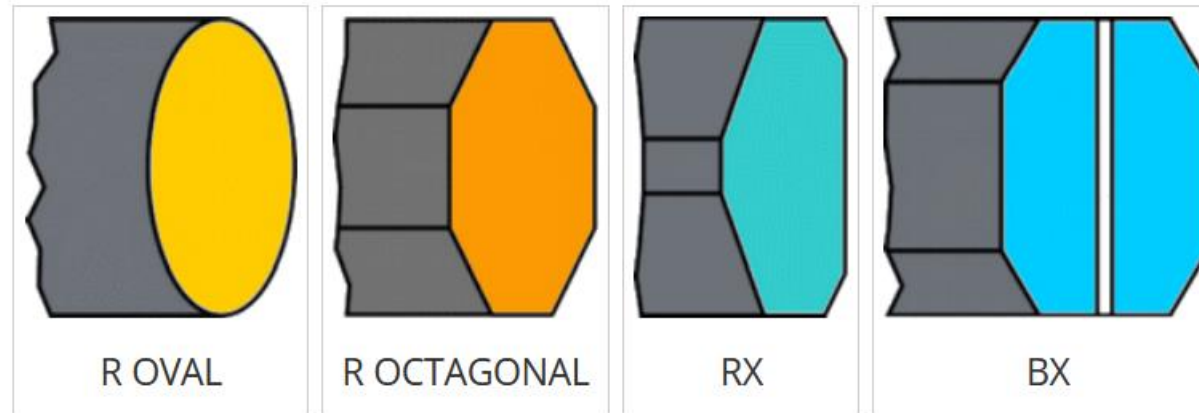
RX TYPE RING

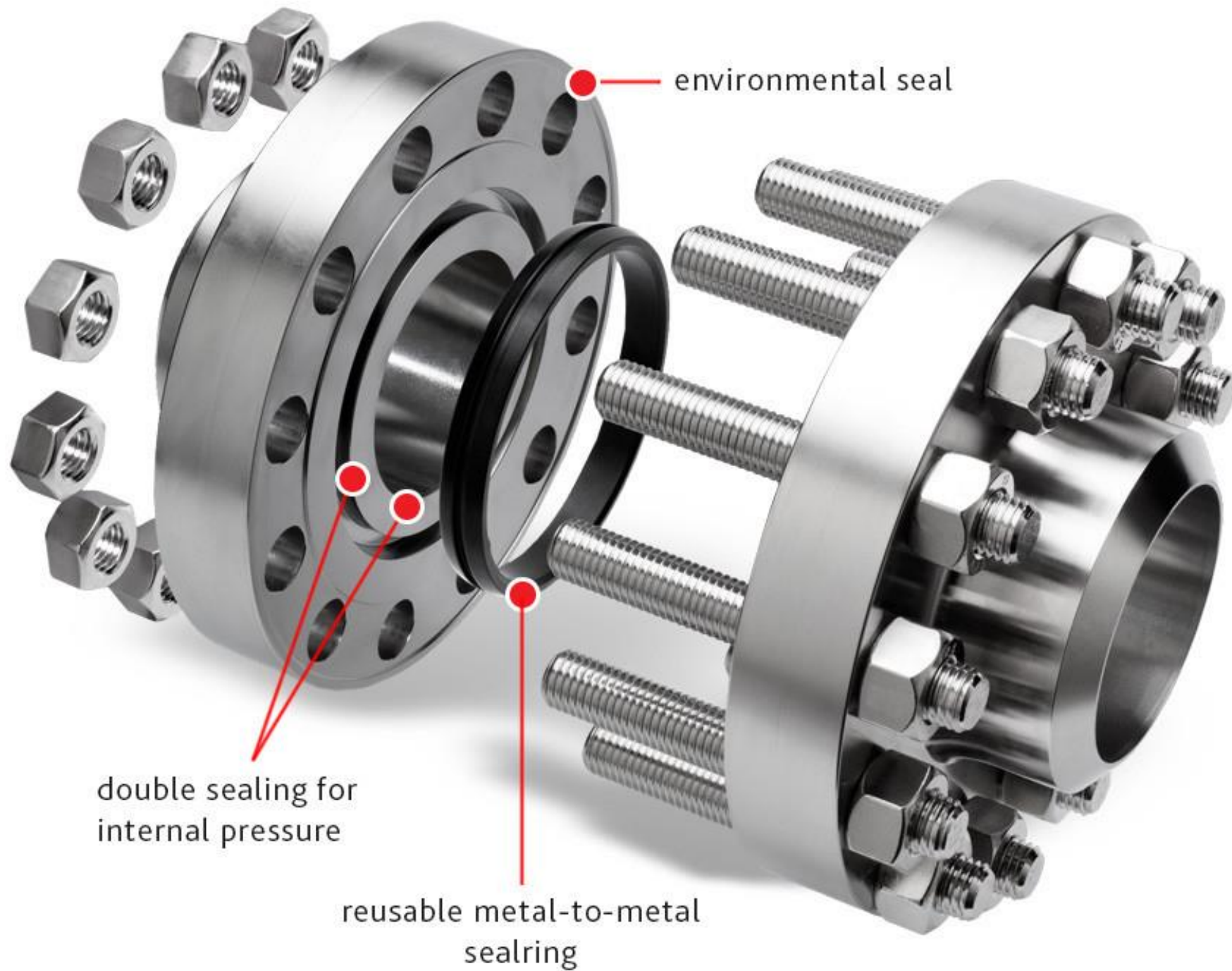


Pipe Flanges

Ring Joint Gasket

Ring Type Joint gaskets are metallic sealing rings, suitable for high-pressure and high-temperature applications. They are always applied to special, accompanying flanges which ensure good, reliable sealing with the correct choice of profiles and material.



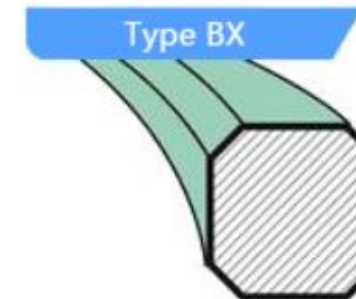
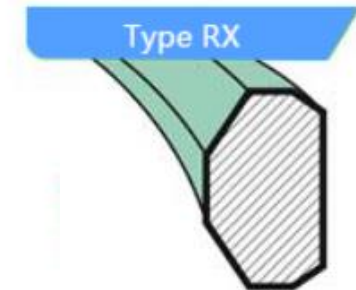
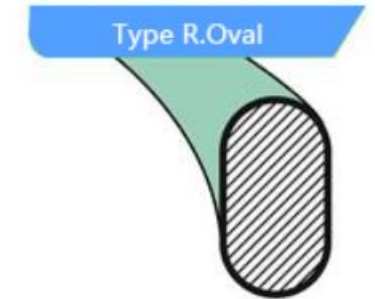
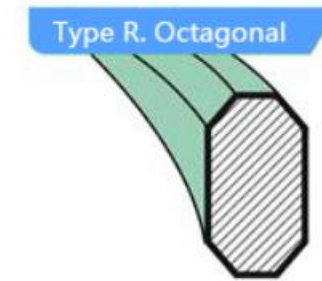


Pipe Flanges

Ring Joint Gasket

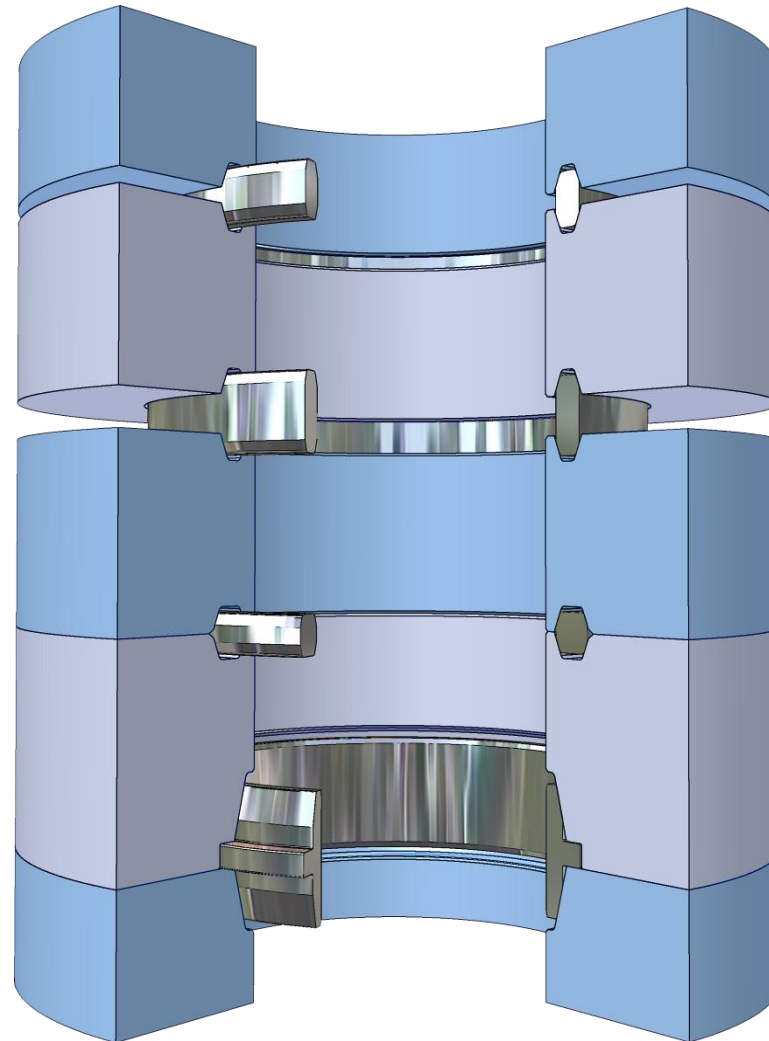
There are three basic styles of API approved ring gaskets:

- ❖ **R-style** includes both oval and octagonal cross sections, The API type “R” rig gasket is not a pressure energized gasket therefore this type does NOT recommend for BOP equipment or safety critical equipment as x-mas tree, wellhead valves, etc.
- ❖ **RX-style** is a pressure energized ring joint gasket.
- ❖ **BX-style** ring gaskets require a BX groove on the flange.



Pipe Flanges

Ring Joint Gasket



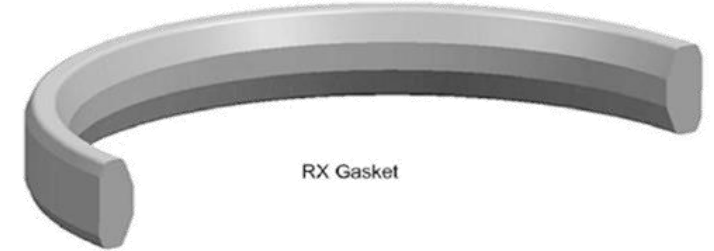
API

R Ring Gasket

RX Ring Gasket

BX (face-to-face contact)

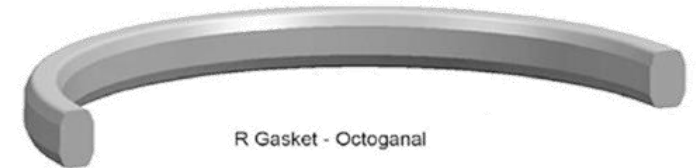
CF Ring Gasket



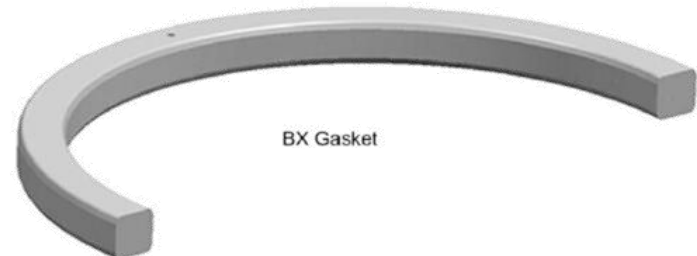
RX Gasket



R Gasket - Oval



R Gasket - Octagonal



BX Gasket





04

Static Equipment

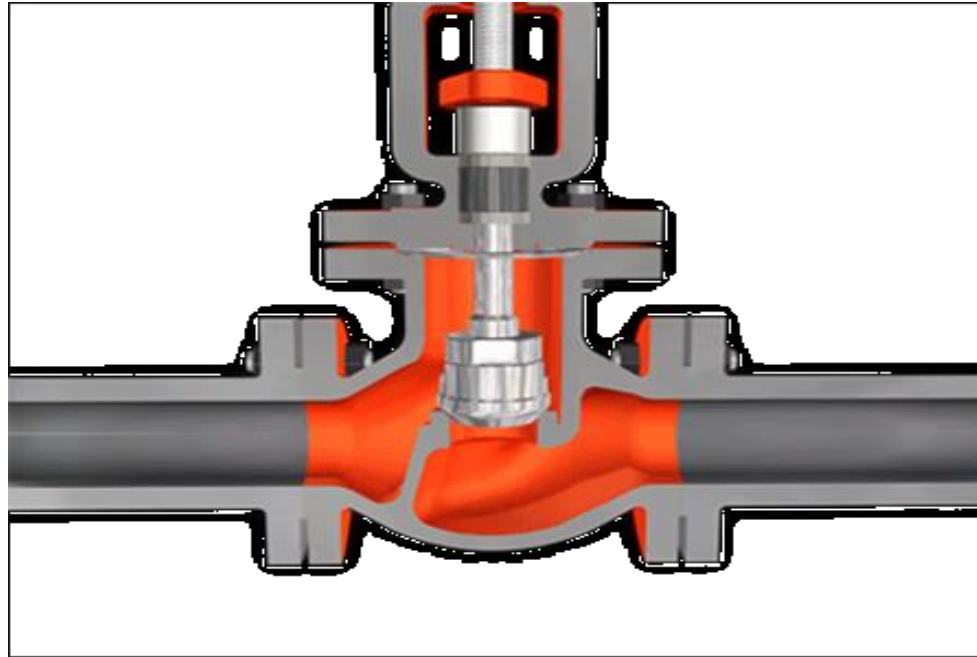
Valves



What is Valve?

Valve definition

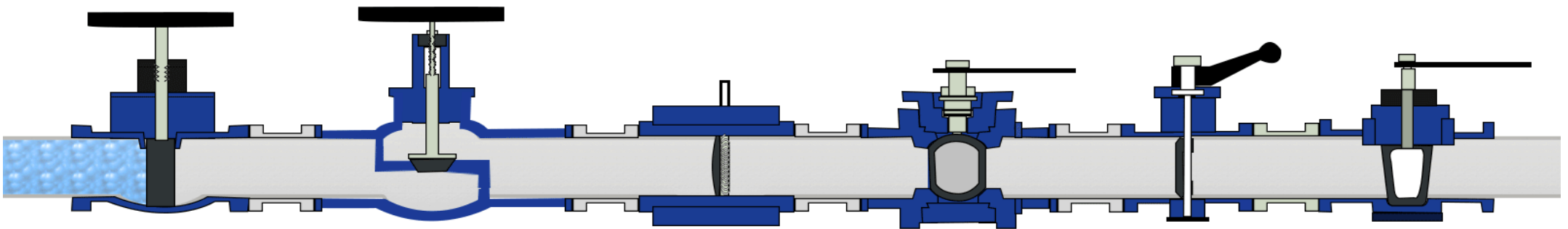
- A device that *regulates, directs* or *controls the flow* of a fluid by opening, closing, or partially obstructing various passageways.
- Valves are designed to withstand pressure, temperature, and flow.



What is Valve?

Valve Cost

- Valve *cost* is up to *20* to *30*% of the *pipng cost* for a plant, depending on the process; and the cost of a given type and size of valve can vary 100%, depending on its construction.
- The *size* of a *valve* is mainly *determined* by the *size* of its *ends*, which connect to the pipe



What is Valve?

Valve Cost

Size	ANSI 600 RF plug valve	ANSI 600 RF gate valve	ANSI 600 RF port ball valve
2"	\$1820	\$1075	\$1365
3"	\$2958	\$1505	\$1730
4"	\$4095	\$2480	\$2483
6"	\$8228	\$4583	\$4120

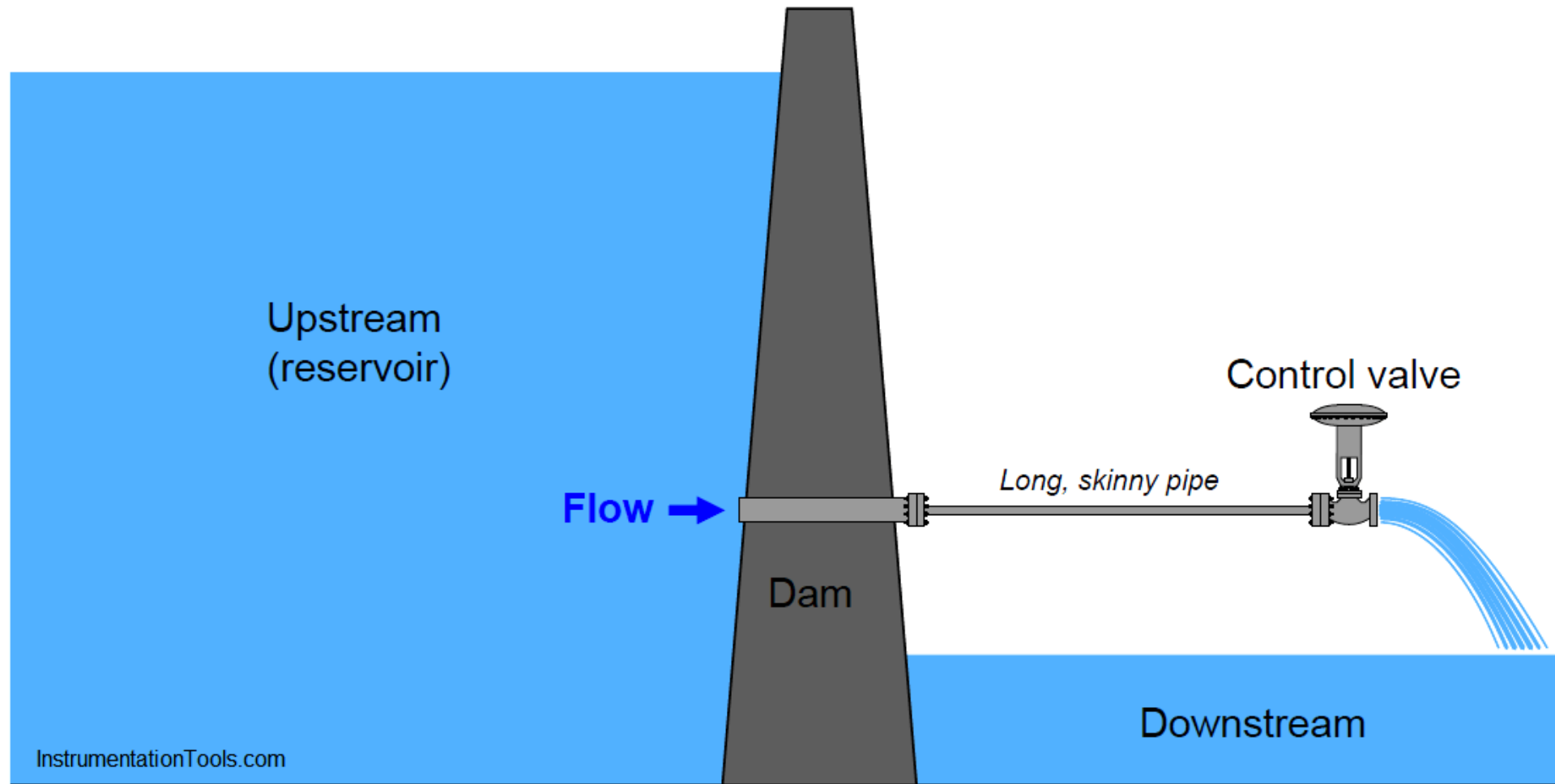


What is Valve?

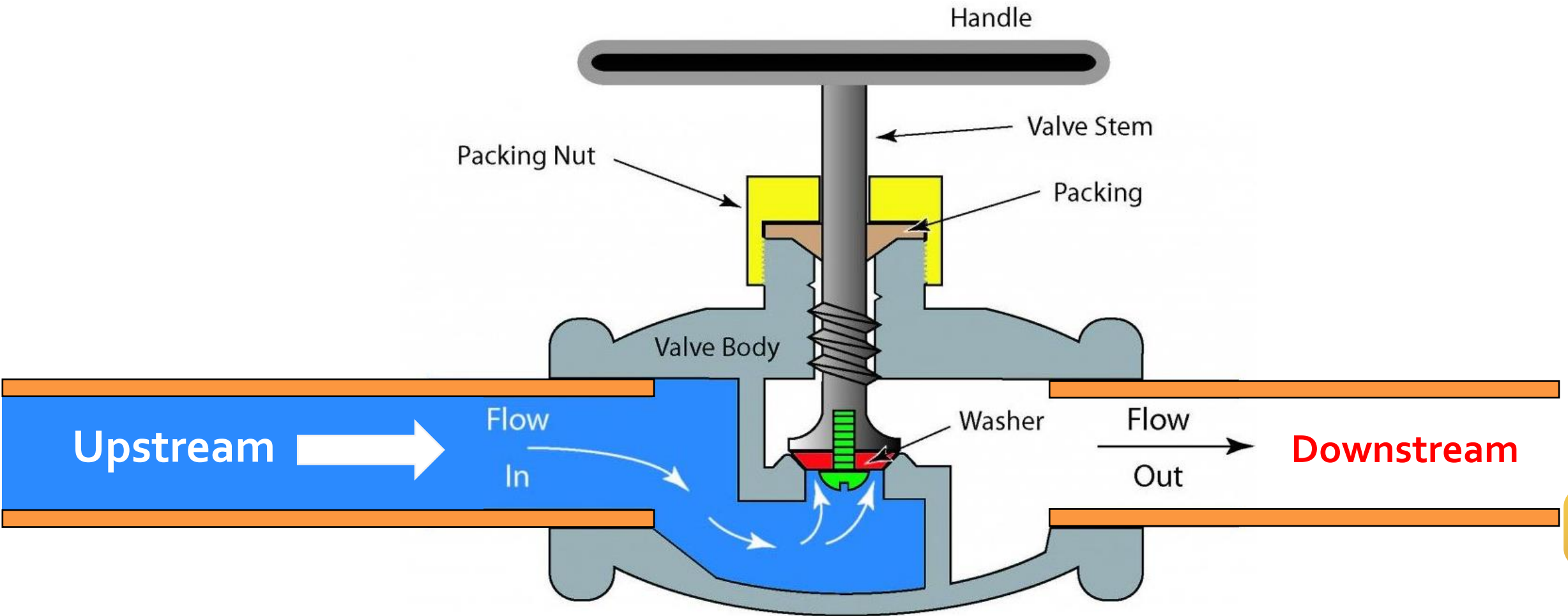
Valve Manufactures



What is Valve?

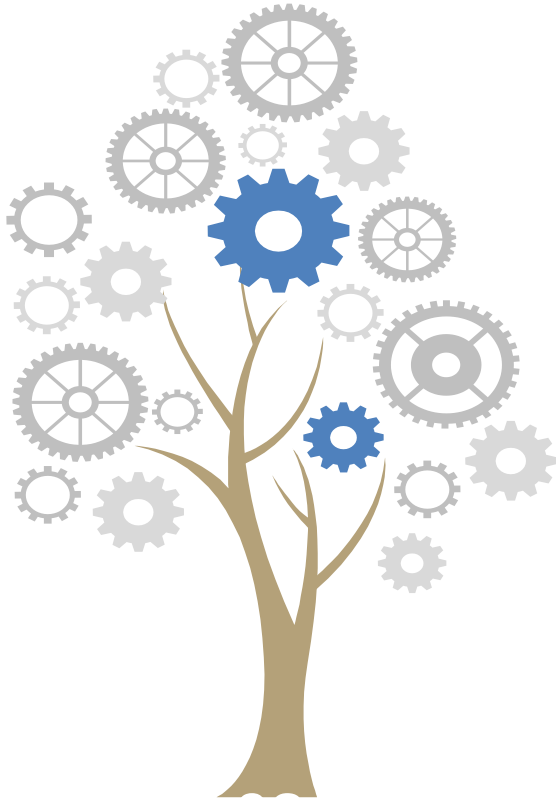


Valve Flow



What is Valve?

Valve Functions



Start and stop flow (On-off valves)



Control or regulate flow (Regulating valves)



Prevent back-flow (Check valves)



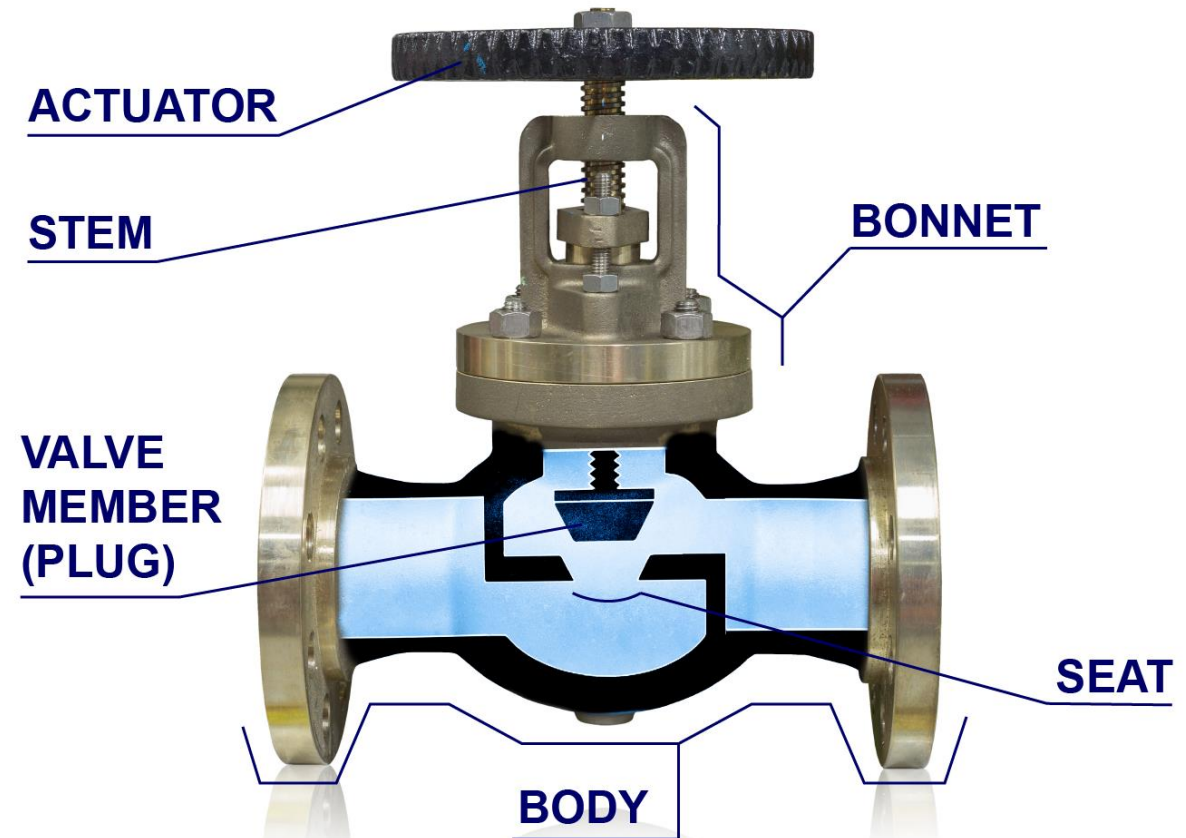
Relief over & under flow pressure.



What is Valve?

Valve Components

- Body.
- Bonnet.
- Stem.
- Disc.
- Seat.
- Stuffing Box.
- Packing.



Valve Components?

1. Body

- Main *pressure rating* part
- *Hold* all other *parts*
- Are cast or *forged structure* made.
- Valve body *must be strong* enough to hold the *maximum pressure* of the process fluid.
- *End connected* with *pipeline*



Valve Components?

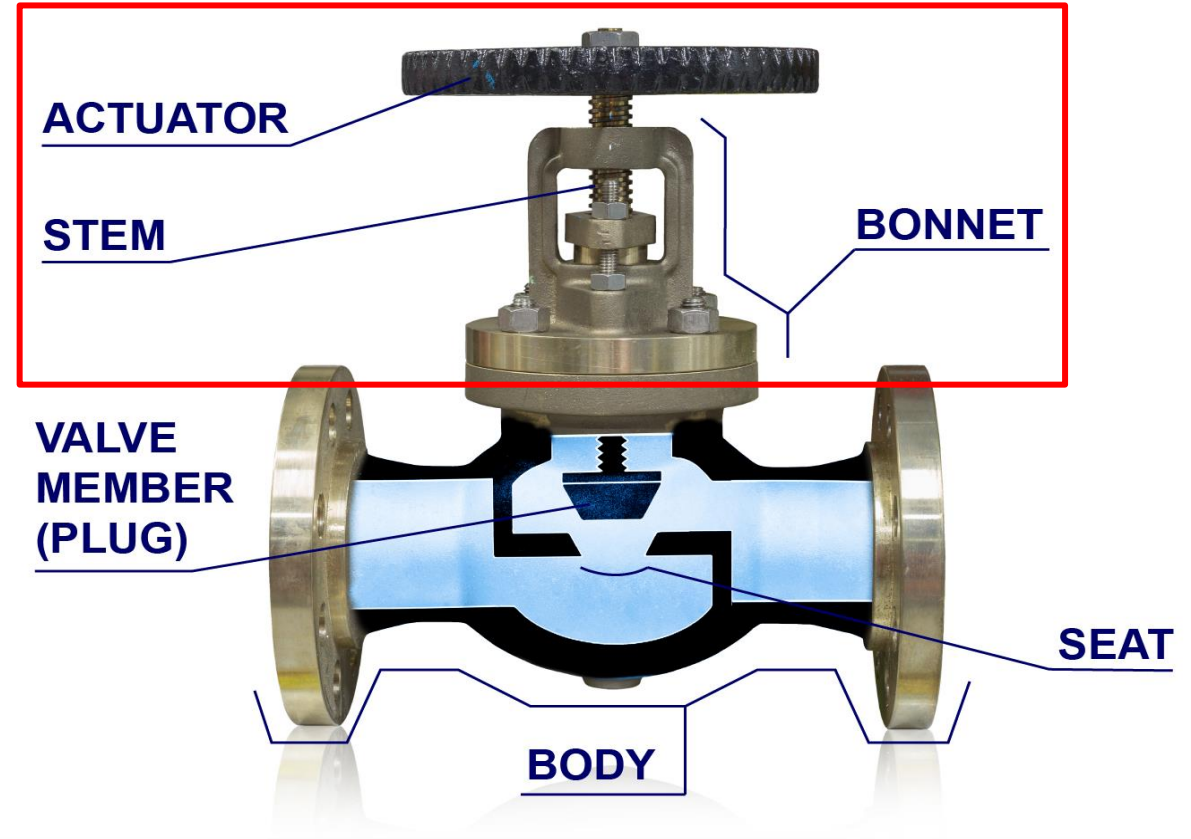
1. Body



Valve Components?

2. Bonnet

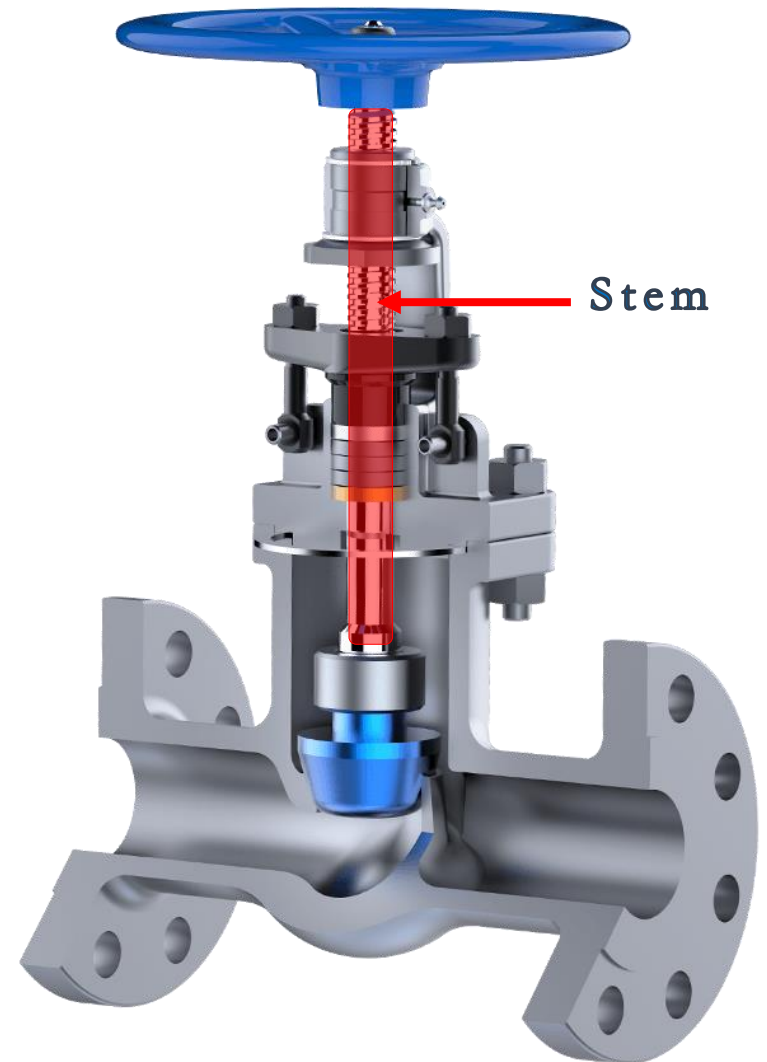
- Bonnet contains packing, gland and stem.
- The bonnet is attached to valve body by screws or bolts.



Valve Components?

3. Stem

- The stem, which connects the actuator and disc, is responsible for positioning the disc.
- Stems are typically forged and connected to the disc by threaded or welded joints.
- There are two types of valve stems: rising stems and non-rising stems.



Valve Components?

4. DISC & SEAT

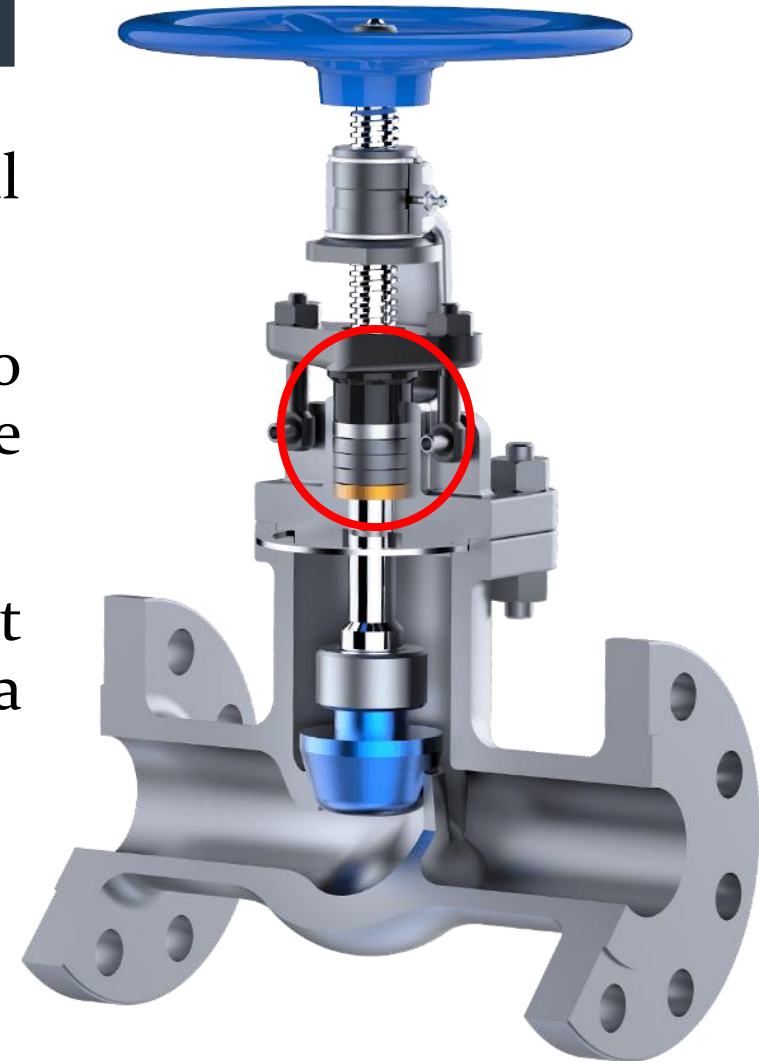
- Fluid flow control.
 - I. Start / allow
 - II. Throttle
 - III. Stop flow
- The type of disk define valve name.



Valve Components?

5. PACKING

- Stuffing box is a chamber that holds anti-seal material (packing).
- Most valves use some form of packing to prevent leakage from the space between the stem and the bonnet.
- Packing is commonly a fibrous material that forms a seal between the internal parts of a valve and the outside.

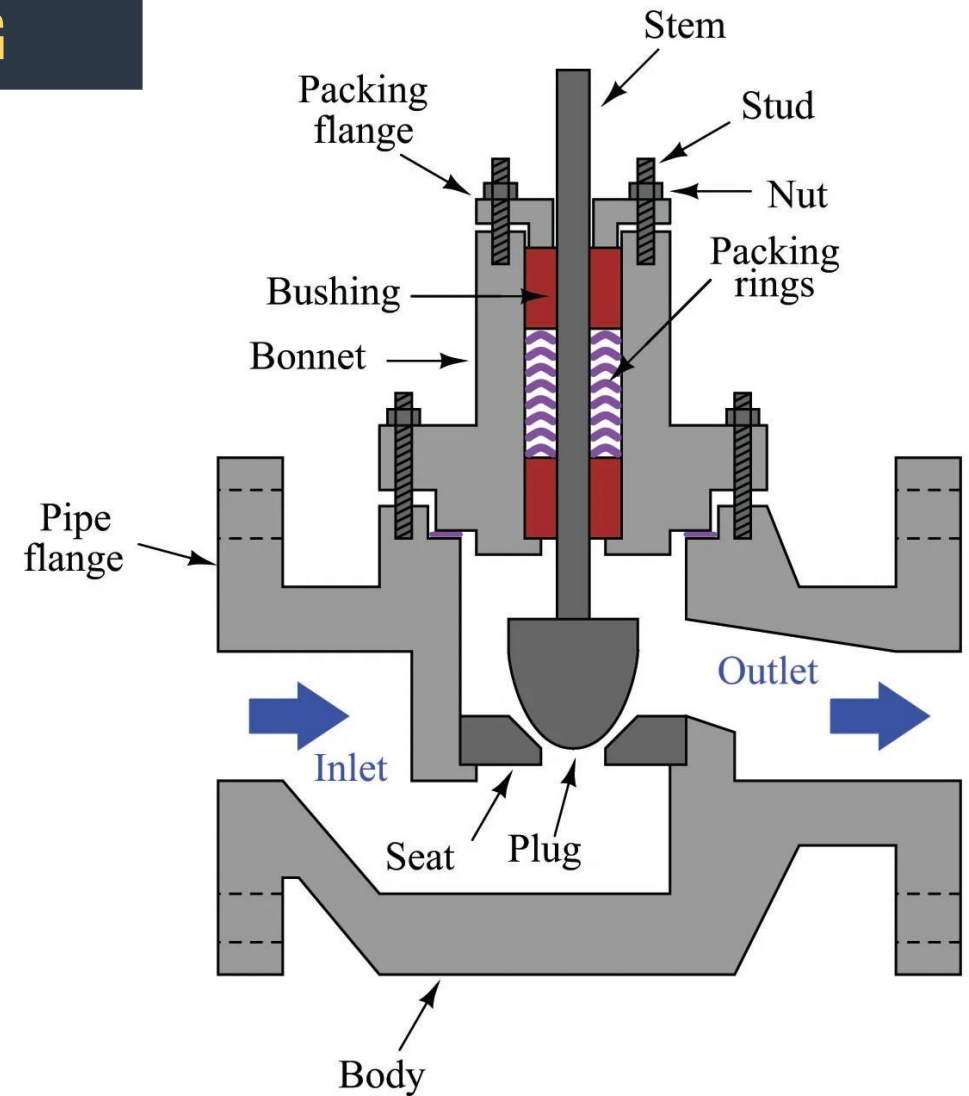


Valve Components?

5. PACKING



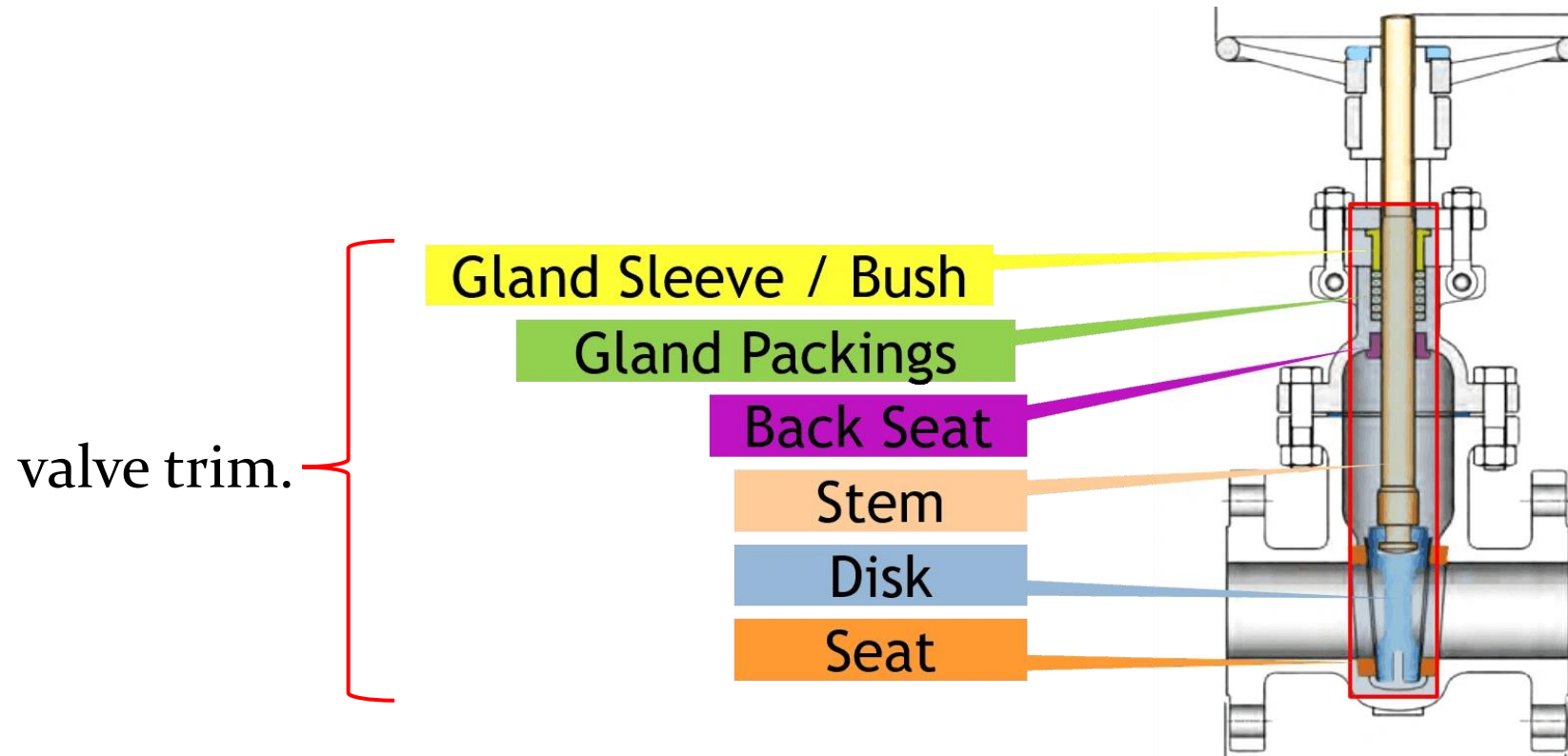
4 Ring Valve Packing Set



Valve Components?

6. Valve Trim

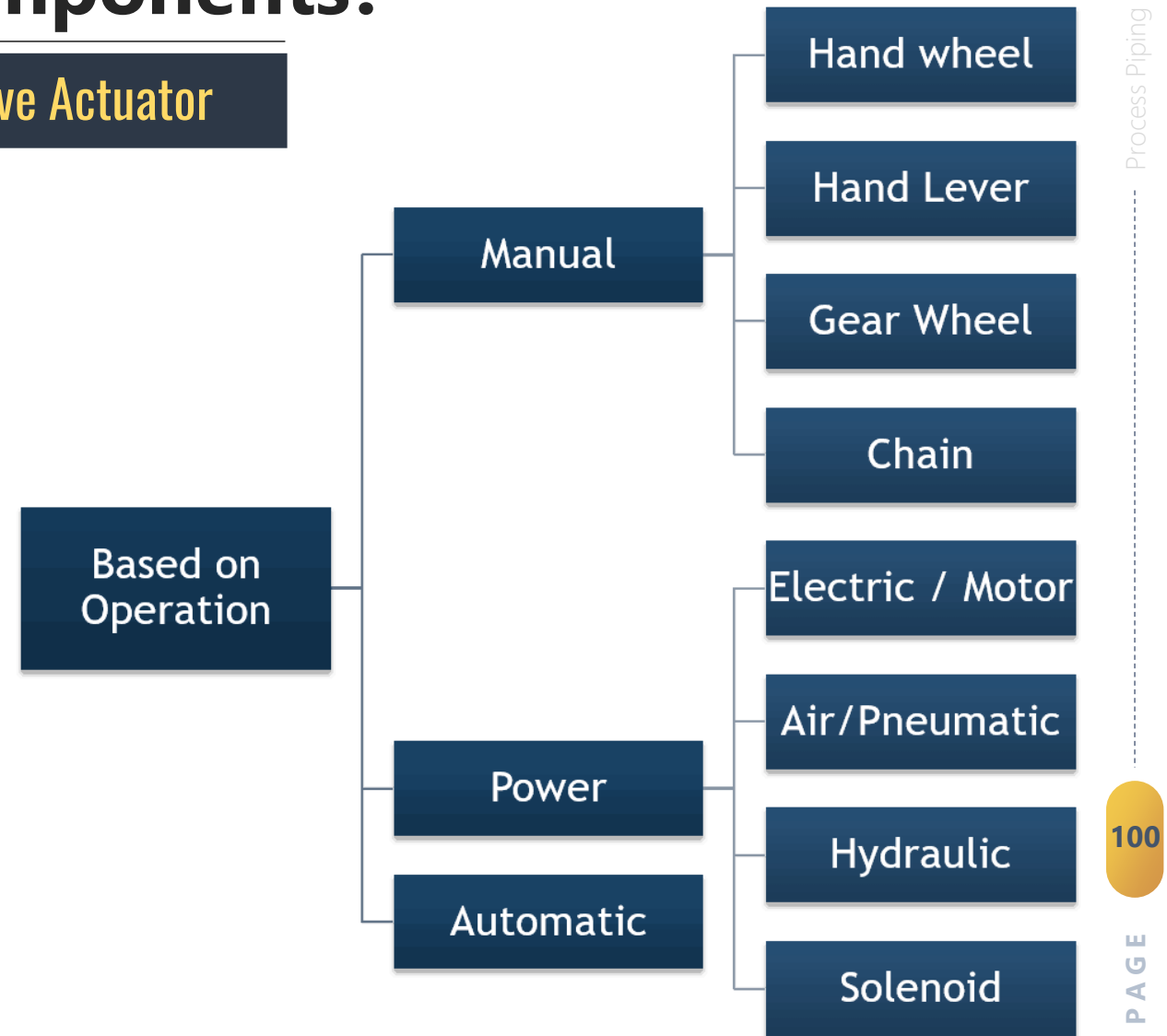
- The internal elements of a valve which are in contact with fluids are collectively referred to as a valve's trim.



Valve Components?

7. Valve Actuator

- A valve actuator is a mechanical device that uses a power source to operate a valve.
- This power source can be electric, pneumatic (compressed air), or hydraulic (the flow of oil).



Manual Valve Actuators



Hand Wheels



Chain Operated



Gear Operated

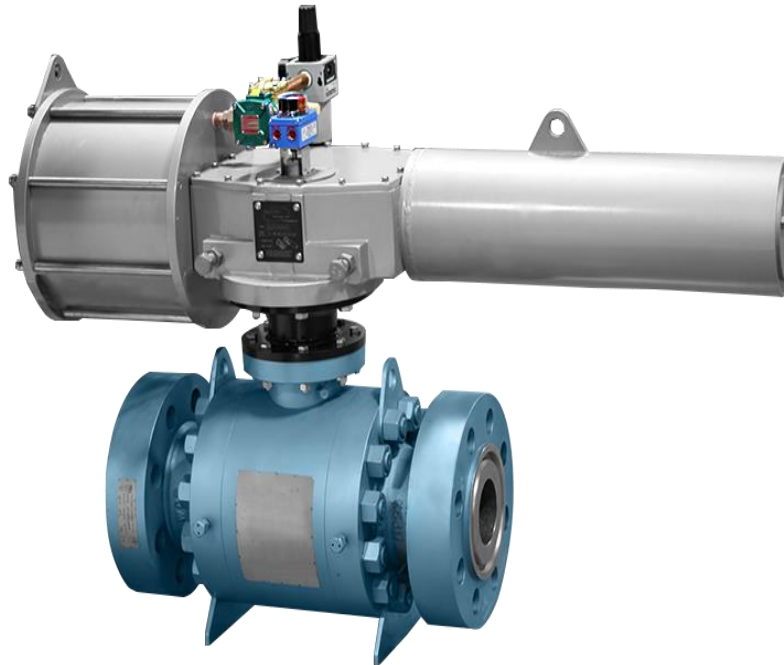


Lever Operated

Automatic Valve Actuators



a) Electric ACTUATORS



b) Hydraulic ACTUATORS



c) Pneumatic ACTUATORS



04

Static Equipment

Valve Classifications

• VALVE SPECIFICATION

1. Pressure Temperature Rating.

is the maximum allowable sustained non-shock pressure at the corresponding tabulated temperature. These are listed in ANSI B 16.34 and ANSI B 16.5.

Series	75T, 75V	75E
Material group	2.2	
Material name	CF3M, CF8M	
Temperature, °F	Working pressure, psig	
– 20 to 100	275	275
150	255	255
200	235	235
250	225	225
300	215	—
350	205	—
400	195	—
450	100 ^①	—



• Valve Classification

01

According to function

02

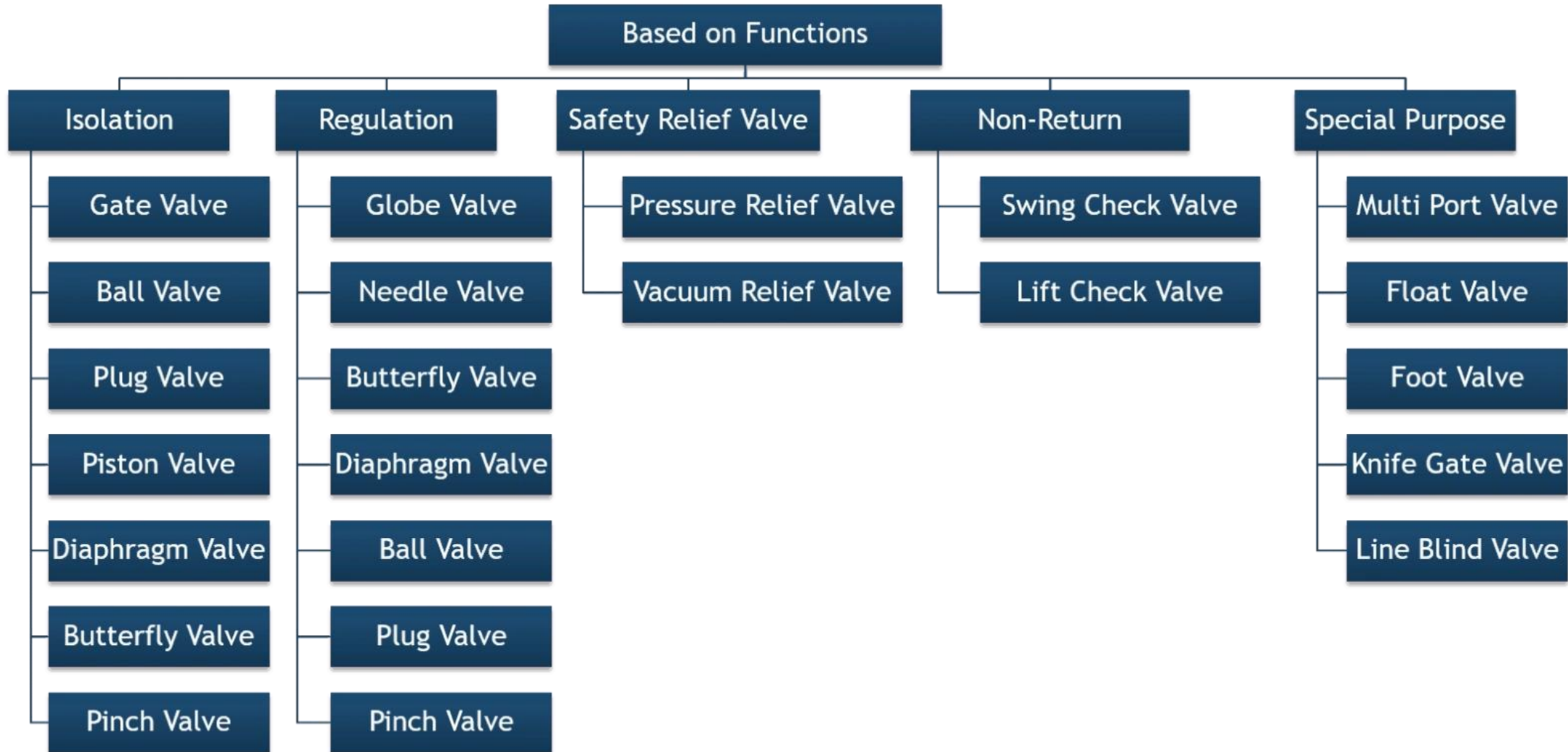
According to application

03

According to motion



- According to function



Valve Classification According to function

- *Isolation Valves*

Sometimes referred to as block valves

used to start or stop the flow

gate, plug, ball, pressure-relief,



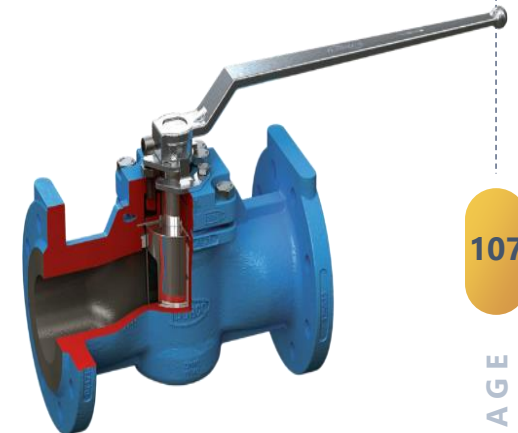
Safety relief
valves



Ball valves



Gate valve



Plug valve



Valve Classification

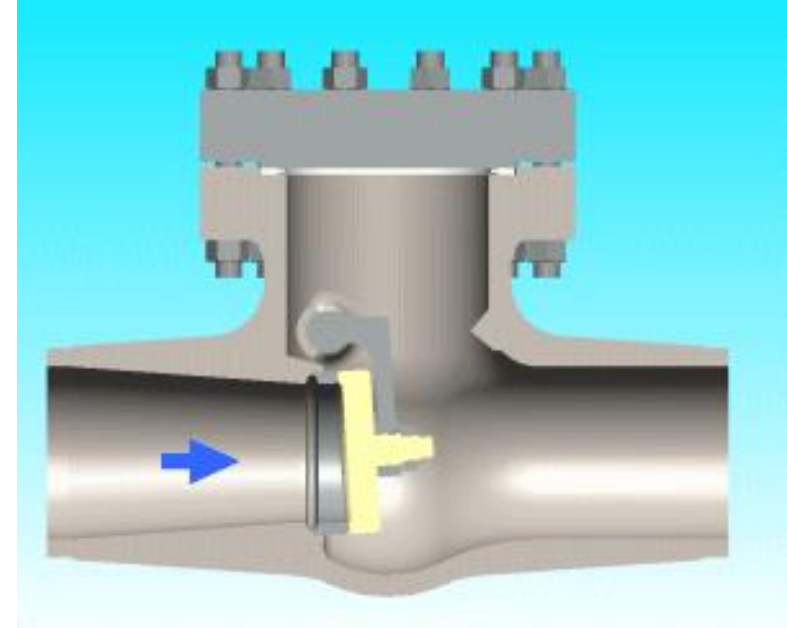
According to function

- *Nonreturn valve*

A check valve, non-return valve, reflux valve, retention valve or one-way valve is a valve that normally allows fluid (liquid or gas) to flow through it in only one direction.



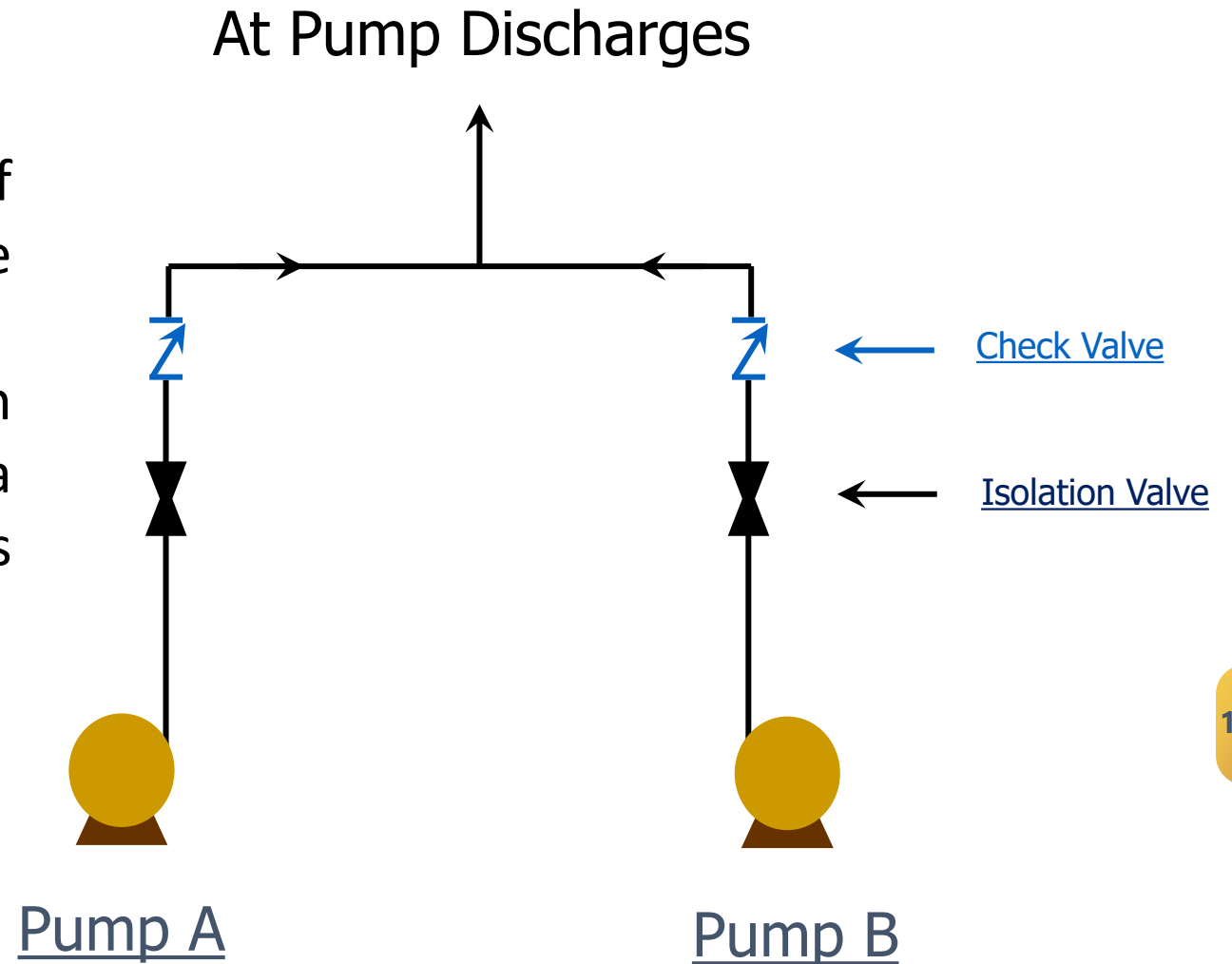
Check valve



According to function

Nonreturn valve

- Used to prevent backflow of fluid, which could damage equipment or upset the process.
- Useful in protecting a pump in liquid applications or a compressor in gas applications from backflow



Valve Classification

According to function

Throttling Valves

used to regulate the flow, temperature, or pressure

Globe valve is the most common
pressure regulation valves



Globe valve



According to function

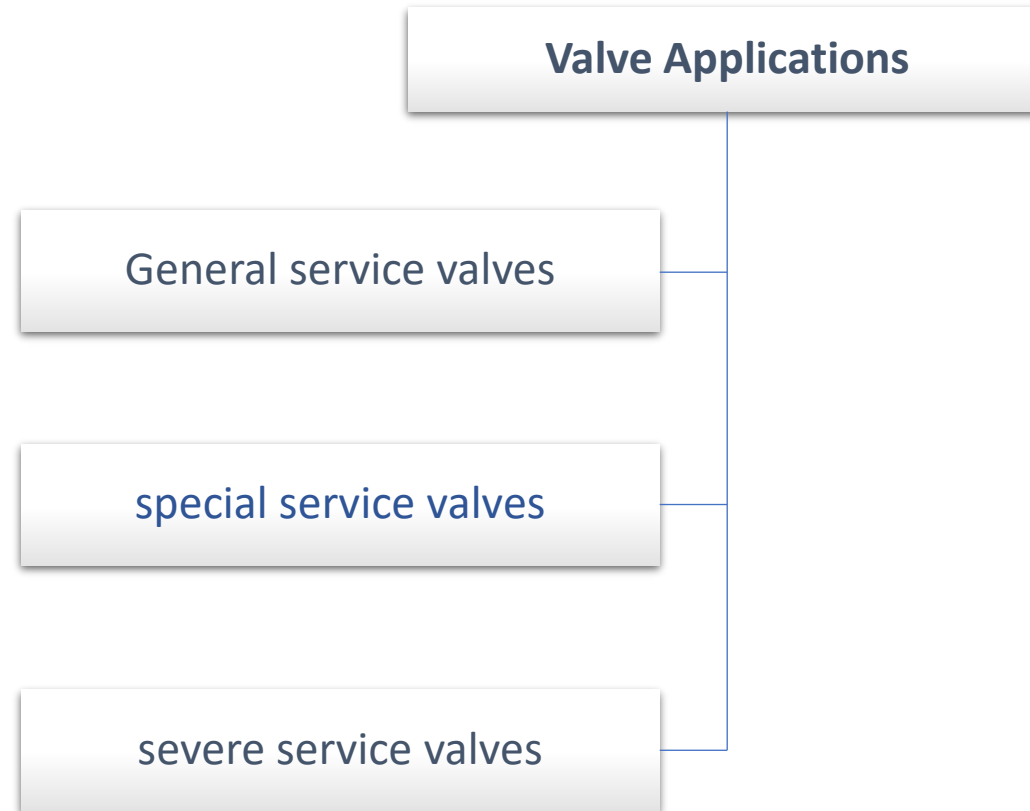
Throttling Valves

Valve function may be completed by process and/or safety requirements:

- Normally open (NO) or normally closed (NC).
- Locked open (LO) or locked closed (LC).
- I Shutdown valve (SDV), emergency shutdown valve (ESDV), and blowdown valve (BDV).
- I Motor-operated valve (MOV) and remote-operated valve (ROV).



Valve Classification According to Applications

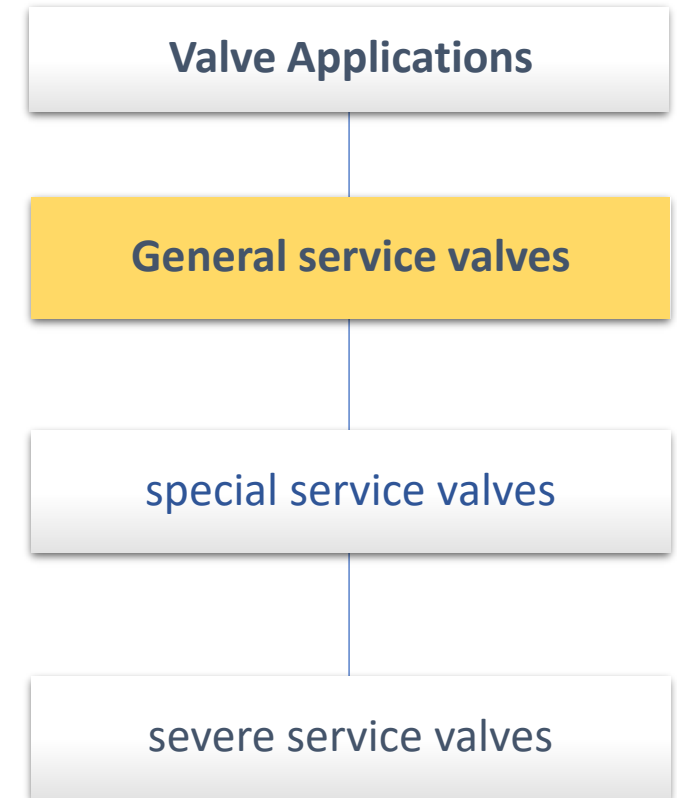


According to Applications

General service valves

Designed for the majority of applications that have:

1. lower-pressure ratings between Class 150 and 600
2. Temperature ratings between 46 and 343°C
3. Noncorrosive fluids, and common pressure drops that do not result in cavitation or flashing.



According to Applications

Valve rating

The rating of valves defines as the pressure – temperature relationship within which the valve may be operated.

➤ **WOG** (Water, oil, gas).

Rating used for small valves.

➤ **WSP** (Working Steam Pressure).

The high temperature rating.



Series	75T, 75V	75E
Material group	2.2	
Material name	CF3M, CF8M	
Temperature, °F	Working pressure, psig	
– 20 to 100	275	275
150	255	255
200	235	235
250	225	225
300	215	—
350	205	—
400	195	—
450	100 ^①	—



Valve Classification According to Applications

Valve rating

- NPS versus DN

inches	millimeters
0.25	6
0.5	15
1.0	25
2.0	50
4.0	100
8.0	200
16.0	400

- ANSI Pressure versus PN

psi	bar
150	16
300	40
600	100
900	160
1500	250
2500	400
4500	700

Note: PN correlates to DIN (Deutsche Industrie Norme) pressure-temperature rating standards, which may vary significantly from ANSI pres.-temp. ratings.



Valve Selection Considerations

Valves are characterized by the following:

- Type.
- Nominal diameter (inches).
- ASME class number (150#, 300#, etc.).
- Body and trim material.



Valve Selection Considerations

Valve	Stop-start	Throttling	Frequent operation	Low pressure drop	Size range mm	Pressure range (bar)	Temperature range (°C)
Gate	✓			✓	3-1220	vac to 667	-270 to 680
Slide	✓				50-1900	atm. to 27	-18 to 650
Ball	✓		✓	✓	6-914	atm to 500	-55 to 500
Plug	✓		✓	✓	6-406	atm to 200	-70 to 200
Globe (Z)	✓	✓	✓		3-726	vac to 667	-270 to 540
Y-type	✓	✓	✓	✓	3-762	vac to 167	-270 to 540
Butterfly	✓	✓	✓	✓	50-914	vac to 80	-30 to 540
Diaphragm	✓	✓			3-610	vac to 20	-50 to 230
Needle		✓			3-25	vac to 667	-70 to 260



Valve Selection Considerations

Table 12.2.3 Typical sizes and operating ranges of isolation valves

Valve type	Size		Pressure range		Temperature range		Pressure drop ¹ bar
	Min. (mm)	Max. (mm)	Min. (bar)	Max. (bar)	Min. (° C)	Max. (° C)	
Gate	3	2 250	>0	700	-196	675	0.007
Globe	3	760	>0	700	-196	650	0.590
Diaphragm	3	610	>0	21	-50	175	0.021
Ball (full bore)	6	1 220	>0	525	-55	300	0.007
Butterfly	50	1 830	>0	102	-30	538	0.120

¹ **Note:** Typical values for a DN150 bore valve passing saturated steam at 24 bar, flowing at 40 m/s.



Valve material

- It specifies the grade of steel used in the valve casting.
- There are actually 3 grades A,B & C which define the ductility & tensile strength. WCA, WCB, and WCC.
- WCB stands for "Wrought Carbon" with Grade B. Sometimes you can think "C" as casting.
- Grade B is having very good ductility & tensile strength as compare to Grade A & C.

W = Low-temperature water service
O = Low-temperature oil service
G = Low-temperature gas service
→ = Flow direction



According to Applications

2. *Special service valves*

1. Designed for a single application that is outside normal process applications (custom-engineered valves).
2. Handled a demanding temperature, high pressure or a corrosive medium.



Valve Applications

General service valves

special service valves

severe service valves



According to Applications

3. Severe service valves

1. Equipped with special features to handle volatile applications and high pressure drops (highly engineered trims).
2. Special actuation may be required to overcome the forces of the process.



Valve Applications

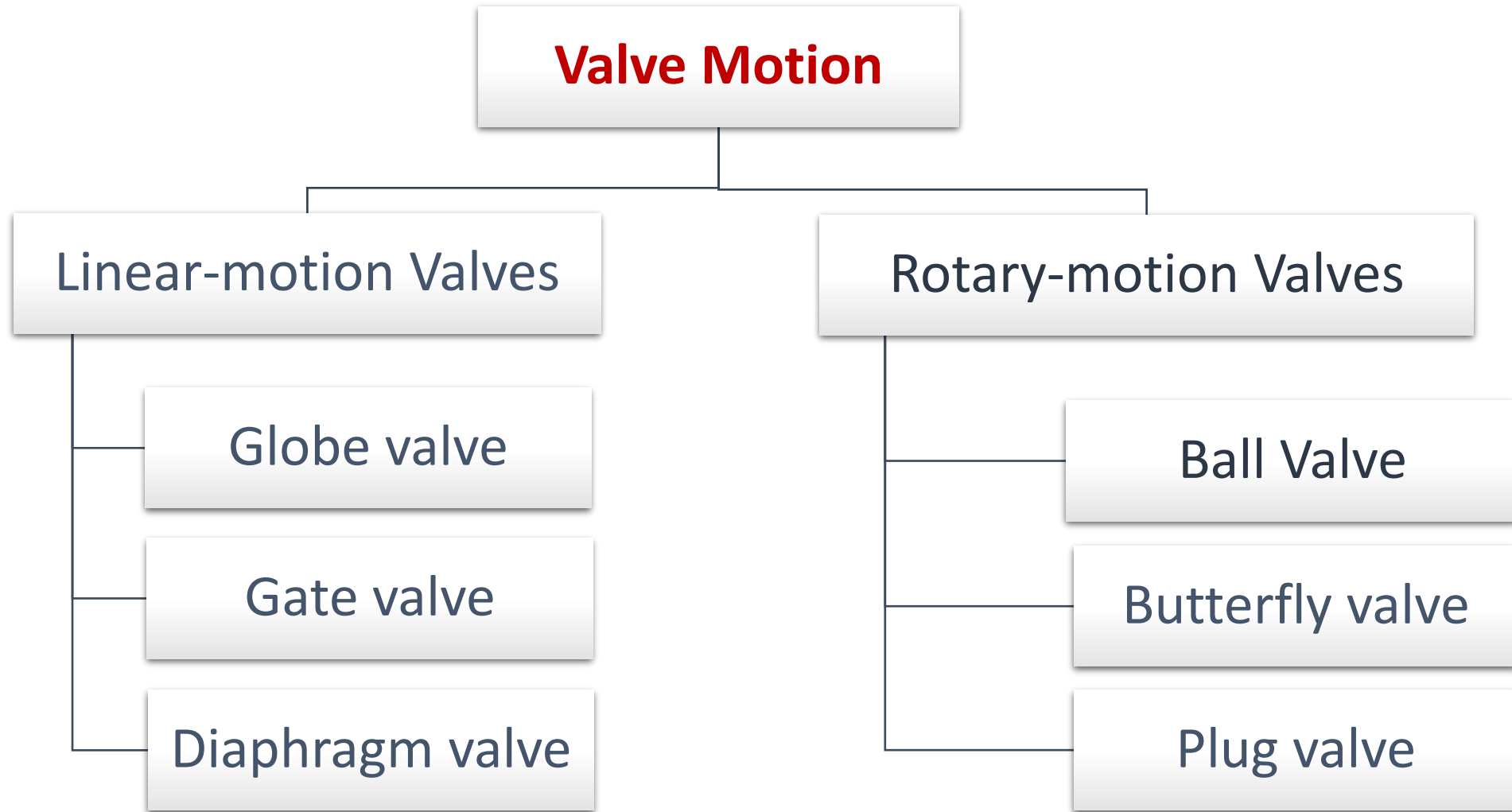
General service valves

special service valves

severe service valves



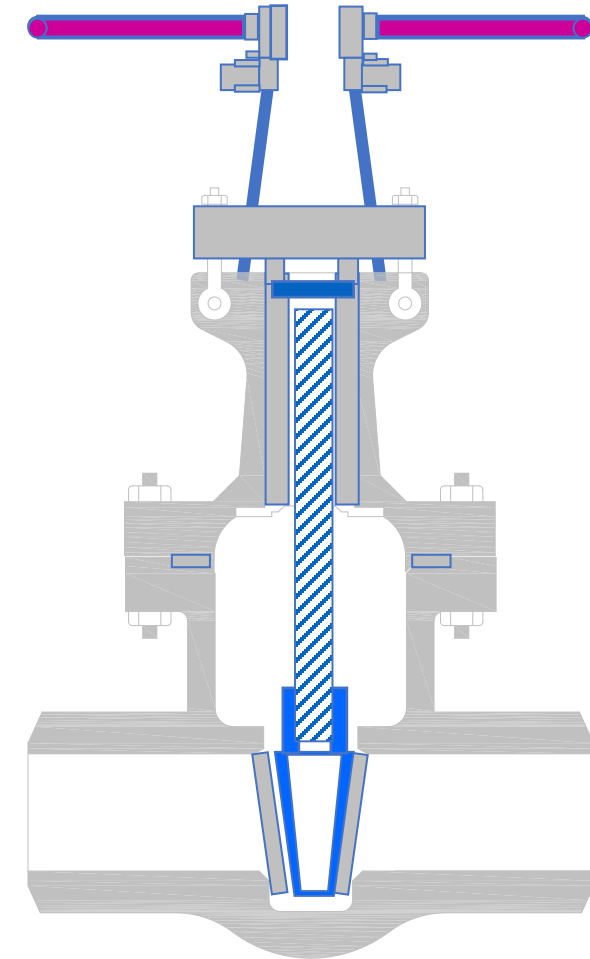
Valve Classification According to Motion



According to Motion

Linear-motion Valves

1. Had a sliding-stem design that pushes a closure element into an open or closed position.
2. Simple design, easy maintenance, and versatile with various sizes, pressure class and design options.
3. Example: gate, globe, diaphragm, three-way.



Valve Classification According to Motion

Linear-motion Valves

Valve types	Linear motion	Rotary motion	Quarter turn
Gate Valve	X		
Globe valve	X		
Plug valve		X	X
Ball valve		X	X
Butterfly valve		X	X
Diaphragm valve	X		
Pinch valve	X		

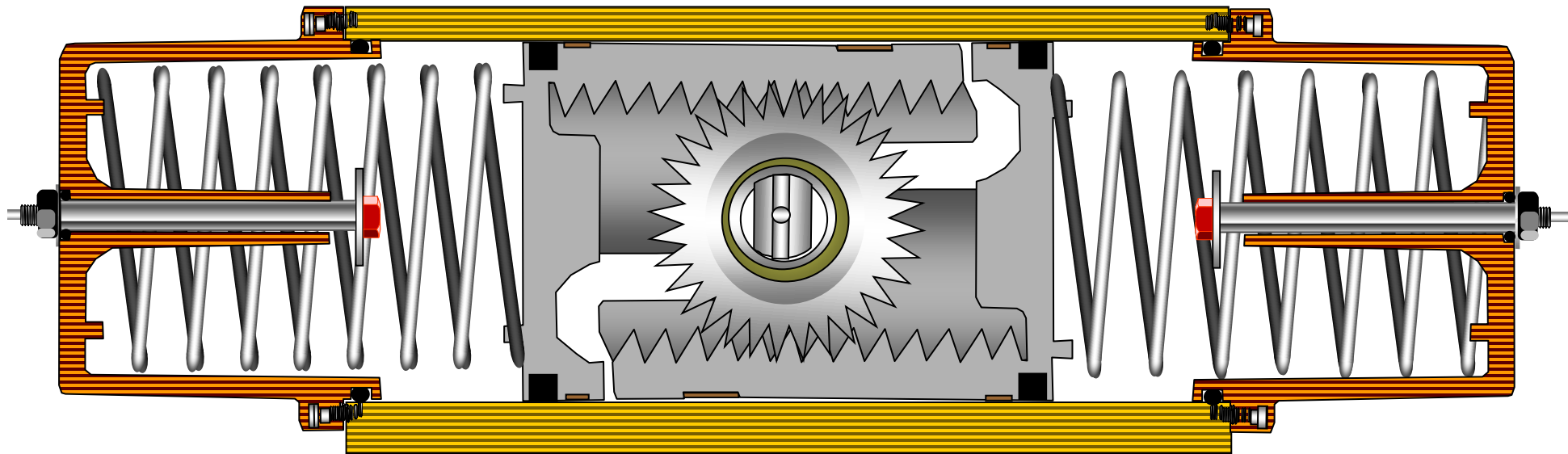


Valve Classification

According to Motion

Rotary-motion Valves

1. Used a closure element that rotates through a quarter-turn range to open and block the flow.
2. Limited to certain pressure drops.
3. Prone to cavitation and flashing problems.

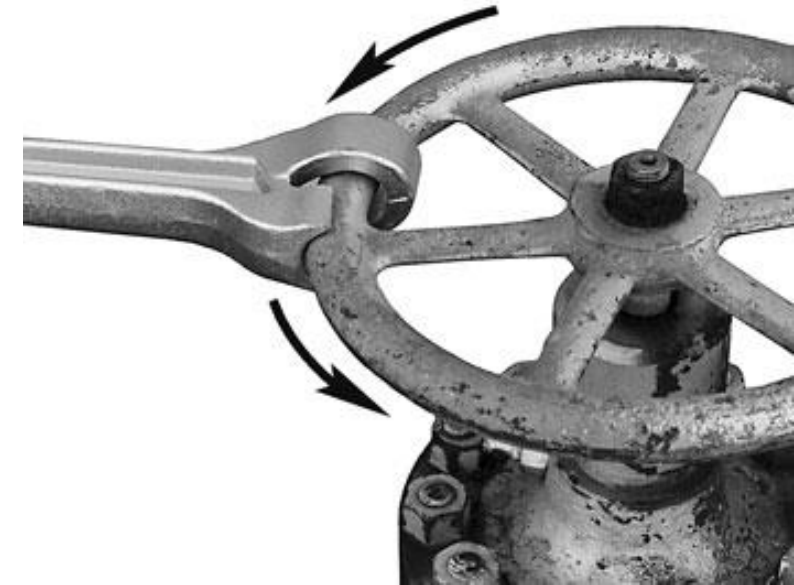
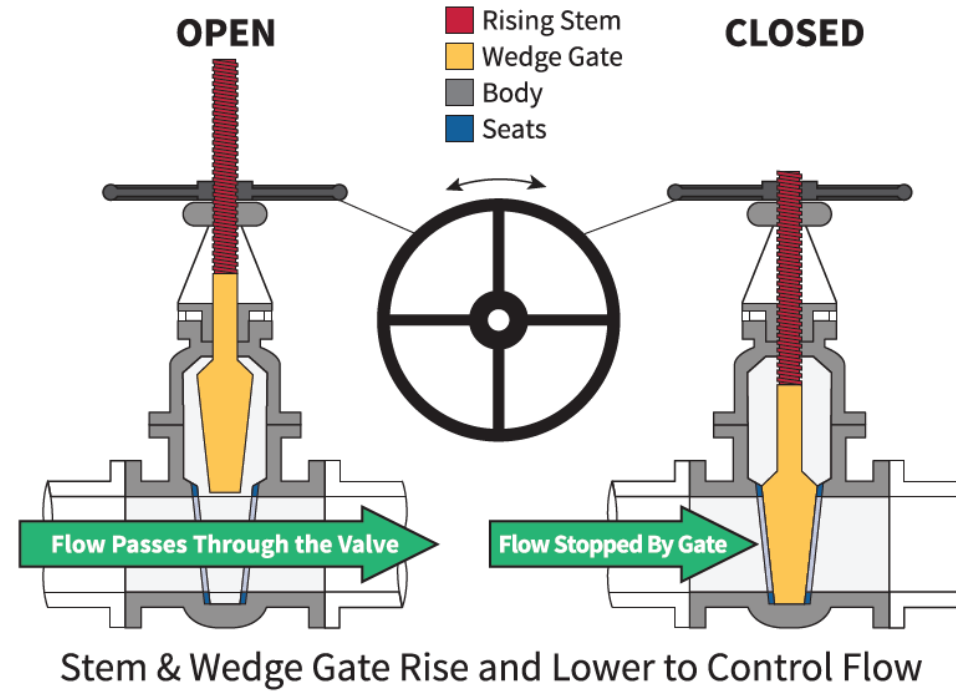


Valve Classification According to Motion

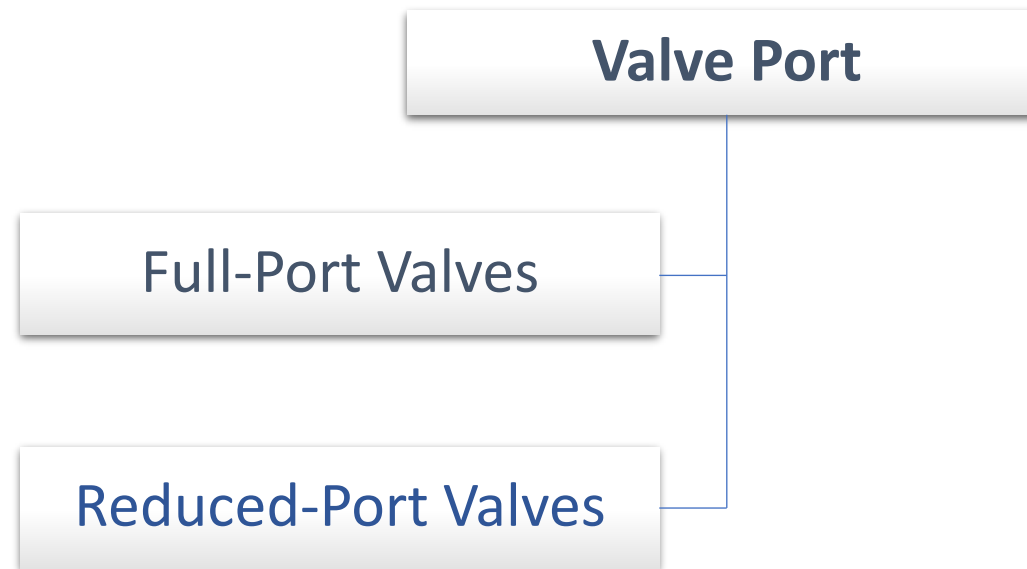
Rotary-motion Valves

1. Right tightly = close
2. Lefty Lucy = open

Gate Valve



Valve Classification According to Port Size



Valve Classification

According to Port Size

Full-Port Valves

- A allow for the use of a pig in the pipeline
- B Example: gate and ball valves



Valve Classification

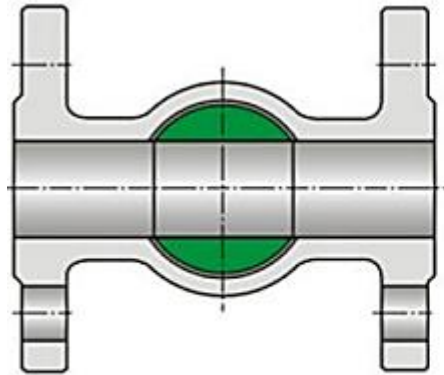
According to Port Size

Reduced-Port Valves

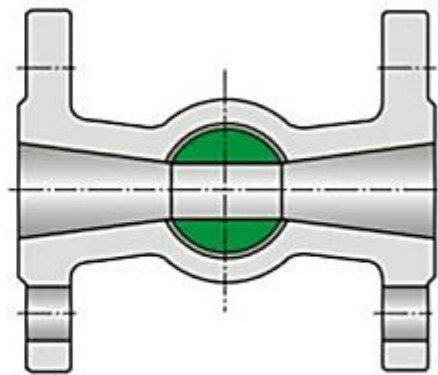
A

valves whose closure elements restrict the flow.

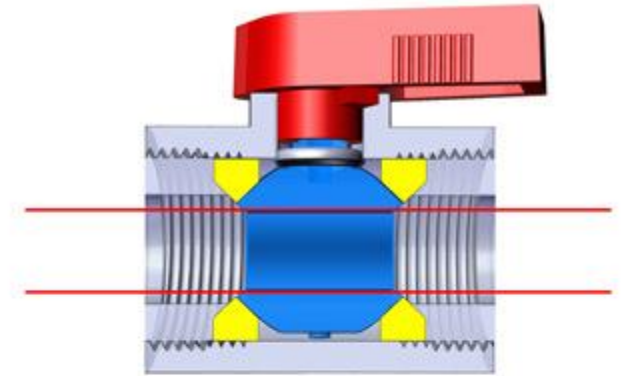
flow area of that port of the closure element is less than the area of the inside diameter of the pipeline



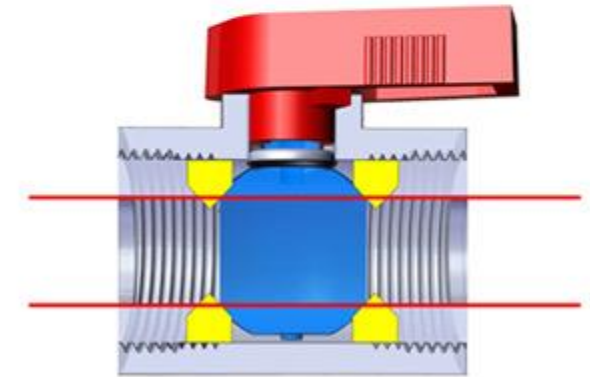
Full-bore Channel Type



Reduced-bore Channel Type



Standard Port



Full Port





05

Static Equipment

Valve Types



• Globe Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

A

A globe valve is a linear motion valve used to stop, start, and regulate the fluid flow.

B

This movement creates the annular space between the disk and seat ring that gradually close as the valve closed. This characteristic provides the globe valve good throttling ability required for regulating the flow.



• Globe Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



• Globe Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

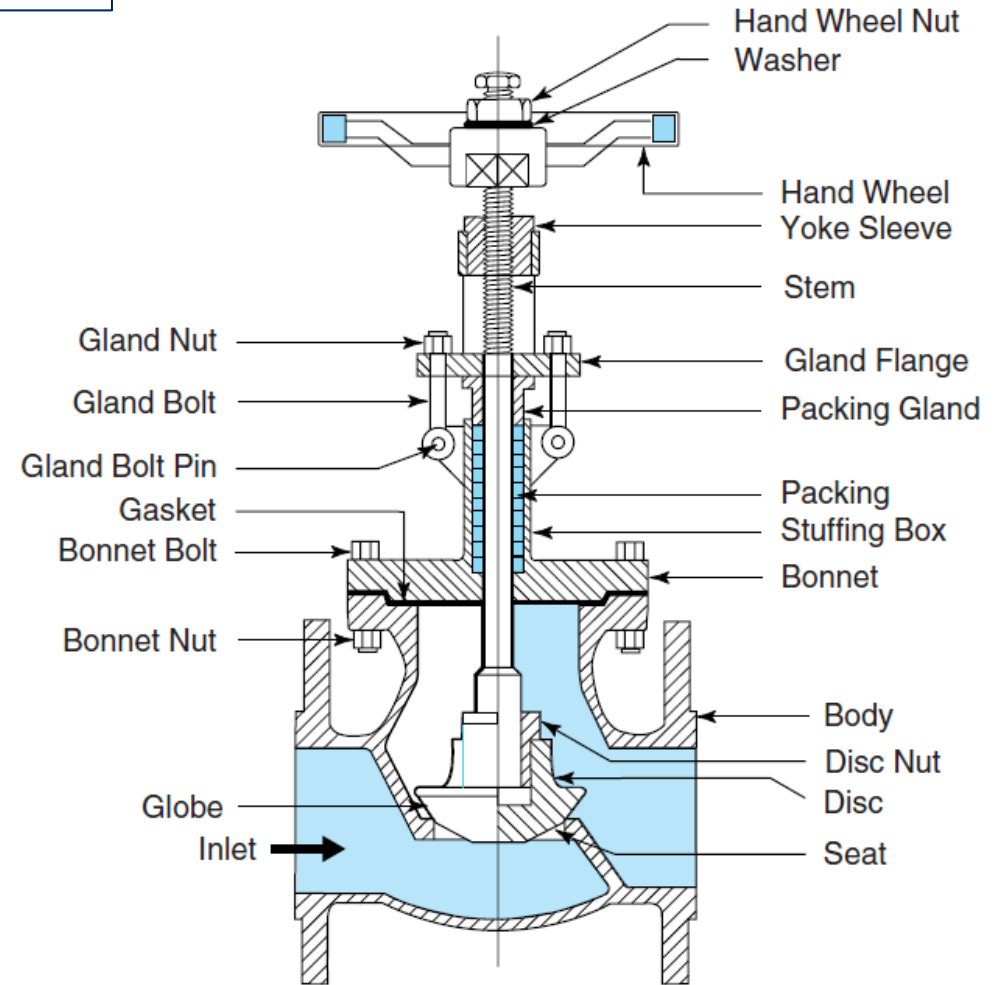
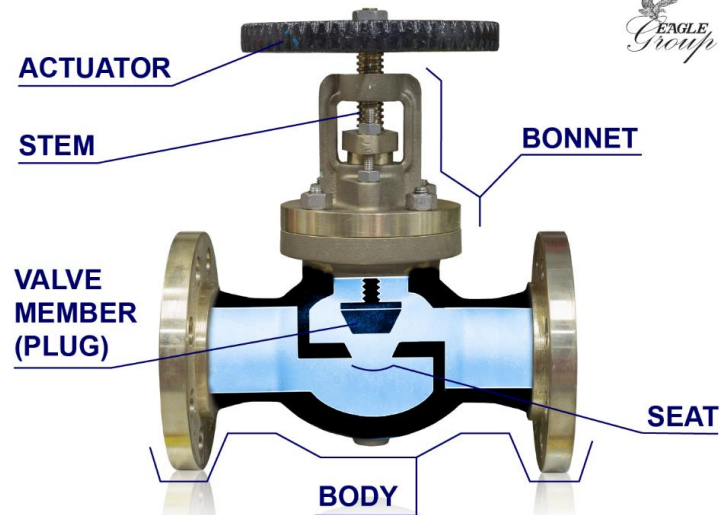
Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve components



• Globe Valve

Flow direction

Globe valve

Ball Valve

Gate valve

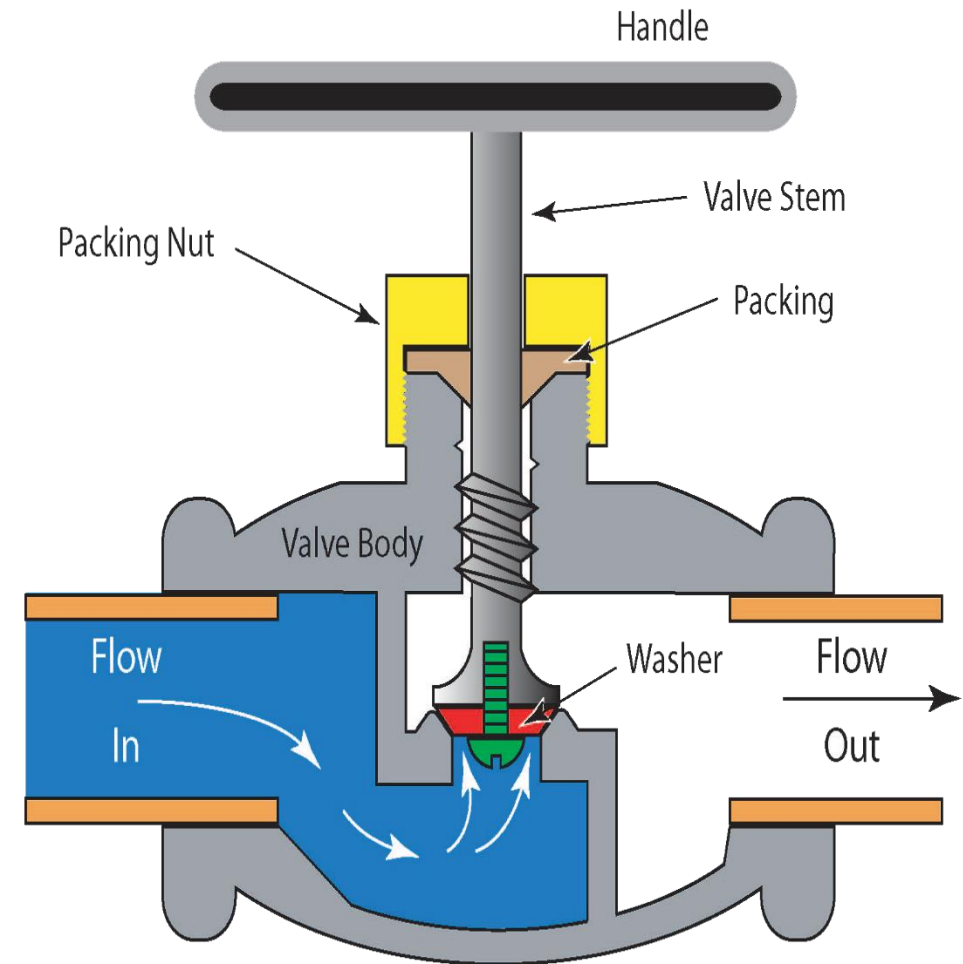
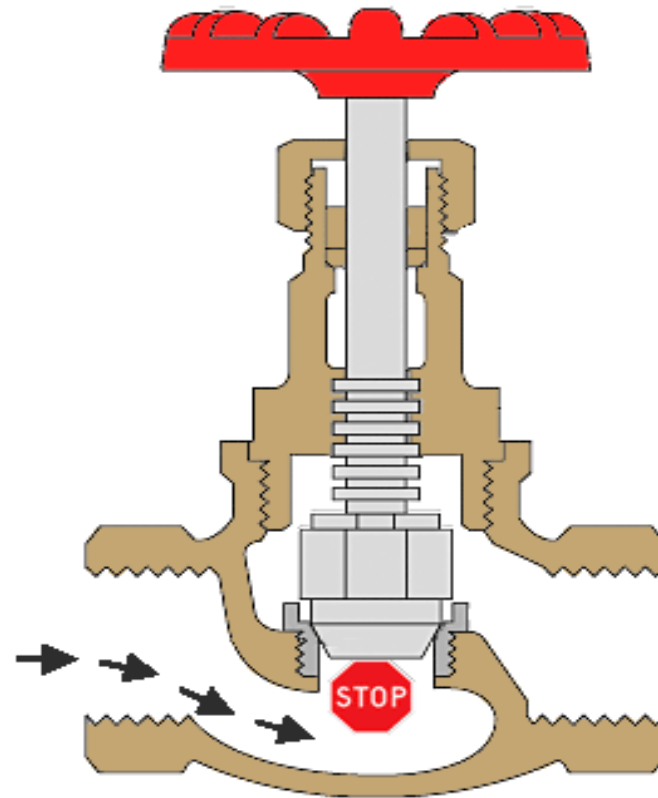
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



• Globe Valve

Flow direction

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

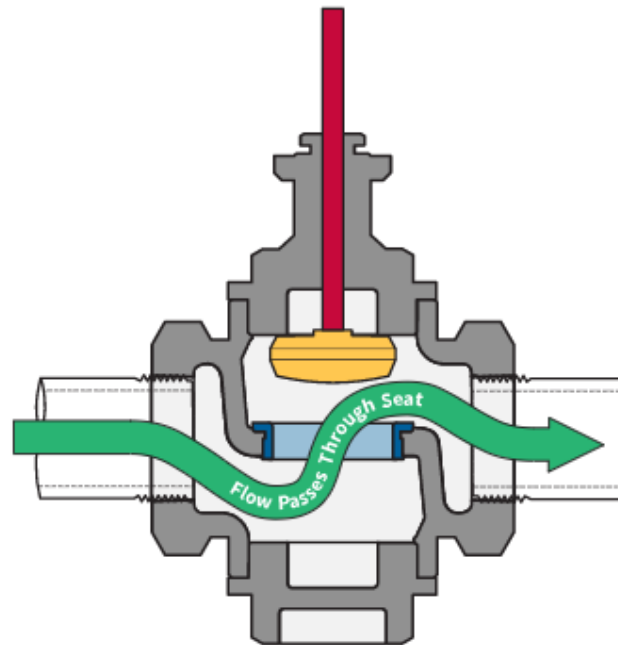
Check valve

Plug Valve

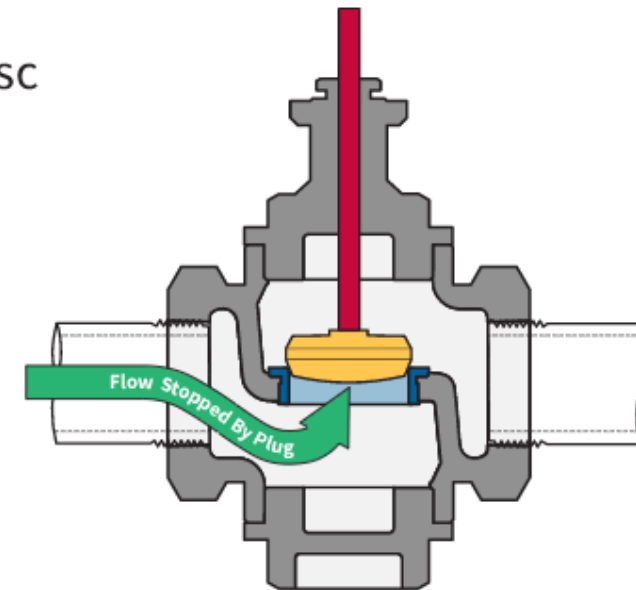
Needle valve

Butterfly Valve

FULL OPEN



CLOSED



■ Stem
■ Plug Disc
■ Body
■ Seat

Stem & Plug Disc Rise and Lower to Control Flow



• Globe Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

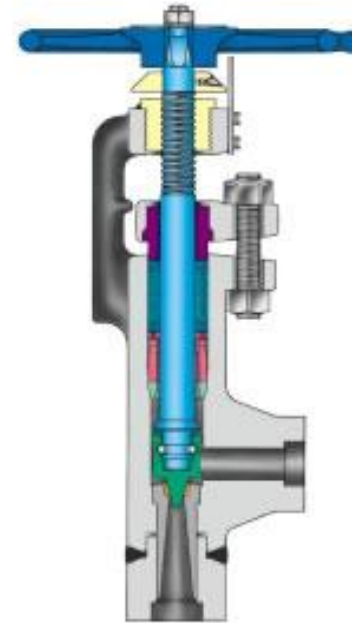
Butterfly Valve

A

Body designs: Z-body, Y-body, and angle



Y-Pattern



Angle



Z-body



• Globe Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

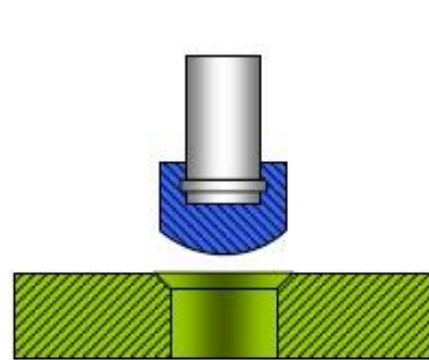
Plug Valve

Needle valve

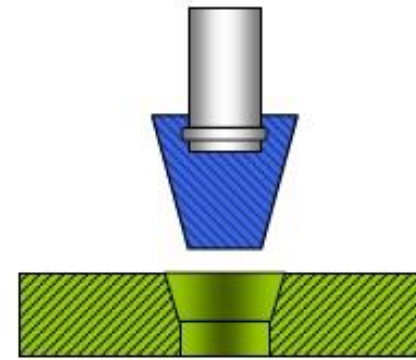
Butterfly Valve

B

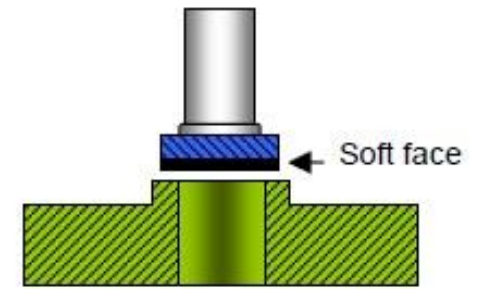
Disk design : ball disk, composition disk, and plug disk.



(a) Ball Disc

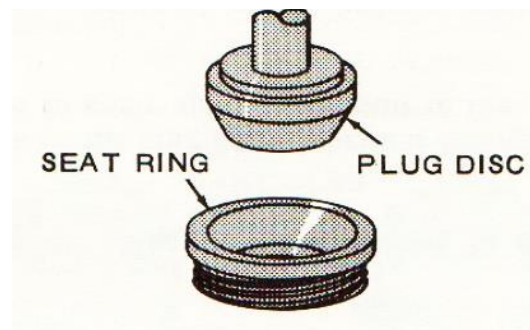


(b) Plug Disc



(c) Composition Disc

Globe Valve Discs



Needle



Parabollic



Plug



• Globe Valve

Advantages & Disadvantages

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

Advantages	Disadvantages
Recommended for throttling applications.	Flow path causes a significant pressure drop.
Good for frequent operation.	Globe valves are more costly than alternative valves.
Easy to repair.	High pressure drop
	Noisy in high pressure applications



• Ball Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

A

A Ball valve is a quarter-turn rotary motion valve that uses a ball shaped disk to stop or start the flow.

B

When the valve is opened the hole of disk is turned in-line with the direction of the flow. When the valve is shut, the ball is rotated so that the hole is perpendicular to flow direction.

Most ball valves are of the quick-acting type, which requires a 90° turn of the valve handle to operate the valve.



• Ball Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



• Ball Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

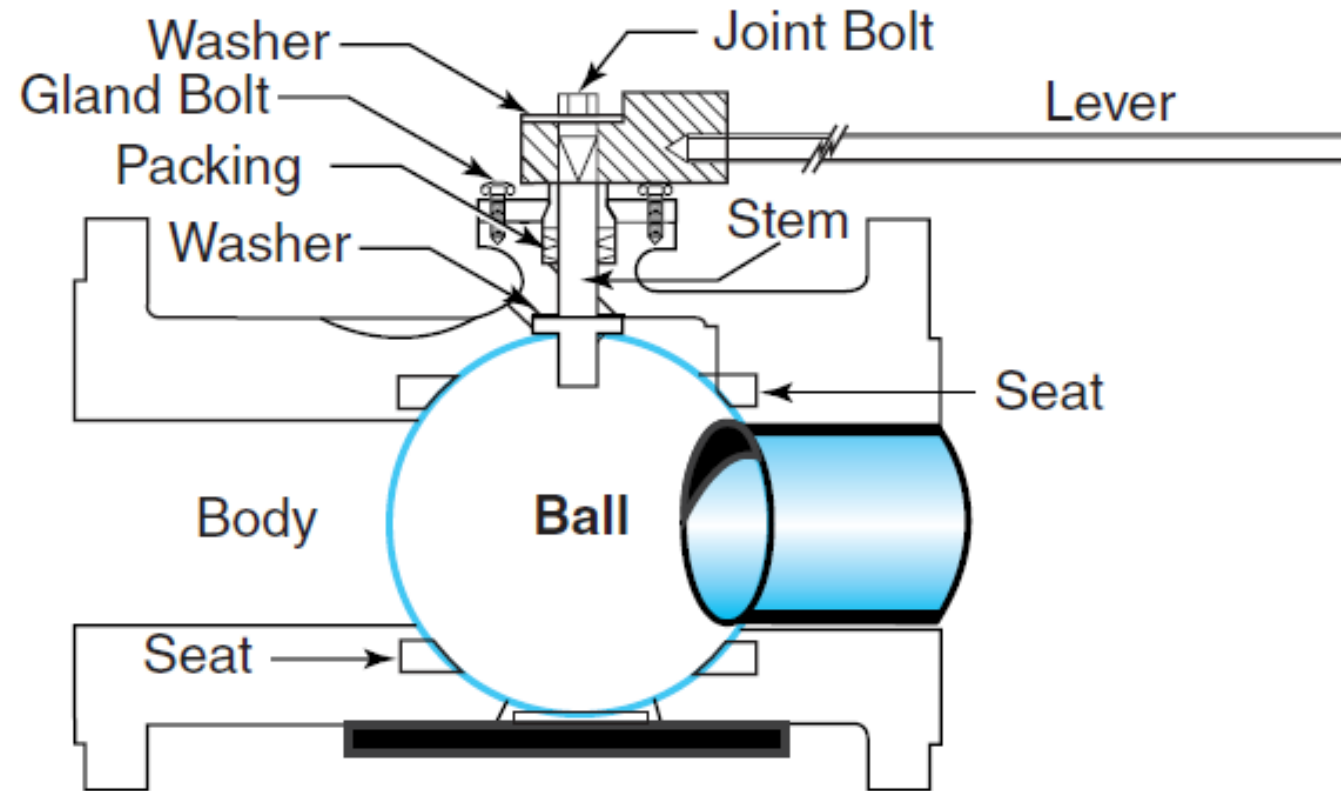
Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve components



• Ball Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

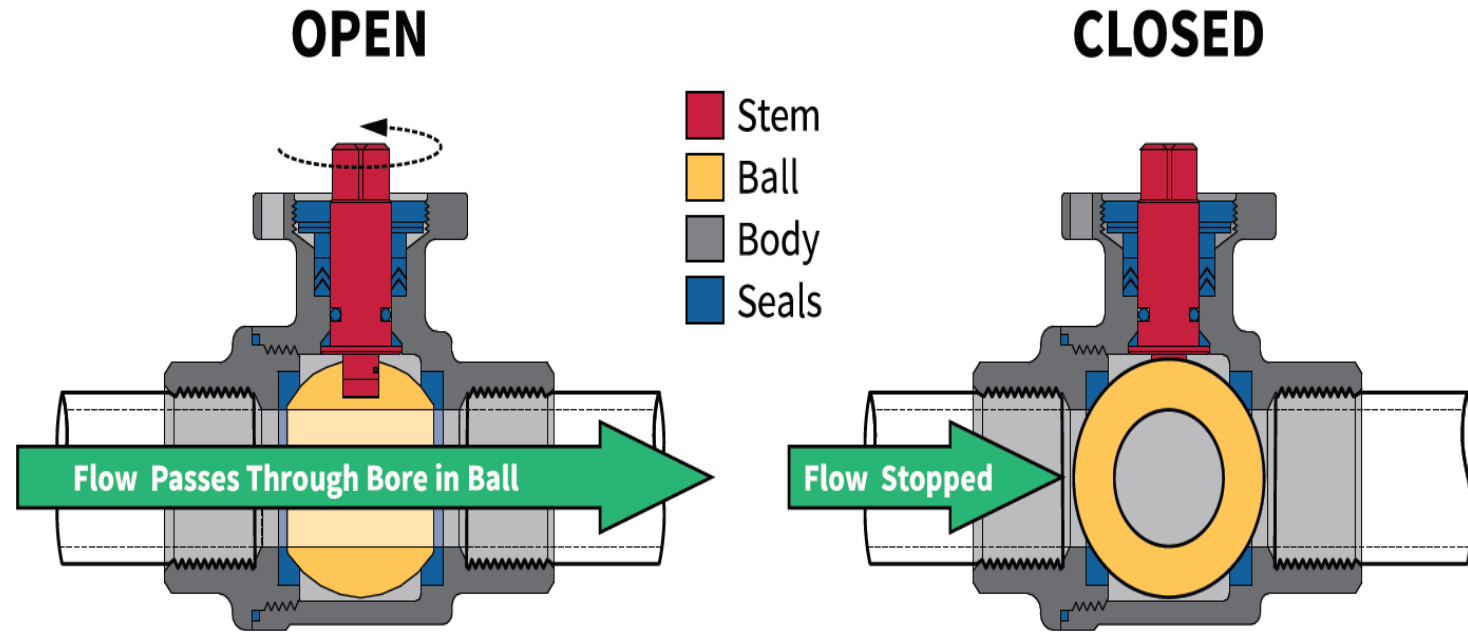
Check valve

Plug Valve

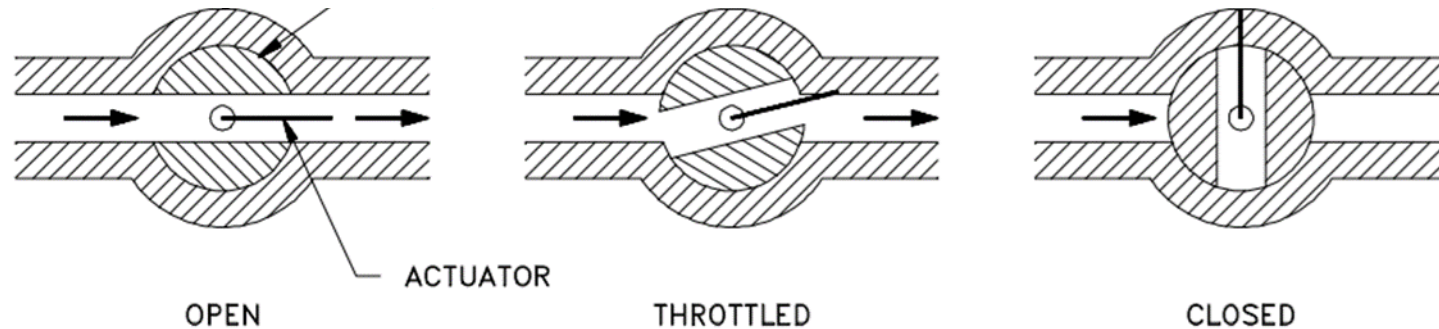
Needle valve

Butterfly Valve

Flow direction



Stem & Ball Rotate 90° from OPEN to CLOSED



• Ball Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

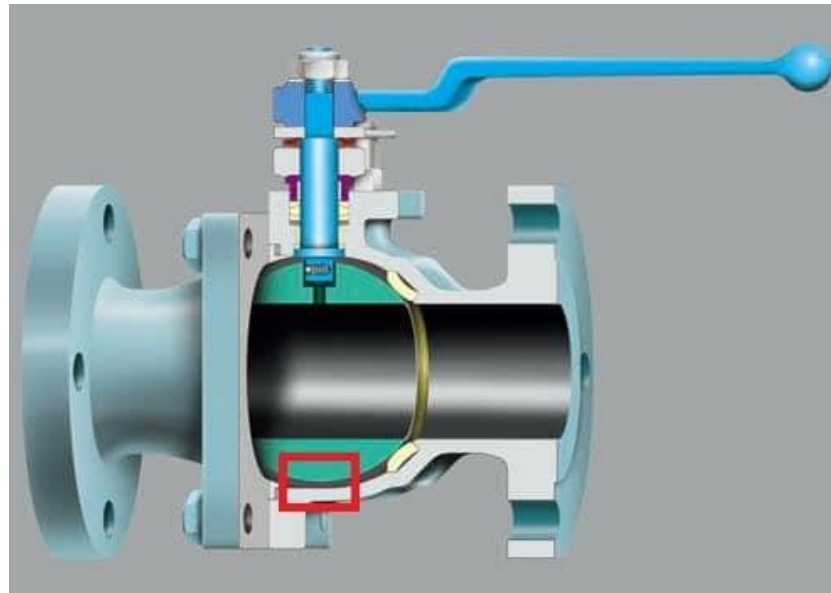
Needle valve

Butterfly Valve

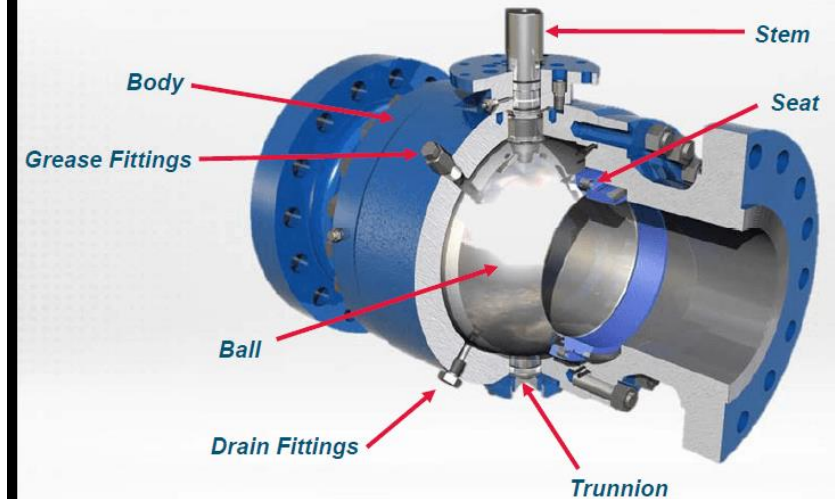
Body design

A

Body designs: Float ball valve & Trunnion Mounted Ball Valve



Trunnion-mounted ball valve



• Ball Valve

Body design

Ball valves are manufactured in different body arrangements

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



Top entry



Side entry or split body



Three-piece body



• Ball Valve

Advantages & Disadvantages

Globe valve
Ball Valve
Gate valve
Diaphragm Valve
Check valve
Plug Valve
Needle valve
Butterfly Valve

Advantages	Disadvantages
Low pressure drop	Poor throttling characteristics
Easy operation	Wear and tear
Fast acting	Temperature operation limitation
Two-way flow possible	
Low maintenance costs	
Ball is used for opening & closing	



• Gate Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

A

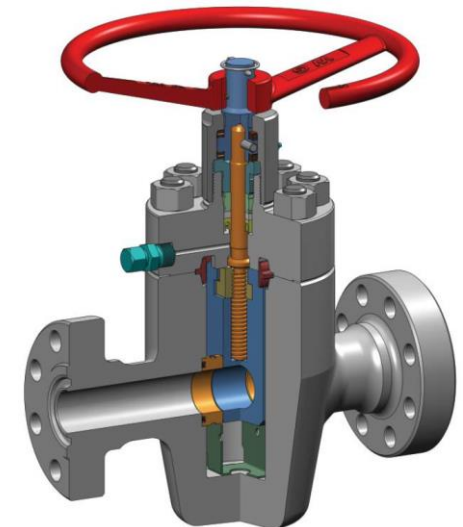
A gate valve can be defined as a type of valve that used a gate or wedge type disk and the disk moves perpendicular to flow to start or stop the fluid flow in piping.

B

It is a linear motion valve used to start or stop fluid flow.

C

These valves are either in fully open or fully closed position.



• Gate Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

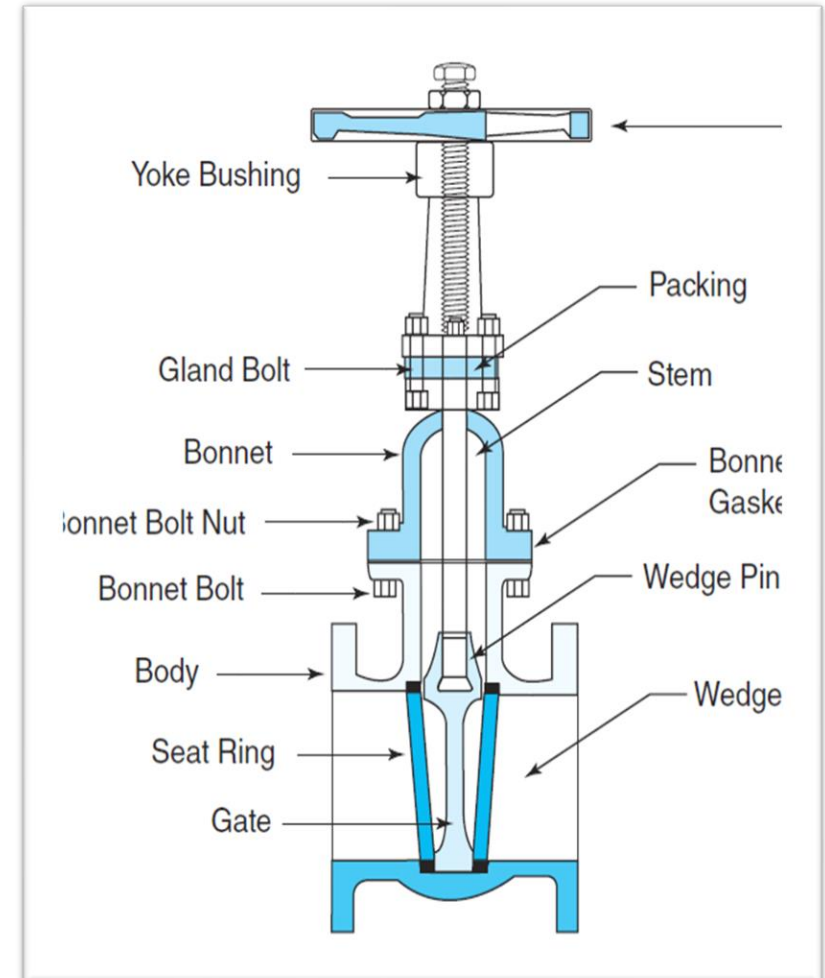
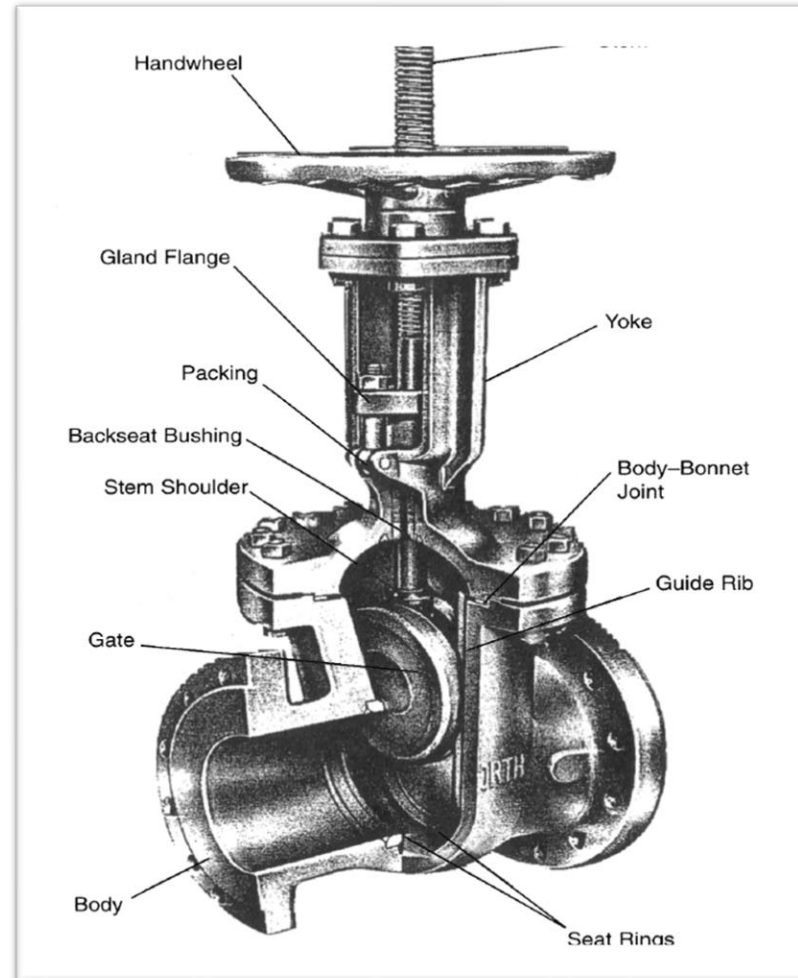
Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve components



• Gate Valve

Valve components

Globe valve

Ball Valve

Gate valve

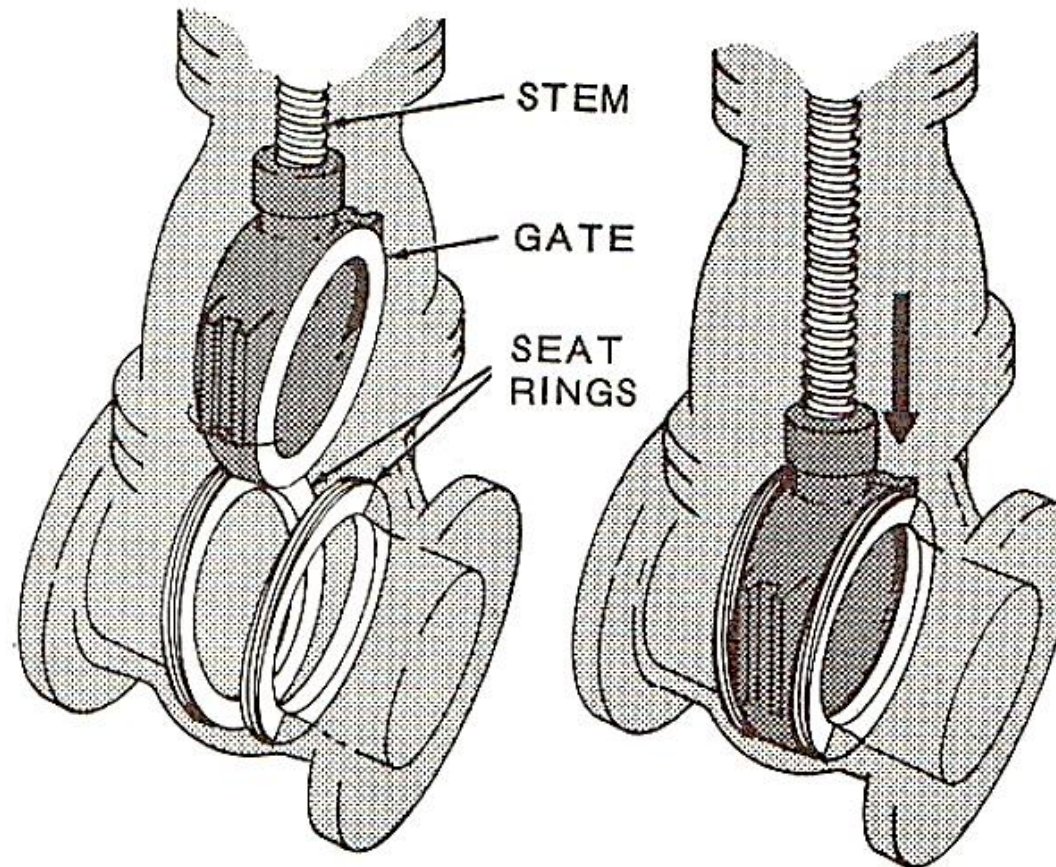
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



• Gate Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

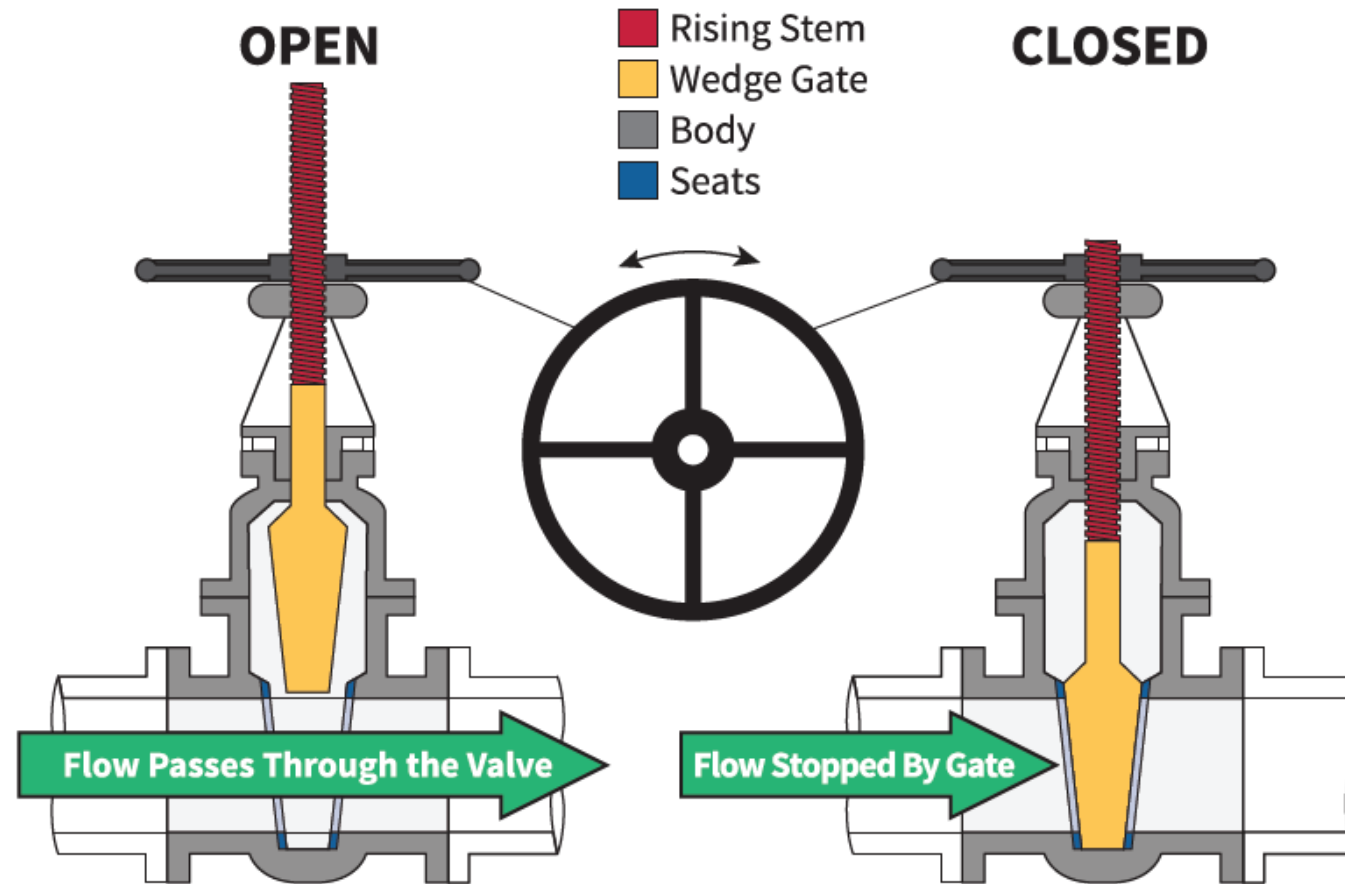
Check valve

Plug Valve

Needle valve

Butterfly Valve

Flow direction



Stem & Wedge Gate Rise and Lower to Control Flow



• Gate Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve operation



• Gate Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

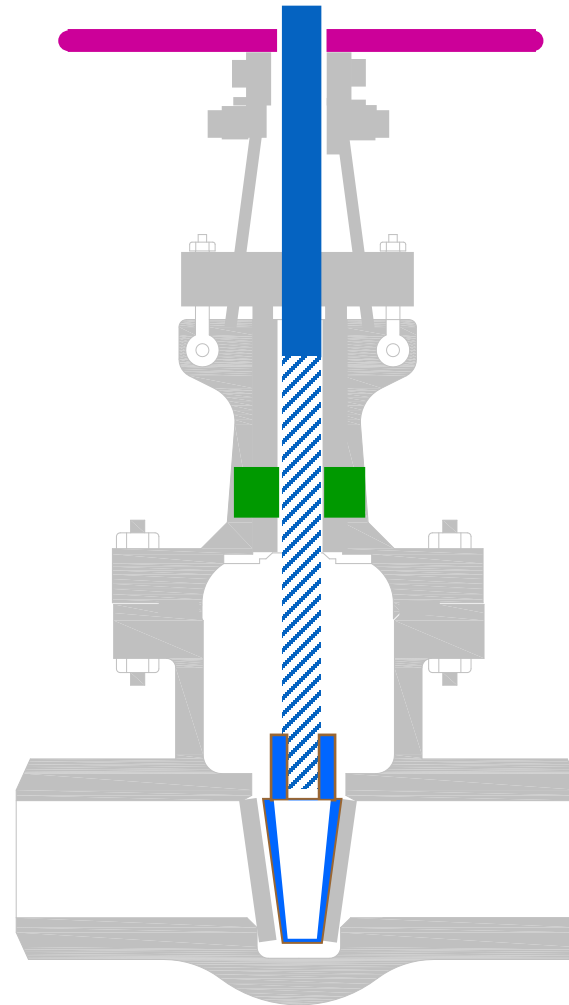
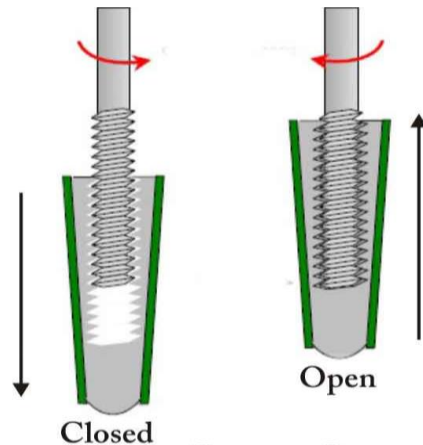
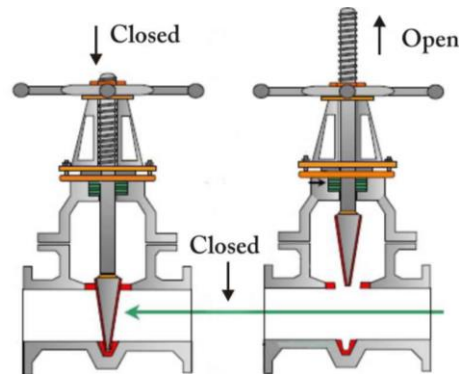
Needle valve

Butterfly Valve

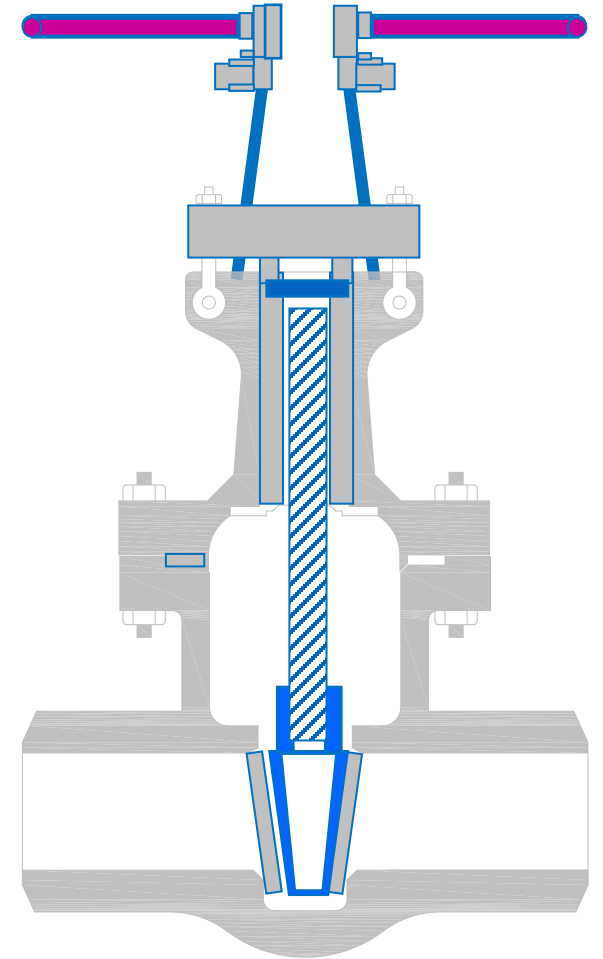
Body design

A

BASED ON STEM



• Rising Stem Gate Valve



• None Rising Stem Gate Valve



• Gate Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

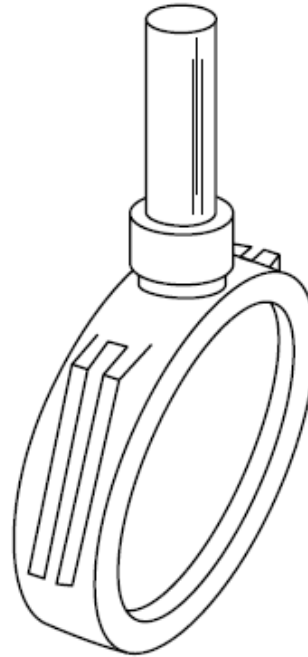
Needle valve

Butterfly Valve

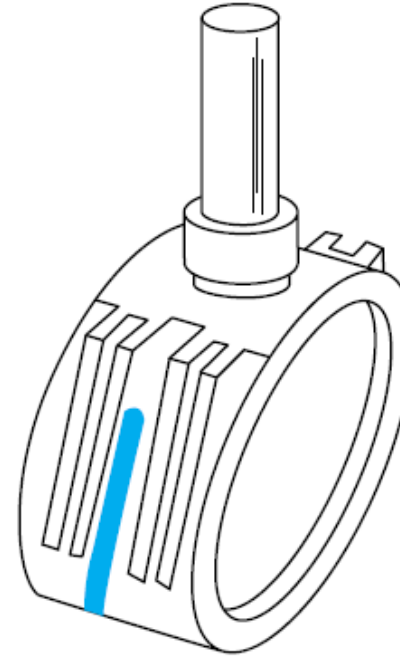
Body design

B

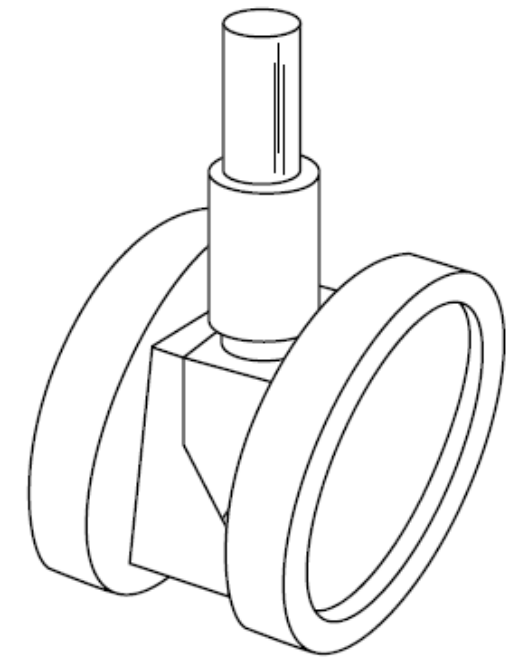
BASED ON GATE DESIGN



Solid Wedge



Solid Split



Parallel Discs



• Gate Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

Advantages & Disadvantages

Advantages	Disadvantages
Small Fluid Resistance	Flow changes nonlinearly with stem travel
Little torque required for opening and closing	Vibration/cavitation when partially open
Little pressure drop	Subject to wear
No flow restriction	Repair work is difficult
Good sealing when closed	



• Diaphragm Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

A

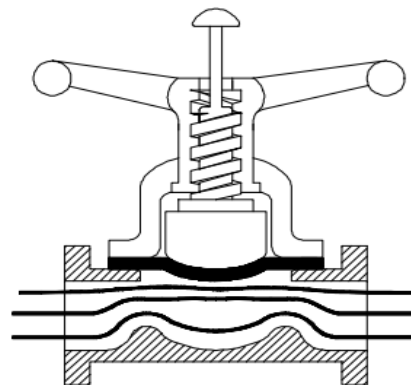
A diaphragm valve is a linear motion valve that is used to start, regulate, and stop fluid flow.

B

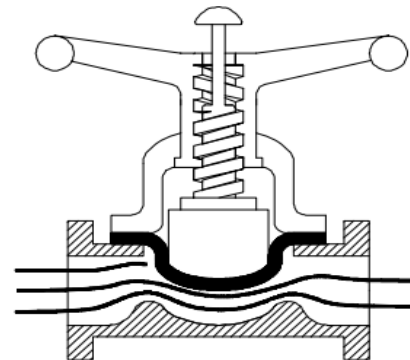
The name is derived from its flexible disk, which mates with a seat located in the open area at the top of the valve body to form a seal.

C

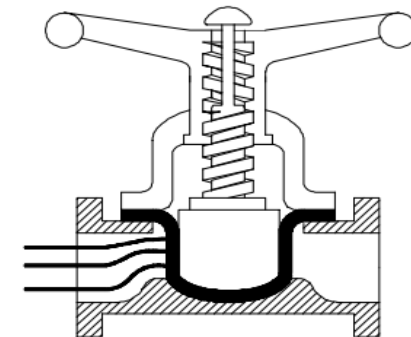
These valves are either in fully open or fully closed position.



OPEN



THROTTLING



CLOSED



• Diaphragm Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

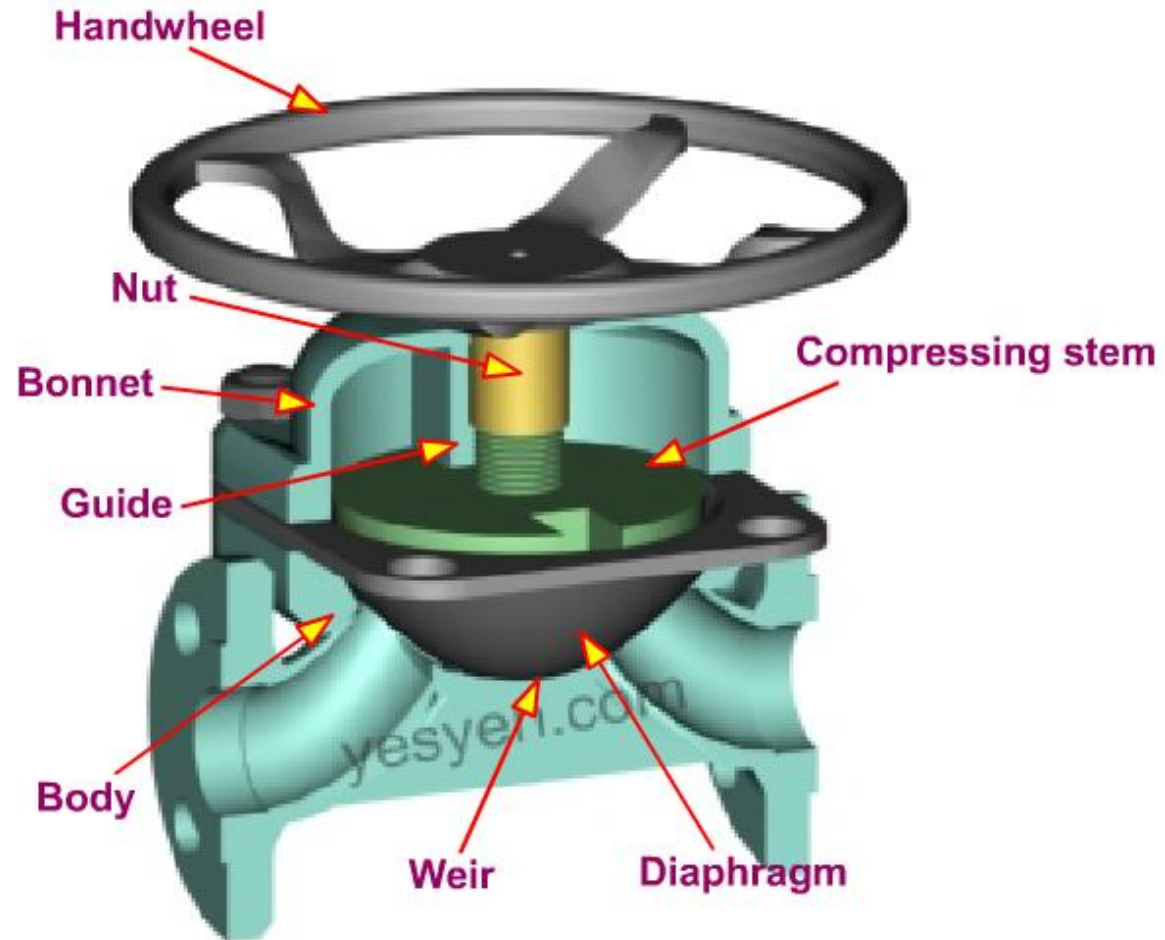
Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve components



- **Diaphragm Valve**

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

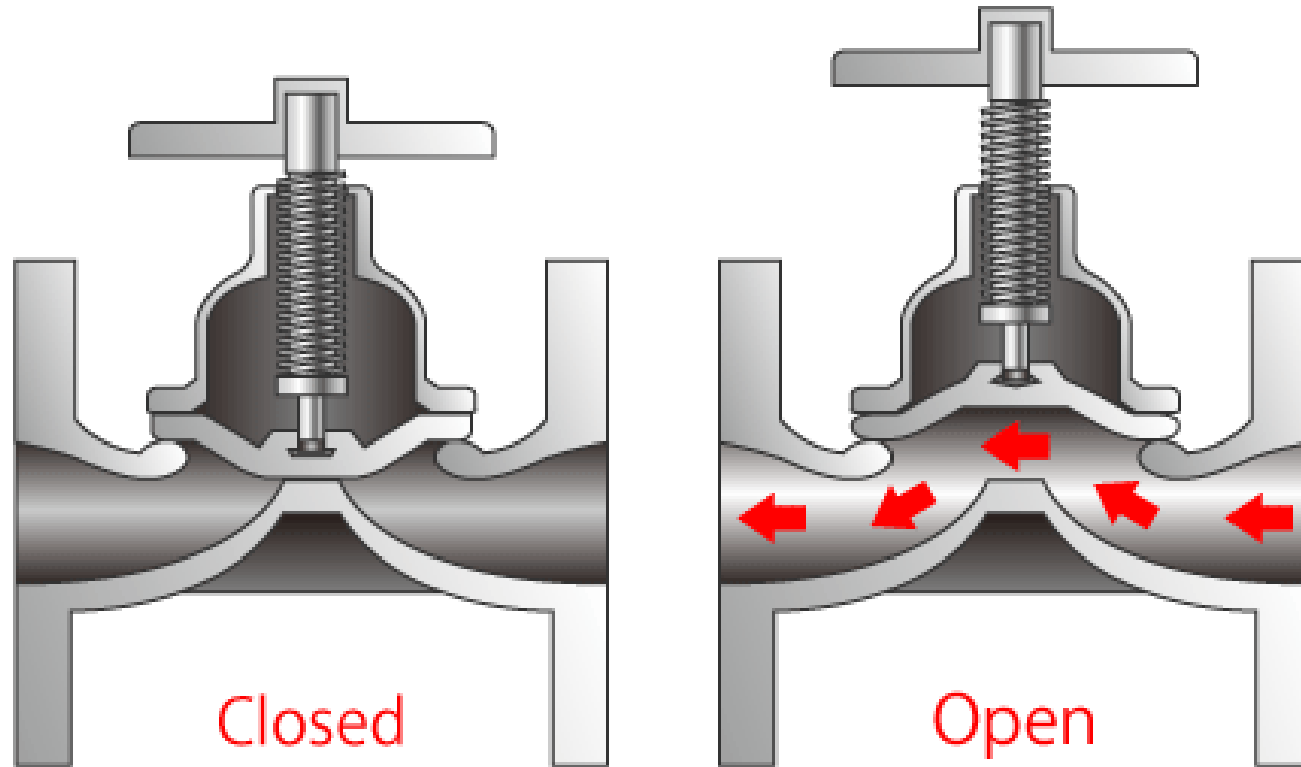
Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve Flow direction



- **Diaphragm Valve**

Valve operation

Globe valve

Ball Valve

Gate valve

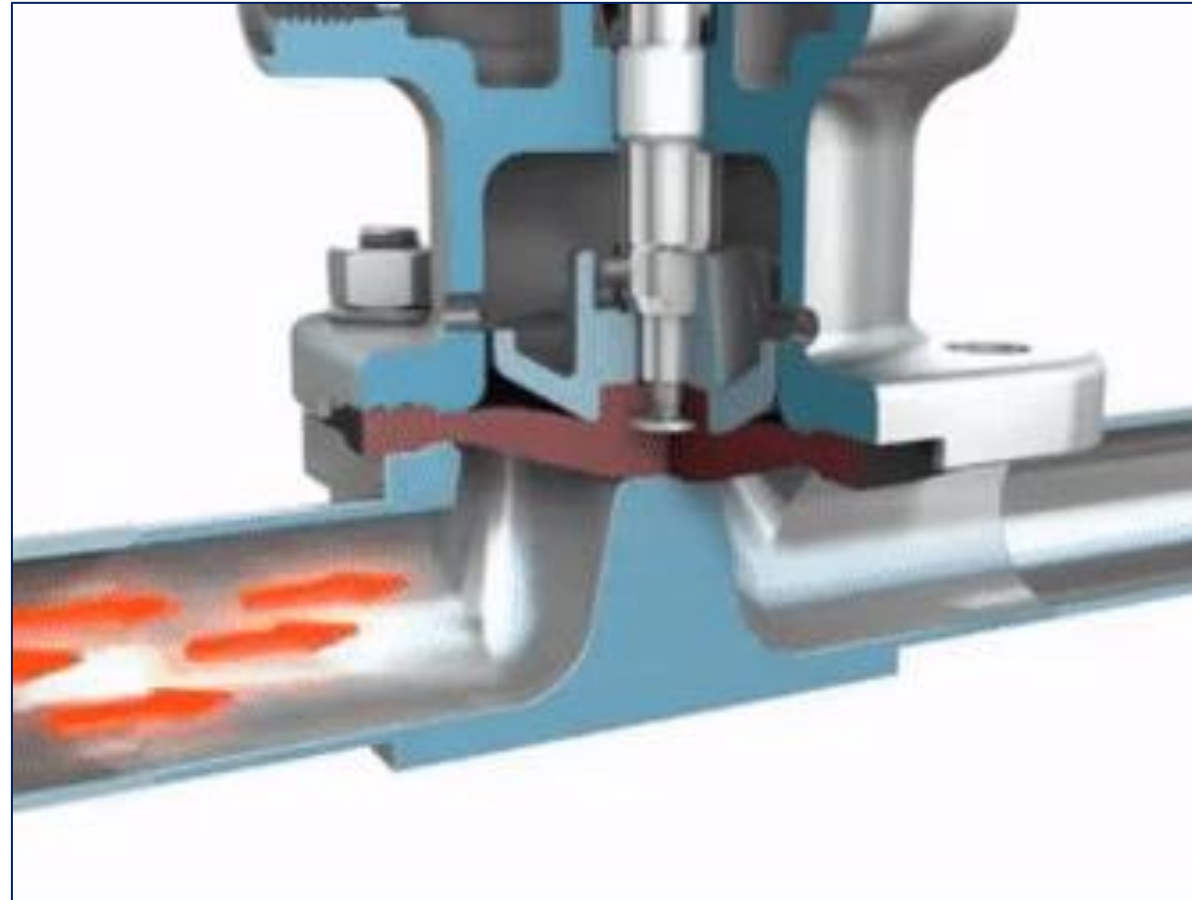
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



• Diaphragm Valve

Advantages & Disadvantages

Globe valve
Ball Valve
Gate valve
Diaphragm Valve
Check valve
Plug Valve
Needle valve
Butterfly Valve

Advantages	Disadvantages
Quick Opening On/Off valve	operation temperature and pressure have limits
used for throttling service.	hydrostatic pressure that can be applied to the diaphragm is limited.
Low Pressure drop	
suited for the handling of corrosive fluids, slurries, radioactive fluids.	Dimensions of diaphragm valves are limited. They are produced in DN15-DN300 dimensions.
no packing glands to maintain	



Check Valve



Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

A

known as non-return valves are valves that allow fluids to flow in only one way/direction.

B

Can protect equipment and minimize damage in case of a leak in the upstream line.



Check Valve



Valve operation

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



Check Valve



Flow direction

Globe valve

Ball Valve

Gate valve

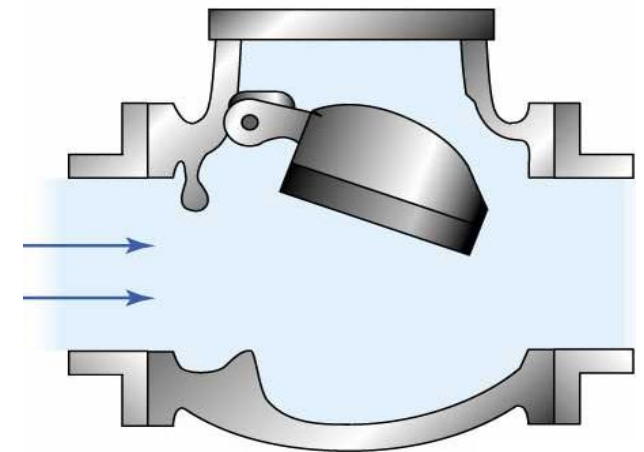
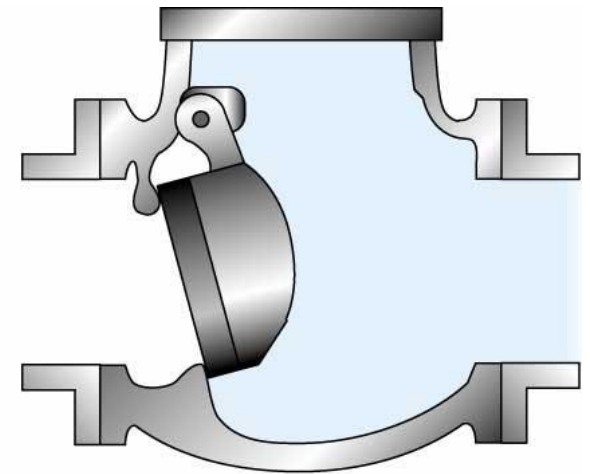
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



Check Valve



Globe valve

Ball Valve

Gate valve

Diaphragm Valve

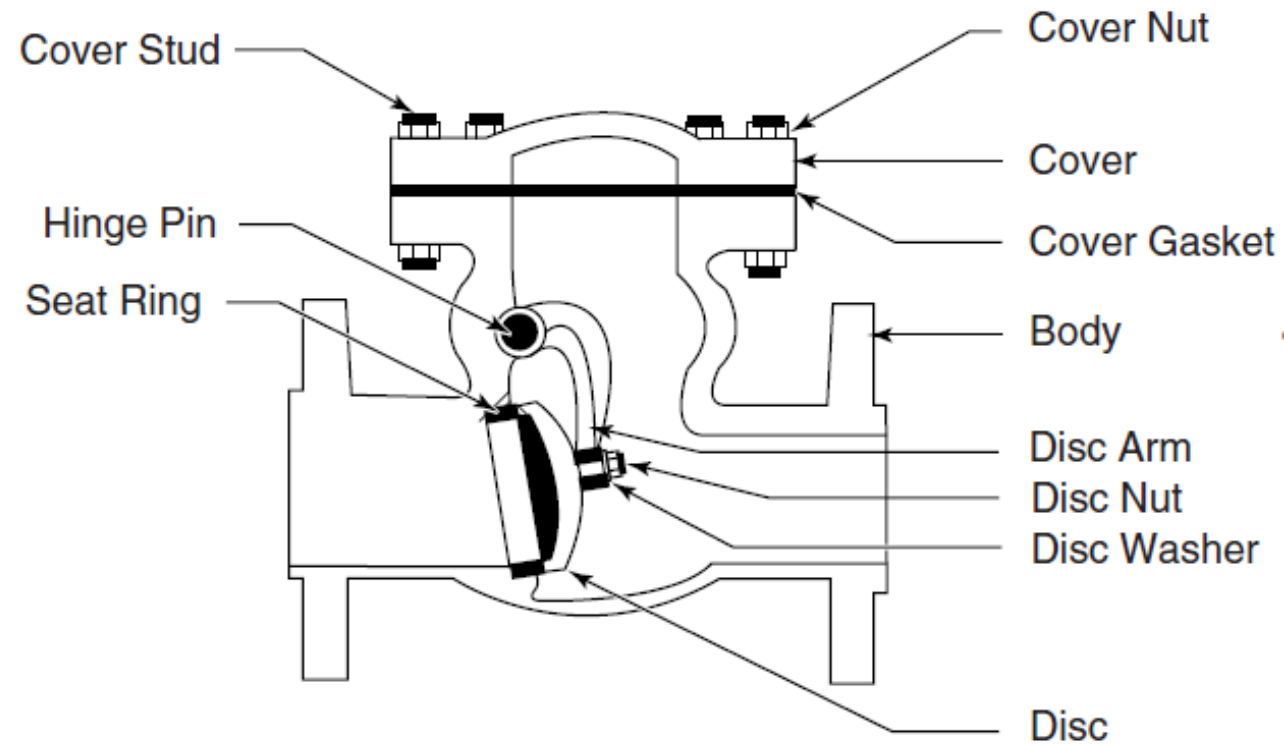
Check valve

Plug Valve

Needle valve

Butterfly Valve

**Valve
component**



Valves Types

Check Valve



Body design

A

BASED ON STEM

Globe valve

Ball Valve

Gate valve

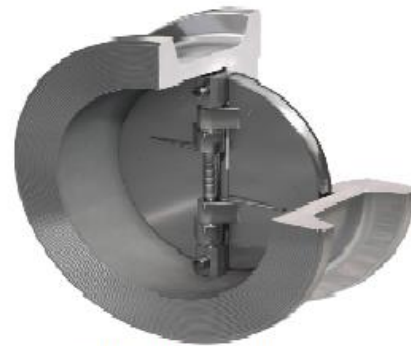
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



DUAL DISC CHECK VALVE



SWING CHECK VALVE



LIFT / PISTON CHECK VALVE



BALL CHECK VALVE



SILENT CHECK VALVE



NOZZLE TYPE CHECK VALVE



WAFER CHECK VALVE



TILTING DISC CHECK VALVE



Check Valve



Body design

A

Swing Check Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



Check Valve



Body design

B

Spilt (wafer) Disk Check valve

Globe valve

Ball Valve

Gate valve

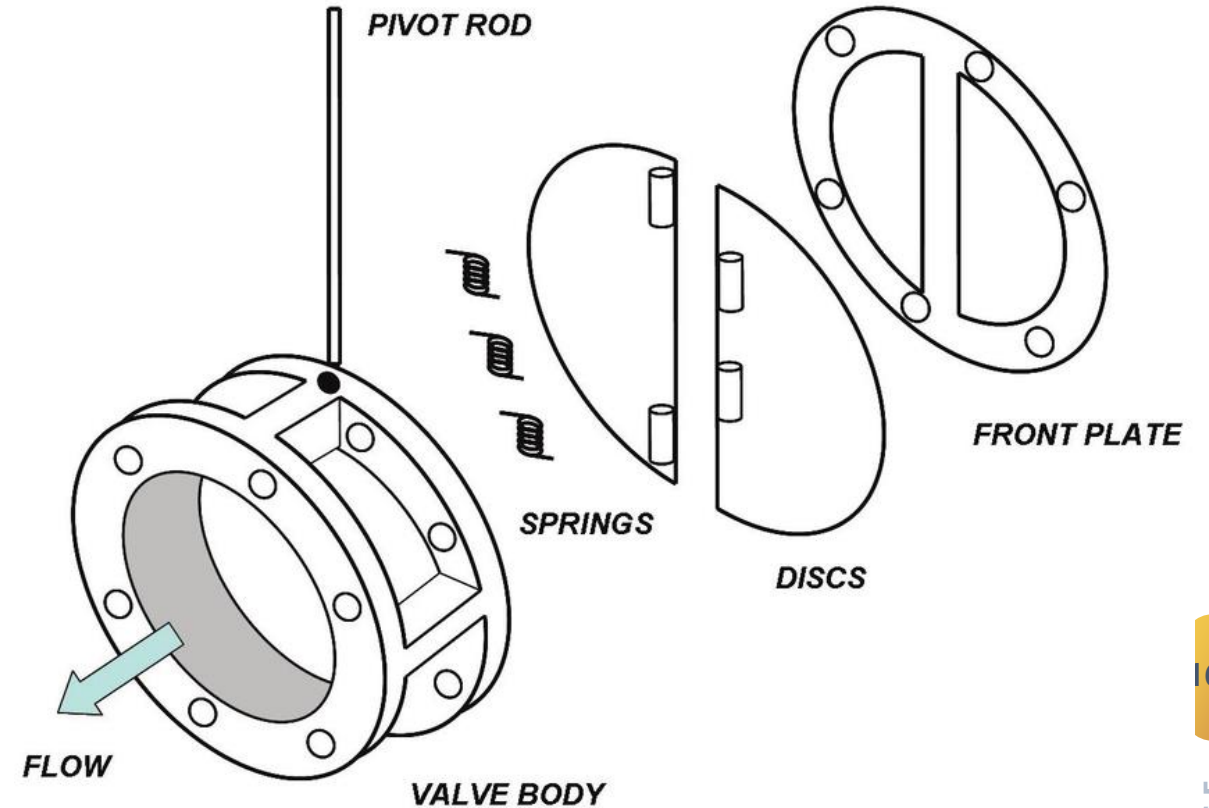
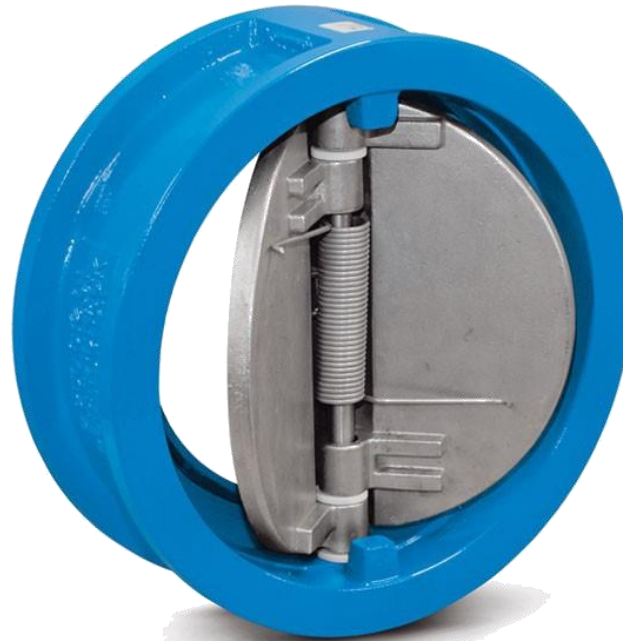
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



Check Valve



Body design

C

LIFT CHECK VALVES

Globe valve

Ball Valve

Gate valve

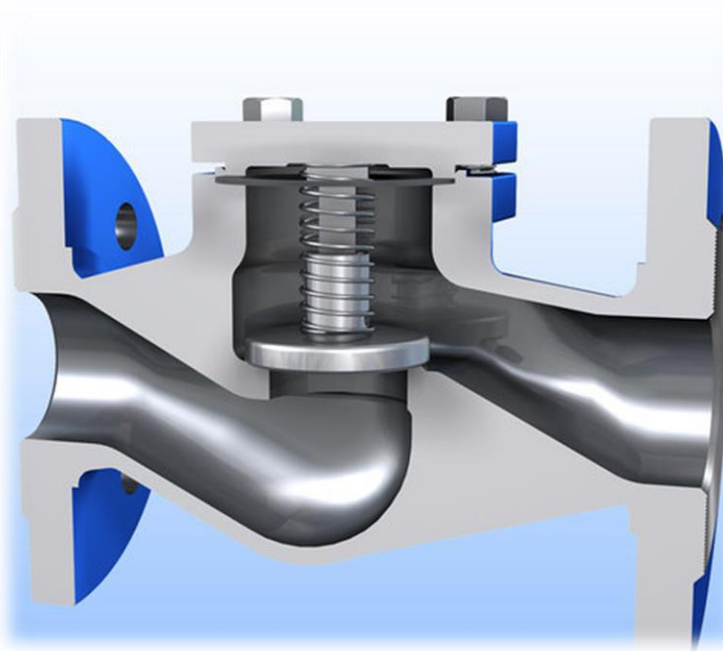
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



Check Valve



Body design

D

Ball CHECK VALVE

Globe valve

Ball Valve

Gate valve

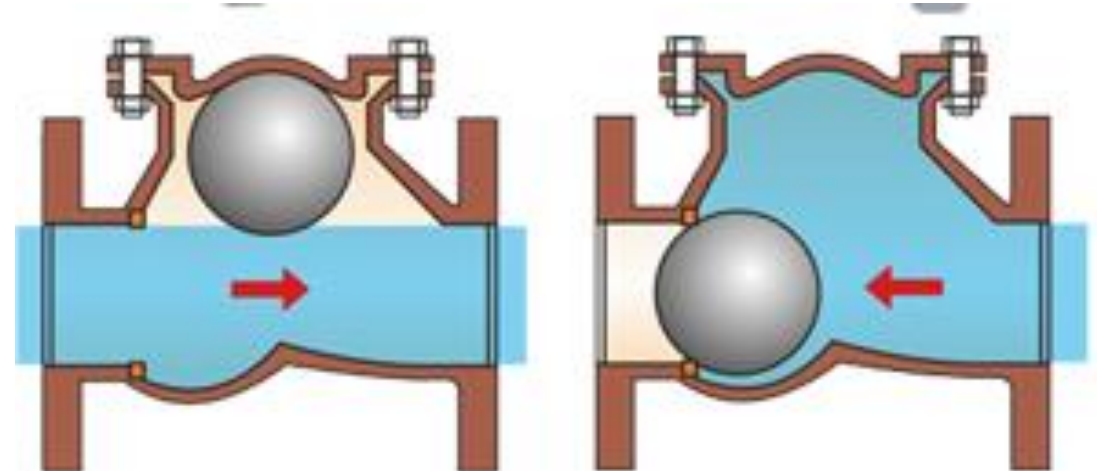
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



Check Valve



Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

Advantages & Disadvantages

Advantages	Disadvantages
Low pressure drop	difficult to determine whether the valve is open or closed
Quick opening	the condition of internal parts cannot be assessed.
Low maintenance costs	limitations on its installation configurations
Used for both high/low pressure	Valve disc can stick in open position.
Used for both horizontal & vertical flow	



Plug Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

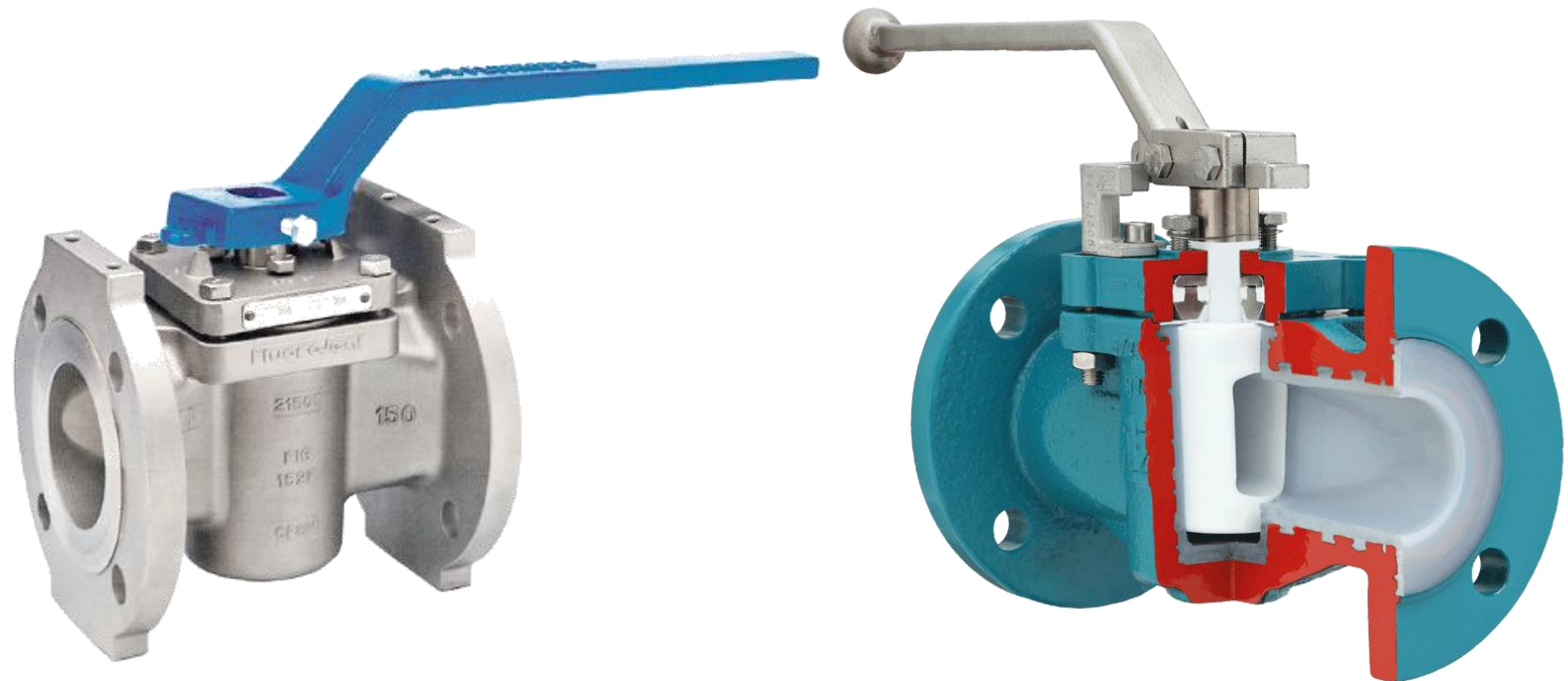
Check valve

Plug Valve

Needle valve

Butterfly Valve

- A** Plug valve is Quarter-turn rotary motion Valve that uses a tapered or cylindrical plug to stop or start the flow.
- B** The disk is in plug shape, which has a passage to pass the flow. In open position, this bored passage is in line with the flow.



Plug Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

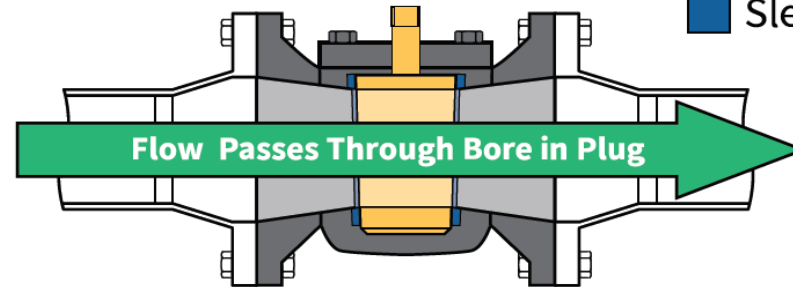
Plug Valve

Needle valve

Butterfly Valve

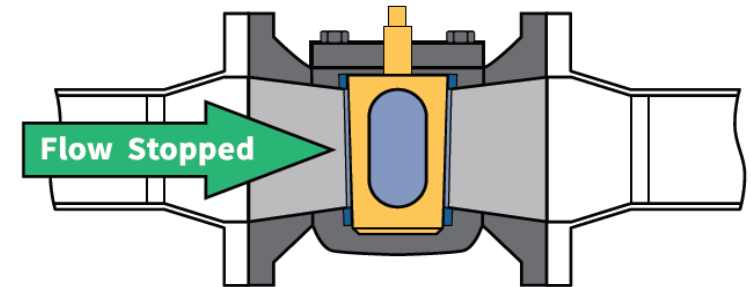
*Flow
direction*

OPEN

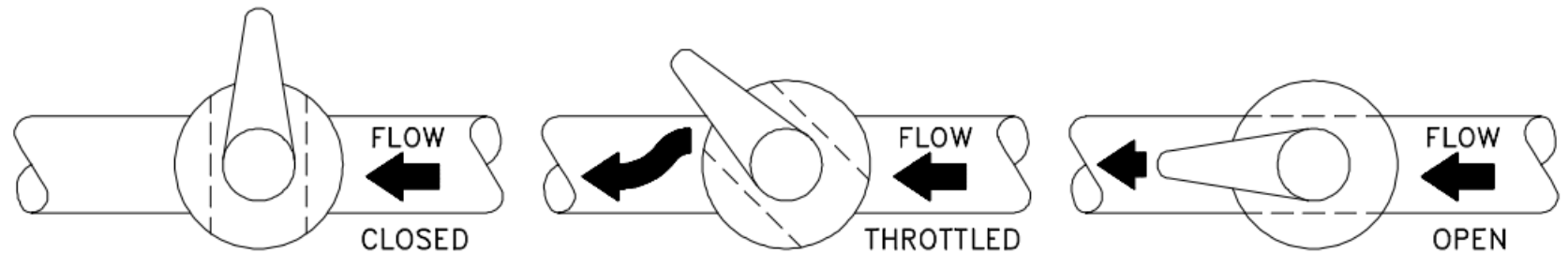


1 Piece Plug & Stem
Body
Sleeve

CLOSED



Stem & Plug Rotate 90° from OPEN to CLOSED



Plug Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

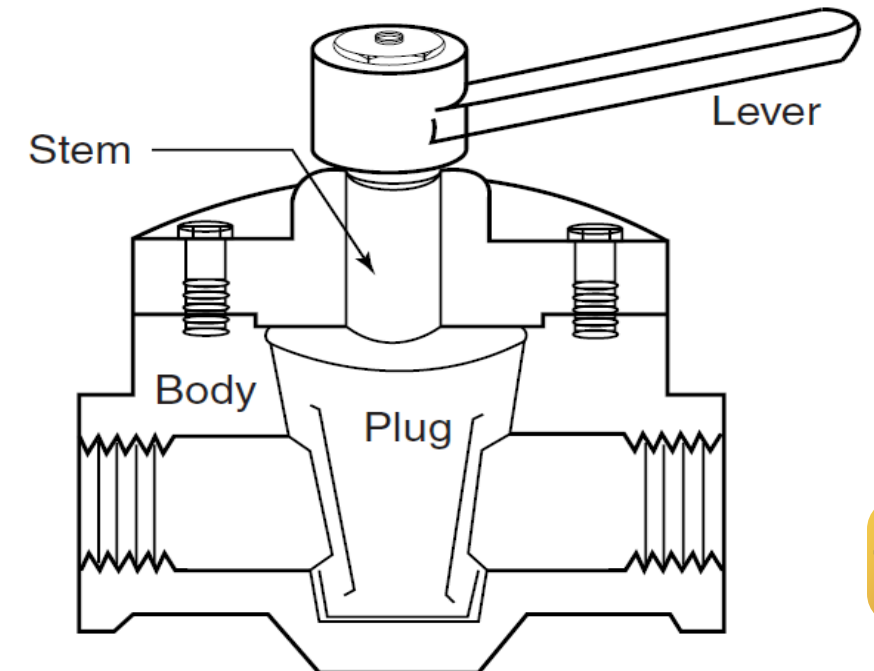
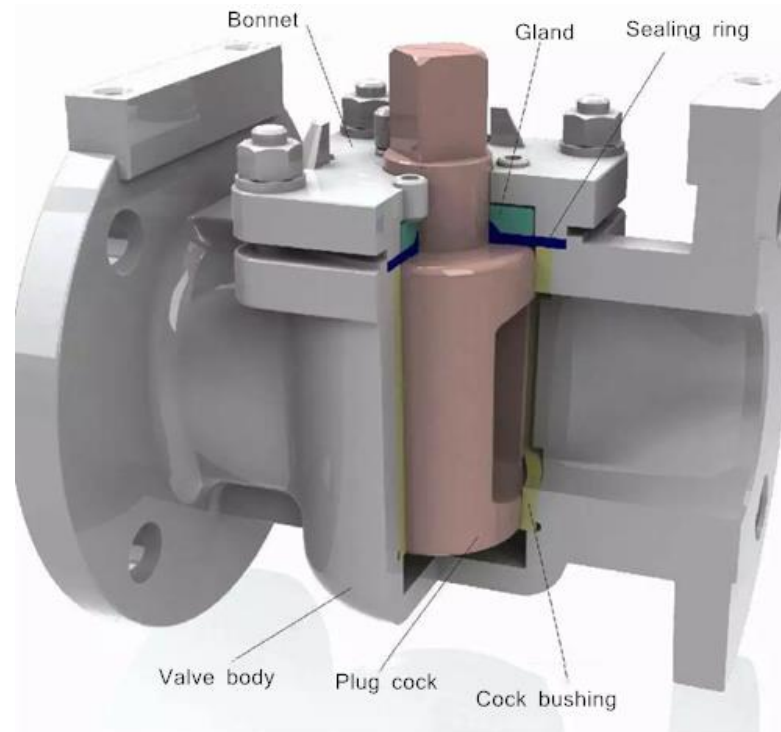
Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve component



Plug Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

Advantages & Disadvantages

Advantages	Disadvantages
simple design with few parts	first movement (opening-closing) requires a large amount of force
open and close easily	Require a gearbox or an actuator.
low flow resistance	costs are much larger than ball valves
Provide reliable leakage	
Smaller in size than most other valves	



Needle Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

A

• A small type of globe valve,

B

• Used in instrument systems for throttling of small volumes. They have metal-to-metal seats, but due to the small size, can be used for positive shut-off Passageways that may plug easily and limit their use to very small flow rates.



Needle Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

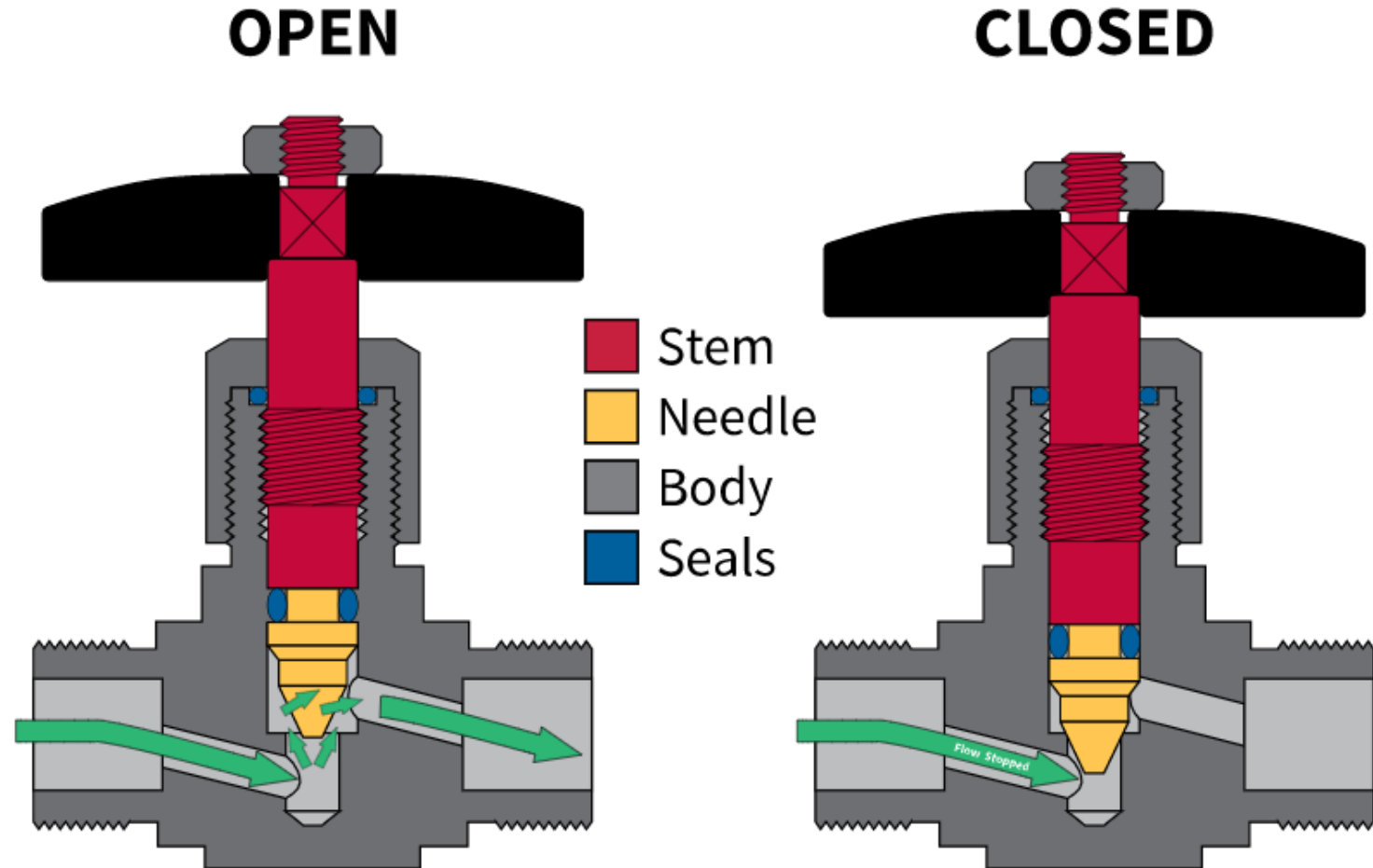
Check valve

Plug Valve

Needle valve

Butterfly Valve

Flow direction



Needle Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

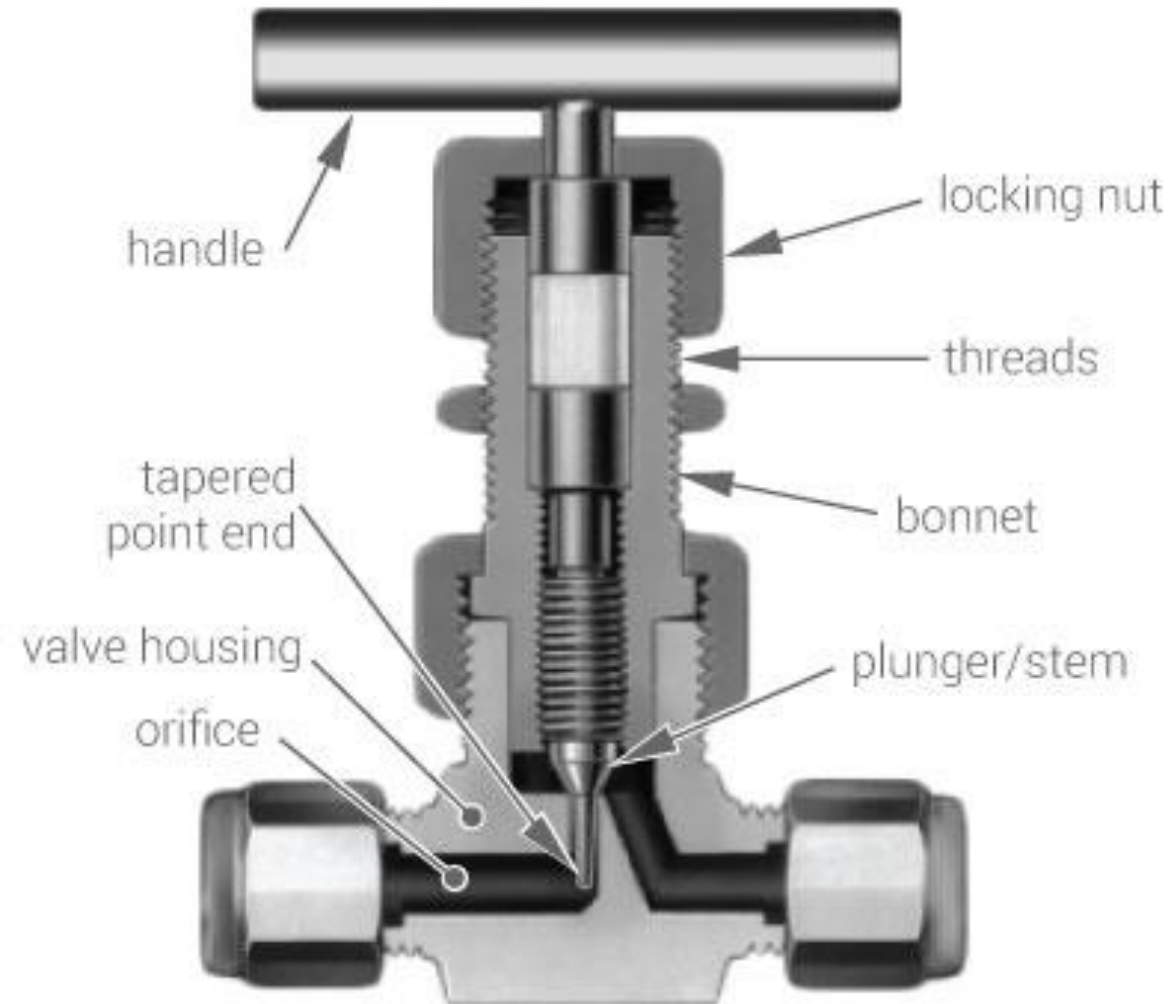
Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve component



Butterfly Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



A Butterfly valve is a quarter-turn rotary motion valve, that is used to stop, regulate, and start the flow. Butterfly valves are a quick open type.



A 90° rotation of the handle can completely close or open the valve.



Butterfly Valve

Globe valve

Ball Valve

Gate valve

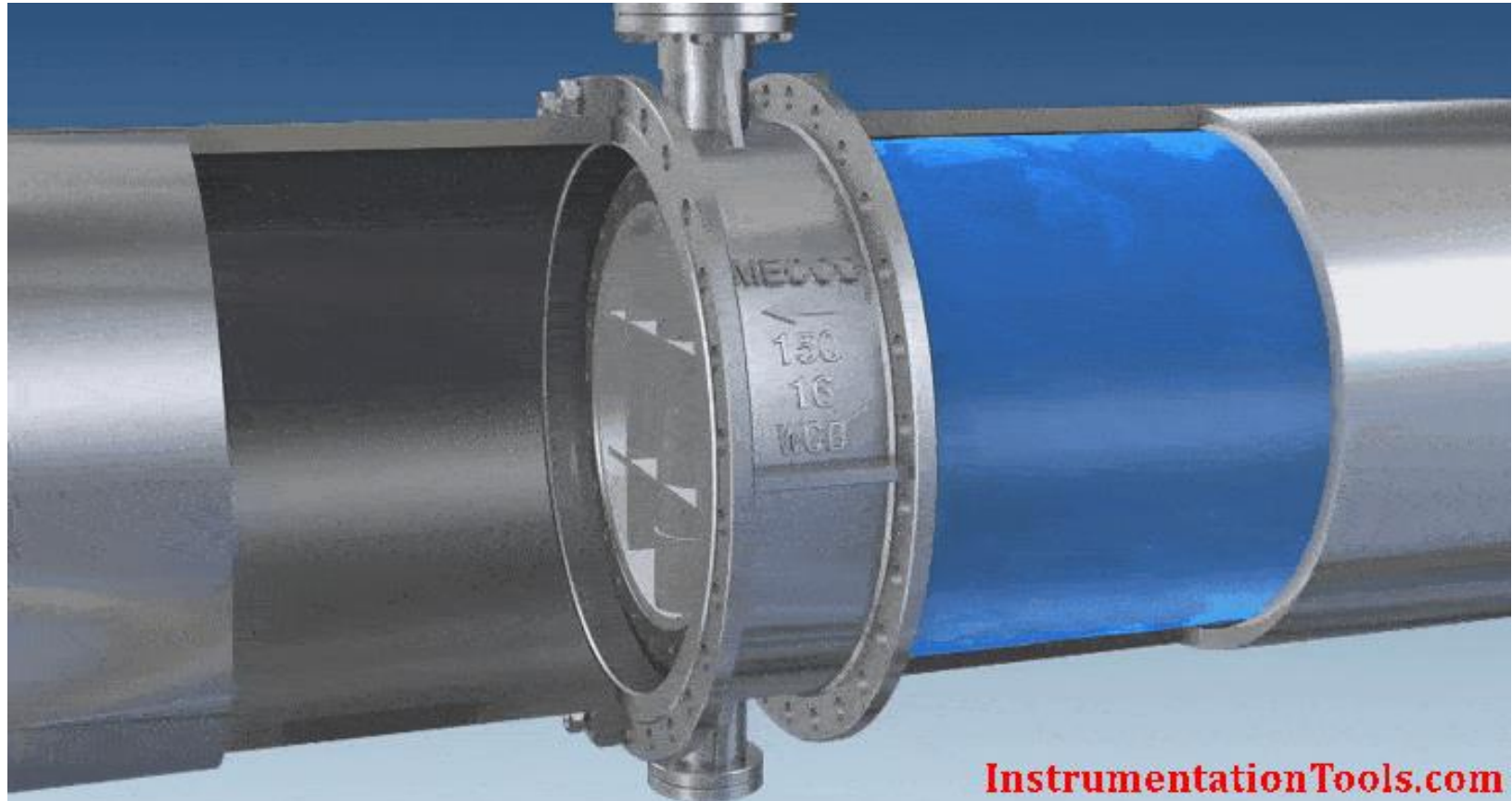
Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve



Butterfly Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

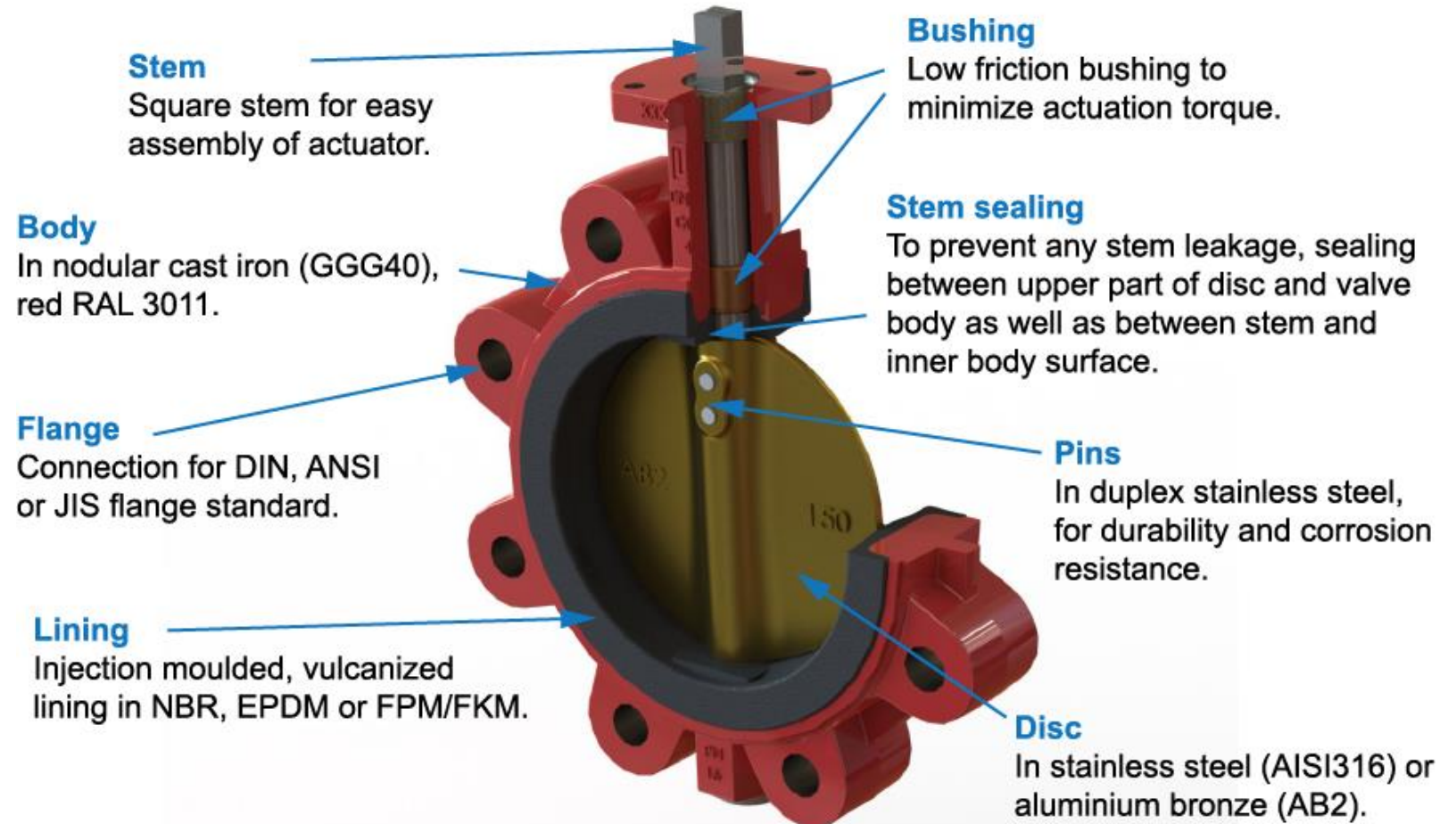
Check valve

Plug Valve

Needle valve

Butterfly Valve

Valve component



Butterfly Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

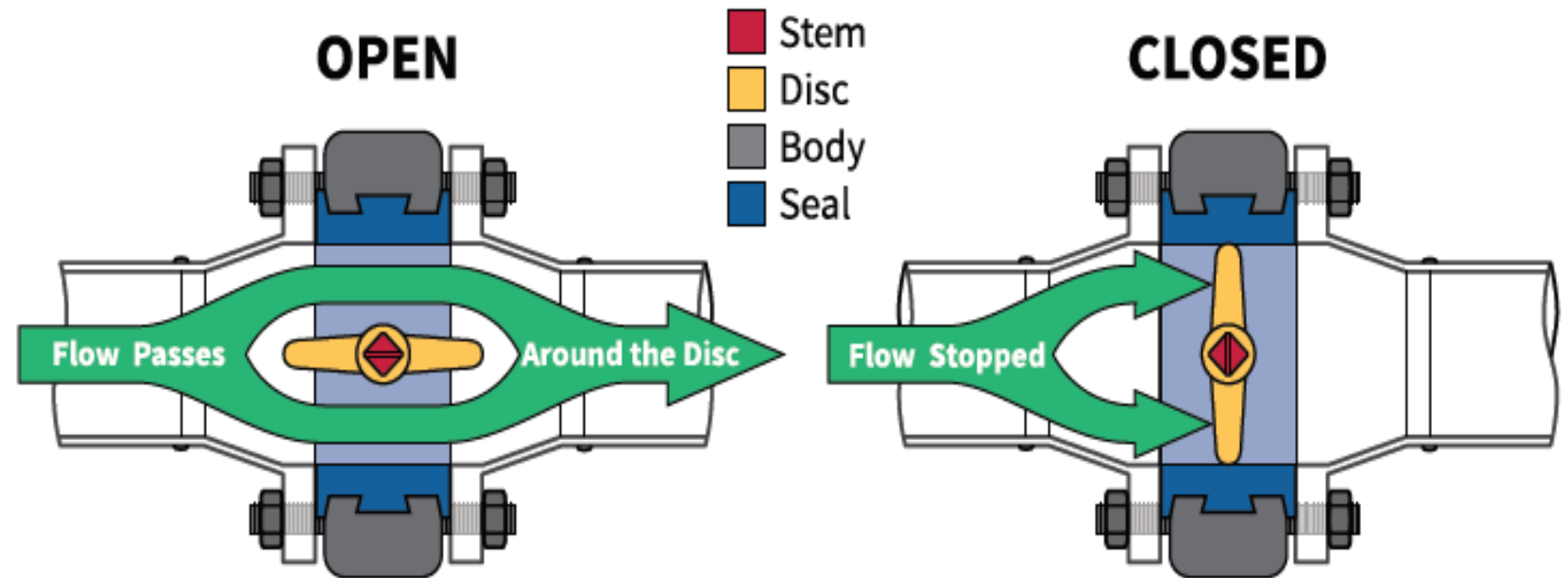
Check valve

Plug Valve

Needle valve

Butterfly Valve

Flow direction



Stem & Disc Rotate 90° from OPEN to CLOSED



Butterfly Valve

Globe valve

Ball Valve

Gate valve

Diaphragm Valve

Check valve

Plug Valve

Needle valve

Butterfly Valve

Advantages & Disadvantages

Advantages	Disadvantages
relatively inexpensive, quarter-turn valves.	Throttling is limited to low differential pressure
Easily/quickly operated	There is a chance for cavitation
Good for large flow/low pressure applications due to saving in weight/size/cost	
suitable for large valve applications due to Compact, lightweight design	
Little pressure drop	





06

Static Equipment

Special Valve

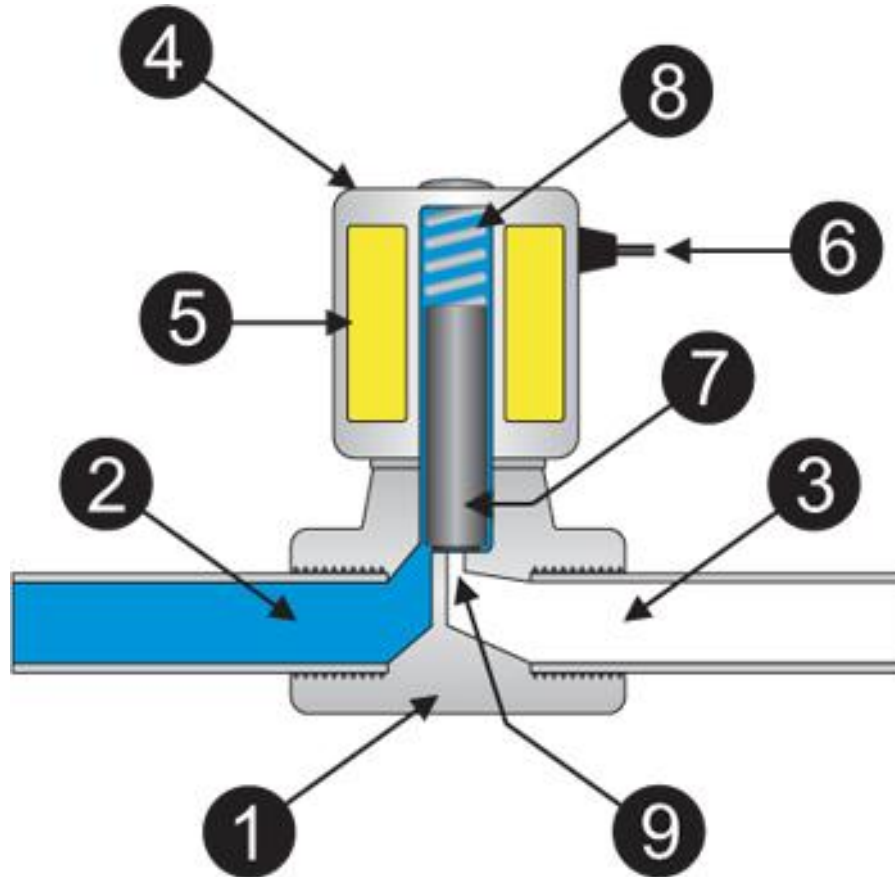
Solenoid Valve

- A An electrically operated valve where an electromagnet is used as an actuator to change the valve state.
- B Used only in an ON/OFF manner. In a two-way solenoid valve, the valve is open when the solenoid coil is energized.



Solenoid Valve

Valve component



1. Valve Body

2. Inlet Port

3. Outlet Port

4. Coil / Solenoid

5. Coil Windings

6. Lead Wires

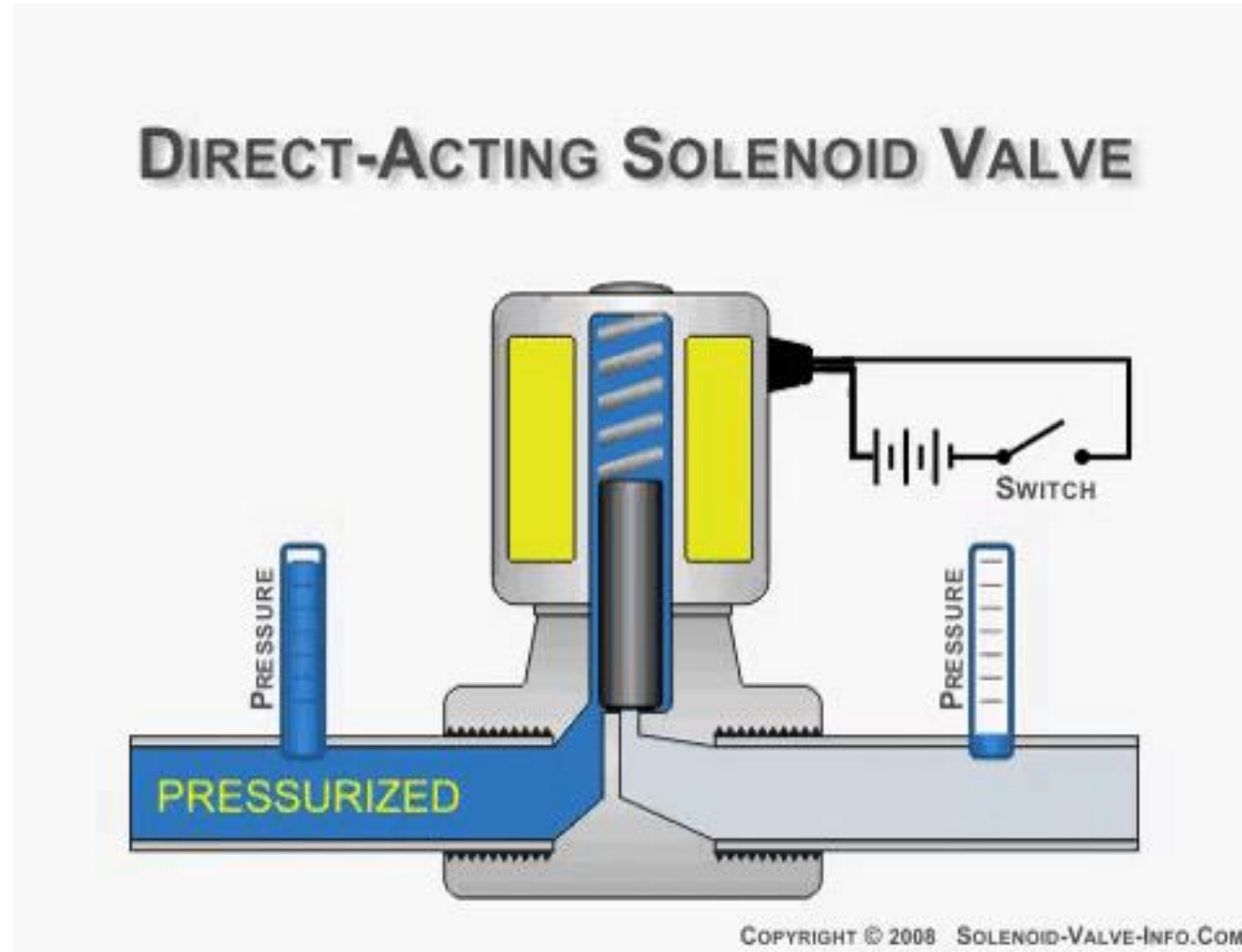
7. Plunger

8. Spring

9. Orifice



Solenoid Valve



Special Valves

Protection Valves

Types of protection valves

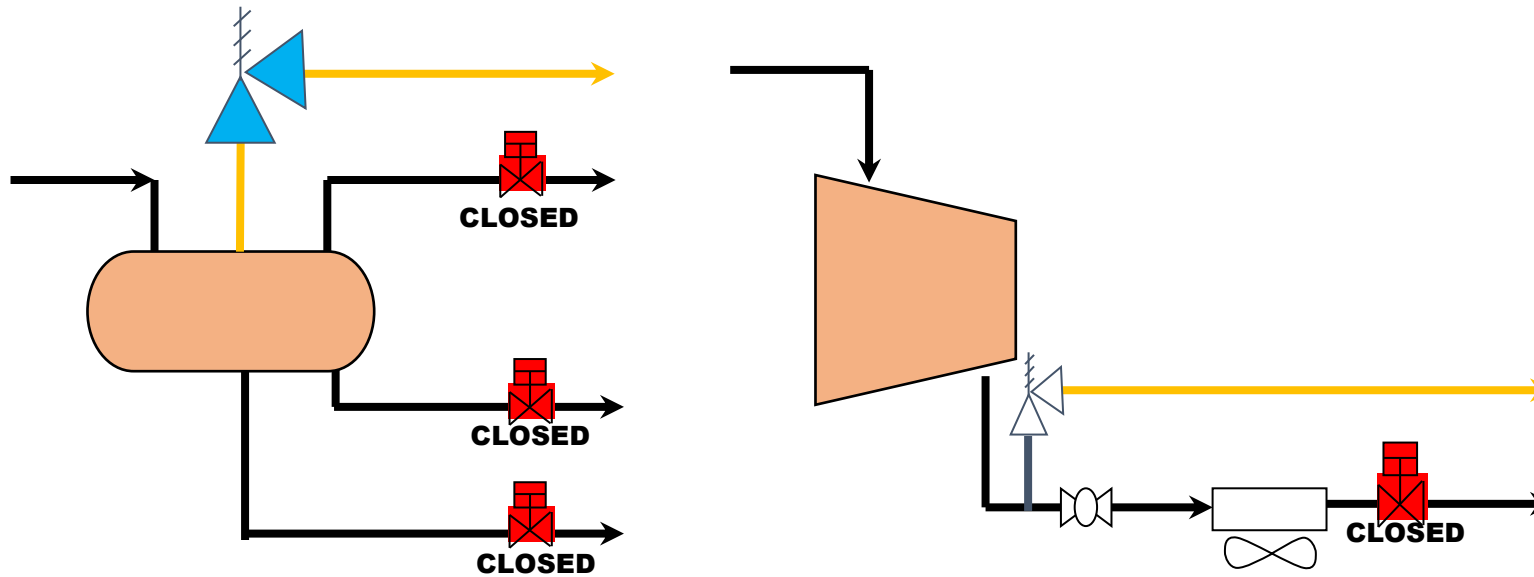
- Overpressure relief valves.
- Pressure vacuum relief valves.
- Rupture Disks



Protection Valves

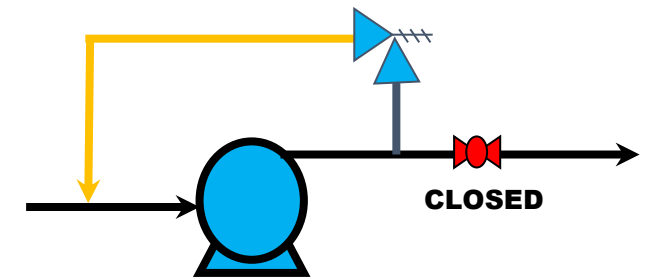
PSV Locations

- Blocked Outlet/ Blocked Discharge



Process Vessel

Compressor



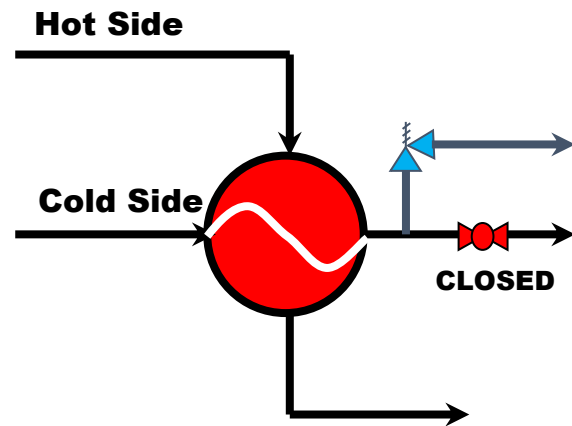
Pump



Protection Valves

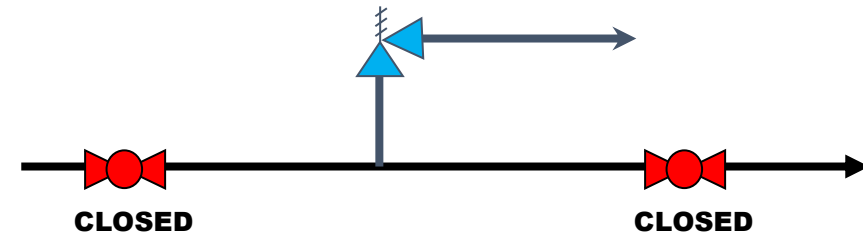
PSV Locations

- Thermal Expansion/ Thermal Relief



Heat Exchanger

OR



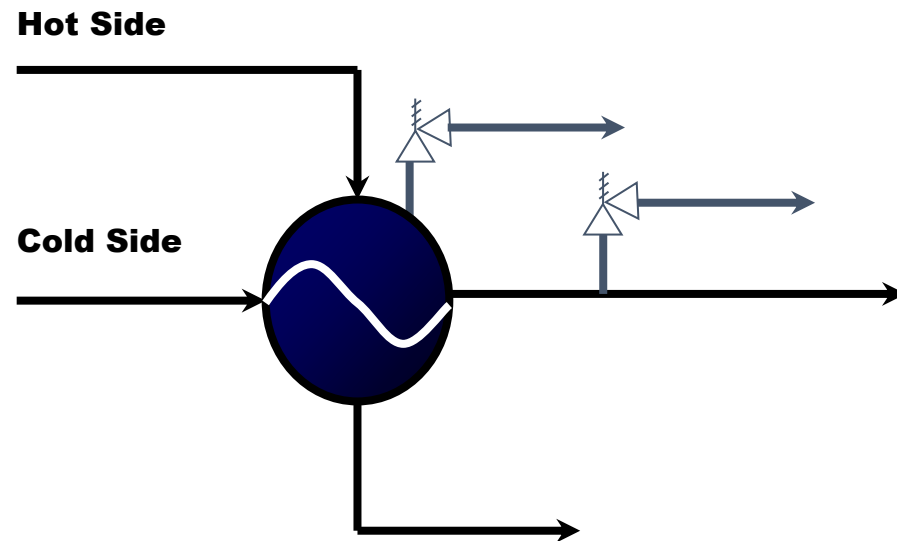
Line



Protection Valves

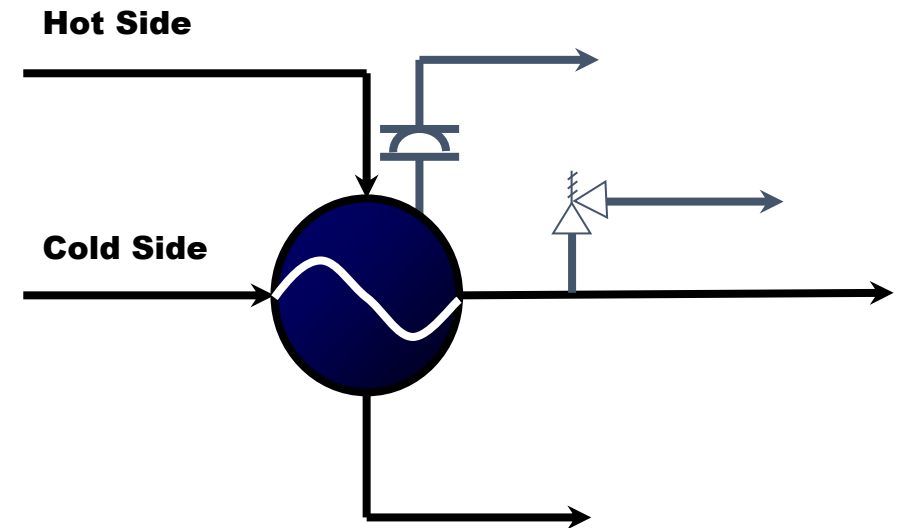
PSV Locations

- Tube Rupture



Heat Exchanger

OR



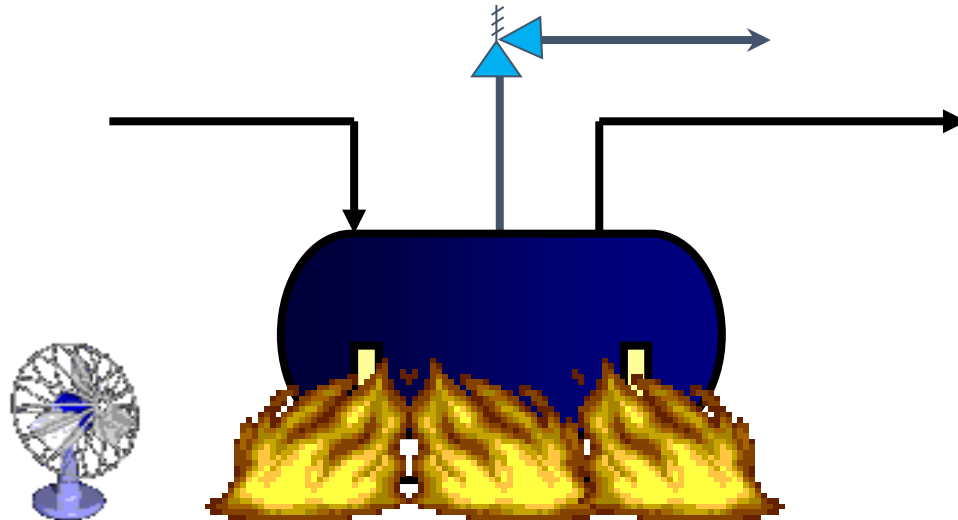
Heat Exchanger



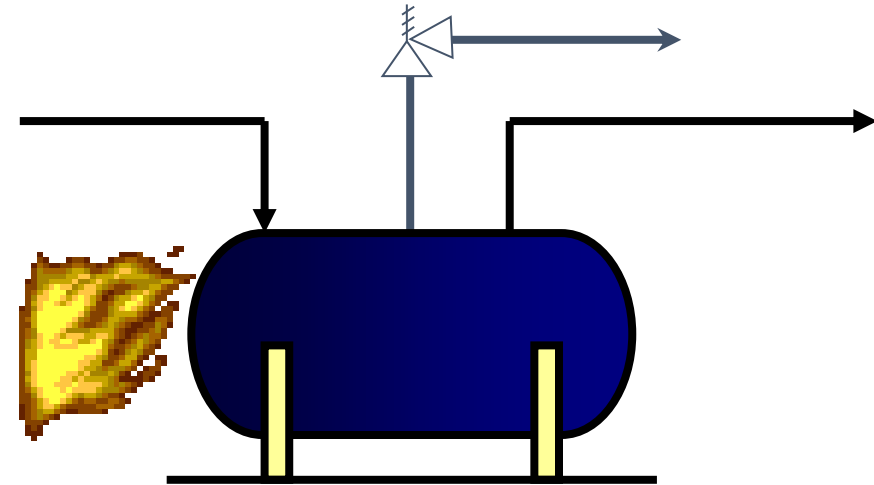
Protection Valves

PSV Locations

- Fire Type



Pool Fire



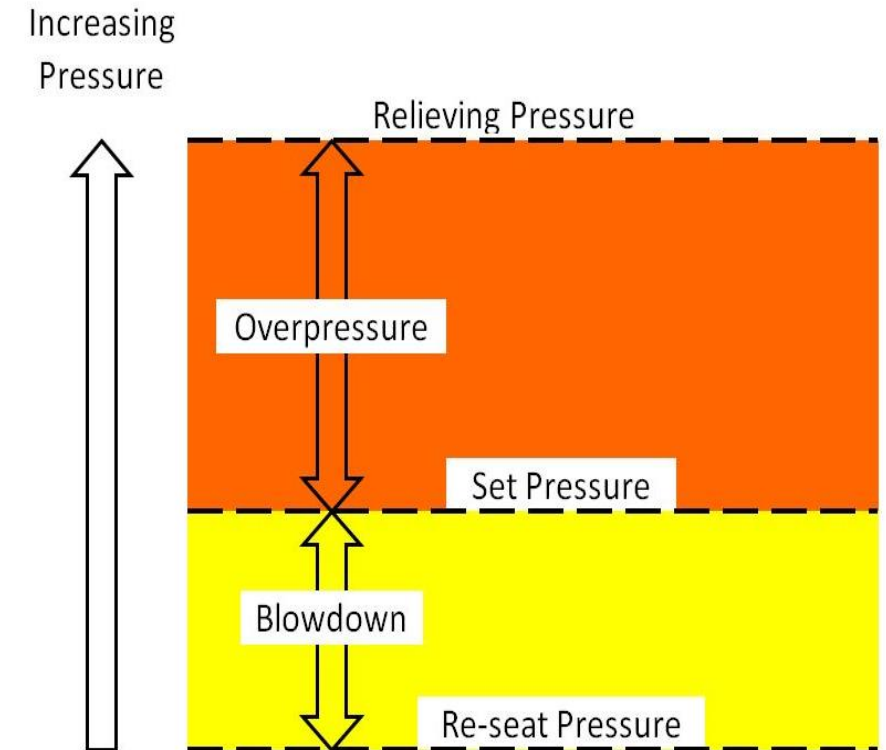
Jet Fire



Protection Valves

1. Pressure relief valves PRV

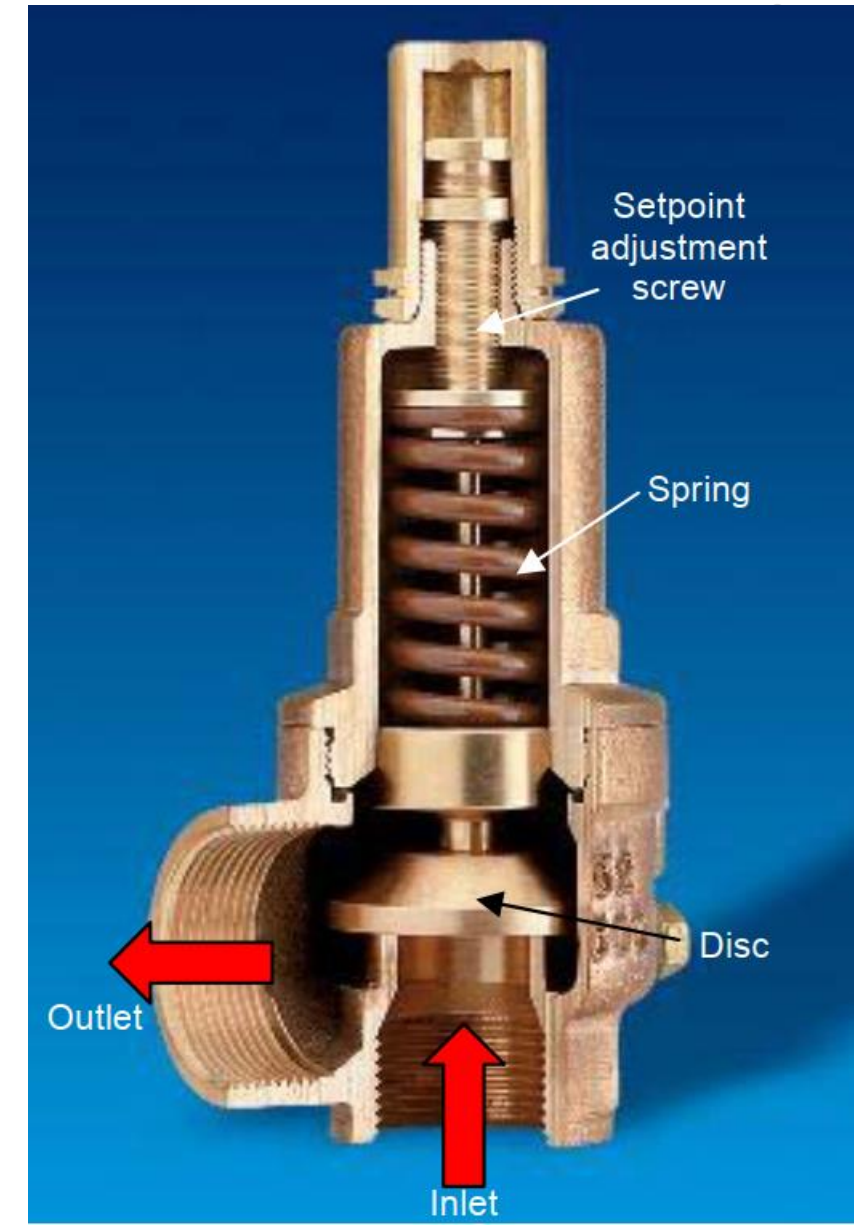
- Are used mainly to relieve overpressure of **liquids**.
- Fluid pressure pushes against the spring to open the valve.
- The fluid pressure needed to push the valve open is called the **setpoint** pressure.
- The setpoint pressure is usually the maximum normal operating pressure of the liquid.



Protection Valves

1. Pressure relief valves PRV

- When *the liquid pressure exceeds* the *setpoint* pressure, the *valve opens slowly*. It *releases just* enough *liquid* to bring the pressure down to the *normal operating pressure*.

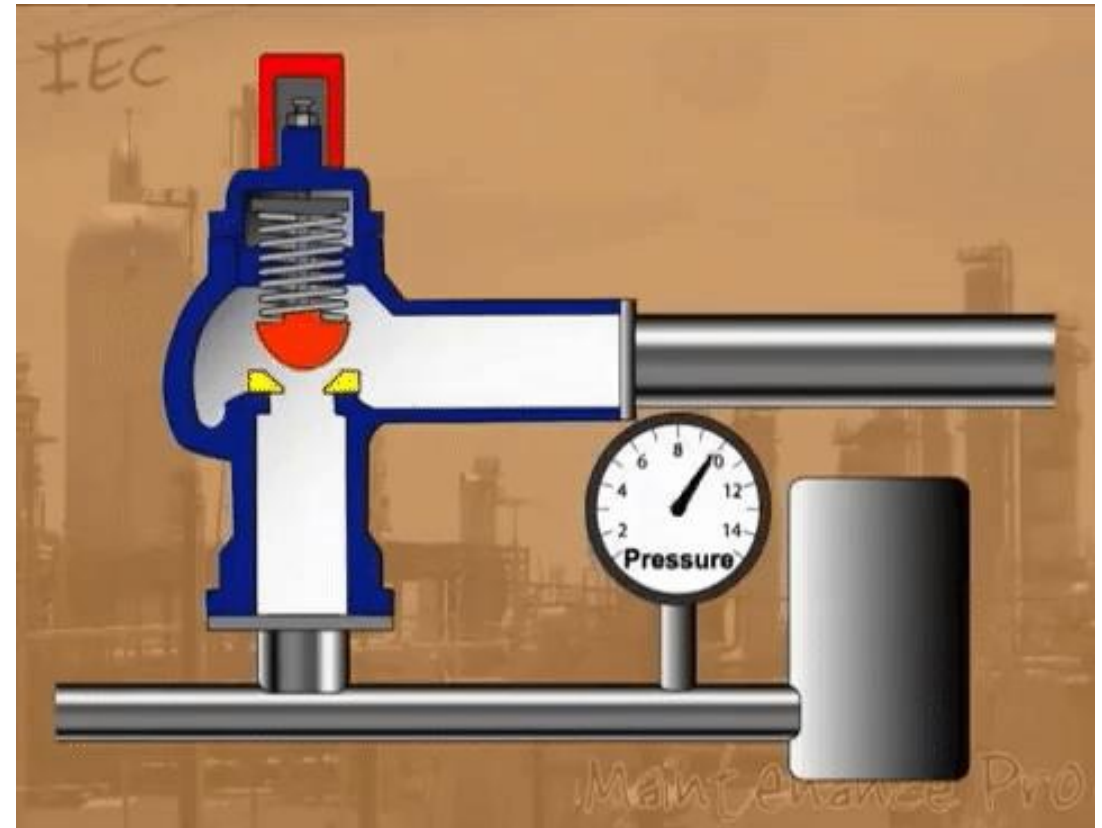


Protection Valves

1. Pressure relief valves PRV

Relief valves are characterized by:

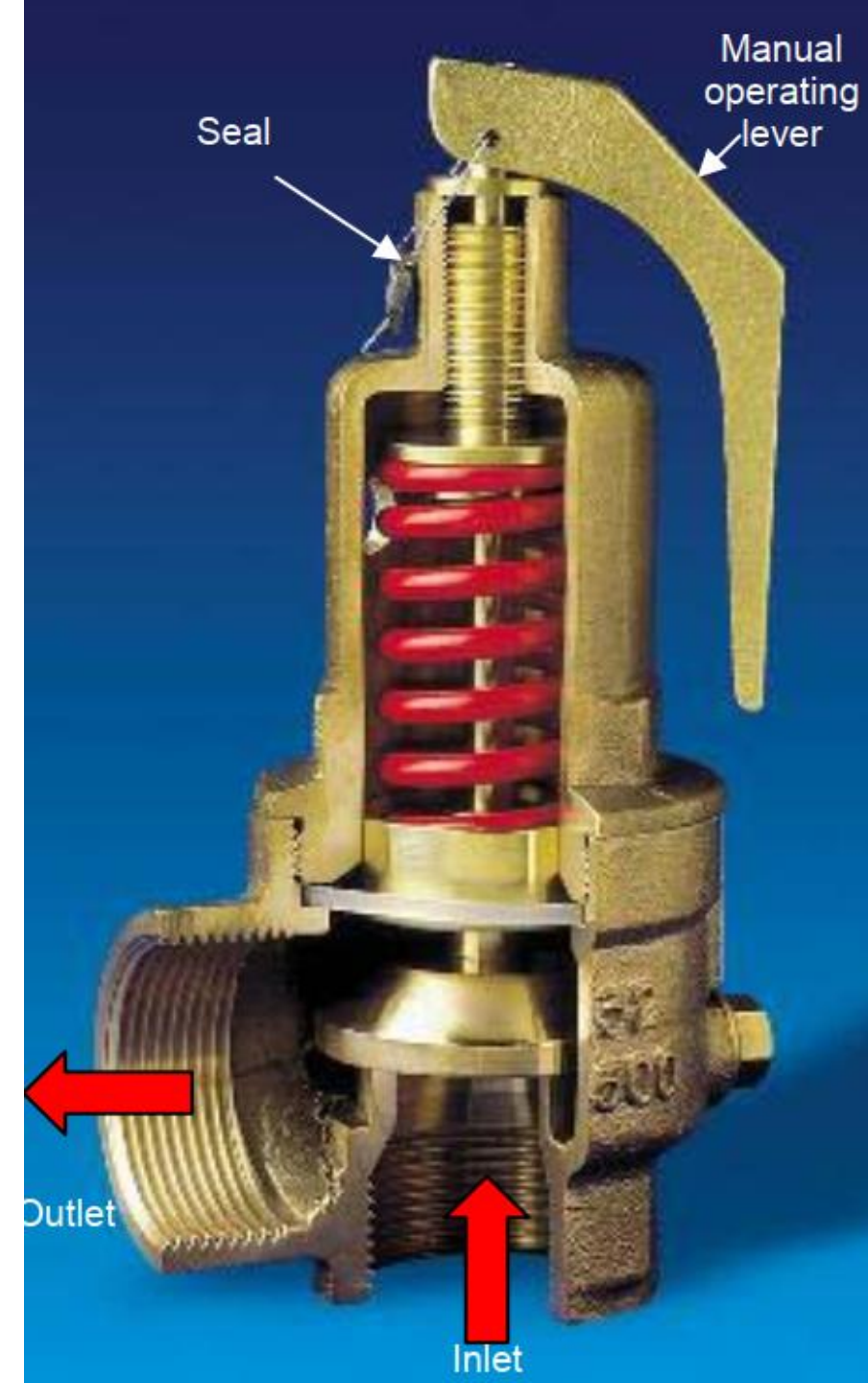
- Slow response times (tenths of a second up to > 1 second)
- Risk of blockage
- Trace leakage



Protection Valves

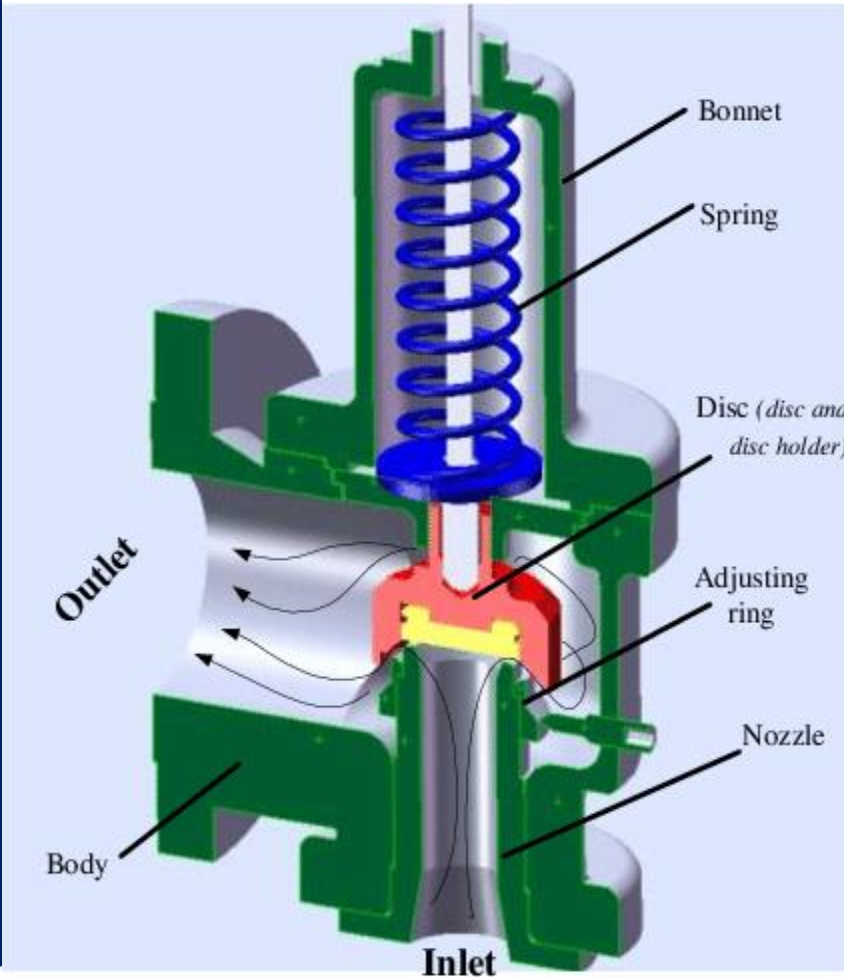
2. Pressure Safety Valves (PSVs)

- Used mainly to relieve overpressure of gases.
- When the fluid pressure exceeds the setpoint pressure, the valve pops fully open.
- This happens very quickly to release overpressure as quickly as possible.
- The PSV outlet diameter is greater than the inlet for the same reason as for the PRV

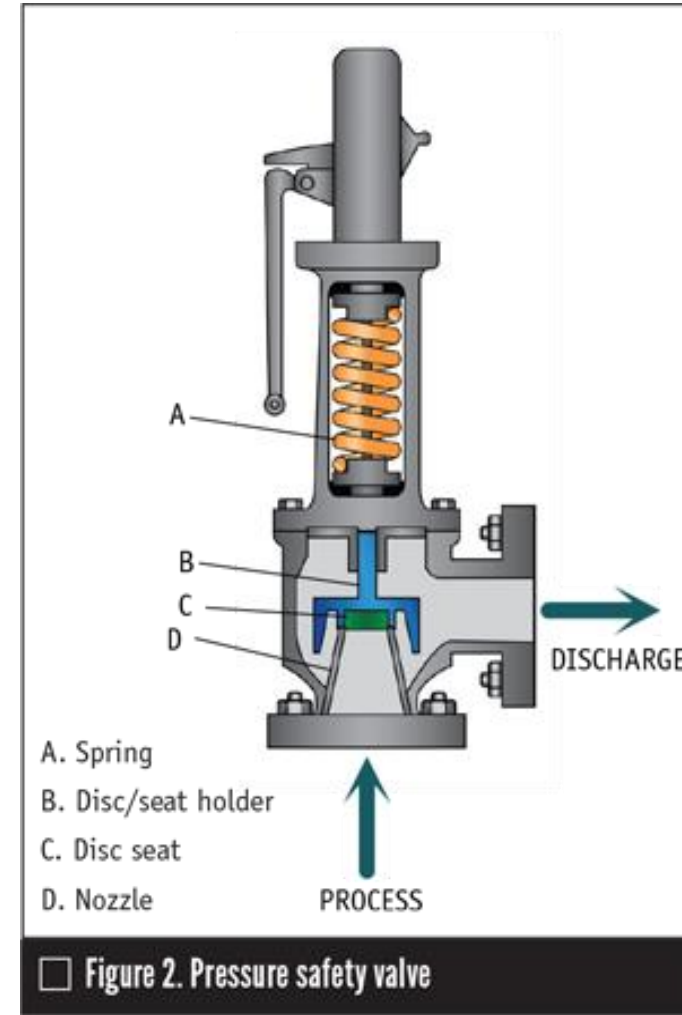
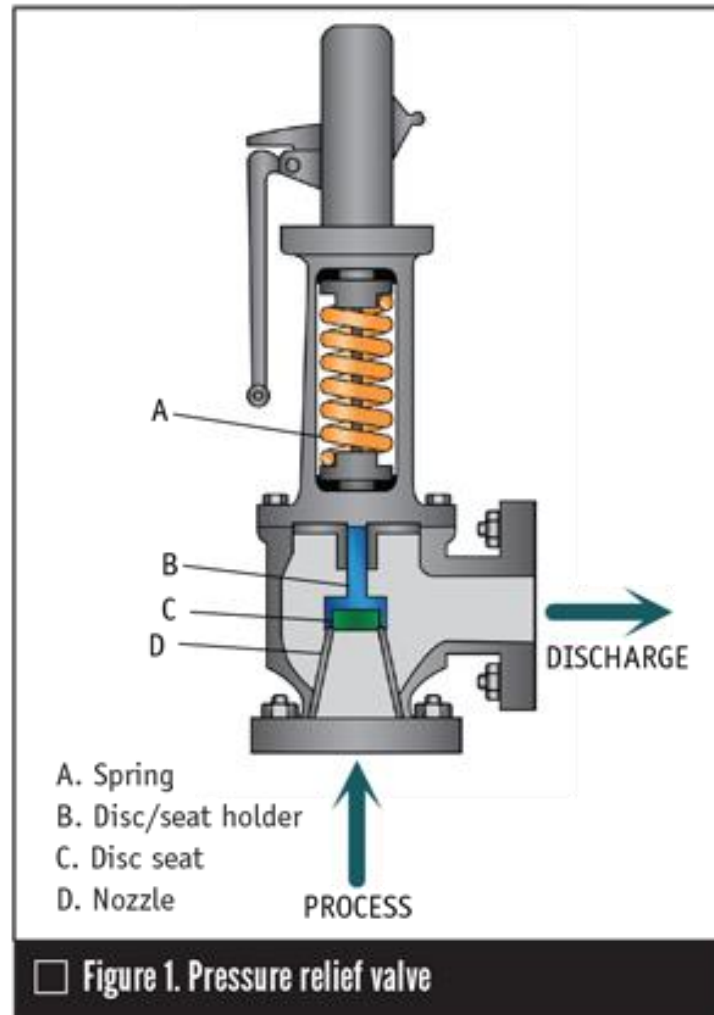


Protection Valves

2. Pressure Safety Valves (PSVs)



Protection Valves



Protection Valves

Relief Valve	Safety Valve
A relief valve is a device used to limit the pressure in a system within a specific set level.	A safety valve is a device designed to actuate automatically to release excess pressure.
The opening of a relief valve is directly proportional to the increase in the vessel pressure.	A safety valve opens almost immediately and fully in order to prevent overpressure condition.
A relief valve opens when the pressure reached the specific set pressure limit and it is usually operated by an operator.	The purpose of a safety valve is to protect people, property, and environment. It is used to release excess pressure without operator assistance.
The setpoint of a relief valve is usually set at 10 percent above the working pressure limit.	The setpoint of a safety valve is usually set at 3 percent above the working pressure limit.
Relief valves are divided into pop-type, direct-operated, pilot-operated, and internal relief valves.	Safety valves are divided into a wide range of types based on applications and performance in different areas.

Difference Between | net



Protection Valves

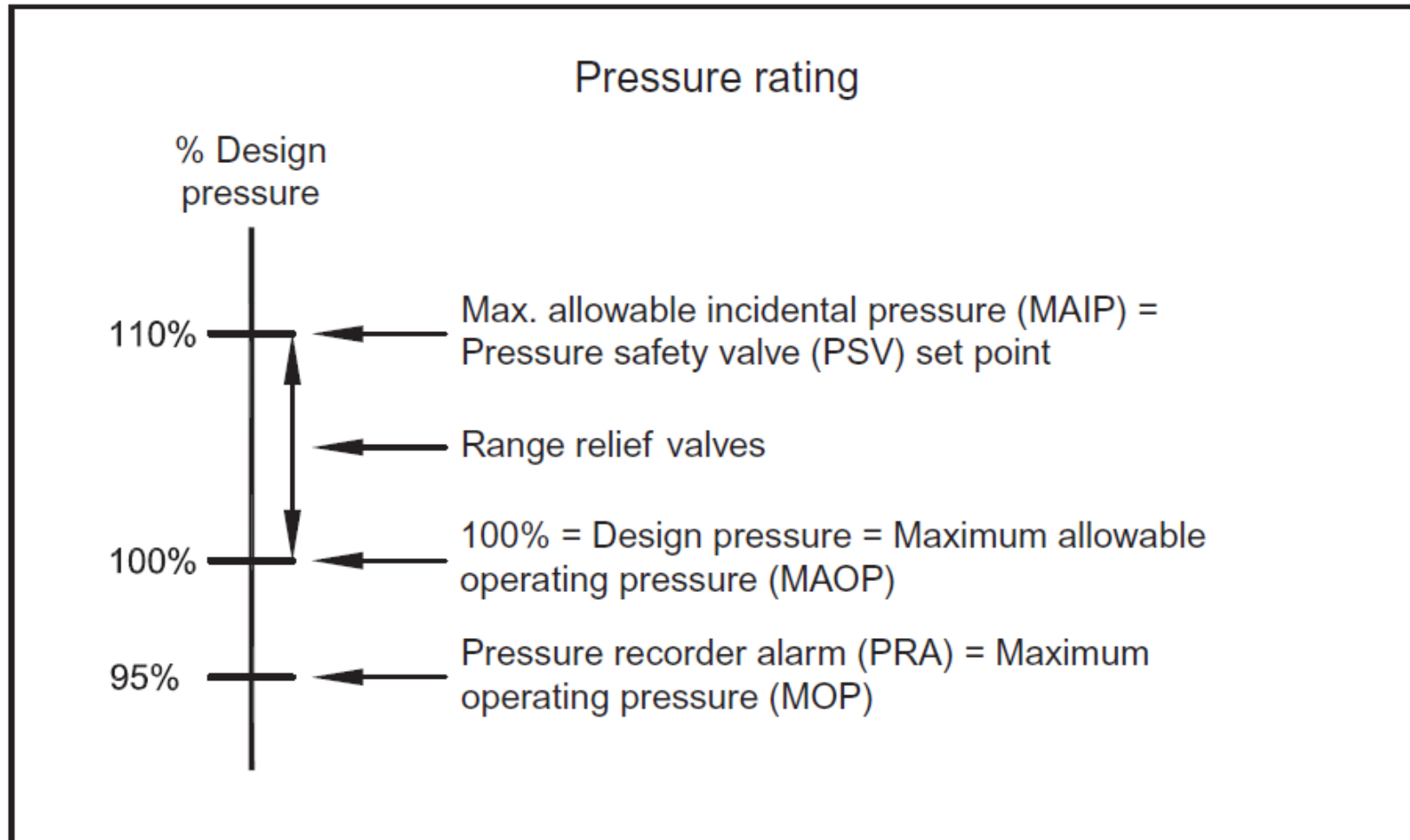
Safety Valve - an automatic pressure relieving device actuated by the static pressure upstream of the valve and characterized by a full-opening pop action. It is used for gas or vapor service.

Relief Valve - an automatic pressure relieving device actuated by the static pressure upstream of the valve which opens further with increase in pressure over the opening pressure. It is used primarily for liquid service. A relief valve can be used in this application because water is non-compressible and the removal of a small amount of fluid from a solid system decreases the pressure dramatically.

Safety Relief Valve - an automatic pressure-actuated relieving device suitable for use either as a safety valve or relief valve, depending on application.



Protection Valves



Protection Valves

Rupture Discs

- Rupture discs, also called bursting discs, are a simple and cheap form of pressure safety device.
- A **Rupture Disk** is a non-reclosing **pressure relief** device actuated by static differential pressure between the inlet and outlet of the device and designed to function by the bursting of a rupture disk.



Protection Valves

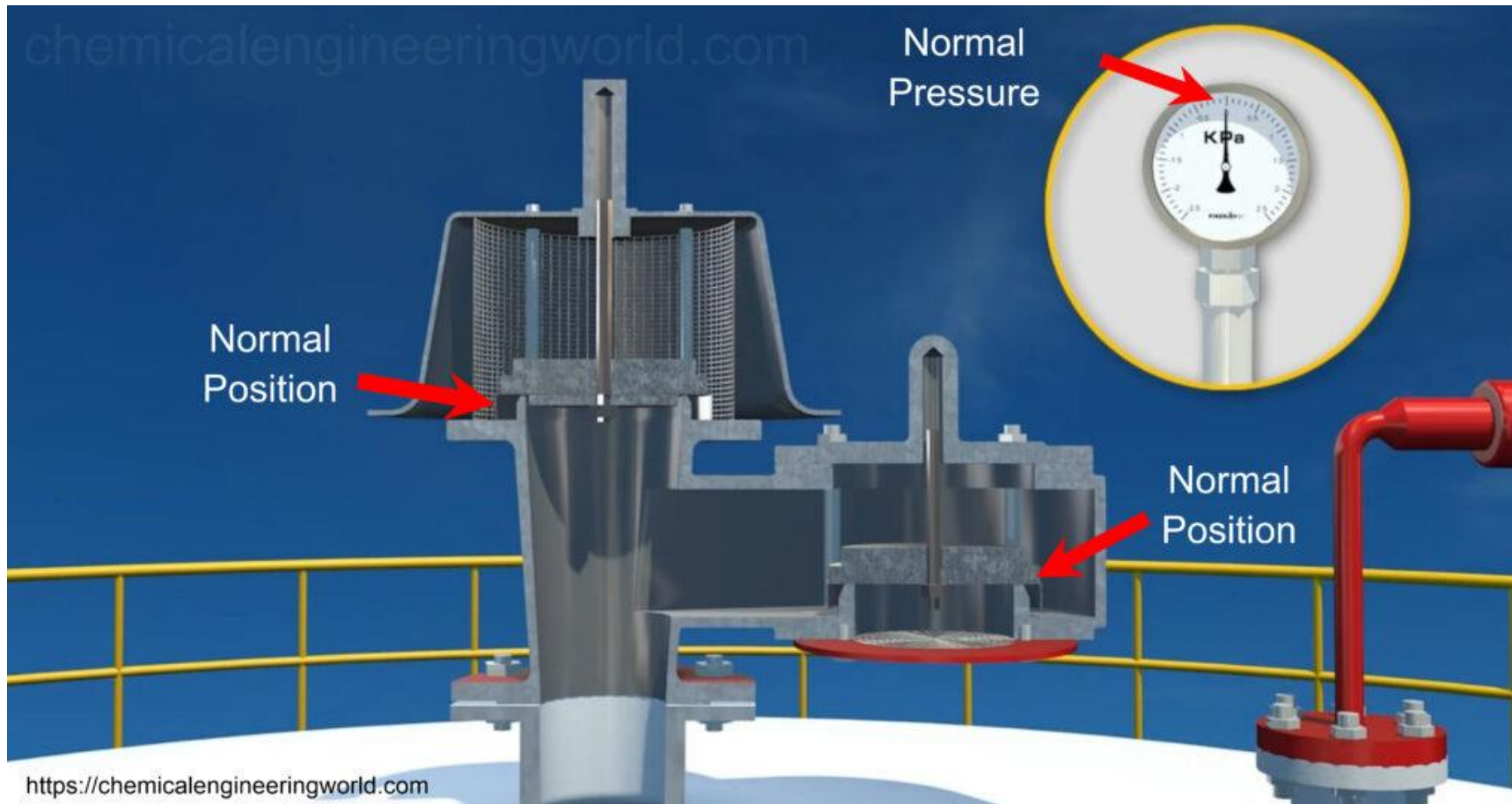
Pressure/Vacuum Relief Valves

- **Breathing valve** special types of Relief Valves which are specifically designed for tank protection.
- used to protect low pressure tanks constructed for internal pressures less than 15 psig against overpressure and vacuum which occurs normally as a result of liquid movement into or out of the tanks.



Protection Valves

Pressure/Vacuum Relief Valves

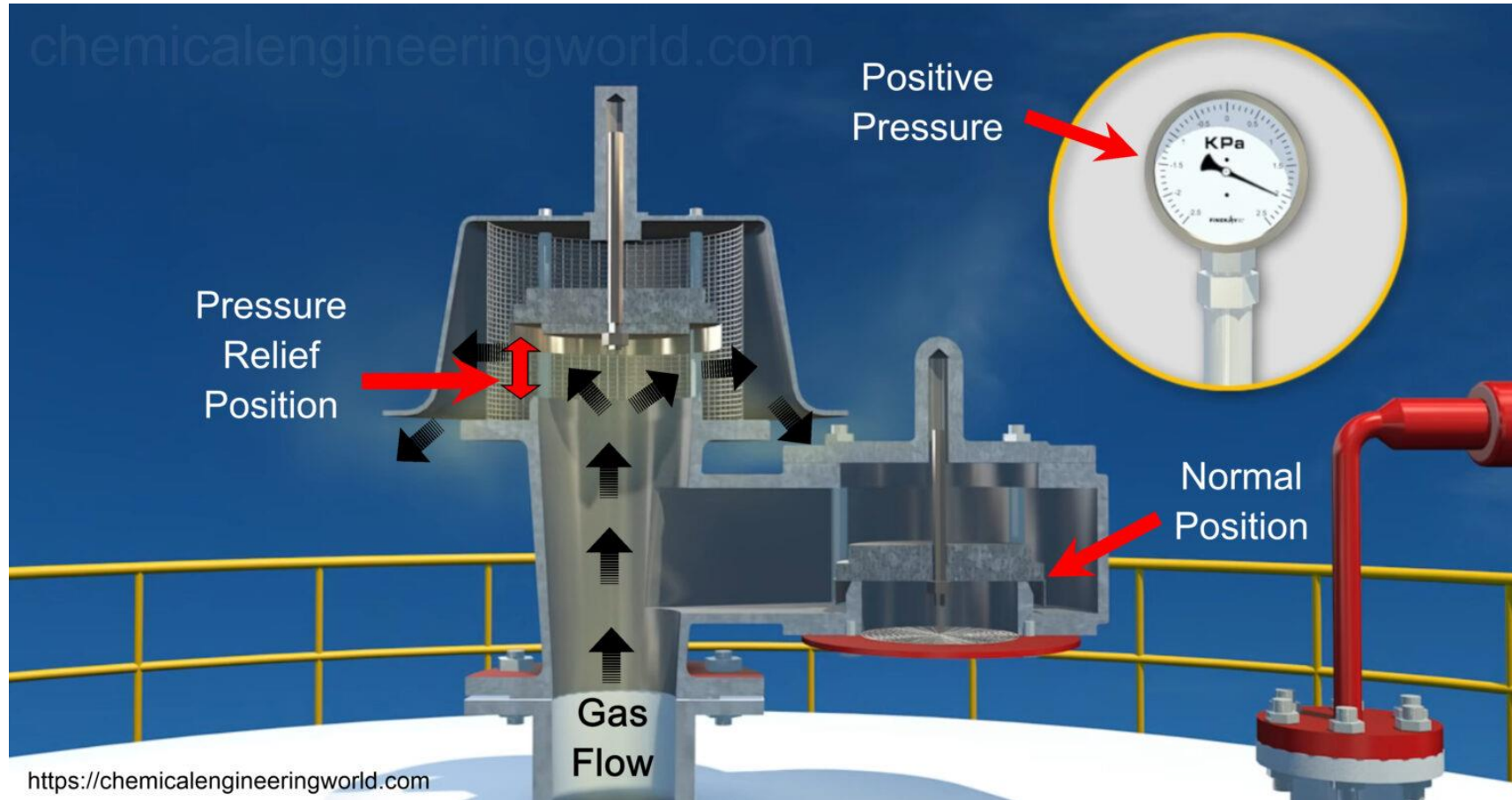


<https://chemicalengineeringworld.com>



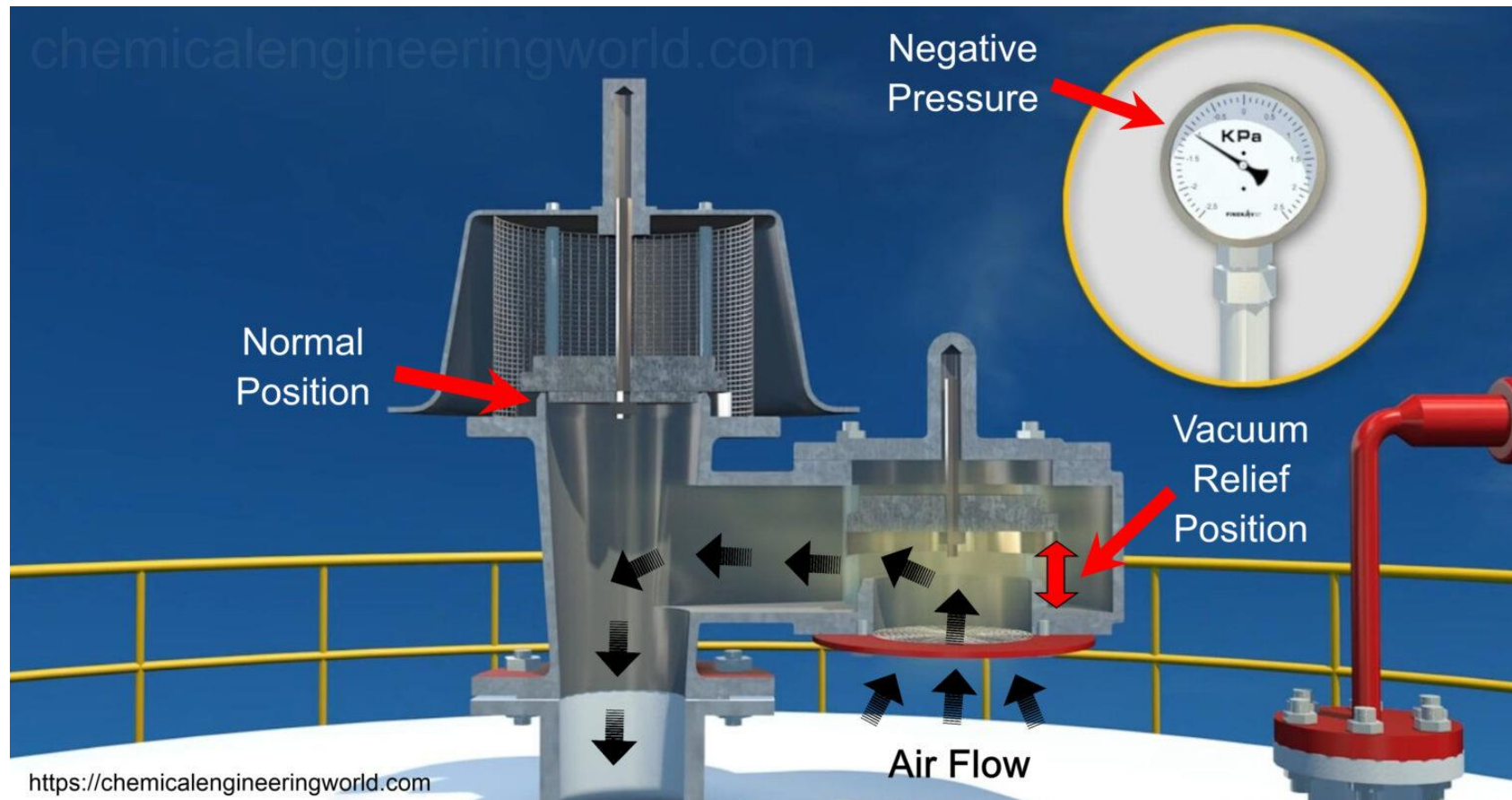
Protection Valves

Pressure/Vacuum Relief Valves



Protection Valves

Pressure/Vacuum Relief Valves



Protection Valves

Pressure/Vacuum Relief Valves



Protection Valves

Pressure/Vacuum Relief Valves



Diverter Valves



3-way valve



4-way valve



Double block and bleed





07

Static Equipment

Valves End connection

Valve End Connections

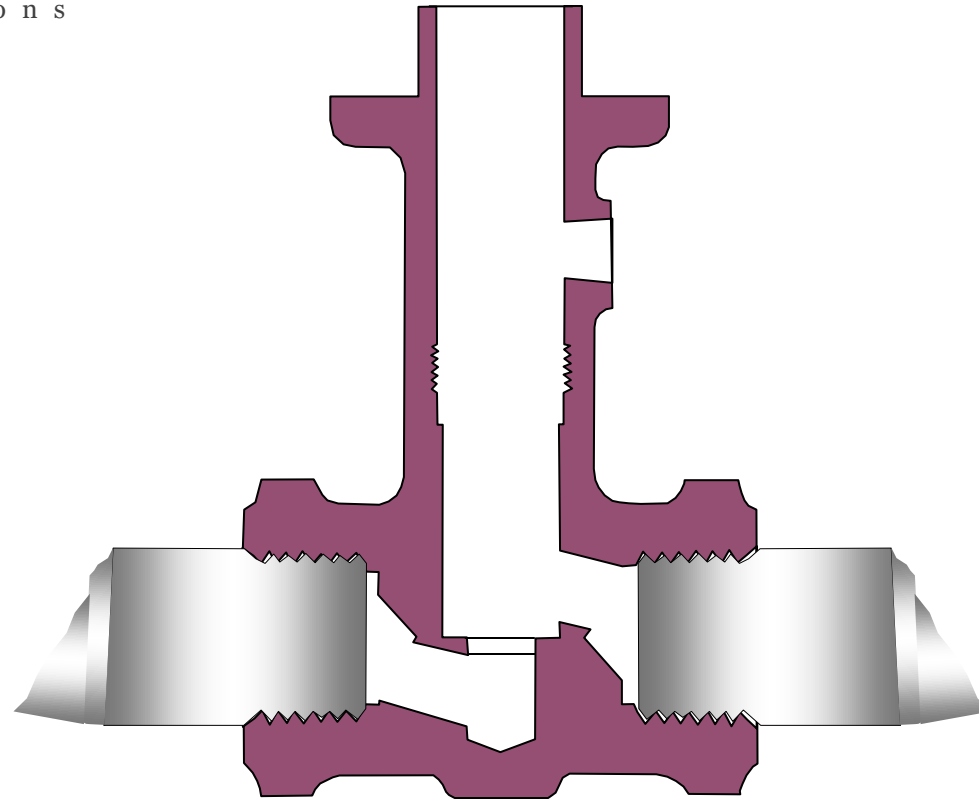
Classifications

- 1 Threaded ends
- 2 Welded ends
- 3 Flanged ends



Threaded Ends

Classifications

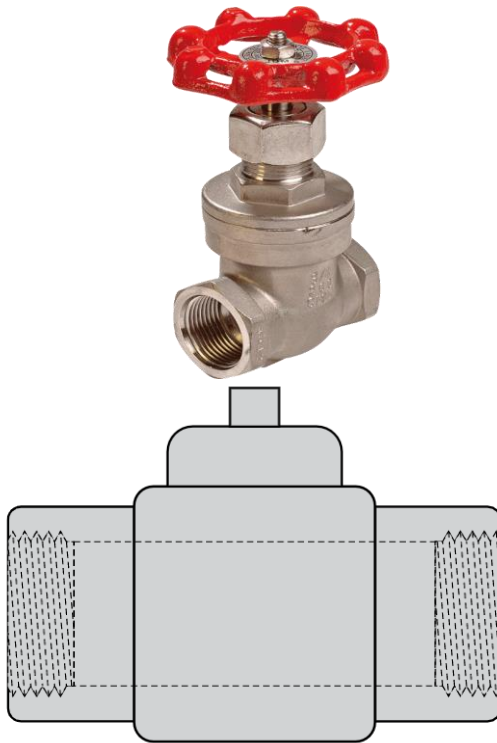


Threaded (NPT)

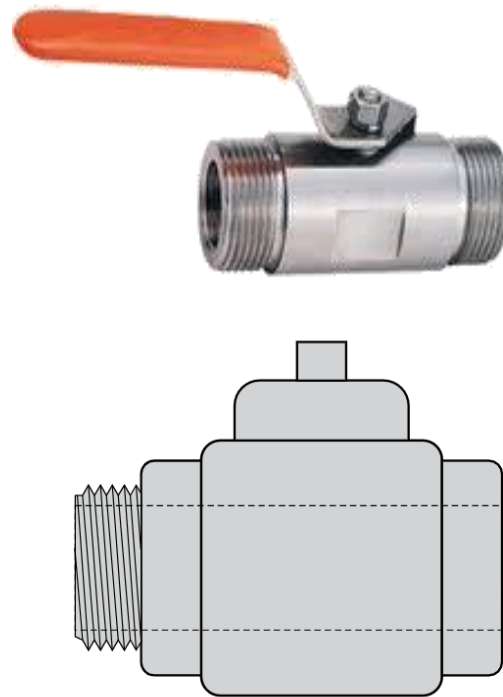


Threaded Ends

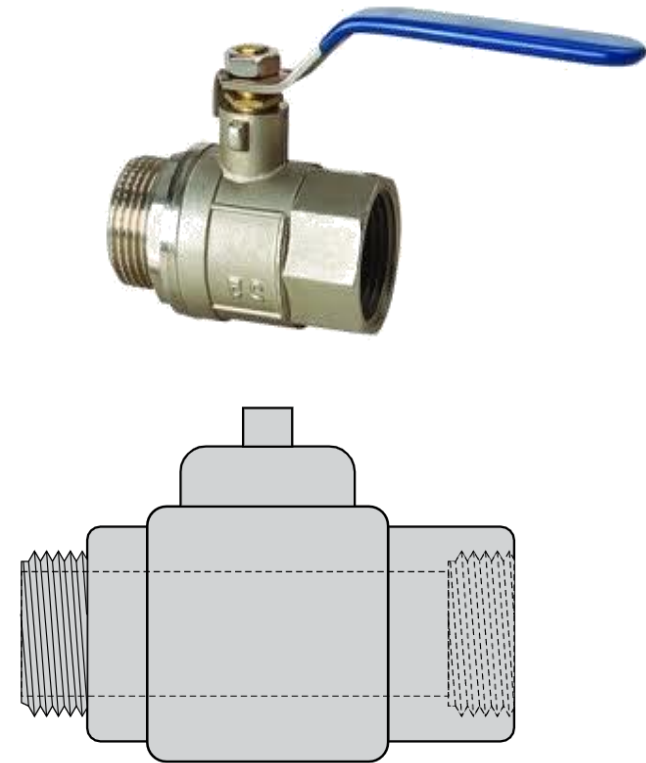
Classifications



Female x Female



Male x Male



Male x Female

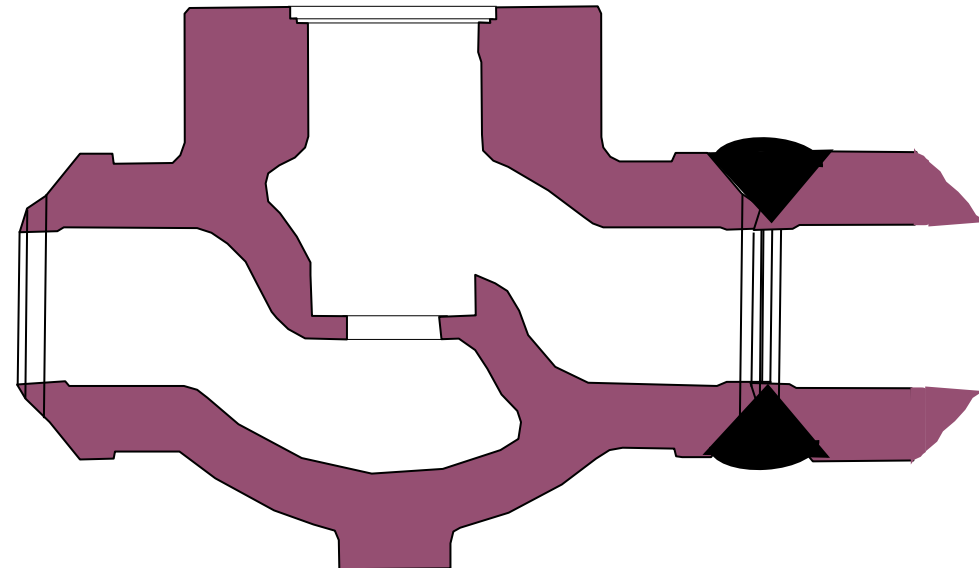


Welded Ends

Classifications

A

When zero leakage is required for environmental, safety, or any efficiency reasons the piping can be welded to the valve, providing one piece construction. Many users insist that high-pressure application requires a permanent end especially if they involve high temperatures



Flanged Ends

Classifications

A

The most expensive but are the best for installation and removal.
The main advantage of flanges is that the valve can be removed easily from the line



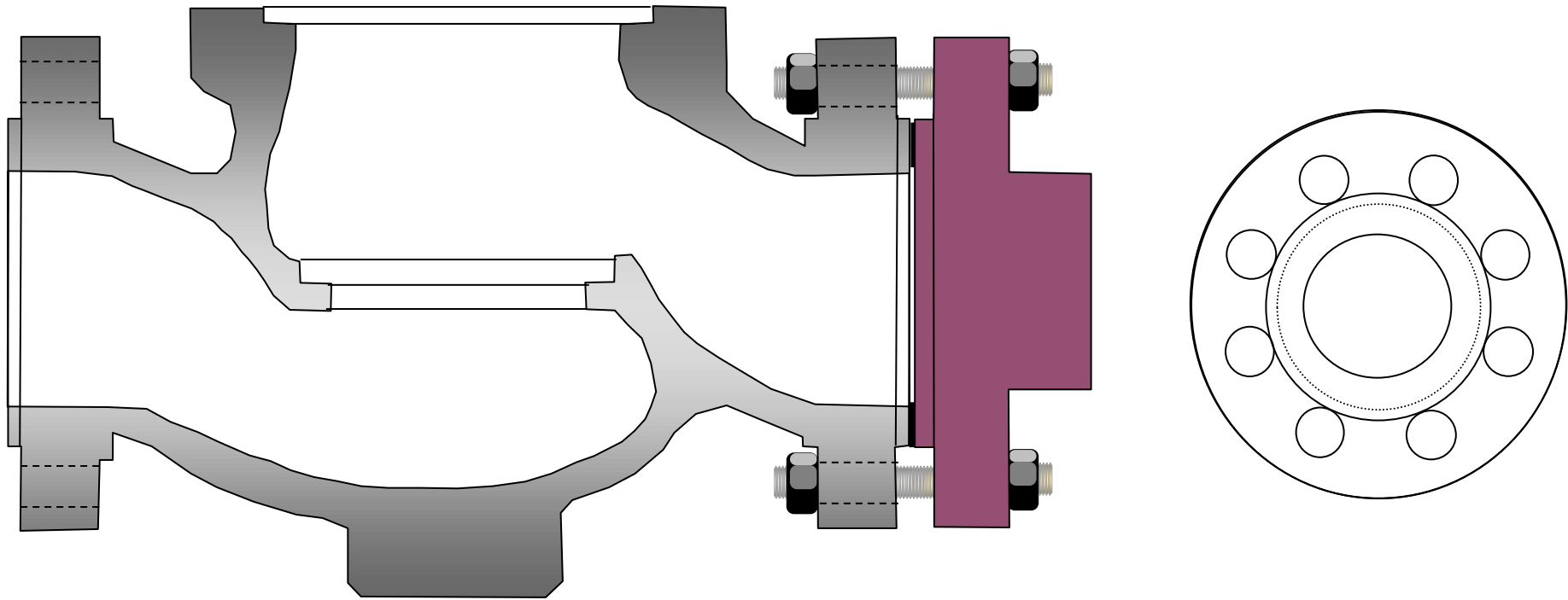
Flanged end



Flanged Ends

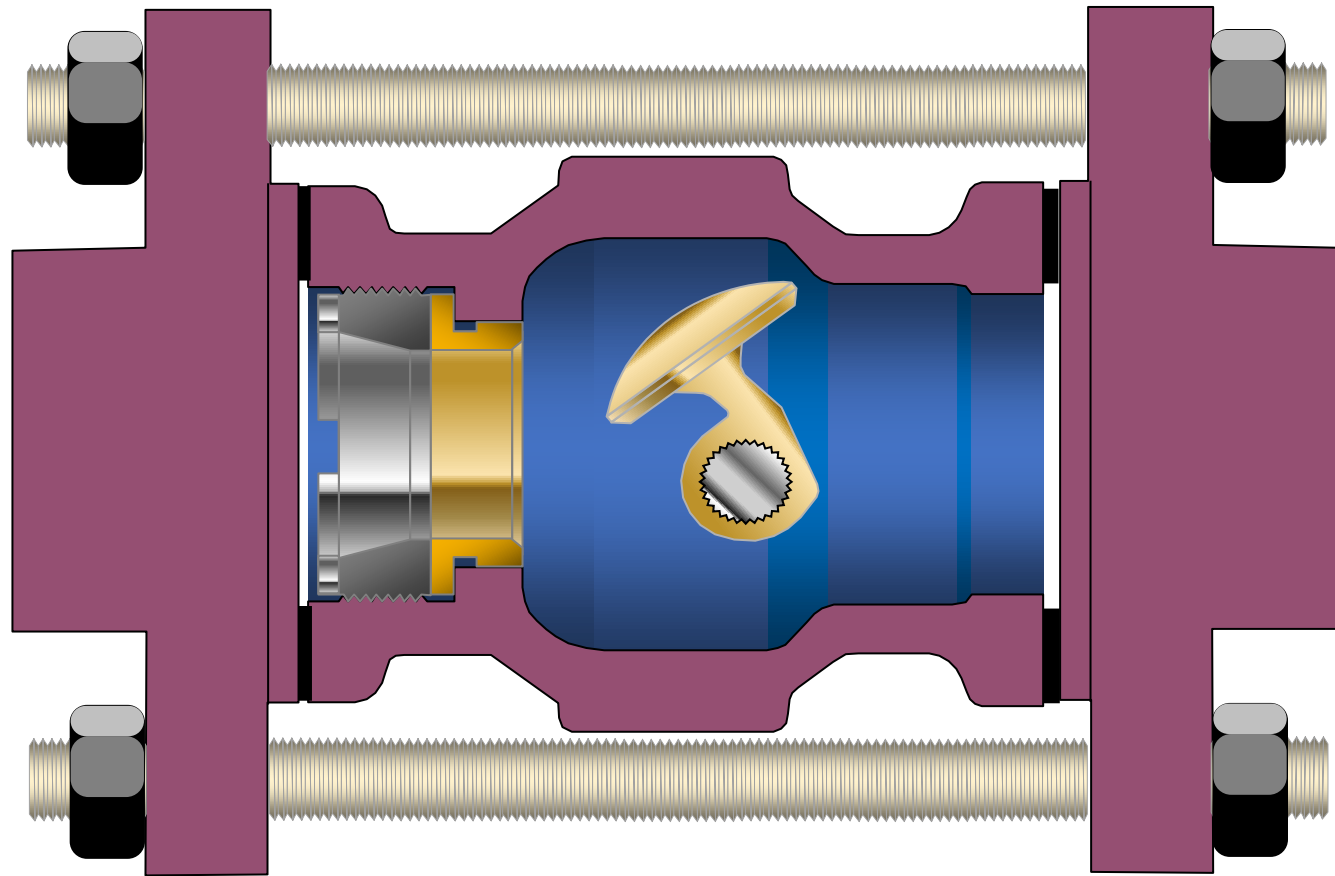
Classifications

Raised Face (RF)



Flanged Ends

Classifications

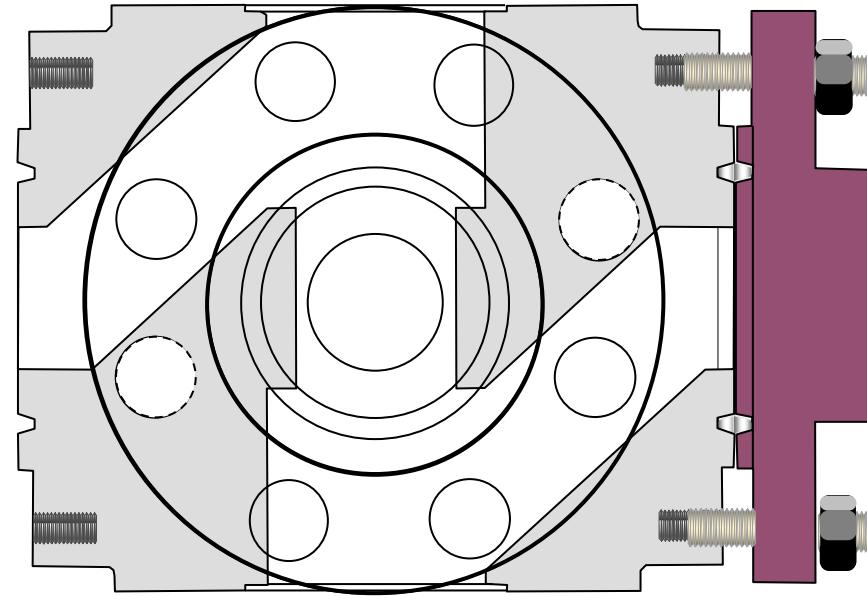


Flangeless



Flanged Ends

Classifications



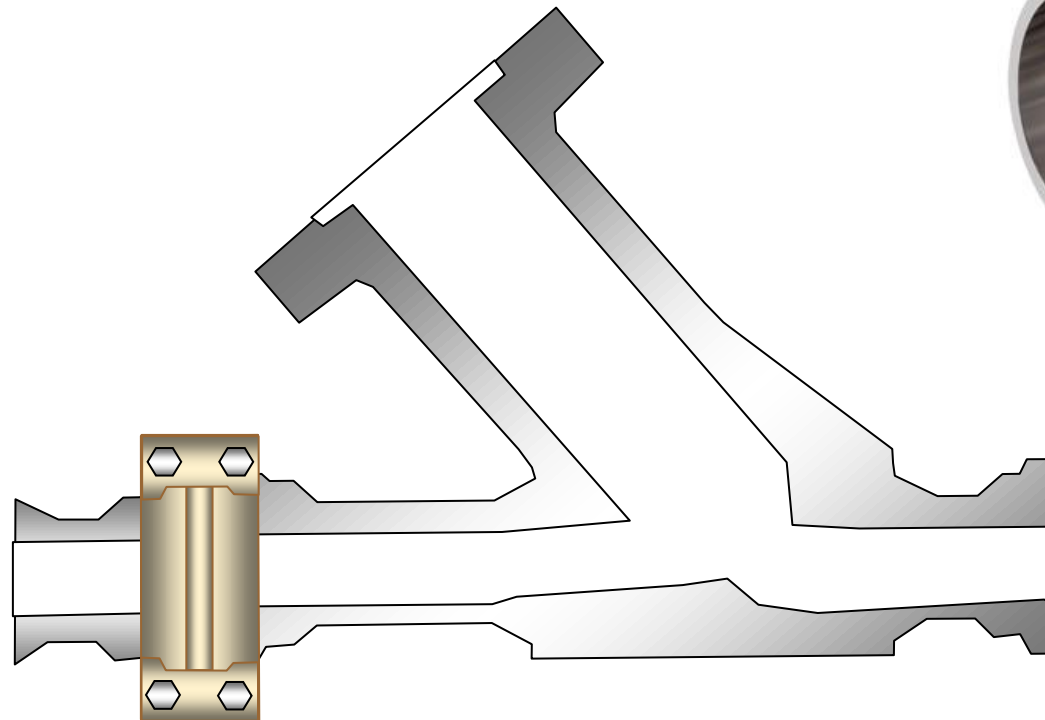
Ring Type Joint (RTJ)



Flanged Ends

Classifications

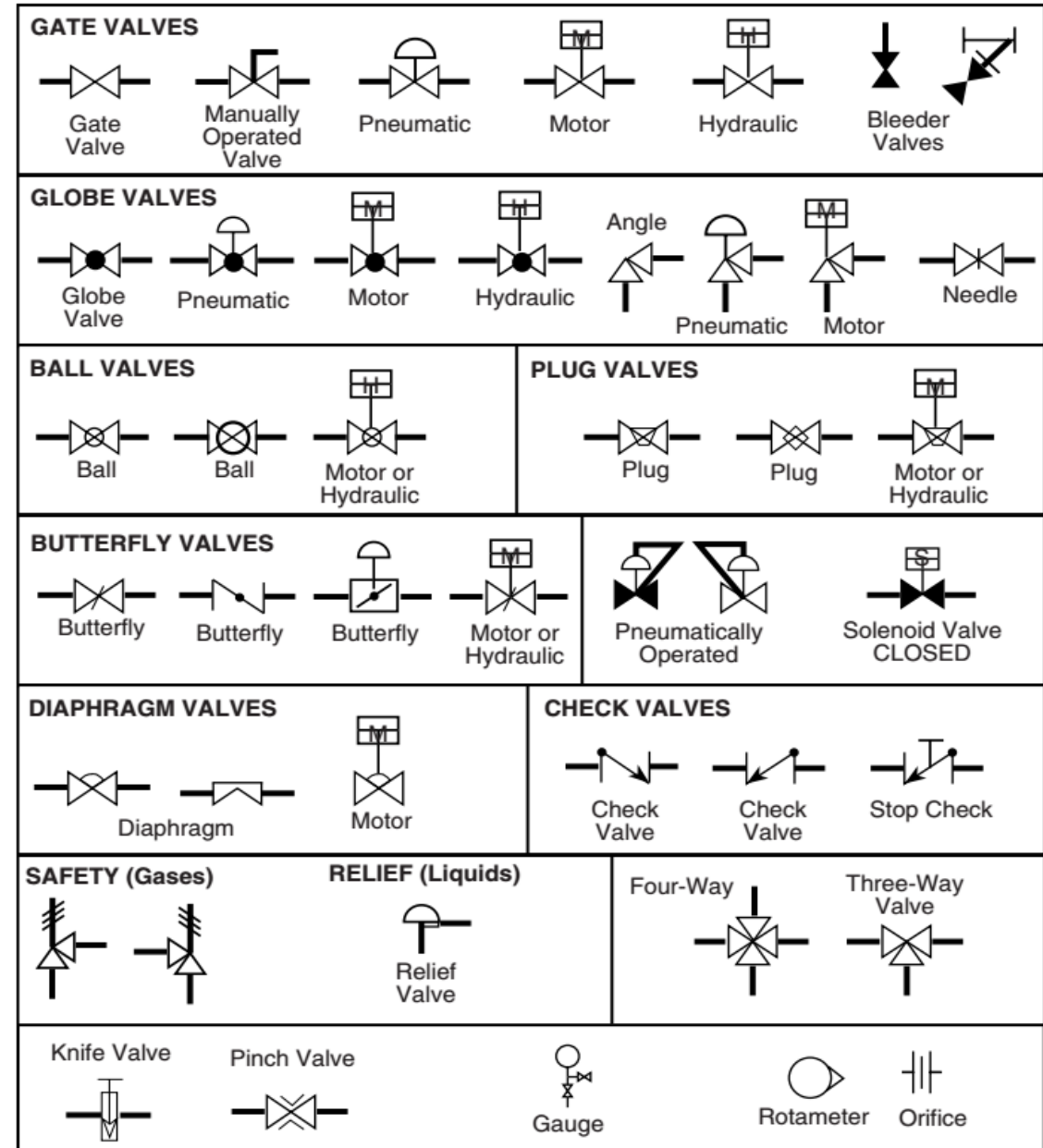
Clamp Connection



PID Symbols

Valves P&ID

Drawing Engineering



Control Valve



Control valve parts

Actuator

Valve BODY



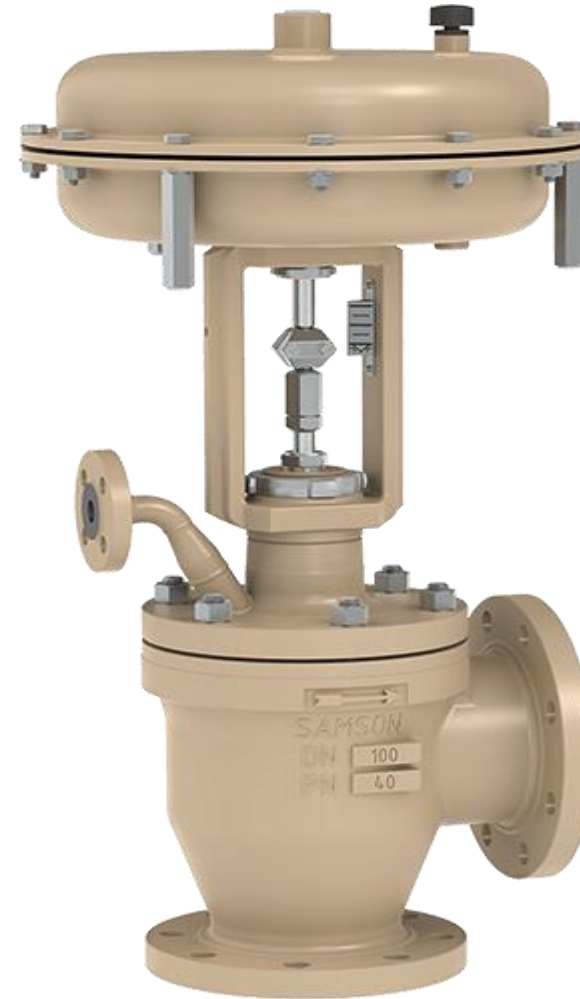
Control valve parts

Actuator

Provides the mechanical power necessary to move the components within the valve body

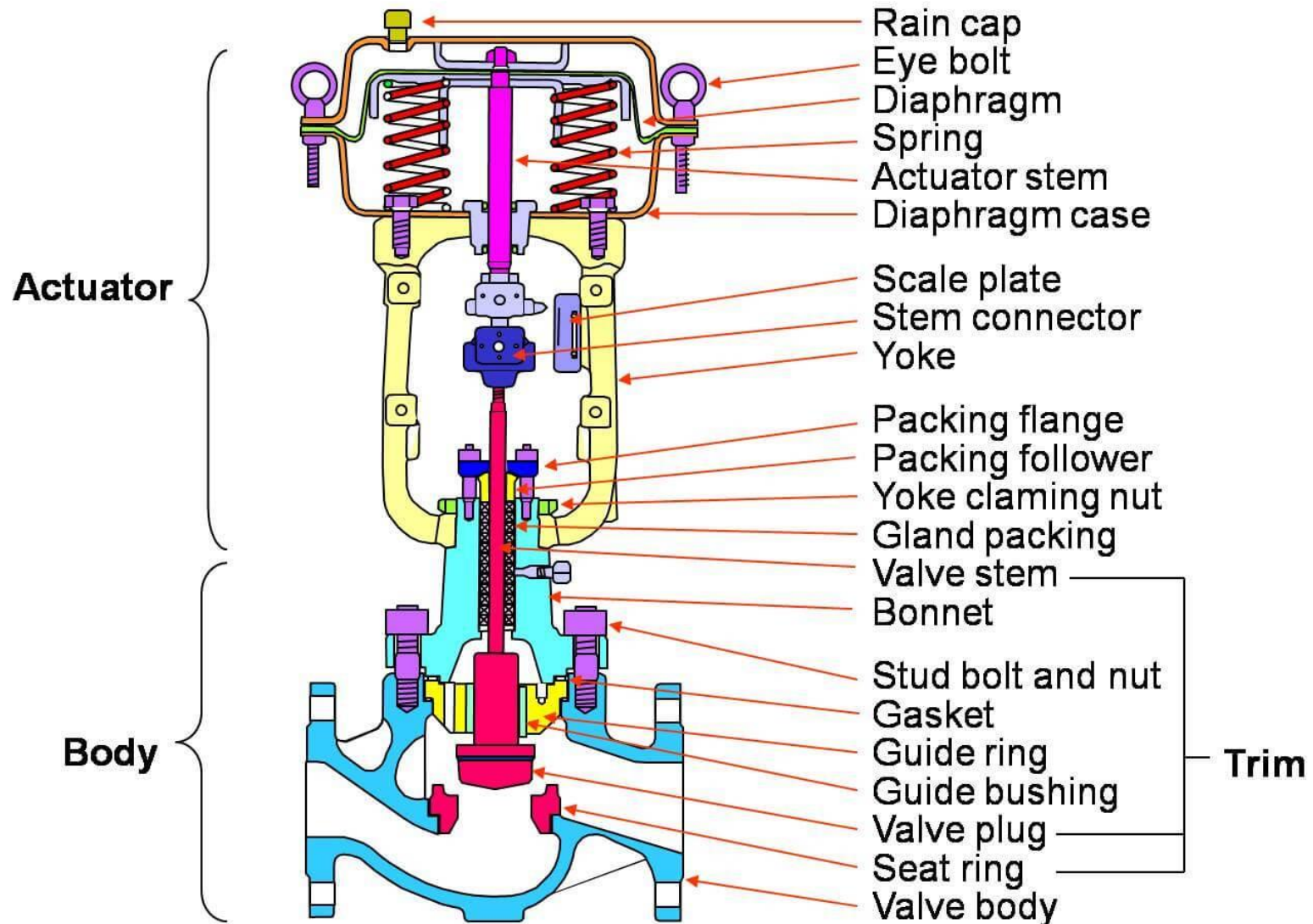
Body

Contains all the Mechanical components necessary to influence fluid flow

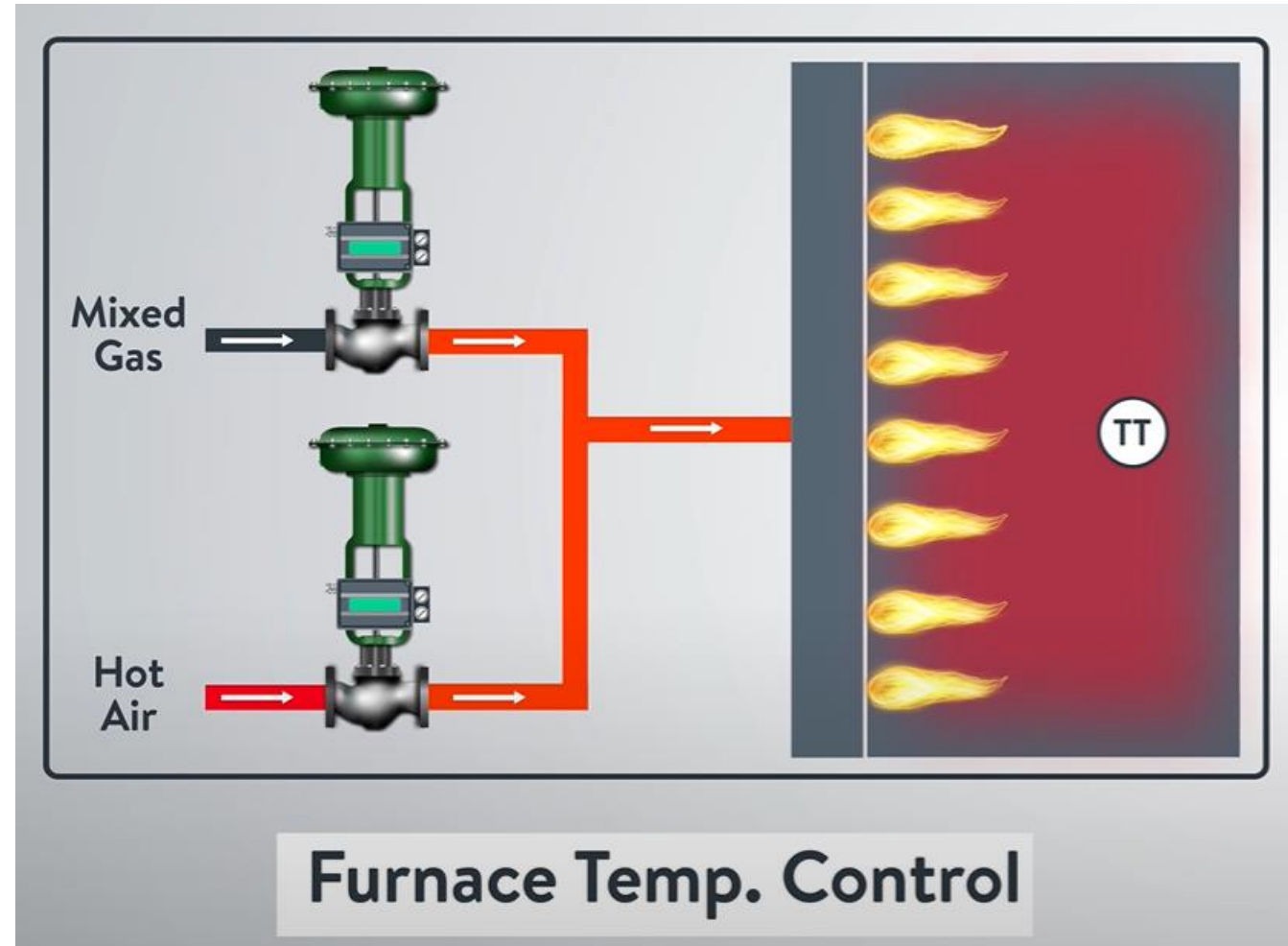


Control valve parts

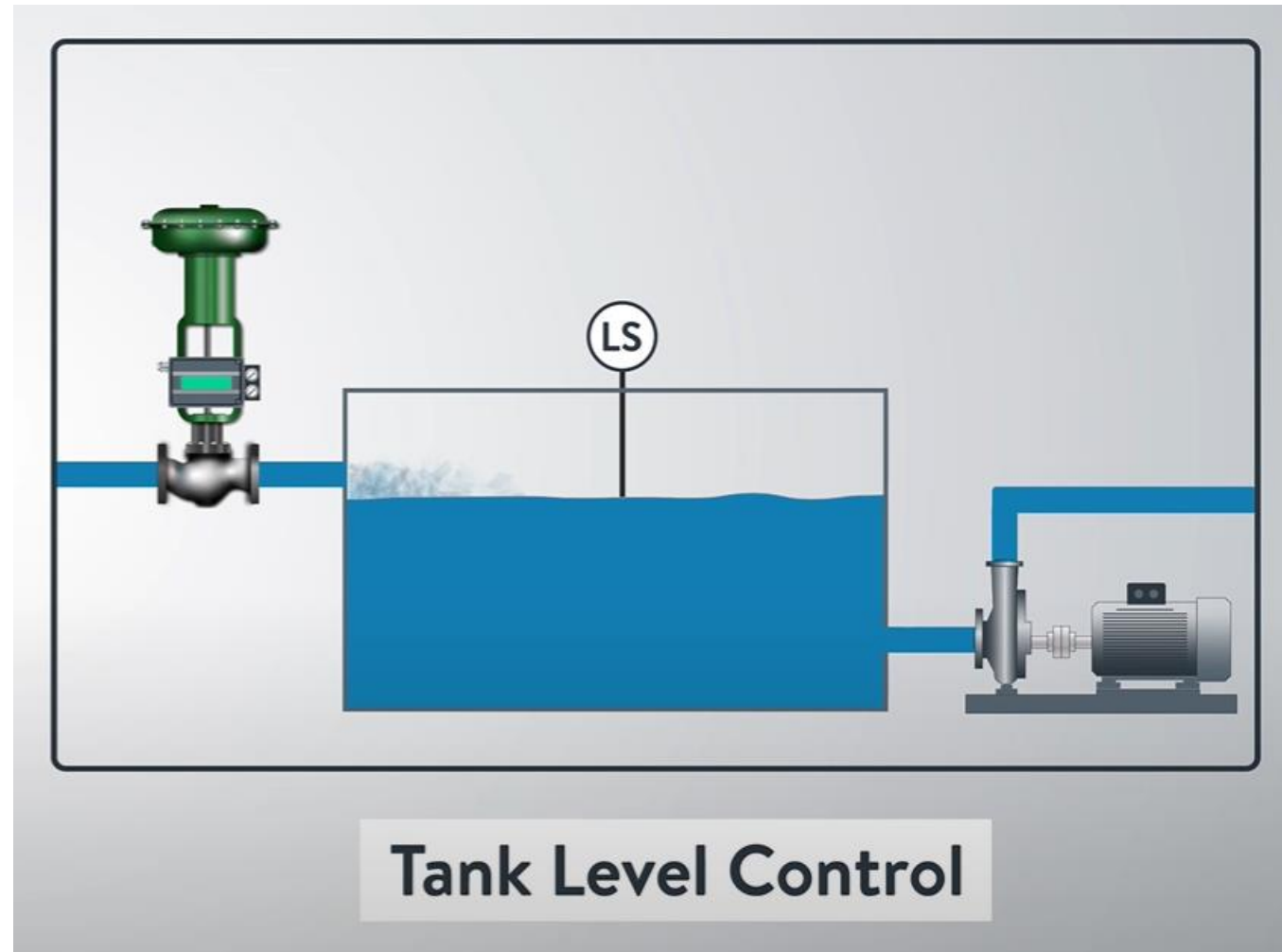
The internal elements of a valve are collectively referred to as a valve's trim.



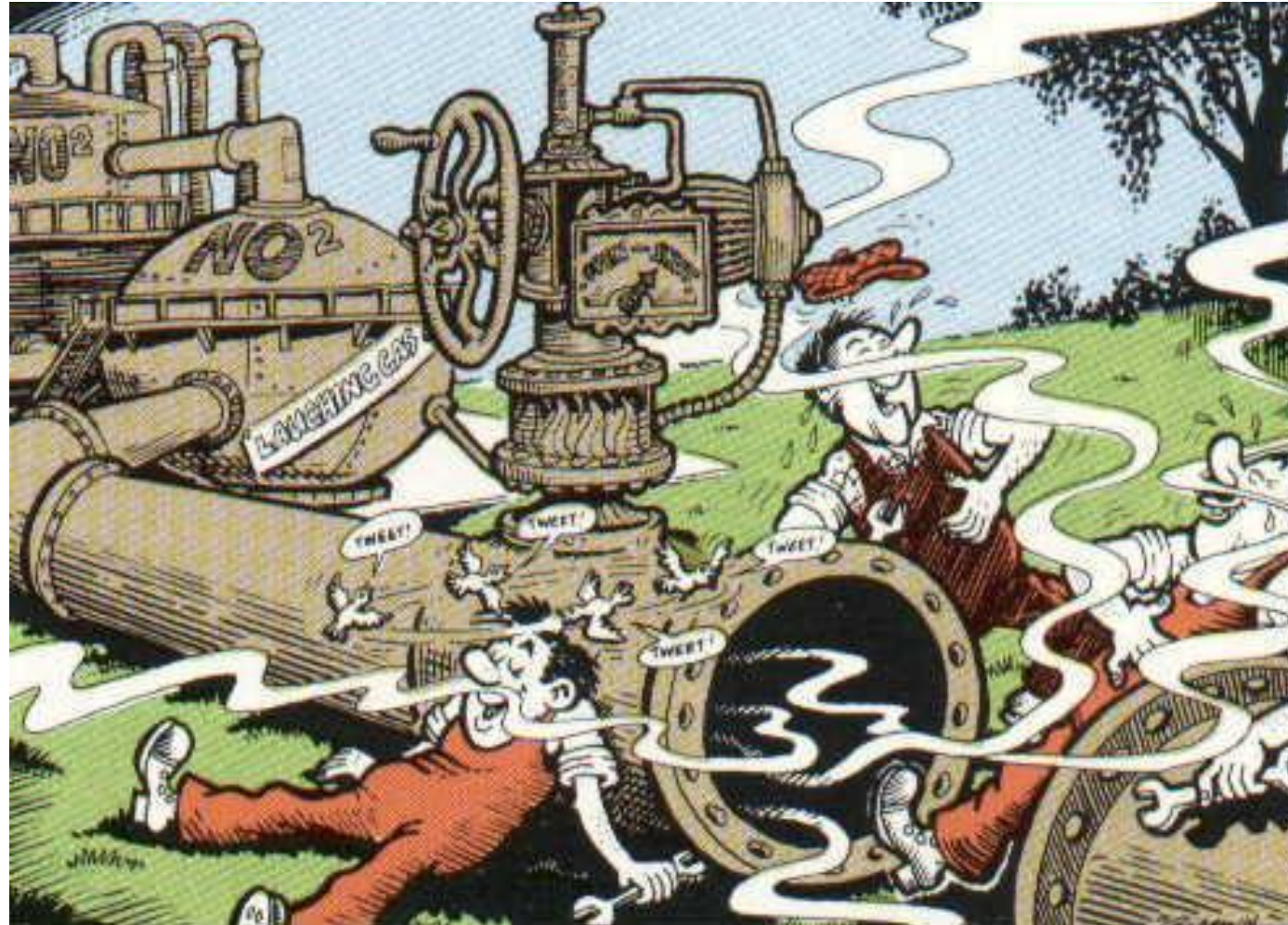
Control valve Applications



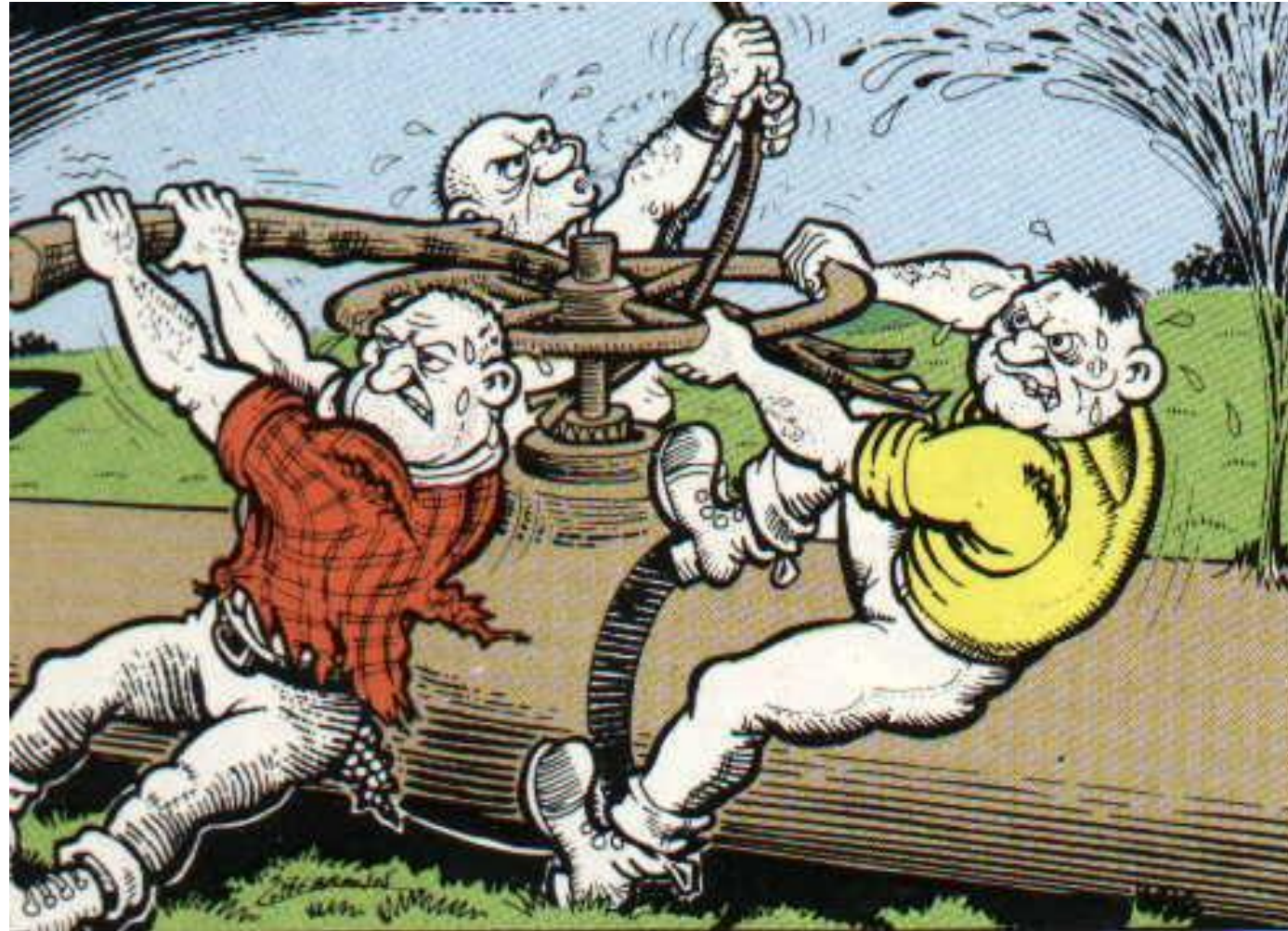
Control valve Applications



Why actuator required?



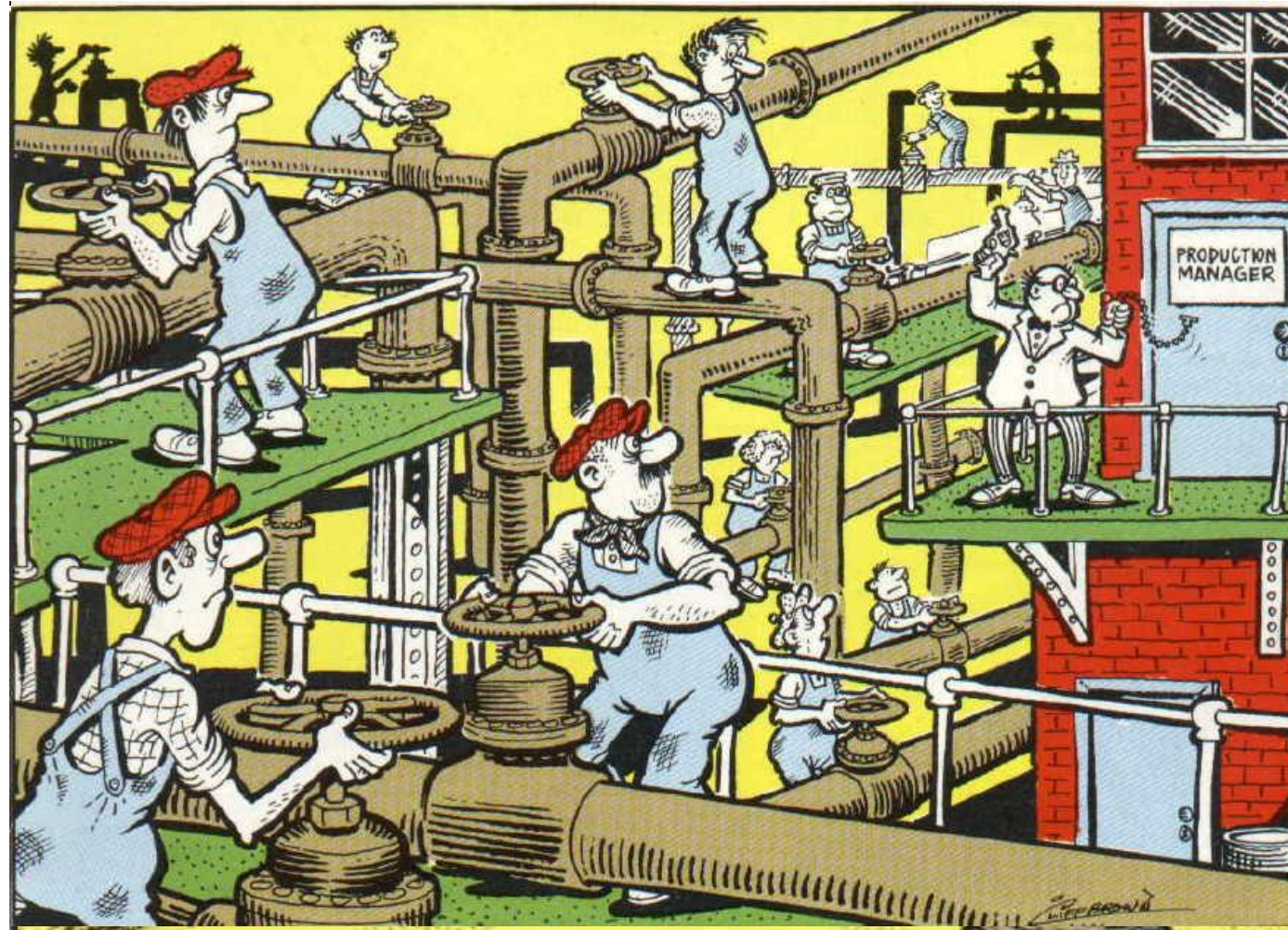
Why actuator required?



Why actuator required?



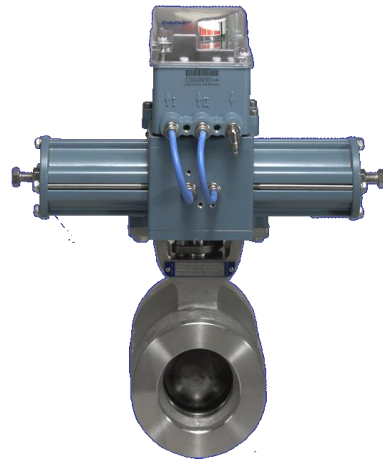
Why actuator required?



Types of Control Valves



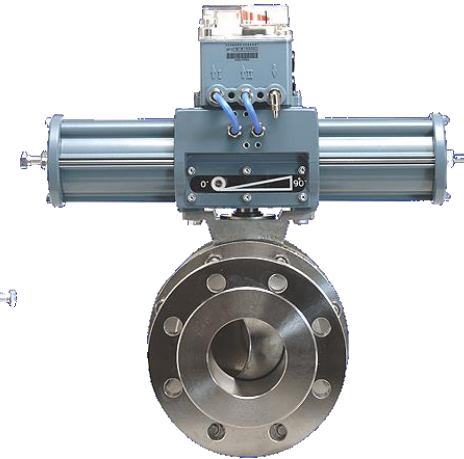
Globe valve



Ball sector valve



Butterfly valve



Ball valve



Globe valve



Types of Actuators

- Actuator: An actuator is a pneumatic hydraulic, or electrically powered device which supplies force and motion to open or close a valve.
- There are six main types of actuator:
 - Manual
 - Electric motor
 - Electric solenoid
 - Pneumatic
 - Hydraulic
 - Self-actuated—check valves, PRVs and PSVs



Manual Valve Actuators



Hand Wheels



Chain Operated



Gear Operated

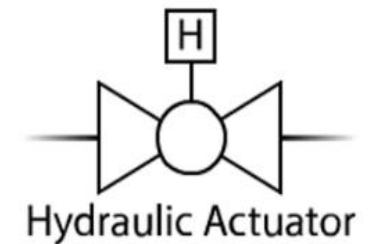
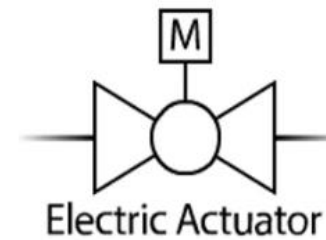
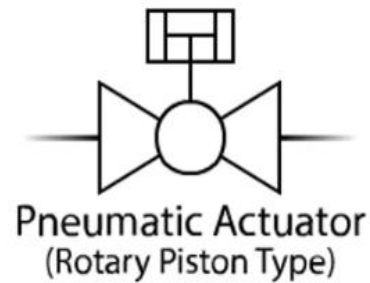
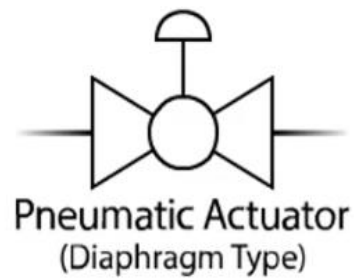


Lever Operated

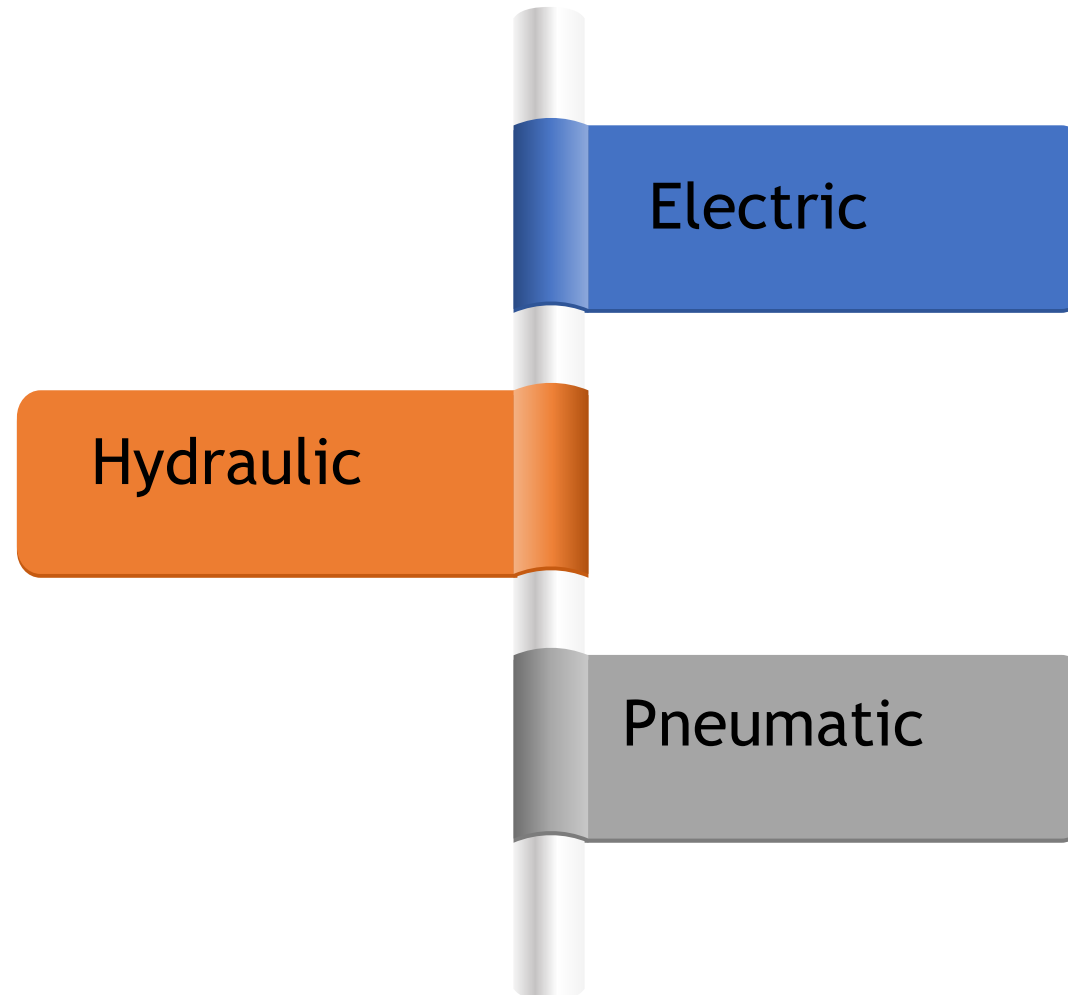


Types of Actuators

Now P&ID Symbol as per Actuator



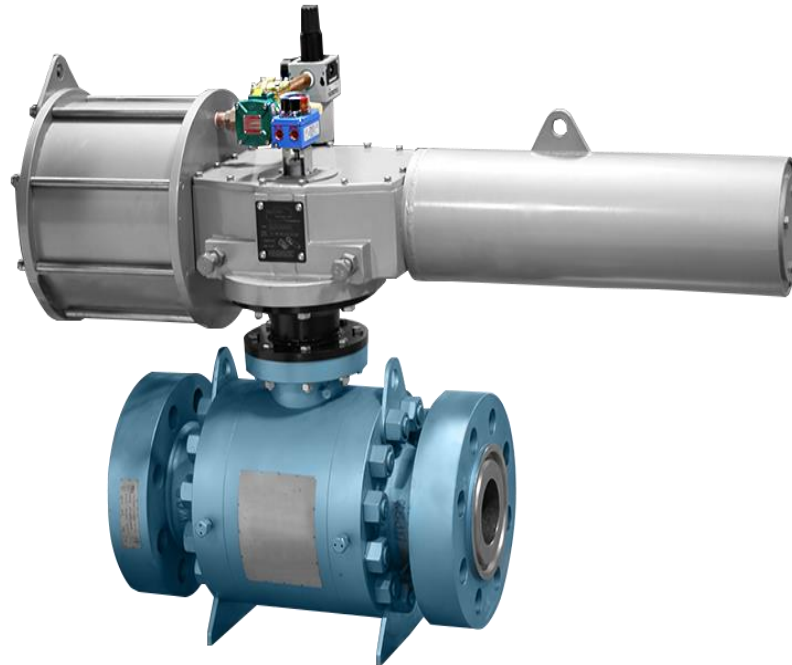
Types of automatic Actuators



Automatic Valve Actuators



a) Electric ACTUATORS



b) Hydraulic ACTUATORS

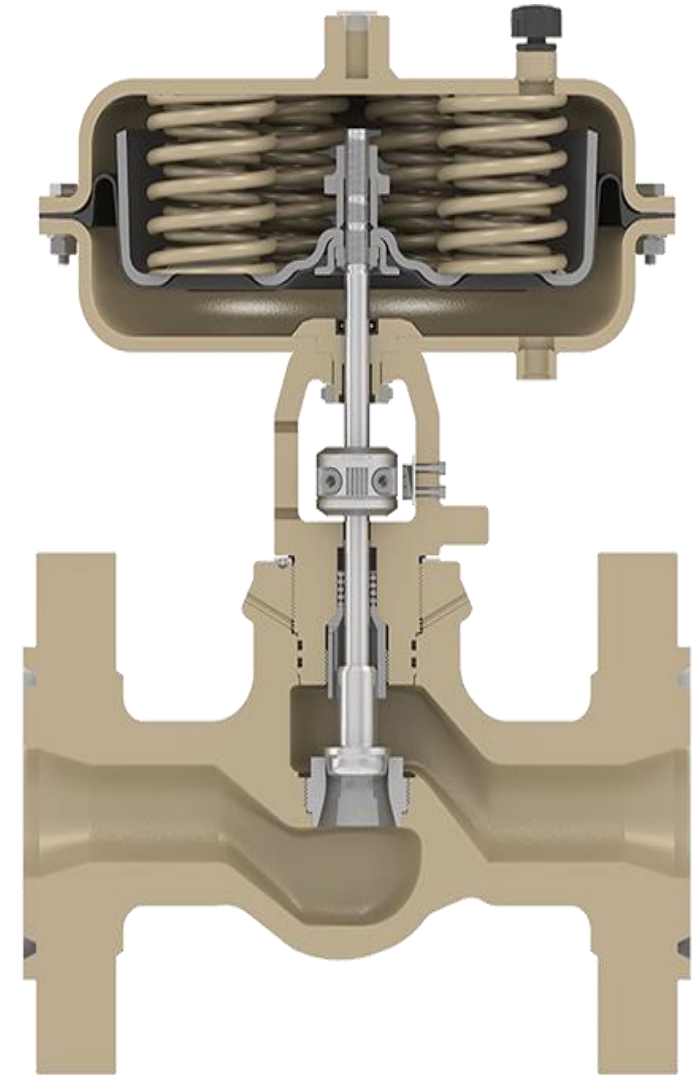


c) Pneumatic ACTUATORS

Automatic Valve Actuators

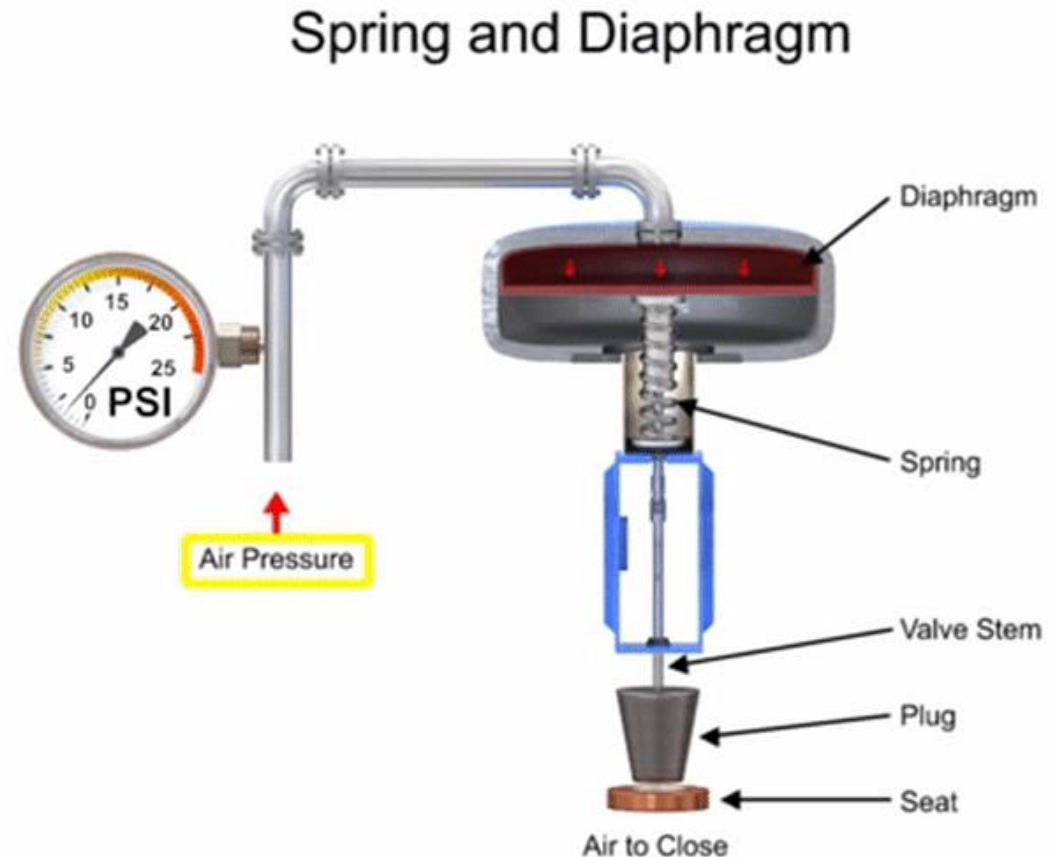
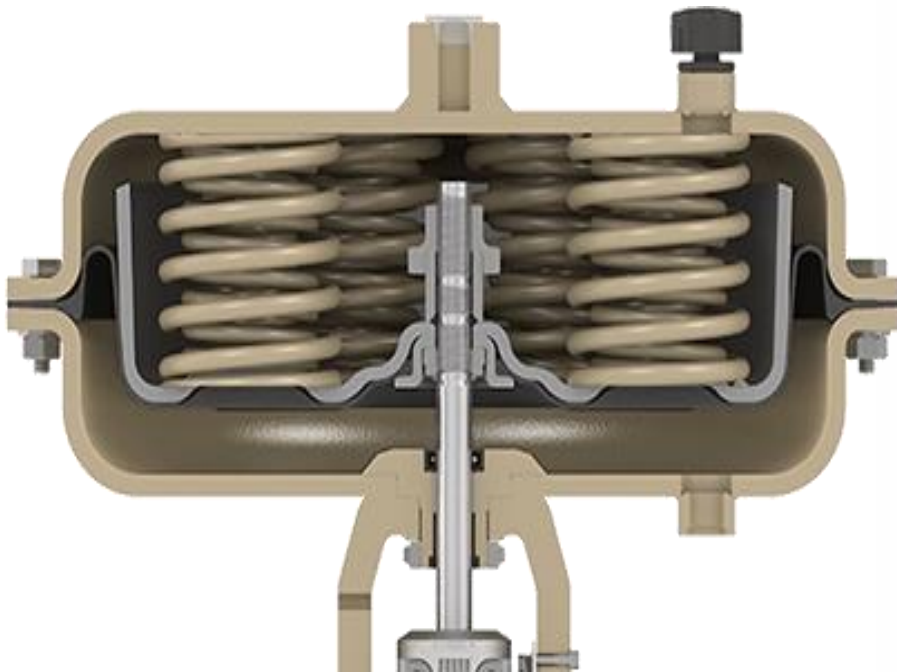
a. Pneumatic Actuators

- A● Use air pressure pushing against either a flexible diaphragm or a piston to move a valve mechanism.
- B● Air pressure required to motivate a pneumatic actuator may come directly from the output of a pneumatic process control, or from signal transducer translating an electrical signal into an air pressure signal (I/P)



Automatic Valve Actuators

a. Pneumatic Actuators



Automatic Valve Actuators

a. Pneumatic Actuators

Failure mode

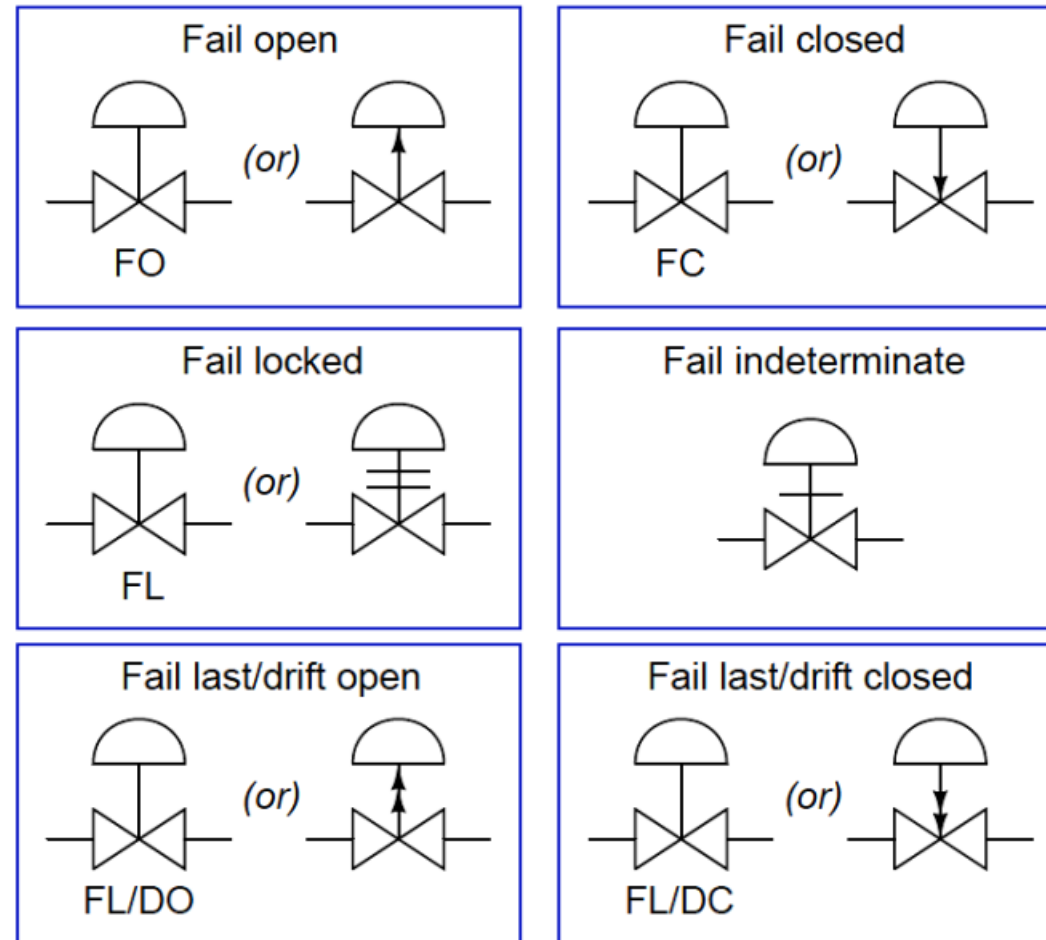
- *Air to open*
 - spring to close.
 - valve fails in the closed position if the air system goes down.
 - air supply located on the bottom of the dome.
- *Air to close*
 - spring to open.
 - valve fails in the open position, if the air system goes down.
 - air supply located on the top of the dome



Automatic Valve Actuators

a. *Pneumatic Actuators*

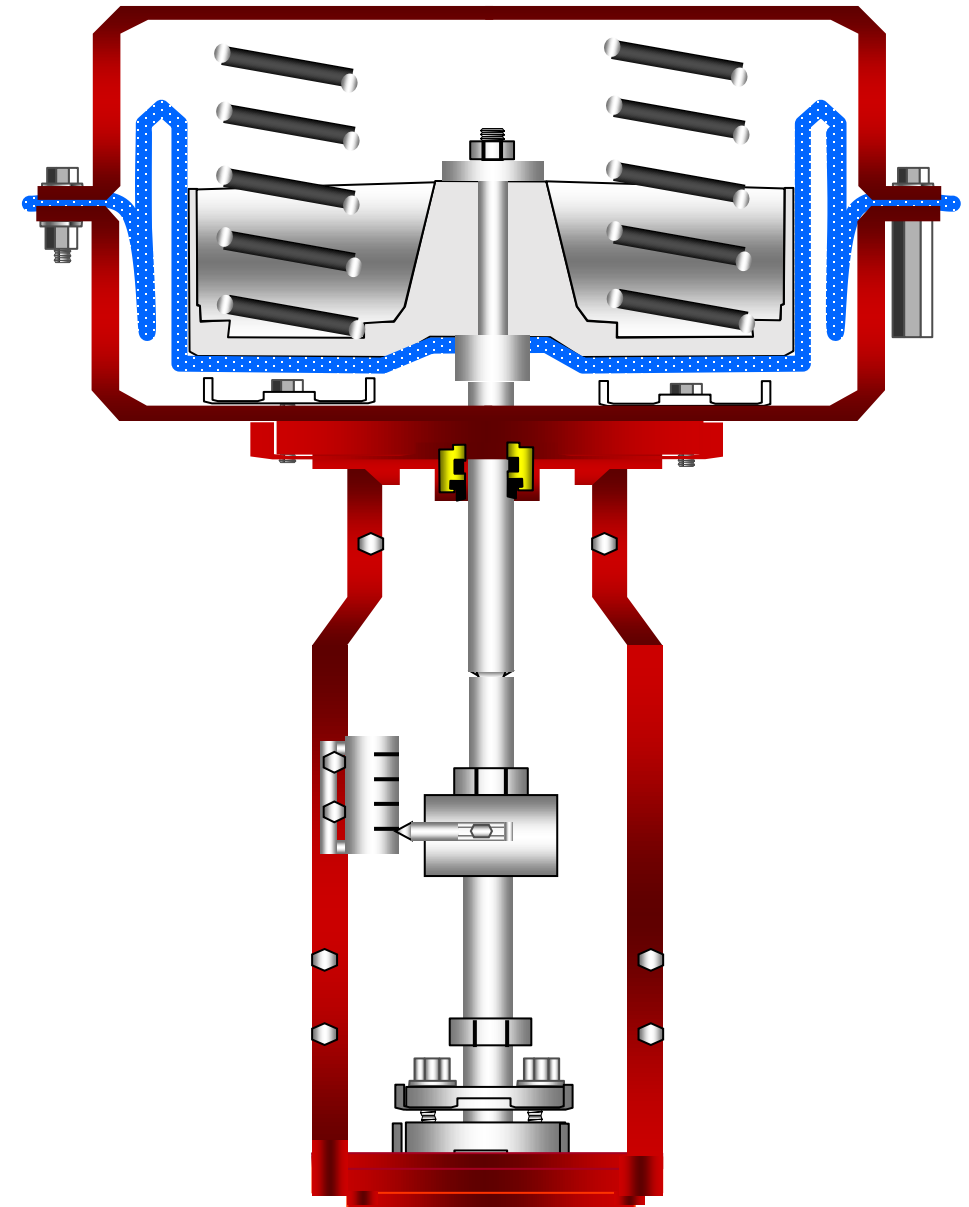
Failure mode



Control valve

Automatic Valve Actuators

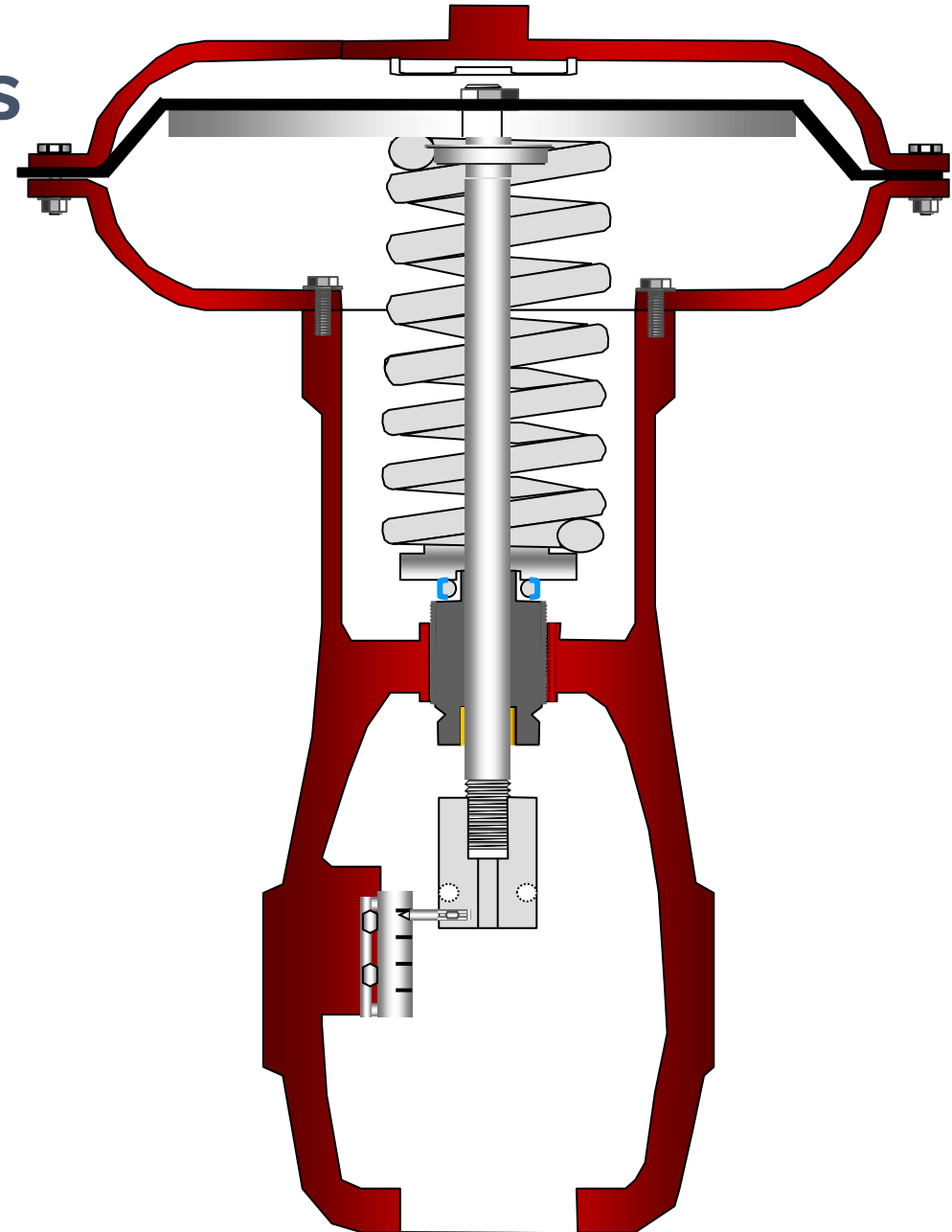
Fail Close



Control valve

Automatic Valve Actuators

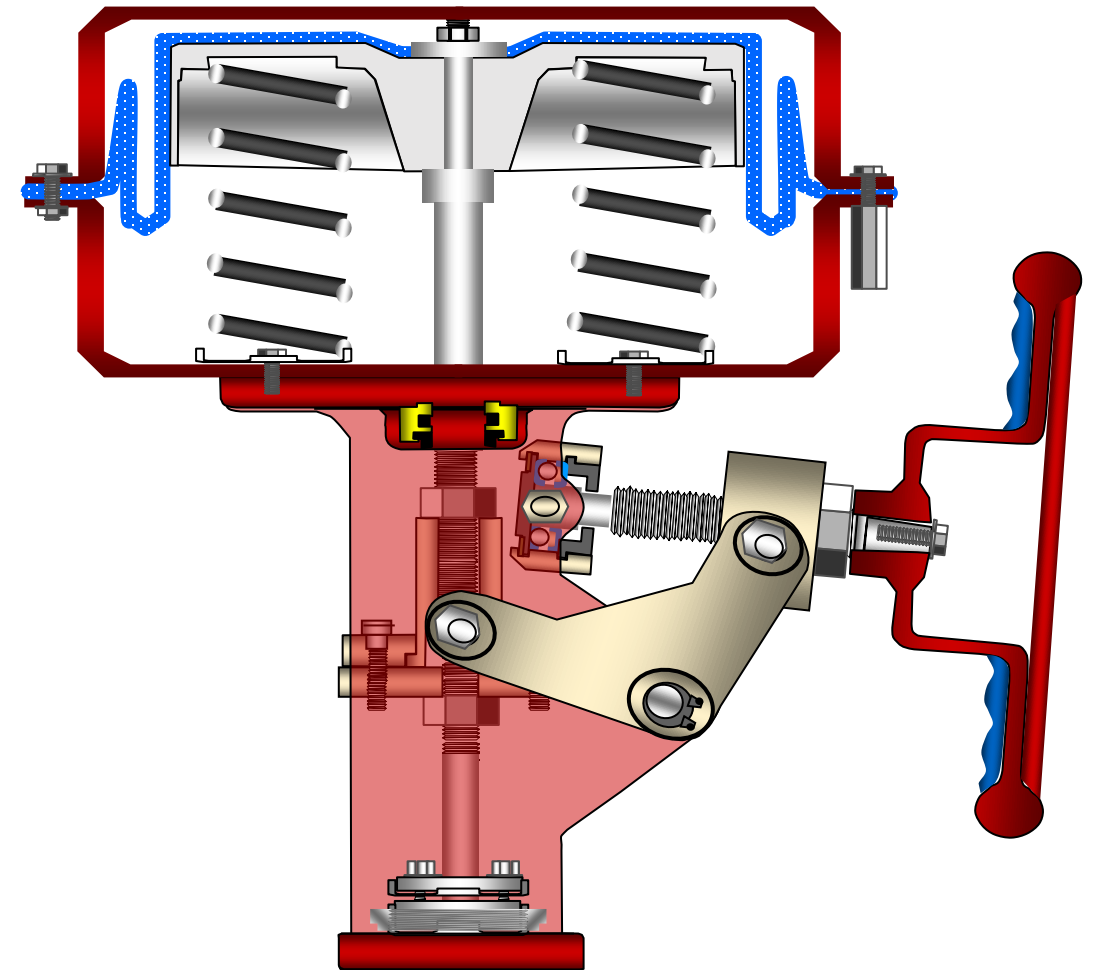
Fail Open



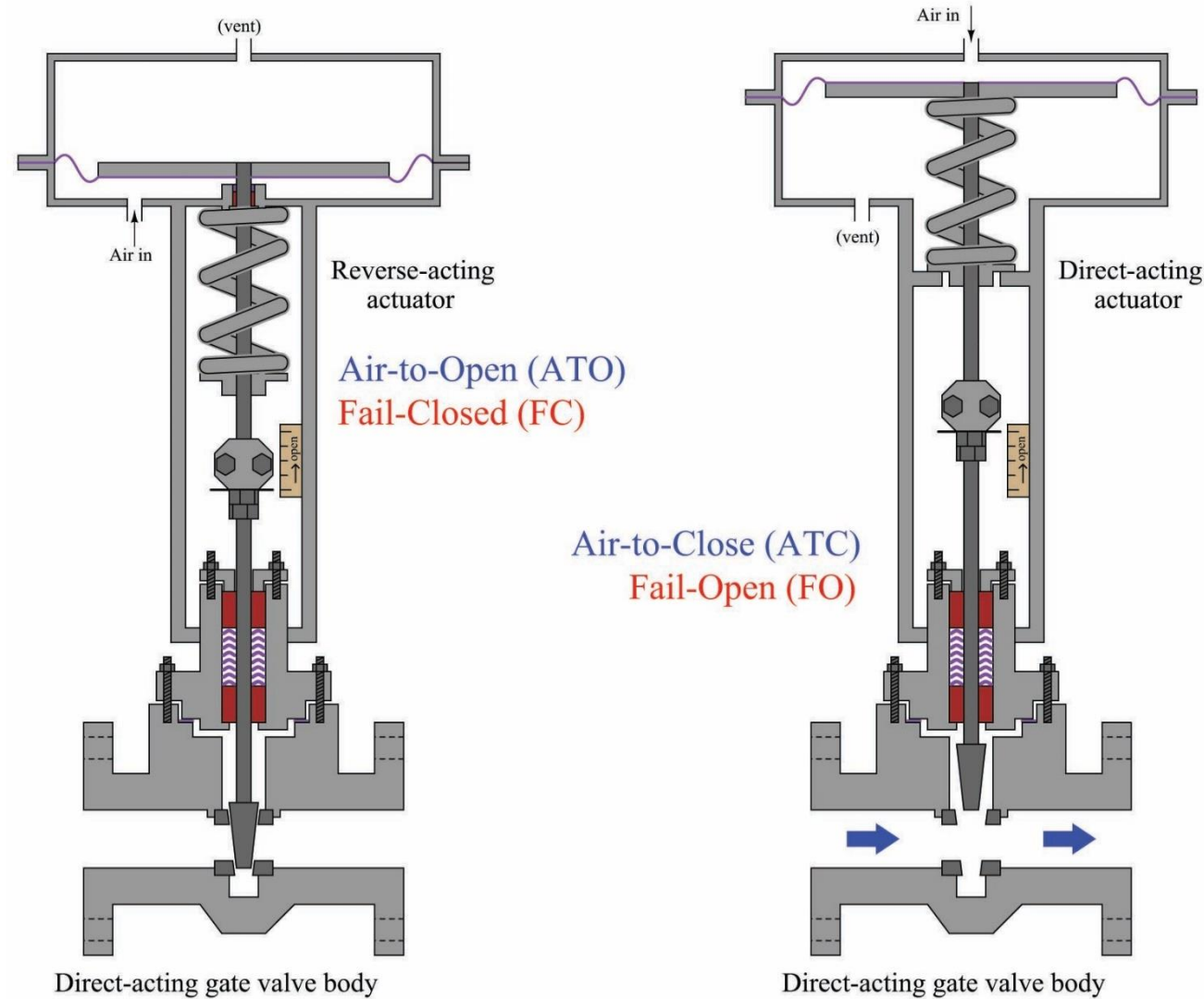
Automatic Valve Actuators

Manual Override

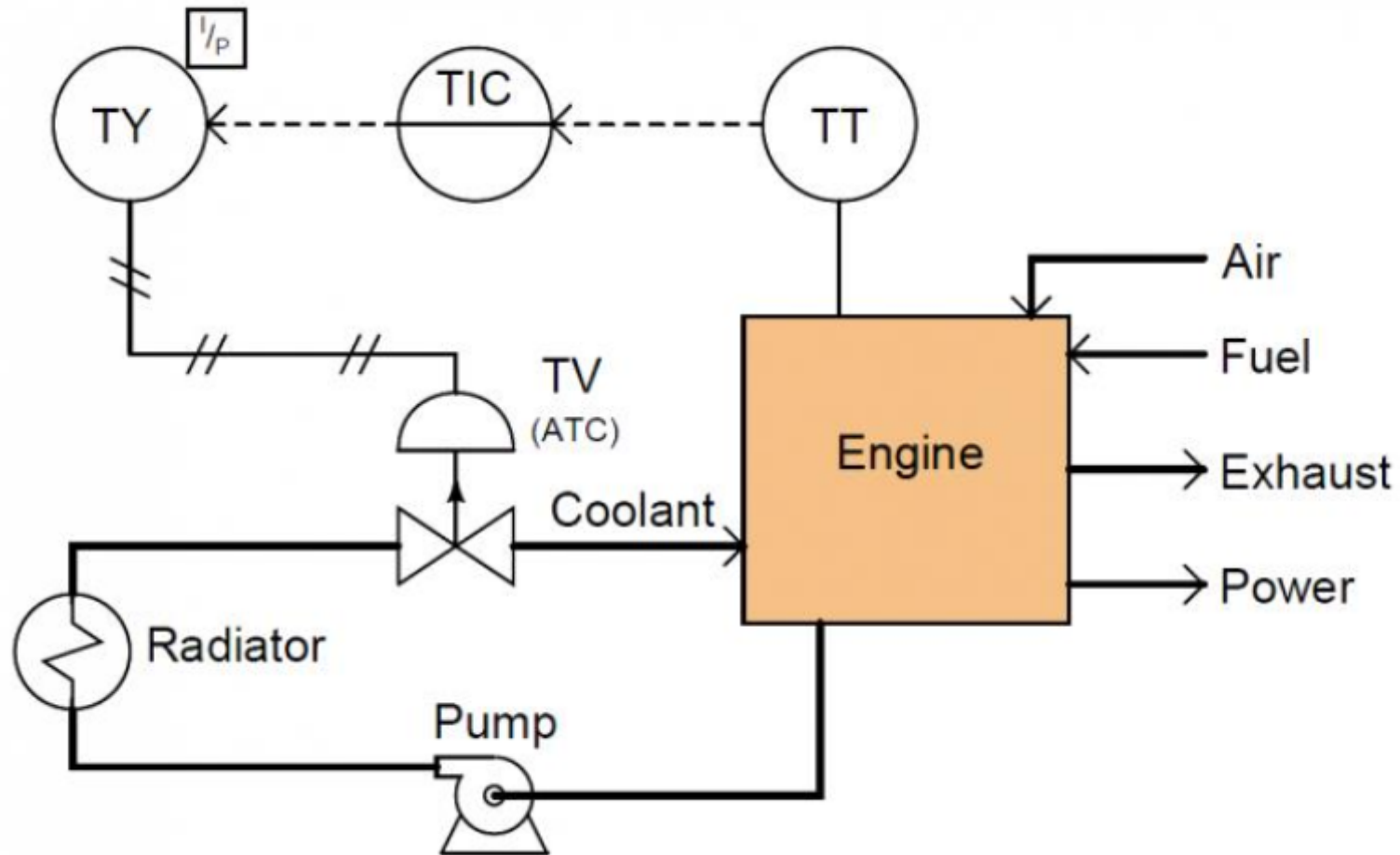
- ATC/FO
 - Side Mounted H/W



Automatic Valve Actuators



Automatic Valve Actuators

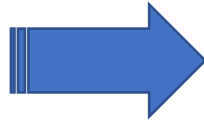


Control loop

Control valve



PLC
Logic



Electrical – Pneumatic
positioner



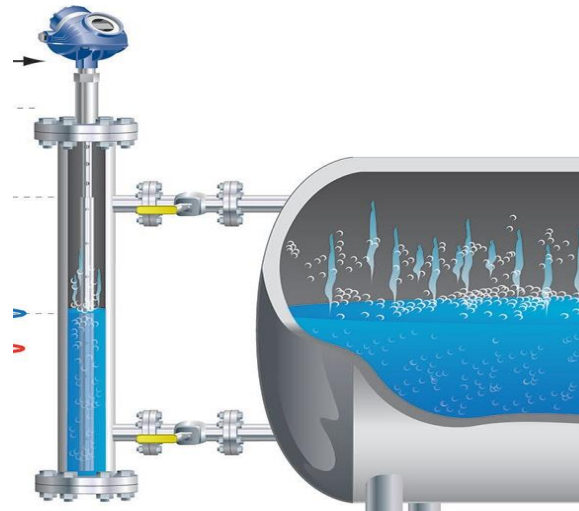
Pneumatic Actuator

Translate



Control loop

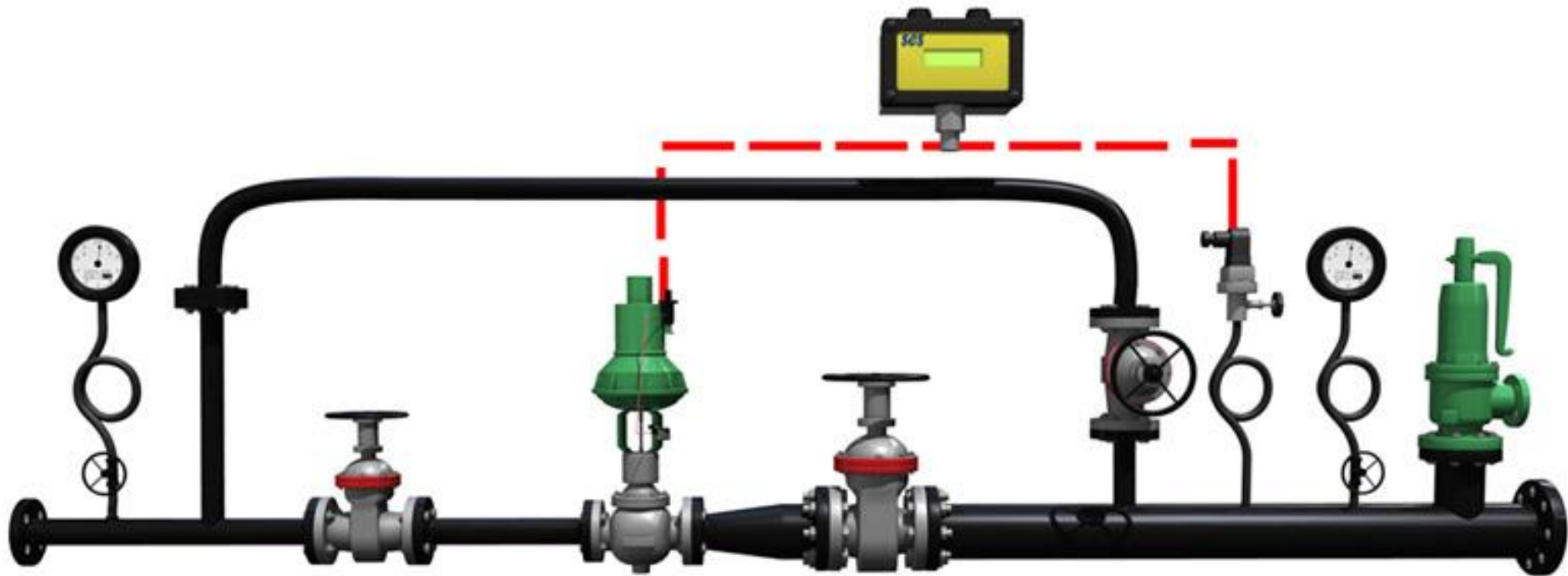
Process variables - Sensors



Electrical – Pneumatic
positioner
Translate



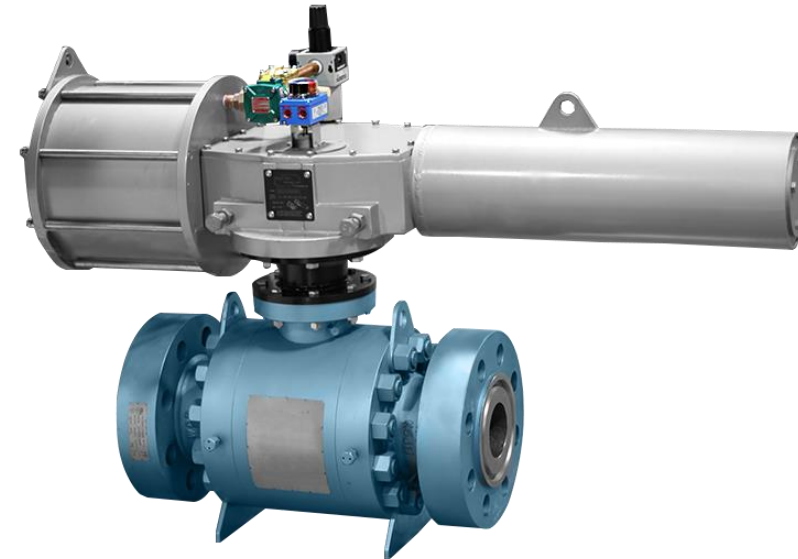
Valve Arrangement



Automatic Valve Actuators

b. Hydraulic actuators

- Uses liquid pressure rather than gas pressure to move the valve mechanism.
- use a piston rather than a diaphragm to convert fluid pressure into mechanical force
- More powerful than a pneumatic actuator of the same size



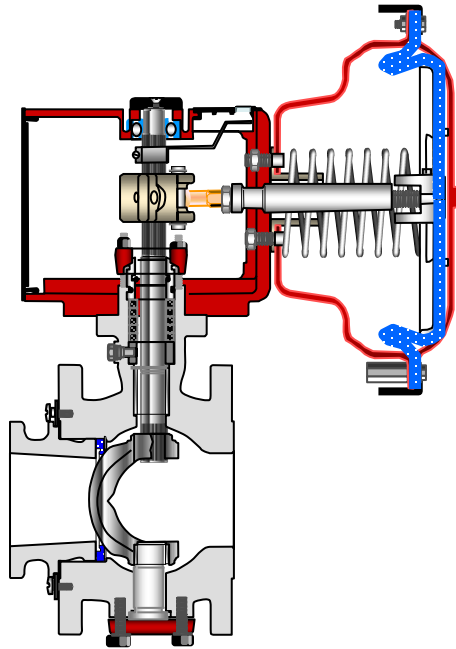
Automatic Valve Actuators

c. *Electrical actuators*

- A • Electric actuators include electric motors and solenoid-actuated valves. Electric motors can be used to open, close, and position a valve manually, automatically, or semi-automatically.



Control Valve motion

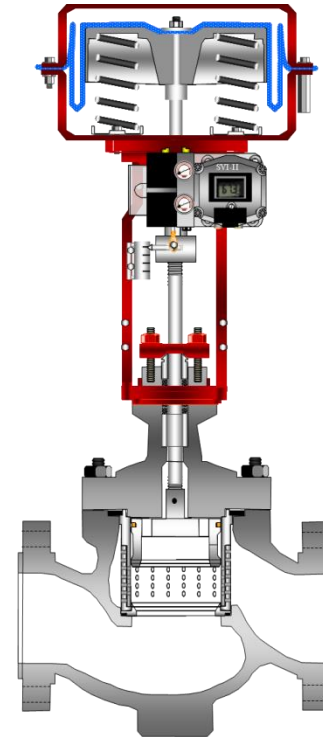


- **Reciprocating**

- Globe
- Angle
- Severe Service

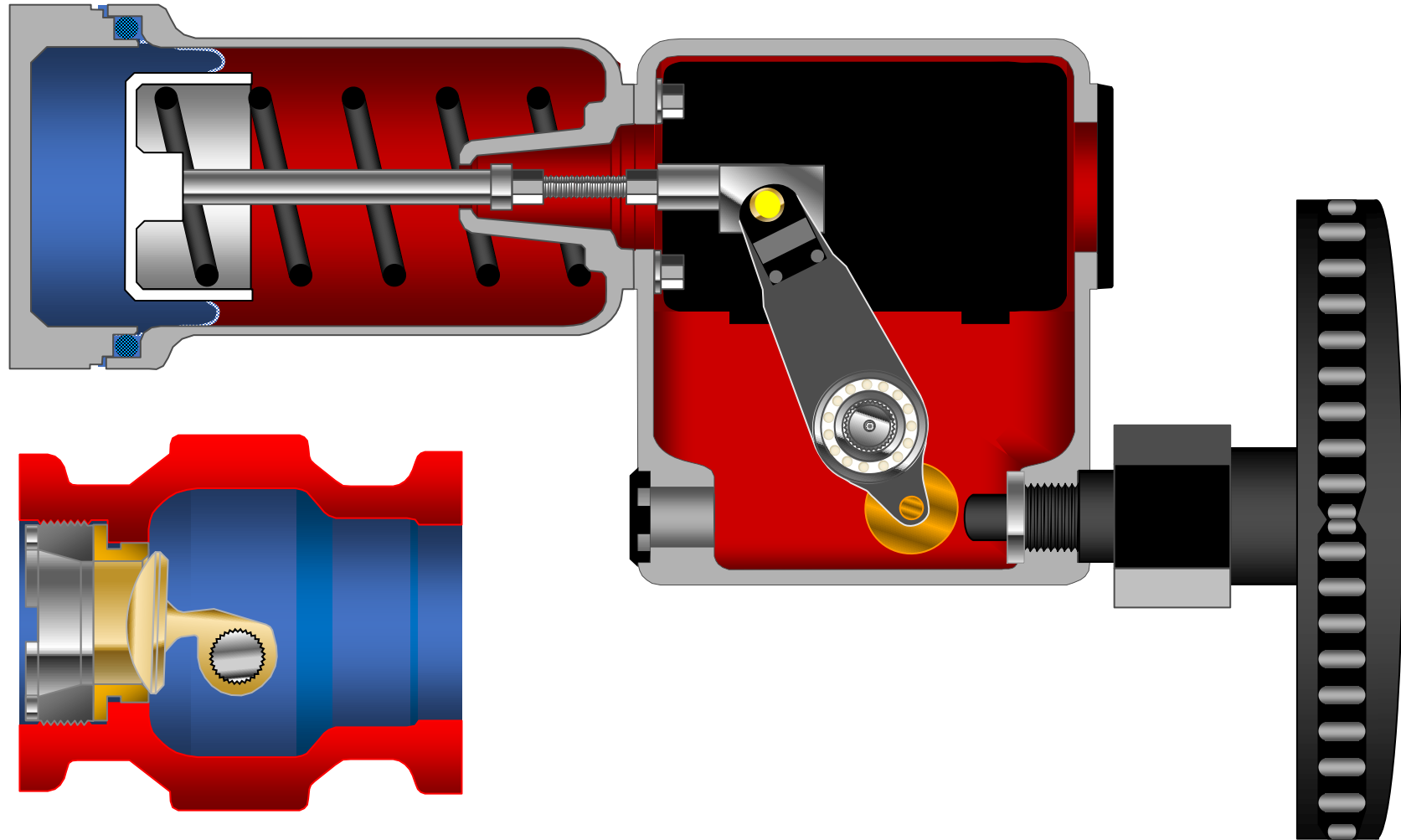
- **Rotary**

- Butterfly
- Ball
- Rotary Globe

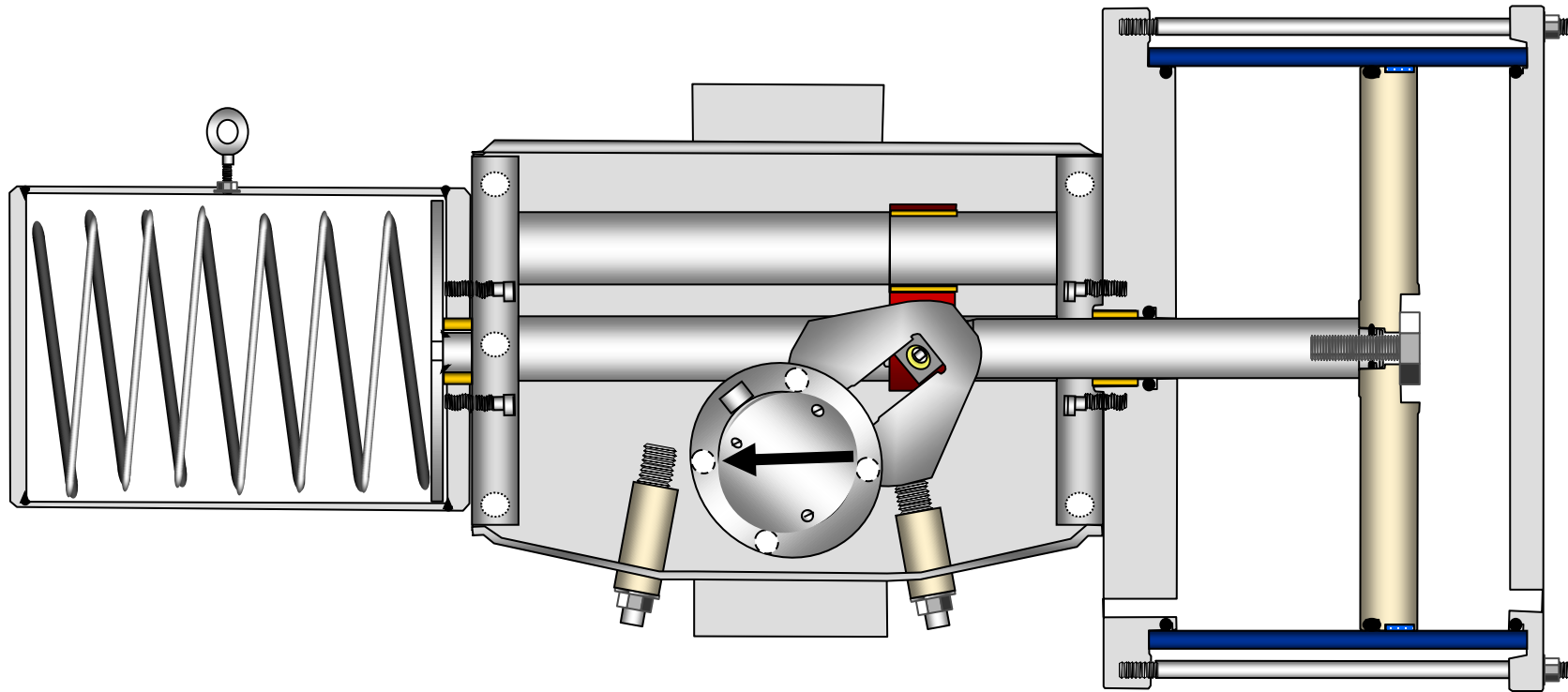


Control valve

Actuator Mechanism

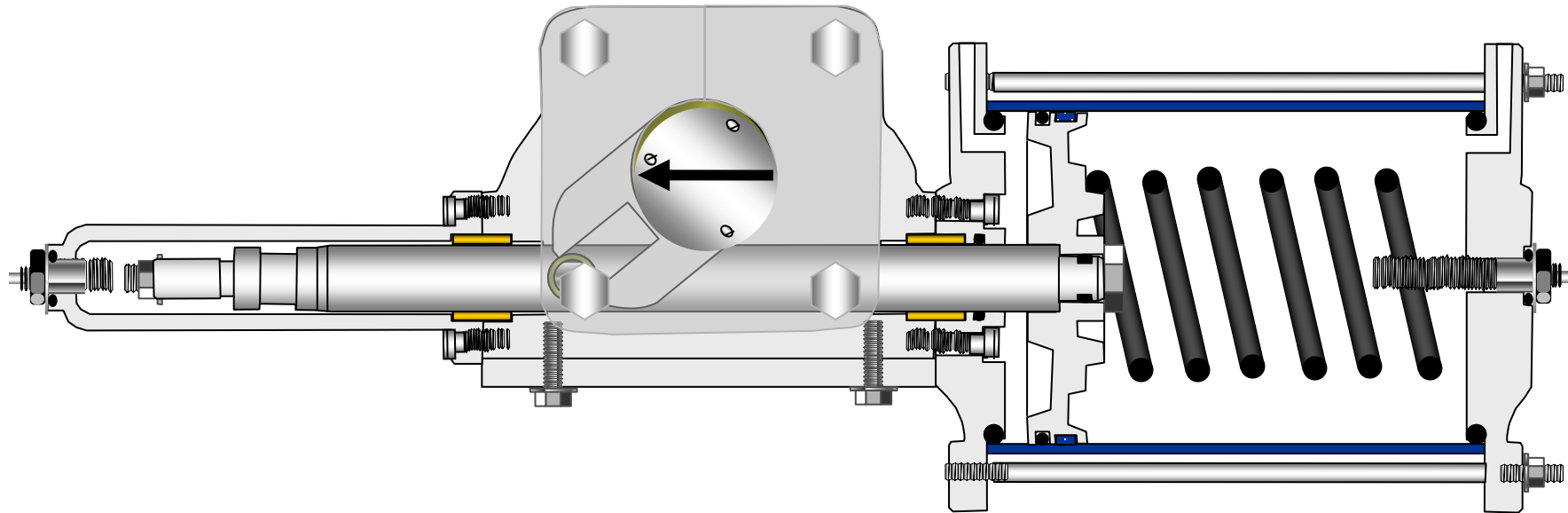


Actuator Mechanism

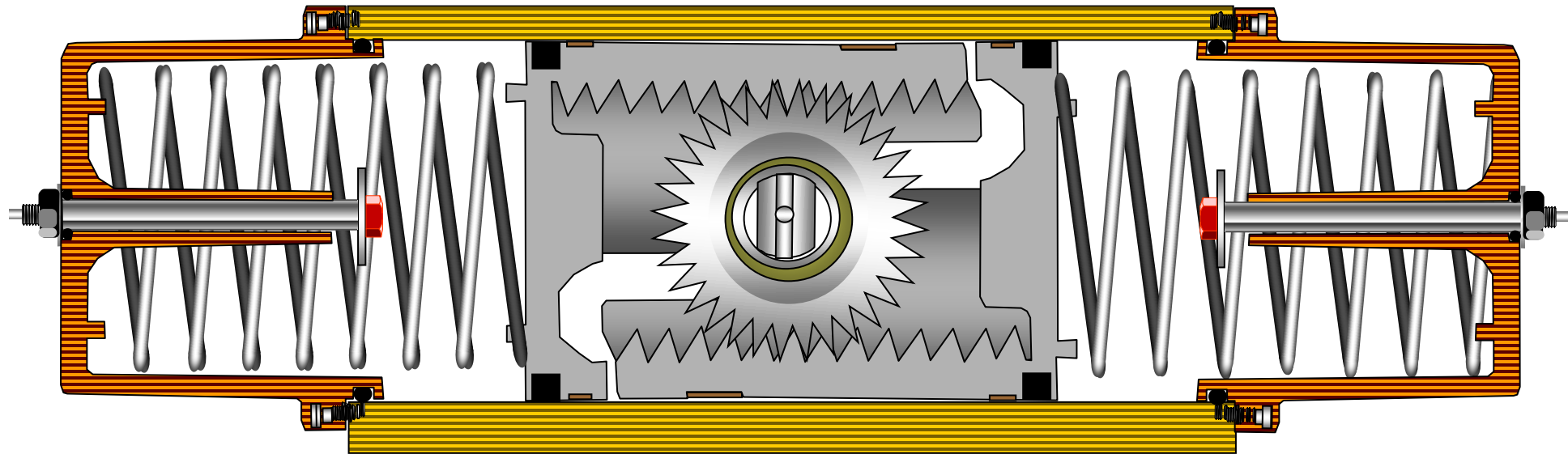


Actuator Mechanism

Pneumatic Piston Actuator Single Acting

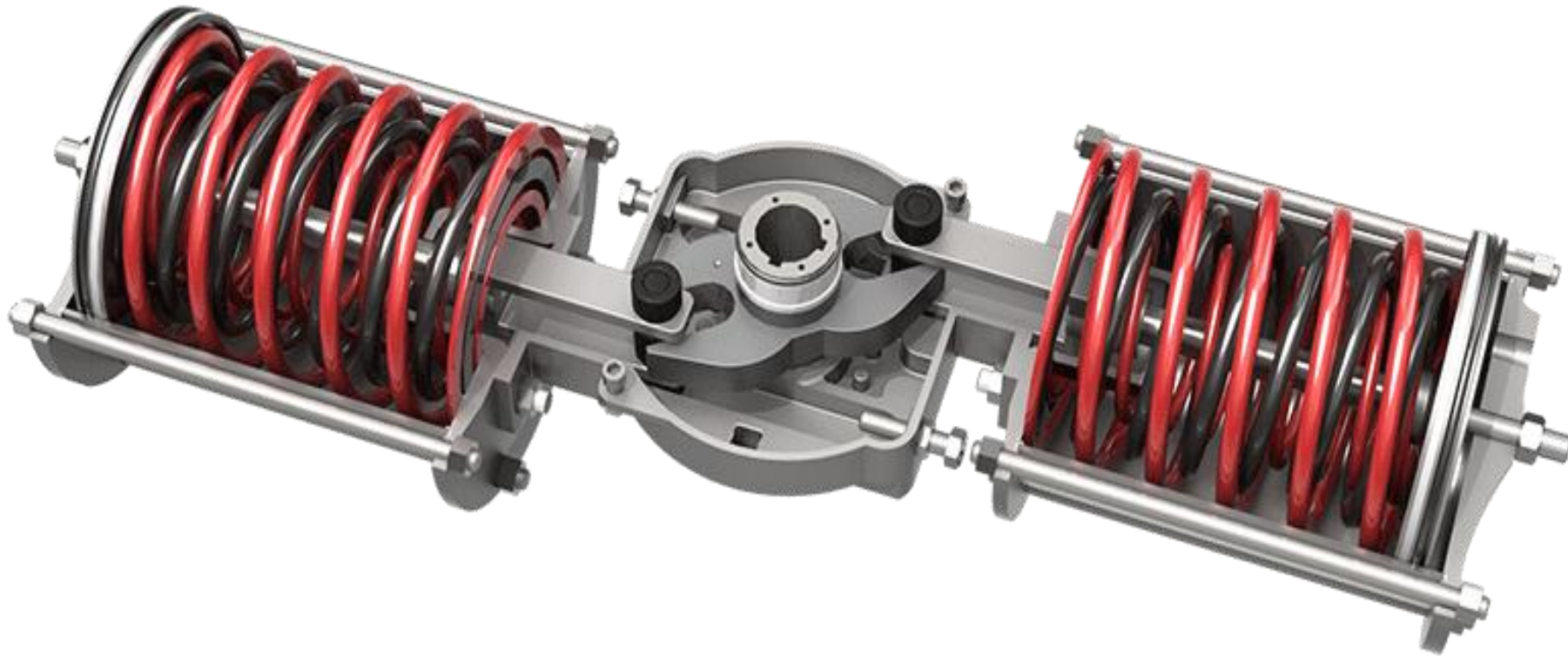


Valve Operation



Control valve

Valve Operation



Actuators Component

Limit switch

A

-----● A limit switch is a device that is used to prove the open or closed position of a valve.



Control Valve sizing

a. Valve flow Coefficient

- Valve Flow Coefficient (C_v)
 - is a valve's capacity for a liquid or gas to flow through it.
 - It is technically defined as “the volume of water at 60°F (in US gallons) that will flow through a valve per minute with a pressure drop of 1 psi across the valve.”
 - In simpler terms, the larger the opening in a valve, the larger the C_v . As a valve is opening, the C_v increases until the valve is fully open, where it reaches its highest possible C_v , or 100% open C_v .



Control Valve sizing

a. Valve flow Coefficient

$$C_v = Q \sqrt{\frac{SG}{\Delta P}}$$

where:

Q is the rate of flow (expressed in US gallons per minute),

SG is the **specific gravity** of the fluid (for water = 1),

ΔP is the pressure drop across the valve (expressed in psi).

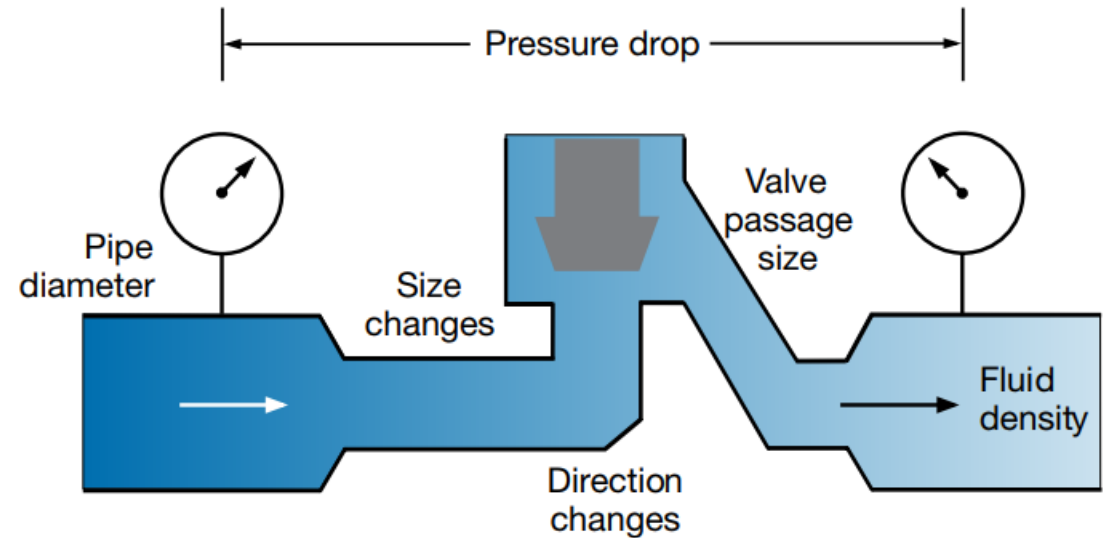
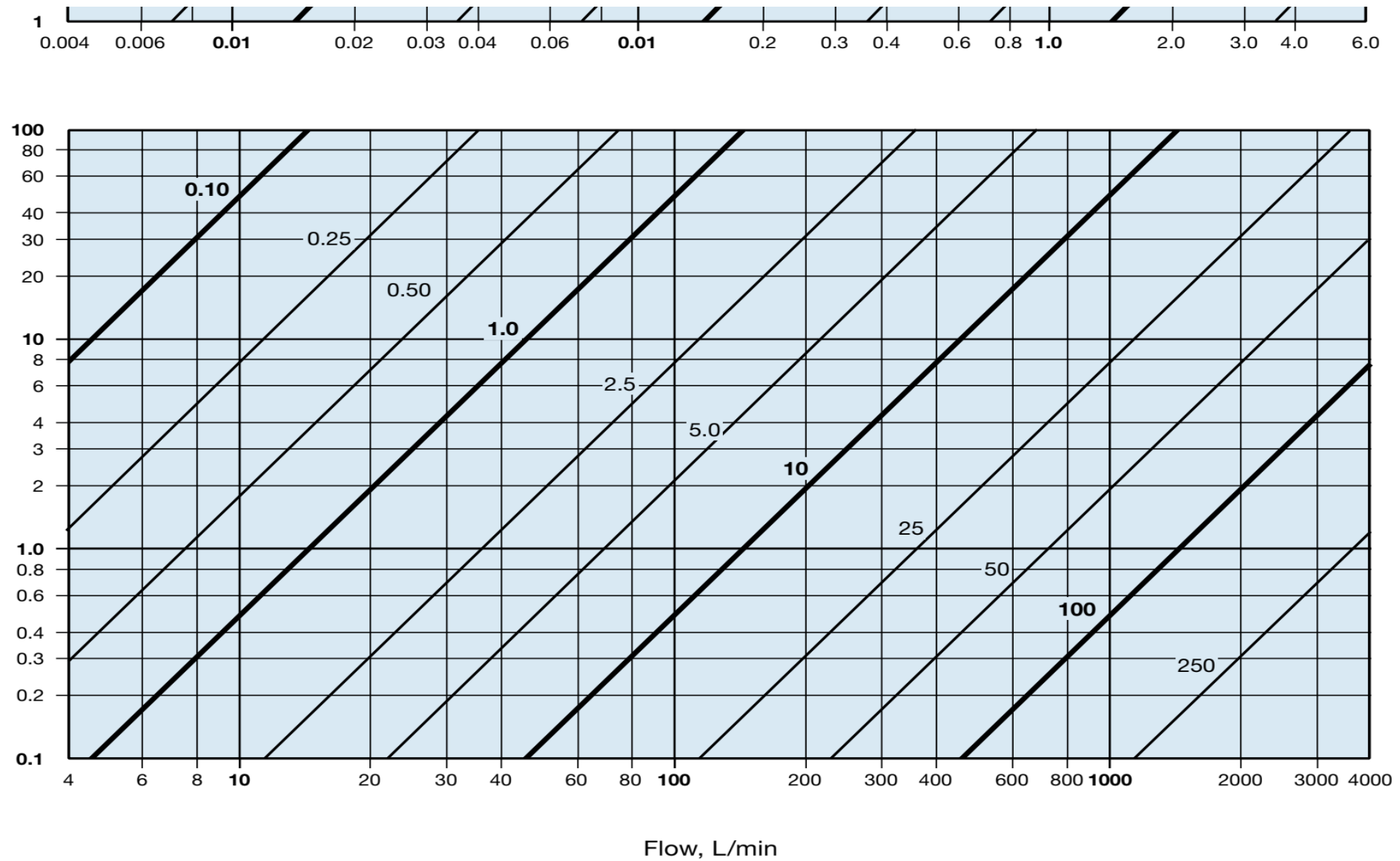


Fig. 2. Calculating the flow rate through a valve is much more complex. The valve flow coefficient (C_v) takes into account all the dimensions and other factors—including size and direction changes—that affect fluid flow.



Pressure Drop, bar

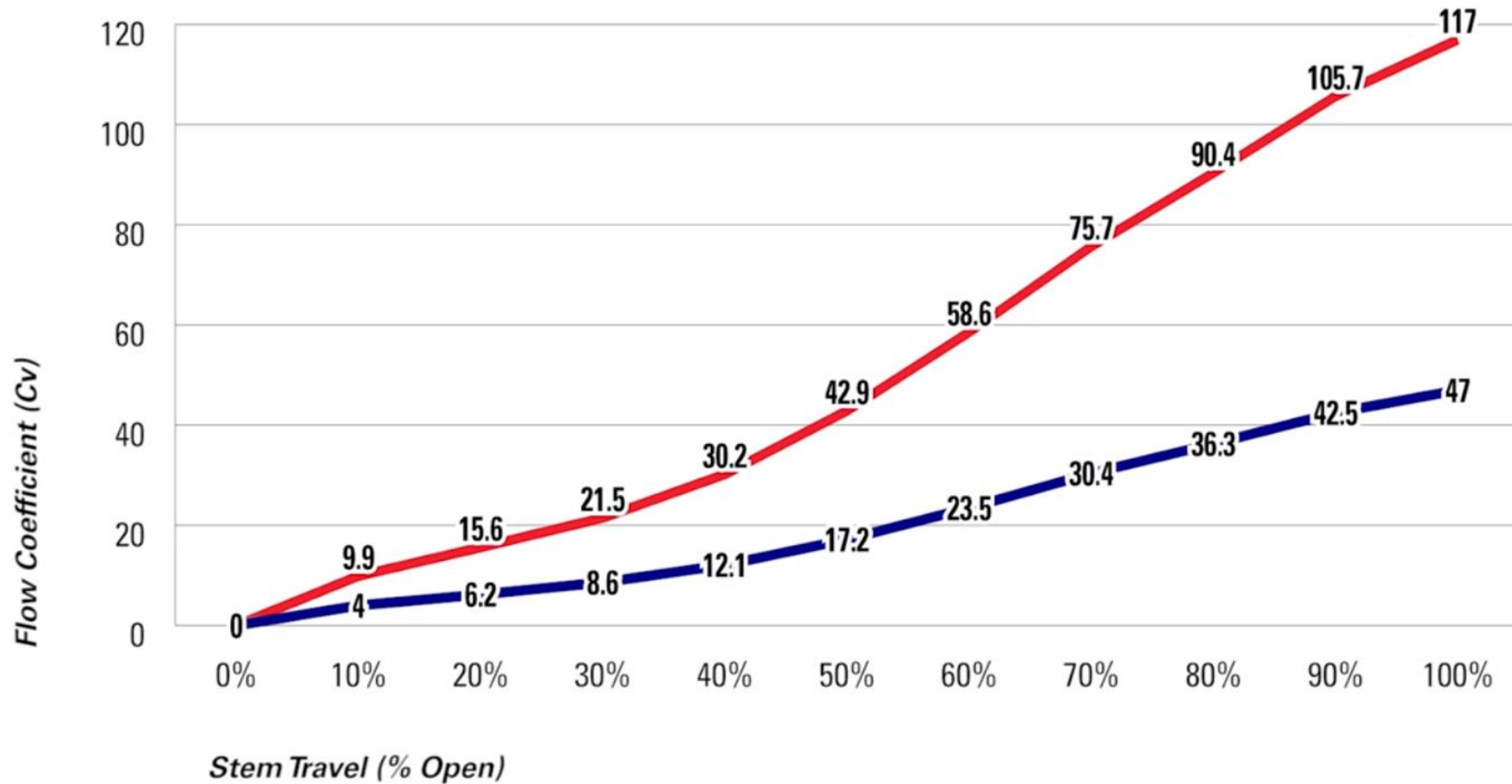


Example:

- Enter the vertical scale with the pressure drop across the valve ($\Delta p = 30$ bar).
- Read across to the desired flow rate ($q = 0.2$ L/min).
- The diagonal line is the desired C_v value ($C_v = 0.0025$).



Flow Coefficient (Cv) at Stem Travel (% Open)

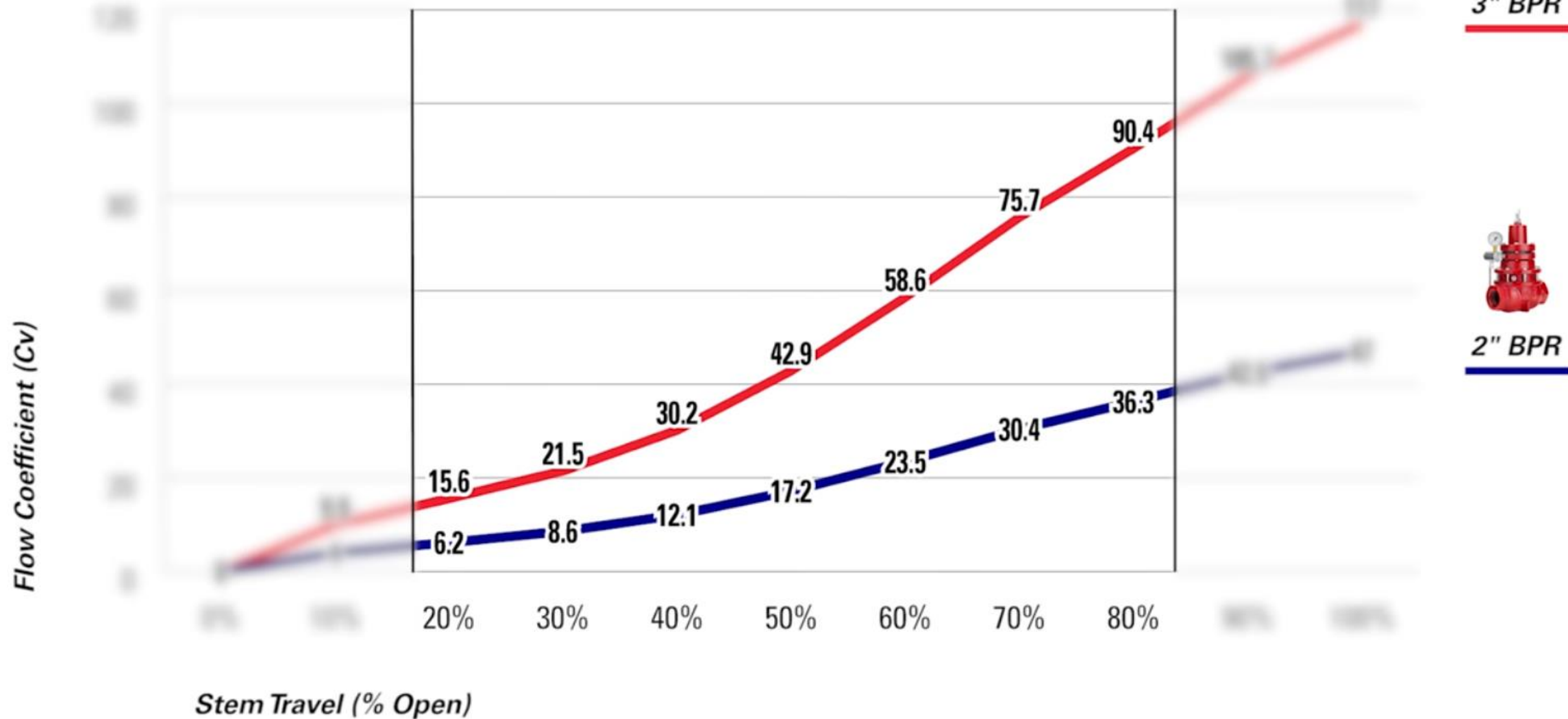


3" BPR



2" BPR

Flow Coefficient (Cv) at Stem Travel (% Open)



Fill in your conditions and click "Calculate C_v " to display applicable products.

[Instructional Video](#)

[View Formula](#)

Gas Sizing	Liquid Sizing Simplified	Liquid Sizing Extended	Glycol Pump Sizing	Steam Sizing
	Condition 1	Condition 2	Condition 3	Condition 4
Gas Specific Gravity	.65			
Flowing Temp. °fahrenheit	80			
Critical Flow Factor (C_f)	.75	.75	.75	.75
Upstream Pressure psig	100			
Downstream Pressure	80			
Flow Rate mmcf/d Calculate Flow Rate	1			
Valve Flow Coefficient (C_v) Calculate Cv				
	Notes:	Notes:	Notes:	Notes:

Valve Coefficients

* Select Valve From Dropdown

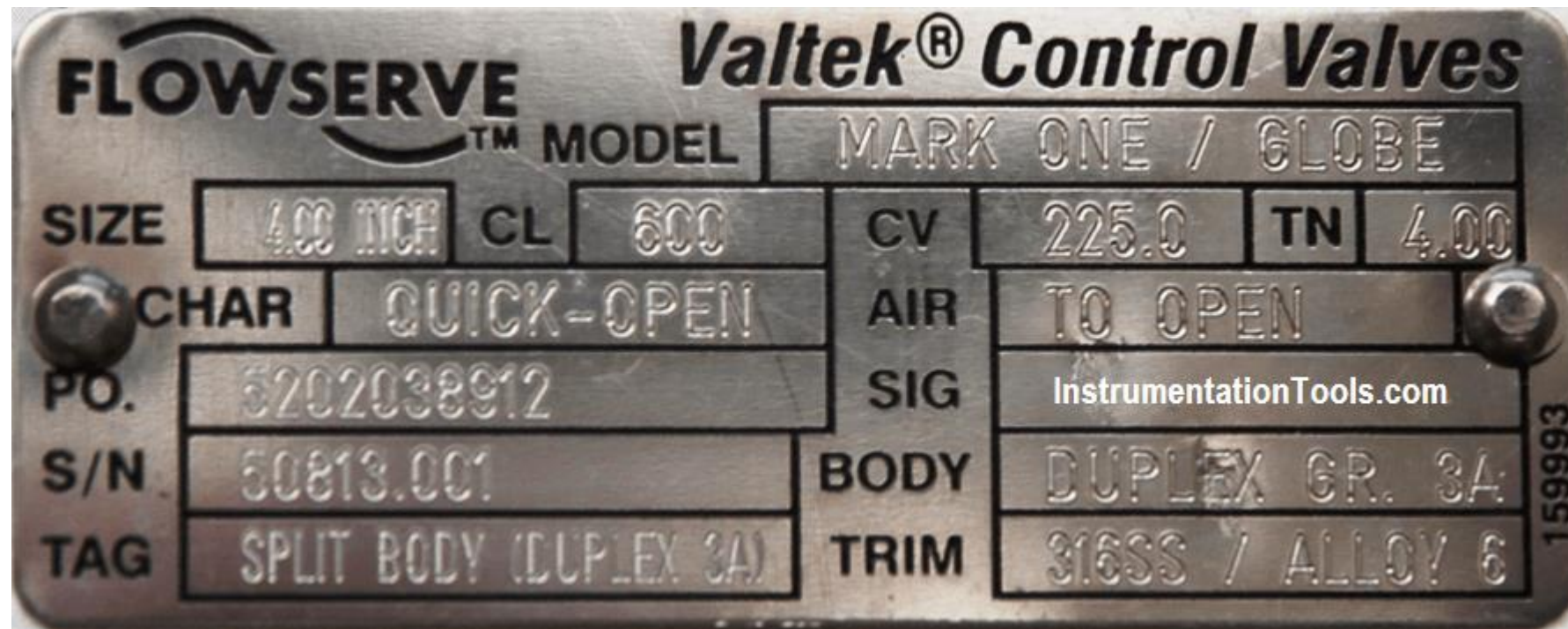
Reset Calculator

Print/Save PDF



Control Valve sizing

a. Valve flow Coefficient



Control Valve Failure

a. Valve flow Coefficient

1. Cavitation
2. Flashing
3. Trim erosion
4. Vibration
5. Corrosion
6. Packing leakage



Control Valve Failure

a. Valve flow Coefficient

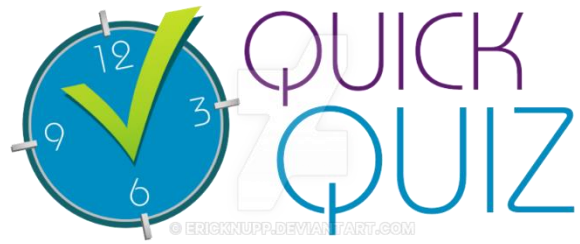
1. Cavitation
2. Flashing
3. Trim erosion
4. Vibration
5. Corrosion
6. Packing leakage





<https://instrumentationtools.com/valve-quiz/>





The purpose of valve packing is to:

- (A) Help reduce cavitation in the valve trim
- (B) Increase stiction
- (C) Cushion the valve against harm during shipment
- (D) Seal process fluid from escaping past the stem
- (E) Lubricate the valve trim

11. Regardless of type, all valves have the following basic parts, with the exception of ____

- a) bonnet
- b) nipple
- c) actuator
- d) body

The proper “fail safe” status of a valve should always be dictated by:

- (A) economic savings
- (B) the configuration of the positioner
- (C) the controller’s tuning
- (D) the controller’s action (direct or reverse)
- (E) the nature of the process

12. The body of a valve typically receives inlet and outlet piping through any of the following types of joints EXCEPT:.

- a) glued
- b) welded
- c) threaded





14. The manually operated handwheel, manual lever, motor operator, solenoid operator, pneumatic operator, or hydraulic ram are all examples of

- a) a yoke
- b) a stem
- c) a bonnet
- d) an actuator

17. Most valves use _____ to prevent leakage from the space between the stem and the bonnet.

- a) o- rings
- b) a liquid seal
- c) a metal to metal seal
- d) packing

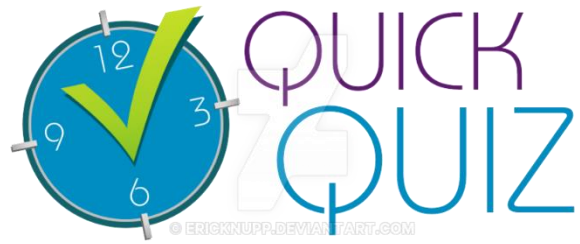
16. The stem in a valve, which connects the actuator and disk, is responsible for positioning the disk.

- a) True
- b) False

24. A globe valve is suitable for stopping and starting fluid flow, but not for regulating flow.

- a) True
- b) False





25. Which of the following is the globe valve body design that is the simplest and most common for water applications?

- a. Z-body
- b. X-body
- c. Angle
- d. Y-body

28. Which of the following valve types has an actuator that is of the quick-acting type, requiring only a 90 deg turn of the handle to fully open or close the valve?

- a) gate valve
- b) globe valve
- c) ball valve
- d) pinch valve

29. Which of the following valve types is well suited for an application where corrosion or metal contamination of the fluid might be a problem, because the operating mechanism is completely isolated from the fluid?

- a) pinch valve
- b) gate valve
- c) butterfly valve
- d) reducing valve

30. Which of the following types of valve causes the greatest head loss when completely open?

- a) ball valve
- b) gate valve
- c) butterfly valve
- d) globe valve





31. Which of the following is a disadvantage of ball valves?

- a) They are large and heavy.
- b) They have high maintenance costs.
- c) They have relatively poor throttling characteristics
- d) They are among the most expensive of the valve types.

32. The gland of a plug valve is equivalent to the ____ of a gate or globe valve.

- a) body
- b) packing
- c) seat
- d) bonnet

33. Which type of valve has advantages over other valve designs in weight, space and cost for large valve applications?

- a) butterfly valve
- b) globe valve
- c) diaphragm valves
- d) gate valves

34. All of the following are general types of check valves EXCEPT _.

- a) butterfly
- b) plug
- c) swing
- d) tilting disc





35. Relief and safety valves prevent equipment damage by relieving accidental over-pressurization of fluid systems.

- a) True
- b) False



