CONTROL VALVES

(INTRODUCTION, SELECTING & SIZING)

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AGENDA

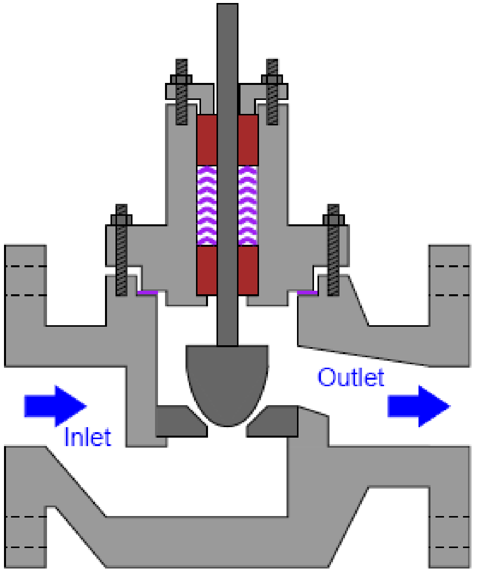
1. Valve body types
2. Control valves
3. Control valve behaviors
4. Control valve problems
5. Control valve sizing
6. Actuators
7. Positioners
8. Valve Accessory
9. Valve materials
10. Control valve selection

1. VALVE BODY TYPES

- Sliding stem valves
  - Globe valves
    - Single seat globe valve
    - Double seat globe valve
    - 3-way globe valve
    - Needle valve
    - Angle valve
  - Gate valves
  - Diaphragm valves
- Rotary valves
  - Butterfly valves
  - Ball valves
  - Plug valves

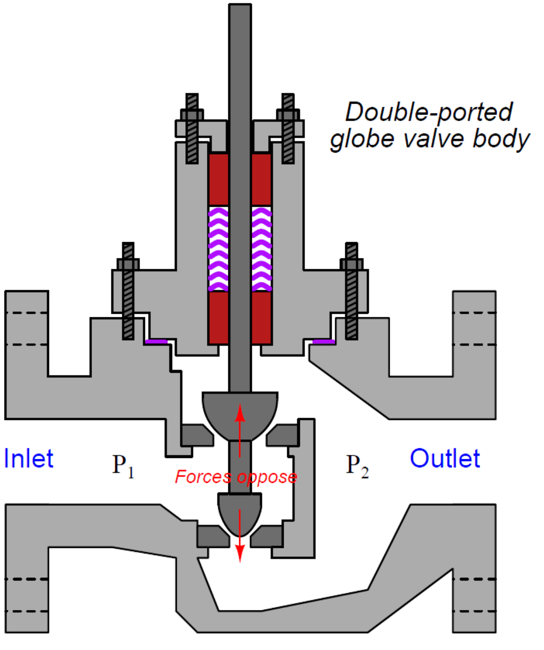
1-1-1. GLOBE VALVES- SINGLE SEAT

- The most famous control valve in industry.
- Tight shut off capability, Leakage less than 0.05%
- Fast to open or close
- Difficult to manufacture in small sizes
- Quite heavy



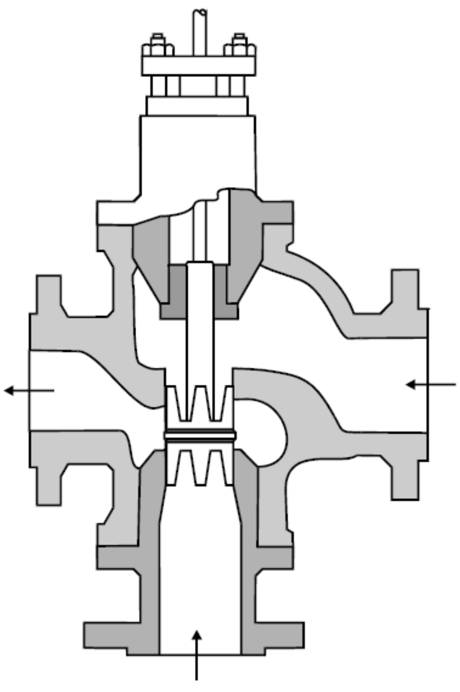
1-1-2. GLOBE VALVES- DOUBLE SEAT

- Larger capacity
- Naturally balanced
- Lower leakage class

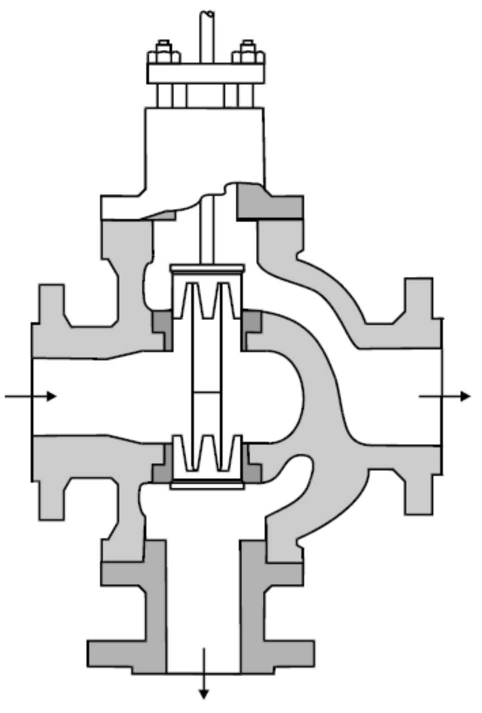


1-1-3. GLOBE VALVES- 3 WAY

- Mixing

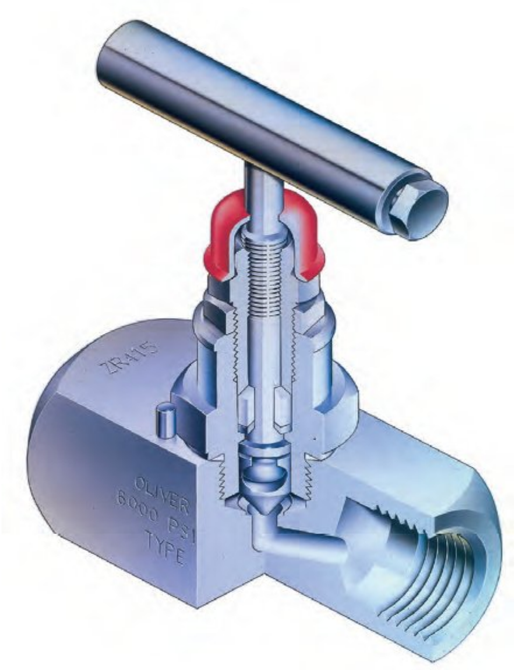


- Delivering



1-1-4. GLOBE VALVES- NEEDLE VALVE

- Precise low flow control
- Pressure reducing

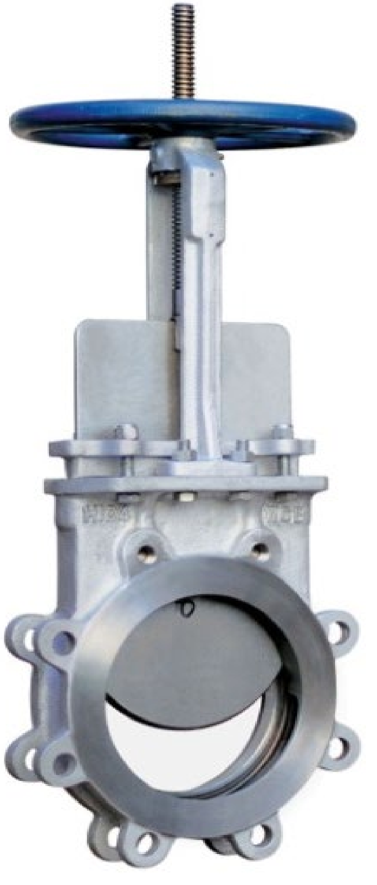


1-1-5. GLOBE VALVES- ANGLE VALVE

- Space limitation
- High pressure drop

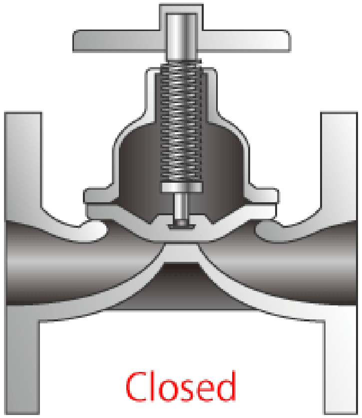
1-2. GATE VALVES

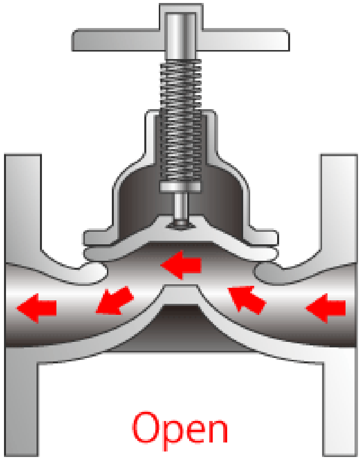
- High flow capacity
- Higher leakage class
- ON/OFF applications
- Prone to erosion



1-3. DIAPHRAGM VALVES

- Very simple
- Often used for corrosive, slurry, and sanitary services





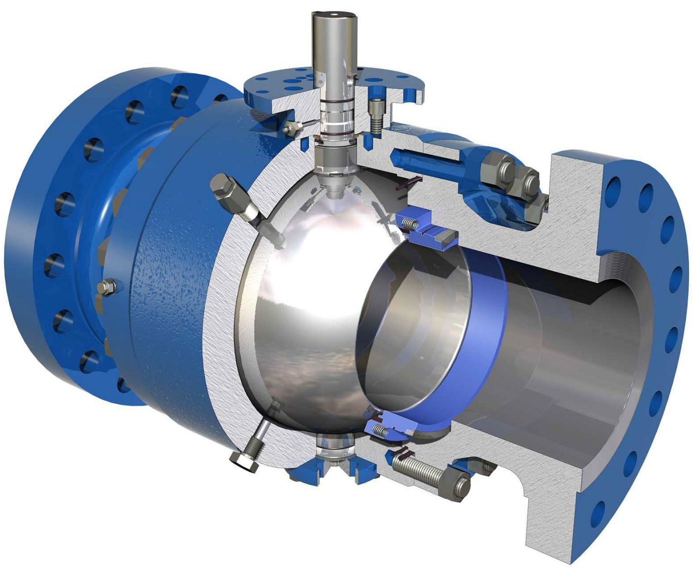
1-4. BUTTERFLY VALVES

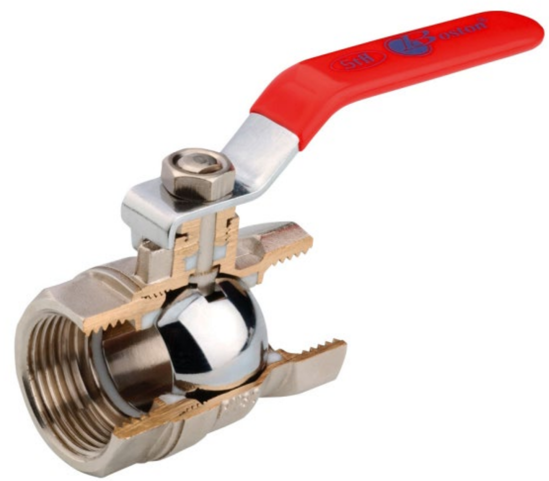
- Highest capacity
- Low pressure drop
- Lower leakage class
- Under pressure rating # 300

1-5. BALL VALVES

- Quick, tight shutoff, high capacity, and require only a ¼ turn to operate
- almost ½ price of globe valves

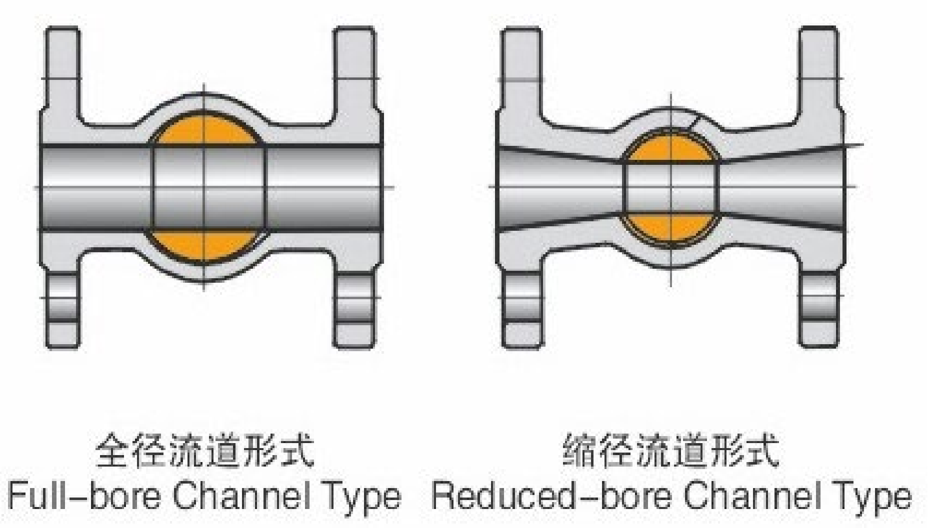
Normally used for on-off service (like emergency shutdown application).





1-5-1. BALL VALVES

- Full bore
- Reduced bore
- V-notch



1-5-2. BALL VALVES

- Top entry

Top entry valves allow access from the top without removing the valve from the pipeline.

- Side entry

For maintenance or replacement, it may be necessary to remove the valve from the pipeline.

The ball and internal components of side entry ball valves enter from the side of the valve body.

1-6. PLUG VALVES

- Similar to a ball valve except that a cylinder is used instead of a sphere
- More expensive but more rugged than a ball valve
- Require more torque to turn but still easy to actuate

1-7. CHECK VALVES

- Check valves are generally installed in pipelines to prevent backflow.
- A check valve is basically a one-way valve, in which the flow can run freely one way, but if the flow turns, the valve will close to protect the piping, other valves, pumps etc.

DUAL DISC CHECK VALVE

SWING CHECK VALVE

LIFT /PISTON CHECK VALVE

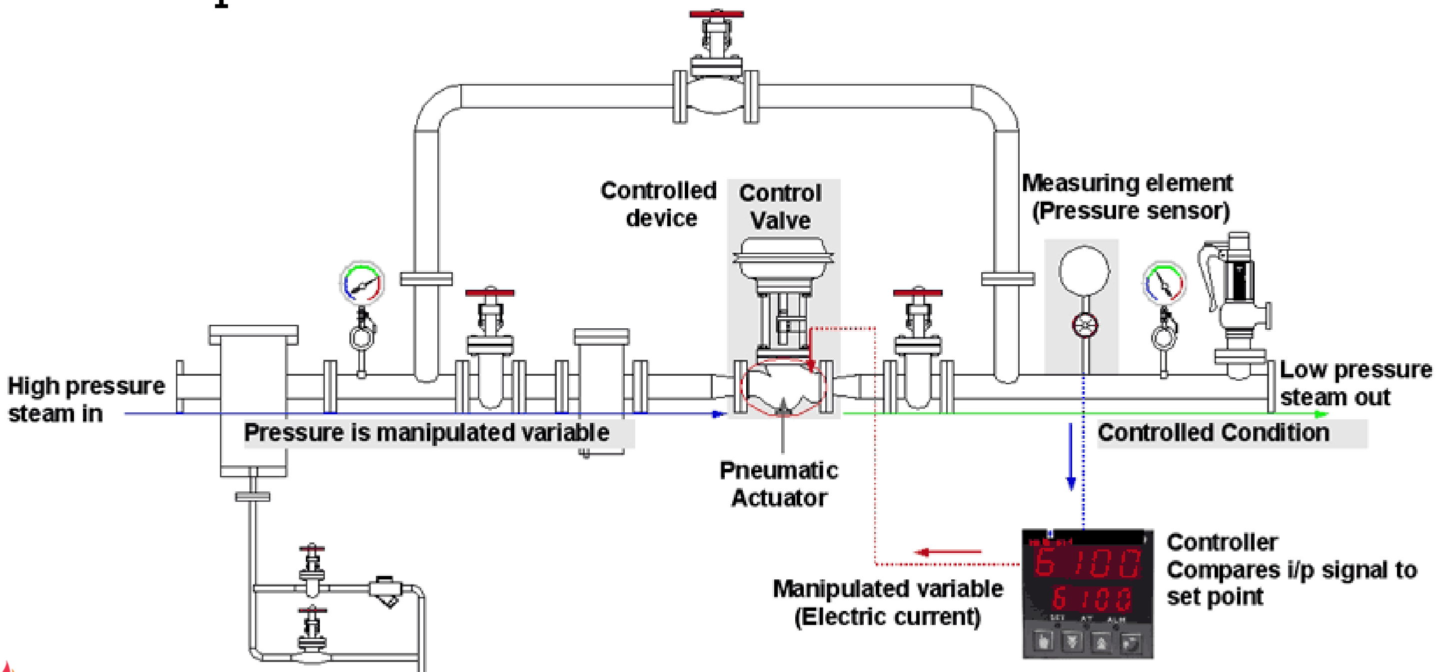
BALL CHECK VALVE

1-8. PRESSURE SAFETY VALVES

- A Pressure Safety Valve (PSV) is a type of valve used to quickly release gasses from equipment in order to avoid over pressurization and potential process safety incidents.

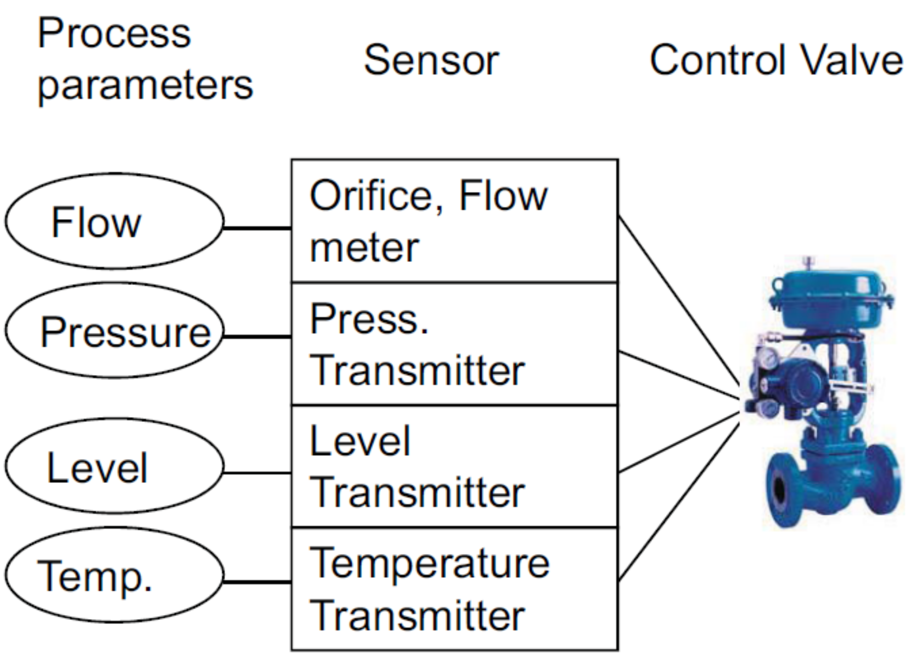
2. CONTROL VALVE

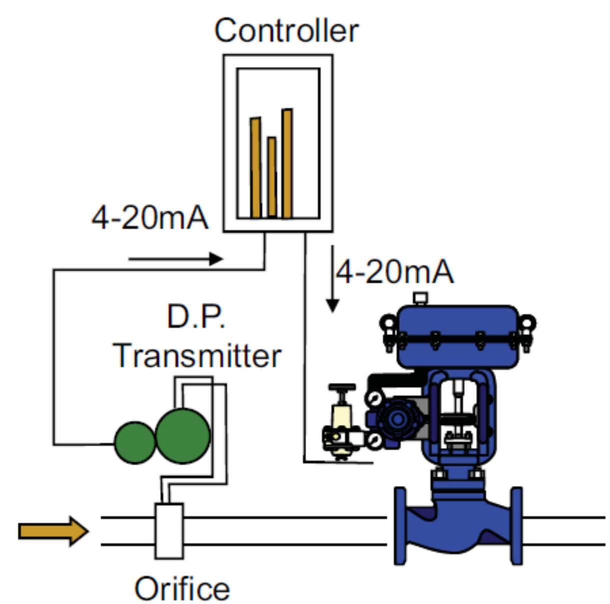
- The most common final control element in the process control industries is the control valve. The control valve manipulates a flowing fluid, such as gas, steam, water, or chemical compounds, to compensate for the load disturbance and keep the regulated process variable as close as possible to the desired set point.
- Control loop



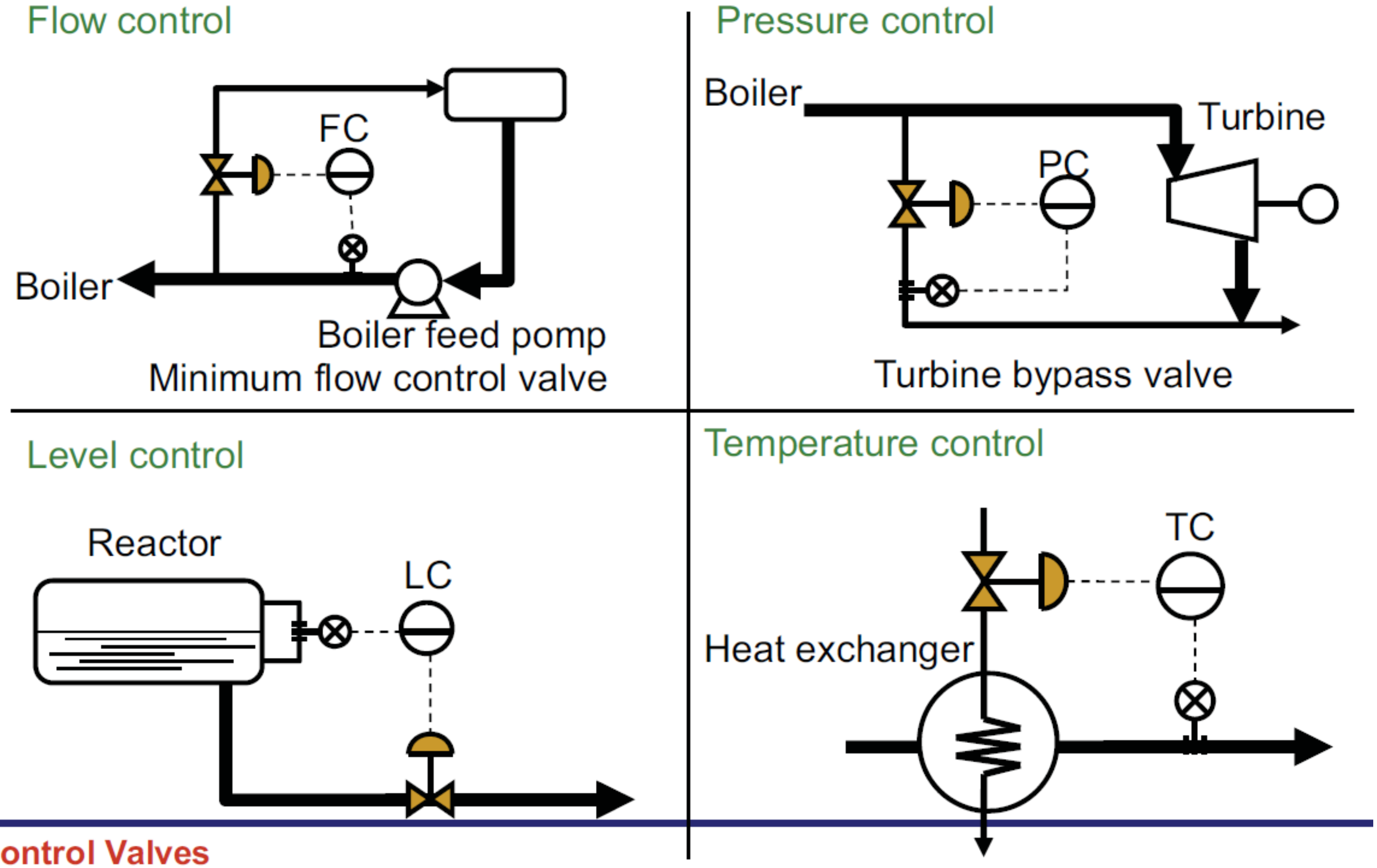
2-1. INDUSTRIAL CONTROL LOOP

- Most control loops in industry are related to pressure, temperature, level and flow quantities. Their control valves are PV, TV, LV and FV respectively.



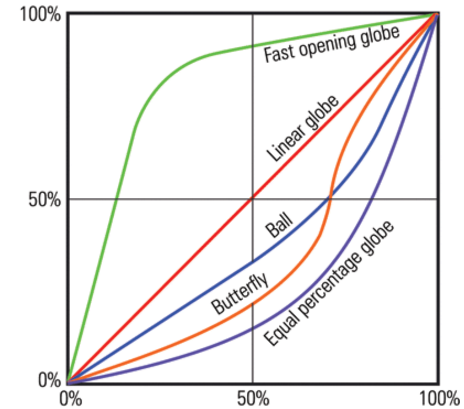


2-1. CONTROL LOOP EXAMPLES



Control Valves

2-2. CONTROL VALVE TYPES



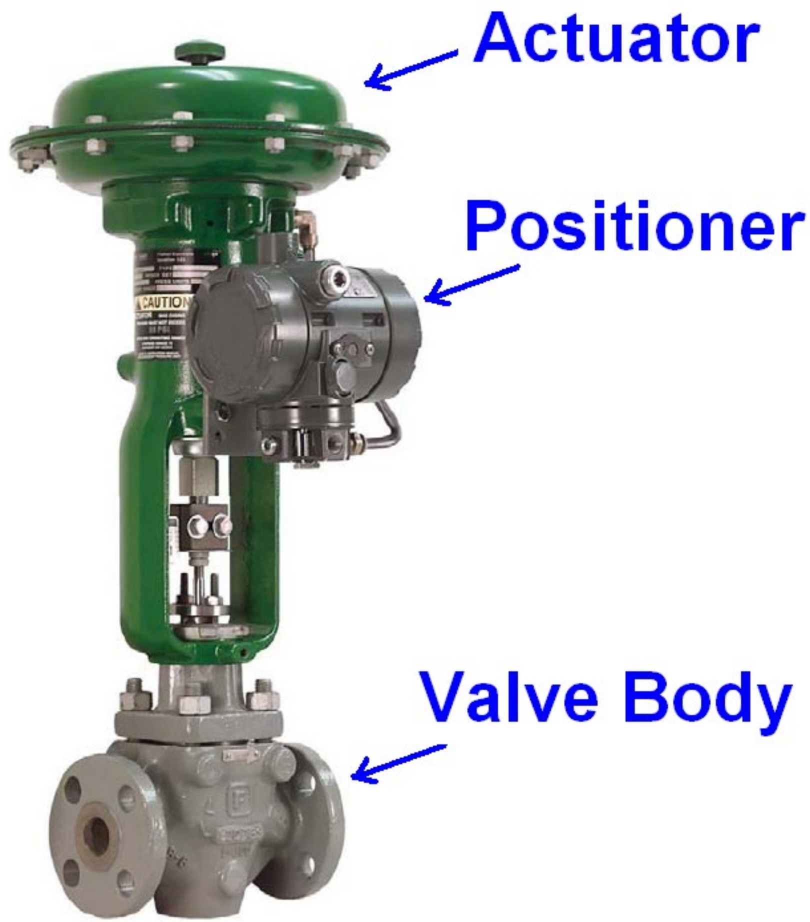
- Globe valves

- Butterfly valves

- Ball valves

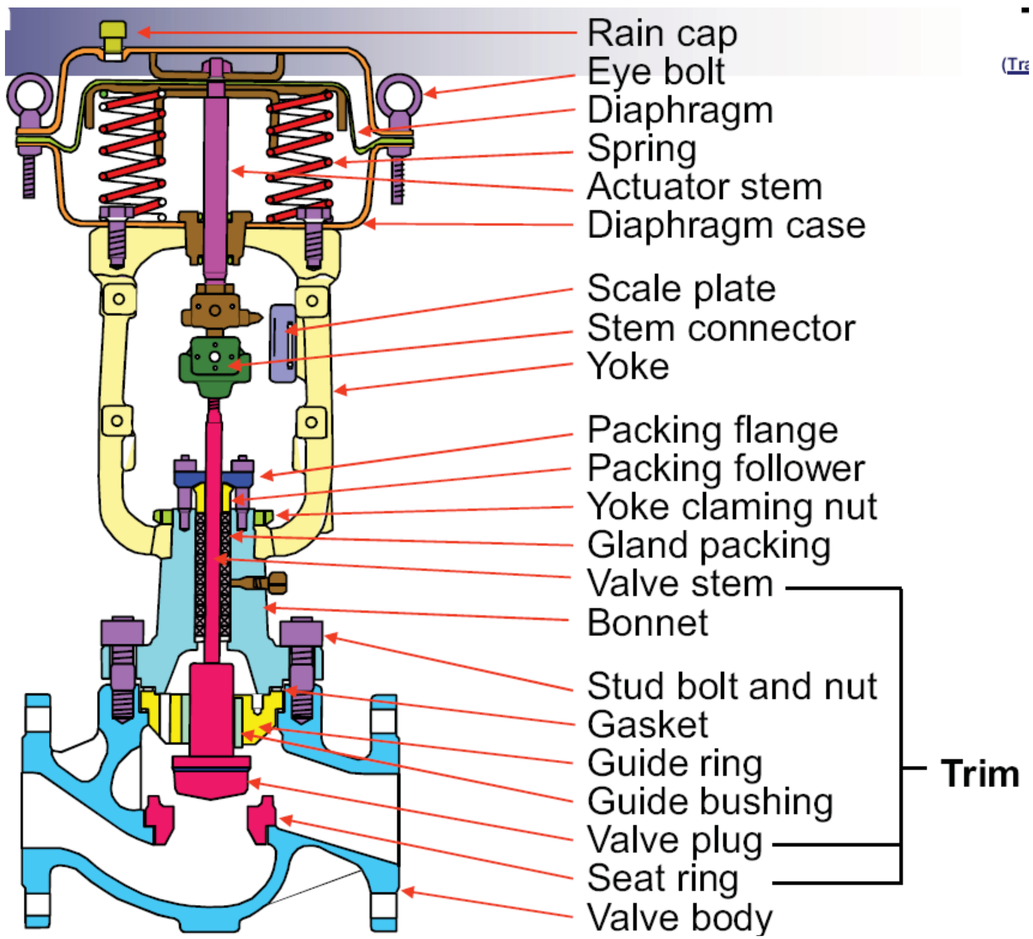
2-3. CONTROL VALVE GENERAL COMPONENTS

- Valve body
- Actuator
- Positioner

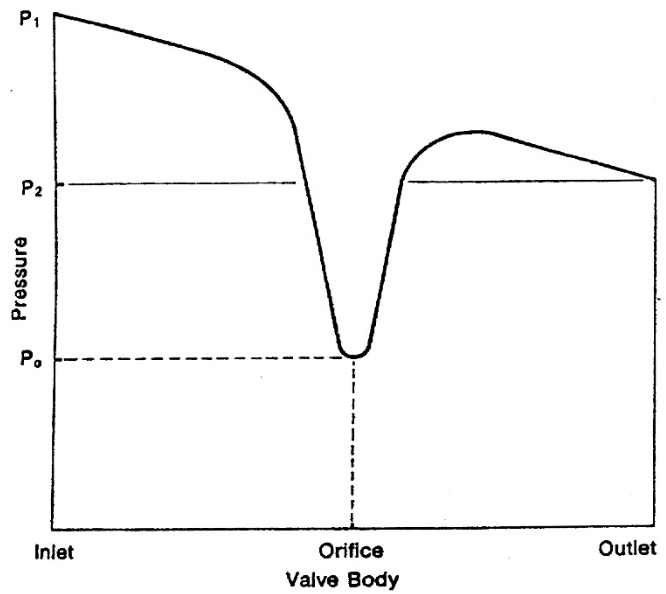


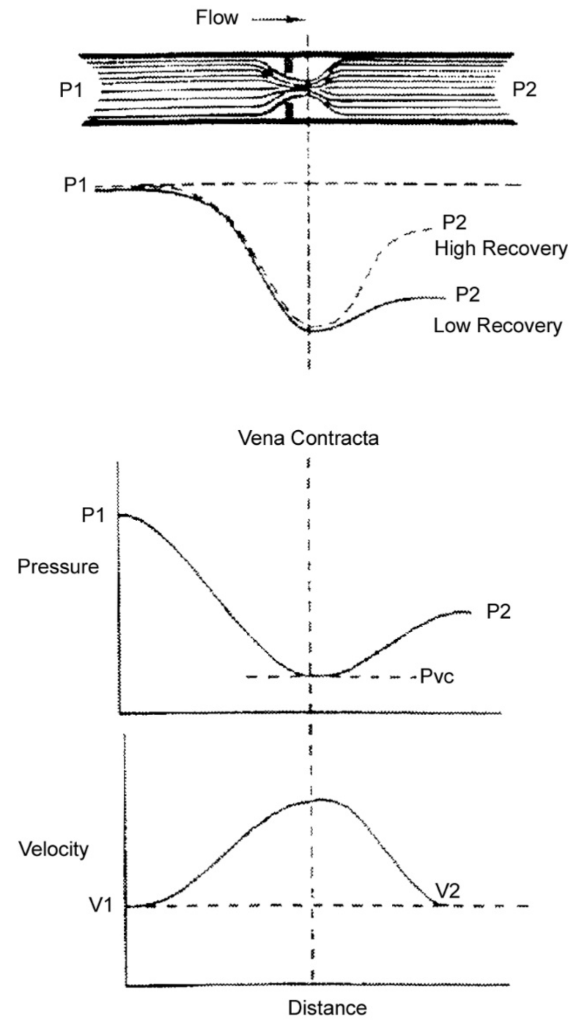
2-4. CONTROL VALVES COMPONENTS

- Body
- Bonnet
- Yoke
- Stem
- Plug
- Seat ring
- Cage
- Packing



2-5. CONTROL VALVE THERMODYNAMIC BEHAVIOR



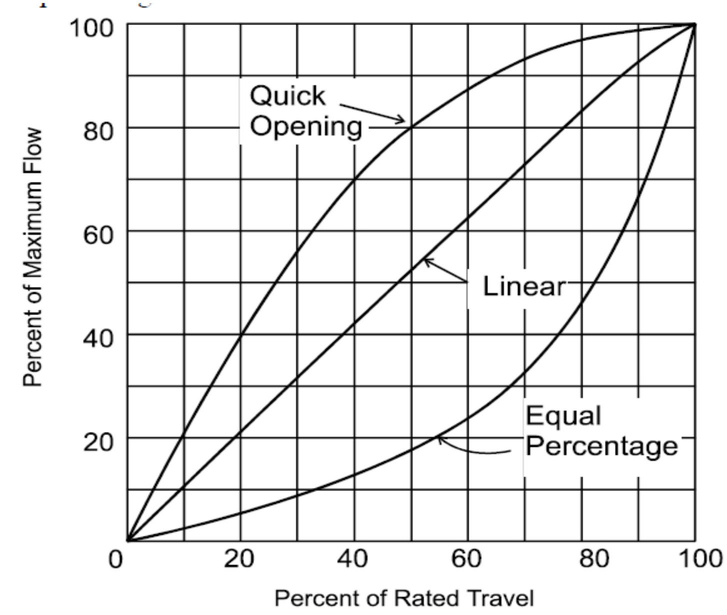


2-6. CONTROL VALVES STANDARDS

Standard	Description
IEC 60534	Control Valves Standards
ISA S 75.01	Flow Equation for Sizing Control Valves
ISA S 75.02	Control Valves Capacity Test Procedure
IEC 60534-8	Industrial-Process Control Valves
EEMUA 140	Noise Procedure Specifications
API 598	Valve Inspections and Testing

3-CONTROL VALVE BEHAVIORS

- Linear
- Quick opening
- Equal percentage



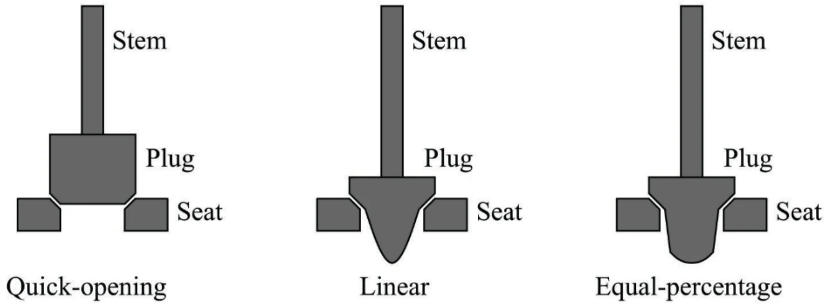
Type	Equation †
Linear	$V = P$
Quick Opening	$V = \dfrac{10.0P}{\sqrt{\left(1.0 + 9.9 \times 10^{-3} P^2\right)}}$
Equal Percentage	$V = \dfrac{0.01P^2}{\sqrt{2.0 - 1.0 \times 10^{-8} P^4}}$

† *Where:*
P = Valve opening as a percentage of maximum opening
V = Flow coefficient as a percentage of flow coefficient at maximum opening

3-1. CONTROL VALVE BEHAVIOR (DETERMINANT COMPONENTS)

- Plug

The contoured plug is profiled valve plug to give linear, equal percentage or quick opening characteristics.

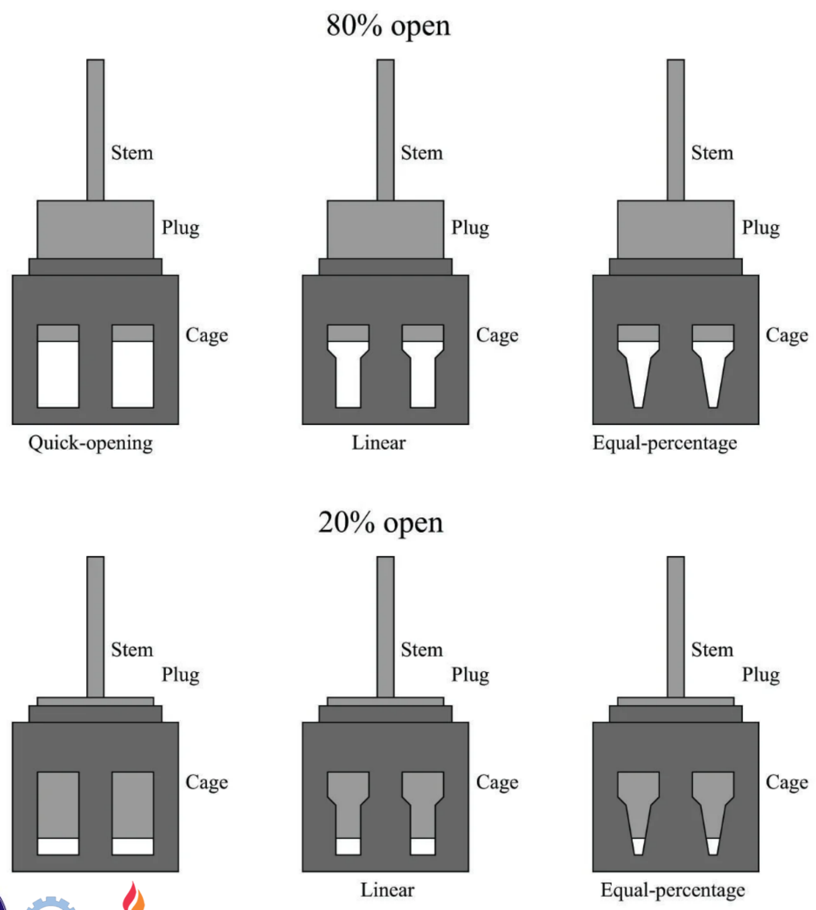


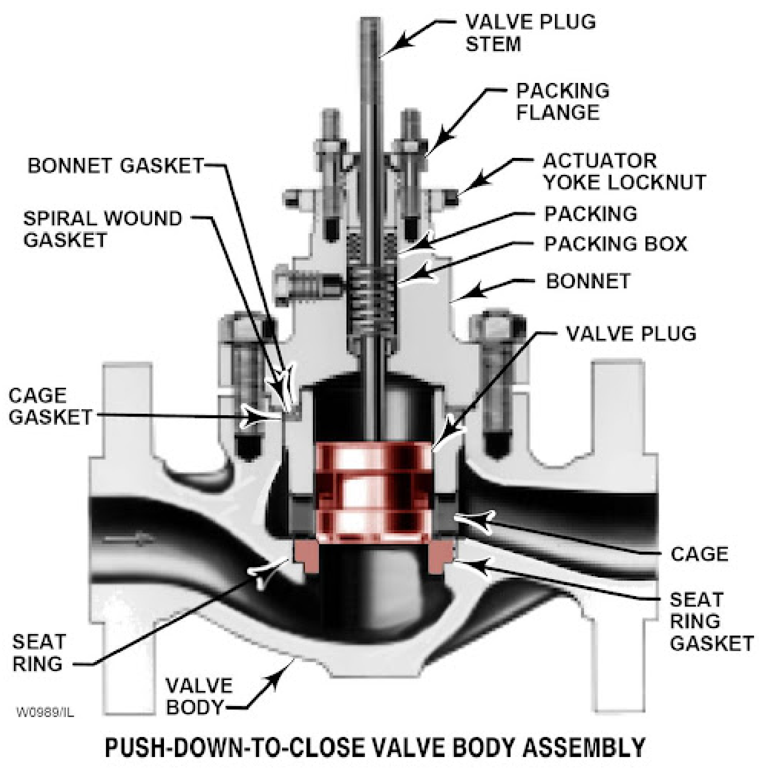
- Cage

The cage provides exceptional stability to the plug even at very high differential pressure which eliminates vibration that could otherwise damage or destroy the valve.

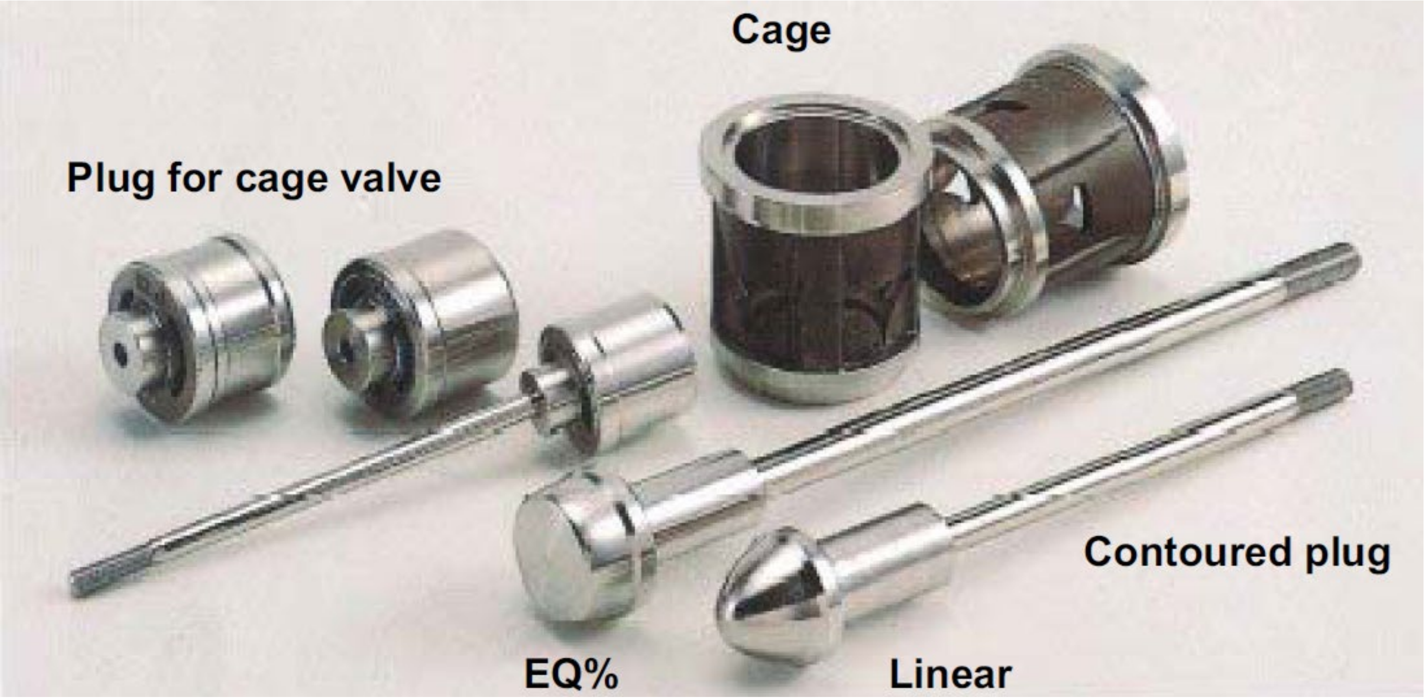
3-1. CONTROL VALVE BEHAVIOR (DETERMINANT COMPONENTS)

- Cage (Continue)

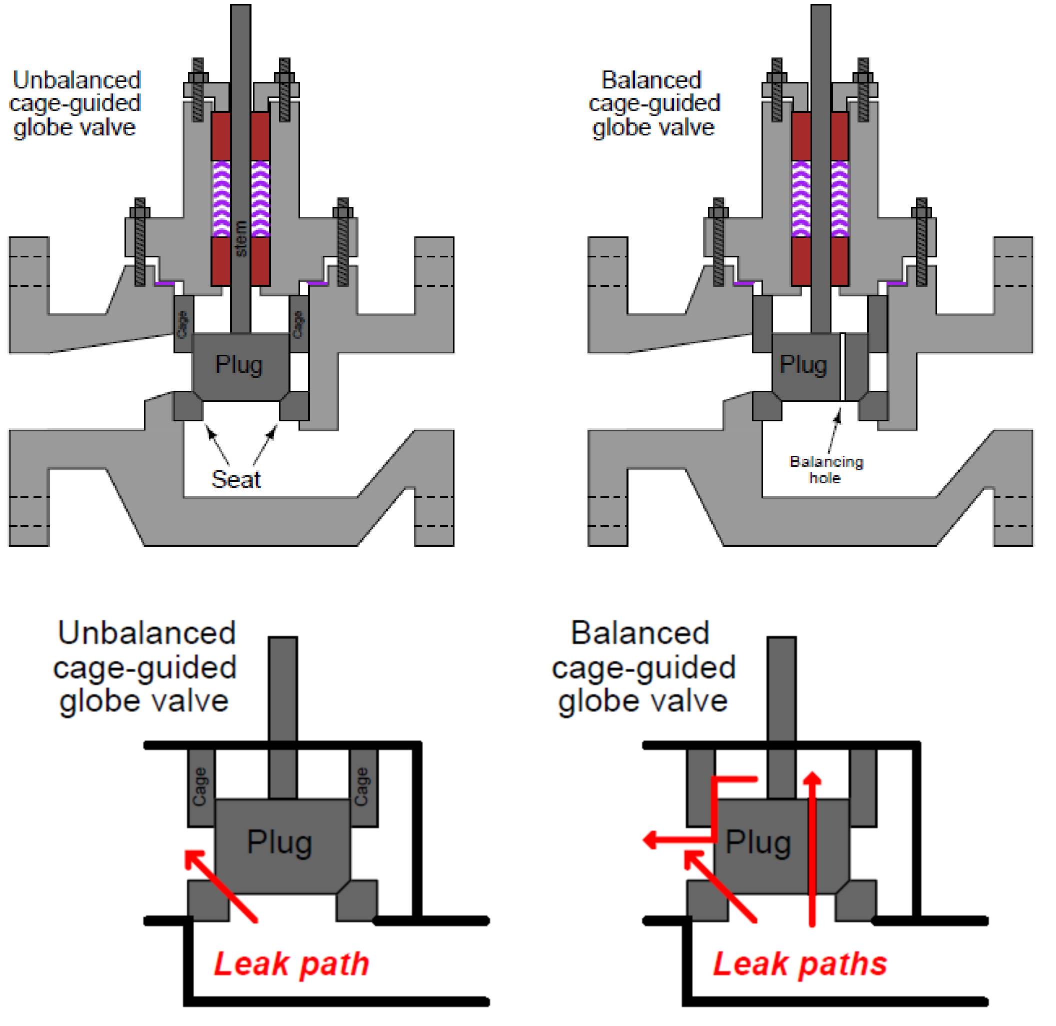




3-2. TYPE OF CONTROL VALVE PLUGS

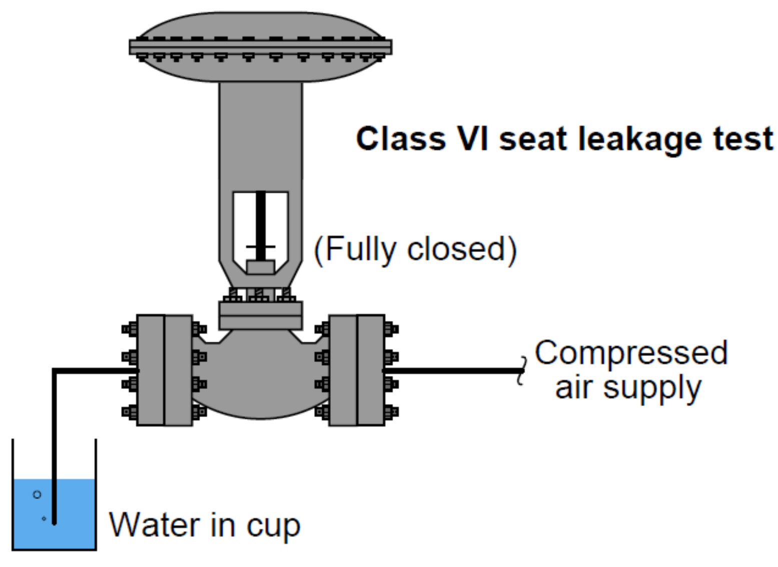


3-3. GLOBE VALVES-(BALANCED OR UNBALANCED)



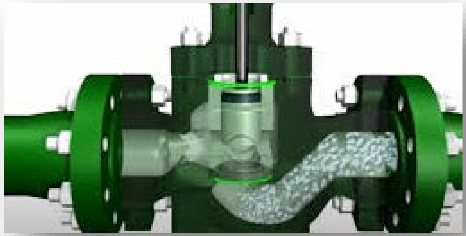
3-4. LEAKAGE CLASS

Class	Maximum allowable leakage rate	Test pressure drop
I	(no specification given)	(no specification given)
II	0.5% of rated flow capacity, air or water	45-60 PSI or max. operating
III	0.1% of rated flow capacity, air or water	45-60 PSI or max. operating
IV	0.01% of rated flow capacity, air or water	45-60 PSI or max. operating
V	0.0005 ml/min water per inch orifice size per PSI	Max. operating
VI	Bubble test, air or nitrogen	50 PSI or max. operating

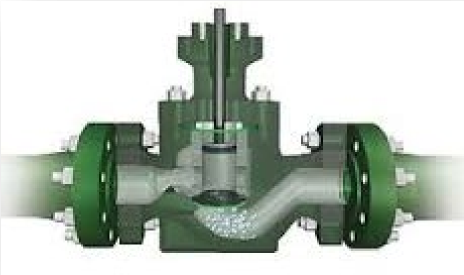


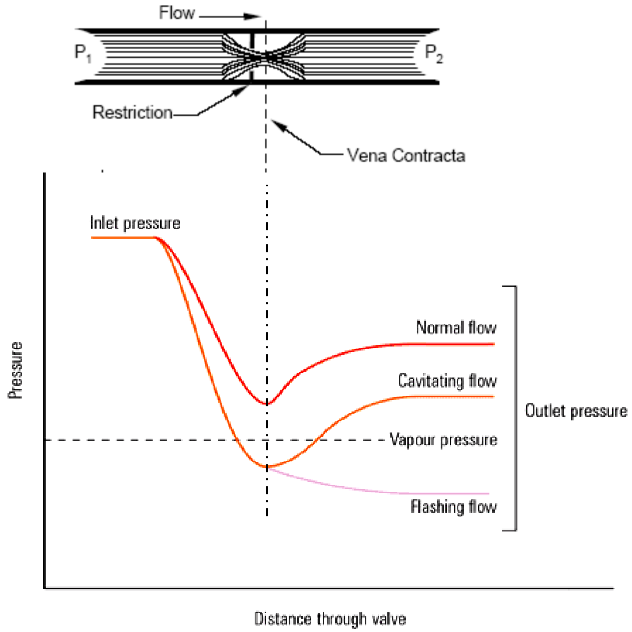
4. CONTROL VALVE PROBLEMS

- Flashing



- Cavitation



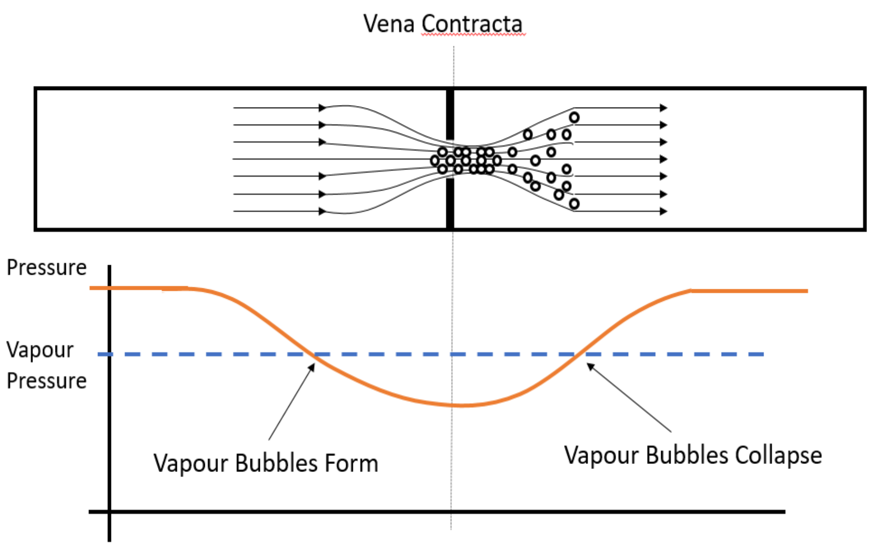


- Choked Flow

- Noise

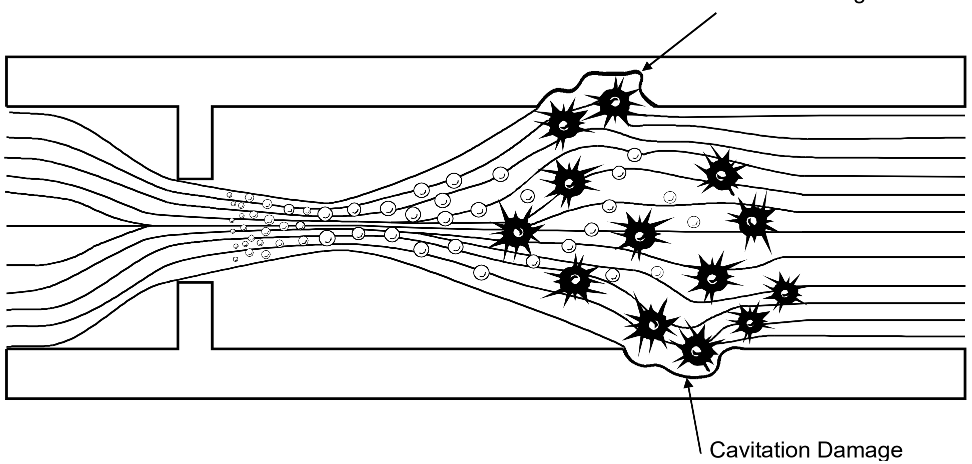
4-1. FLASHING

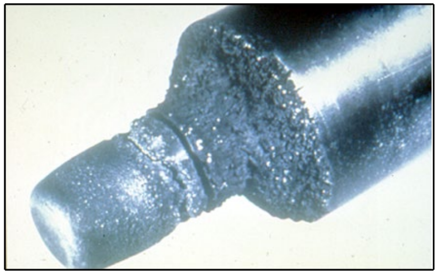
- The liquid pressure drops below the vapor pressure and remains as vapor at downstream.
- Flashing will cause choke flow condition to occur.
- In addition the vapor bubbles can also cause mechanical damage to the valve and piping system.



4-2. CAVITATION

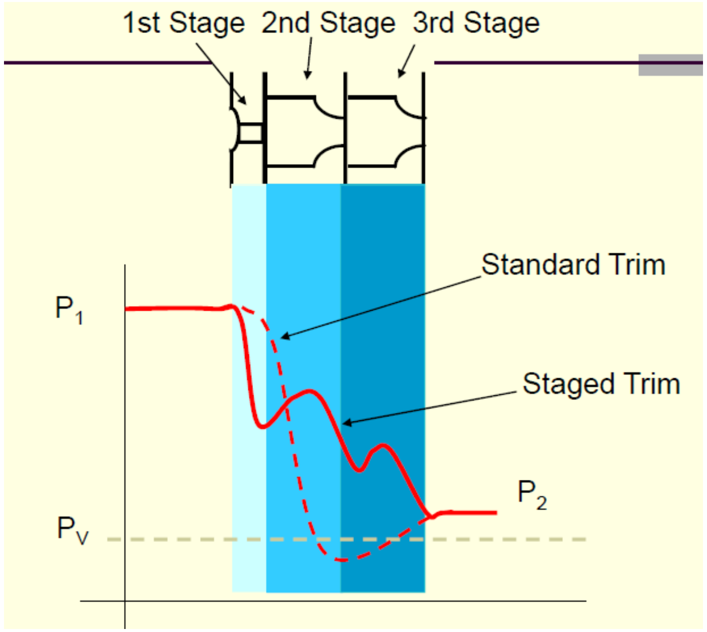
- A two-stage phenomenon of liquid flow. The first stage is the formation of cavities (vapor bubbles) within the liquid stream.
- The second stage is the collapse or implosion of those cavities (beyond the vena contracta) back into an all liquid state. The energy released by cavitating liquids can, under certain circumstances, cause physical damage of valve or piping components

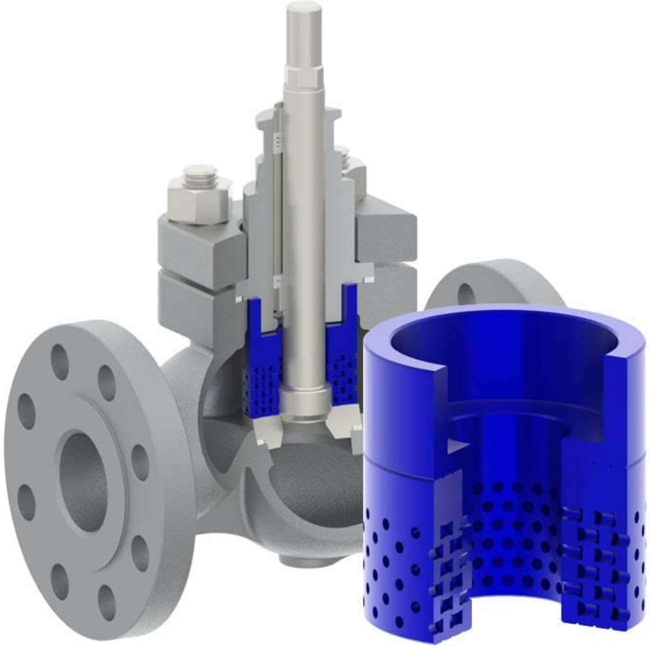




4-2-1. STAGED PRESSURE DROP

- Multi stage trims can help manage high pressure drops and avoid cavitation. The range includes various options offering up to 30 stages of pressure drop.



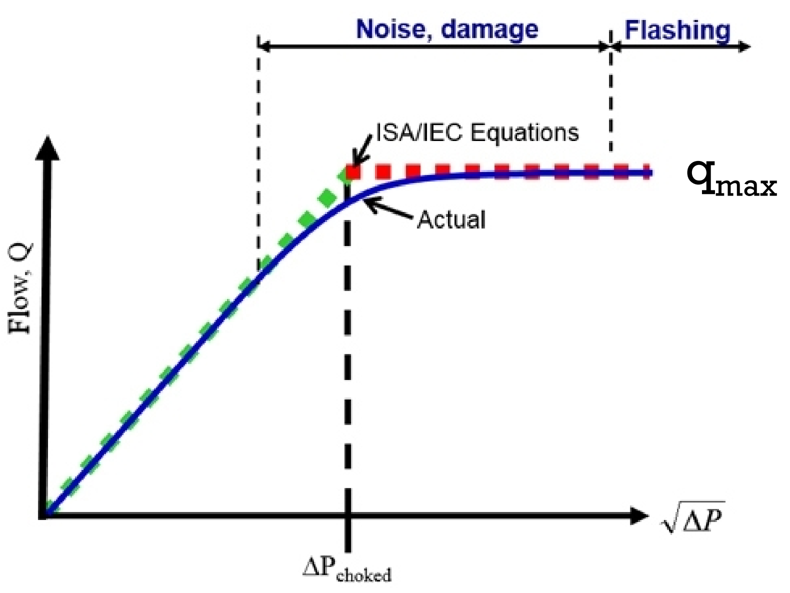


4-3. CHOKED FLOW

- Choked flow is the point at which decreasing downstream pressure will not increase the flow through a valve. This typically happens in high differential applications in a high pressure control valve in gas back pressure or pressure reducing service.

$$\Delta P_{Choked} = F_L^2(P_1 - F_F P_v)$$

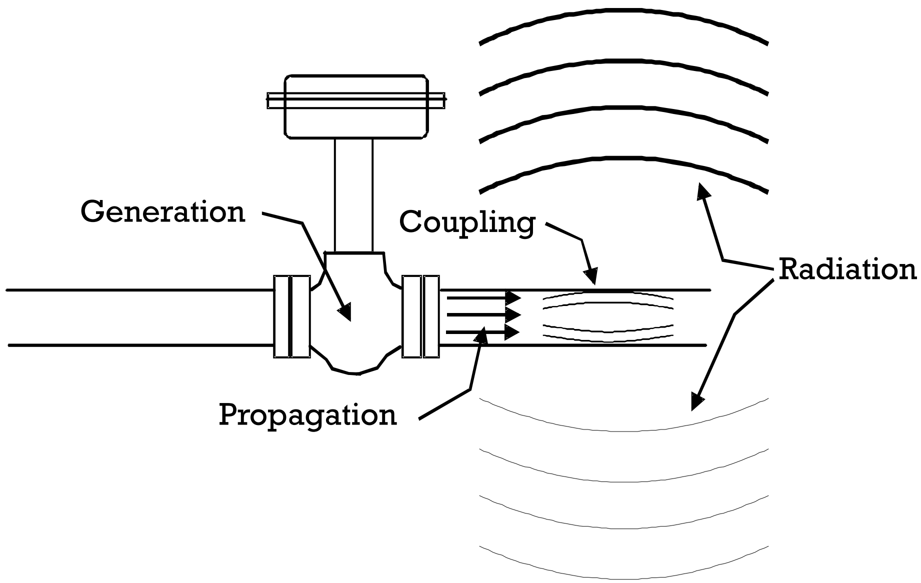
$$F_F \cong 0.96 - 0.28(P_v/P_c)^{1/2}$$



- F_L: Pressure recovery factor
- F_F: Critical pressure ratio factor

4-4. NOISE

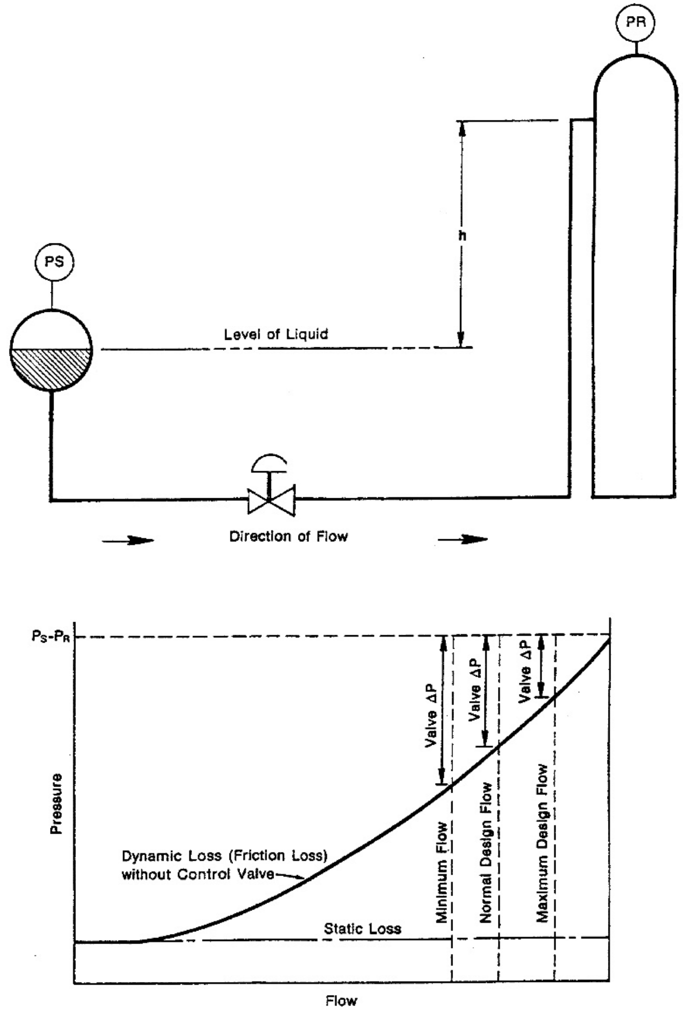
- High noise levels can cause pipe vibration and damage to downstream equipment
- The maximum noise level for each control valve shall be limited to 85 dBA for normal operation
- Noise above 110 dBA can destroy a valve very quickly

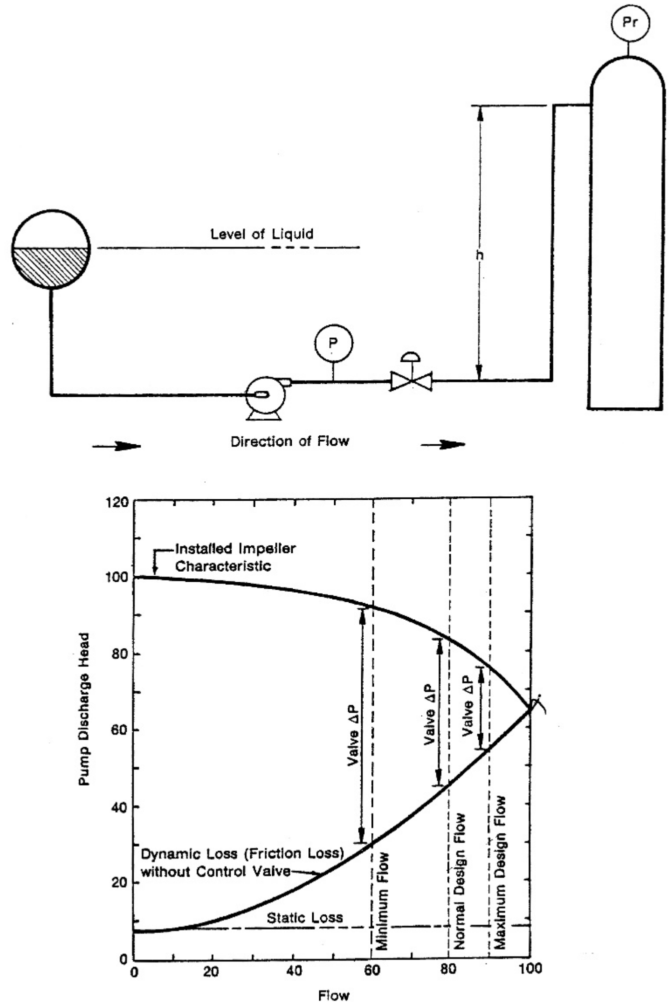


5. CONTROL VALVE SIZING

- Type of fluid
- Temperature of fluid
- Flow rate of fluid
- Viscosity of fluid
- Specific Gravity of fluid
- Inlet pressure (Upstream)
- Outlet pressure (Downstream) of fluid
- Delta P shutoff for actuator sizing
- Pipe size/Schedule
- Decide Flow Direction and characteristics
- Calculate Cv

5. CONTROL VALVE SIZING





5-1. CONTROL VALVE SIZING-(LIQUID SERVICES)

- CV is the number of US gallons per minute of water which pass through a given flow restriction with a pressure drop of 1 psi.

Measuring system	Flow equation	Unit (Flow)	Unit (Press.)	Unit (Density)	Relation with C_V
American	$Q = C_v\sqrt{\frac{\Delta P}{G_f}}$	gal/min	psi (lb/in^2)	lb/ft^3	1
Metric	$Q = K_v\sqrt{\frac{\Delta P}{G_f}}$	m^3/h	bar	Kg/m^3	$C_v = 1.156K_v$
SI	$Q = A_v\sqrt{\frac{\Delta P}{G_f}}$	m^3/s	Pa	Kg/m^3	$A_v = 2.4\times10^{-5}C_v$

5-2. CONTROL VALVE SIZING-(GAS SERVICES)

$$C_v = \frac{Q}{1360 F_P P_l Y} \sqrt{\frac{G_g T_l Z}{x}}$$

$$Y = 1 - \frac{x}{3 F_k x_T}; \; x = \frac{\Delta p}{P_l}; \; F_k = \frac{k}{1.4}$$

- k: Ratio of specific heats for gases
- F_k: Ratio of specific heats factor
- Y: Expansion factor for gases
- Z: Compressibility factor
- x_T: Critical pressure drop ratio factor

5-3. CONTROL VALVE SIZING

Table of ISA Formulas

REMARKS	EQUATIONS	VALUE OF N[1] U.S.	VALUE OF N[1] SI
LIQUID Turbulent and Non-Cavitating	$q_f = N_1 F_p C_v \sqrt{\frac{\Delta p}{G_f}}$	1.00	0.0865
	$w_f = N_6 F_p C_v \sqrt{\Delta p \gamma}$	63.3	2.73
Choked	$q_f = N_1 F_{LP} C_v \sqrt{\frac{p_1 - p_{vc}}{G_f}}$	1.00	0.0865
	$w_f = N_6 F_{LP} C_v \sqrt{\frac{p_1 - p_{vc}}{G_f}}$	63.3	2.73
	$p_{vc} = F_F p_v$		
	$F_F = 0.96 - 0.28 \sqrt{\frac{p_v}{p_c}}$		
	$F_{LP} = \left[\frac{1}{F_L^2} + \frac{K_i}{N_2}\left(C_d\right)^2\right]^{-1/2}$	890	0.00214
	K_i = (See Piping Geometry Factor)		
Laminar	$q_f = N_{10} \frac{\Delta p}{\mu}\left(F_s F_p C_v\right)^{3/2}$	52	173
	$F_s = \left(\frac{F_p F_d^2}{F_{LP}}\right)^{1/3} \left[\frac{(F_{LP} C_v)^2}{N_2 D^4} + 1\right]^{1/6}$	890	0.00214
Transitional	$q_f = N_1 F_R F_p C_v \sqrt{\frac{\Delta p}{G_f}}$	1.00	0.0865

[1] U.S. units are: pounds per hour, gallons per minute, pounds per square inch absolute, pounds per cubic foot, °R, and inches.

SI units are: kilograms per hour, cubic meters per hour, kPa, kilograms per cubic meter, °K, and millimeters.

Table of ISA Formulas (continued)

REMARKS	EQUATIONS	VALUE OF N U.S.	VALUE OF N SI
Gas or Vapor - (All Equations: $x \le F_k x_T$)			
	$w_g = N_6 F_p C_v Y \sqrt{x p_1 \gamma_1}$	63.3	2.73
	$q_g = N_7 F_p C_v p_1 Y \sqrt{\frac{x}{G_g T_1 Z}}$	1360	4.17
Variations for Selected units.	$w_g = N_8 F_p C_v p_1 Y \sqrt{\frac{xM}{T_1 Z}}$	19.3	0.948
	$q_g = N_9 F_p C_v p_1 Y \sqrt{\frac{x}{M T_1 Z}}$	7320	22.4
Expansion factor lower limit = 0.667	$Y = 1 - \frac{x}{3 F_k x_T}$		
Sp. ht. ratio factor	$F_k = k/1.40$		
Mfr's. Factors	$x_T = \frac{C_1^2}{1600} = 0.84 C_f^2$		
x_T with reducers	$x_{TP} = \frac{x_T}{F_p^2}\left[\frac{x_T K_i}{N_5}\left(C_d\right)^2 + 1\right]^{-1}$	1000	0.0024
	K_i = (See Piping Geometry Factor)		
Steam (Dry and Saturated)			
For $x < x_{Tp}$	$w = N F_p C_v p_1 \left(3 - \frac{x}{x_{TP}}\right)\left(\sqrt{x}\right)$	1.0	0.152
For $x \ge x_{Tp}$ (Choked Flow)	$w = N F_p C_v p_1 \sqrt{x_{TP}}$	2.0	0.304

5-3. CONTROL VALVE SIZING

Table of ISA Formulas (continued)

REMARKS	EQUATIONS	VALUE OF N U.S.	SI
Piping Geometry Factor For F_{LP} see "Liquid Choked Flow"	$F_p = \left[\frac{\sum K}{N_2}\left(C_d\right)^2 + 1\right]^{-1/2}$	890	0.00214
Sum of velocity head coefficients	$\sum K = K_1 + K_2 + K_{B1} - K_{B2}$		
Bernoulli coefficient	$K_{B1} = K_{B2} = 1 - \left(\frac{d}{D}\right)^4$		
Resistance coefficients for abrupt transitions	$K_1 = 0.5\left[1 - \left(\frac{d}{D}\right)^2\right]^2$		
Inlet fitting coefficient for F_{LP} and x_{TP}.	$K_2 = 1.0\left[1 - \left(\frac{d}{D}\right)^2\right]^2$ $K_i = K_1 + K_{B1}$		

Line Velocity	Feet/Second	Meters/Second	Range (Ft./Sec.)
Liquid	$U = \frac{q}{2.45D^2}$	$U = 354\,\frac{q}{D^2}$	5-10 Norm. 40-50 Max.
Gas	$U = \frac{qT}{695pD^2}$	$U = 1.24\,\frac{qT}{pD^2}$	250-400
Vapor	$U = \frac{w}{19.6\gamma D^2}$	$U = 354\,\frac{W}{\gamma D^2}$	70 Wet 300 superheated
Steam	$U = \frac{23w}{pD^2}$	$U = 685\,\frac{W}{pD^2}$	

Acoustic Velocity (Mach 1.0)			
Gas	$U_a = 223\sqrt{\frac{kT}{M}}$	$U_a = 91\sqrt{\frac{kT}{M}}$	< 0.3 Mach
Air	$U_a = 49\sqrt{T}$	$U_a = 20\sqrt{T}$	
Steam, Superheated	$U_a = 60\sqrt{T}$	$U_a = 24.5\sqrt{T}$	<0.15 Mach
Steam, Dry Saturated	$U_a = 1650$	$U_a = 500$	<0.10 Mach
Vapor	$U_a = 68.1\sqrt{kpv}$	$U_a = 1038\sqrt{kpv}$	

5-3. CONTROL VALVE SIZING

Nomenclature of ISA Formulas

a	Area of orifice or valve opening, in.^{2}
C	Coefficient of discharge, dimensionless. Includes effect of jet contraction and Reynolds number, mach number (gas at high velocities), turbulence.
C_d	Relative capacity (at rated C_v) $C_d = N_3 C_v / d^2$.
c_p	Specific heat at constant pressure.
c_v	Specific heat at constant volume.
C_v	Valve coefficient, $38\, a\bar{K} / F_L$.
d	Valve inlet diameter, inches or mm.
D	Pipe diameter, inches or mm.
F	Velocity of approach factor $= \frac{1}{\sqrt{1-m^2}}$.
F_d	Experimentally determined factor relating valve C_v to an equivalent diameter for Reynolds number. (See Table IV)
f	Weight fraction
F_F	Liquid critical pressure ratio factor, $F_F = p_{vc}/p_v$
F_k	Ratio of specific heats factor.
F_L	Pressure recovery factor. When the valve is not choked: $F_L = \sqrt{(p_1 - p_2) / (p_1 - p_{vc})}$
F_{LP}	Combined pressure loss and piping geometry factors for valve/fitting assembly.
F_P	Correction factor for piping around valve (e.g. reducers) $F_P C_v$ = effective C_v for valve/fitting assembly.
F_R	Correction factor for Reynolds number, where $F_R C_v$ = effective C_v.
F_s	Laminar, or streamline, flow factor.
g	Acceleration due to gravity.
G_f	Specific gravity of liquids at flowing temperature relative to water at 60°F or 15°C.
G_g	Specific gravity of gas relative to air with both at standard temperature and pressure.
h	Effective differential head, height of fluid.
$\bar{K}$	Flow coefficient = CF, dimensionless.
ΣK	Sum total of effective velocity head coefficients where $K(U^2/2g) = h$.
K_B	Bernoulli coefficient $= 1 - (d/D)^4$.

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Nomenclature of ISA Formulas (continued)

K_c	Cavitation index. Actually the ratio $\Delta p/(p_1 - p_v)$ at which cavitation measurably affects the value of C_v.
K_i	Inlet velocity head coefficient, $K_1 + K_{B1}$
K_1	Resistance coefficient for inlet fitting.
K_2	Resistance coefficient for outlet fitting.
k	Ratio of specific heats of a gas $= c_p/c_v$, dimensionless.
M	Molecular weight.
m	Ratio of areas.
N	Numerical constant (See Table I)
p	Absolute static pressure.
p_c	Thermodynamic critical pressure
p_r	Reduced pressure, p/p_c
p_v	Vapor pressure of liquid at inlet
q	Volume rate of flow.
Re_v	Reynolds number for a valve.
T	Absolute temperature.
T_c	Thermodynamic critical temperature
T_r	Reduced temperature, T/T_c
U	Average velocity.
v	Specific volume $(1/\gamma)$.
w	Weight rate of flow.
x	Ratio of differential pressure to absolute inlet static pressure, $x = (p_1 - p_2) / p_1$
x_T	Terminal or ultimate value of x, used to establish expansion factor, Y.
x_{TP}	Value of x_T for valve/fitting assembly.
Y	Expansion factor. Ratio of flow coefficient for a gas to that for a liquid at the same Reynolds number (includes radial as well as longitudinal expansion effects).

5-4. CONTROL VALVE SIZING

Chocked Condition In gases:

$$x_T = \frac{1}{F_k}\left[\frac{dP_{ch}}{P_{in}}\right], F_k = \frac{C_P}{C_V}$$

Chocked Condition In Liquids:

$$F_L = \sqrt{\frac{(P_1 - P_2)}{(P_1 - P_{VC})}}$$

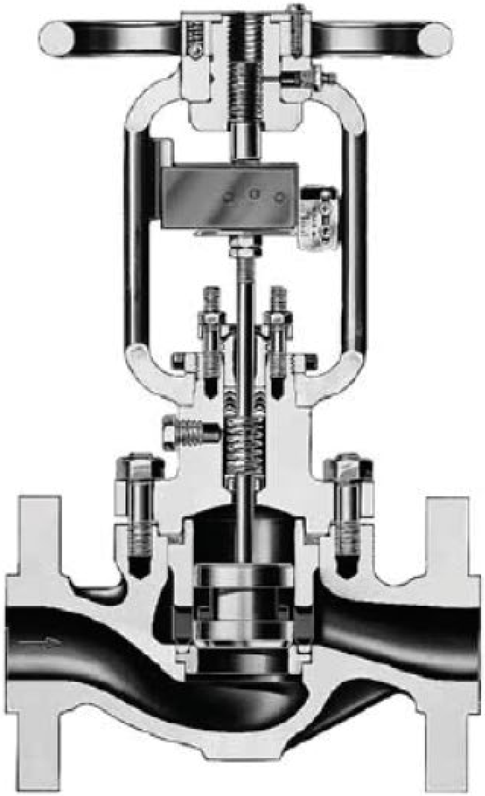
Valve Style	Body Size, Inches	Flow Characteristic					
		Equal Percentage			Linear		
		C_v	X_c	F_L	C_v	X_c	F_L
Globe	1	8	0.74	0.88	17	0.61	0.84
	1-1/2	17	0.69	0.84	30	0.70	0.82
	2	25	0.70	0.85	62	0.68	0.77
	2-1/2	49	0.66	0.84	84	0.71	0.81
	3	66	0.66	0.82	118	0.70	0.82
	4	125	0.67	0.82	181	0.74	0.82
	6	239	0.74	0.85	367	0.78	0.84
	8	268	0.60	0.85	526	0.74	0.87
Ball	1	16	0.53	0.86	–	–	–
	2	59	0.53	0.81	–	–	–
	3	120	0.50	0.80	–	–	–
	4	195	0.52	0.80	–	–	–
	6	340	0.52	0.80	–	–	–
	8	518	0.54	0.82	–	–	–
	10	1000	0.47	0.80	–	–	–
	12	1530	0.49	0.78	–	–	–
Butterfly	2	60	0.37	0.69	–	–	–
	3	111	0.40	0.69	–	–	–
	4	238	0.40	0.69	–	–	–
	6	635	.040	0.69	–	–	–
	8	1020	0.40	0.69	–	–	–
	10	1430	0.40	0.69	–	–	–
	12	2220	0.40	0.69	–	–	–
	14	2840	0.40	0.69	–	–	–
	16	3870	0.40	0.69	–	–	–

*At approximately 70% of valve travel. Maximum valve capacity may be estimated using the values given in this figure in conjunction with Fig. 4-29. For a more detailed analysis of capacity capabilities of a given valve at other percentages of travel, consult the valve manufacturer's data.

6-ACTUATORS

- Actuator type
  - Manual
  - Pneumatic
    - Diaphragm
    - Piston
    - Single or double acting
  - Hydraulic
  - Electrical
- Fail conditions

6-1. ACTUATORS-MANUAL



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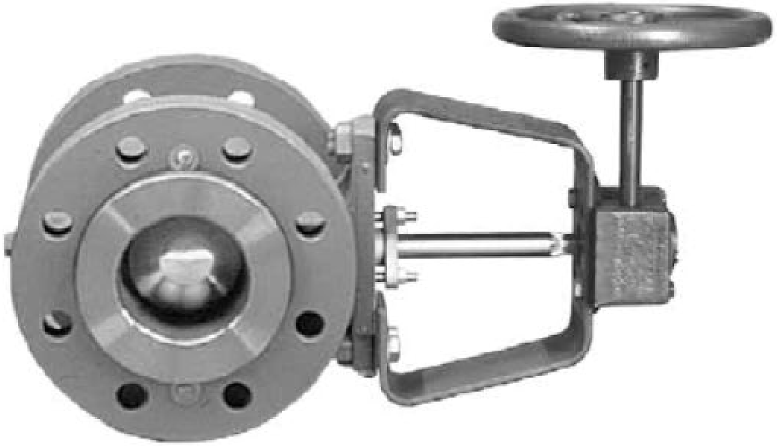
FOR SLIDING-STEM VALVES



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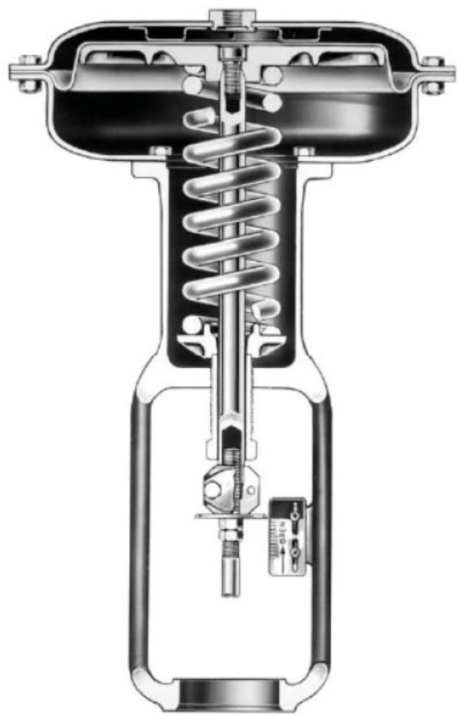
FOR ROTARY-SHAFT VALVES

6-2. ACTUATORS-PNEUMATIC DIAPHRAGM

- Direct action: Valve opens when driving power has failed.
- Reverse action: Valve closes when driving power has failed



3/IL DIRECT-ACTING

W0364/IL REVERSE-ACTING

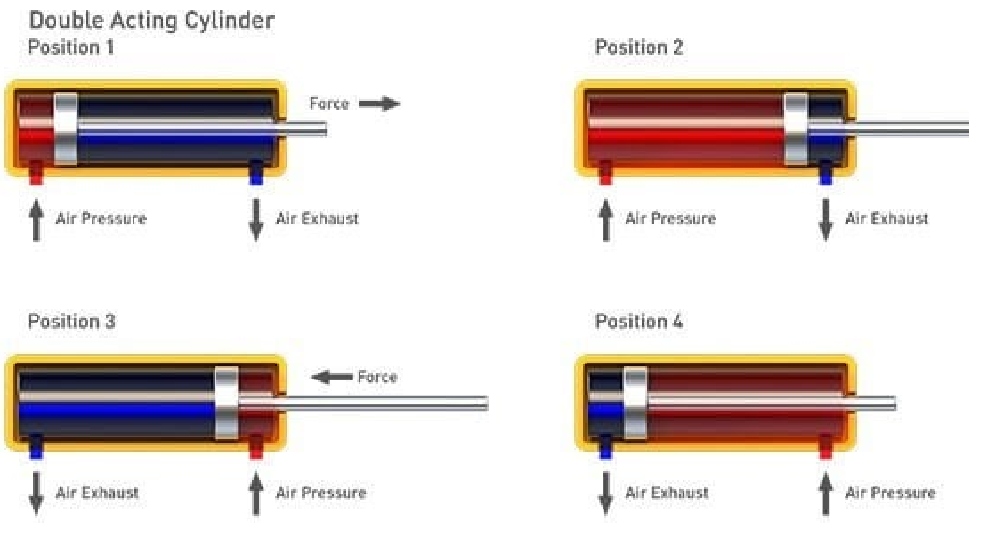
MEHRAZ
Petro Farayand Consulting Engineers

6-3-1. ACTUATORS-PNEUMATIC PISTON

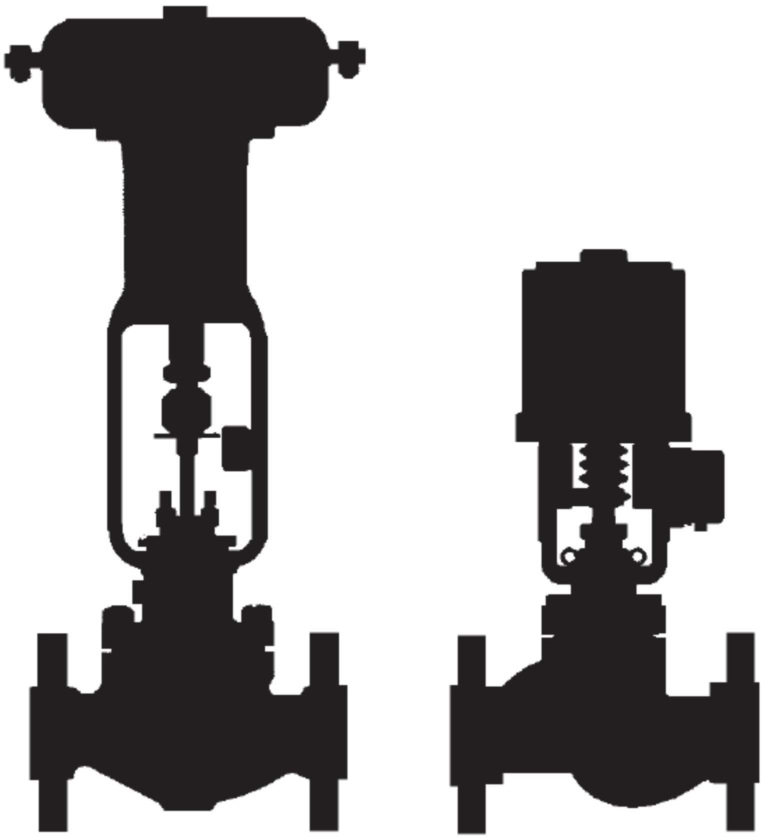
- A single-acting pneumatic actuator uses air to open the valve and a mechanical spring to close the valve.

6-3-2. ACTUATORS-PNEUMATIC PISTON

- Double-acting actuators use air pressure to both open and close the valve.

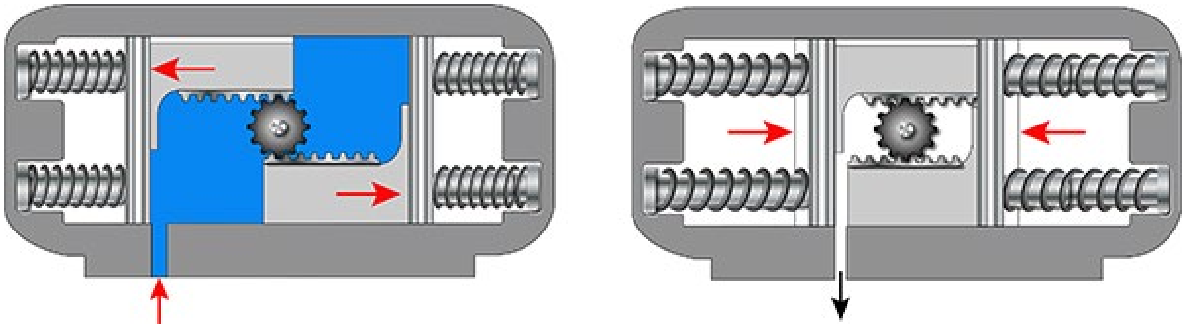


6-3-3. HEIGHT COMPARISON
(BETWEEN DIAPHRAGM AND PISTON ACTUATORS)



6-4. RACK AND PINION ACTUATORS

- Rack and pinion actuators are mechanical devices used to automatically open and close valves or dampers.
- "Rack and pinion" is a generic term for a pair of gears which convert linear motion into rotational motion.



6-5. ELECTRO HYDRAULIC ACTUATORS

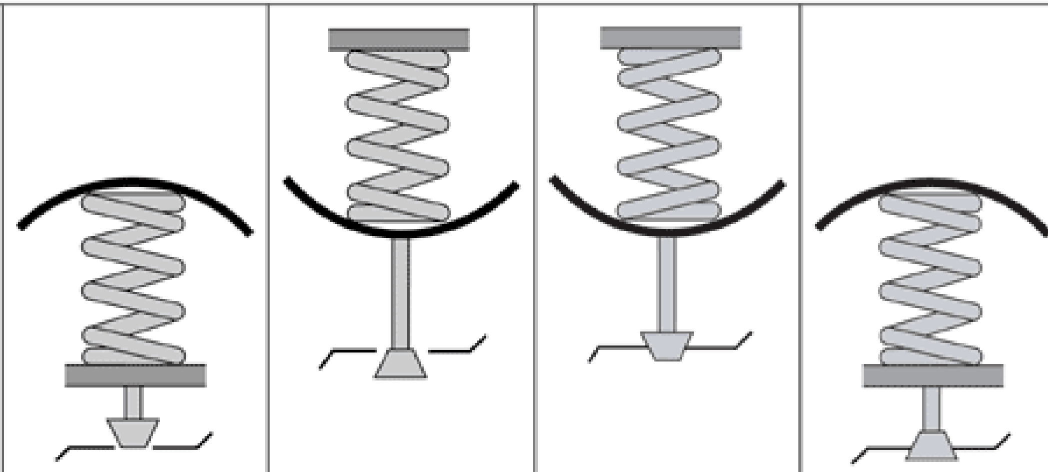
- devices that operate a valve through pressurized hydraulic fluid with the electrical source of energy.

6-6. ACTUATOR TYPES COMPARISON

	Pneumatic type	Hydraulic type	Motorized type
Response time	Dead time is rather long. Action speed is fast.	Dead time is short. Action speed is fast	No dead time. Action speed is slow
Maintaining safety position at supply fail time	Possible by using integrated spring or connecting volume tank easily and certainly.	Difficult to maintain	Can stop and maintain only the position at an emergency time.
Output power	Middle for spring diaphragm type. Big for piston cylinder type.	Small for oil integrated type. Big for oil separated installation type	Bigger than pneumatic type and oil pressure type
Structure	Simple	Complicated	Complicated
Weather proof and Exprosion proof	Not necessary	Should be considered	Should be considered
Air piping or electric wiring	Simple	Simple for oil integrated type. Complicated for oil separated installation	Simple
Maintenance work	Easy	Complicated	Complicated
Cost	Reasonable	Expensive	Expensive

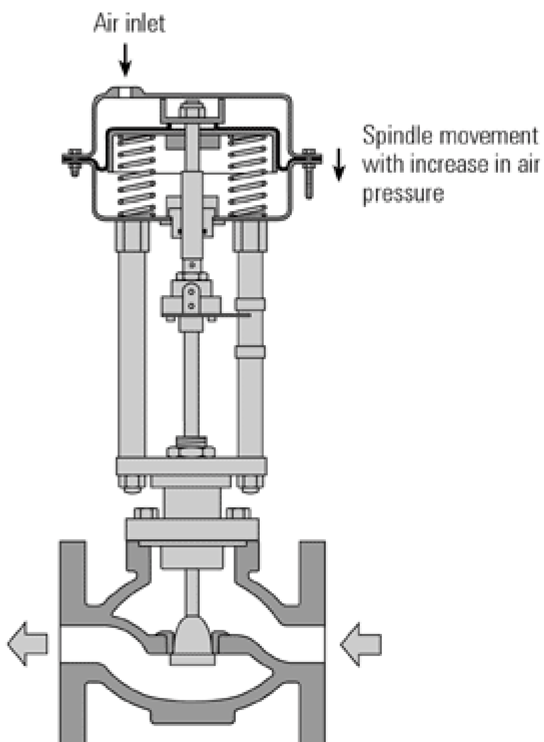
6-7. CTUATORS- FAIL CONDITIONS

- ATO - Air To Open
- ATC - Air To Close
- FLP – Fail Last Position

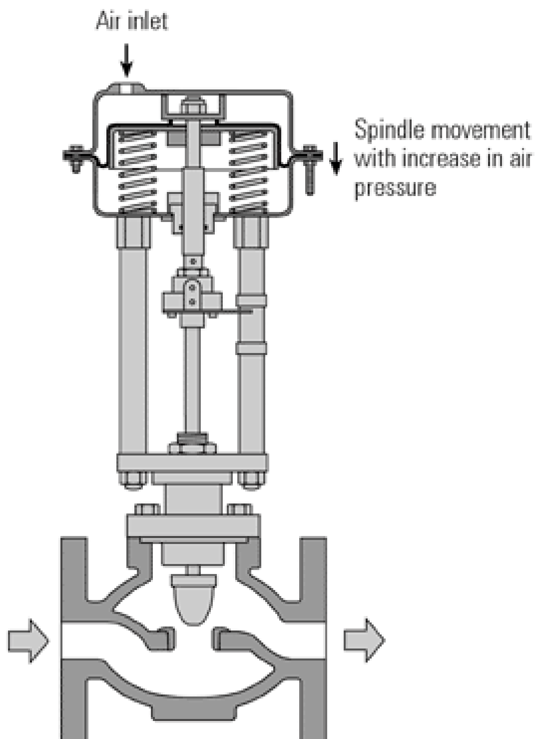


Two port valves				
Actuator action	Direct	Reverse	Reverse	Direct
Valve action	Direct	Reverse	Direct	Reverse
On air failure	Valve opens		Valve closes	

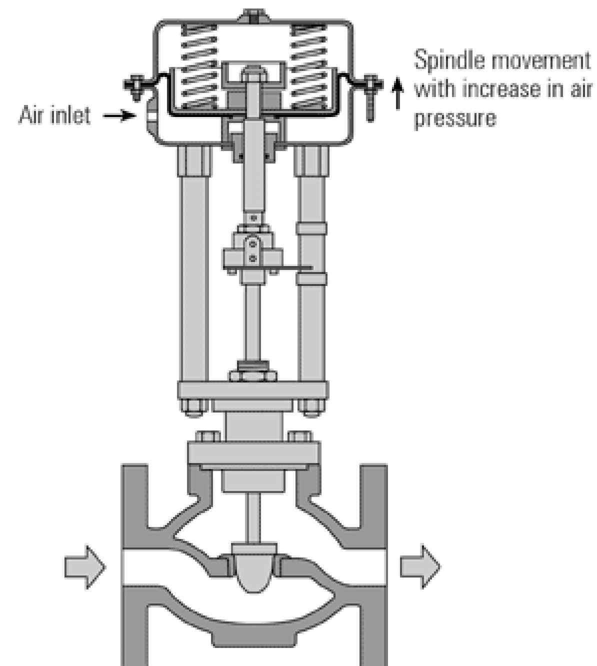
6-7. ACTUATORS- FAIL CONDITIONS



Air-to-open, normally closed



Direct acting (spring retract) air-to-close, normally open



Reverse acting (spring extend) air-to-open, normally closed

7. POSITIONERS

- A positioner for a control valve receive signal from controller and converts the signal to the appropriate opening or closing setting of the valve based on a desired set point for a process variable, whether it be pressure, temperature, or flow. It provides the accurate control of the valve.
- A positioner ensures that there is a linear relationship between the signal input from the control system and the position of the control valve.
- This means that for a given input signal, the valve will always attempt to maintain the same position regardless of changes in valve differential pressure, stem friction, diaphragm hysteresis and so on.
- A positioner may be used as a signal amplifier or booster. It accepts a low pressure air control signal from controller and, by using its own higher pressure input, multiplies this to provide a higher pressure output air signal to the actuator diaphragm, if required, to ensure that the valve reaches the desired position.

7. POSITIONERS

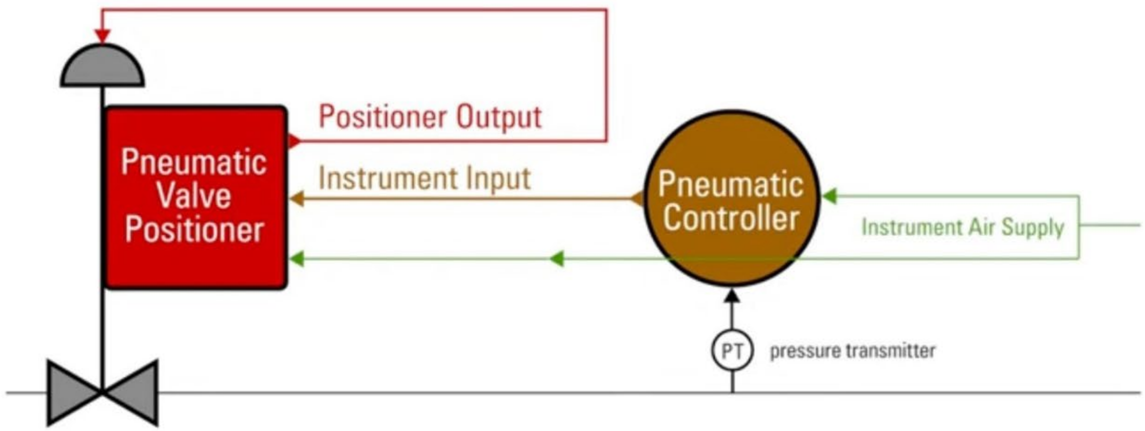
PNEUMATIC

ANALOG
(ELECTRO-PNEUMATIC / EP)

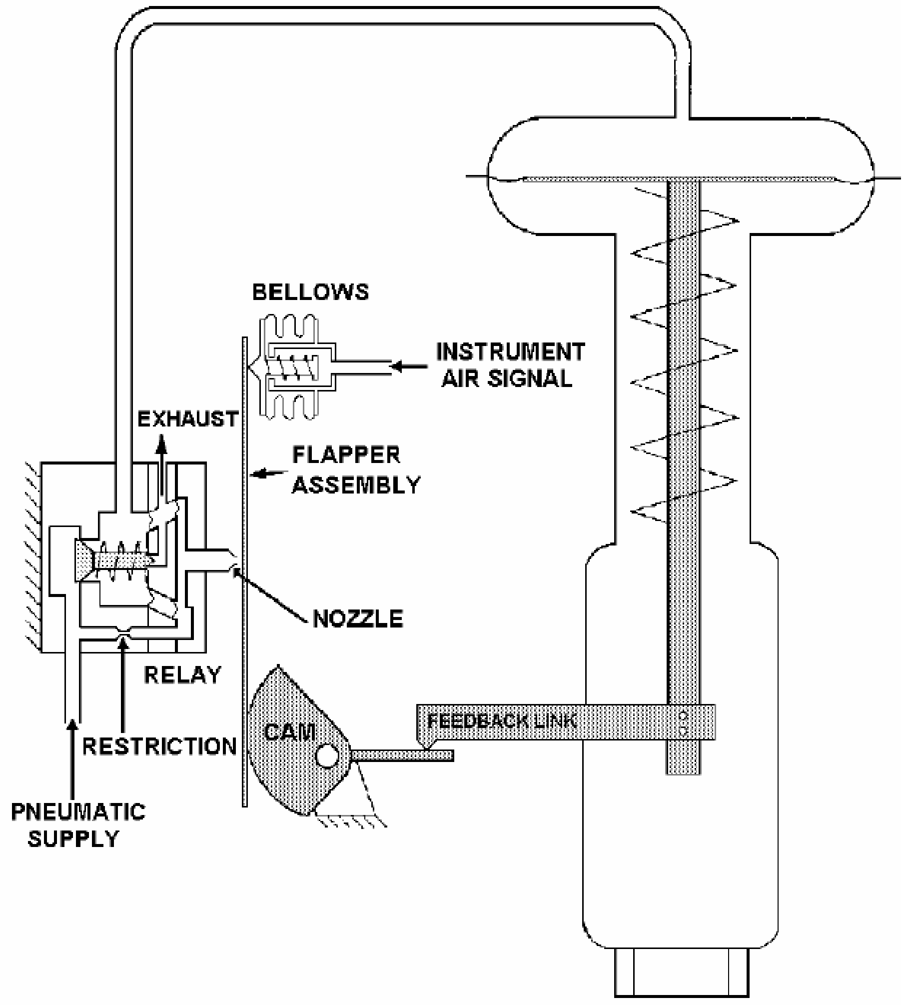
DIGITAL

7-1. POSITIONERS (A PNEUMATIC VALVE POSITIONER)

- A Pneumatic Valve Positioner receives a pneumatic signal from a controller. Accurate valve stem or shaft position proportional to the pneumatic input signal.

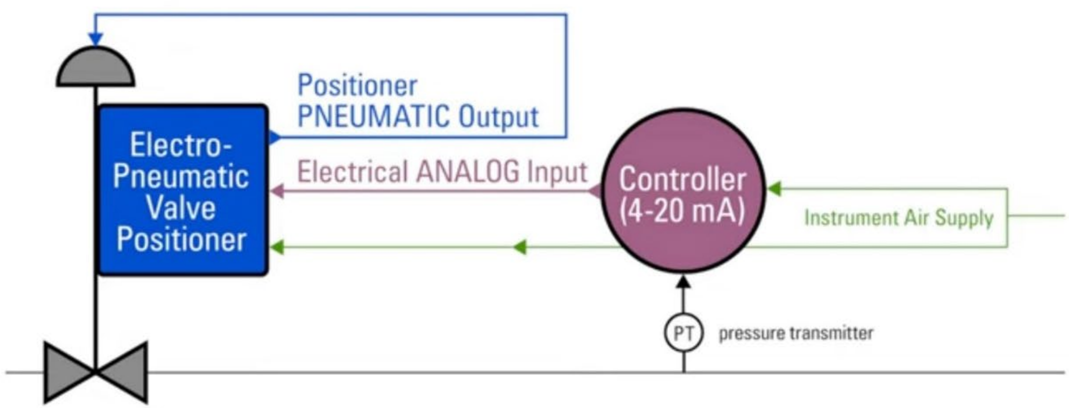


7-1. POSITIONERS (A PNEUMATIC VALVE POSITIONER)



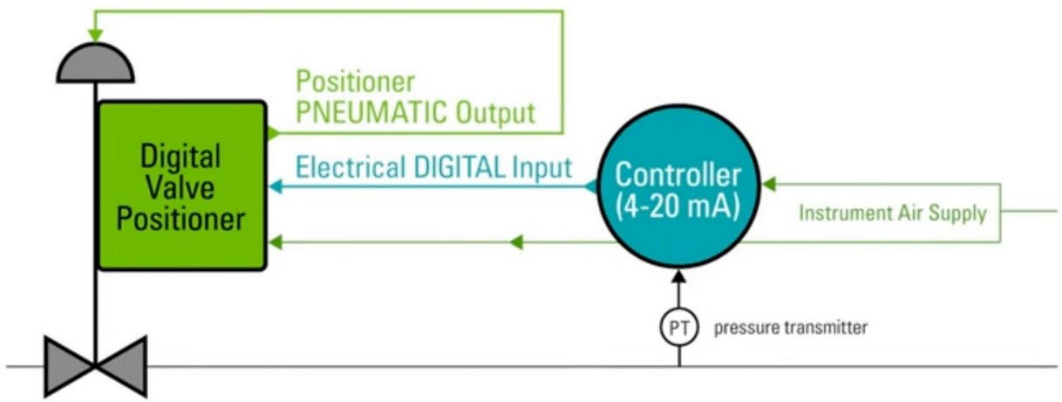
7-2. POSITIONERS (ANALOG I/P POSITIONER)

- An Electro-Pneumatic or I/P (I-to-P) Positioner use a mix of both electricity signal and air pressure. It receives an electric signal from a controller, Convert the electronic current signal (4-20 mA DC signal) into a pneumatic pressure signal and send a corresponding pneumatic signal 3-15 psi or 0.2-1.0 bar to a pneumatic valve actuator.



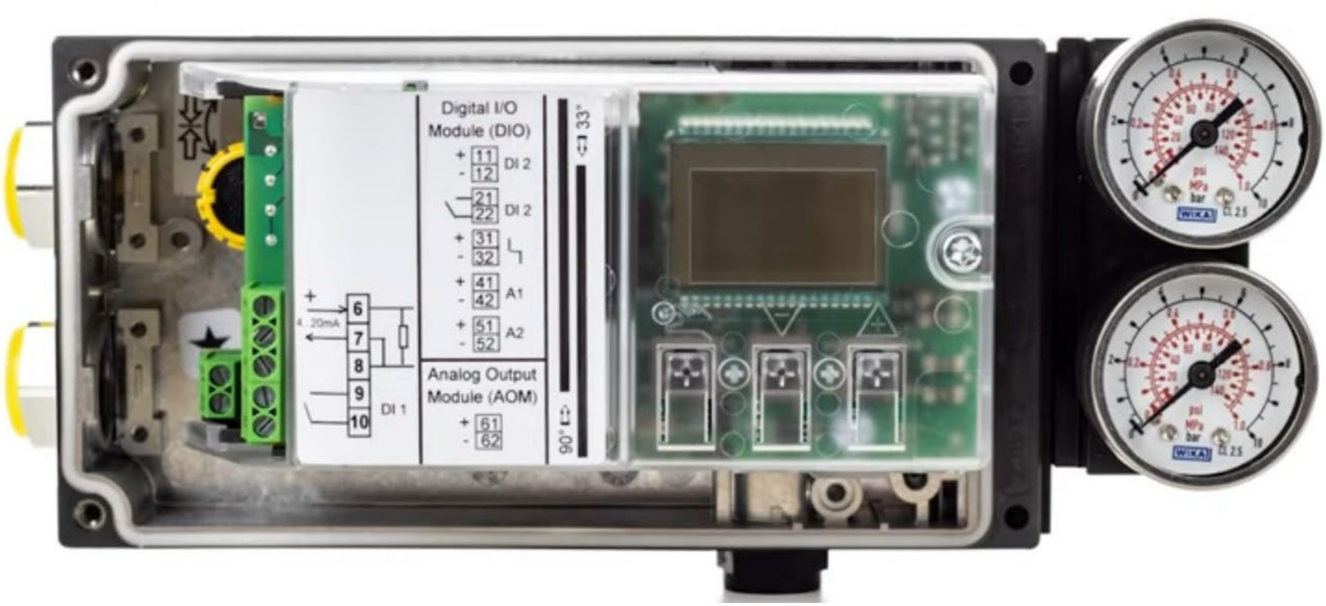
7-3. POSITIONERS (DIGITAL VALVE POSITIONER)

- A digital valve positioner also receives an electric signal from a controller. But it is digital as opposed to analog. It then sends a corresponding pneumatic signal to a pneumatic valve actuator.



7-3. POSITIONERS (DIGITAL VALVE POSITIONER)

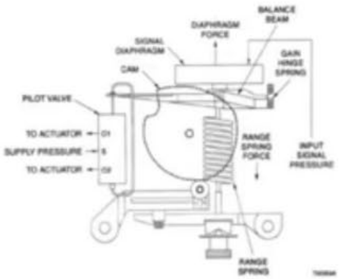
- It also differs from an EP because it uses a microprocessor to convert the control signal and perform the position control rather than a mechanical beam cam and flapper assembly found in an EP. This electrical input allows more advance capabilities for the users.



7-3. POSITIONERS (DIGITAL VALVE POSITIONER)

- These digital smart positioners also collect data to automatically alert users about valve performance, diagnostics and maintenance.

Microprocessor



Mechanical beam, cam and flapper assembly

8. VALVE ACCESSORY

- It A device that is mounted on the actuator to complement the actuator's function and make it a complete operating unit.
- Examples include:
- Positioners
- Supply pressure regulators
- Solenoids & Solenoid Valve Manifold
- Limit Switches
- Supply Pressure Regulator
- Pneumatic Lock-Up Systems
- Electro-Pneumatic Transducers

9. VALVE MATERIALS

- Valve body material selection is usually based on the Pressure, Temperature, Corrosive properties and Erosive Properties of the flow media.
- Cast Iron (ASTM A126) is used for steam. Water. Gas and non corrosive fluids and is inexpensive.
- Cast Bronze (ASTM B61& ASTM B62) is used for steam, Air, Water, Oil and non corrosive fluids.
- Cast carbon steel (ASTM A216-Grade WCB) is the most popular steel for valve bodies in moderate service such as Air, superheat or saturated steam, non corrosive fluids.
- Cast Chrome-Moly Steel (ASTM A217-Grade WCB-C9) has addition of chromium/Molybdenum that provide corrosion resistance and also is suitable for temperature up to 1050 Deg.F.
- Cast type 304 SST (ASTM A351-Grade CF8) is for oxidizing and very corrosive fluids.
- Cast type 316 SST (ASTM A351-Grade CF8M) is same as 304 SST but since it has addition of Molybdenum then better resistance to corrosion.

10. CONTROL VALVE SELECTION

- Select Valve type
- Select Higher Cv from available
- Select Valve size, trim size for available range
- End Conn. type (Flanged or Screwed) and rating selection
- Leakage class selection
- Material Selection
- Actuator selection
- Packing and bonnet type selection
- Valve Action (F.C. or F.O)
- Instrument Air Supply Pressure
- Accessories /Positioners/Etc. selection

SAMPLE DATASHEET

CONTROL VALVE DATA SHEET

				MAX. FLOW	NORM.FLOW	MIN.FLOW	SHUT-OFF
1	SERVICE CONDITION	TAG NO		P&ID NO. :			
2		FLUID:		SERVICE			
3			UNITS	MAX. FLOW	NORM.FLOW	MIN.FLOW	SHUT-OFF
4		FLOW RATE	KG/HR				
5		INLET PRESSURE	BARA				
6		OUTLET PRESSURE	BARA				
7		INLET TEMPERATURE	°C				
8		DENSITY@(PT)/SPEC.GRAV.@atm,15 C/MW	KG/M3				
9		VISCOSITY/ SPEC HEATS RATIO CP/CV	cP/				
10		VAPOR PRESSURE PV	BARA				
11		LIQ CRITICAL PRESS.	BARA				
12		COMPRESSIBILITY FACTOR Z	---				
13		CALCULATED CV	---				
14		REQUIRED CV	---				
15		MAX. ALLOWED NOISE	dBA				

16	LINE	PIPE LINE NO.		43	ACTUATOR	TYPE	
17		PIPE LINE SIZE: IN/OUT		44		SIZE	EFF AREA
18		SCHEDULE: IN/OUT		45		ON/ OFF	MODULATION
19		PIPE LINE INSULATION		46		SPRING ACTION TO OPEN/CLOSE	
20	SERVICE CONDITION	TYPE		47		MAX. ALLOWABLE PRESSURE	
21		SIZE	ANSI CLASS	48		MIN. REQUIRED PRESSURE	
22		MAX PRESS. Bara	MAX. TEMP. 0C	49		AVAILABLE AIR SUPPLY PRESS barg	
23		BODY/BONNET MATL		50		MAX.	MIN.
24		LINER MATERIAL / ID		51		BENCH SET RANGE bar g	
25		END CONNECTIONS	IN	52		ACT ORIENTATION	
26			OUT	53		HANDWHEEL TYPE	
27		FLG. FACE FINISH		54		AIR FAILURE VALVE	SET AT
28		END EXT/MATL.		55		INPUT SIGNAL	
29		FLOW DIRECTION		56	POS	TYPE	
30		TYPE OF BONNET		57		ON INCR SIGNAL OUTPUT INCR/ DEACR	
31		LUB & ISO VALVE		58		GAUGES	BY-PASS
32		PACKING MATERIAL	PACKING TYPE	59		CAM CHARACTERISTC	
33		TIGHT SHUT-OFF REQUIRED (yes/no) :	S.L.:	60	SWTC	TYPE	
34	TRIM	TYPE		61		CONTACTS	RATING
35		SIZE	RATED TRAVEL	62		ACTUATION POINTS	
36		CHARACTERISTIC		63	AIR SET	SUP / SET PRESSURE	AIR CONNECTION SIZE:
37		BALANCED/UNBALANCED		64		FILTER	GAUGE
38		SELECTED Cv: FL: XR:		65	TEST	HYDRO PRESSURE	
39		TRIM MATERIAL		66		ANSI / FCI LEAKAGE CLASS	
40		SEAT MATERIAL		67			
41		CAGE/GUIDE MATERIAL		68	SOV	MANUFACTURER	
42		STEM MATERIAL		69		MODEL NO.	

NOTES:


THANK YOU!