Application ratio :

In order to characterize potential cavitation conditions we required the application ratio given as ,

$$\text{Application ratio} = \frac{P_i - P_0}{P_i - P_v}; \text{ where}$$

P_i = inlet pressure, absolute

P_0 = outlet pressure, absolute

P_v = vapor pressure of the fluid, absolute Example 1:

Example 1.

Inlet pressure of a particular fluid handled is 30 psia, outlet pressure is 20 psia, and vapor pressure is 16 psia. Calculate the application ratio and predict the chances of cavitation and flashing.

Solution:

Given, P_i = 30 psia

P_0 = 20 psia

P_v = 16 psia

We know

$$\text{Application ratio} = \frac{P_i - P_0}{P_i - P_v} = \frac{30-20}{30-16} = 0.71$$

As application ratio < 1, it results to cavitation but no flashing.

Characteristics

- Controller valve characteristic defines the relationship between valve opening and flow rate under constant pressure conditions.
- ***Quick opening*** – In this type, the relationship between flow and valve opening is approximately linear up to 60-70% of the valve opening. After this limit, the flow doesn't change rapidly with the change in the valve opening.
- ***Linear*** – The flow is directly proportional to the valve opening for a constant pressure drop. The relationship, thus, can be expressed as a straight line. It is given as:

$$\left(\frac{Q}{Q_{max}}\right) = \left(\frac{S}{S_{max}}\right)$$

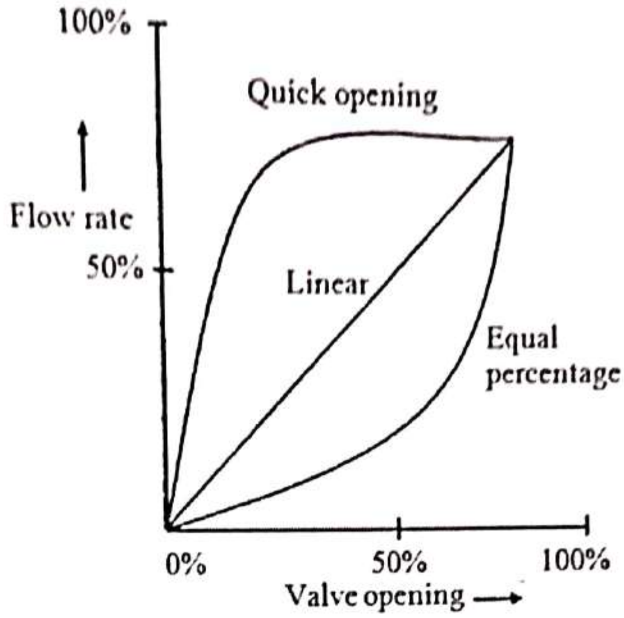
Where S = Stem position

S_{max} = maximum stem position.

Q = Flow rate

Q_{max} = maximum Flow rate

- *Equal percentage* – Equal increments of valve movement produce an equal percentage changes in inflow.. The gain of equal percentage valve is directly proportional to flow through the valve. Gain is low when valve is nearly closed and gain is high when valve is nearly open.



- The above Figure illustrates the effect of flow rate on the differential pressure across the control valve. At low flow, the head loss through the pipes is less (10 psig), leaving a larger differential pressure across the valve; while at high low, the head loss through the pipe is more (40 psig), leaving a smaller differential pressure across the valve.

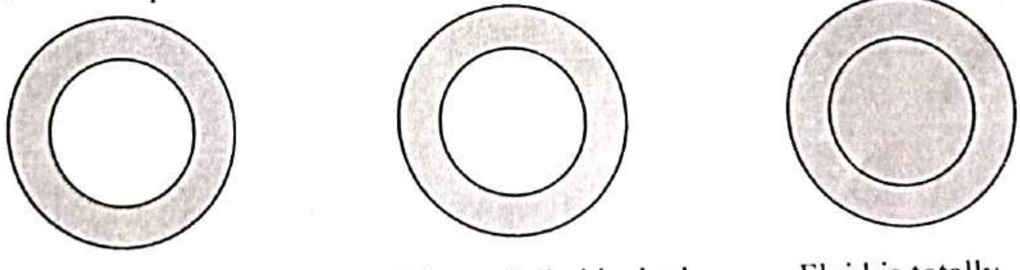
ypes of Ball:

all Valve

all valves are stop valves that use a ball to stop or start the flow of fluid.

he figure shows the end view of the ball within the ball valve at different stages of rotation.

alve fully open Valve half-open Valve fully closed



Fluid passes freely   Fluid is partially blocked   Fluid is totally

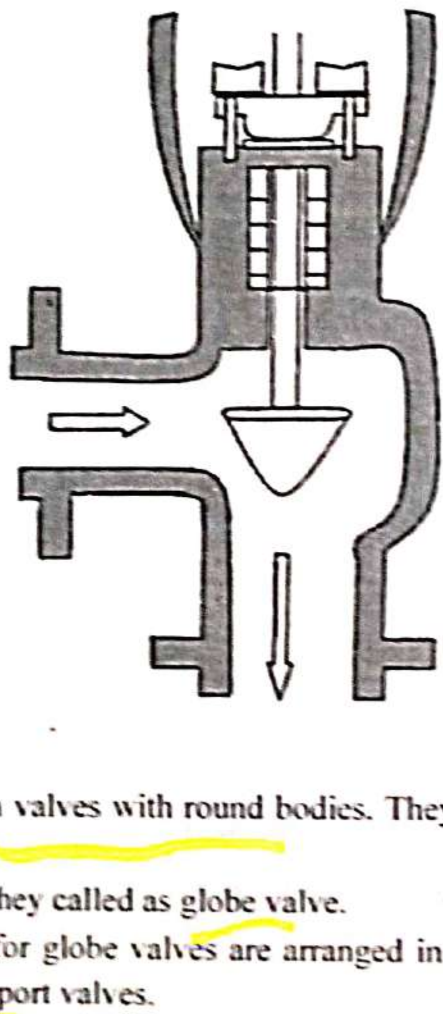
End view of ball within ball valve

- Most ball valves are of quick-acting type. They require only a 90 turn to either completely open o the valve. Best suited valve characteristics for ball valves are quick opening and linear. Th recommended for fully open/closed operations with poor throttling characterisitics. It provide sealing with low torque.

Gate valve

- A gate valve, or sluice valve, as it is sometimes known, is a valve that opens by lifting a ro rectangular gate out of the path of the fluid. Gate valves are used when a straight-line flow of fl minimum flow restriction are needed.
- In Gate valves the part that either stops or allows the flow through the valve acts somewhat like a
- When the valve is wide open, the gate is fully drawn up into the valve bonnet.

Globe Valve



- These Valves are linear motion valves with round bodies. They are widely used in industry to re fluid.
- Because of the globular shape they called as globe valve.
- The inlet and outlet openings for globe valves are arranged in a way to satisfy the flow requirem Globe valves are typically two-port valves.

...lle Valve

- Needle control valves have a slender, tapered point at the end of the valve stem that is lowered through the seat: to restrict or block the flow. Needle valves are similar in design and operation to the globe valve. The long tapered end of the valve permits a much smaller seating surface area than that of the globe valve. Therefore, the needle valve is more suitable' as a throttle valve.
- Fluid flowing through the valve turns 90° and passes through an orifice that is the seat for a rod with a cone-shaped tip. These small valves are widely used to at low flow rates. The fine threading of the stem allow for precise resistance to flow.

...lief Valve

- Relief valves are used to control excess pressure. Relief valves are automatic valves used on system lines and equipment to prevent over pressurization.
- Most relief valves simply lift at a preset pressure and reset when the pressure drops slightly below the lifting pressure.
- They do not maintain flow or pressure at a given amount, but prevent pressure from rising above a specific level when the system is temporarily overloaded. In a pneumatic system, the relief valve controls excess pressure by discharging the excess gas to the atmosphere.
- These are used for automatic release of gas from a boiler.

...afety Valve:

- Safety valves are used to release excess pressure in gases or compressible fluids.
- Safety valve also has spring force counteracting the pressure created by the fluid system. When force created by spring force exceeds the spring force, the valve "pops" fully open and vents air to atmosphere. Safety valves are sized in such manner that they have greater flow capacity than the source which 'created excessive pressure situation.
- A relief valve opens only as necessary to relieve the over-pressure condition, while a safety valve rapidly pops fully open as soon as the pressure setting is reached. A safety valve will stay fully open until the pressure drops below, a reset pressure which is lower than the actuating set point pressure.

ELECTRICAL ACTUATORS

Armature Controlled DC Servomotor

Input = e_a ; output = θ

Air gap flux $\phi \propto i_f$ =

$T_m \propto \phi\, i_a$

$\propto k_f\, i_f\, i_a$

$TM = k_1\, k_f\, I\, i_a$

$\Rightarrow\ T_m = k_T\, i_a$ .....(2)

K_T = motor torque constant

Back emf $\propto$ speed

$e_b \propto (d\theta / dt)$

$e_b = k_b\, (d\theta/dt)$ ..... (3)

Analysis of armature loop

$e_a - e_b = i_a R_a + L_a(di_a/dt)$ ..... (4)

At load $T_m = j(d^2\theta/dt^2) + f_0(d\theta/dt)$ ..... (5)

Applying laplace transform

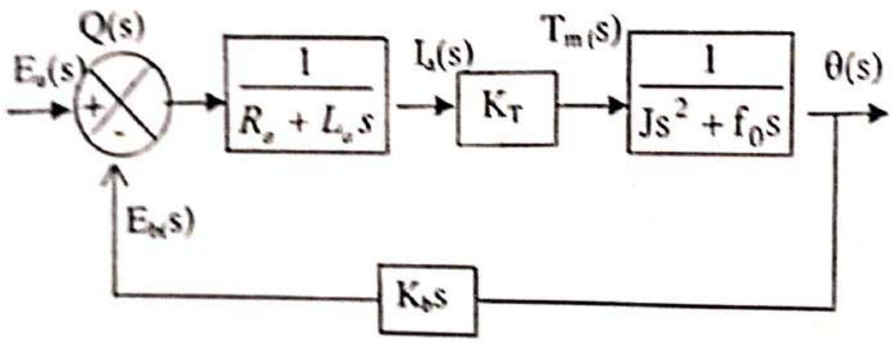
$T_m(s) = kI_a(s)$ ..... (6)

$E_b(s) = k_b(s)\, \theta\, (s)$ ..... (7)

$E_a(s) - E_b(s) = I_a(s)\{R_a t - as\}$ ..... (8)

$T_m(s) = \theta(s)\, \{Js^2 + f_0 s\}$ ..... (9)

We can draw the block diagram as



Field controlled D.C servomotor

Air gap flux $\phi \propto i_f$ ..... (1)

Armature reactance

$T_m \propto \phi$

$T_m \propto k_f i_f i$

$T_m = k_1\, k_f\, i$

$\therefore\ T_m = k_T\, i_f$ ..... (2)

Back emf $\propto$ speed

$e_b \propto (d\theta/dt)$

$e_b = K_b\,(d\theta/dt)$ ...... (3)

Analysis of field loop

$e_f = i_f\, R_f\, L_f\,(di_f/dt)$ ...... (4)

At load

$T_m(s) = J(d^2\theta/dt^2\,) + f_0(d\theta/dt)$ ...... (5)

Applying laplace transform

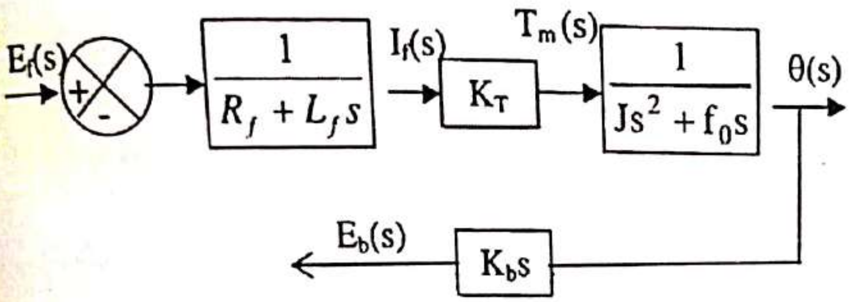
$T_m(s) = K_T I_f(s)$ ...... (6)

$E_b(s) = K_b(s)\,\theta\,(s)$ ...... (7)

$E_f(s) = J_f(s)\,(R_f + L_f)$ ...... (8)

$T_m(s) = \theta(s)\,\{Js^2 + f_o s\}$ ..... (9)

From above equation we can the block diagram as



Principle of variable resistive transducer Potentiometer:

Input = xi (displacement of wiper)

Output = e_0

Principle of operation

$e \rightarrow$ supply voltage

$x_t \rightarrow$ Length of resistance element

R_p = total resistance of potentiometer

(Resistance/unit length) = R_p/x_t