VALVES
VALVES

Valves

- Control Valves
- Pressure Relief Valves
- On-off Valves
- Check Valves
ON-OFF VALVES

Gate Valves
ON-OFF VALVES

Ball Valves
ON-OFF VALVES

Plug Valves
ON-OFF VALVES

- Stopping the flow
- Providing tight shutoff when being closed
- Providing low pressure drops when being fully opened
- Most of control valves can be used for on-off duty, especially ball valves
- Gate valves are often used in on-off service
CHECK VALVES

- Prevent reversal of flow
- Open with forward flow and close against reverse flow

- Types of check valves
  - Lift check valves
  - Swing check valves
  - Tilting-disk check valves
CHECK VALVES
Lift Check Valves

• depend on gravity for operation

• high pressure services
CHECK VALVES

Swing Check Valves

- closure member swings about a hinge
- employed along with gate valve
- low fluid velocities
- flow reversals are infrequent
CHECK VALVES

Tilting-Disk Check Valves

- closure member rotates about a point between the center and edge of disc
- spring loaded
- more expensive
- more difficult to repair
CONTROL VALVES

❖ General characteristics and functions
❖ Types of control valves
❖ Flow characteristics
❖ Valve selection
CONTROL VALVES

General characteristics and functions

- Used to regulate the flow automatically to any desired amount
- High pressure drop
CONTROL VALVES

Types of control valves

- Globe valves
- Ball valves
- Butterfly valves
- Plug valves
CONTROL VALVES

Globe Valves

- Linear stem motion
- Significant pressure drop
- Control the flow
- Good in service with fluid containing no solid
CONTROL VALVES

Ball Valves

- Rotary stem motion
- Small friction
- Small pressure drop
- High flow capacity
- Provide tight shutoff
- Well suited for on-off service
- Not good in throttling service
CONTROL VALVES

Butterfly Valves

- Rotary stem motion
- Small pressure drop
- Large flow capacity
- Good service with fluid with or without solid
- Handle on-off duty
- Handle throttling duty
CONTROL VALVES

Plug Valves

- Rotary stem motion
- Provide tight shutoff
- Multiport plug valves can be used to simplify the piping system
- Well suited for on-off service
CONTROL VALVES

Inherent Flow Characteristics
CONTROL VALVES

Valve Selection

- Characteristics of each type of control valves
- Pressure of the system
- Temperature of the system
- Type of flowing fluid
VA L V E S

Energy Balance

Total energy balance

\[ \Delta(U + PE + KE) = \sum_I (H + PE + KE) - \sum_O (H + PE + KE) + \sum_Q - \sum_W \]

The energy balance is reduced to

\[ H_I - H_O + \rho \left( \frac{v_I^2 - v_O^2}{2} \right) = 0 \]

\[ H_I = H_O \]
VALVES

Pressure Drop

\[
g \Delta z + \int \frac{dP}{\rho} + \Delta \left( \frac{v^2}{2} \right) = \dot{W}_o - \delta F
\]

\[
dP = - \rho \delta F - \rho \Delta \left( \frac{v^2}{2} \right)
\]

\[
\delta F = h_L = K \frac{v^2}{2}
\]

\[
\Delta P = - K \frac{v^2 \rho}{2} - \rho \Delta \left( \frac{v^2}{2} \right)
\]
VALVES

Pressure Drop Across Control Valves
VALVES
Configuration of Piping Associated with a Control Valve
VA LV E S

Joule-Thomson Effect

- Isenthalpic expansion

\[ \mu_{JT} = \left( \frac{\partial T}{\partial P} \right)_H \]

- \( \mu_{JT} > 0 \), T decreases
- \( \mu_{JT} < 0 \), T increases
PRESSURE RELIEF VALVES

Purposes and Operating Conditions

Pressure relief valves are designed to protect a system from being over-pressurized.

- P < 10,000 psia
- T < 1,000°F
PRESSURE RELIEF VALVES

Types of Pressure Relief Valves

- Direct-loaded relief valves
- Pilot-operated relief valves
PRESSURE RELIEF VALVES

Direct-loaded Relief Valves
PRESSURE RELIEF VALVES

Safety Valves
PRESSURE RELIEF VALVES

Relief Valves
PRESSURE RELIEF VALVES

Safety-Relief Valves

Diagram of a safety-relief valve with labeled parts:
- Cap
- Adjusting bolt
- Adjusting bolt lock nut
- Bonnet
- Spring
- Spindle
- Spring washers
- Guide
- Guide ring set screw
- Guide ring set screw gasket
- Nozzle ring set screw
- Nozzle ring set screw gasket
- Nozzle ring
- Semi-nozzle Body
- Disc
- Spindle lockclip
- Guide ring
PRESSURE RELIEF VALVES

Sizing Valves for Liquid Services

❖ Piping:

\[ A = \frac{Q \sqrt{S}}{27.2 \sqrt{P_d}} \]

❖ Viscous liquid:

\[ A = \frac{Q \sqrt{S}}{27.2 \sqrt{P_d K_u}} \]

❖ Pressure vessels:

\[ A = \frac{Q \sqrt{S}}{27.2 \sqrt{P_d K_p}} \]