Chapter 6 : Transportation And Metering of Fluids

Important Terms ⇒

★ **IPS (iron pipe size), NPS (normal pipe size) are standard sizes for steel pipe.**

★ **Schedule number : The wall thickness of pipe is indicated by Schedule number, which increases with thickness.**

★ **BWG : The wall thickness of tubing is given by Birmingham Wire Gauge (BWG) which ranges from 24(very light) to 7(very heavy).**

★ **Steam Trap : It is a special type of valve which allows water and inert gas to pass through while holding back the steam.**

★ **Valves :**

Gate valve ⇒ 1. Unidirectional flow
2. Low pressure drop

Globe valve ⇒ 1. Multidirectional flow
2. High pressure drop

★ **Positive displacement devices : They apply direct pressure to the fluid.**

★ **Centrifugal pumps : They use torque to generate rotation.**

★ **Cavitation : If the suction pressure is only slightly greater than the vapor pressure, some liquid may flash to vapor inside the pump, a process called cavitation, which greatly reduces the pump capacity and causes severe erosion. If the suction pressure is actually less than the vapor pressure, there will be vaporization in the suction line, and no liquid can be drawn into the pump.**

★ **NPSH (Net positive suction head) :** To avoid cavitation, the pressure at the pump inlet must exceed the vapor pressure by a certain value, called the net positive suction head (NPSH).

$$\text{NPSH} = \frac{g_c}{g}\left(\frac{p_{a'} - p_v}{\rho} - h_{fs}\right) - Z_a$$

where $p_{a'}$ = absolute pressure at surface of reservoir
p_v = vapor pressure
h_{fs} = friction in suction line

★ **Volumetric Efficiency :** Ratio of fluid volume discharged to the volume swept by the piston/ plunger is called volumetric efficiency.

★ **Positive displacement pump :** A definite volume of liquid is trapped in a chamber, which is alternately filled from the inlet and emptied at a higher pressure through discharge.

★ **Volute :** The liquid leaving the outer periphery of the impeller is collected in a spiral casing called the voulte. In volute the velocity head of liquid is converted into pressure head.

★ **Vacuum Pumps :** A compressor that takes suction at a pressure below atmospheric pressure and discharges against atmospheric pressure is called vacuum pump.

★ **Pumps :**

1. Positive displacement pumps
2. Centrifugal pumps

★ **Positive displacement pumps :**

1. **Reciprocating pumps =** Chamber is stationary cylinder with a piston/plunger.
   E.g.: Piston pump,plunger pump,diaphragm pump

2. **Rotary pumps =** Chamber moves from inlet to discharge and back to the inlet.
   E.g. : Spur-gear pump, Internal-gear pump

★ **Centrifugal Pumps :** In the second major class of pumps the mechanical energy of the liquid is increased by centrifugal action.

★ **Fans :** Large fans are usually centrifugal, operating on exactly the same principle as centrifugal pumps. Their impeller blades, however, may be curved forward; this would lead to instability in a pump, but not in a fan.

★ **Full-bore meters :** Full-bore meters include variable-head meters such as venturi and orifice meters and variable-area meters such as rotameters.

★ **Venturi-meters :** In the venturi meter, the velocity is increased, and the pressure decreased, in the upstream cone. The pressure drop in the upstream cone is utilized to measure the rate of flow through the instrument. The velocity is then decreased, and the original pressure largely recovered, in the downstream cone. To make the pressure recovery large, the angle of the downstream cone *C* is small, so boundary-layer separation is prevented and friction minimized.

$$\overline{V}_b = \frac{1}{\sqrt{\alpha_b - \beta^4 \alpha_a}} \sqrt{\frac{2g_c(p_a - p_b)}{\rho}} \quad , \quad \overline{V}_b = \frac{C_v}{\sqrt{1 - \beta^4}} \sqrt{\frac{2g_c(p_a - p_b)}{\rho}}$$

★ **Orifice Meter :** The principle of the orifice meter is identical with that of the venturi. The reduction of the cross section of the flowing stream in passing

through the orifice increases the velocity head at the expense of the pressure head, and the reduction in pressure between the taps is measured by the manometer. Bernoulli's equation provides a basis for correlating the increase in velocity head with the decrease in pressure head.

$$u_o = \frac{C_o}{\sqrt{1-\beta^4}} \sqrt{\frac{2g_c(p_a - p_b)}{\rho}}$$