$T_A = T_B$

$$\frac{P_A}{g\rho_A} + X_A + \frac{U_A^2}{2g} = \frac{P_B}{g\rho_B} + X_B + \frac{U_B^2}{2g}$$

+ W (work done by pump)

− f (frictional losses that occurs)

$$\frac{P_A}{g\rho_A} + X_A + \frac{U_A^2}{2g} + W - f = \frac{P_B}{g\rho_B} + X_B + \frac{U_B^2}{2g}$$

Flow Meters

→ Used to measure the rate of flow of liq.

→ To determine rate at which liq is flowing

→ Copper plates

Ⓐ Direct weighing method
Ⓑ Hydrodynamic method
Ⓒ Direct displacement method

$\left.\begin{array}{l}\text{(a), (b), (c)}\end{array}\right\}$ Principles of flow meters

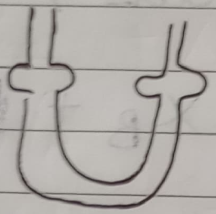
We will study hydrodynamic method (based on bernoulli's theorem)

Orifice meter

→ Based on hydrodynamic method.

→ Principle → Bernoulli's theorem

Differential manometer (two liq are used) is used alongwith a orifice meter.

 → differential manometer

Change in velocity

Change in pressure

Velocity more at point B

Pressure more at point A

Rate of flow of fluid ↓

$$u_0 = C_0\sqrt{2g\Delta H}$$

u_0 = Vel of fluid at point of orifice meter

~~As~~ g = acceleration due to gravity

ΔH = Change in height of manometer tube

C_0 = Constant.

Imp → Derivation of formula (100% Q will come).

Mathematical

Two points are considered A & B

Velocity at point A = U_A

Pressure at point A = P_A

Density at point A = ρ_A

Velocity at point B = U_B

Pressure at point B = P_B

Density at point B = ρ_B

height at point A = X_A

height at point B = X_B

Total energy at point A

$$T_A = \frac{P_A}{g\rho_A} + X_A + \frac{U_A^2}{2g}$$

$$T_B = \frac{P_B}{g\rho_B} + X_B + \frac{U_B^2}{2g}$$

Total energy at point B

$T_A = T_B$

$$\frac{P_A}{g\rho_A} + X_A + \frac{U_A^2}{2g} + W - f = \frac{P_B}{g\rho_B} + X_B + \frac{U_B^2}{2g}$$

Assumptions

→ $\rho_A = \rho_B = \rho$ (same liq is flowing)

→ pipe is horizontal, the distance of point A & B from ground level is same, $X_A = X_B = X$

→ No pump is used, hence no +W & −f (frictional loss)

Therefore,

$$\frac{P_A}{g\rho} + \frac{U_A^2}{2g} = \frac{P_B}{g\rho} + \frac{U_B^2}{2g}$$

$$\frac{U_B^2}{2g} - \frac{U_A^2}{2g} = \frac{P_A}{g\rho} - \frac{P_B}{g\rho}$$

$$\frac{1}{2g}(U_B^2 - U_A^2) = \frac{1}{g\rho}(P_A - P_B)$$

$$\frac{1}{2g}(U_B^2 - U_A^2) = \frac{1}{g\rho}\Delta P$$

$$(U_B^2 - U_A^2) = \frac{2g}{g\rho}\Delta P = \Delta H$$ (Change in height of manometer tube

$$(U_B^2 - U_A^2) = 2g \times \Delta H$$

Taking sq. root on both sides

$$\sqrt{(U_B^2 - U_A^2)} = \sqrt{2g\Delta H}$$

→ Point B is point of constriction i.e point is narrow k/a Vena Contracta

at Vena contracta (velocity is max shown by U_0 ($\therefore U_B = U_0$)

hence acc. to bernoulli's theorem the velocity at point A is ~~negtible~~ negligible as considered to velocity at point B

$$\sqrt{U_o^2} = \sqrt{2g\,\Delta H}$$

~~Sq. both sides~~

$$U_o = \sqrt{2g\,\Delta H}$$

$C_o \rightarrow$ orifice meter constant

$$U_o = C_o\sqrt{2g\,\Delta H}$$