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19/ENG01/017

CHEMICAL ENGINEERING

ENG 214 ASSIGNMENT

1. **A conical tube of length 2.0 m is fixed vertically with its smaller end upwards. The velocity of flow at the smaller end is 5 m/s while at the lower end it is 2 m/s. The pressure head at the smaller end is 2.5m of liquid. The loss of head in the tube is given as $(0.35(v1-v2)^2)/2g$. where v1 is the velocity at the smaller end and v2 at the lower end respectively. Determine the pressure head at the lower end. Flow takes place in the downward direction.**

SOLUTION

L = 2.0m

V_1 = 5m /s

$\frac{P_1}{\rho g}$ = 2.5m of liquid

V_2 = 2 m /s

$H_L = \frac{0.35\ (v_1 - V_2)^2}{2g}$

$= \frac{0.35\ (5-2)^2}{2\times 9.8}$

H_L = 0.16m

$\frac{P_2}{\rho g}$ = ?

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

Z_2 = 0, Z_1 = 2

$$2.5 + \frac{5^2}{2 \times 9.8} + 2 = \frac{P_2}{\rho g} + \frac{2^2}{2 \times 9.8} + 0 + 0.16$$

$\frac{P_2}{\rho g}$ = 5.77 – 0.363

$\frac{P_2}{\rho g}$ = 5.407m of fluid.

2. **A horizontal venturimeter with inlet diameter 20cm and throat diameter 10cm is used to measure the flow of water. The pressure at inlet is 17.658N/cm^2 and the vacuum pressure at the throat is 30cm of mercury. Find the discharge of water through venturimeter. Take C_d = 0.98.**

SOLUTION

d_1 = 20cm

a_1 = 314.16 cm^2

d_2 = 10cm

a_2 = 78.74 cm^2

P_1 = 17.658N/cm^2 = 17.658 x 10^4 N/ m^2

ρ = 1000 kg/ m^3

$\frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{9.81 \times 1000}$ = 18m of water

$\frac{P_1}{\rho g}$ = 30m of mercury

= - 0.30m of mercury = - 0.30 × 13.6 = - 4.08m of water

Differential head = h = $\frac{P_1}{\rho g} - \frac{P_2}{\rho g}$ = 18 – (-4.08)

= 18 + 4.08 = 22.08 m of water = 2208cm of water

$$Q = C_d \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$$

$$= 0.98 \times \frac{314.16 \times 78.74}{\sqrt{(314.16)^2 - (78.74)^2}} \times \sqrt{2 \times 9.81 \times 2208}$$

= 165.555 lit/s

3. **An orifice meter with orifice diameter 15cm is inserted in a pipe of 30cm diameter. The pressure difference measured by a mercury oil differential manometer on the two sides of the orifice meter gives a reading of 50cm of mercury. Find the rate of flow of oil of specific gravity of 0.9, when the co-efficient of discharge of the meter is 0.64.**

SOLUTION

4. **A sub-marine moves horizontally in sea and has its axis 15m below the surface of water. A pitot-tube properly placed just in front of the sub-marine and along its axis is connected to the two limbs of a U-tube containing mercury. The difference of mercury level is found to be 170mm. Find the speed of the sub-marine knowing the Sp.gr. of mercury is 13.6 and that of sea-water is 1.026 with respect to fresh water.**

SOLUTION

$$V = c\sqrt{2gr}(\frac{spgr_m}{s} - 1)$$

$$X = \frac{170}{1000} = 0.17m$$

$$spgr_m = 13.6$$

$$Spgr_s = 1.026$$

$$C = 1$$

$$V = 1 * \sqrt{2} \times 9.81 \times 6.17 \times (\frac{13.6}{1.026} - 1)$$

V = 6.4 m / s

5. **A pump delivers at the rate of 0.05m^3/min with a pressure change of 15bar. The speed of roration is 1700rev/min while the normal displacement is given as 10cm^3/rev. If the torgue input is 15Nm. Compute (i) Volumetric Efficiency, (ii) Fluid Power, (iii) Shaft Power, and (iv) Overall Efficiency.**

SOLUTION

Idea flow rate = Nominal Displacement x Speed = 10 x 1700 = 17000 cm^3 /min = 0.017m^3/ min.

Volumetric efficiency = Actual Flow/Ideal Flow = 0.05/0.017 = 2.941 or 294.1%.

Q = 0.05 /60 m^3 /s = 8.33 x 10^{-4}m^3 /s

Δp = 15 x 10^5 N/m^2

Fluid Power = Q Δp = 8.33 x 10^{-4} x 15 x 10^5 = 1249.5 Watts

Shaft Power = $2\pi NT/60 = 2\pi \times 1700 \times 15 /60 = 2670.35$ Nm

Overall Efficiency = F.P. /S.P. = 1249.5/2670.35 = 0.4679 or 46.79%