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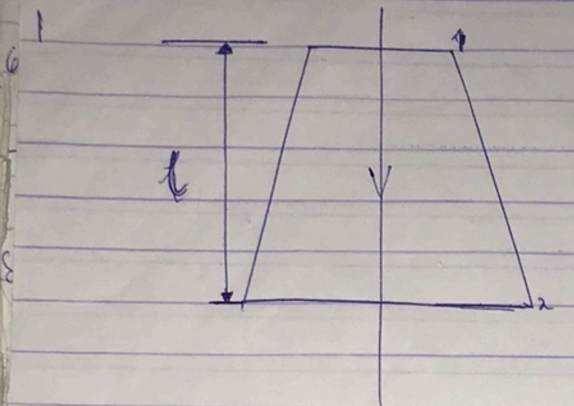
18/ENG06/076
Elect/Elect



Length, $l = 2.0m$

The velocity flow at smaller end $= V_1 = 5m/s$

The velocity flow at lower end $= V_2 = 2m/s$

Let the pressure head at the smaller end $= P_s = 2.5m$ of liquid

Let the loss of head $= H_2 = \frac{0.35(V_1 - V_2)^2}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$

Let the pressure head at the lower end $= P_2 = ?$

Apply Bernoulli's equation

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + H_2$$

Where $P_s = \frac{P_1}{\rho g}$ and $P_2 = \frac{P_2}{\rho g}$

$Z_1 = 2.0$ and $Z_2 = 0$ (datum line passes through section 2)

Inputting values into the equation

$$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = P_L + \frac{2^2}{2 \times 9.81} + 0 + 0.161$$

$$2.5 + \frac{25}{19.62} + 2 = P_L + \frac{4}{19.62} + 0.161$$

$$2.5 + \frac{25}{19.62} + 2 - \left(\frac{4}{19.62} + 0.161\right) = P_L$$

$5.776 - 0.365 = P_c$

$P_c = 5.409m$ of fluid

2) Let inlet diameter $= D_1 = 20cm$

Let throat diameter $= D_2 = 10cm$

Let inlet area $= A_1 = \frac{\pi D_1^2}{4} = \frac{\pi (20)^2}{4} = 314.16cm^2$

Let throat area $A_2 = \frac{\pi D_2}{4} = \frac{\pi (10)^2}{4} = 78.54cm^2$

Density of water, $\rho = 1000 kg/m^3$

Pressure at inlet $= 17.658 N/cm^2 = 17.658 \times 10^4 N/m^2$

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

$\frac{P_2}{\rho g} = -30cm$ of mercury, $S.G_{Hg} = 13.6$

$\frac{P_2}{\rho g} = -30 \times 10^{-2}$ m of mercury $\times 13.6$

$= -4.08m$

Let differential Head $= H_d = \frac{P_1}{\rho g} - \frac{P_2}{\rho g}$

$= 18 - (-4.08)$

$= 18 + 4.08 = 22.08m \times 100$

$H = 2208cm$

Using, $Q = \frac{C_d \sqrt{2gh} \cdot A_1 A_2}{\sqrt{A_1^2 - A_2}}$

$= \frac{0.98 \times \sqrt{2 \times 981 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$

$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.184112}$

$= 165455.3 cm^3/s = \frac{165455.3}{1000} = 165.455$ Lit/Sec

3) Diameter of pipe d_1 = 30cm

$$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 1706.8 \, cm^2$$

Diameter of pipe d_2 = 15cm

$$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (15)^2}{4} = 176.72 \, cm$$

Specific gravity of oil, $S_o = 0.9$

Specific gravity of mercury $S_m = 13.6$

Differential manometer reading, $x = 50$ cm of mercury

Co-efficient of discharge, $C_d = 0.64$

Differential head, $h = x\left(\frac{S_m}{S_o} - 1\right)$

$$h = 50\left(\frac{13.6}{0.9} - 1\right)$$

$$h = 705.50 \text{ cm of oil}$$

the rate of flow of oil is

$$Q = \frac{C_d \sqrt{2gh} \cdot A_1 \cdot A_2}{\sqrt{A_1^2 - A_2^2}}$$

$$Q = \frac{0.64 \times \sqrt{2 \times 981 \times 705.56} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (176.72)}}$$

$$Q = 137443.29 \, cm^3/s$$

$$Q = \frac{137443.29}{1000} = 137.44 \text{ Lit/s}$$

4) The difference of mercury level, $x = 170mm$ $= 170 \times 10^{3} = 0.17m$

The specific gravity of mercury, $S_g = 13.6$

The specific gravity of Seawater, $S_o = 1.026$

The speed, $V = ?$

$$V = \sqrt{2gh}, \quad h = ?$$

$$h = x\left[\frac{S_g}{S_o} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$$

$$= 2.0834m$$

$$\therefore V = \sqrt{2 \times 9.81 \times 2.0834} = 6.393m/s$$

In km/hr

$$V = \frac{6.393 \times 60^2}{1000} = 23.01 km/hr$$

5) $Q = 0.05m^3/min = 50 dm^3/min$

$P_o = 15 bar = 15 \times 100000 = 15 \times 10^5 N/m^2$

Speed $= 1700 rev/min$

$T = 15Nm$, $N.D = 10cm^3/rev$

i) Volumetric Efficiency $= \dfrac{\text{Actual flow rate}}{\text{Ideal flow rate}}$

Ideal flow rate = Nominal flow rate × Speed

$= 10cm^3/rev \times 1700 rev/min$

$= 17000 cm^3/min$

Ideal flow rate $= \dfrac{17000}{1000000} = 0.017m^3/min$

Actual flow rate $= 0.05m^3/min$

Volumetric Efficiency $= \dfrac{0.05}{0.017} = 2.94\% = 294\%$

ii) Fluid power $= 15 \times 10^5 \times 8.33 \times 10^{-4}$

$15 \times 10^5 \times 83.3 \times 10^{-5}$

$= 1249.5 \times 10^{5-5}$

Fluid power $= 1249.5$ watts

iii) Shaft power $= \frac{2\pi N T}{60} = \frac{2\pi \times 1700 \times 15}{60}$

Shaft power $= 2670.35$ Watts

iv) Overall Efficiency $= \frac{\text{Fluid power}}{\text{Shaft power}}$

$\frac{\text{Fluid power}}{\text{Shaft power}} = \frac{1249.5}{2670.35} = 0.468$

Overall Efficiency $= 0.468 \times 100 = 46.8\%$