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Computer Engineering

Question One

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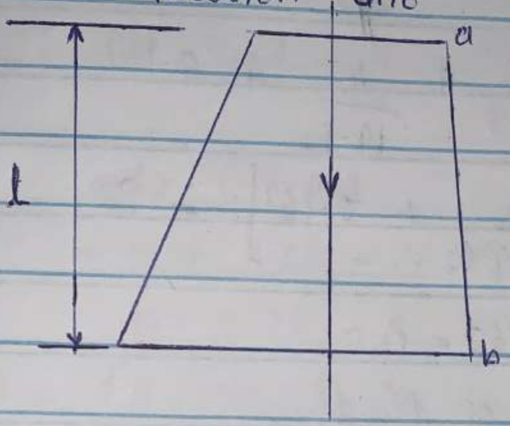

length, L = 2.0m

The Velocity flow at Smaller end = V_1 = 5m/s

" 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 pressure head at the Smaller~~

let the Loss of head = $H_L = \frac{0.35(V_1 - V_2)^2}{2g}$

$$= \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161\text{m}$$

let the pressure head at the lower end = P_L = ?

Applying Bernoulli's Equ

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

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

$Z_1 = 2.0$ and $Z_2 = 0$

In putting values into the equ

$$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = P_2 + \frac{2^2}{2 \times 9.81} + 0 + 0.161$$

$$2.5 + \frac{25}{19.62} + 2 = P_2 + \frac{4}{19.62} + 0.161$$

$$2.5 + \frac{25}{19.62} + 2 - \left(\frac{4}{19.62} + 0.161\right) = P_2$$

$$5.774 - 0.365 = P_2$$

$P_2 = 5.409\,m$ of Fluid

Question Two

2 inlet diameter $= D_1 = 20\,cm$

throat diameter $= D_2 = 10\,cm$

let inlet area $= A_1$

$$= \frac{\pi D_1^2}{4} = \frac{\pi (20)^2}{4} = 314.16\,cm^2$$

let throat area $= A_2$

$$= \frac{\pi (10)^2}{4} = 78.54\,cm^2$$

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

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

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

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

$\frac{P_2}{\rho g} = -30 \times 10^{-2}$ m of mercury $\times 13.6 = -4.08$ m

let Differential Head $= H = \frac{P_1}{\rho g} - \frac{P_2}{\rho g}$

$= 18 - [-4.08]$

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

$H = 2208$ cm

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

$$= \frac{0.98 \times \sqrt{2 \times 9.81 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$$

$$= \frac{0.98 \times 2081.87 \times 2467.1264}{304.184112}$$

$= 165455.3\ cm^3/s$

$= \frac{165455.3}{1000}$ $= 165.45$ lit/sec

Question Three

3 Diameter of pipe = 30cm

$$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 706.86\,cm^2$$

Diameter of orifice, $d_2 = 15cm$

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

S_o, Specific gravity of oil = 0.4

S_{hg}, Specific gravity of mercury = 13.6

Differential manometer reading, x = 50cm of mercury

Coefficient of discharge, Cd = 0.64

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

$$h = 50\left(\frac{13.6}{0.4} - 1\right)$$

$$h = 705.96\,cm \text{ of oil}$$

∴ rate of flow of oil

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

$$Q = \frac{0.64 \times \sqrt{2 \times 9.81 \times 705.56} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (176.72)}}$$

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

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

Question Four

1. 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 water, $S_o = 1.026$

The speed, $V = ?$

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

$$h = x\left(\frac{S_g}{S_o} - 1\right) = 0.17\left(\frac{13.6}{1.026} - 1\right) = 2.0836m$$

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

In km/hr

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

Question Five

5 ~~A pump delivers~~ $Q = 0.05 m^3/min = 50 dm^3/min$

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

Speed $= 1700 rev/min$

$T = 15 Nm$, $ND = 10 cm^3/rev$

i) volumetric efficiency

$$= \frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$$

Ideal flow rate = Nominal flow rate × Speed

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

$= 17000 cm^3/min$

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

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

$\therefore$ Volumetric Eff $= \frac{0.05}{0.017} = 2.94\%$ $= 294\%$

ii Fluid power $= P \times Q$

$P = 15 \times 10^5 N/m^2$

$Q = 0.05 m^3/min = \frac{0.05}{60} = 8.33 \times 10^{-4} m^3/s$

Fluid Power $= 15 \times 10^5 \times 8.33 \times 10^{-4}$

$= 15 \times 10^5 \times 8333 \times 10^{-5}$

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

$= 1249.5$ watts

iii Shaft power $= \frac{2\pi N T}{60}$

$= \frac{2\pi \times 1700 \times 15}{60}$

$= 2670.35$ watts

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

$= \frac{1249.5}{2670.35} = 0.468$

$= 0.468 \times 100 = 46.8\%$