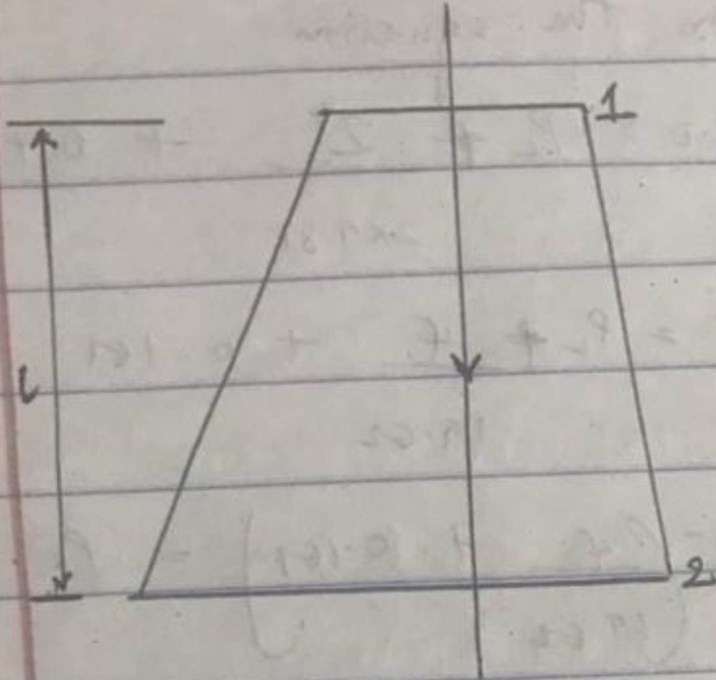
1.



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length, $L = 2.5m$

$V_1 = 5m/s$

$V_2 = 2m/s$

$P_s = 2.5m$ of liquid

$$H_L = \frac{0.35(V_1 - V_2)^2}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$$

$P_L = ?$

Applying Bernoulli's Equation

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

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

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$S_o = 0.9$; $S_{Hg} = 13.6$; $x = 50$ cm of mercury

$C_d = 0.64$

$$h = x\left(\frac{S_{Hg}}{S_o} - 1\right)$$

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

$h = 705.56$ cm of oil

∴ The ratio of flow of oil is

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

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

$Q = 137443.29$ cm^3/s

$$Q = \frac{137443.29}{1000} = 137.44 \text{ litres}$$

4 $x = 170$ mm $= 170 \times 10^{-3} = 0.17$ m

$S_g = 13.6$

$S_o = 1.026$

$V = ?$

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

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

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

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

$= 18 - (-4.08)$

$= 18 + 4.08 = 22.08 \text{m} \times 100 = 2208 \text{cm}$

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

$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.18412}$

$= 165455.3 \text{cm}^3/\text{s}$

$= \frac{165455.3}{1000} = 165.455$ lit/sec

3. $d_1 = 30$ cm

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

$d_2 = 15$ cm

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

$Z_1 = 2.0$ and $Z_2 = 0$ (datum lines passed through section 2)

Inputting values into the equation

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

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

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

$$5.774 - 0.365 = P_2$$

$P_2 = 5.409$m of fluid

2. $D_1 = 20cm$; $D_2 = 10cm$

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

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

$\rho = 1000kg/m^3$

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

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

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

$\therefore \quad = 2.0834m$

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

In Km/hr

$v = \frac{6.393 \times 60^2}{1000} = 23.01 Km/hr$

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

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

speed = 1700 rev/min

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

(i) volumetric efficiency = $\frac{\text{Actual flowrate}}{\text{Ideal flow rate}}$

Ideal flow rate = Nominal flow rate x speed

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

$= 17000 cm^3/min$

Ideal flow rate = $\frac{17000}{100000} = 0.017 m^3/min$

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

~~$\therefore$ volumetric efficiency = $\frac{0.05}{60} = 8.33 \times 10^{-4}$~~

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$\therefore$ volumetric efficiency $= \frac{0.05}{0.077} = 2.94\%$

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

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

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

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 $= 0.468 \times 100 = 46.8\%$