$$\therefore\ 2.5 + \frac{5^2}{2\times 9.81} + 2.0 = \frac{P_2}{\rho g} + \frac{2^2}{2\times 9.81} + 0 + 0.16$$

$$2.5 + 1.27 + 2.0 = \frac{P_2}{\rho g} + 0.204 + 0.16$$

$$5.77 = \frac{P_2}{\rho g} + 0.364$$

$$\therefore\ \frac{P_2}{\rho g} = 5.77 - 0.364 = \underline{\underline{5.406\text{m of liquid}}}$$

2. ~~Diameter of inlet~~ $\cancel{= \frac{\pi}{4} \times \left(\frac{20}{100}\right)^2 =}$

2. $d_{inlet} = \frac{20cm}{100} = 0.2m$

$a_{inlet} = \frac{\pi}{4} \times (0.2)^2 = 0.0314\, m^2$

$d_{throat} = \frac{10cm}{100} = 0.1m$

$a_{throat} = \frac{\pi}{4} \times (0.1)^2 = 7.85 \times 10^{-3}\, m^2$

ρ for water $= 1000\,kgm^{-3}$

$P_1 = 17.658\, N/cm^2 = 17.658 \times 10^4\, N/m^2$

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

$\frac{P_2}{\rho g} = -30cm$ of mercury

$= -0.3m$ of mercury

$= -0.3 \times 13.6 = -4.08m$ of water

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

$= 22.08m$ of water

Using discharge equation

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

$$\cancel{= 0.98 \times \frac{0.314 \times 7.85\times10^{-3}}{\sqrt{0.314^2 - (7.85\times10^{-3})^2}}}$$

$$= 0.98 \times \frac{0.0314 \times 7.85\times10^{-3}}{\sqrt{0.0314^2 - (7.85\times10^{-3})^2}} \times \sqrt{2\times9.81\times22.08}$$

$$\cancel{= 0.98 \times 8.107 \times 20.81}$$

$$\cancel{= 165.333\ m^3/s = 165.333\ lit/s}$$

$$= 0.98 \times 8.107\times10^{-3} \times 20.81$$

$$= 0.1653\ m^3/s = 165.3\ lit/s$$

3. $A_{orifice} = \frac{\pi}{4} \times (15)^2 = 176.714\ cm^2$ (A_o area of orifice)

$A_{pipe} = \frac{\pi}{4} \times (30)^2 = 706.858\ cm^2$ (A_P area of pipe)

differential head $(h) = \left[\frac{13.6}{0.9} - 1\right] \times 50\ cm$ of oil

$= 705.556\ cm$ of oil

$$Q = \frac{C_d \times A_o A_P}{\sqrt{A_P^2 - A_o^2}} \times \sqrt{2gh}$$

$$= \frac{0.64 \times 176.714 \times 706.858}{\sqrt{706.858^2 - 176.714^2}} \times \sqrt{2 \times 9.81 \times 705.556}$$

$$= 0.64 \times 182.5094 \times 117.656$$

$= 13742.96\ cm^3/sec$

$= 13.74296$ lits/sec

4. Difference of mercury level $x = 170\,mm = 0.17\,m$
Sp. gr. of mercury $S_g = 13.6$
Sp. gr. of sea-water $S_{sw} = 1.026$

$$\therefore \quad h = x\left[\frac{S_g}{S_{sw}} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834\,m$$

Using $V = \sqrt{2gh}$

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

Converting to km/hr

$$\frac{6.393 \times 60 \times 60}{1000} = 23\,km/hr$$

5. Volumetric flow rate

Changing from dm^3/min to m^3/min

$10 dm = 1 m$

$\therefore 10^3 dm^3 = 1 m^3$

$1000 dm^3 = 1 m^3$

$5 dm^3 = ?$

$? = \frac{5}{1000} = 0.005$

$\therefore$ Volumetric flow rate $= \cancel{0.005 dm^3/min} = 0.005\ m^3/min$

Actual flow rate $= \frac{0.005}{60} = 8.33 \times 10^{-5}\ m^3/sec$

Speed $= 1700$ rpm

changing to rps

$\frac{1700}{60} = 28.33$ rev/sec

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

Norminal displacement $= 10 cm^3/rev$

Note that $100^3 cm^3 = 1 m^3$

$10 cm^3 = x$

$x = \frac{10}{100^3} = 1 \times 10^{-5}\ m^3/rev$

$\therefore$ Ideal flow rate = Nominal Displacement $\times$ Speed

$28.33 \times 1 \times 10^{-5}$

$= 2.833 \times 10^{-4}$

a) Volume Efficiency $= \dfrac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100\%$

$$= \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100$$

$$= 29.4\%$$

b) Fluid Power $= Q \cdot \partial P$

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

$$= 124.95 \text{ Nm/sec}$$

c) Shaft Power $= T \cdot \omega$

$T = 15 \text{ Nm}$

$\omega = 2 \times \frac{22}{7} \times 28.33 = 178.07 \text{ rad/sec}$

$\therefore$ Shaft Power $= 15 \times 178.07 = 2671.05$ watts

d) Overall Efficiency $= \dfrac{\text{Fluid Power}}{\text{Shaft Power}} \times 100\%$

$$= \frac{124.95}{2671.05} \times 100 = 4.67\%$$

CHIOKE VICTOR U.P.
18/ENG02/031
COMPUTER ENGINEERING
ENG 214 ASSIGNMENT SOLUTION

1. Let smaller end be represented by (1) and lower end by (2)

Given parameters

$L = 2.0m$

$V_1 = 5m/s$

$P_1/\rho g = 2.5m$ of liquid

$V_2 = 2m/s$

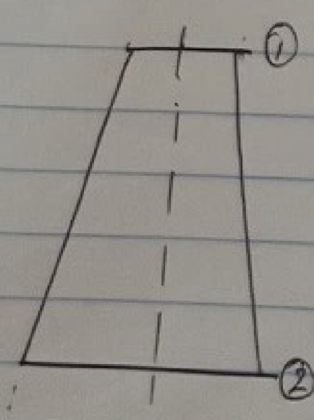
$P_2/\rho g = ?$

$$\text{Loss of head } (h_L) = \frac{0.35(v_1 - v_2)^2}{2g}$$

$$= \frac{0.35(5-2)^2}{2 \times 9.81} = 0.16m$$

Using bernoulli's equation

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



Letting the line pass through the section, Then $Z_1 = 2.0$, $Z_2 = 0$