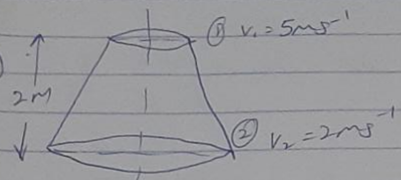
Kiburdu Benedict I.
18/ENG06/036
Mechanical engineering
Fluid mechanics assignment.

1) 

$P_1 = \frac{P_1}{w} = 2.5M$

$H_L = 0.35\frac{(v_1 - v_2)^2}{2g}$

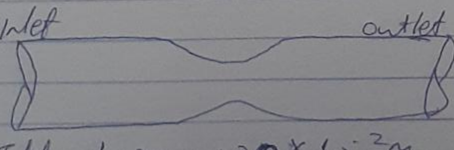
$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + H_L$$

$$\frac{P_2}{w} = \frac{P_1}{w} = \frac{V_1^2 - V_2^2}{2g} + (Z_1 - Z_2) - \frac{0.35(V_1 - V_2)^2}{2g}$$

$$\frac{P_2}{w} = 2.5 + \frac{5^2 - 2^2}{2(9.81)} + 2 - \frac{0.35(5-2)^2}{2(9.81)}$$

$$\frac{P_2}{w} = 2.5 + 1.07 + 2 - 0.161$$

$$\frac{P_2}{w} = 5.409 \text{m of liquid.}$$

2) 

Inlet, $d_1 = 20cm = 20 \times 10^{-2}m$

$$A = \frac{\pi d^2}{4} = \frac{\pi \times (20 \times 10^{-2})^2}{4}$$

$A_1 = 0.0314m^2$

Throat diameter, $d_2 = 10cm = 10 \times 10^{-2}m$

$P_1 = 17.668 N/cm^2$

$= 17.668 \times 10^4 Nm^{-2}$

$C_d = 0.98$

$$A = \frac{\pi d^2}{4} = \frac{\pi \times (10 \times 10^{-2})^2}{4}$$

$A_2 = 7.85 \times 10^{-3} m^2$

5. $Q = 0.05 dm^3 min^{-1} = 8.33 \times 10^{-5} m^3 sec^{-1}$

Speed of rotation = 1700 rev/min = 28.3 rev/sec

Nominal displacement = $10 cm^3/rev = 10^{-5} m^3/rev$

Torque input = 15 NM.

pressure change = 15 bar = $15 \times 10^5 Nm^{-2}$

- Ideal flow rate = nominal displacement x speed rotation

$= 10^{-5} \times 28.3 = 2.83 \times 10^{-4} m^3/sec$

a) Volumetric efficiency $= \frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100$

$= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100$

$= 29.45\%$

b) Fluid power, $P_f = Q \times \Delta P = 8.33 \times 10^{-5} \times 15 \times 10^5$

$= 124.95$ watts.

c) Shaft power, $= T \times w$

$w = 2 \times \pi \times$ speed of rotation $= 2 \times \pi \times 28.3$

$w = 177.81$ rad/sec

∴ Shaft power $= 15 \times 177.81 = 2667.2$ watts

d) Overall efficiency $= \frac{\text{fluid power}}{\text{Shaft power}} \times 100$

$= \frac{124.95}{2667.2} \times 100$

$= 4.68\%$

Differential head $h = y\left(\frac{S_{hL}}{S_O} - 1\right)$

$S_{hL} = 13.6$

$y = 50 \times 10^{-2}$

$h = 50 \times 10^{-2}\left(\frac{13.6}{0.9} - 1\right)$

$h = 50 \times 10^{-2} \times 14.11$

$= 7.055\ m$

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

$= \frac{0.64 \times 0.01767 \times 0.07069 \times \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{(0.07069^2) - (0.01767^2)}}$

$= 0.1374\ m^3 s^{-1}$

4. $y = 170\ mmHg = 0.17\ mHg$, $S.g_{Hg} = 13.6$, $S.g_{sw} = 1.026$

$\Delta h = y\left(\frac{S.g_{Hg}}{S.g_{sw}} - 1\right)$

$\Delta h = 0.17\left(\frac{13.6}{1.026} - 1\right)$

$\Delta h = 2.08\ m$

$v = \sqrt{2g\Delta h}$

$v = \sqrt{2 \times 9.81 \times 2.08}$

$v = 6.388\ ms^{-1}$

To get h;

$$\frac{P_1}{W} - \frac{P_2}{W} = h$$

$P_1 = 17.668 \times 10^4 Nm^{-2}$

$W = 9.81 \times 10^3 Nm^{-3}$

But we have that throat vacuum pressure = 30cm of Hg

$= 0.3m Hg$

$= 0.3 \times 13.6 = 4.08$

$\frac{P_2}{W} = -4.08$ (Since vacuum pressure)

Then $\frac{P_1}{W} = \frac{17.658 \times 10^4}{9.81 \times 10^3} = 18$

$\therefore \frac{P_1}{W} - \frac{P_2}{W}$; $18 - -4.08 = 22.08$

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

$$0.98 \times 0.0314 \times 7.85 \times 10^{-3} \times \sqrt{\frac{2 \times 9.81 \times 22.08}{(0.0314^2 - (7.85 \times 10^{-3})^2)}}$$

$= 2.4156 \times 10^{-4} \times 684.59$

$= 0.1653$

$Q_{actual} = 0.1653 m^3 s^{-1}$

3) Orifice meter ; Given that

$d_o = 15cm = 15 \times 10^{-2} m$ pipe diameter ; $d_p = 30cm = 30 \times 10^{-2} m$

$A_o = \frac{\pi \times (15 \times 10^{-2})^2}{4}$ $A_p = \frac{\pi \times (30 \times 10^{-2})^2}{4}$

$= 0.01767 m^2$ $= 0.07069 m^2$

S.G of O.C = 0.9(50)

Coefficient of discharge = 0.64

Reading of differential = 50cm Hg