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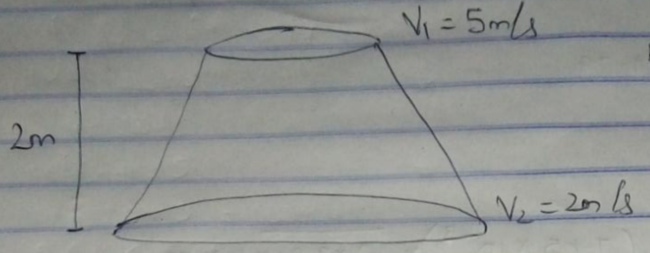
18/ENG06/038
Mechanical Engineering

6)

1)



$P_{T_1} = P_1/w = 2.5m$

$H_L = \frac{0.35(V_1 - V_2)^2}{2g}$

Using Bernoulli's equation $\frac{P_2}{w} = ?$

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

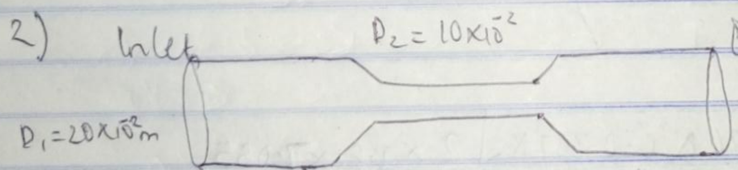
$$\frac{P_2}{w} = \frac{P_1}{w} + \left[\frac{V_1^2 - V_2^2}{2g}\right] + [Z_1 - Z_2] - H_L$$

$$= 2.5 + \left(\frac{5^2 - 2^2}{2 \times 9.81}\right) + 2 - \frac{0.35(5-2)^2}{2 \times 9.81}$$

$$= 2.5 + 1.07 + 2 - 0.161$$

$$\frac{P_2}{w} = 5.409m$$

2)



$P_1 = 17.658 N/cm^2 = 17.658 \times 10^4 N/m^2$ $C_d = 0.98$

$P_2 = 30cmHg = 30 \times 10^{-2} mHg$ $Q = x$

$$A_1 = \frac{\pi \times (20 \times 10^{-2})^2}{4} \qquad A_2 = \frac{\pi \times (10 \times 10^{-2})^2}{4}$$

$$= 0.03m^2 \qquad = 7.85 \times 10^{-3} m^2$$

$$\frac{P_2}{w} = 0.3 \times 13.6 = 4.08 mHg$$

$$\frac{P_2}{w} = -4.08 \text{ (since vacuum pressure)}$$

$$\frac{P_2}{w} = \frac{17.658 \times 10^4}{4.81 \times 10^3} = 36.71$$

$$h = \frac{P_1}{w} - \frac{P_2}{w} = 36.71 - (-4.08)$$

$$= 40.79$$

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

$$Q = \frac{0.98 \times 0.03 \times (7.85 \times 10^{-3}) \times \sqrt{2 \times 9.81 \times 40.79}}{\sqrt{(0.03)^2 - (7.85 \times 10^{-3})^2}}$$

$$Q = 0.225 m^3/s$$

3 $d_0 = 15 \times 10^{-2} m$ $d_1 = 30 \times 10^{-2} m$ $C_d = 0.64$

$A_0 = \frac{\pi \times (15 \times 10^{-2})^2}{4}$ $y = 50 \times 10^{-2} mHg$ $Q = ?$

$S \cdot g\ oil = 0.9$ $S_m = 13.6$

$= 0.01767 m^2$ $S_o = 0.9$

$$A_1 = \frac{\pi \times (30 \times 10^{-2})^2}{4} = 0.0707 m^2$$

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

$H = 7.055 m$

$$Q = \frac{0.64 \times 0.0176 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.055}}{(0.0707^2 - 0.0176^2)}$$

$Q = 0.132 m/s$

4) $y = 120\,mmHg = 170 \times 10^{-3}\,mHg$

$Sg_{mercury} = 13.6\,Hg$

$Sg_{sea\ water} = 1.026$

$V = \sqrt{2gH}$

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

$V = 6.39\,m/s$

$H = y \times \frac{S_{hg}}{S_o} - 1$

$H = 170 \times 10^{-3} \left(\frac{13.6}{1.026} - 1 \right)$

$H = 2.08$

5) $Q = 5\,dm^3/min = 8.33 \times 10^{-5}\,m^3/sec$

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

$V = 1700\,rev/min = 28.33\,m/sec$

$T = 15\,m/m$

Normal displacement $= 10\,cm^3/rev = 1 \times 10^{-5}\,m^3/rev$

Volumetric efficiency

$\frac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100\%$ Idea flowrate = displacement x speed

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

$Q = 2.833 \times 10^{-4}\,m^3/sec$

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

$= 29.4\%$

fluid power $(Q \times \Delta P)$

$= 8.33 \times 10^{-5} \times 15 \times 10^{5} = 124.95\,watts$

Shaft power $= T \times w$

$w = 2 \times \pi \times V = 2 \times \pi \times 28.33 = 178\,rad/sec$

i.e. Shaft power

$= 15 \times 178 = 2670\,watts$

Over all efficiency

$= \frac{\text{fluid power}}{\text{Shaft power}} \times 100\%$

$= \frac{124.95}{2670} \times 100 = 4.68\%$