NWUDU OKECHUKWU JEREMIAH
18/ENG04/055
ELECTRICAL/ELECTRONICS ENGINEERING
ENG 214

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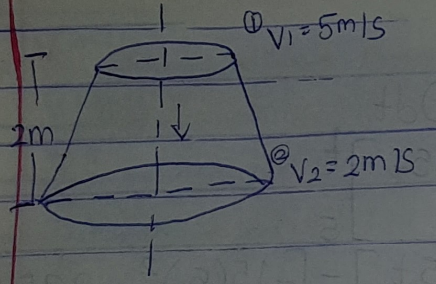


$$\frac{P_T}{w} = \frac{P_1}{w} = 2.5m$$

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

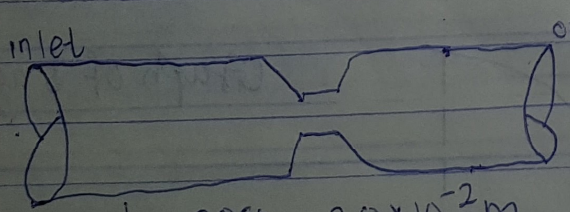
$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + H_L$$

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

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

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

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



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

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

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

$P_1 = 17.668N/cm^2 = 17.668 \times 10^4 N/m^2$

$Cd = 0.98$

To get h;

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

$P_1 = 17668 \times 10^4 N/m^2$

$w = 9.81 \times 10^3 N/m^3$

Throat vacuum pressure = 30cm of Hg = 0.3m Hg

$= 0.3 \times 13.6 = 4.08$

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

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

$$\therefore \frac{P_1}{w} - \frac{P_2}{w}, \quad 18 - (-4.08) = 22.68$$

$$Q = CdA_1A_2\sqrt{\frac{2gh}{(A_1^2 - A_2^2)}}$$

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

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

$= 0.1653$

$Q_{actual} = 0.1653 m^3/s$

3 Orificemeter, 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.P.G of oil = 0.9 (SO)

Coefficient of discharge = 0.64

Reading of differential = 50cmhg

Differential head $h_L = y\left[\frac{5h_L}{50} - 1\right]$

$5h_L = 13.6$

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

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

$h = 50 \times 10^{-2} \times 14.11$, $= 7.055m$

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

$= \frac{0.64 \times 0.01767 \times 0.07069 \times \sqrt{2 \times 9.81 \times 7.065}}{\sqrt{(0.07069^2) - (0.01767^2)}}$

$= \frac{7.994 \times 10^{-4} \times 11.765}{\sqrt{4.68 \times 10^{-3}}} = 0.1374 m^3/s$

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

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

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

$\Delta h = 2.08m$

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

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

$V = 6.388 m/s$

5 $Q = 0.05 dm^3/mm = 8.33 \times 10^{-5} m^3/sec$

Speed of rotation = $1700 \frac{Rev}{min} = 28.3 \frac{Rev}{sec}$

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

Torque Input = 15Nm

Pressure change = 15 bar = $15 \times 10^5 N/m^2$

Ideal Flowrate = Nominal displacement × Speed Rotation,

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

a Volumetric Efficiency = $\frac{\text{Actual Flowrate}}{\text{Ideal Flowrate}} \times 100$

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

$= 29.45\%$

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, $= \tilde{T} \times 10$

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

$w = 2 \times \pi \times 28.3$

$w = 177.81$ rad/sec

∴ Shaft Power $= 15 \times 177.81$

$= 2667.2$ watts

d Overall Efficiency = $\frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100$

$= \frac{124.95}{2667.2} \times 100 = 4.68\%$.