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MATRIC N^o: 18/ENG05/056

DEPARTMENT: Mechatronics Engineering

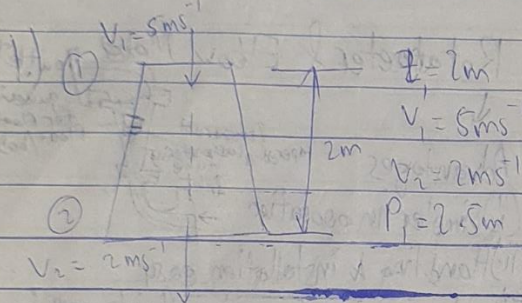
COURSE: ENG 214

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18/ENG051056

Mechatronics Engineering

ENG 235 Assignment



$$\text{Loss of head} = \frac{0.35(V_1 - V_2)^2}{2g}$$
$$= \frac{0.35(5 - 2)^2}{2(9.81)}$$

$$h_L = 0.16 \text{ m}$$

Applying Bernoulli's equation for conical tube

$$\frac{P_1}{\rho} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho} + \frac{V_2^2}{2g} + z_2 + h_L$$

$$z_1 = 2 \text{ m}, z_2 = 0 \text{ m}$$

$$\frac{2.5 + 5^2}{2(9.81)} + 2 = \frac{P_2}{\rho} + \frac{2^2}{2(9.81)} + 0 + 0.16$$

$$\Rightarrow 2.5 + 1.27 + 2 = \frac{P_2}{\rho} + 0.203 + 0.16$$

$$\Rightarrow 5.77 = \frac{P_2}{\rho} + 0.363$$

$$\frac{P_2}{\rho} = 5.77 - 0.363$$

$$= 5.41 \text{ m}$$

head at larger opening = 5.41 m

$$2) d_1 = 20 \text{ cm} = 0.2 \text{ m (inlet)}$$

$$A_1 = \frac{\pi d_1^2}{4} = 0.03142 \text{ m}^2$$

$$d_2 = 10 \text{ cm} = 0.1 \text{ m (throat)}$$

$$A_2 = \frac{\pi d_2^2}{4} = 0.00785 \text{ m}^2$$

$$C_d = 0.98$$

$$P_1 = 17.658 \text{ N/cm}^2 = 176580 \text{ N/m}^2$$

$$\text{Vacuum Pressure} = 30 \text{ cmHg} = 0.3 \text{ mHg}$$

$$h_1 = \frac{P_1}{\rho g} = \frac{176580}{9.81 \times 1000}$$

$$h_2 = P_2 = -0.3 \text{ mHg}$$

$$= (-0.3 \times 13.6) \text{ mH}_2\text{O}$$

$$= -4.08 \text{ mH}_2\text{O}$$

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

$$= 22.08 \text{ m}$$

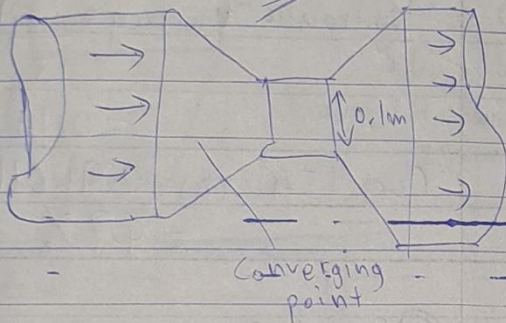
$$Q = C_d A_1 A_2 \sqrt{2g h} / \sqrt{A_1^2 - A_2^2}$$

$$Q = 0.98 \times 0.03142 \times 0.00785 \times \sqrt{2 \times 9.81 \times 22.08} / \sqrt{0.03142^2 - 0.00785^2}$$

$$Q = \frac{2.42 \times 10^{-4} \times \sqrt{433.21}}{\sqrt{9.76 \times 10^{-4}}}$$

$$Q = \frac{5.037 \times 10^{-3}}{0.0309}$$

$$Q = 0.166 \text{ m}^3 \text{ s}^{-1}$$



3) $d_0 = 15 \text{ cm} = 0.15 \text{ m}$

$d_1 = 30 \text{ cm} = 0.3 \text{ m}$

$A_0 = \pi (0.15)^2 / 4 = 0.0177 \text{ m}^2$

$A_1 = \pi (0.3)^2 / 4 = 0.07 \text{ m}^2$

$h = y \left(\frac{J_{ac}}{J_0} - 1 \right) = 0.5 \left(\frac{13.6}{0.9} - 1 \right)$

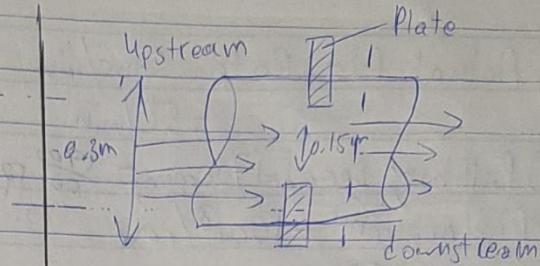
$h = 7.65 \text{ m}$

$$Q = \frac{C_d A_0 \times A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$$

$$Q = \frac{0.64 \times 0.0177 \times 0.07 \times \sqrt{2 \times 9.81 \times 7.65}}{\sqrt{0.07^2 - 0.0177^2}}$$

$$Q = \frac{7.9296 \times 10^{-4} \times \sqrt{138.32}}{\sqrt{4.59 \times 10^{-3}}}$$

$$Q = \frac{9.326 \times 10^{-3}}{0.069} = 0.137 \text{ m}^3 \text{ s}^{-1}$$



4) Reading from manometer
 = 170 mm Hg
 = 0.17 m Hg

Specific gravity of Hg = 13.6

Specific gravity of sea water = 1.026

$$h = y \left(\frac{J_m}{J_c} - 1 \right)$$

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

$$h = 0.17 (12.26)$$

$$h = 2.084 \text{ m}$$

$$V = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.084} = \sqrt{40.89} = 6.39 \text{ m s}^{-1}$$

$$\begin{aligned} \text{5.) Actual flow Rate} &= 5 \text{ dm}^3/\text{min} \\ &= 5 \text{ L/min} \end{aligned}$$

$$\text{(a) } P = 15 \text{ bar; Speed} = 1700 \text{ rpm} = \frac{1700}{60} \text{ rps}$$

$$\text{Displacement} = 10 \text{ cm}^3/\text{rev}$$

$$\text{Torque} = 15 \text{ Nm}$$

$$\text{Volumetric efficiency} = \frac{\text{Theoretical Flow} \times 100}{\text{Actual flow}}$$

$$\text{Theoretical flow} = \text{Displacement} \times \text{speed}$$

$$\text{but } 10 \text{ cm}^3/\text{rev} = \cancel{10} 0.01 \text{ L/rev}$$

$$\text{Theoretical flow} = 0.01 \times 1700 = 17 \text{ L/min}$$

$$\text{Volumetric efficiency} = \frac{5 \times 100}{17}$$

$$\approx 29.4\%$$

$$\text{(b) Fluid Power} = \frac{\text{Pressure} \times \text{Actual Flow}}{600}$$

$$= \frac{15 \times 10^5 \times 5}{60000}$$

$$\approx 125 \text{ W}$$

$$\textcircled{c} \text{ Shaft Power} = T \times \omega$$

$$\omega = \text{angular speed}$$

$$= 2\pi \times \text{speed}$$

$$= 2\pi \times \frac{1700}{60}$$

$$\approx 178.024 \text{ rad/sec}$$

$$= 178.024 \text{ rad/sec}$$

$$\text{Shaft Power} = 15 \times 178.024 \approx 2670.35 \text{ W}$$

$$\textcircled{d} \text{ Overall Efficiency} = \frac{\text{Fluid Power}}{\text{shaft Power}}$$

$$E = \frac{125}{2670.35} \times 100\%$$

$$2670.35$$

$$E \approx 4.68\%$$