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18/ENG06/023
MECHANICAL ENGINEERING.
FLUID MECHANICS.
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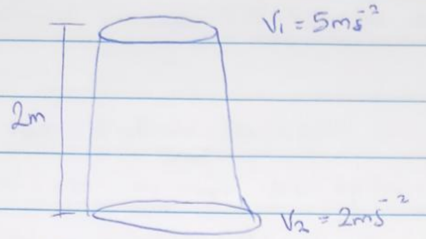


Soln

Head loss $= H_L = \frac{0.35(V_1 - V_2)}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$

$H_L = 0.161m$

Pressure of head at lower end $(P_L) = n$

Applying Bernolli's equation

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

where $P_S = \frac{P_1}{\rho g}$ and $P_L = \frac{P_2}{\rho g}$

$Z_1 = 2.0$ and $Z_2 = 0$

Substitutiong the values of all Parameters into the eqn

$$2.5 + \frac{5}{2 \times 9.81} + 2.0 = P_L + \frac{2^2}{2 \times 9.81} + 0 + ~~0.261~~ 0.161$$

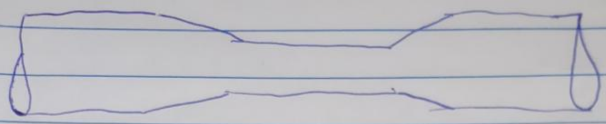
$$2.5 + \frac{25}{10.62} + 2.0 = P_L + \frac{4}{10.62} + 0.161$$

$$2.5 + \frac{25}{10.62} + 2 - \left(\frac{4}{19.62} + 0.161\right) - P_L$$

$5.774 - 0.365 = P_L$

$P_L = 5.409m$ of fluid

2



diamete = 20×10^{-2} m

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

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

$$A_1 = \frac{\pi \times (20 \times 10^{-2})^2}{4} = 0.03 m^2$$

$C_d = 0.98$

$$A_2 = \frac{\pi \times (10 \times 10^{-2})^2}{4} = 7.85 \times 10^{-3} m^2$$

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

$$\frac{P_2}{w} = -4.08 \qquad \frac{P_1}{w} = \frac{17.058 \times 10^4}{4.81 \times 10^3} = 18$$

$$\therefore h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-4.08) = 22.08$$

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

$$Q = \frac{0.98 \times 0.03 \times (7.85 \times 10^{-3}) \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(0.03^2 - (7.85 \times 10^{-3})^2)}}$$

$$Q = 0.166 m^3/s$$

3. $d_1 = 30 \times 10^{-2}$ m

$y = 50 \times 10^{-2}$ mHg $\qquad S_m = 13.6$

$C_d = 0.64 \qquad S_o = 0.9$

S_g of oil $= 0.9$

$$H = y\left[\frac{S_m}{S_o} - 1\right]$$

$D = 15 \times 10^{-2}$ m

$$A^o = \frac{\pi d^2}{4} = \frac{\pi \times (15 \times 10^{-2})^2}{4} = 0.0707 m^2$$

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

$H = 7.055m$

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

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

$Q = 0.137 m^3/s$

4. $y = 170 mmHg = 170 \times 10^{-3} mHg$

S.g of mercury = 13.6 Hg

S.g of Sea water = 1.026

$v = \sqrt{2gh}$

$v = 6.3 m/s$

$$H = y \times \frac{S_{h}}{S_0} - 1$$

$$H = 170 \times 10^{-3} \times \left(\frac{13.6}{1.025} - 1\right) = 2.08m$$

5. $Q = 0.05 m^3/mm = 500 m^3/mn$

$P = 15 bar = 15 \times 100000 = 15 \times 10^5 N/m^2$

Speed = 170 rev/min

$T = 15Nm$, $NO = 10 cm^3/rev$

1. Volumetric efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$

Ideal flow rate = Nominal flow rate × Speed

= $10 cm^3/rev \times 1700$ rev/min

= $17000 cm^3/min$

Ideal flow rate = $\frac{17000}{1000000}$ = $0.017 m^3/min$

Actual flow rate = $0.05 m^3/mm$

volumetric efficiency = $\frac{0.05}{0.017}$ = 2.94% = 294%

ii. Fluid Power = P × Q

$P = 15 \times 15\ N/m^2$

$Q = 0.05 m^3/min = \frac{0.05}{60} = 8.33 \times 10^{-4} ms^{-2}$

Fluid Power $= 15 \times 10^5 \times 8.33 \times 10^{-4}$

$= ~~124~~\ 1249.5$ watts

iii. Shaft Power $= \frac{2\pi NT}{60} = \frac{2\pi \times 1700 \times 15}{60}$

Shaft power = 2670.35 watts

Overall efficiency $= \frac{\text{Fluid Power}}{\text{Shaft Power}}$

$\frac{\text{Fluid power}}{\text{Shaft power}} = \frac{1249.5}{267.35} = 0.468$

Overall efficiency = 0.468 × 100 = 46.8%