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18/ENG03/047
CIVIL ENGINEERING

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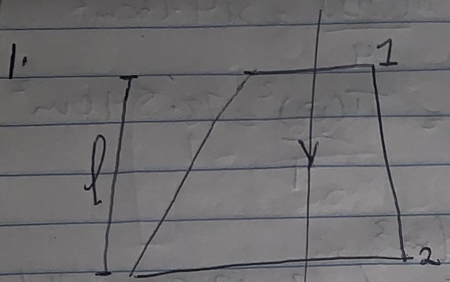
1.



Length = 2.0m – l
Velocity flow at smaller end = 5 m/s – V_1
velocity flow at lower end = 2m/s – V_2
Let the pressure head at the smaller end
= P_S
P_S = 2.5m of liquid

Let Loss of the head = H_L = $\frac{0.35(V1-V2)^2}{2g}$

$= \frac{0.35(5-2)^2}{2\times9.81} = 0.161m$

Pressure at lower end, P_L = ?
Applying Bernoulli'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 $Z_2 = 0$

Substituting in values

$$2.5 + \frac{5^2}{2\times9.81} + 2.0 = P_L + \frac{2^2}{2\times9.81} + 0 + 0.161$$

$$2.5 + \frac{25}{1962} + 2 = Pl + \frac{4}{19.62} + 0.161$$

$$2.5 + \frac{25}{19.62} + 2 = PL + \frac{4}{19.62} + 0.161$$

$$2.5 + \frac{25}{1962} + 2 - \left(\frac{4}{19.62} + 0.161\right) = PL$$

$$5.\cancel{7}4 - 0.365 = P_L$$

$$P_L = 5.409\,m$$

2. Let inlet diameter = $D_1 = 20cm$
Let throat diameter = $D_2 = 10cm$
Let inlet area = $A_1 = \frac{\pi D_1^2}{4} = \frac{\pi(20)^2}{4} = 314.16cm^2$
Let throat area = $A_2 = \frac{\pi D_2^2}{4} = \frac{\pi(10)^2}{4} = 78.54cm^2$

Density of water, $\rho = 1000kg/m^3$
Pressure at inlet = $17.658 N/cm^2 = 17.658 \times 10^4 N/m^2$

$\therefore \frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{1000 \times 9.81} = 18m$

$\frac{P_2}{\rho g} = -30cm$ of mercury, $S_{Hg} = 13.6$

$\frac{P_2}{\rho g} = -30 \times 10^{-2}m$ of mercury $\times 13.6$

$= -4.08$

HD, differential Head $= 18 - (-4.08)$

$= 22.08 \times 100$

$H_D = 2208cm$

using, $Q = \frac{Cd\sqrt{2gh}\,A_1A_2}{\sqrt{A_1^2 - A_2^2}}$

$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.184112}$

$= 165455.3 cm^3/s$

$= 165.45 lit/sec$

3.

$d_1 = 30cm$

$$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 706.86 cm^2$$

$d_2 = 15cm$

$$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (15)^2}{4} = 176.72cm^2$$

$S_o = 0.9$

$S_{mg} = 13.6$

manometer reading, x, = 50cm of mg H

$C_d = 0.64$

Differential head, $h = x\left(\frac{S_{Hg}}{S_o} - 1\right)$

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

$h = 705.56$ cm of oil

The rate of flow of oil

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

$$Q = \frac{0.64 \times \sqrt{2 \times 9.81 \times 705.56} \times 706.86 \times}{\sqrt{(706.86)^2 - (176.72)^2}}$$

$Q = 137.44$ lit/s

4. $x = 170mm = 170 \times 10^{-3} = 0.17m$

$S_g = 13.6$

$S_o = 1.026$

$V = ?$

$$h = x\left[\frac{S_g}{S_o} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$$

$$= 2.0834m$$

$$\therefore V = \sqrt{2 \times 9.81 \times 2.0834} = 6.393m/s$$

$$\text{or} = 23.01km/hr$$

5. $Q = 0.05m^3/mm = 50dm^3/mm$

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

$V = 1700 rev/mm$

$T = 15N/m$ $\quad$ $N(i) = 10cm^2/rev$

(i) $$V.E = \frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$$

$$IFr = 10 \times 1700 = 17000 \ cm^2/mm$$

$$= \frac{17000}{1000000} = 0.017m^2/mm$$

$$\therefore VE = \frac{0.05}{0.017} = 2.94\%$$

(ii) Fluid Power = $P \times Q$

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

$Q = 0.05m^3/mm = \frac{0.05}{60}$

$= 8.33 \times 10^{-4} m/s$

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

$= 1249.5 \times 10^{5-5}$

$= 1249.5$ watts

(iii) Shaft Power $= \cancel{\frac{2\pi NP}{60}} = \cancel{2\pi}$ $\frac{2\pi NP}{60}$

$= \frac{2\pi \times 1700 \times 15}{60}$

$= 2670.35$ watts

Overall Efficiency $= \frac{\text{Fluid power}}{\text{Shaft pu}}$

$= \frac{1249.5}{2670.35}$

$= 0.468\ \%$