

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

$$Q = \frac{0.98 \times 0.03 \times (7.85 \times 10^{-3}) \times \sqrt{2 \times 9.81 \times 21.08}}{\sqrt{(0.03^2 - (7.85 \times 10^{-3})^2)}}$$

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

$$3 \quad A_0 = 15 \times 10^{-2} \text{ m}$$

$$A_0 = \pi \times (15 \times 10^{-2})^2$$

$$A_0 = 0.01767 \text{ m}^2$$

$$A_1 = \pi \times (30 \times 10^{-2})^2$$

$$A_1 = 0.0707 \text{ m}^2$$

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

$$H = 7.055 \text{ m}$$

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

$$Q = \frac{0.64 \times 0.01767 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{(0.0707^2 - 0.01767^2)}}$$

$$Q = 0.137 \text{ m}^3/\text{s}$$

$$4 \quad y = 170 \text{ mm Hg} = 170 \times 10^{-3} \text{ m Hg}$$

$$\text{S.g. of mercury} = 13.6 \text{ Hg}$$

$$\text{S.g. of sea water} = 1.026$$

$$V = \sqrt{2gH}$$

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

$$V = 6.39 \text{ m/s}$$

$$H = y \left[\frac{S_{h_1}}{S_0} - 1 \right]$$

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

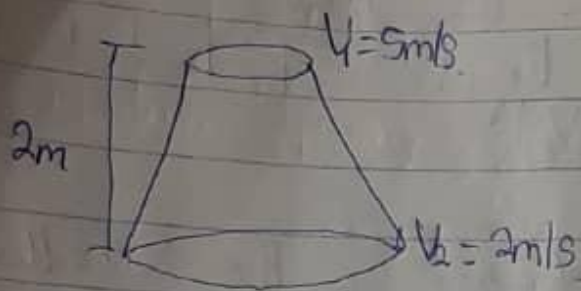
$$H = 2.08 \text{ m}$$

$$5 \quad \text{Actual flow rate } Q = 0.05 \text{ m}^3 \text{ } 5 \text{ dm}^3/\text{min} = 8.33 \times 10^{-5} \text{ m}^3/\text{Sec}$$

$$\text{Press } P = 15 \text{ bar} = 15 \times 10^5 \text{ N/m}^2$$

$$V = 1700 \text{ rev/min} = 28.33 \text{ rev/Sec}$$

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$$P_1 = \frac{P_i}{w} = 2.5 \text{ m}$$

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

Using Bernoulli's equation. $P_2 = ?$

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

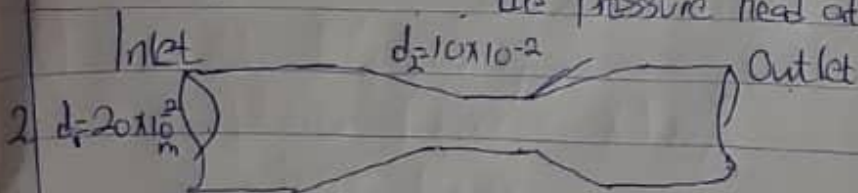
$$\frac{P_2}{w} = \frac{P_1}{w} + \left[\frac{V_1^2 - V_2^2}{2g} \right] + [Z_1 - Z_2] - H_L$$

$$\frac{P_2}{w} = 2.5 + \left[\frac{5^2 - 2^2}{2 \times 9.81} \right] + 2 - \frac{0.35 (5-2)^2}{2 \times 9.81}$$

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

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

the pressure head at the lower end = 5.409m



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

$$P_2 = 30 \text{ cmHg} = 30 \times 10^{-2} \text{ mHg} \quad \phi = ?$$

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

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

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

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

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

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

$$\gamma = 15 \text{ N/m}^3$$

$$\text{Normal displacement} = 100 \text{ cm}^3/\text{rev} = 1 \times 10^{-5} \text{ m}^3/\text{rev}$$

i) Volumetric Efficiency

$$\frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100\%$$

$$\text{Ideal flow rate} = \text{displacement} \times \text{Speed}$$

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

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

$$\text{Volumetric Efficiency} = \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100$$
$$= 29.4\%$$

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

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

iii) Shaft power $= \gamma \times W$

$$W = 2 \times \pi \times V$$

$$W = 2 \times \pi \times 28.33 = 178 \text{ rad/sec}$$

$$\text{Shaft power} = \gamma \times W$$

$$= 15 \times 178$$

$$= 2670 \text{ watts}$$

iv) Overall Efficiency

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

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

$$= 4.68\%$$

$$= 4.68\%$$