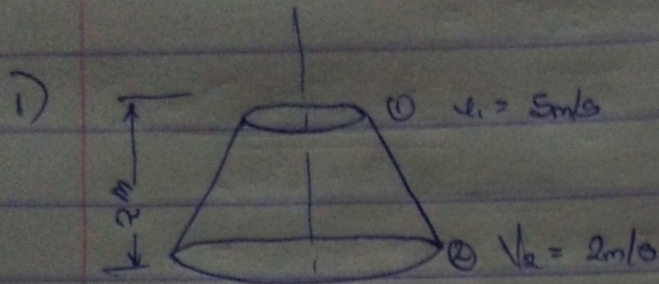


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Course



$$P_T = P_1/\rho = 2.5\text{ m}$$

$$P_1/\rho + \frac{v_1^2}{2g} + z_1 = P_2/\rho + \frac{v_2^2}{2g} + z_2 + h_L$$
$$h_L = \frac{0.35[v_1 - v_2]^2}{2g}$$
$$P_2/\rho = P_1/\rho + \frac{v_1^2 - v_2^2}{2g} + [z_1 - z_2] - \frac{0.35(v_1 - v_2)^2}{2g}$$

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

$$P_2/\rho = 2.5 + 1.01 + 2 - 0.161$$

$$\therefore P_2/\rho = 5.409\text{ m of liquid}$$

2) let inlet diameter = $D_1 = 20\text{ cm}$

let throat diameter = $D_2 = 10\text{ cm}$

$$\text{let inlet area} = A_1 = \frac{\pi D_1^2}{4} = \frac{\pi(20)^2}{4} = 314.16\text{ cm}^2$$

$$\text{let throat area} = A_2 = \frac{\pi D_2^2}{4} = \frac{\pi(10)^2}{4} = 78.54\text{ cm}^2$$

Density of water, $\rho = 1000\text{ kg/m}^3$

Pressure at inlet = 17.658 N/m^2

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

$$P_2/\rho g = -30 \text{ cm of mercury, } S.G.Hg = 13.6$$

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

$$\Rightarrow -4.08 \text{ m}$$

$$\text{Let Differential Head} = H = P_1/\rho g - P_2/\rho g$$

$$= 18 - (-4.08)$$

$$= 18 + 4.08 = 22.08 \text{ m} \times 100$$

$$\therefore H = 2208 \text{ cm}$$

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

$$\Rightarrow \frac{0.98 \times \sqrt{2 \times 981 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$$

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

$$= 165455.3 \text{ cm}^3/\text{s}$$

$$= \frac{165455.3}{1000} = 165.455 \text{ lit/sec}$$

3) $A_{\text{orifice}} = \pi/4 \times (15)^2 = 176.714 \text{ cm}^2$ (A_0 area of orifice)
 $A_{\text{pipe}} = \pi/4 \times (30)^2 = 706.858 \text{ cm}^2$ (A_p area of pipe)
 differential head (h) = $\left[\frac{13.6}{0.9} - 1\right] \times 50 \text{ cm of oil}$
 $= 705.556 \text{ cm of oil}$

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

$$= \frac{0.64 \times 176.714 \times 706.858 \times \sqrt{2 \times 9.81 \times 705.556}}{\sqrt{706.858^2 - 176.714^2}}$$

$$= 0.64 \times 182.5094 \times 117.656$$

$$= 13742.96 \text{ cm}^3/\text{sec}$$

$$\Rightarrow 13.74296 \text{ lits/sec}$$

4) The difference of mercury $sc = 170 \text{ mm} = 170 \times 10^{-3}$
 $= 0.17 \text{ m}$

The specific gravity of mercury, $S_g = 13.6$
 The specific gravity of sea water, $S_o = 1.026$
 The speed, $v = ?$

$$v = \sqrt{2gh}, \quad h = ?$$

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

$$= 2.0834 \text{ m}$$

$$\therefore v = \sqrt{2 \times 9.81 \times 2.0834} = 6.893 \text{ m/s}$$

in Km/hr

$$V = \frac{6.898 \times 60^2}{1000} = 23.01 \text{ km/hr}$$

$$5) Q = 0.05 \text{ m}^3/\text{min} = 50 \text{ dm}^3/\text{min}$$

$$P_0 = 15 \text{ bar} = 15 \times 100000 = 15 \times 10^5 \text{ N/m}^2$$

$$\text{speed} = 1700 \text{ rev/min}$$

$$T = 15 \text{ Nm}, ND = 10 \text{ cm}^3/\text{rev}$$

$$i) \text{ Volumetric Efficiency} = \frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$$

$$\text{Ideal flow rate} = \text{Nominal flow rate} \times \text{speed}$$

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

$$= 17000 \text{ cm}^3/\text{min}$$

$$\text{Ideal flow rate} = \frac{17000}{100000} = 0.17 \text{ m}^3/\text{min}$$

$$\text{Actual flow rate} = 0.05 \text{ m}^3/\text{min}$$

$$\therefore \text{Volumetric Efficiency} = \frac{0.05}{0.17} = 2.94\% = \text{~~2.94\%~~}$$

$$ii) \text{ fluid Power} = P \times Q \quad \text{where } P = 15 \times 10^5 \text{ N/m}^2$$
$$Q = 0.05 \text{ m}^3/\text{min} = \frac{0.05}{60}$$
$$= 8.33 \times 10^{-4} \text{ m}^3/\text{s}$$

$$\text{fluid power} = 15 \times 10^5 \times 8.33 \times 10^{-4}$$

$$= 15 \times 10^5 \times 83.3 \times 10^{-5} = 1249.5 \times 10^{5-5}$$

$$\Rightarrow 1249.5 \text{ watts}$$

$$\text{iii) Shaft power} = \frac{2\pi NT}{60} = \frac{2\pi \times 1700 \times 15}{60}$$

$$\text{Shaft power} = 2670.35 \text{ watts}$$

$$\text{iv) Overall Efficiency} = \frac{\text{Third Power}}{\text{Shaft Power}}$$

$$\Rightarrow \frac{1249.5}{2670.35} = 0.468$$

$$\Rightarrow \text{Overall Efficiency} = 0.468 \times 100 = 46.8\%$$