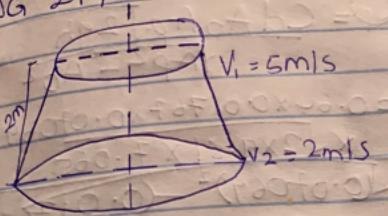


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 DEPT: Biomedical Engineering
 FLUID MECHANICS
 ENG 214.



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

$$H_L = 0.35 (V_1 - V_2)^2$$

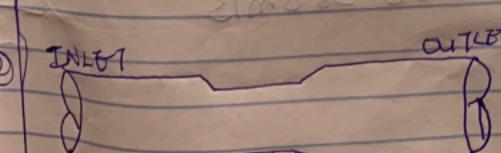
$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2$$

$$\frac{P_2}{w} = \frac{P_1}{w} = V_1^2 - V_2^2 + (Z_1 - Z_2) - 0.35(V_1 - V_2)^2$$

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

$$\frac{P_2}{w} = 2.5 + 0.07 + 2 - 0.62$$

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



AT THE INLET

$$d_1 = 20 \text{ cm} = 20 \times 10^{-2} \text{ m}$$

$$A = \frac{\pi d^2}{4} = \frac{\pi \times (20 \times 10^{-2})^2}{4}$$

$$A_1 = 0.0314 \text{ m}^2$$

$$P_1 = 17.663 \text{ N/cm}^2$$

$$= 17.663 \times 10^6 \text{ N/m}^2$$

$$C_d = 0.98$$

The throat diameter,

$$d_2 = 10 \text{ cm} = 10 \times 10^{-2} \text{ m}$$

$$A = \pi d^2 = \pi \times (10 \times 10^{-2})^2$$

$$= 3.14 \times 10^{-3} \text{ m}^2$$

$$A_2 = 7.85 \times 10^{-3} \text{ m}^2$$

To find h' ,

$$\frac{P_1}{w} = \frac{P_2}{w} = h' / 10 \cdot 0 =$$

$$P_1 = 17.668 \times 10^4 \text{ N/m}^2$$

$$w = 9.81 \times 10^3 \text{ N/m}^2$$

But, The throat vacuum pressure

$$= 30 \text{ cm of Hg} = 0.3 \text{ m Hg}$$

$$0.3 \times 13.6 = 4.08$$

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

$$\text{Then, } \frac{P_1}{w} = \frac{17.668 \times 10^4}{9.81 \times 10^3}$$

$$= 18 - (-4.08) = 22.08$$

$$\therefore \frac{P_1 - P_2}{w} = h' / 10 \cdot 0 =$$

$$= 18 - (-4.08) = 22.08$$

$$= 18 + 4.08 \times 0.2 = 22.08$$

$$= 22.08 \times 0.2 = 4.416$$

$$Q = C_d A_1 A_2 \left[\frac{2gh}{(A_1^2 - A_2^2)} \right]$$

$$98 \times 0.0314 \times 7.85 \times 10^{-3} \times$$

$$2.4156 \times 10^{-4} \times 6.845 = 0.1653$$

$$\text{Actual} = 0.1653 \text{ m}^2/\text{s}$$

Ditometer, $\rho = 1000 \text{ kg/m}^3$
given in the question,

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

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

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

Pipe diameter $d_p = 30 \text{ cm}$

$$A_p = \pi \times (30 \times 10^{-2})^2 \text{ m}^2$$

$$A_p = 0.07069 \text{ m}^2$$

$$S.P.G \text{ of oil} = 0.9$$

Coefficient of discharge

$$C = 0.64$$

Reading of differential

$$= 50 \text{ cm Hg}$$

Differential head h_d

$$h_d = 5hL - 1.9 - 1.9$$

$$5hL = 13.6 - 1.9 - 1.9 = 10.8$$

$$h = 50 \times 10^{-2} + 81 =$$

$$h = 50 \times 10^{-2} \times 13.6$$

$$h = 50 \times 10^{-2} \times 13.6 = 1.9$$

$$h = 50 \times 10^{-2} \times 14.11 = 1.9$$

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

$$2 \times 9.81 \times 22.08 \times (0.0314^2 \times 7.85 \times 10^{-3})$$

$$Q = Cd A_o A_p \frac{P_2 g}{T A_p^2 - A_o^2}$$

$$= 0.64 \times 0.01767 \times 0.07069$$

$$\times \sqrt{2 \times 9.81 \times 7.065}$$

$$\sqrt{(0.07069)^2 - (0.01767)^2}$$

$$= 7.99 \times 10^{-4} \times 11.765$$

$$\sqrt{4.68 \times 10^{-3}}$$

$$= 0.1374 \text{ m}^3/\text{s}$$

$$4) y = 170 \text{ mm Hg}$$

$$= 0.17 \text{ m Hg}$$

$$S.g Hg = 13.6$$

$$S.g = 1.026_{sw}$$

$$\Delta h = y / (S.g Hg - 1)$$

$$\Delta h = 0.17 / (13.6 - 1)$$

$$\Delta h = 0.17 / (1.026 + 2)$$

$$\Delta h = 0.17 / 3.026$$

$$\Delta h = 2.08 \text{ m}$$

$$V = \sqrt{2g \Delta h}$$

$$V = \sqrt{2 \times 9.81 \times 20.8} \text{ m/s}$$

$$V = 6.388 \text{ m/s}$$

$$\textcircled{1} \quad Q = 0.05 \text{ dm}^3/\text{mm} = 8.33 \times 10^{-3} \text{ m}^3/\text{sec}$$

Speed of rotation = 1700 rev/min = 28.3 rev/sec

Nominal Displacement = 10 cm³/rev = 10⁻³ m³/rev

Torque Input = 15 Nm

Pressure change = 15 bar = 15 × 10⁵ N/m²

Ideal flowrate = Nominal displacement × speed of rotation
 $= 2.83 \times 10^{-4} \text{ m}^3/\text{sec}$

$\textcircled{2}$ Volumetric Efficiency = $\frac{\text{Actual Flowrate}}{\text{Ideal Flowrate}} \times 100$
 $= \frac{8.33 \times 10^{-3}}{2.83 \times 10^{-4}} \times 100$
 $= 29.45\%$

$$\textcircled{3} \quad \text{Fluid power, } P_F = Q \times \Delta P$$
 $= 8.33 \times 10^{-3} \times 15 \times 10^5$
 $= 124.95 \text{ watts.}$

$$\textcircled{4} \quad \text{Shaft power} = T \times \omega$$
 $\omega = 2 \times \pi \times \text{Speed of rotations.}$
 $\omega = 2 \times \pi \times 28.3$
 $\omega = 177.8 \text{ rad/sec}$
 $\therefore \text{Shaft power} = 15 \times 177.8$
 $= 22667.2 \text{ watts.}$

$$\textcircled{5} \quad \text{Overall Efficiency} = \frac{\text{Fluid Power}}{\text{Shaft power}} \times 100$$
 $= \frac{124.95 \times 100}{22667.2}$
 $= 4.68\%$