

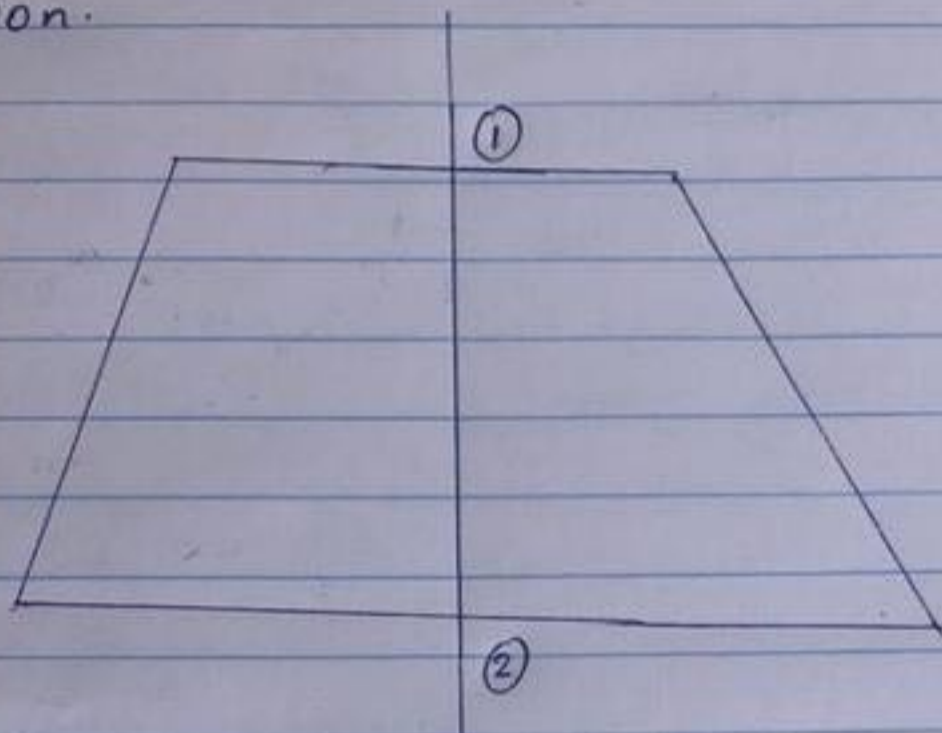
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Course Title: FLUID MECHANICS

Solution.



Let smaller end be represented by ①. Lower end by Rep by

②

Solution.

$$l = 0.2 \text{ m} \quad P_1 = P_2 = P_g = 2.5 \text{ m}, \quad v_1 = 5 \text{ m/s}, \quad v_2 = 2 \text{ m/s}$$

$$\text{Loss of head} = h_l = \frac{0.35(v_1 - v_2)^2}{2g}$$

$$= \frac{0.35(5-2)^2}{2g} = \frac{0.35(3^2)}{2 \times 9.81} = \frac{0.35(9)}{2 \times 9.81} = 0.16 \text{ m}$$

Pressure head $P_2/P_g = ?$ (x), applying Bernoulli's equation at ① and ②

$$P_1/P_g + \frac{v_1^2}{2g} + Z_1 = P_2/P_g + \frac{v_2^2}{2g} + Z_2 + h_l$$

$$Z_2 = 0, \quad Z_1 = 2.0$$

$$2.5 + \frac{(5)^2}{2 \times 9.81} + 2.0 = \frac{P_2}{P_g} + \frac{(2)^2}{2 \times 9.81} + 0.16$$

$$2.5 + 1.27 + 2.0 = \frac{P_2}{P_g} + 0.203 + 0.16$$

$$\frac{P_2}{P_g} = (2.5 + 1.27 + 2.0) - (0.203 + 0.16)$$
$$= 5.77 - 0.363 = 5.407 = 5.4 \text{ m of fluid.}$$

2) DATA.

$$\text{Inlet Diameter } (D_1) = 20\text{cm} = 0.2\text{m}$$

$$\text{Throat Diameter } (D_2) = 100 = 0.10\text{m}$$

$$\text{Area of inlet } a_1 = \frac{\pi}{4} \times (0.2)^2 = 0.031416\text{m}^2$$

$$\text{Area of throat} = \frac{\pi}{4} \times (d_2)^2 = \frac{\pi}{4} \times (0.1)^2 \\ = 0.007854\text{m}^2$$

$$C_d = 0.98, \text{ pressure } (p_1) = 17.685 \times 10^4 \text{Nm}^2, \rho = 10000 \text{Kglm}^3$$

$$P_1/\rho g = \frac{17.653 \times 10^4}{9.81 \times 1000} = 18\text{m}$$

$$P_2/\rho g = 30\text{cm of mercury} = -0.3\text{m} \times 13.6 = -4.$$

differential head.

$$h = P_1/\rho g - P_2/\rho g = 18 - (-4)$$

$$= 22.08\text{mlwater.}$$

$$Q = \frac{C_d \times a_1 \times a_2 \times \sqrt{2gh}}{\sqrt{(a_1)^2 - (a_2)^2}}$$

$$= \frac{0.98 \times 314.16 \times 0.007854 \times \sqrt{2 \times 9.81 \times 22.08\text{m}}}{\sqrt{(314.16)^2 - (0.007854)^2}}$$

$$= \frac{50328837.21 \times 165555}{304} = 0.165\text{m.}$$

$$= 165.56 \text{lit/s}$$

3. DATA

Orifice Diameter - 15cm

Pipe Diameter - 30cm

Co-efficient of discharge of the meter is - 0.64.

Flow of oil of Specific gravity - 0.9.

Solution.

$$A_o = \frac{\pi}{4} (15)^2 = 176.714\text{cm}^2 \text{ (Area of the Orifice)}$$

$$A_p = \frac{\pi}{4} (30)^2 = 706.838\text{cm}^2 \text{ (Area of the pipe)}$$

$$H = \left[\frac{13.6}{0.9} - 1 \right] \times 50\text{cm of oil}$$

$$= [15.1 - 1] \times 50\text{cm} = 14.1 \times 50 = 705.56$$

DATA.

5. Rate of Pump - $0.05 \text{ m}^3/\text{min} = 500 \text{ dm}^3/\text{min}$

Pressure change - 15 bar.

Speed rotation - 1700 rev/min

normal displacement - $10 \text{ cm}^3/\text{rev}$

tongue input - 15 Nm .

Solution.

Ideal flow rate = Normal displacement \times Speed

$$= 15 \times 1700 = 25,500 \text{ cm}^3/\text{min} = 25.500 \text{ dm}^3/\text{min}$$

$$= 25.5$$

Volumetric efficiency.

$$= \frac{\text{Actual flow}}{\text{Ideal flow}} = \frac{500}{25.5} = 19.60$$

$$\text{Ideal flow } 25.5$$

$$Q = \frac{(500 \times 10^{-3})}{60 \text{ m}^3/\text{s}} = 83.3 \times 10^{-4} \text{ m}^3/\text{s}$$

$$60 \text{ m}^3/\text{s}$$

fluid power.

$$\Delta P = 100 \times 10^5 \text{ N/m}^2, \text{ fluid power} = Q \Delta P = 83.3 \times 10^{-4} \times 100 \times 10^5$$

$$\text{fluid power} = 83300 \text{ W}$$

Shaft Power

$$= \frac{2\pi NT}{60} = \frac{2\pi \times 1700 \times 25.5}{60} = 4541.4 \text{ Nm}$$

$$60$$

Overall efficiency.

$$= \frac{\text{fluid power}}{\text{Shaft power}} = \frac{83300}{4541.4} = 18.342$$

$$\text{Shaft power } 4541.4$$

$$\text{Overall efficiency} = 18.342 \text{ or } 1834.2\%$$

$$Q_1 = \frac{C_d A_0 A_p \sqrt{2gh}}{\sqrt{(A_p^2) - (A_0^2)}}$$

$$Q = \frac{0.64 \times 176.71 \times 706.86 \times \sqrt{2 \times 9.81 \times 7.05 \times 100}}{\sqrt{(706.85)^2 - (176.74)^2}}$$

$$= \frac{0.64 \times 176.71 \times 706.85 \times \sqrt{2 \times 9.81 \times 7.05 \times 100} \text{ cm}^3/\text{sec}}{\sqrt{(706.858)^2 - (176.74)^2}}$$

$$Q = 137414.25 \text{ cm}^3/\text{sec}$$

$$\text{Litres} = 137.41425 \text{ lit/Sec}$$

$$\text{Rate of flow of oil} = 137.414 \text{ lit/Sec}$$

4. DATA

$$\text{Diff of mercury level, } x = 170 \text{ mm} = 0.17 \text{ m}$$

$$\text{Specific gravity of mercury} = 13.6$$

$$\text{Specific gravity (sp)} = 1.026$$

Solution.

$$h = x \left[\frac{S_g}{S_0} - 1 \right] = 0.17 \left[\frac{13.6}{1.026} - 1 \right]$$

$$= 2.0834 \text{ m}$$

$$v = \sqrt{2gh}$$

$$= 2 \times 9.81 \times 2.08$$

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

$$= \frac{6.39 \times 60 \times 60}{1000}$$

$$1000$$

$$= \frac{23004}{1000} = 23.004$$

$$\text{Speed of submarine} = 23.004 \text{ km/hr}$$

$$= 23.004 \text{ km/hr}$$