

Name: Okenabirhie Oghenemeru Nita

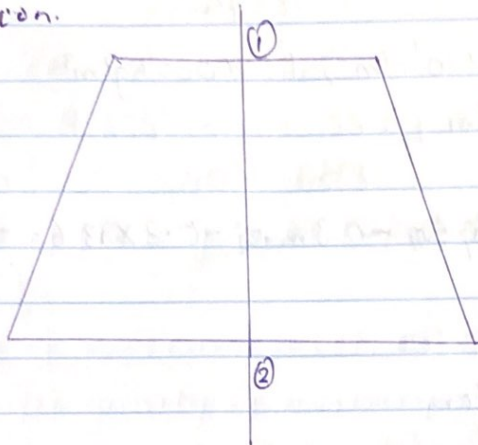
Matric No: 18/ENGO8/015

Department: Biomedical Engineering

COURSE TITLE: FLUID MECHANICS.

Solution.

(1)



Let smaller end be represented by (1). Lower end by represented by (2)

Solution.

$$L = 2.0 \text{ m} \quad P.S.P_g = 2.5 \text{ m}$$

$$v_1 = 5 \text{ m/s} \quad v_2 = 2 \text{ m/s}$$

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

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

Pressure head  $\frac{P_2}{P_g} = ?(x)$ , applying Bernoulli's equation at (1) & (2)

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

$$Z_2 = 0, Z_1 = 2.0$$

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

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

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

2) DATA.

Inlet Diameter ( $D_1$ ) = 20cm = 0.2m

throat Diameter ( $D_2$ ) = 100 = 0.10m

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

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

$C_d = 0.98$ , pressure ( $P_1$ ) =  $17.685 \times 10^4 \text{ Nm}^2$ ,  $\rho = 10000 \text{ Kg/m}^3$

$$\frac{P_1}{\rho g} = \frac{17.685 \times 10^4}{9.81 \times 1000} = 18 \text{ m}$$

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

differential head.

$$h = \frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 18 - (-4)$$

$$= 22.08 \text{ m water.}$$

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

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

$$= \frac{50328837.21 \times 16555}{304} = 0.165 \text{ m.}$$

$$304$$

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

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.

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

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

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

$$= [15.1 - 1] \times 50 = 14.1 \times 50 = 705.56$$

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

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

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

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

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

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

4. DATA

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

Specific gravity of mercury = 13.6

Specific gravity (sp) = 1.026

Solution.

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

$$= 2.0834 \text{ m}$$

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

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

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

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

$$= 23.004$$

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

Speed of Submarine = 23.004 Km/hr

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

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.

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

$$\text{Ideal flow } 25.5$$

$$Q = \frac{(500 \times 10^{-3})}{60 \text{ m}^3/\text{s}} = 8.33 \times 10^{-4} \text{ m}^3/\text{s}$$

fluid power.

$$\Delta P = 100 \times 10^5 \text{ N/m}^2, \text{ fluid power} = Q \Delta P = 8.33 \times 10^{-4} \times 100 \times 10^5$$

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

Shaft Power

$$= \frac{2\pi NT}{60} = \frac{2\pi \times 1700 \times 25.5}{60} = 4541.4 \text{ N/m}$$

Overall efficiency.

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

$$\text{shaft power } 4541.4$$

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