

$$1) Z_1 = 2\text{m}, Z_2 = 0\text{m}, l = 2\text{m}, V_1 = 5\text{m/s}, V_2 = 2\text{m/s}$$

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

$$\text{Head loss} = \frac{0.35(5-2)^2}{2 \times 9.81}$$

$$(h_L) \text{ Head loss} = 0.160\text{m}$$

Applying Bernoulli's equation

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

$$2.5 + \frac{(5)^2}{2 \times 9.81} + 2 = \frac{P_2}{\rho} + \frac{(2)^2}{2 \times 9.81} + 0 + 0.160$$

$$2.5 + 1.2742 + 2 = \frac{P_2}{\rho} + 0.2039 + 0.160$$

$$5.7742 = \frac{P_2}{\rho} + 0.3640$$

$$\frac{P_2}{\rho} = 5.7742 - 0.3640$$

EBITU, UKPONO FRIDAY

MAT NO. 18/ENG04/027

ELECTRICAL ELECTRONICS ENGINEERING

$$\frac{P_2}{W} = 5.4102 \text{ m}$$

$$\textcircled{2} \quad d_1 = 20 \text{ cm} = 0.2 \text{ m}, \quad C_d = 0.98$$

$$A_1 = \frac{\pi (d_1)^2}{4} = \frac{\pi \times (0.2)^2}{4} = 0.03142 \text{ m}^2$$

$$d_2 = 10 \text{ cm} = 0.1 \text{ m}$$

$$A_2 = \frac{\pi (d_2)^2}{4} = \frac{\pi \times (0.1)^2}{4} = 0.007855 \text{ m}^2$$

$$P_1 = 17.658 \text{ N/cm}^2 = 176580 \text{ N/m}^2$$

$$\frac{P_1}{W} = \frac{P_1}{\rho \times g} = \frac{176580}{1000 \times 9.81} = 18 \text{ m}$$

$$\text{Vacuum pressure} = 30 \text{ cm of Hg mercury (Hg)} \\ = -0.3 \text{ m mercury (Hg)}$$

$$P_2 = -0.3 \times 13.6$$

$$\frac{P_2}{W} = -4.08 \text{ m}$$

$$h = \frac{P_1 - P_2}{W}$$

$$h = 18 - (-4.08) = 22.08 \text{ m}$$

$$Q_{\text{actual}} = \frac{C_d A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$Q_{\text{actual}} = \frac{0.98 \times 0.03142 \times 0.007855 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.03142^2 - 0.007855^2}}$$

$$Q_{\text{actual}} = \frac{5.03477 \times 10^{-3}}{0.03042}$$



$$Q_{actual} = 0.1655 \text{ m}^3/\text{s}$$

$$(3) d_0 = 15 \text{ cm} = 0.15 \text{ m}$$
$$A_0 = \frac{\pi (d_0)^2}{4} = \frac{\pi \times (0.15)^2}{4} = 0.0177 \text{ m}^2$$

$$d_1 = 30 \text{ cm} = 0.3 \text{ m}$$
$$A_1 = \frac{\pi (d_1)^2}{4} = \frac{\pi \times (0.3)^2}{4} = 0.0707 \text{ m}^2$$

$$C_d = 0.64$$

$$\text{differential reading (y)} = 50 \text{ cm} = 0.5 \text{ m}$$

$$(\rho_{Hg}) \text{ Specific gravity of mercury} = 13.6$$

$$\text{Specific gravity of oil (Soil)} = 0.9$$

$$\text{Differential head (h)} = y \left[\frac{\rho_{Hg}}{\rho_{oil}} - 1 \right]$$

$$= 0.5 \left[\frac{13.6}{0.9} - 1 \right]$$

$$= 0.5 (14.11)$$

$$= 7.055 \text{ m}$$

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

$$Q = \frac{0.64 \times 0.0177 \times 0.0707 \times \sqrt{2 \times 9.81 \times 2.055}}{\sqrt{0.0707^2 - 0.0177^2}}$$

$$Q = \frac{9.4226 \times 10^{-3}}{0.0684}$$

$$Q = 0.1378 \text{ m}^3/\text{s}$$

(A) depth = 15m

manometer reading = 170mm = 0.17m

Specific gravity mercury $S_{Hg} = 13.6$

Specific gravity seawater $S_{\text{seawater}} = 1.026$

$$h = y \left[\frac{S_{Hg}}{S_{\text{seawater}}} - 1 \right]$$

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

$$h = 0.17 (12.255)$$

$$h = 2.08335 \text{ m}$$

$$\text{Velocity } V = \sqrt{2gh}$$

$$V = \sqrt{2 \times 9.81 \times 2.08335}$$

$$V = 6.3934 \text{ m/s}$$

$$\text{Actual flow rate} = 0.05 \text{ m}^3/\text{min} = 8.33 \times 10^{-4} \text{ m}^3/\text{s}$$

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

$$\text{Speed} = 1700 \text{ rev/min} = 28.33 \text{ rev/s}$$

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

$$\text{Torque input} = 15 \text{ Nm}$$

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

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

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

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

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

$$= 2.94 \times 100\%$$

$$= 294\%$$

$$\text{Fluid power} = \text{Actual rate} \times \text{pressure}$$

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

$$\text{Fluid power} = 1249.5 \text{ W}$$

$$\text{Shaft power} = \text{Torque} \times \text{angular speed}$$

$$\text{Angular speed} = 2 \times \pi \times \text{speed}$$

$$= 2 \times \pi \times 28.33$$

$$\text{Angular speed} = 178.0026 \text{ rad/s}$$

$$\text{Shaft power} = 15 \times 178.0026 = 2670.039 \text{ Watts}$$

$$\text{Overall efficiency} = \frac{\text{fluid power}}{\text{shaft power}} \times 100\%$$

$$= \frac{1249.5}{2670.039} \times 100\%$$

$$= 0.468 \times 100$$

$$= 46.8\%$$

$$= 46.8\%$$