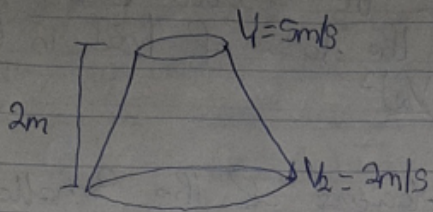




NAME: AKA PEACE OTAOGHENE  
 MATRIC NO: 18/ENG01/002  
 DEPARTMENT: CHEMICAL ENGINEERING.



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

$$H_L = \frac{0.35 (V_1 - V_2)^2}{2g}$$

Using Bernoulli's equation.  $\frac{P_2}{w} = ?$

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

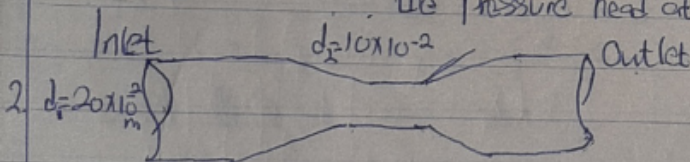
$$\frac{P_2}{w} = \frac{P_1}{w} + \left[ \frac{V_1^2 - V_2^2}{2g} \right] + [Z_1 - Z_2] - H_L$$

$$\frac{P_2}{w} = 2.5 + \left[ \frac{5^2 - 2^2}{2 \times 9.81} \right] + 2 - \frac{0.35 (5-2)^2}{2 \times 9.81}$$

$$\frac{P_2}{w} = 2.5 + 1.07 + 2 - 0.161$$

$$\frac{P_2}{w} = 5.409m$$

the pressure head at the lower end is 5.409m



$$P_1 = 17.658 N/cm^2 = 17.658 \times 10^4 N/m^2, C_d = 0.98$$

$$P_2 = 300 mmHg = 30 \times 10^{-2} mHg, Q = ?$$

$$A_1 = \pi \times (20 \times 10^{-2})^2$$

$$A_2 = \pi \times (10 \times 10^{-2})^2$$

$$A_1 = 0.03m^2$$

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

$$\frac{P_2}{w} = 0.3 \times 13.6 = 4.08 mHg$$

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

$$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-4.08) = 22.08$$

$$\frac{P_1}{w} = \frac{17.658 \times 10^4}{9.81 \times 10^3} = 18$$

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

$$Q = \frac{0.98 \times 0.03 \times (7.85 \times 10^{-3}) \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(0.03)^2 - (7.85 \times 10^{-3})^2}}$$

$$Q = 0.166 \text{ m}^3/\text{s}$$

3.  $A_0 = 15 \times 10^{-2} \text{ m}^2$

$$A_0 = \frac{\pi \times (15 \times 10^{-2})^2}{4}$$

$$A_0 = 0.1767 \text{ m}^2$$

$$A_1 = \frac{\pi \times (30 \times 10^{-2})^2}{4}$$

$$A_1 = 0.0707 \text{ m}^2$$

$$H = 50 \times 10^{-2} \left[ \frac{13.6}{0.9} - 1 \right]$$

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

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

$$Q = \frac{0.64 \times 0.1767 \times 0.0707 \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{(0.0707)^2 - (0.1767)^2}}$$

$$Q = 0.137 \text{ m}^3/\text{s}$$

4.  $y = 170 \text{ mmHg} = 170 \times 10^{-3} \text{ mHg}$

S.g of mercury = 13.6

S.g of Sea water = 1.026

$$V = \sqrt{2gH}$$

$$V = \sqrt{2 \times 9.81 \times 2.08}$$

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

$$H = y \left[ \frac{S_{H_1}}{S_0} - 1 \right]$$

$$H = 170 \times 10^{-3} \times \left( \frac{13.6}{1.026} - 1 \right)$$

$$H = 2.08 \text{ m}$$

5. Actual flow rate  $Q = 0.05 \text{ m}^3/\text{min} = 8.33 \times 10^{-5} \text{ m}^3/\text{Sec}$

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

$V = 1700 \text{ rev/min} = 28.33 \text{ rev/Sec}$

$\gamma = 15 \text{ N/m}^3$  Normal displacement =  $100 \text{ cm}^3/\text{rev} = 1 \times 10^{-5} \text{ m}^3/\text{rev}$

i) Volumetric Efficiency

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

Ideal flow rate = displacement  $\times$  Speed

$$Q = 1 \times 10^{-5} \times 28.33 \\ = 2.833 \times 10^{-4} \text{ m}^3/\text{sec}$$

$$\text{Volumetric Efficiency} = \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100 \\ = 29.4\%$$

ii) fluid power  $(Q \times \Delta P)$

$$= 8.33 \times 10^{-5} \times 15 \times 10^5 = 124.95 \text{ watts}$$

iii) Shaft power =  $\tau \times \omega$

$$\omega = 2\pi \times \text{RPM}$$

$$\omega = 2\pi \times 28.33 = 178 \text{ rad/sec}$$

Shaft power =  $\tau \times \omega$

$$= 15 \times 178 \\ = 2670 \text{ watts}$$

iv) Overall Efficiency

$$\frac{\text{Fluid Power} \times 100\%}{\text{Shaft Power}}$$

$$= \frac{124.95}{2670} \times 100$$

$$= 4.68\%$$

