UGWUOKE CHUKWUDUMEBI DAVID
18/ENG04/074
ELECT ELECT

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

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

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

Head loss $= 0.1601m$

Using Bernoulli's equation,

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

$2.5 + \frac{(5)^2}{2 \times 9.81} + 2 = \frac{P_2}{w} + \frac{(2)^2}{2 \times 9.81} + 0 + 0.1601$

$2.5 + 1.2742 + 2 = \frac{P_2}{w} + 0.2039 + 0.1601$

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

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

$\frac{P_2}{w} = 5.4102m$

2) $d_1 = 20cm = 0.2m$

$Cd = 0.98$

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

$d_2 = 10cm = 0.1m$

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

$P_1 = 17.658N/cm^2 = 176580N/m^2$

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

vacuum pressure $= 30cm\ of\ Hg$

$= -0.3m\ Hg$

$P_2 = -0.3 \times 13.6$

$\frac{P_2}{w} = -4.08m$

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

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

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

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

$$Q_{actual} = \frac{5.03417 \times 10^{-3}}{0.03042}$$

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

(3) $d_o = 15 cm = 0.15 m$

$$A_o = \frac{\pi (d_o)^2}{4} = \frac{\pi \times (0.15)^2}{4} = 0.0177 m^2$$

$d_i = 30 cm = 0.3 m$

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

$C_d = 0.64$

differential reading (y) = 50 cm = 0.5 m

(S_{Hg}) Specific gravity of mercury = 13.6

(S_{oil}) Specific gravity of oil = 0.9

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

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

$$= 0.5 (14.11)$$

$$= 7.055 m$$

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

$$Q = \frac{0.64 \times 0.0177 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{0.0707^2 - 0.0177^2}}$$

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

$$Q = 0.1378 m^3/s$$

4) depth = 15m
manometer reading = 170mm = 0.17m
specific gravity mercury (S_{Hg}) = 13.6
specific gravity seawater (S_{water}) = 1.026

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

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

$h = 0.17(12.255)$

$h = 2.08335m$

velocity $v = \sqrt{2 \times g \times h}$

$v = \sqrt{2 \times 9.8 \times 2.08335}$

$v = 6.394 m/s$

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

pressure = $15 bar = 15 \times 10^5 N/m^2$

speed = 1700 rev/min = 28.33 rev/s

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

Torque input = 15Nm

(i) volumetric efficiency = $\frac{\text{Actual flow rate}}{\text{ideal flow rate}} \times 100\%$

Ideal flow rate = nominal displacement x speed

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

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

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

$= 2.94 \times 100\%$

$= 294\%$ //

ii) Fluid power = Actual rate x pressure

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

fluid power = 1249.5 kW either //

iii) Shaft power = Torque x angular speed

Angular speed = $2 \times \pi \times$ speed

$= 2 \times \pi \times 28.33$

angular speed = 178.0026 rad/s

Shaft power = $15 \times 178.0026 = 2670.039$ watts //

iv) overall efficiency = $\frac{\text{fluid power}}{\text{shaft power}} \times 100\%$

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

$= 0.468 \times 100$

$= 46.8\%$