Nama: Awogbami Gbaluwaga
Dept: Elect/Elect
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1) ~~Question 1~~

parameters
$Z_1 = 0$, $Z_2 = 2m$, $V_1 = 5m/s$
$V_2 = 2m/s$, $\frac{P_1}{w} = 2.5m$
& $\frac{P_2}{w} = ?$

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

$$h_L = \frac{(0.35(5-2)^2)}{2 \times 9.81}$$

$$h_L = \frac{3.15}{19.62} = 0.16$$

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

$$2.5 + 0 + \frac{5^2}{2 \times 9.81} = \frac{P_2}{w} + 2 + \frac{3^2}{2 \times 9.81} + 0.16$$

$$\frac{P_2}{w} = 0.5 + \frac{5^2}{19.62} - \frac{3^2}{2 \times 9.81} - 0.16$$

$$\frac{P_2}{w} = 0.34 + \frac{25-9}{19.62}$$

$$\frac{P_2}{w} = 0.34 + 0.82$$

$$\frac{P_2}{w} = 1.16m$$

2) Question 2

Parameter
$d_1 = 20cm$, $d_2 = 10cm$,
$P_1 = 17.658 N/m^2$
$C_d = 0.98$

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

$$d_1 = \frac{20}{100} = 0.2m$$

$$A_1 = \frac{3.142 \times (0.2)^2}{4} = 0.031m$$

$$d_2 = \frac{10}{100} = 0.1m$$

$$A_2 = \frac{3.142 \times (0.1)^2}{4} = 0.008m$$

$$P_1 = 17.658 N/m^2 = \frac{17.658}{10^{-4}}$$

$$= 17.658 \times 10^4 N/m^2$$

$P_2 = 30cm = 0.3m$

$$\frac{P_1}{w} = \frac{17.658 \times 10^4}{1000 \times 9.81}$$

$$= 1.8 \times 10^1$$

$h_m = 18m$

$$h = \frac{P_1 - P_2}{w} = 18 - 0.3$$

$$= 17.7$$

$$Q_{actual} = \frac{0.98 \cdot 0.031 \cdot 0.008 \sqrt{2 \times 9.81 \times 17.7}}{\sqrt{(0.03)^2 - (0.008)^2}}$$

$$= \frac{0.00824304 \times \sqrt{347.274}}{\sqrt{9.61 \times 10^{-9} - 6.4 \times 10^{-5}}}$$

$$= 0.15$$

Question 3

$d_0 = 15cm = 0.15m$

$d_1 = 30cm = 0.3m$

$$A_0 = \frac{\pi d^2}{4} = \frac{3.142 \times 0.15^2}{4}$$

$$= 0.018\ m^2$$

$$A_1 = \frac{\pi d^2}{4} = \frac{3.142 \times 0.3^2}{4}$$

$$= 0.07\ m^2$$

$y = 50cm$ of Hg

$y = 0.5m$ of Hg

$$h = y\left(\frac{\text{S.g of mecwy} - 1}{\text{S.g of oil}}\right)$$

$$h = 0.5\left(\frac{13.6}{0.9} - 1\right)$$

$$h = 7.06$$

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

$$Q = \frac{0.64 \times 0.018 \times 0.07\sqrt{2 \times 9.81 \times 7.06}}{\sqrt{(0.07)^2 - (0.018)^2}}$$

$$Q = 0.14$$

Question 4

~~$y = 150, 170mm$~~

Sp.gr of mecwy = 13.6

Sp.gr of Sea water = 1.026

$y = 170mm = 0.17m$

$$h = \left(\frac{\text{Sp.gr of mecwy}}{\text{Sp.gr of Sea water}} - 1\right) \times y$$

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

$$h = 2.08$$

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

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

$$V = 6.388\ m/s$$

Question 5

i) Volumetric efficiency

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

$$= \text{Actual flow rate} = 0.05\ m^3/min$$

$$= \frac{0.05}{60} = 8.33 \times 10^{-4}$$

$$= \text{Ideal flow rate} = \text{nominal} \times \text{speed displacement}$$

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

Speed $= 1700\ rev/min$

$$= \frac{1700}{60} = 28.33$$

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

Ideal flow rate = 2.833×10^{-4}

$V.E = \frac{8.33 \times 10^{-4}}{2.833 \times 10^{-4}} \times 100$

$= 2.940 \times 100$

$= 294\%$

ii) fluid power

$P_f = Q \cdot \partial P$

~~$= 8.33 \times 10^{-4}$~~

$\Delta P = 15$ bar

$\Delta P = 15 \times 10^5 N/m^2$

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

$P_f = 1249.5$ watts

iii) Shaft power = $T.w$

where

T = Torque ~~been~~ input (Nm)

w = angular speed (rad/sec)

$T = 15$ Nm

$w = 2\pi N$

N = Speed rotation

$= 1700$ rev/min

$= \frac{1700}{60} = 28.33$

$w = 2 \times \frac{22}{7} \times 28.33$

$w = 178.07$

$S_p = 15 \times 178.07$

$= 2671.05$

iv) Overall efficiency

$= \frac{\text{fluid power}}{\text{Shaft power}} \times 100\%$

$= \frac{1249.5}{2671.05} \times 100\%$

$= 46.779\%$