1.

$P_1 = 2.5m$

$V_1 = 5m/s$

$V_2 = 2m/s$

$H_L = 0.35$

Using

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

$$\frac{2.5}{1000 \times 9.81} + \cancel{Z_1} + \frac{5^2}{2 \times 9.81} = \frac{P_2}{1000 \times 9.81} + \cancel{Z_2} + \frac{2^2}{2 \times 9.81}$$

$Z_1 = Z_2$

$$\frac{2.5}{9810} + \frac{25}{19.62} = \frac{P_2}{9810} + \frac{4}{19.62}$$

$$\frac{2.5}{9810} + \frac{25}{19.62} - \frac{4}{19.62} = \frac{P_2}{9810}$$

$$\underline{2.548 \times 10^{-4}} + 1.2742 - 0.20387 = \frac{P_2}{9810}$$

1.0705848×9810

$P_2 = 10502.436m$

olumetric flow rate $= x = \dfrac{0.05}{100\%}$

tual flow rate $= 5 \times 10^{-5}\,m^3/min$

m^3/min to m^3/sec

$60\,sec = 1\,min$

$= \dfrac{5 \times 10^{-5}}{60}$

$Q = 8.33 \times 10^{-7}$

$= 1700\,rev/min$

$= \dfrac{1700}{60}$

$= 28.3\,rev/sec$

re $= 15\,bar$

~~15 bar~~ $1\,bar = 1 \times 10^5\,N/m^2$

$15\,bar = x$

$x = 1 \times 10^5 \times 15$

$= 1.5 \times 10^6$

$h = 0.5\left(\frac{13.6 - 1}{0.9}\right)$ | $Q = \frac{8.003\times10^{-4} \times 118.83}{0.0683}$

$h = 0.5\left(\frac{12.6}{0.9}\right)$ | $= 1.3885 m^3/s$

$h = 7.16$

$$Q = \frac{0.64 \times 0.0177 \times 0.07065\sqrt{2\times 9.81 \times 7.16}}{\sqrt{(0.07065)^2 - (0.0177)^2}}$$

$$Q = \frac{\cancel{8.003\times10^{-4}} \times \cancel{140.479}}{\cancel{4.677\times10^{-3}}} = \frac{\cancel{0.1124}}{\cancel{4.677\times10^{-3}}}$$

$$= \cancel{24.03 m^3/s}$$

4. $l - 15m$

$P = 170mm$

$S.g = 13.6$

$S.g$ of Sea water - 1.026

Submarine diameter 1.5m

Reading difference in manometer - 170mm

Convert to m = 0.17m.

The head is expressed

$$h = p\left(\frac{S.g \text{ of mercury}}{S.g \text{ of sea water}} - 1\right)$$

$p = 0.17m$

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

$$h = 0.17\left(\frac{12.6}{1.026}\right)$$

$h = 0.17 \times 12.28$

$h = 2.087m$ of sea water

The speed of the sub-marine =

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

$$= \sqrt{2 \times 9.81 \times 2.087}$$

$$v = 6.39 m/s$$

Normal displacement = $10cm^3/rev$

$100cm - 1m$

~~$10^3cm^3 / 1m$~~ $10 \times 10^6 cm^3 = 1m$

~~$10cm^3 / x$~~ $10cm^3 = x$

$x = \dfrac{10}{1000,000}$

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

Ideal flow rate = nominal × speed

displacement

$28.3 \times 1 \times 10^{-5}$

$= 2.83 \times 10^{-4} m^3/sec$

tric Efficiency = $\dfrac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100\%$

$\dfrac{8.33 \times 10^{-7}}{2.83 \times 10^{-4}} \times 100$

~~0.294~~ $2.94 \times 10^{-3}\%$

Nominal displacement $= 10cm^3/rev$

$100cm = 1m$

$100^3cm^3 = 1m^3$ $\quad 10 \times 10^6 cm^3 = 1m^3$

$10cm^3 = x$ $\quad 10cm^3 = x$

$$x = \frac{10}{1000{,}000}$$

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

Ideal flow rate = nominal displacement $\times$ speed

$28.3 \times 1 \times 10^{-5}$

$= 2.83 \times 10^{-4} m^3/sec$

Volumetric Efficiency $= \dfrac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100\%$

$$\frac{8.33 \times 10^{-7}}{2.83 \times 10^{-4}} \times 100$$

$\cancel{0.294}$ $2.94 \times 10^{-3}\%$

$8.33 \times 10 \times 1.5 \times 10$

$1.2495 \, Nm/sec$

Shaft Power = $T \cdot w$

where T = Torque input (Nm)

w = Angular speed (rad/sec)

$T = 15 \, Nm$

$w = \frac{2\pi N}{60}$ for rpm

$w = \frac{2 \times 22}{7} \times 28.3$

$w = 177.89 \, rad/sec$

Shaft Power = $15 \times 177.89 \, rad/sec$

FLM

iv) Overall efficiency

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

$$\frac{1.2495}{2668.29} \times 100\%$$

$$= 4.682 \times 10^{-4}\%$$

$$Q_{actual} = \frac{0.98 \times 0.0314 \times 7.855\times10^{-3}\sqrt{2\times9.81\times4.2565}}{\sqrt{(0.0314)^2 - (7.855\times10^{-3})^2}}$$

$$= \frac{2.209\times10^{-3}}{9.2426\times10^{-4}} = \frac{2.209\times10^{-3}}{0.03040}$$

$Q_{actual} = \cancel{2.39100}\ 0.07266$

$\cancel{= 2.39}$

3. Using

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

$d_1 = 15cm$

$= 0.15m$

$A_1 = \frac{3.14 \times (0.15)^2}{4}$

$A_1 = 0.0177m^2$

$d_2 = 30cm$

$= 0.3m$

$A_2 = \frac{3.14 \times (0.3)^2}{4}$

$= 0.07065m^2$

$P_1 = 50cm$

$= 0.5m$

$h = \cancel{y}\left(\frac{S.g\ of\ Mercury}{S.g\ of\ Oil}\right) -$

$h = P\left(\frac{S.g\ of\ Mercury}{S.g\ of\ Oil}\right) -$

$\sqrt{(A_1 - A_2)^2}$

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

2 Using

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

$d_1 = 20cm$

$= 0.2m$

$$A_1 = \frac{3.142 \times (0.2)^2}{4} = 0.0314 m^2$$

$A_2 = d_2 = 10cm = 0.1m$

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

$A_2 = 7.855 \times 10^{-3} m^2$

$\therefore 0.17658 N/m^2$

Specific Gravity of Mercury $= 13.6$

$$\frac{P_1}{w} = \frac{P_1}{\rho g} = \frac{0.17658}{1000 \times 9.81}$$

$= 1.8 \times 10^{-5}$

Vacuum pressure

$$= \frac{P_2}{w} = 0.3$$

$= 4.08m$

$h = P_1 + P_2$

$= 0.17658 + 4.08$

$= 4.25658$