$V = \sqrt{2 \times 9.81 \times (2.0842)}$

$= 6.39 m/s$

$\therefore$ speed of submarine $= 6.39 m/s$

5) $Q = 0.05 m^3/min = 50 dm^3/min$

$P_1 = 15 bar = 15 \times 100{,}000 = 15 \times 10^5 N/m^2$

speed $= 1700 rev/min$, $ND = 10 cm^3/rev$

$T = 15 Nm$

(i) Volumetric efficiency $= \frac{\text{Actual flowrate}}{\text{ideal flowrate}}$

ideal flowrate = Nominal flowrate × speed

$= 10 cm^3/rev \times 1700 rev/min$

$= 17000 cm^3/min$

$= 0.017 m^3/min$

Actual flowrate $= 0.05 m^3/min$

Volumetric efficiency $= \frac{0.05}{0.017} = 2.94\%$

(ii) Fluid power $= P \times Q$ $\qquad Q = \frac{0.05}{60} = 8.33 \times 10^{-4}$

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

$= 1249.5$ watts.

(iii) Shaft power $= \frac{2\pi NT}{60} = \frac{2\pi \times 1700 \times 15}{60}$

$= 2670.35$ watts.

(iv) Overall efficiency $= \frac{\text{fluid Power}}{\text{Shaft Power}}$

$= \frac{1249.5}{2670.35} = 0.468 \times 100$

$= 46.8\%$

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1.) $V_1 = 5ms^{-1}$ $P_1 = 2.5m$
$V_2 = 2ms^{-1}$ $P_2 = ?$

$$P_1 - P_2 = \frac{0.35(V_1 - V_2)^2}{2g}$$

$$= \frac{0.35 \times 3^2}{2 \times 9.81} = 0.161$$

$P_1 - P_2 = 0.161$
$2.5 - P_2 = 0.161$
$P_2 = 2.5 + 0.161 = 2.67m.$
Pressure at the lower end is 2.67m.

2.) $D = 200mm$
$= 0.20m$

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi(0.20)^2}{4} = 0.0314m^2$$

$$P_1 = 17.638 \, N/cm^2 = \frac{17.658}{10^{-6}} = 17658000$$

Specific gravity of mercury = 13.6

$$\frac{P_1}{w} = \frac{P}{\rho g} = \frac{17.658 \times 10^{-6}}{1000 \times 9.81} = 1.8 \times 10^{-9}$$

Vaccum pressure $= \frac{P_2}{w} = 300mHg$

$d_2 = 100m = 0.10m$

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi(0.10)^2}{4} = 7.85 \times 10^{-3}$$

$h = 1.8 \times 10^{-9} + 4.08$
$= 4.08m$

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

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

$$= \frac{0.98 \times 0.0314 \times 7.85 \times 10^{-3} \sqrt{2 \times 9.81 \times 4.08}}{\sqrt{(0.0314)^2 - (7.85 \times 10^{-3})^2}}$$

$= 0.0711$ or 7.11×10^{-5} lit/sec

3 $D_1 = 150mm = 0.15m$

$D_2 = 300mm = 0.30m$

$$A_2 = \frac{\pi d_2^2}{4} = \frac{3.142 \times 0.30^2}{4} = 0.0707m^2$$

$$A_1 = \frac{\pi d_1^2}{4} = \frac{3.142 \times 0.15^2}{4} = 0.0177m^2$$

$y = 500mmHg = 0.50mHg$

$C_d = 0.61$

$$h = \frac{S.G \text{ of } Hg - S.G \text{ of oil}}{S.G \text{ of oil}} \times y$$

$$= \frac{13.6 - 0.9}{0.9} \times 0.5 = 7.06m$$

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

$$= \frac{0.61 \times 0.0707 \times 0.0177 \sqrt{2 \times 9.81 \times 7.06}}{\sqrt{(0.0707)^2 - (0.0177)^2}}$$

$= 0.1377$ or 13.77 lit/sec

4 $V = \sqrt{2gh}$

$$H = y \left(\frac{S.G \text{ of } mHg - S.G \text{ of water}}{S.G \text{ of water}} \right)$$

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

$= 0.17 \times 12.24$

$= 2.0812m$