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Fluid mechanics

1) $V_1 = 5ms^{-1}$, $V_2 = 2ms^{-1}$
$D_1 = 2.5m$
$P_{12} = ?$ $P_T - P_{T2} = \frac{0.35(V_1 - V_2)^2}{2g}$

$= \frac{0.33 \times 3^2}{2 \times 9.81} = 0.161$

$\therefore P_{T_1} - P_{T_2} = 0.161$
$2.5 - P_{T2} = 0.161$
$P_{T_2} = 2.5 + 0.161$
$P_{T_2} = 2.67m$
$\therefore$ pressure head at lower end $= 2.62m$

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

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

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

Specific gravity of mercury $= 13.6$

$\frac{P_1}{\omega} = \frac{P_1}{Pg} = \frac{17.658 \times 10^6}{1000 \times 9.81} = 1.8 \times 10^{-4}$

Vaccum pressure $= \frac{P_2}{\omega} = 300mmHg$

3) $d = 150mm = 0.15m$
Pipe diameter $d_2 = 300mm = 0.30m$

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

$A_1 = \frac{\pi d_i^2}{4} = \frac{3.142 \times 0.30^2}{4} = 0.0707m^2$

$y = 500mmHg = 0.50mHg$
$cd = 0.64$

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

ific gravity of mercury = 13.6
Seawater = 1026

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

$= 0.17 \times 12.255$

$= 2.0834\,m$

$\frac{13.6 - 0.9}{0.9} \times 0.5$

$= 7.06m$

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

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

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

$= 0.17 \times 12.26$

$= 2.0842\,m$

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

$= 6.39\,ms^{-1}$

$\therefore$ Speed of submarine $= 6.39\,ms^{-1}$