If d_1 150mm = 0.15m

Pipe diameter d_2 = 300mm = 0.3m

$A_2 = \frac{\pi d_2^2}{4} = \frac{3.142 \times 0.15^2}{4} = 0.0177m^2$

$A_1 = \frac{\pi d_1^2}{4} = \frac{3.142 \times 0.30^2}{4} = 0.0703m^2$

h_2 500mmH_2O = 0.5mH_2O

$h = \frac{S.G\ of\ H_2O \times h_2\ of\ oil}{S.G\ of\ oil}$

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

$= 7.06m$

Theoretical flow rate actual

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

$Q_{act} = \frac{0.0207 \times 0.0177 \sqrt{2 \times 9.81 \times 7.06}}{\sqrt{(0.0703)^2 - (0.0177)^2}}$

$= 0.1777_{6}$

$V = \sqrt{2gh}$

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

$h = 0.13\left(\frac{13.6 - 1.026}{1.026}\right)$

$= 0.13 \times 12.26$

$= 2.0847m$

$V = \sqrt{2 \times 9.81 \times 2.0847}$

$= 6.76ms^{-1}$ $\therefore$ Speed of submarine = $6.76ms^{-1}$

Discharge = $0.05m^3/s$

$\rho = 1kg$

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18/Eng 08/024
Fluid Mechanics

(1) $V_1 = 5ms^{-1}$ $V_2 = 2ms^{-1}$
$P_1 = 2.5m$ $P_2 = ?$
$$P_1 - P_2 = \frac{0.35 (V_1 - V_2)^2}{2g}$$
$$= \frac{0.35 \times 3^2}{2 \times 9.81} = 0.161$$

$\therefore P_1 - P_2 = 0.161$
$2.5 - P_2 = 0.161$
$P_2 = 2.5 + 0.161$
$P_2 = 2.67m$
$\therefore$ pressure head of cone end = 2.67m

(2) $D = 200mm$
$= 0.20m$
$$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.20)^2}{4} = 0.0314 m^2$$
$$P_1 = 17.658 N/cm^2 = \frac{17.658}{10^{-6}} = 17658000$$

Specific gravity of mercury = 13.6
$$\frac{P_1}{w} = \frac{P_1}{\rho g} = \frac{17.658 \times 10^{-6}}{1000 \times 9.81} = 1.8 \times 10^{-7}$$

vacuum pressure P_2/w = 300mmHg

$d_2 = 100mm \times 10$
$= -0.30 \times 13.6$ $A_2 = \pi d^2/4 = \pi \frac{(0.10)^2}{4} = 7.85 \times 10^{-3}$
$P_2 = -4.08$
$h = 1.8 \times 10^{-7} + 4.08$
$= 4.080000002 m$

$h = P_1/w - P_2/w$

$$Q_{actual} = \frac{C_d A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.98 \times 0.0314 \times 7.85 \times 10^{-3} \sqrt{2 \times 9.81 \times 4.08000}}{\sqrt{(0.0314)^2 - (7.85 \times 10^{-3})^2}}$$
$= 0.0716869 16664$