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18/ENG03/043
Civil Engineering

1. $v = 5ms^{-1}$, $V_2 = 2ms^{-1}$

$P_{r_1} = 2.5m$, $P_{r_2} = ?$

$PT_1 - PT_2 = \frac{0.35(V_1 - V_2)}{2g}$: $\frac{0.35 \times 3^2}{2 \times 9.81} = 0.161$

$\therefore P_{T_1} - PT_2 = 0.161$

$2.5 - PT = 0.161$

$PT_2 = 2.5 - 0.161$

$PT_2 = 2.67m$

2) 200

$= 0.20m$

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

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

Specific gravity of mercury = 13.6

$\frac{P_1}{w} = \frac{P_1}{\rho g} = \frac{17.658 \times 10^6}{1000 \times 9.81} = 1.8 \times 10^8$

vacuum pressure $= \frac{P_2}{w}$. 300mmHg

= 300 mmHg

$d_2 = 100mm = 0.1$

-0.30×13.6 $A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.10)^2}{4}$

$= 7.85 \times 10^{-5}$

$P_2 = -4.08$

$h = 1.8 \times 10^{-4} + 4.08 =$

4.08000000m.

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

Qactual $\left(\frac{d \ P_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}\right)$

$$\frac{0.98\times 0.0314\times 7.185\times 10^{-3}\ \sqrt{2\times 9.81\times 4.05000000}}{\sqrt{(0.0314)^2 - (7.85\times 10^{-3})^2}}$$

$= 0.00710891665$

3) $d_1 = 150mm = 0.15m$

Pipe diameter $d_2 = 300mm = 0.30m$

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

$$A_2 = \frac{\pi (0.30)^2}{4} = 0.0707\,m^2$$

$y = 500mmHg = 0.50\,mHg$

$cd = 0.64$

$$h = \frac{Sg\ of\ hg - sg\ of\ 0.1}{sg\ of\ 0.1}\times y = \frac{13.6 - 0.9}{0.9}\times 0.05$$

$= 7.00m$

Rate of flow, $q_{actual} = \frac{Cd\ A_2 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

$$\frac{0.64\times 0.0707\times 0.0177\ \sqrt{2\times 9.81\times 7.06}}{\sqrt{(0.0708)^2 - (0.0177)^2}}$$

$= 0.1377\,m^3/s$

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

$$H = y\left(\frac{sg\ of\ mercury - sg\ of\ water}{sg\ of\ water}\right)$$

$$H = 0.17\left(\frac{13.6 - 1.0261}{1.026}\right) = 2.0842m$$

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

$6.39 ms^{-1}$

speed of submarine $= 6.39 ms^{-1}$

5) Actual flowrate $Q = 5dm^3/min$ $= 8.33 \times 10^{-5} m^3/sec$

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

$v = 1700 rev/min = 28.33 rev/sec$

$T = 15 Nm$ Normal deplacement $= 100 cm^3/rev$

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

Volumetric efficiency

$\frac{\text{Actual flowrate}}{\text{ideal flowrate}} \times 100\%$

ideal flowrate = displace × speed

$Q = 1 \times 10^{-5} \times 28.33$

$= 2.833 \times 10^{-4} m^3/sec$

volumetric efficiency $= \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100$

$= 29.4\%$

fluid power $(Q \times \Delta P)$

$= 8.33 \times 10^{-5} \times 15 \times 10^5 = 124.95$ watts

Shaft Power $= T \times w$

$w = 2 \times \pi \times V = 2 \times \pi \times 28.33$

$= 178 rad/sec$

$= T \times w$

$= 15 \times 178 = 2670$ watts

Overall Efficency

$\frac{\text{fluid power}}{\text{shaft power}} \times 100\%$

$\frac{124.95}{2670} \times 100$ $= 4.68\%$