Date. Page.

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Civil Engineering
18/ENG03/038

Fluid Mechanics

1) $V = 5ms^{-1}$, $V_2 = 2ms^{-1}$

$P_T = 2.5m$, $P_{T_2} = ?$

$P_{T_1} = P_{T_2} = \frac{0.35 (V_1 - V_2)^2}{2g} = \frac{0.35 \times 3^2}{2 \times 9.81}$

$= 0.161$

$\therefore P_{T_1} - P_{T_2} = 0.161$

$2.5 - P_{T_2} = 0.161$

$2.5 - 0.161 = P_{T_2}$

$\therefore P_{T_2} = 2.67m$

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

(d_1 = 200mm = 0.2m)

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

Specific gravity of mercury = 13.6

$\frac{P_1}{w} = \frac{P_1}{\rho g} = \frac{17.658 \times 10^{-6}}{1000 \times 9.81} = 1.80 \times 10^{-3}$

Date. Page.

Vacuum pressure $= \frac{P_2}{w} = 300mmHg$

$d_2 = 100mm = 0.1m$

$= 0.30 \times 13.6$

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

$P_2 = -4.08$

$h = 1.8 \times 10^{-4} \times 4.08 = 408\,000\,000m$

3. $d_0 = 15 \times 10^{-2} m$

$A_0 = \frac{\pi \times (15 \times 10^{-2})^2}{4}$

$d_1 = 30 \times 10^{-2} m$

$0.0176 = 0.018m^2$

$y = 50 \times 10^{-2} mHg$

Sg of oil = 0.9

$A_1 = \frac{\pi \times (30 \times 10^{-2})^2}{4} = 0.0707m^2$

$H = 50 \times 10^{-2} \left[\frac{13.6}{0.9} - 1\right] = 7.055 m$

$Q = \frac{C_d A_0 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}} = \frac{0.64 \times 0.176 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.055}}{0.707^2 - 0.0176^2}$

$Q = 0.137 m^3/s$

Date. Page.

4.) $y = 170\,mmHg = 170 \times 10^{-3}\,mHg$

S_g of mercury $= 13.6$ hg

S_g of sea water $= 1.026$

$H = \frac{y \times S_m}{S_o} - 1$

$V = \sqrt{2gH}$

$V = \sqrt{2 \times 9.81 \times 2.08}$

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

$H = 170 \times 10^{-3} \times \left(\frac{13.6}{1.026} - 1\right)$

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

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

$V = 1700\,rev/min = 28.33\,m/sec$

$T = 15\,N/m$ Normal displacement $= 100\,cm^3/rev$

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

Volumetric Efficiency

$\frac{\text{Actual Flowrate}}{\text{Ideal Flowrate}} \times 100\%$

ideal Flowrate = displacement × Speed

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

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

Date. Page.

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 $= T \times \omega$

$\omega = 2 \times \pi \times V = 2 \times \pi \times 28.33 = 178\,rad/sec$

$= T \times \omega$

$= 15 \times 178 = 2670$ watts

Overall Efficiency

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

$= \frac{124.95}{2620} \times 100 = 4.68\%$

Wesley’s assignment