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DEPARTMENT: MECHANICAL ENGINEERING
COURSE: FLUID MECHANICS ASSIGNMENT

(1) $l = 2m$

$v_1 = 5m/s$

$V_2 = 2m/s$

$P_a/w = 2.5m$

$h_L = \frac{0.35(v_1 - V_2)^2}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$

To get P_2/w; comparing:

$P_1/w + V_1^2/2g + Z_1 = P_2/w + V_2^2/2g + Z_2 + h_L$

$Z_2 = 0$

$Z_1 = 2m$

$2.5 + 5^2/2\times9.81 + 2 = P_2/w + 2^2/2\times9.81 + 0 + 0.161$

$5.77 = P_2/w + 0.365$

$P_2/w = 5.77 - 0.365$

$= 5.405m$

(2) $d_1 = 0.2m$; $d_2 = 0.1m$; $P_1 = 17.658\ N/cm^2$; $P_2 = -30mmHg$;

$Cd = 0.98$

$A_1 = \frac{\pi \times 0.2^2}{4} = 3.14 \times 10^{-3} m^2$

$A_2 = \frac{\pi \times 0.1^2}{4} = 7.85 \times 10^{-4} m^2$

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

$P_1 = \frac{17.658}{10^{-4}} = 176.58 \times 10^3 N/m^2$

$P_1/w = \frac{176.58 \times 10^3}{1000 \times 9.81} = 18m$

$P_2/w = -0.30 \times 13.6 = -4.08$

$h = 18 + 4.08 = 22.08m$

$Q = \frac{Cd \times A_1 A_2 \sqrt{2gh}}{\sqrt{(A_1)^2 - (A_2)^2}}$

$= \frac{0.98 \times 314.16 \times 0.007854 \times \sqrt{2 \times 9.81 \times 22.08m}}{\sqrt{(314.16)^2 - (0.001854)^2}}$

$= \frac{50328837.21 \times 165555}{304} = 0.165m$

$= 1.656 \times 10^{-2} \; m^3/s$

③ $P_2 = 15cm = 0.15m$

$P_1 = 30cm = 0.3m$

$y = 50cmHg = 0.5mHg$

Sg of oil = 0.9; Sg of mercury = 13.6

$cd = 0.64$

Area of pipe $(A_1) = \frac{\pi \times 0.3^2}{4} = 0.071m^2$

Area of orifice meter $(A_O) = \frac{\pi \times 0.15^2}{4}$

$= 0.0177m^2$

$h = y\left[{S_{ghl}}/{S_O} - 1\right]$

S_{ghl} = Specific gravity of heavier liquid

$h = 0.5\left[13.6/0.9 - 1\right] = 7.056m$

$Q = \frac{Cd \; A_O \; A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_O^2}}$

$= \frac{0.64 \times 0.0177 \times 0.071 \times \sqrt{2 \times 9.81 \times 7.056}}{\sqrt{0.071^2 - 0.0177^2}}$

$= 0.138 \; m^3/s$

④ Manometer reading $(y) = 170mmHg$

$= 0.17mHg$

$S_{ghl} = 13.6$

Sg of sea water $(S_w) = 1.026$

$h = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.08$

Velocity of the substance:

$v = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.08}$

$= 6.39m/s$

⑤ $Q = 5dm^3/min$

$= \left[\frac{5}{1000} \times \frac{1}{60}\right] m^3/s = 8.3 \times 10^{-5} \; m^3/s$

$V = 1700 rev/min = \frac{1700}{60}$

$= 28.33 rev/sec$

$Q_p = 10cm^3/rev = 10 \times 10^{-6} \; m^3/rev$

Ideal flowrate = Speed X displacement

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

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

(i) Vol. Efficiency $= \frac{\text{Actual Q}}{\text{Ideal Q}} \times 100$

$= \frac{8.3 \times 10^{-5}}{2.85 \times 10^{-4}} \times 100$

$= 29.33\%$

(ii) Fluid Power = Flowrate X Pressure

$= 8.3 \times 10^{-5} \times (15 \times 10^5)$

$= 124.5 \; kW$

(iii) Shaft Power = Torque X angular velocity; $\omega = 2\pi V$

$= 2\pi \times 28.33 = 178 \; rads^{-1}$

Shaft Power $= 15 \times 178 = 2670 \; kW$

(iv) Overall Efficiency $= \frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100$

$= \frac{124.5}{2670} \times 100 = 4.66\%$