Ahanefule Terence
18/ENG02/015
Computer Engineering.

(B) Real flowrate = $10 dm^3/min$ T = 12.5 Nm

$= \frac{10\times10^{-3}}{60} = 1.67\times10^{-4}\ m^3/s.$

Pressure = 12 bar = $12\times10^{-5} N/m$

Speed = 1500 rev/min = $\frac{1500 rev}{60}$ = 25 rev/sec.

Normal displacement = $\frac{10 cm^3}{rev} = 1\times10^{-6}\ m^3/rev.$

Ideal Flowrate = normal displacement x speed

$= 1\times10^{-5}\times 25$

$= 2.5\times10^{-4}\ m^3/sec.$

(i) Volumetric efficiency = $\frac{\text{Real flowrate}}{\text{Ideal flowrate}}\times 100\%$

$= \frac{1.67\times10^{-4}}{2.5\times10^{-4}}\times 100\%$

$= 66.8\%$

(ii) Fluid power = Q.dp.

$= 1.67\times10^{-4}\times 12\times10^{5}$

= 200.4 watts.

(iii) Shaft power = T. w

$w = 2\pi N = 2\times\pi\times 25$

$= 157.08$

$= 12.5\times 157.08$

Shaft power = 1963.5 watts.

Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft power.}}$

$= \frac{200.4}{1963.5} = 0.102\times 100 = 10\%$

②

Diameter $= 20 \times 10^{-2} m$

$P_1 = 17.658 N/cm^2 = 17.658 \times 10^4 N/m^2$

$P_2 = 30cm Hg = 30 \times 10^{-2} m Hg$

$A_1 = \frac{\pi \times (20 \times 10^{-2})^2}{4} = 0.03 m^2$

$Cd = 0.98$

$Q = ?$

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

$\frac{P_2}{w} = 0.3 \times 13.6 = 4.08 m Hg$

$\frac{P_2}{w} = -4.08 \quad \frac{P_1}{w} = \frac{17.658 \times 10^4}{9.81 \times 10^3} = 18$

$h = \frac{P_1}{w} - \frac{P_2}{w} = 18 - (-4.08) = 22.08$

$Q = \frac{Cd A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.98 \times 0.03 \times (7.85 \times 10^{-3}) \times \sqrt{2 \times 9.81}}{\sqrt{0.03^2 - (7.85 \times 10^{-3})^2}}$

$Q = 0.166 m^3/s$

③ ~~Number 3~~

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

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

$Cd = 0.64$

S_g of Oil $= 0.9$

$H = y\left[\frac{S_{h_1}}{S_0} - 1\right] \quad S_{h_1} = 13.6, \quad S_0 = 0.9$

$D = 15 \times 10^{-2} m$

$A_0 = \frac{\pi d^2}{4} = \frac{\pi \times (15 \times 10^{-2})^2}{4} = 0.0707 m^2$

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

$H = 7.055 m$

$Q = \frac{Cd\, A_0 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$

$Q = \frac{0.64 \times 0.0176 \times 0.0707 \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{(0.0707^2 - 0.0176^2)}}$

$= 0.137 m^3/s$

④ $y = 170 mm Hg = 170 \times 10^{-3} m hg$

S_g of mercury $= 13.6 Hg$

S_g of Seawater $= 1.025$

$V = \sqrt{2gh}$

$V = 6.32 m/s$

$H = y \times \frac{S_{h_1}}{S_0} - 1$

$H = 170 \times 10^{-3} \times \left(\frac{13.6}{1.025} - 1\right) = 2.08 m$

⑤ Headloss $= H_1 = \frac{0.35(V_1 - V_2)^2}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161 m$

$H_1 = 0.161 m$

Pressure of head at lower end $(P_2) = P$

Applying Bernoulli's Equation

$P_1/\rho g + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + H$

where $P_s = \frac{P_1}{\rho g}$ & $P_2 = \frac{P_2}{\rho g}$

$Z_1 = 20$ & $Z_2 = 0$

Substituting the values of the parameter into the equation

$$2.5 + \frac{5}{2 \times 9.81} + 2.0 = P_1 + \frac{2^2}{2 \times 98.1} + 0 + 0.261$$

$$2.\ \ 2.5 + \frac{25}{19.62} + 2 = -\left(\frac{4}{19.62} + 0.161\right) - P_L$$

$5.774 - 0.365 = P_L$

$P_L = 5.409$ m of fluid