ISOKARIARI DATONYE
18/Eng06/029
Mechanical Engineering

Question 1

$V_1 = 5m/s$

$V_2 = 2m/s$

$P_S = 2.5m$

$$H_L = \frac{0.35(V_1 - V_2)^2}{2g}$$

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

$P_L = ?$

using Equation

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

where $P_S = \frac{P_1}{\rho g}$ and $P_L = \frac{P_2}{\rho g}$

$Z_1 = 2.0$ and $Z_2 = 0$

$$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = P_L + \frac{2^2}{2 \times 9.81} + 0 + 0.161$$

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

$5.774 - 0.365 = P_L$

$P_L = 5.409$ m of oxied fluid

2 Inlet $D = D_1 = 20$ cm

Outlet $D_2 = 10$ cm

let inlet area $A_1 = \frac{\pi (10)^2}{4} = 78.54 cm^2$

Density of water, $\rho = 1000$ kg/m³

Pressure at inlet $= 17.658$ N/cm² $= 17.658 \times 10^4$ N/m²

$\therefore \frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{1000 \times 9.81} = 18$ m

$\frac{P_2}{\rho g} = -30$ cm of mercury, S.g Hg = 13.6

$\frac{P_2}{\rho g} = -30 \times 10^{-2}$ m of mercury $\times 13.6$

$= -4.08$ m

let Differential Head $= H_d = \frac{P_1}{\rho g} - \frac{P_2}{\rho g}$

$= 18 - (-4.08)$

$= 18 + 4.08 = 22.08$ m $\times 100$

$H = 2208$ cm

using, $Q_1 = \frac{C_d \sqrt{2gh} \cdot A_1 A_2}{\sqrt{A_1^2 - A_2^2}}$

$$= \frac{0.98 \times \sqrt{2 \times 981 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$$

$$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.18412}$$

$= 165455.3 \ cm^3/s$

$= \frac{165455.3}{1000} = 165.455 \ lit/sec$

3 $A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 706.82 \ cm^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (15)^2}{4} = 176.72 \ cm^2$

$S_o = 0.9$

$S_{hg} = 13.6$

$x = 50cm$ of mercury

$C_d = 0.64$

$$h = x\left(\frac{S_{hg}}{S_o} - 1\right)$$

$$h = 50\left(\frac{13.6}{0.9} - 1\right)$$

$h = 705.56$ cm of oil

The rate of flow of oil is

$$Q_1 = \frac{c_d \sqrt{2gh} \cdot A_1 \cdot A_2}{\sqrt{A_1^2 - A_2^2}}$$

$$Q = \frac{0.64 \times \sqrt{2 \times 981 \times 705.56} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (176.72)}}$$

$$Q_1 = 137443.29 \ cm^3/s$$

$$= \frac{137443.29}{1000} = 137.44 \ lit/s$$

4) $V = \sqrt{2gh}$ $\quad h = ?$

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

$$= 2.0834 m$$

$$\therefore V = \sqrt{2 \times 9.81 \times 2.0834} = 6.393 m/s$$

$$V = \frac{6.393 \times 60^2}{1000} = 23.01 \ km/hr$$

5 $Q = 0.05 m^3/min = 50 dm^3/min$

$P_o = 15 bar = 15 \times 100\,000 = 15 \times 10^5 \ N/m^2$

speed $= 1700 rev/min$

$T = 15 Nm$, $ND = 10 cm^3/rev$

$$\text{Volumetric Efficiency} = \frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$$

Ideal flow rate = Nominal flowrate x speed

$= 10\,cm^3/rev \times 1700\,rev/min$

$= 17000\,cm^3/min$

Ideal flow rate $= \frac{17000}{1000000} = 0.017\,m^3/min$

Actual flow rate $= 0.05\,m^3/min$

∴ Volumetric Efficiency $= \frac{0.05}{0.017} = 2.94\%$

Fluid Power $= P \times Q$

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

$Q = 0.05\,m^3/min = \frac{0.05}{60} = 8.33 \times 10^{-4}\,m^3/s$

Fluid Power $= 15 \times 10^5 \times 8.33 \times 10^{-4}$

$= 15 \times 10^5 \times 83.3 \times 10^{-5}$

$= 1249.5 \times 10^{5-5}$

$= 1249.5$ watts

Shaft Power $= \frac{2\pi N T}{60} = \frac{2\pi \times 1700 \times 15}{60}$

Shaft Power $= 2670.35$ watts

Overall Efficiency $= \frac{\text{Fluid Power}}{\text{Shaft "}}$

$= \frac{1249.5}{2670.35} = 0.468 \times 100$

$= 46.8\%$