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18/ENG04/032
Electrical Electronics Engineering

1) Length, $L = 2.0m$

The velocity flow at smaller end $= V_1 = 5m/s$

The velocity flow at larger end $= V_2 = 2m/s$

Let the pressure head at the smaller end $= P_S = 2.5m$ of liquid.

let the loss of head $= H_L = \frac{0.35(V_1 - V_2)^2}{2g}$

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

Let the pressure head at the lower end $= P_L = ?$

Applying Bernoulli's 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 $z_2 = 0$

Inputting values into the equation

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

$$2.5 + \frac{25}{19.62} + 2 = P_L + \frac{4}{19.62} + 0.161$$

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

$$5.774 - 0.365 = P_L$$

$P_L = 5.409m$ of fluid.

2) Let inlet diameter $= D_1 = 20cm$

let throat diameter $= D_2 = 10cm$

let inlet area $= A_1 = \frac{\pi D_1^2}{4} = \frac{\pi(20)^2}{4} = 314.16cm^2$

let throat area $= A_2 = \frac{\pi D_2^2}{4} = \frac{\pi(10)^2}{4} = 78.54cm^2$

Density of water, $\rho = 1000kg/m^3$

Pressure of inlet $= 17.658 N/cm^2 = 17.658\times 10^4 N/m^2$

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

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

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

$= -4.08m$

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

$= 18 - (-4.08)$

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

$h = 220.8cm$

Using $Q = \frac{C_d\sqrt{2gh} \cdot A_1 A_2}{\sqrt{A_1^2 - A_2^2}}$

$= 0.98 \times \frac{\sqrt{2 \times 981 \times 220.8} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$

$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.184112}$

$= 165455.3 cm^3/s$

$= \frac{165455.3}{1000} = 165.455 Lt/sec.$

3) Diameter of pipe $d_1 = 30cm$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 706.86cm^2$

Diameter of orifice, $d_2 = 15cm$

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

Specific gravity of oil, $S_0 = 0.9$

specific gravity of mercury, $S_{hg} = 13.6$

Differential manometer reading, $x = 50cm$ of mercury

co-efficient discharge, $C_d = 0.64$

Differential head, $h = x\left(\frac{S_{hg}}{S_0} - 1\right)$

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

$h = 705.56cm$ of oil

The rate of flow of oil is

$Q = \frac{C_d\sqrt{2gh} \cdot A_1 \cdot A_2}{\sqrt{A_1^2 - A_2^2}}$

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

$Q = 137443.29 \, cm^3/s$

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

4) The difference of mercury lead, $x = 170\,mm = 170 \times 10^{-3} = 0.17\,m$

The specific gravity of mercury, $S_g = 13.6$

The specific gravity of sea water, $S_o = 1.026$

The speed, $v = ?$

$$v = \sqrt{2gh}, \quad h = ?$$

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

$$= 2.0834\,m$$

$$\therefore v = \sqrt{2 \times 9.81 \times 2.0834} = 6.393\,m/s.$$

in Km/hr

$$v = \frac{6.93 \times 60^2}{1000} = 23.01\,Km/hr$$

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

$P_o = 15\,bar = 15 \times 100000 = 15 \times 10^5\,N/m^2$

Speed $= 1700\,rev/min$

$T = 15\,Nm$, $NO = 10\,cm^3/rev$

i) volumetric Efficiency $= \frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$

Ideal flow rate = Nominal flow rate × 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 $= 0.05\,m^3/min$

$\therefore$ volumetric efficiency $= \frac{0.05}{0.017} = 2.94\% = 294\%$

ii) Fluid power $= P \times Q$

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

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

fluid power $= 15 \times 10^5 \times 8.33 \times 10^{-4}$

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

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

Fluid power $= 1249.5$ watts.

iii) Shaft power $= \frac{2\pi NT}{60} = \frac{2\pi \times 1700 \times 15}{60}$

Shaft power = 2670·35 watts.

(iv) Overall Efficiency = $\frac{\text{fluid power}}{\text{Shaft power}}$

$\frac{\text{fluid power}}{\text{Shaft power}} = \frac{1249.5}{2670.35} = 0.468$

∴ Overall Efficiency = 0·468 × 100 = 46·8%.