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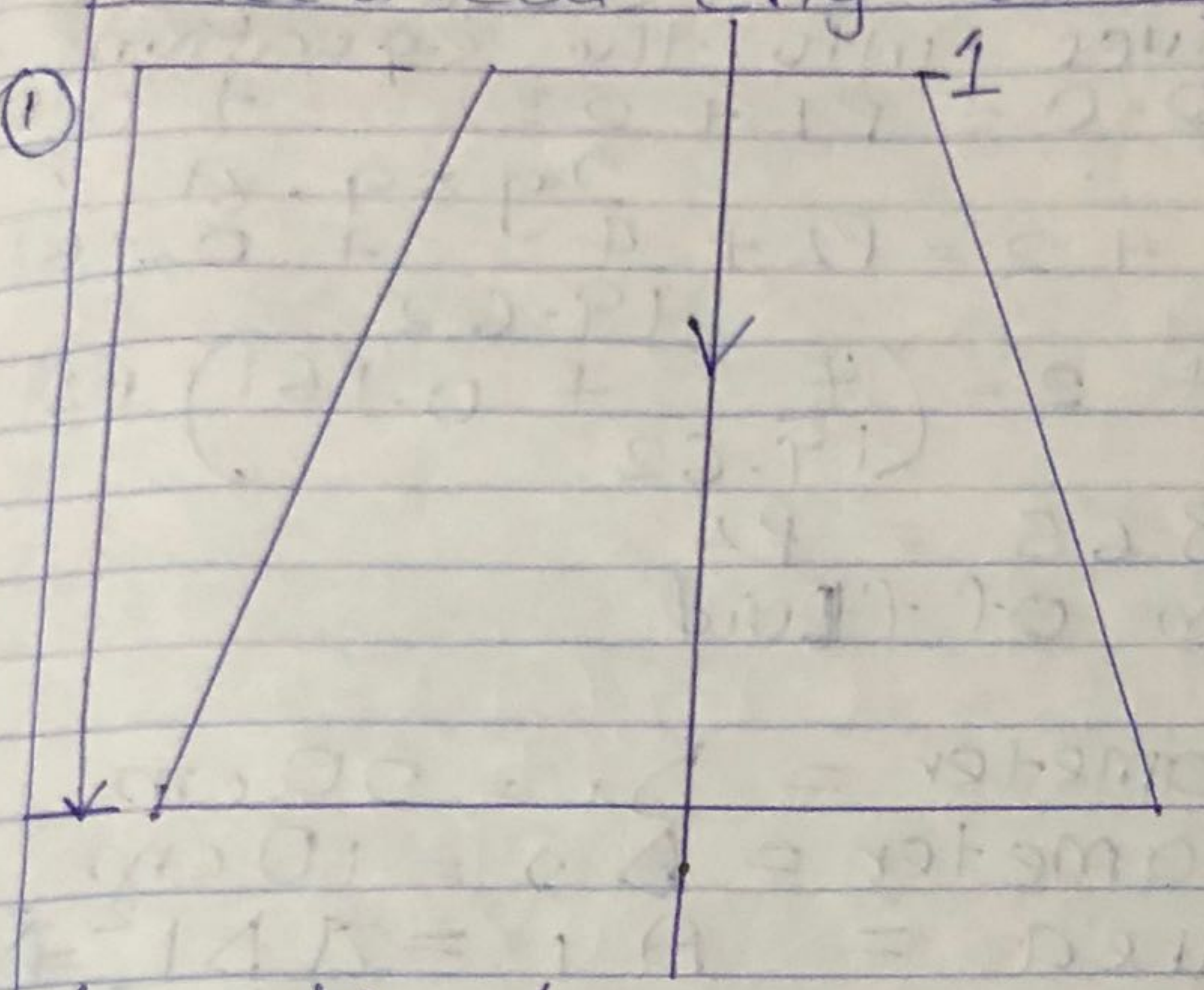
Electrical Engineering

(1)



Length, $L = 2.0m$

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

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

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

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

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

$= 0.161 m$

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 $z_2 = 0$ (datum line passes through section 2)

Im values into the equation

$$2.5 + \frac{5^2}{2\times 9.81} + 2.0 = P_2 + \frac{2^2}{2g\times 9.81} + 0.016$$

$$2.5 + \frac{25}{19.62} + 2 = P_2 + \frac{4}{19.62} + 0.161$$

$$2.5 + \frac{25}{19.62} + 2 - \left(\frac{4}{19.62} + 0.161\right) = P_2$$

$$5.774 - 0.365 = P_2$$

$P_2 = 5.409$ m of fluid

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

Let throat diameter $= D_2 = 10$ cm

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

$= 314.16$

Let throat area

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

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

Pressure at inlet $= 17.658\ N/cm^2$

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

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

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

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

$= -4.08$ m

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

$= 18 - (-4.08)$

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

$H = 2208$ cm

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

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

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

$= 165455.3 \; cm^3/s$

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

3. Diameter of pipe $= 30cm$

$A_1 = \frac{\pi d_1^2}{4} = \pi \frac{(30)^2}{4} = 1706.86 cm^2$

Diameter of orifice, $d_2 = 15cm$

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

Specific gravity of oil, $S_o = 0.9$

Specific gravity of mercury, $S_{ng} = 13.6$

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

Coefficient of discharge, $c_d = 0.64$

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

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

$h = 705.56cm$ of oil

∴ The rate of flow of oil is:

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

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

$Q = 137443.29\ cm^3/s$

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

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

The specific gravity of mercury, $S_g = 13.6$
The specific gravity of sea water, $S_o = 1.026$

The speed, $V = ?$

$V = \sqrt{2gh}$, $h = ?$

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

$= 2.0834\ m$

$\therefore V = \sqrt{2 \times 9.81 \times 2.0834} = 6.39\ m/s$

In Km/hr

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

5. $Q = 0.5\ m^3/min = 50\ dm^3/min$
$P_o = 15\ bar = 15 \times 100000 = 15 \times 10^5\ N/m^2$
Speed $= 170$ over/min
$T = 15.4m$, $ND = 10\ cm^3/rev$

(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 $= \frac{17000}{1000000} = 0.017\ m^3$

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 = 0.0
Fluid po
Fluid
iii) Shaft
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$Q = 0.05\, m^3/min = \frac{0.05}{60} = 8.33 \times 10^{-4} m/s$

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

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

$= 12495 \times 10^{5-5}$

Fluid power $= 1249.5$ watt

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

Shaft power $= 2670.35$ watt

Overall Efficiency $= \frac{\text{Fluid power}}{\text{Shaft power}}$

Fluid power $= 1249.5$ $= 0.468$

Shaft power $= 2670.35$

Overall Efficiency $= 0.468 \times 100$

$= 46.8\%$