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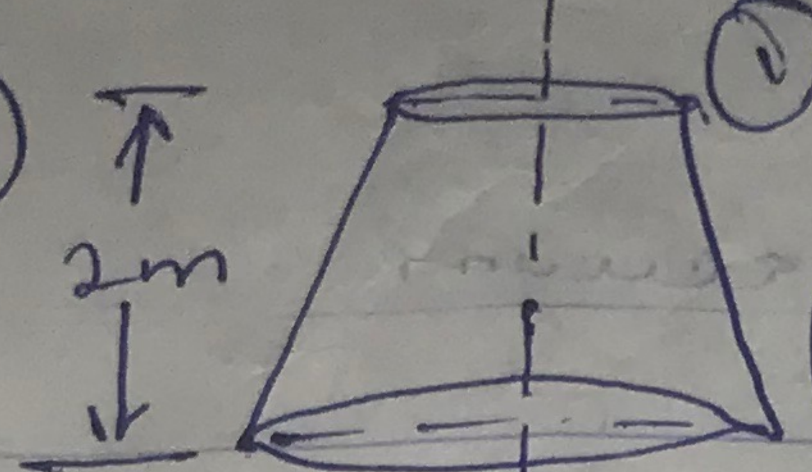
Civil Engineering
18/ Eng03 4050

1)



① $V_1 = 5m/s$

② $V_2 = 2m/s$

$$\frac{P_1}{w} = 2.5m$$

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

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

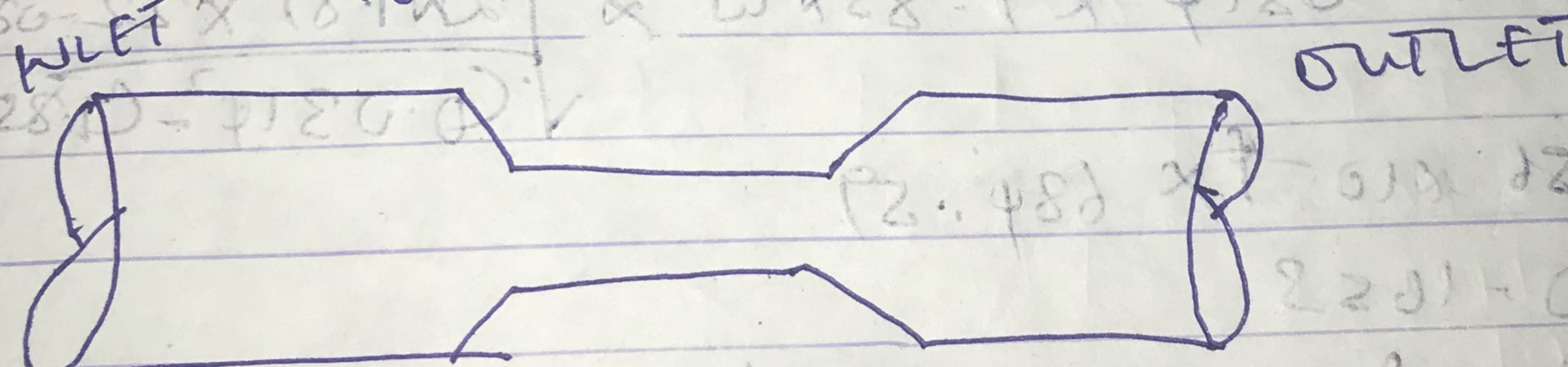
$$\frac{P_2}{w} = \frac{P_1}{w} = \frac{V_1^2 - V_2^2}{2g} + (Z_1 - Z_2) - \frac{0.35(V_1 - V_2)^2}{2g}$$

$$\frac{P_2}{w} = 2.5 + \frac{5^2 - 2^2}{2(9.81)} + 2 - \frac{0.35(5-2)^2}{2(9.81)}$$

$$\frac{P_2}{w} = 2.5 + 1.07 + 2 - 0.161$$

$$\frac{P_2}{w} = 5.409m \text{ of liquid}$$

2)



INLET, $d_1 = 20cm = 20 \times 10^{-2} m$

$$A = \frac{\pi d^3}{4} = \frac{\pi \times (20 \times 10^{-2})^2}{4}$$

$A_1 = 0.0314 m^2$

THROAT DIAMETER, $d_2 = 10cm$
$= 10 \times 10^{-2} m$

$$A = \frac{\pi d^2}{4} = \frac{\pi \times (10 \times 10^{-2})^2}{4}$$

$A_2 = 7.85 \times 10^{-3} m^2$

$P_1 = 17.668 N/cm^2$

$cd = 0.98$

To get h,

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

$P_1 = 17.668 \times 10^4 \ N/m^2$

$w = 9.81 \times 10^3 \ N/m^3$

But we have ~~that~~ ~~throat~~ vacuum pressure = 30cm of Hg

$= 0.3 \ m Hg$

$= 0.3 \times 13.6 = 4.08$

$\frac{P_2}{w} = -4.08$ (Since vacuum pressure)

Then $\frac{P_1}{w} = \frac{17.658 \times 10^4}{9.81 \times 10^3} = 18$

$\therefore \frac{P_1}{w} - \frac{P_2}{w};\ 18 - -4.08 = 22.08$

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

$= 0.98 \times 0.0314 \times 7.85 \times 10^{-3} \times \sqrt{\frac{2 \times 9.81 \times 22.08}{(0.0314^2 - (7.85 \times 10^{-3})^2)}}$

$= 2.4156 \times 10^{-4} \times 684.59$

$= 0.1653$

$\therefore Q_{actual} = 0.1653 m^3/s$

3) Orifice meter; Given that

$d_o = 15cm = 15 \times 10^{-2} m$, Pipe Diameter; $d_p = 30$

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

$A_o = \frac{\pi \times (15 \times 10^{-2})^2}{4}$, $A_p = \frac{\pi \times (30 \times 10^{-2})^2}{4}$

$= 0.01767 m^2$ $\quad = 0.07069 m^2$

Sp. G. of oil = 0.9 (S_0)

Coeff...

Readin...

$\therefore$ Diffe...

Sh...

h

$Q = C$...

$= 0$...

$=$

4) ...

Coefficient of discharge = 0.64
Reading of differential = 500 mhg

Differential head h = $y\left[\frac{Shl}{S0} - 1\right]$

Shl = 13.6

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

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

$h = 50 \times 10^{-2} \times 14.11$

= 7.055 m

$Q = \frac{C_d A_o A_p \sqrt{2gh}}{\sqrt{A_p^2 - A_o^2}}$

$= \frac{0.64 \times 0.01767 \times 0.07069 \times \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{(0.07069^2) - (0.01767^2)}}$

$= \frac{7.994 \times 10^{-4} \times 11.765}{\sqrt{4.68 \times 10^{-3}}}$

$= 0.1374\ m^3/s$

4) y = 170 mm Hg = 0.17 m Hg, S. g Hg = 13.6, S. g sw = 1.026

$\Delta h = y\left(\frac{S\ g\ Hg}{S\ g\ sw} - 1\right)$

$\Delta h = 0.17\left(\frac{13.6}{1.026} - 1\right)$

$\Delta h = 2.08\ m$

$V = \sqrt{2g\Delta h}$

$V = \sqrt{2 \times 9.81 \times 2.08}$

$V = 6.388\ m/s$

5) Q = 0.05 dm^3/min = 8.33 × 10^{-5} m^3/sec
Speed of rotation = 1700 Rev/min = 28.3 Rev/sec
Nominal Displacement = 10 cm^3/rev = 10^{-5} m^3/rev.
Torque Input = 15 Nm
Pressure change = 15 bar = 15 × 10^5 N/m^2
– Ideal Flowrate = Nominal displacement × Speed rotation
= 10^{-5} × 28.3 = 2.83 × 10^{-4} m^3/sec

a) Volumetric Efficiency = $\frac{\text{Actual Flowrate}}{\text{Ideal flowrate}}$ × 100

= $\frac{8.33 \times 10^{-5} \times 100}{2.83 \times 10^{-4}}$

= 29.45%

b) Fluid power, P_F = Q × Δp
= 8.33 × 10^{-5} × 15 × 10^5
= 124.95 watts

c) Shaft power, T × ω
ω = 2 × π × Speed of rotation
ω = 2 × π × 28.3
ω = 177.81 rad/sec
∴ Shaft power = 15 × 177.81
= 2667.2 watts

d) Overall Efficiency = $\frac{\text{Fluid Power}}{\text{Shaft power}}$ × 100

= $\frac{124.95}{2667.2}$ × 100

= 4.68%