Volumetric Flow = 5 l/min = $8.3333 \times 10^{-5} m^3/s$
Pressure change = 15 bar = $1.5 \times 10^{6} N/m^2$
Speed of rotation = 1700 rev/min = 28.333 rev/s
Nominal displacement = 10 $cm^3$/rev = $1 \times 10^{-5} m^3$/rev
Torque input = 15 Nm

a) Volumetric Eff = $\frac{\text{Actual Flowrate}}{\text{Theoretical Flowrate}} \times \frac{100}{1}$

Theoretical Flowrate = speed of rotation × displacement
$= 28.333 \times 1 \times 10^{-5}$
$= 2.83 \times 10^{-4}$

Volumetric Eff $= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100$
$= 29.45\%$

b) Fluid Power $= Q(P_2 - P_1)$
$= 8.3333 \times 10^{-5} (1.5 \times 10^{6})$
$= 124.95$ watt

c) Shaft Power $= T \times \omega$
$\omega = 2 \times \pi \times$ speed of rotation
$\omega = 2 \times \pi \times 28.3 = 177.81$ rad/sec
Shaft Power $= 15 \times 177.81$
$= 2667.2$ watt

d) Overall Eff $= \frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100 = \frac{124.95}{2667.2} \times 100$

$\Rightarrow 4.68\%$

Question 3

(3) Orifice diameter = 15 cm = 15 × $10^{-2}$ m

Pipe diameter = 30 cm = 3.0 × $10^{-2}$ m

$P_1 - P_2$ = 50 cm Hg = 6666.12 N/m²

S.g of oil = 0.9

$C_d = 0.64$

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

$A_0 = \frac{\pi (15 \times 10^{-2})^2}{4} = 0.0177$ $\quad A_1 = \frac{\pi (30 \times 10^{-2})^2}{4} = 0.0707$

| | |
|---|---|
| $h = \frac{P_1 - P_2}{w}$ | $S.g = \frac{w}{1000 \times 9.81}$ |
| $h = \frac{6666.12}{8829}$ | $0.9 = \frac{w}{1000 \times 9.81}$ |
| $h = 0.755$ | $w = 8829$ |

$$Q = 0.64 \times 0.0177 \times 0.0707 \times \frac{\sqrt{2 \times 9.81 \times 0.755}}{\sqrt{0.0707^2 - 0.0177^2}}$$

$$Q = 0.64 \times 0.0177 \times 0.0707 \times \frac{3.849}{\sqrt{0.0707^2 - 0.0177^2}}$$

$Q = 0.045$

Question 4

4) Difference of mercury level = 170 mm = 0.17 m

S.g of mercury = 13.6

S.g of Sea = 1.026

$$h = x\left[\frac{S.g \text{ of mercury}}{S.g \text{ of Sea}} - 1\right]$$

$$h = 0.17\left[\frac{13.6}{1.026} - 1\right] \quad h = 2.083$$

$V = C_v \times \sqrt{2 \times g \times h}$

$V = 1 \times \sqrt{2 \times 9.81 \times 2.083}$

$V = 6.39$ m/s

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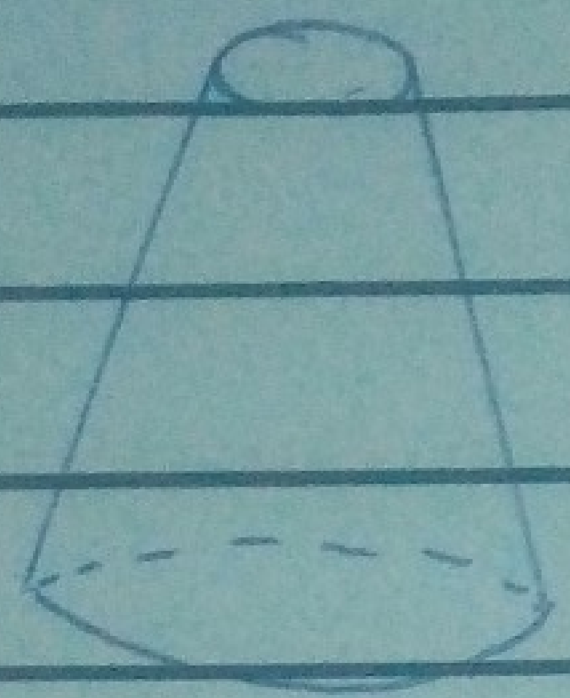
Question (1)

(1)



$V_1 = 5m/s,\ V_2 = 2m/s$

$\frac{P_1}{w} = 2.5m;\ \frac{P_2}{w} = ?$

Using Bernoulli's equation

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

$Z_1 \neq Z_2$

$$2.5 + 2.0 + \frac{5^2}{2 \times 9.81} = \frac{P_2}{w} + 0 + \frac{2^2}{2 \times 9.81}$$

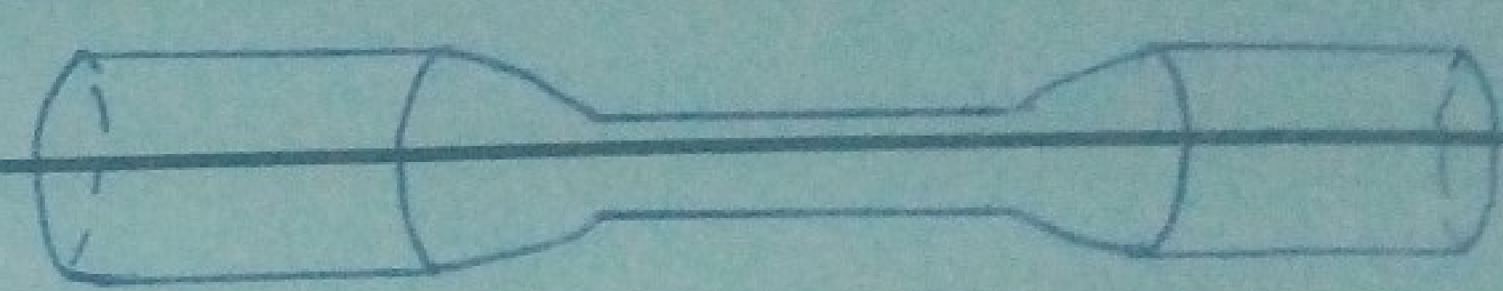
$$2.5 + 2.0 + 1.27 = \frac{P_2}{w} + 0 + 0.20$$

$$5.77A = \frac{P_2}{w} + 0.20$$

$$\frac{P_2}{w} = 5.54m$$

Question 2

2)



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

$d_2 = 10cm = 1 \times 10^{-2} m$

for $P_1 = 17.678 N/cm^2 = 176580 N/m^2$

$P_2 = 30cm\ Hg = 3999.67 N/m^2$

$C_d = 0.98$

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

$$h = \frac{P_1 - P_2}{w} \quad h = \frac{176 5.8 - 3999.67}{1000 \times 9.81}$$

$h = 17.59m$

$A_1 = \frac{\pi (0.2)^2}{4} = 0.0314 m^2$

$A_2 = \frac{\pi (0.1)^2}{4} = 7.854 \times 10^{-3} m^2$

$$Q = \frac{0.98 \times 0.0314 \times 7.854 \times 10^{-3} \sqrt{2 \times 9.81 \times 17.59}}{\sqrt{0.0314^2 - (7.854 \times 10^{-3})^2}}$$

$$Q = \frac{0.98 \times 0.0314 \times 7.854 \times 10^{-3} \times 18.57}{0.03}$$

$Q = 0.1497$

$Q \approx 0.15$