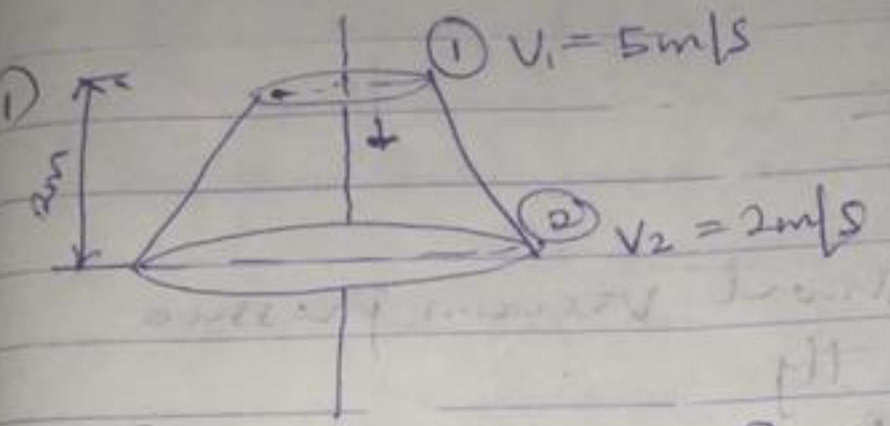
CHIEKE CHUKWUMSO FAITH
18/ENG01/006
AERO/ASTRO ENG
FLUID MECHANICS
ENG 214

1) 

$P_T = \frac{P_1}{W} = 2.5m$

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

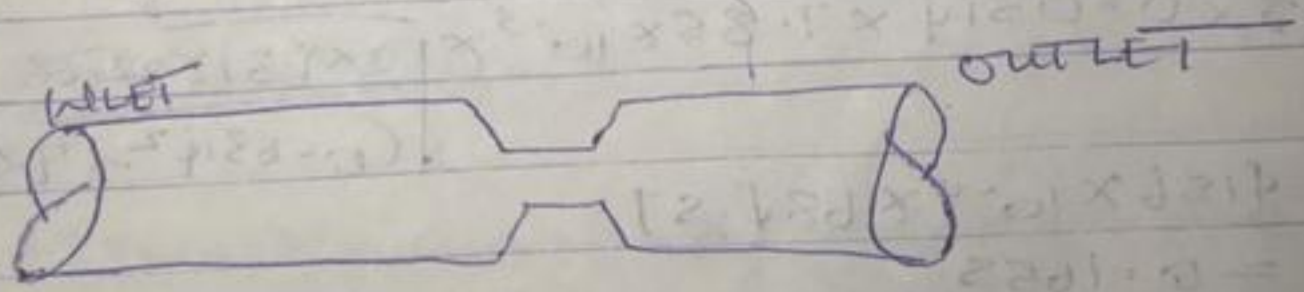
$$\frac{P_1}{W} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{W} + \frac{V_2^2}{2g} + z_2 + H_L$$

$$\frac{P_2}{W} = \frac{P_1}{W} + \frac{V_1^2 - V_2^2}{2g} + (z_1 - z_2) - \frac{0.35(V_1 - V_2)^2}{2g}$$

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

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

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

2) 

INLET; $d_i = 20cm = 20 \times 10^{-2} m$

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

$A_1 = 0.0314 m^2$ THROAT DIAMETER, d $= 10 \times 10^{-2} m$

$P_1 = 17.658 N/cm^2$

$= 17.668 \times 10^4 N/m^2$ $A_2 = \frac{\pi \times (10 \times 10^{-2})^2}{4}$

$Cd = 0.78$ $A_2 = 7.85 \times 10^{-3} m^2$

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

$= 0.3m$ Hg

$= 0.3 \times 13.6 = 4.08$

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

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

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

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

$= 0.78 \times 0.0314 \times 7.85 \times 10^{-3} \times \sqrt{\frac{2 \times 9.81 \times 22.08}{(0.0314^2 - (7.85 \times 10^{-3})^2)}}$

$= 2.4156 \times 10^{-4} \times 684.57$

$= 0.1653$

Q actual $= 0.1653 m^3/s$

5) Orifice meter; Given that

$d_0 = 15cm = 15 \times 10^{-2} m$ Pipe Diameter, $d_p = 30cm = 30 \times 10^{-2} m$

$A_0 = \frac{\pi \times (15 \times 10^{-2})^2}{4}$

~~$A_0 = A$~~
~~$A_0 = \pi \times (0.5 \times$~~

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

$= 0.01767 m^2$ $= 0.07067 m^2$

S.P.G of oil $= 0.9 (S_0)$

Coefficient of discharge $= 0.64$

Reading of differential $= 500 mhg$.

Differential head $h = y\left(\frac{S_{hl}}{S_0} - 1\right)$

$S_{hl} = 13.6$

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

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

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

$= 7.055 m$

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

$= \frac{0.64 \times 0.01767 \times 0.07067 \times \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{(0.07067^2) - (0.01767^2)}}$

$= \frac{7.774 \times 10^{-4} \times 11.765}{\sqrt{4.68 \times 10^{-3}}}$

$= 0.1314 m^3/s$.

f) $y = 170 mm Hg = 0.17 m Hg$, $S.g Hg = 13.6$, $S.g S$
$= 1.026$

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

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

$\Delta h = 2.08 m$

$V = \sqrt{2g\Delta h}$
$V = \sqrt{2 \times 9.81 \times 2.08}$
$V = 6.388\ m/s$

5) $Q = 0.05\ m^3/min = 833 \times 10^{-5}\ m^3/sec$
Speed of Rotation = 1700 Rev/min = 28.3 Rev/s
Nominal Displacement = $10\ cm^3/rev = 10^{-5}\ m^3/rev$
Torque Input = 15 Nm.
Pressure change = 15 bar = $15 \times 10^5\ N/m^2$
- Ideal Flow rate = Nominal displacement × Speed rotation,
$= 10^{-5} \times 28.5 = 2.83 \times 10^{-4}\ m^3/s$

a). Volumetric Efficiency = $\frac{\text{Actual Flowrate} \times 100}{\text{Ideal Flowrate}}$
$= \frac{8.33 \times 10^{-5} \times 100}{2.83 \times 10^{-4}}$
$= 29.45\%$

b) Fluid Power, $P_P = Q \times \Delta p$
$= 8.33 \times 10^{-5} \times 15 \times 10^5$
$= 124.95$ watts

c) Shaft power, $= T \times \omega$
$\omega = 2 \times \pi \times$ Speed of Rotation.
$\omega = 2 \times \pi \times 28.3$
$\omega = 177.81$ rad/sec.
∴ Shaft Power $= 15 \times 177.81$
$= 2667.2$ watts

d) Overall Efficiency = $\frac{\text{Fluid power} \times 100}{\text{Shaft power}}$
$= \frac{124.95}{2667.2} \times 100$
$= 4.68\%$