4 $y = 170 \text{ mmHg} = 0.17 \text{ mHg}$,

$S.g_{Hg} = 13.6$

$S.g_{sw} = 1.026$

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

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

$$\Delta h = 2.08 \text{ m}$$

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

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

$$v = 6.388 \text{ m/s}$$

5 $Q = 0.05 \text{ dm}^3/\text{min} = 8.33 \times 10^{-5} \text{ m}^3/\text{sec}$

Speed of rotation $= 1900$ rev/min $= 28.3$ rev/sec

Nominal Displacement $= 10 \text{ cm}^3/\text{rev} = 10^{-5} \text{ m}^3/\text{rev}$

Torque Input $= 15 \text{ Nm}$

Pressure change $= 15 \text{ bar} = 15 \times 10^5 \text{ N/m}^2$

- Ideal flowrate = Nominal displacement × Speed rotation

$$= 10^{-5} \times 28.3 = 2.83 \times 10^{-4} \text{ m}^3/\text{sec}$$

a Volumetric efficiency $= \frac{\text{actual flowrate}}{\text{Ideal flowrate}} \times 100$

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

$$= 29.45\%$$

b Fluid Power, $P_f = Q \times \Delta P$

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

$$= 124.95 \text{ watts}$$

c Shaft Power $= T \times \omega$

$\omega = 2 \times \pi \times$ Speed of rotation

$\omega = 2 \times \pi \times 28.3$

$= 2667.2$ watts

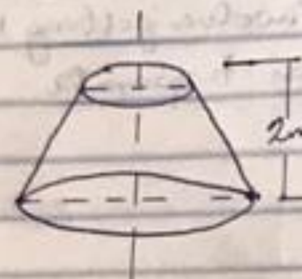
d Overall efficiency $= \frac{\text{fluid Power}}{\text{Shaft power}} \times 100$

$$= \frac{124.95}{2667.2} \times 100$$

$$= 4.68\%$$

Bessey Jg Auétie
chemical Engineering
18/ENG01/004

1) $V_1 = 5m/s$ $\quad \frac{P_1}{w} = 2.5m$



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

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

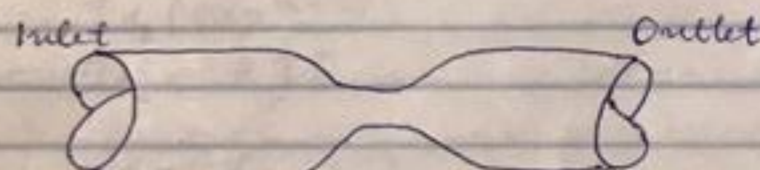
$$\frac{P_2}{w} = \frac{P_1}{w} = \frac{V_1^2 - V_2^2}{2g} + (Z_1 - Z_2) - \frac{0.35(V_1 - V_2)^2}{2g}$$

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

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

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

2



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

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

$A_1 = 0.0314m^2$ $\quad$ Throat Diameter, $d_2 = 10cm = 10 \times 10^{-2}m$

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

$A = \frac{\pi d^2}{4} = \frac{\pi \times (10 \times 10^{-2})^2}{4}$ $\quad C_d = 0.98$

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

To get h;

$\frac{P_1}{w} - \frac{P_2}{w} = h$ $\quad P_1 = 17.668 \times 10^4 N/m^2$
$w = 9.81 \times 10^3 N/m^3$

But we have throat vacuum pressure = 30cm of Hg
$= 0.3m Hg$

$= 0.3 \times 13.6 = 4.08$ $\quad \frac{P_2}{w} = -4.08$ (Since vac Pressure)

$$\frac{P_1}{w} = \frac{17.668 \times 10^4}{9.81 \times 10^3} = 18$$

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

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

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

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

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

3 Orifice meter given that
$d_o = 15cm = 15 \times 10^{-2}m$ $\quad$ Pipe Diameter d_p = ~~30cm~~ 30 cm = $30 \times 10^{-2}m$

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

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

S.P.G of Oil = 0.9(S_o)
Coefficient of discharge = 0.64
Reading of differential = 50cmHg
Differential head $h = y\left[\frac{S_h}{S_o} - 1\right]$

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

$h = 50 \times 10^{-2} \times 14.11$
$= 7.055m$

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

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

$$= \frac{7.994 \times 10^{-4} \times 11.765}{\sqrt{4.68 \times 10^{-3}}} = 0.1374 m^3/s$$