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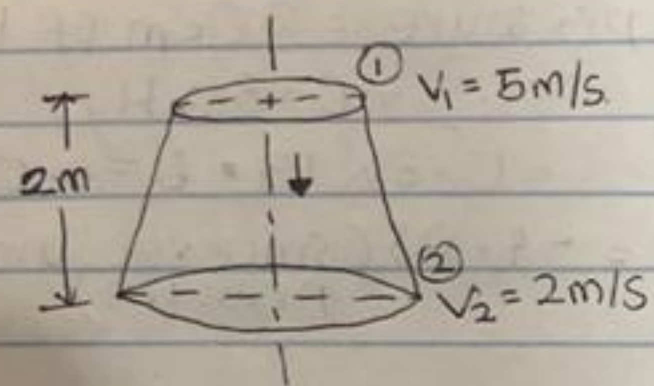
CHEMICAL ENGINEERING
18/ENG01/016.
FLUID MECHANICS.
ENG 214.

1.)




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

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

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

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

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

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

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

2.)


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

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

$A_1 = 0.0314m^2$

$P_1 = 17.668 N/cm^2$

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

$Cd = 0.98$

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

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

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

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

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

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

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

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

$= 0.1653$

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

3.) Orificemeter; Given that

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

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

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

S.P.G of Oil $= 0.9\ (S_o)$

coefficient of discharge $= 0.64$.

Reading of differential $= 50cm\ hg$.

Differential head $h_1 = y\left[\frac{5hL}{50} - 1\right]$

$5hL = 13.6$

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

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

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

$= 7.055\,m$

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

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

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

$= 0.1374\,m^3/s$

4.) $y = 170\,mmHg = 0.17\,mHg$, $S.g_{Hg} = 13.6$, $S.g_{sw} = 1.026$

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

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

$\Delta h = 2.08\,m$

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

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

$V = 6.388\,m/s$

5.) $Q = 0.05\,dm^3/mm = 8.33 \times 10^{-5}\,m^3/sec$

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 $= 15\,bar = 15 \times 10^5\,N/m^2$

- Ideal Flowrate = Nominal displacement × Speed Rotation,

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

a.) Volumetric Efficiency = $\frac{\text{Actual Flowrate}}{\text{Ideal Flowrate}} \times 100$

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

$\simeq 29.45\%$

b) Fluid Power, $P_F = Q \times \Delta P$

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

$= 124.95$ Watts

c) Shaft Power, $= \tau \times \omega$

$\omega = 2 \times \pi \times$ speed of Rotation.

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

$\omega = 177.81$ rad/sec.

$\therefore$ Shaftpower $= 15 \times 177.81$

$= 2667.2$ Watts

d.) Overall Efficiency $= \frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100$.

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

$= 4.68\%$.