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CHEMICAL ~~CIVIL~~ ENGINEERING

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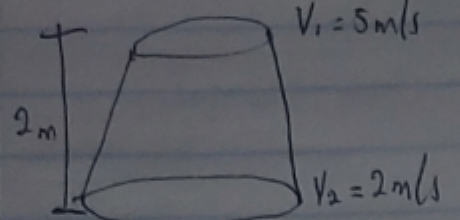


$P_1/w = P_1/w = 2.5m$

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

Using Bernoulli's equation $P_2/w = ?$

$P_1/w + V_1^2/2g + Z_1 = P_2/w + V_2^2/2g + Z_2 + H_L$

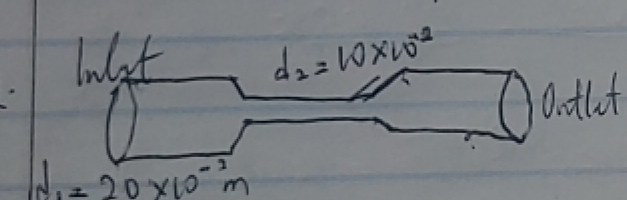
$P_2/w = P_1/w + \left[\frac{V_1^2 - V_2^2}{2g}\right] + [Z_1 - Z_2] - H_L$

$P_2/w = 2.5 + \left[\frac{5^2 - 2^2}{2 \times 9.81}\right] + 2 - \frac{0.35(5-2)^2}{2 \times 9.81}$

$P_2/w = 2.5 + 1.07 + 2 - 0.161$

$P_2/w = 5.409m$ The pressure head at the lower end

2.



$P_1 = 17.658 N/cm^2 = 17.658 \times 10^4 N/m^2$, $Cd = 0.98$

$P_2 = 30 cm Hg = 30 \times 10^{-2} m Hg$, $Q = ?$

$A_1 = \frac{\pi \times (20 \times 10^{-2})^2}{4}$ $A_2 = \frac{\pi \times (10 \times 10^{-2})^2}{4}$

$= 0.03m^2$ $= 7.85 \times 10^{-3} m^2$

$\frac{P_2}{w} = 0.3 \times 13.6 = -4.08 m Hg$

$\frac{P_1}{w} = 17.058 \times 10^4 / 9.81 \times 10^3 = 18$

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

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

$= \frac{0.98 \times 0.03 \times (7.85 \times 10^{-3}) \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(0.03)^2 - (7.85 \times 10^{-3})^2}}$

$Q = 0.166 m^3/s$

3) $d_2 = 15 \times 10^{-2} m$, $y = 50 \times 10^{-2} m Hg$

$d_1 = 30 \times 10^{-2} m$, $Cd = 0.64$

$S_{m} = 13.6$, $S_o = 0.9$, $Q = ?$

$A_1 = \frac{\pi \times (30 \times 10^{-2})^2}{4} = 0.0707m^2$

$A_2 = \frac{\pi \times (15 \times 10^{-2})^2}{4} = 0.01767m^2$

$H = y\left[\frac{S_m}{S_o} - 1\right]$

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

$H = 7.055m$

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

$= \frac{0.64 \times 0.0176 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.055}}{0.0707^2 - 0.0176^2}$

$Q = 0.137 m^3/s$

4) $y = 170 mm hg = 170 \times 10^{-3} m hg$

Sg of mercury $= 13.6 hg$

Sg of sea water $= 1.026$

$V = \sqrt{2gH}$

$H = y \times \frac{S_m}{S_o} - 1$

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

$V = 6.39 m/s$

$H = y \times \left[\frac{S_m}{S_o} - 1\right]$

$= 170 \times 10^{-3} \times \left[\frac{13.6}{1.026} - 1\right]$

$H = 2.08m$

$T = 15 Nm$
Volumetric Effi...
Actual flowrate / Ideal flowrate
$Q = 1 \times 10^{-5}$
$= 2.833$
Volumetric Eff...
fluid power
$= 8.33$
Shaft power
$w = 2\pi$
$= 7$
Overall
fluid / shaft
$= 12$ / 26

5 Actual flowrate $Q = 5\,dm^3/min = 8.33 \times 10^{-5}\,m^3/sec$

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

$V = 1700\,rev/min = 28.33\,rev/sec$

$T = 15\,Nm$ Nominal displacement $= 10\,cm^3/rev = 1 \times 10^{-5}\,m^3/rev$

Volumetric Efficiency

$\frac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100\%$ Ideal flowrate = Displacement × Speed

$Q = 1 \times 10^{-5} \times 28.33$

$= 2.833 \times 10^{-4}\,m^2/sec$

Volumetric Efficiency $= \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100 = 29.4\%$

fluid power $(Q \times \Delta P)$

$= 8.33 \times 10^{-5} \times 15 \times 10^5 = 124.95$ watts

Shaft power $= T \times \omega$

$\omega = 2 \times \pi \times V = 2 \times \pi \times 28.33 = 178\,rad/sec$

$= T \times \omega = 15 \times 178 = 2670$ watts

Overall Efficiency

$\frac{\text{fluid power}}{\text{shaft power}} \times 100\%$

$= \frac{124.95}{2670} \times 100 = 4.68\%$