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Computer Engineering

1.) Length, $L = 2.0m$
$V_1 = 5m/s$
$V_2 = 2m/s$
Let the pressure head at the smaller end $= P_s = 2.5m$ of liquid
Let the loss of head $= H_L = \frac{0.35(V_1 - V_2)^2}{2g}$
$= \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$
Let the pressure head ~~$= H_2 = 0.3$~~ at the lower end $= P_L = ?$
Bernoulli's Equation
$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + H$
where $P_s = P_1/\rho g$ and $P_L = P_2/\rho g$
$Z_1 = 2.0$ and $Z_2 = 0$
Substituting values in eqn
$2.5 + 5^2/2 \times 9.81 + 2.0 = P_L + 2^2/2g \times 9.81 + 0.16$
$2.5 + \frac{25}{19.62} + 2 - \left(\frac{4}{19.62} + 0.161\right) = P_L$
$5.774 - 0.365 = P_L$
$P_L = 5.409m$ of fluid

2.) $D_1 = 20cm$, $D_2 = 10cm$
$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi (20)^2}{4} = 314.16cm^2$
Let throat area $= A_2 = \frac{\pi D_2^2}{4} = \frac{\pi (10)^2}{4} = 78.54cm^2$
Pressure at inlet $= 17.658N/cm^2 = 17.658 \times 10^4 N/m^2$
$\therefore \frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{1000 \times 9.81} = 18m$
$\frac{P_2}{\rho g} = 30cm$ of Mercury, $S.g\,Hg = 13.6$
$\therefore \frac{P_2}{\rho g} = -30 \times 10^{-2}m$ of Mercury $\times 13.6$
$= -4.08m$
Let Differential Head $= H = \frac{P_1}{\rho g} - \frac{P_2}{\rho g}$
$= 18 - (-4.08)$
$= 18 + 4.08 = 22.08m \times 100$
$H = 2208cm$
Using $Q = \frac{C_d \sqrt{2gh} \cdot A_1 A_2}{\sqrt{A_1^2 - A_2^2}}$
$= \frac{0.98 \times \sqrt{2 \times 981 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$
$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.184112}$
$= 165455.3cm^3/s$
$= \frac{165455.3}{1000} = 165.455\,lit/sec$

3.) Diameter of pipe $d_1 = 30cm$
$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 1706.86cm^2$

Diameter of Orifice, $d_2 = 15cm$
$A_2 = \pi d_2^2/4 = \pi (15)^2/4 = 176.72cm$
Specific gravity of oil, $S_o = 0.9$
Specific gravity of mercury $= 13.6$
Differential Manometer reading, $x = 50cm$ of mercury
Coefficient of discharge, $C_d = 0.64$
Differential head, $h = x\left(\frac{S_{Hg}}{S_o} - 1\right)$
$h = 50\left(\frac{13.6}{0.9} - 1\right)$
$h = 705.56cm$ of oil
$\therefore$ Rate of flow of oil is
$Q = \frac{C_d \sqrt{2gh} \cdot A_1 \cdot A_2}{\sqrt{A_1^2 - A_2^2}}$
$Q = 0.64 \times \frac{\sqrt{2 \times 981 \times 705.56} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (176.72)}}$
$Q = 137443.29cm^3/s$
$Q = \frac{137443.29}{1000} = 137.44\,lit/s$

4. The difference of Mercury level, $x = 170mm = 170 \times 10^{-3} = 0.17m$
The specific gravity of mercury, $S_g = 13.6$
The specific gravity of sea water, $S_o = 1.026$

$h = x\left[\frac{S_g}{S_o} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834m$
$\because V = \sqrt{2gh}$
$\therefore \sqrt{2 \times 9.81 \times 2.0834} = 6.393m/s$
In Km/hr
$V = \frac{6.393 \times 60^2}{1000} = 23.01km/hr$

5.) $Q = 0.05m^3/min = 50dm^3/min$
$P_o = 15bar = 15 \times 100000 = 15 \times 10^5 N/m^2$
Speed $= 1700rev/min$
$T = 15Nm$, $NO = 10cm^3/rev$
(i) Volumetric Efficiency $= \frac{\text{Actual flow rate}}{\text{Ideal flow Rate}}$
Ideal Flow Rate = Normal Flow Rate × Speed
$= 10cm^3/rev \times 1700rev/min$
$= 17000cm^3/min$
Ideal Flow Rate $= \frac{17000}{1000000} = 0.017m^3/min$
Actual Flow rate $= 0.05m^3/min$
$\therefore$ Volumetric Efficiency $= 0.05/0.017 = 2.94\% = 294\%$
ii.) Fluid Power $= P \times Q$
$P = 15 \times 10^5 N/m^2$
$Q = 0.05m^3/min = 0.05/60 = 8.33 \times 10^{-4}m^3/s$

Fluid Power $= 15 \times 10^5 \times 8.33 \times 10^{-4}$
$= 15 \times 10^5 \times 83.3 \times 10^{-5}$
$= 1249.5 \times 10^{5-5}$
Fluid Power $= 1249.5$ watts
iii.) Shaft Power $= 2\pi NT = \frac{2\pi \times 1700 \times 15}{60}$
Shaft Power $= 2670.35$ watts
iv.) Overall Efficiency $= \frac{\text{Fluid Power}}{\text{Shaft Power}}$
$= \frac{1249.5}{2670.35} = 0.468$
Overall Efficiency $= 0.468 \times 100 = 46.8\%$