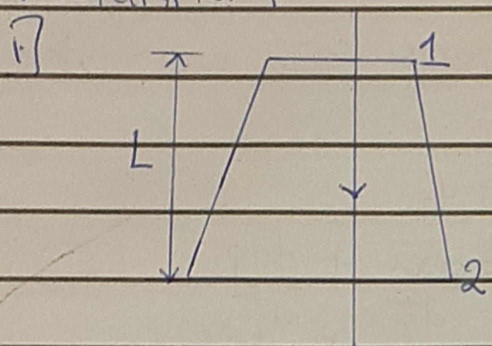
RAJI UMMI-SALMA ONIZE

18/ENG08/020

BIOMEDICAL ENGINEERING

ASSIGNMENT

1]



~~Length, L = 0.2m~~

Length, $L = 2.0m$

$V_1 = 5m/s$, $V_2 = 2m/s$

Pressure head at the smaller end

$P_s = 2.5m$ of liquid

Loss of head, $H_2 = \frac{0.35(V_1 - V_2)^2}{2g}$

$\frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$

Pressure head at the lower end, $P_2 = ?$

Applying Bernoulli's equation

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

$P_s = \frac{P_1}{\rho g}$ & $P_L = \frac{P_2}{\rho g}$

$Z_1 = 2.0$ & $Z_2 = 0$

Putting values into the equation

$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = P_L + \frac{2^2}{2 \times 9.81} + 0 + 0.161$

$2.5 + \frac{25}{19.62} + 2 - \left(\frac{4}{19.62} + 0.161\right) = P_L$

$5.774 - 0.365 = P_L$

$P_L = 5.409m$

2] $D_1 = 20cm$, $D_2 = 10cm$

$A_1 = \frac{\pi D_1^2}{4} = \frac{\pi (20)^2}{4}$

$= 314.28 cm^2$

$A_2 = \frac{\pi D_2^2}{4} = 78.55 cm^2$

$\rho = 1000 kg/m^3$

Pressure at inlet, P_1

$= 17.658 N/cm^2 = 17.658 \times 10^4 N/m^2$

$\frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{1000 \times 9.81} = 18m$

$\frac{P_2}{\rho g} = -30cm$ of mercury

S.g Hg = 13.6

$\frac{P_2}{\rho g} = -30 \times 10^{-2} m$ of mercury $\times 13.6$

$= -4.08m$

Differential head, $H_d = \frac{P_1}{\rho g} - \frac{P_2}{\rho g}$

$= 18 - (-4.08)$

$18 + 4.08 = 22.08m \times 100$

$H_d = 2208 cm$

Using $Q = \frac{C_d \sqrt{2gh} \cdot A_1 A_2}{\sqrt{A_1^2 - A_2^2}}$

$= \frac{0.98 \times \sqrt{2 \times 9.81 \times 2208} \times 314.2 \times 78.55}{\sqrt{(314.2)^2 - (78.55)^2}}$

$= \frac{0.98 \times 2081.37 \times 24680.41}{304.2228418}$

$= 165476.3441 \, cm^2/s$

$= \frac{165476.3441}{1000} = 165.476$ lit/sec

3] $d_1 = 30cm$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 706.95 cm^2$

$d_2 = 15cm$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (15)^2}{4} = 176.73 cm^2$

S.g of oil = 0.9, S.g of mecury = 13.6

$C_d = 0.64$, differential manometer reading, $X = 50cm$ of mecury

Differential head, $h = x\left(\frac{S_m}{S_o} - 1\right)$

$h = 50\left(\frac{13.6}{0.9} - 1\right)$

$h = 705.56cm$

$Q = \frac{C_d \sqrt{2gh} \, A_1 \cdot A_2}{\sqrt{A_1^2 - A_2^2}}$

$Q = \frac{0.64 \times \sqrt{2 \times 9.81 \times 705.56} \times 706.95 \times 176.73}{\sqrt{(706.95)^2 - (176.73)^2}}$

$Q = 13744.21 \, cm^3/s$

$Q = \frac{13744.21}{1000} = 13.744$ lit/s

4.) Difference of mercury, $x = 170mm = 170 \times 10^{-3} = 0.17m$

S.g of mercury, $S_g = 13.6$

S.g of sea water, $S_o = 1.026$

Speed, $v = ?$

$v = \sqrt{2gh}$, $h = ?$

$h = x\left[\frac{S_g}{S_o} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$

$= 2.0834m$

$V = \sqrt{2 \times 9.81 \times 2.0834} = 6.393 m/s$

$V = \frac{6.393 \times 60^2}{1000} = 23.01 km/hr$

5.) $Q = 0.05 m^3/min = 50 dm^3/min$

$P_o = 15 bar = 15 \times 100000 = 15 \times 10^5 N/m^2$

Speed = 1700 rev/min, ND = $10 cm^3/rev$

T = 15 Nm,

i.) Volumetric Efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$

Ideal flow rate = Nominal flow rate × speed

$= 10 cm^3/rev \times 1700 rev/min$

$= 17000 cm^3/min$

$= 0.017 m^3/min$

Actual flow rate $= 0.05 m^3/min$

Volumetric Efficiency $= \frac{0.05}{0.017} = 2.94\%$ #

ii) Fluid power = P × Q

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

$Q = 0.05 m^3/min = \frac{0.05}{60} = 8.33 \times 10^{-4} m^3/s$

Fluid power $= 15 \times 10^5 \times 8.33 \times 10^{-4}$

$= 1249.5$ watts

iii.) Shaft power $= \frac{2\pi N T}{60} = \frac{2\pi \times 1700 \times 15}{60}$

$= 2670.35$ watts

iv.) Overall Efficiency $= \frac{\text{Fluid Power}}{\text{Shaft Power}}$

$= \frac{1249.5}{2670.35} = 0.468$

Overall Efficiency $= 0.468 \times 100$

$= 46.8\%$