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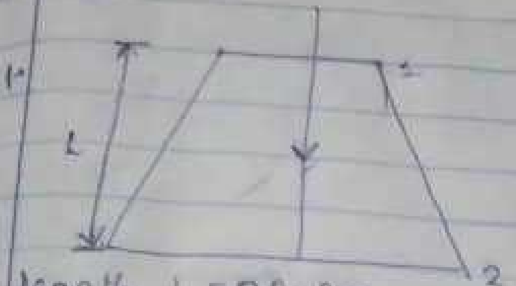
18/ENG02/072
Fluid mechanics - ENG 224
Computer Engineering



length, L = 02.0m
$V_1 = 5m/s$, $V_2 = 2m/s$
Pressure head at the smaller end, Ps = 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 head, P_L = ?
Using Bernoullis equation;

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

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

$Z_1 = 2.0$, $Z_2 = 0$
Substituting the values;

$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = P_L + \frac{2^2}{2 \times 9.81} + 0.0161$

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

$5.774 - 0.365 = P_L$
$P_L = 5.409m$

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

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

$= 314.2cm^2$

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

$\rho = 1000 kg/m^3$
Pressure at inlet, $P_1 = 17.658 N/cm^2$
$= 17.658 \times 10^4 Nm^2$

$\frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{1000 \times 981} = 18m$

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

sg Hg = 13.6

$\frac{P_2}{\rho g} = -30 \times 10^{-2}$m of Hg $\times 13.6$
$= -4.08m$

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

$= 18 - (-4.08)$
$18 + 4.08 = 22.08m \times 100$
$H_d = 2208cm$

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

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

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

$= 165.476$ litre/sec

3. $D_1 = 30cm$, $A_1 = \frac{\pi d^2}{4} = 706.95cm^2$

$D_2 = 15cm$, $A_2 = \frac{\pi d^2}{4} = 176.73cm^2$

S.G of oil = 0.9, S.G of mercury = 13.6

Cd = 0.64.

Differential manometer reading, x = 50cm of mercury

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

$h = 705.56cm$

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

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

$Q = 13744.21 cm^3/s$

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

4. Difference of mercury x = 170mm = 0.17m

S.G of mercury, SG = 13.6

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

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

$P_1 = 5bar = 15 \times 10^5$ [illegible] $= 15 \times 10^5 N/m^2$

Speed = 1700rev/min, ND = [illegible]

T = 15Nm

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

Ideal flow rate = Nominal flow rate × speed

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

$= 0.017 m^3/min$

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

Volumetric efficiency = $\frac{0.05}{0.017}$ = [illegible]

ii) Fluid power = P × Q

$P = 15 \times 10^5 N/m^2$, $Q = 0.05m^3/min$

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

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

$= 1249.5 Watts$

iii) Shaft power $= \frac{2\pi N T}{60}$ = [illegible]

$= 2670.35W$

iv) Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft power}}$

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

Overall efficiency = 0.468 × 100

= 46.8%