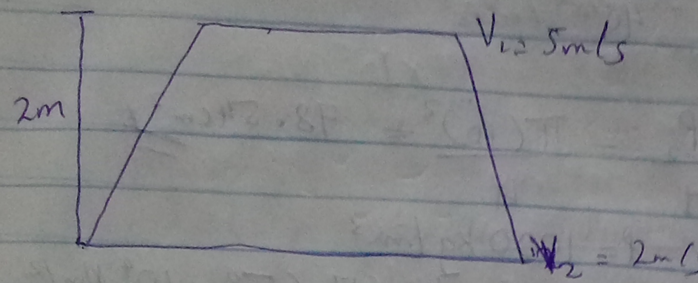
Oreoluwa Ayodele Anointed
18/ENG03/052
ENG214 FLUID MECHANICS

1)



L = 20m
P_1 = 2.5m of Liquid
$P_T = P_1/w$ = 2.5m

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

Using bernoulli's equation $\frac{P_1}{w} = ?$

$$\frac{P_1}{w} + \frac{V^2}{2g} + z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + z_2 + H_L$$

$$\frac{P_2}{w} = \frac{P_1}{w} + \left[\frac{V_1^2 - V_2^2}{2g}\right] + [z_1 - z_2] - H_L$$

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

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

$\frac{P_2}{w}$ = 5.409m ∴ Pressure head at the lower = 5.409m

2) P_1 = 20cm
P_2 = 10cm
Inlet $A_1 = \frac{\pi D_1^2}{4}$

2) $D_1 = 20cm$

$D_2 = 10cm$

Inlet $A_1 = \frac{\pi D_1^2}{4} = \frac{\pi (20)^2}{40} = 314.16 cm^2$

~~Throat~~

Outer Area $= A_2 = \frac{\pi D_2}{4} = \frac{\pi (10)^2}{4} = 78.54 cm^2$

Density of Water, $\rho = 1000 kg/m^3$

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

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

$\frac{P_2}{\rho g} = -30cm$ of meaury, $Sg_{Hg} = 13.6$

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

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

$= \frac{0.98 \times \sqrt{2 \times 9.81 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$

$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.184112}$

$= 165455.3 cm^3/s$

$= \frac{165455.3}{1000} = 165.455 L/s$

4) D

2020.05.28 20:46

3) $A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 706.86 cm^2$

Diameter of orifice, $d_2 = 15cm$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (15)^2}{4} = 176.72 cm$

Specific gravity of oil, $S = 0.9$

Specific gravity of mecury, $S_{mg} = 13.6$

Differential of manometer reading, $x = 50cm$ of mecury

Coefficient of discharge, $C_d = 0.64$

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

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

$h = 705.56cm$ of oil

∴ The rate of flow of oil

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

$$Q = \frac{0.64 \times \sqrt{2 \times 981 \times 7056} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (176.72)}}$$

$Q = 137443.29 \ cm^3/s$

$Q = \frac{137443.29}{1000} = 137.4 \ L/s$

4) Differential of mecury, $x = 170mm = 170 \times 10^{-3} = 0.17m$

Specific gravity of mecury $= S_{mg} = 13.6$

S.g of Sea water, $S_w = 1.626$

Speed $V = ?$

$V = \sqrt{2gh}$

$h = x\left[\frac{S_{mg}}{S_w} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834mm$

∴ $V = \sqrt{2 \times 9.81 \times 2.0834} = 6.393$

In Km/hr

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

5) Q = 0.05 m³/min = 50 dm³/min

P_2 = 15 bar = 15 × 100000 = 15 × 10⁵ N/m²

speed = 1700 rev/min

T = 15 Nm, ND = 10 cm³/rev

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

Ideal Flow rate = Nominal Flow rate × speed

= 10 cm³/rev × 17000 rev/min

= 17000 cm³/min

Ideal Flow rate = $\frac{17000}{1000000}$ = 0.017 m³/min

Actual Flow rate = 0.05 m³/min

∴ Volumetric Efficiency = $\frac{0.05}{0.017}$ = 2.94% = 294%

ii) Fluid Power = P × Q

P = 15 × 10⁵ N/m²

Q = 0.05 m³/min = $\frac{0.05}{60}$ = 8.33 × 10⁻⁴ m/s

Fluid Power = 15 × 10⁵ + 8.33

= 15 × 10⁵ × 83.3 × 10⁻⁵

= 1249.5 × 10⁻⁵ = 1249.5 watts

iii) Shaft Power = $2 \times \pi \times \frac{T}{60}$

$= \frac{2 \times \pi \times 700 \times 15}{60}$ = 2670.35 watts

iv) Overall Efficiency = $\frac{\text{Fluid Power}}{\text{Shaft Power}} = \frac{1249.5}{2670.35}$ = 0.468

O.E = 0.468 × 100 = 46.8 %

2020.05.28 20:46