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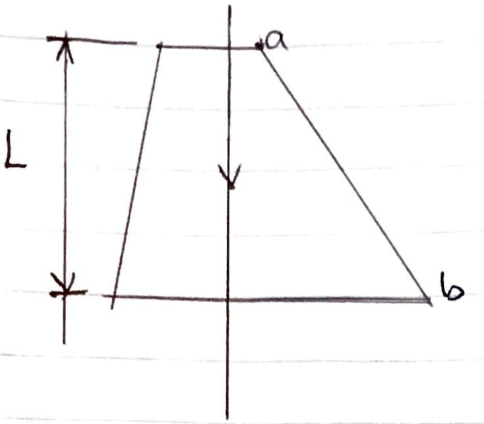
Computer Engineering
18/ENG02/006
ENG214 Fluid mechanics Assignment.

1.



length, L = 2.0m

The velocity flow at smaller end = V_1 = 5m/s

Velocity flow at lower end = V_2 = 2m/s

Let the pressure head at the smaller end = P_s = 2.5m of liquid

Let the loss of head = $H_2 = \frac{0.35(V1-V2)^2}{2g}$

$$= \frac{0.35(5-2)^2}{2\times9.81} = \underline{0.161m}$$

Let the pressure head at the lower end = P_L = ?

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

$z_1 = 2.0$ and $z_2 = 0$

$$2.5 + \frac{5^2}{2\times9.81} + 2.0 = P_L + \frac{2^2}{2\times9.81} + 0 + 0.161$$

$$2.5 + \frac{25}{19.62} + 2 = P_L + \frac{4}{19.62} + 0.161$$

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

$5.774 - 0.365 = P_L$

$P_L = 5.409$m of fluid.

2. Let Inlet diameter = $D_1 = 20$cm

Let throat diameter = $D_2 = 10$cm

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

Let throat area = $A_2 = \frac{\pi D_2^2}{4} = \frac{\pi (10)^2}{4} = 78.54$ cm^2

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

Pressure at inlet = 17.658 N/cm^2 = 17.658×10^4 N/m^2

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

$\frac{P_2}{\rho g} = 30$cm of mercury, $S.g_{Hg} = 13.6$

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

Let differential head $= \frac{P_1}{\rho g} - \frac{P_2}{\rho g}$

$$= 18 - (-4.08)$$
$$= 18 + 4.08 = 22.08\text{m} \times 100$$
$$H = 2208\text{ cm.}$$

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

$$= \frac{0.98 \times \sqrt{2 \times 981 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$$

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

$= 165455.3$ cm^3/s

$= \frac{165455.3}{1000} = 165.455$ lit/sec

3. Diameter of pipe = 30cm

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

Diameter of orifice, d_2 = 15cm

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

Specific gravity of oil, $S_0 = 0.9$

Specific gravity of mercury, $S_{hg} = 13.6$

Differential manometer reading, x = 50cm of mercury

Coefficient of discharge, $C_d = 0.64$

Differential head, $h = x\left(\frac{S_{hg}}{S_0} - 1\right)$

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

h = 705.56 cm of oil

∴ The rate of flow of oil is

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

$$Q = 0.64 \times \frac{\sqrt{2 \times 981 \times 705.56} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (1.76.72)}}$$

$Q = 137443.29 \text{ cm}^3/\text{s}$

$Q = 137443.29 \text{ cm}^2/\text{s}$

$Q = \frac{137443.29}{1000} = 137.44$ lit/s.

4) The difference of mercury load, x = 170mm = 170×10^{-3} = 0.17m

The specific gravity of mercury, Sg = 13.6

The specific gravity of sea water, $S_0 = 1.026$

The speed, V = ?

$$V = \sqrt{2gh}$$

$$h = x\left[\frac{Sg}{S_0} - 1\right] = 0.17\left[\frac{13.6}{1.020} - 1\right] = 20834 \text{ m}$$

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

In km/hr $\quad V = \frac{6.393 \times 60^2}{1000} = 23.01\,Km/hr.$

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

$P_0 = 15\,bar = 15 \times 100000 = 15\times10^5\,N/m^2$

Speed $= 1700\,rev/min$

$T = 15\,Nm,\ ND = 10\,cm^3/rev$

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

Ideal flow rate = Nominal flow rate × speed.

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

$= 17000\,cm^3/min$

Ideal flow rate $= \frac{17000}{1000000} = 0.017\,m^3/min$

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

$\therefore$ Volumetric efficiency $= \frac{0.05}{0.017} = 2.94\% = 294\%$

ii) fluid power $= P \times Q$

$P = 15\times10^5\,N/m^2$

$Q = 0.05\,m^3/min = \frac{0.05}{60} = 8.33\times10^{-4}\,m/s.$

fluid Power $= 15\times10^5 \times 8.33\times10^{-4}$

$= 15\times10^5 \times 83.3\times10^{-5}$

$= 1249.5 \times \cancel{10}^{5-5}$

fluid Power = 1249.5 watts

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

Shaft Power = 2670.35 watts

$$\text{Overall efficiency} = \frac{\text{fluid Power}}{\text{Shaft Power}}$$

$$\frac{\text{fluid Power}}{\text{Shaft Power}} = \frac{1249.5}{2670.35} = 0.468$$

$$\text{Overall efficiency} = 0.468 \times 100 = 46.8\%$$