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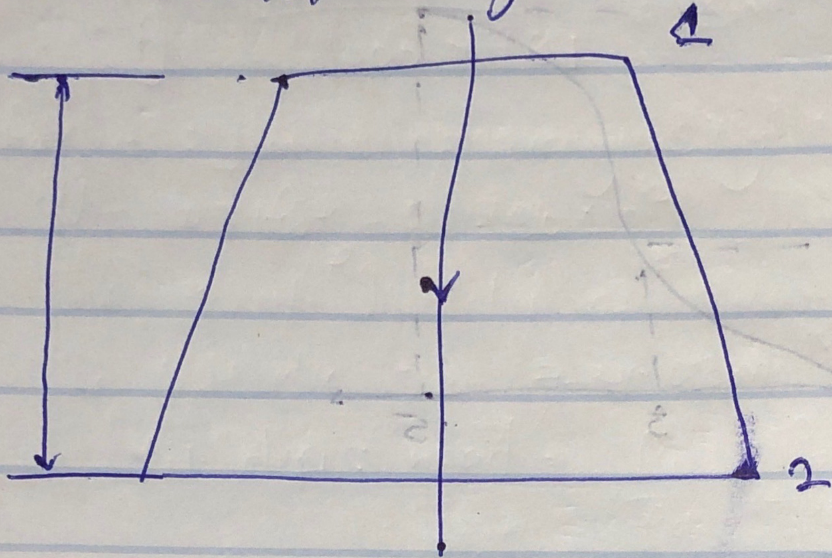
18/ENG04/061
Elect/Elect Engr.

Q1



length, L = 2.0m

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

The velocity " " " " V_2 = 2m/s

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

Let the loss of head = $H_L = \frac{0.35(V_1 - V_2)}{2g}$

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

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

Applying Bernoullis Eq

$$P_1/\rho g + V_1^2/2g + z_1 = P_2/\rho g + V_2^2/2g + Z_2 + H$$

where $P_s = P_1/\rho g$ and $P_L = P_2/\rho g$

$= z_1 = 2.0$ and $z_2 = 0$

Inputting values into the eq

$$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = P_L + \frac{2^2}{2 \times 9.81} + 0 + 0.16$$

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

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

$$5.774 - 0.365 = P_L$$

$P_L = 5.409$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

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 of Inlet = 17.658 N/cm² = 17.658 × 10⁴ N/m

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

$P_2/\rho g$ = -30cm of mercury s.Hg = 13.6

$P_2/\rho g$ = -30 × 10⁻² m of mercury × 13.6

= -4.08 m

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

= 18 - (-4.08)

= 18 + 4.08 = 22.08 m × 100

H = 2208 cm

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

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

$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.184}$

Q = 165455.3 cm³/s

Q = 165455.3 / 1000 = 165.455

(3) Diameter of Pipe = 30 cm

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

Diameter of Orifice, d_2 = 15cm

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

Specific gravity of oil, So = 0.9
Specific gravity of mercury Sng = 13.6
Diff. manometer reading = 50 cm of mercury
Co efficient of dischage, cd = 0.64
diff - head $h = x\left(\frac{Sng}{So} - 1\right)$

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

h = 705.56 cm of oil

The ratio of flow of oil

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

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

Q = 137443.29 cm^3/s

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

(4) The difference of mercury load $x = 170mm$
$= 170 \times 10^{-3} = 0.17m$
the specific gravity of mercury $S_g = 13.6$
The specific gravity of sea water, $S_0 = 1.026$
The speed $v = ?$

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

$$h = x\left[\frac{S_g}{S_0} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$$

$= 2.0834m$

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

In km/hr

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

(5) $Q = 0.05m^3/min = 50dm^3/min$
$P_0 = 15bar = 15 \times 100,000 = 15 \times 10^5 N/m^2$
Speed $= 1700\ rev/min$
$T = 15Nm$, $v_0 = 10cm/rev$

i Volumetric Efficiency $= \dfrac{\text{Actual flow rate}}{\text{Ideal flow rate}}$

Ideal flow rate = Nominal flow rate x Speed
= 10cm/rev x 1700 rev/min
= 17000 cm^3/mm

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

Actual flow rate = 0.05 m^3/mm

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

..ii) Fluid Power = P x Q

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

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

Fluid Power $= 15 \times 10^5 \times 8.33 \times 10^{-4}$
$= 15 \times 10^5 \times 83.38 \times 10^{-5}$
$= 12495 \times 10^{5-5}$

Fluid Power = 1249.5 watts

III Shaft Power $= \frac{2\pi NT}{60} = 2\pi \times 1700 \times 15$

Shaft Power = 2670.35 watts

v) Overshaft Efficiency = $\frac{\text{Fluid Power}}{\text{Shaft Power}}$

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

Overshaft Efficiency = 0.468 × 100
= 46.8 %