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Question 5.

Given

Rate of delive by pump $(Q_d) = 0.05 m^3/min$

Pressure change $(\Delta P) = 15$ bar $= 1500$ kpa

Speed of Rotation $(N) = 1700$ Rpm

Normal displacement $V_n = 10 cm^3/rev$

Normal displacement Rate

$Q_n = 10 \times N \times (10^{-2})^3 \; m^3/min$

$Q_n = 10^{-5} \times 1700 = 0.017 \; m^3/min$

(a) Volumetric efficiency : $\eta_V = \frac{Qd}{Qn}$

$= \frac{0.05}{0.017} = 2.941$

$\eta_V = 294.11\%$

(b) $\frac{\text{Fluid Power}}{\text{water or power}}$ = power $= \rho g Q H$

$\Delta P = \rho g H$

$\therefore$ power $= \Delta P \times q$

$P = 15 \times 10^2 \times \left(\frac{0.05}{60}\right) = 1.25 \, kW$

$P = 1250 \, W$

(c) shaft power : $P_s = T \times W = T \times \frac{2 \pi N}{60}$

$P_s = \frac{15 \times 2\pi \times 170}{60} = 2670.353 \, W$

(d) Overall efficiency : % $\frac{W.P}{S.P} = \frac{1250}{2690.353}$

$\eta_o = 0.4681 = 46.81\%$

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Question 14

Solution.

Given:

Diff. of mercury level $x = 170mm = 0.17m$

Sp. gr. of mercury $S_g = 13.6$

Sp. gr. of sea-water, $S_o = 1.026$

$$h = x\left[\frac{S_g}{S_o} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834m$$

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

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

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Question 3.

We know that

Actual discharge through orifice meter is given by

~~Qat~~ $Q_{act} = \frac{C_d A_1 A_0 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$

A_1 = pipe area

A_0 = orifice area

h = piezometric head differerace between point 1 $ 2

~~$h = y\left(\frac{P_m}{\rho_f}\right.$~~ $h = x\left(\frac{S_g}{S_o} - 1\right)$

$h = \frac{50}{100}\left(\frac{13.6}{0.9} - 1\right)$

$= 7.05\ m$

$Q_{act} = \frac{0.64 \times \frac{\pi}{4}(0.3)^2 \times \frac{\pi}{4}(0.15)^2 \times \sqrt{2 \times 9.8 \times 7.05}}{\sqrt{\left(\frac{\pi}{4}(0.3)^2\right)^2 - \left(\frac{\pi}{4}(0.15)^2\right)^2}}$

$= 0.13742\ m^2/s$

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Continuation of Question 2

pressure at throat = $\frac{P_2}{\rho g}$ = −30 cm of mercury

= −0.3 m of mercury

= −0.3 × 13.6

= −4.08 m of water

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

= 18 − (−4.08)

= 22.08 m of water

= 2208 cm of water.

Putting value in eqn (ii)

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

= 165483.3122 cm^3/s

= 165.483122 L/s

∴ The discharge through Venturimeter = 165.48 L/s

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Question 1 Continues

putting values in eq (i)

$$2.5 + \frac{(15)^2}{2\times 9.81} + 2 = \frac{P_2}{\rho g} + \frac{(2)^2}{2\times 9.81} + 0 + 0.16$$

$$\frac{P_2}{\rho g} = (2.5 + 1.27 + 2) - (0.203 + 0.16)$$

$$= 5.77 - 0.363$$

$$\frac{P_2}{\rho g} = 5.407 m \text{ of fluid.}$$

The pressure head at lower end is 5.407 m of fluid.

Question 2.

Diameter at inlet $d_1 = 20 cm$

Area at inlet $a_1 = \frac{\pi}{4}(20)^2 = 314.16 \, cm^2$

Diameter at throat $d_2 = 10 cm$

Area at throat $A_2 = \frac{\pi}{4}(10)^2 = 78.74 \, cm^2$

The discharge Q is given by

$$Q = Cd \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh} \quad \text{—(ii)}$$

$$Cd = 0.98$$

Pressure at inlet $P_1 = 17.658 \, N/cm^2$

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

In term of water $\frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{9.81 \times 100}$

$$= 18 m \text{ of water.}$$

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ENG 214
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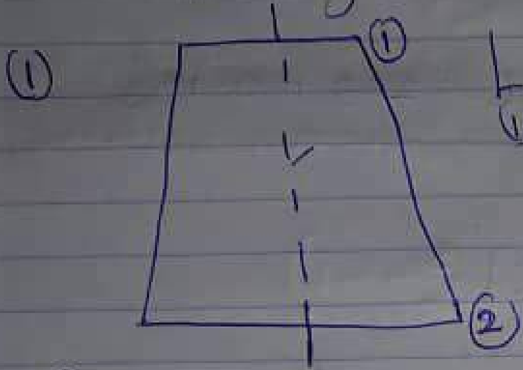

Let smaller end represent (1) and the lower end (2)

Given
length of tube $L = 2m$
Velocity at smaller end $V_1 = 5m/s$

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

Pressure head at smaller end $\frac{P_1}{\rho g} = 2.5m$

Head loss $h = \frac{0.35(V_1 - V_2)^2}{2g}$

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

let $h_L = 0.16m$

Applying Bernoulli's equation between the 1 & 2

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

let the datum be at section (2)

$\therefore Z_1 = 2m$

$Z_2 = 0$