18/ENG02/021 COMPUTER ENGINEERING

AMBROSE-OTHNIEL

17. A conical tube of length 2.0m is fixed vertically with its smaller end upwards. The velocity of flow at the smaller end is 5m/s while at the lower end it is 2m/s. The pressure head at the smaller end is 2.5m of liquid. The loss of head in the tube is $\left(\frac{0.35(V_1-V_2)^2}{2g}\right)$, where V_1 is the velocity at the smaller end and V_2 at the lower end respectively. Determine the pressure head at the lower end, Flow takes place in ~~smaller~~ downward direc.

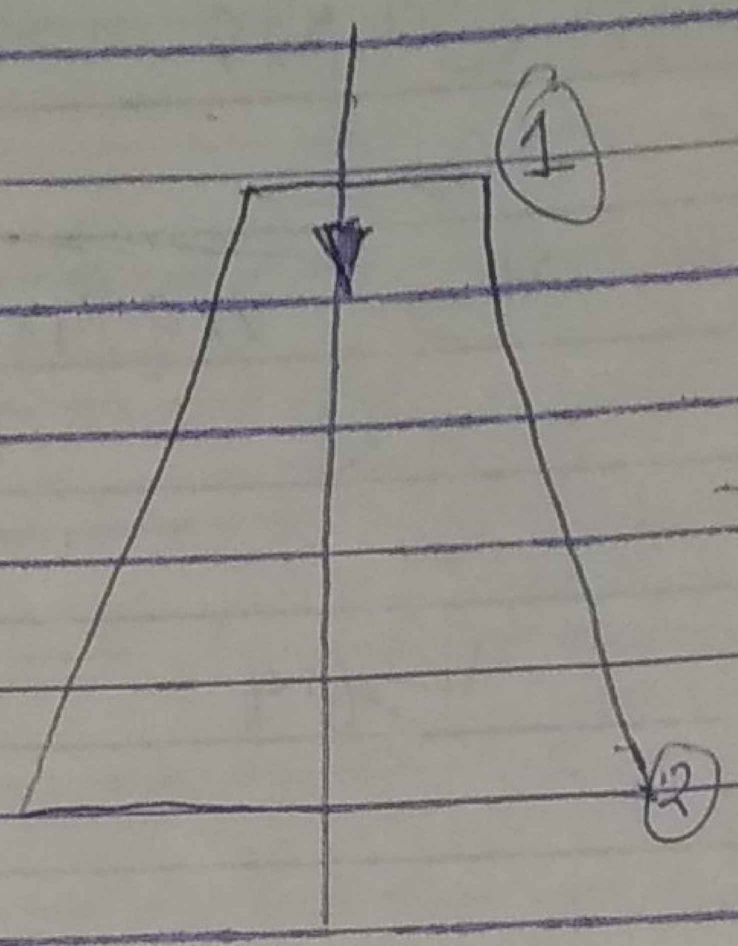
Soln.

Length of tube, $L = 2.0m$

$V_1 = 5m/s$

$P_1/\rho g = 2.5m$ of liquid,

$V_2 = 2m/s$



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

$= \frac{0.35[5-2]^2}{2g} = \frac{0.35 \times 9}{2 \times 9.81} = 0.16m.$

Pressure head, $\frac{P_2}{\rho g} = ?$

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

Let the datum line passes through Section (2). Then $Z_2 = 0, Z_1 = 2.0$

$$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = \frac{P_2}{\rho g} + \frac{2^2}{2 \times 9.81} + 0 + 0.16$$

$$2.5 + 1.27 + 2.0 = \frac{P_2}{\rho g} + 0.203 + 0.16$$

$$\frac{P_2}{\rho g} = 5.77 - 0.363$$

$$\frac{P_2}{\rho g} = 5.407$$

2) A horizontal venturimeter with inlet diameter 20cm & throat diameter 10cm is used to measure the flow of water. The pressure at inlet is 17.658 N/cm² and the vacuum pressure at the throat is 30cm of mercury. Find the discharge of water through venturimeter. Take $C_d = 0.98$

Soln

Inlet

$d_1 = 20cm$

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

Throat

$d_2 = 10cm$

$a_2 = \pi/4 \times 10^2 = 78.74 \, cm^2$

$P_1 = 17.658 \, N/cm^2 = 17.658 \times 10^4 \, N/m^2$

ρ for water $= 1000 \, kg/m^3$ & $\frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{9.81 \times 1000} = 18m$ of water

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

$= -0.30m$ of mercury

$= -0.30 \times 13.6 = -4.08$ m of water

$\therefore$ Differential head $h = \frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 18 - (-4.08)$

$= 18 + 4.08 = 22.08$ m of water
$= 2208$ cm of water

The discharge $Q = C_d \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$

$= 0.98 \times \frac{314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.74)^2}} \times \sqrt{2 \times 981 \times 2208}$

$= \frac{50388837.21}{304} \times 165555$

$= 165.555$ lit/s

3) An orifice meter with orifice diameter 15cm is inserted in a pipe of 30cm diameter. The pressure difference measured by a mercury oil differential manometer on the two sides of the orifice meter gives a reading of 50cm of mercury. Find the rate of flow of oil of specific gravity of 0.9 when the co-efficient of discharge of the meter is 0.64.

Soln

Diameter of inlet pipe, $d_1 = 30cm = 0.3m$
Area of inlet pipe $a_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4} \times 0.3^2 = 0.07 m^2$

Diameter of the orifice, $d_0 = 15cm = 0.15m$

Throat area, $a_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(0.15)^2 = 0.0176\,m^2$

Specific gravity of the oil, $S = 0.9$

Differential manometer reading $x = 50\,cm\,Hg$

And $h = x\left[\frac{S_{Hg}}{S} - 1\right]$ cm of oil =

$= 50\left[\frac{13.6}{0.9} - 1\right]$ cm of oil

$= \cancel{25.56}$ cm of oil =

$= 705.56$ cm of oil

$= 7.056$ m of oil

Q through the orifice meter

$$Q = C_d \times \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$$

$$= 0.64 \times \frac{0.07 \times 0.0176}{\sqrt{0.07^2 - 0.0176^2}} \times \sqrt{2 \times 9.81 \times 7.056}$$

$$0.64 \times \frac{1.232 \times 10^{-3}}{0.0678} \times 11.766$$

$$Q = 0.137\,m^3/s$$

d Submarine moves horizontally ... :

$$v = \sqrt{2gr\left(\frac{Sm}{S} - 1\right)}$$

$$x = \frac{170}{1000} = 0.17m$$

$Sm = 13.6$

$S = 1.025$

$C = 1$

$$V = \sqrt{2 \times 9.81 \times 6.17 \left(\frac{13.6}{1.025} - 1\right)}$$

$V = 6.4$