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2) A horizontal venturimeter with inlet diameter 20cm and 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 $C_d = 0.98$.

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Diameter at inlet ; $d_1 = 20cm$

$$a_1 = \pi/4 \times (20)^2 = 314.16 cm^2$$

Diameter at 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 of water $= 1000 \frac{kg}{m^3}$ and $\frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{9.81 \times 1000} = 18m$ of water

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

$= -0.30m$ of mercury

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

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

$= 18 + 4.08 = 22.08m$ of water

$= 2208cm$ of water.

The discharge Q is given by the equation;

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

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

$$= \frac{30328837.21}{304} \times 165555 \ cm^3/s = 165.555 \ lt/s$$

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

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reading of 50 cm of mercury. Find the rate of flow of oil of specific gravity of 0.9, when the coefficient of discharge of the meter is 0.64.

<u>Soln</u>

Diameter of orifice, $d_0 = 15cm$

$\therefore$ area, $a_0 = \frac{\pi}{4}(15)^2 = 176.7 cm^2$

Diameter of pipe, $d_1 = 30cm$

$\therefore$ Area, $a_1 = \frac{\pi}{4}(30)^2 = 706.85 cm^2$

Specific gravity of oil, $S_0 = 0.9$

Reading of differential manometer, $x = 50cm$ of mercury

$\therefore$ Differential head, $h = x\left[\frac{S_g}{S_0} - 1\right] = 50\left[\frac{136}{0.9} - 1\right]$ cm of oil

$= 50 \times 14.11 = 705.5cm$ of oil

$C_d = 0.64$

$\therefore$ The rate of the flow, Q is given by

$$Q = C_d \cdot \frac{a_0 a_1}{\sqrt{a_1^2 - a_0^2}} \times \sqrt{2gh}$$

$$= 0.64 \times \frac{176.7 \times 706.85}{\sqrt{(706.85)^2 - (176.7)^2}} \times \sqrt{2 \times 981 \times 705.5}$$

$$= \frac{94046317.78}{684.4} = 137414.25 \, cm^3/s = 137.414 \text{ litres/s}$$

4) A submarine moves horizontally in sea and has its axis 1.5m below the surface of water. A pitot tube properly placed just in front of the submarine and along its axis is connected to the two limbs of a U-tube containing mercury. The difference in mercury level is found to be 170mm. Find the speed of the submarine knowing the sp. gr. of mercury is 13.6 and that of sea water is 1.026 with respect to fresh water.

<u>Soln</u>

Diff in mercury levels, $x = 170mm = 0.17m$

Sp gr. of mercury $S_g = 13.6$

Sp. gr. of sea water $S_0 = 1.026$

$$h = x\left[\frac{S_g}{S_0} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834 m$$

$$V = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.0834} = 6.393 ms^{-1}$$

$$= \frac{6.393 \times 60 \times 60}{1000} = 23.01 Km hr^{-1}$$

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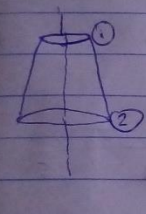
1) A Conical tube of length 2.0m is fixed vertically with its Smaller end upwards. The velocity of flow at the Smaller end is $5ms^{-1}$ while at the lower end it is $2ms^{-1}$. The pressure head at the smaller end is 2.5m of liquid. The loss of head in the tube is given as $(0.35(V1-V_2)^2)/2g$. Where V1 is the velocity at the Smaller end and V2 at the lower end respectively. Determine the pressure head at the lower end if flow takes place in the downward direction.

5) A pump delivers at the rate of $0.05m^3/min$ with a pressure change of 15bar. The speed of rotation is 1700 rev/min while the normal displacement is given as $10cm^3/rev$. If the torque input is 15 NM. Compute.

(i) volumetric efficiency (ii) fluid power (iii) Shaft power (iv) Overall efficiency.

Soln

1) 

where the smaller end is (1) and the lower or bigger end is (2)

length of tube; $L = 2.0m$, $V_1 = 5ms^{-1}$

Pressure head at Smaller end of liquid $= 2.5m$ of liquid

$V_2 = 2ms^{-1}$

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

$$= \frac{0.35(5-2)^2}{2g} = \frac{0.35 \times 9}{2 \times 9.81} = 0.16m$$

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

Applying bernoulli's equation at sections (1) and (2);

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

where the datum line passes through section (2), then $Z_2 = 0$, $Z_1 = 2.0$

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

$$2.5 + 1.27 + 2.0 = P_2/\rho g + 0.203 + 0.16$$

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

$$= 5.77 - 0.363 = 5.407m \text{ of fluid}$$