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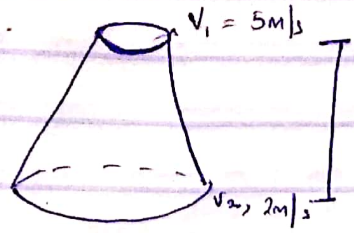
DEPT: MECHANICAL ENGINEERING
MATRIC NO: 18/ENG06/056

1.)



Small section - 1

Larger section - 2

Pressure head at smaller section $\left(\frac{P}{w}\right) = 2.5m$

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

Using bernoulli's equation

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

$$2.5 + \frac{5^2}{2 \times 9.81} + 2 = \frac{P_2}{w} + 0.2039 + 0.1606$$

$$5.774 = \frac{P_2}{w} + 0.3645$$

$$\frac{P_2}{w} = 5.774 - 0.3645 = 5.4095$$

$$\frac{P_2}{w} = 5.42M$$

∴ The pressure head at the second section is 5.41M

2 Inlet diameter (d_1) = 20 cm = 0.2 m.
Throat diameter (d_2) = 10 cm = 0.1 m.
Inlet pressure (P_1) = 17.658 N/cm² = 176580 N/m² ~~1.7678×10⁻³ N/m²~~
Vacuum pressure at the throat = 30 cm of mercury = 0.3 m of mercury
$C_d = 0.98$
Find Q

Solution

Area of inlet, $A_1 = \frac{\pi}{4} \times 0.2^2 = 0.3142\ m^2$

Area of throat, $A_2 = \frac{\pi}{4} \times 0.1^2 = 7.854 \times 10^{-3}\ m^2$

Differential head (h) = $\frac{P_1}{w} - \frac{P_2}{w}$

But $\frac{P_1}{w} = \frac{176580}{9810}$ ~~$\frac{1.7678\times10^{-3}}{9.81}$ = 1.802×10⁻⁴ m 1.802×10⁻⁷ m~~ 18 m

But vacuum pressure at throat $\left(\frac{P_2}{w}\right)$

$\frac{P_2}{w} = -0.3$ m of mercury

$= -0.3 \times 13.6 = -4.08$ m of water

~~∴ Differential head = 1.802×10⁻⁷ − (−4.08)~~
~~= 4.08~~

∴ Differential head = 18 − (− 4.08)
= 22.08

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

$$Q = 0.98 \times \frac{0.3142 \times 7.854 \times 10^{-3}}{\sqrt{(0.3142)^2 - (7.854 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 22.08}$$

$$= 0.98 \times \frac{2.468 \times 10^{-3}}{0.3141} \times 20.81$$

$= 0.160\ m^3/s$

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3 diameter of orifice = 15cm = 0.15 m

diameter of pipe = 30cm = 0.3 m

Specific gravity of oil = 0.9

Coefficient of discharge = 0.64

Reading of the manometer = 50 cm of mercury = 0.5 m of mercury

Find Q

Solution

Area of orifice, $A_0 = \frac{\pi}{4} \times 0.15^2 = 0.0177 m^2$

Area of pipe, $A_1 = \frac{\pi}{4} \times 0.3^2 = 0.0707 m^2$.

Reading of differential manometer (y) = 0.5 m of mercury

Differential head $= y\left[\frac{Sg\ of\ Hg}{Sg\ of\ oil} - 1\right]$

$= 0.5\left[\frac{13.6}{0.9} - 1\right] = 7.06$ m of oil

The discharge $Q_1 = Cd \times \frac{A_0 A_1}{\sqrt{A_1^2 - A_0^2}} \times \sqrt{2gh}$

$= 0.64 \times \frac{0.0177 \times 0.0707}{\sqrt{(0.0707)^2 - (0.0177)^2}} \times \sqrt{2 \times 9.81 \times 7.06}$

$= 0.64 \times 0.0183 \times 11.77$

$=$ ~~0.138m~~ $0.138 m^3/s$.

4 Reading of the differential manometer (y) 170 mm = 0.17 m

Specific gravity of mercury, S.gHg = 13.6

" " " Sea water Sgw = 1.025

To find the head (h) $= y\left[\frac{S.gHg}{Sgw} - 1\right]$

$= 0.17\left[\frac{13.6}{1.025} - 1\right]$

$= 2.09$

∴ Velocity of Submarine $= \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.09} = 6.403 m/s$.

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