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18/ENG06/033
MECHANICAL ENG
ENG 214

Question 1

A 300mm x 150mm Venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.9, flow being upward. The difference in elevation of the throat section and entrance section of the Venturimeter is 300mm. The differential U-tube mercury manometer shows guage deflection of 250mm. Calculate (a) The discharge of oil, and (b) The pressure difference between the enterance section and the throat section. Take the co-efficient of meter 0.98 and specific gravity of mercury as 13.6.

Solution:

Diameter at Inlet(D) 300mm $= 300 \times 10^{-3} \Rightarrow 0.3m$

Area $(A_1) = \frac{\pi d^2}{4} = \frac{\pi (0.3)^2}{4} = 0.070695 m^2$

Diameter at throat $(D_2) = 150mm = 150 \times 10^{-3} \Rightarrow 0.15 M$

Area $(A_2) = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4} = 0.01767 m^2$

Let section (1) represent inlet and section 2 represent throat. Then $Z_2 - Z_1 = 300mm$
$= 0.3m$

Specific gr of oil $= 0.9$
Specific gr. of mercury $= 13.6$
Reading of diff. manometer $x = 250mm = 0.25m$

The differential head, h is given by

$$h = \left(\frac{P_1}{\rho g} + Z_1\right) - \left(\frac{P_2}{\rho g} + Z_2\right)$$

Continuation q No 1

$= x\left[\frac{S_g}{S_o} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right] = 3.5277$ m of oil

~~of oil~~

(i) The discharge, Q of oil $= C_d \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$.

$= \frac{0.98 \times 0.070695 \times 0.01767}{\sqrt{(0.070695)^2 - (0.01767)^2}} \times \sqrt{2 \times 9.81 \times 3.527}$

$\frac{1.224197 \times 10^{-3}}{0.068451} \times 8.31946356 4$

$= 0.14879\ m^3/s$

$= 148.79$ Litres/s

(ii) Pressure difference between entrance and throat section.

$h = \left(\frac{P_1}{\rho g} + Z_1\right) - \left(\frac{P_2}{\rho g} + Z_2\right) = 3.5277$

Or $\left(\frac{P_1}{\rho g} - \frac{P_2}{\rho g}\right) + Z_1 - Z_2 = 3.5277$

Recall $Z_2 - Z_1 = 0.3$ m

$\left(\frac{P_1}{\rho g} - \frac{P_2}{\rho g}\right) - 0.3 = 3.5277$

$\therefore \frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 3.5277 + 0.3 = 3.8277$ m of oil

7m
oil

gh

81x 3.5277

at

il

Question 2

Specific gravity = 0.8

$D_1 = 150\ mm = 0.15 m$

$D_2 = 75\ mm = 0.075 m$

$Z_1 = 150\ mm = 0.15 m$

$Z_2 = 75\ mm = 0.075 m$

Qad = 40 litres/sec = 0.04 m³/secs

cd = 0.96

Pressure difference $(P_1 - P_2)$ =

$$A_1 = \frac{\pi d^2}{4}$$

$$A_1 = \frac{\pi \times (0.15)^2}{4} = 0.0176\ m^2$$

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.075)^2}{4} = 0.00442 m^2$$

$$Qad = \frac{cd \times A_1 \times A_2 \times \sqrt{2gh}}{A_1^2 - A_2^2}$$

$$0.04 = \frac{0.96 \times 0.01767 \times 0.00442 \times \sqrt{2 \times 9.81 \times h}}{(0.01767)^2 - (0.00442)^2}$$

$$h = (0.04/0.96 \times 0.004565 \times 4.429)^2$$

$h = 4.247 m$

$$4.247 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (z_1 - z_2)$$

$$\left(\frac{P_1 - P_2}{\rho g}\right) - 0.15$$

$$(P_1 - P_2) = \rho g\ (4.247 + 0.15)$$

$$(0.8 \times 1000 \times 9.81)(4.247 + 0.15)\ N/m^2$$

$$= 34.51\ kN/m^2$$