MATRIC NO: 17/MH801314
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COURSE: Fluid Mechanics ENG214

1. Considering a vertical venturimeter

Given

$$Sg_{oil} = 0.9 \qquad \rho = 900 kg/m^3$$

$d_i = 300mm = 0.3m$ $\quad A_i = \pi\left(\frac{d_i}{2}\right)^2 = 0.0707m^2$

$d_t = 150mm = 0.15m$ $\quad A_t = \pi\left(\frac{d_t}{2}\right)^2 = 0.0177m^2$

$z_t - z_i = 300mm = 0.3m$ $\qquad Cd = 0.98$

x, gauge deflection $= 250mm = 0.25m$

i. discharge of oil = ? ii. $P_i - P_t$ = ?

SOLUTION:

i. $$h = \left[\frac{P_i}{\rho g} + z_i\right] - \left[\frac{P_t}{\rho g} + z_t\right] = x\left(\frac{Sg_{mercury}}{Sg_{oil}} - 1\right)$$

$$\Rightarrow h = x\left(\frac{Sg_{mercury}}{Sg_{oil}} - 1\right)$$

$$= 0.25\left(\frac{13.6}{0.9} - 1\right)$$

$\therefore h = 3.528m$ of oil

$$Q = Cd \times \frac{A_i A_t}{\sqrt{A_i^2 - A_t^2}} \times \sqrt{2gh}$$

$$\Rightarrow Q = 0.98 \times \frac{0.0707 \times 0.0177}{\sqrt{0.0707^2 - 0.0177^2}} \times \sqrt{2 \times 9.81 \times 3.528}$$

$\therefore Q = 0.1491 m^3/s$

ii. $$h = \left[\frac{P_i}{\rho g} + z_i\right] - \left[\frac{P_t}{\rho g} + z_t\right]$$

$$\Rightarrow 3.528 = \left[\frac{P_i}{\rho g} + z_i\right] - \left[\frac{P_t}{\rho g} + z_t\right]$$

$$3.528 = \frac{P_i}{\rho g} - \frac{P_t}{\rho g} + z_i - z_t$$

$$3.528 = \left[\frac{P_i - P_t}{\rho g}\right] - \left[z_t - z_i\right]$$

$$3.528 = \frac{P_i - P_t}{\rho g} - 0.3$$

$$P_i - P_t = 0.81 \times 900 \left(3.528 + 0.3\right)$$

$$P_i - P_t = 33797.4$$

$$\therefore (P_i - P_t) = 33.80 \text{ kN/m}^2$$

2. Considering a vertical venturimeter

Given

relative ρ of liquid = 0.8 $\rho = 800 \text{ kg/m}^3$

$Q = 40 \text{ ltr/s} = 4 \times 10^{-2} \text{ m}^3/\text{s}$ $C_d = 0.96$

$d_i = 150\text{mm} = 0.15\text{m}$ $A_i = \pi(d_i/2)^2 = 0.0177 \text{ m}^2$ $V_i = Q/A_i = 2.260 \text{ m/s}$

$d_t = 75\text{mm} = 0.075\text{m}$ $A_t = \pi(d_t/2)^2 = 0.0044 \text{ m}^2$ $V_t = Q/A_t = 9.091 \text{ m/s}$

$z_t - z_i = 150\text{mm} = 0.15\text{m}$

$P_i - P_t = ?$

SOLUTION:

$$h = \left[\frac{P_i}{\rho g} + z_i\right] - \left[\frac{P_t}{\rho g} + z_t\right]$$

$$Q = C_d \times \frac{A_i A_t}{\sqrt{A_i^2 - A_t^2}} \times \sqrt{2gh}$$

$$h = \left(\frac{Q}{C_d} \times \frac{\sqrt{A_i^2 - A_t^2}}{A_i A_t}\right)^2 \times \frac{1}{2g}$$

$$\Rightarrow h = \left(\frac{4 \times 10^{-2}}{0.96} \times \frac{\sqrt{0.0177^2 - 0.0044^2}}{0.0177 \times 0.0044}\right)^2 \times \frac{1}{2 \times 9.81}$$

$= 9.1924 \times 0.0509^{4}$

$\therefore \sqrt{h} = 0.4675$

$Q = Cd \times \frac{A_i A_t}{\sqrt{A_i^2 - A_t^2}} \times \sqrt{2gh}$

$\Rightarrow 4 \times 10^{-2} = 0.96 \times \frac{0.0177 \times 0.0044}{\sqrt{0.0177^2 - 0.0044^2}} \times \sqrt{2 \times 9.81} \times \sqrt{h}$

$4 \times 10^{-2} = 0.0193 \times \sqrt{h}$

$h = \left(\frac{4 \times 10^{-2}}{0.0193}\right)^2$

$\therefore h = 4.295$

$h = \left[\frac{P_i}{\rho g} + z_i\right] - \left[\frac{P_t}{\rho g} + z_t\right]$

$\Rightarrow 4.295 = \left[\frac{P_i}{\rho g} - \frac{P_t}{\rho g}\right] - \left[z_t - z_i\right]$

$4.295 = \frac{P_i - P_t}{\rho g} - 0.15$

$(4.295 + 0.15) \times (9.81 \times 800) = P_i - P_t$

$P_i - P_t = 34884.36$

$\therefore P_i - P_t = 34.90 \ kN/m^3$