September 29, 2008

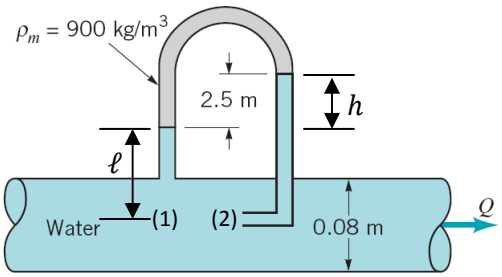
NAME

Fluids-ID

Quiz 3.

1) Determine the pressure difference $p_2 - p_1$ from the inverted U-tube manometer reading.
2) Determine the mean velocity V_1 at point (1) using Bernoulli equation.
3) Determine the flow rate Q through the pipe.

(Hint: ρ = 999 Kg/m^3 for water; g = 9.81 m/s^2)



Bernoulli equation:

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

Flow rate:

$$Q = V \cdot A$$

Solution:

1) Manometer

$$p_1 - \gamma\ell - \gamma_m h + \gamma(\ell + h) = p_2$$

$$p_2 - p_1 = (\gamma - \gamma_m)h = g(\rho - \rho_m)h$$

$$= \left(9.81 \frac{\text{m}}{\text{s}^2}\right)(999 - 900)\left(\frac{\text{Kg}}{\text{m}^3}\right)(2.5 \text{ m}) = \mathbf{2719.3} \frac{\mathbf{N}}{\mathbf{m^2}}$$

2) Bernoulli equation

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 \qquad \text{where } z_1 = z_2 \text{ and } V_2 = 0$$

Thus,

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} = \frac{p_2}{\gamma}$$

$$V_1 = \sqrt{2g\frac{(p_2 - p_1)}{\gamma}} = \sqrt{(2)\left(9.81 \frac{\text{m}}{\text{s}^2}\right)\frac{(2719 \text{ N/m}^2)}{9.81 \text{ m/s}^2 \times 999 \text{ Kg/m}^3}} = \mathbf{2.20} \frac{\mathbf{m}}{\mathbf{s}}$$

3) Flow rate

$$Q = A_1 V_1 = \frac{\pi}{4}(0.08 \text{ m})^2 \times 2.20 \frac{\text{m}}{\text{s}} = \mathbf{0.0111} \frac{\mathbf{m^3}}{\mathbf{s}}$$