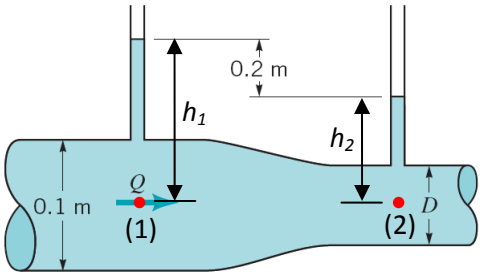
September 25, 2009

NAME

Fluids-ID

Quiz 3.

Water flows through the pipe contraction shown at right. For the given 0.2-m difference in the pressure tap readings, determine the flow rate *Q* if the diameter of the small pipe *D* = 0.05 m.



- Bernoulli equation:

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

- Continuity equation:

$$\rho_1 V_1 A_1=\rho_2 V_2 A_2$$

Solution:

Bernoulli equation with $z_1 = z_2$,

$$\frac{p_1}{\gamma}+\frac{V_1^2}{2g}=\frac{p_2}{\gamma}+\frac{V_2^2}{2g}$$ (+3 points)

where,

$$V_2=\frac{A_1V_1}{A_2}=\frac{(\pi D_1^2/4)}{(\pi D_2^2/4)}V_1=\left(\frac{0.1\ m}{0.05\ m}\right)^2 V_1=4V_1$$

and $p_1=\gamma\cdot h_1, \qquad p_2=\gamma\cdot h_2$ (+4 points)

Thus, the Bernoulli equation becomes as

$$\frac{\gamma\cdot h_1}{\gamma}+\frac{V_1^2}{2g}=\frac{\gamma\cdot h_2}{\gamma}+\frac{(4V_1)^2}{2g}$$

or

$$V_1=\sqrt{\frac{2g}{15}(h_1-h_2)}=\sqrt{\frac{2(9.81\ m/s^2)}{15}(0.2\ m)}=0.51\frac{m}{s}$$ (+1.5 points)

Then, flow rate is

$$Q=A_1V_1=\left(\frac{\pi}{4}\right)(0.1\ m)^2\left(0.51\frac{m}{s}\right)=0.004\ m^3/s$$ (+1.5 points)