December 3, 2007

Quiz 8

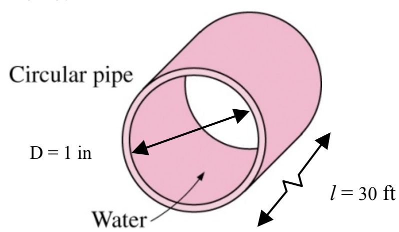
NAME

Student ID

Known: Water flows horizontally through a 1 inch inner diameter pipe over a length of 30 feet. Water has the following properties: $\upsilon=1.21\times10^{-5}$ ft^2/s and $\rho=1.94$ $slug/ft^3$. The equivalent roughness of the pipe, $\varepsilon=0.0001ft$.

Find: Part 1: Determine the friction factor and the pressure drop if the average velocity is 0.2 ft/second.
Part 2: Determine the friction factor and the pressure drop if the average velocity is 1 ft/second.

Assumptions: 1) The flow is fully developed. 2) No change in elevation. 3) There are no bends or contractions.



Equations:

$Re = VD/\upsilon$

$$\frac{1}{\sqrt{f_{turb}}} = -2\log\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f_{turb}}}\right)$$

$f_{lam}=64/Re$

$$h_L = f\frac{lV^2}{2Dg}$$

$$\frac{p_1}{\gamma} + \alpha_1\frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \alpha_2\frac{V_2^2}{2g} + z_2 + h_L$$

Solution:

Part 1:

$Re = VD/\upsilon = (0.2\ ft/s)\ (1/12\ ft) / (0.0000121\ ft^2/s) = 1{,}377$

➔ *Laminar flow*

$f_{lam} = 64/Re = 64 / 1{,}377 = 0.0464$

$$\frac{p_1}{\gamma} + \alpha_1\frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \alpha_2\frac{V_2^2}{2g} + z_2 + h_L$$

$$\frac{p_1}{\gamma} = \frac{p_2}{\gamma} + h_L$$

$$\frac{p_1 - p_2}{\gamma} = h_L$$

$$p_1 - p_2 = \gamma h_L$$

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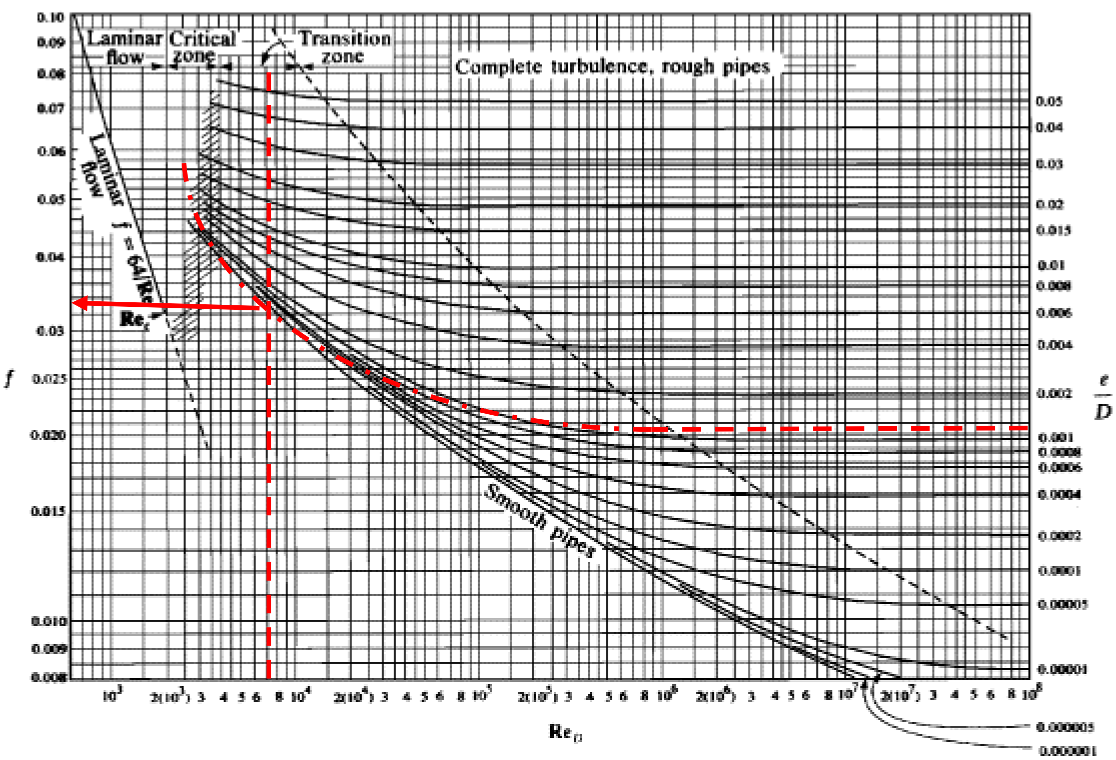
$$\Delta p = \gamma h_L = \rho g f \frac{lV^2}{2Dg} = f\frac{\rho l V^2}{2D} = 0.0464 \times \frac{1.94\frac{slug}{ft^3} \times 30\ ft \times 0.2\ \frac{ft}{s}}{2 \times (1/12) ft} = 0.649\ \frac{lb}{ft^2} = 0.0045\ \frac{lb}{in^2}$$

Part 2:

Re = VD/ υ = (1 ft/s) (1/12 ft) / (0.0000121 ft^2/s) = 6887

- *Turbulent flow*
- *Go to Moody diagram or Colebrook friction factor equation*

ε/D = 0.0001ft / (1/12 ft) = 0.0012



f_{turb} ~ 0.035

$$\Delta p = \gamma h_L = \rho g f \frac{lV^2}{2Dg} = f\frac{\rho l V^2}{2D} = 0.035 \times \frac{1.94\frac{slug}{ft^3} \times 30\ ft \times 1\ \frac{ft}{s}}{2 \times (1/12) ft} = 12.2\ \frac{lb}{ft^2} = 0.0850\ \frac{lb}{in^2}$$