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NAME

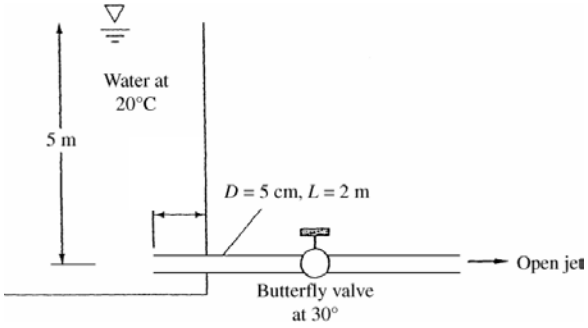
Quiz 13. Water flows from large tank through the galvanized iron pipe to open jet as shown in Figure ($\varepsilon = 0.15mm$; ρ = 998 kg/m^3; μ=0.001 kg/m s; $K_{entrance}$=1; K_{valve}=80)

Energy Equation

$$\frac{p_1}{\rho g}+\frac{V_1^2}{2g}+z_1+h_p=\frac{p_2}{\rho g}+\frac{V_2^2}{2g}+z_2+\frac{V^2}{2g}\left(\frac{f\ell}{d}+\sum K_L\right)$$

Friction Factor Equation

$$\frac{1}{\sqrt{f}}=-1.8\log\left[\left(\frac{\varepsilon/D}{3.7}\right)^{1.11}+\frac{6.9}{Re}\right]$$



Note: Attendance (+2 points), format (+1 point)

a) Determine velocity, V, as a function of friction factor, f, using energy equation.
b) Determine Reynolds number, Re, as a function of velocity, V.
c) Determine velocity *V* by following the steps listed below;
    1) Assume *f* = 0.02 as your first guess and find *V* using the equation from (a)
    2) Find *Re* using the equation from (b) and the *V* from step 1)
    3) Find a new *f* using the friction factor equation and *Re* from step 2)
    4) Find a new *V* using the *f* from step 3) and the equation from (a)
    5) Repeat the steps 2) through 4) until *f* is converged to the thousandth decimal point

Solution:

Since p_1=p_2=0, V_1=0 and h_p=0

$$z_1=z_2+\frac{V^2}{2g}\left(1+\frac{f\ell}{d}+\sum K_L\right)$$

$$V=\left[\frac{2g(z_1-z_2)}{1+\frac{f\ell}{d}+\sum K_L}\right]^{0.5}=\left[\frac{2\times 9.81(5)}{1+\frac{2f}{0.05}+(80+1)}\right]^{0.5}=\left[\frac{98.1}{40f+82}\right]^{0.5}$$

$$V=\left[\frac{98.1}{40f+82}\right]^{0.5}$$ [Equation 1] (+3)

Reynolds number

$$Re=\frac{\rho VD}{\mu}=\frac{998\times V\times 0.05}{0.001}=49900V$$ [Equation 2] (+2)

Rearranging friction factor equation

$$f = \left(-1.8\log\left[\left(\frac{0.003}{3.7}\right)^{1.11} + \frac{6.9}{Re}\right]\right)^{-2} \text{ [Equation 3]}$$

Solving for velocity iteratively using equations (1), (2) and (3)

Assume $f = 0.02 \rightarrow V = 1.088\frac{m}{s} \rightarrow Re = 54315 \rightarrow f = 0.0283$

Assume $f = 0.0283 \rightarrow V = 1.086\frac{m}{s} \rightarrow Re = 54206 \rightarrow f = 0.0283$

Thus

$$V = 1.086\frac{m}{s} \text{ (+2)}$$