33.28 $0.02\frac{ft^3}{s}$ **of** $120°F$ **water flows in a** $1in$ **nominal type L copper pipe with relative roughness of** $.002$**. The length of pipe is** $90ft$ **and the the minor losses have a K value of** 1.5**. What is the total pressure loss through the pipe?**

A. $2.5psi$

B. $5.7psi$

C. $9.3psi$

D. $13.0psi$

Use the Properties of Water table to obtain the kinematic viscosity of water at $120°F$.

$$\nu_{@T=120°F} = 0.609 \times 10^{-5}\frac{ft^2}{s}$$

Use the Copper Pipe Friction Tables to obtain the diameter of a $1in$ nominal type L copper pipe, and use the diameter to calculate the area.

$$D = 1.025in$$

$$A = \frac{\pi}{4}\left(\frac{1.025in}{12\frac{in}{ft}}\right)^2 = 0.00573ft^2$$

Detemine the velocity of the water.

$$Q = vA$$

$$v = \frac{Q}{A} = \frac{0.02\frac{ft^3}{s}}{0.00573ft^2} = 3.49\frac{ft}{s}$$

Determine the Reynolds Number.

$$Re = \frac{vD}{\nu} = \frac{\left(3.49\frac{ft}{s}\right)\left(\frac{1.025in}{12\frac{in}{ft}}\right)}{0.609 \times 10^{-5}\frac{ft^2}{s}} = 48,953 \approx 5 \times 10^4$$

The friction factor is a function of the Reynolds number and relative roughness. Use the Moody Diagram to specify f.

$$f = f\left(Re, \frac{\varepsilon}{D}\right) = f\left(5 \times 10^4, 0.002\right) \approx 0.027$$

The total losses include both major and minor losses. Substitute known values and solve for the friction loss in ft.

$$h_f = h_{f,major} + h_{f,minor} = \frac{fLv^2}{2Dg} + K\frac{v^2}{2g} = \left(\frac{fL}{D} + K\right)\left(\frac{v^2}{2g}\right)$$

$$h_f = \left[\left(\frac{(0.027)\,(90ft)}{\left(\frac{1.025in}{12\frac{in}{ft}}\right)}\right) + 1.5\right]\left[\frac{\left(3.49\frac{ft}{s}\right)^2}{2\left(32.2\frac{ft}{s^2}\right)}\right] = 5.7ft$$

To determine the pressure loss in psi, use the rule of thumb for water to convert from ft to psi.

$$\Delta p = \frac{5.7ft}{2.31\frac{ft}{psi}} = 2.5psi$$

Answer A