33.21 $500gpm$ **of** $40°F$ **chilled water flows through** $500ft$ **of steel pipe with a nominal diameter of** $6in$**. What is the friction loss based on the Darcy-Weisbach equation?**

A. $6ft$

B. $9ft$

C. $16ft$

D. $20ft$

Use the Steel Pipe Friction Tables to look up the diameter for a nominal $6in$ pipe and the velocity corresponding to $500gpm$. Unfortunately, it is not valid to obtain the head loss from the table directly as the problem statement specifically calls for using the Darcy-Weisbach equation. As this problem demonstrates, there is often a discrepancy between the table values and the losses yielded by the equation.

$$D = 6.065in$$

$$v = 5.55\frac{ft}{s}$$

Use the Properties of Water table to obtain the kinematic viscosity at $40°F$.

$$\nu = 1.664 \times 10^{-5}\frac{ft^2}{s}$$

Calculate the Reynolds Number.

$$Re = \frac{vD}{\nu} = \frac{\left(5.55\frac{ft}{s}\right)\left(\frac{6.065in}{12\frac{in}{ft}}\right)}{1.664 \times 10^{-5}\frac{ft^2}{s}} = 168,573 \approx 1.7 \times 10^5$$

Use the table under the Moody Diagram to look up the roughness, ε, for steel, then calculate the Relative Roughness, $\frac{\varepsilon}{D}$.

$$\frac{\varepsilon}{D} = \frac{0.0002ft}{0.5ft} = 0.0004ft$$

Use the Moody Diagram with the Reynolds number and the relative roughness to find the friction factor, f.

$$f \approx 0.0185$$

Substitute into the Darcy equation and solve.

$$h_f = \frac{fLv^2}{2Dg} = \frac{(0.0185)\,(500ft)\left(5.55\frac{ft}{s}\right)^2}{2\left(\frac{6.065in}{12\frac{in}{ft}}\right)\left(32.2\frac{ft}{s^2}\right)} = 8.75ft$$

Notice the losses based on the Darcy equation are around half of what would be predicted by using the steel pipe friction tables directly. This is a typical result as the tables tend to be more conservative.

Answer B