$$\frac{P_1}{\gamma} = (80psi)\left(2.31\frac{ft}{psi}\right) - 100ft + 130.2ft = 215ft$$

$$P_1 = \frac{215ft}{2.31\frac{ft}{psi}} = 93psig$$

Since the required fixture pressure and answer choices are given in psig, it is not necessary to account for atmospheric pressure at any point in the problem.

Answer A

40.11 What is the friction loss per hundred feet for $800gpm$ of $80°F$ water flowing through an $8in$ nominal schedule 40 steel pipe?

A. $1ft$

B. $2ft$

C. $3ft$

D. $4ft$

Start with the Darcy Equation:

$$h_f = \frac{fLv^2}{2gD}$$

Using the Steel Pipe Friction Tables, look up the diameter for a nominal 8 inch pipe and the velocity of $800gpm$ through a pipe of that size:

$$D = 7.981in\left(\frac{1ft}{12in}\right) = 0.6651ft$$

$$v = 5.13\frac{ft}{s}$$

The friction factor is a function of the Reynolds Number, Re, and the relative roughness, $\frac{\epsilon}{D}$. Look up the Properties of Water table to find the kinematic viscosity at $80°F$.

$$Re = \frac{vD}{\nu} = \frac{\left(5.13\frac{ft}{s}\right)(0.6651ft)}{0.93\times10^{-5}\frac{ft^2}{s}} \approx 370,000$$

The roughness factor, ϵ, is assumed to have an average value of $0.0002ft$ for Schedule 40 steel pipe aka commercial steel.

$$\frac{\epsilon}{D} = \frac{0.0002ft}{0.6651ft} \approx 0.0003$$

Using the Moody Diagram:

$$f = f\left(Re, \frac{\epsilon}{D}\right) \approx 0.0165$$

Calculate the friction loss by solving the Darcy equation:

$$h_f = \frac{fLv^2}{2gD} = \frac{(0.0165)(100ft)\left(5.13\frac{ft}{s}\right)^2}{2(0.6651ft)\left(32.2\frac{ft}{s^2}\right)} = 1.01ft$$

Answer A

40.12 $200gpm$ **of** $90°F$ **water flows through** $500ft$ **of** $4in$ **nominal schedule 40 steel pipe, with a discharge that is** $30ft$ **higher than the entrance. The pipe contains the following flanged welded pipe fittings: (4) 90° elbows, (2) 90° long radius elbows, (2) gate valves, and (1) globe valve. What is the pressure difference between the two ends of the pipe?**

A. $7psi$

B. $19psi$

C. $22psi$

D. $34psi$

Start by writing the Bernoulli Equation:

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_f$$

Neglect velocity and solve for the pressure difference $\Delta P = P_1 - P_2$. Note $\Delta z = z_2 - z_1 = 30ft$ which is a positive value since the exit is higher than the entrance.

$$\frac{P_1 - P_2}{\gamma} = (z_2 - z_1) + h_f$$

The main effort of this problem is determining the losses which must include both major and minor losses (i.e. fitting losses). This requires an additional term beyond the typical application of the Darcy Equation, as can be found by looking up Fittings Losses in the reference handbook:

$$h_f = h_{f,major} + h_{f,minor} = \frac{fLv^2}{2gD} + K\frac{v^2}{2g}$$

Start with the major losses, using the Steel Pipe Friction Tables to find the velocity and actual diameter for a volume flow rate of $200gpm$ in a nominal $4inch$ pipe. Use the Properties of Water table to find the kinematic viscosity at 90°F:

$$Re = \frac{vD}{\nu} = \frac{\left(5.04\frac{ft}{s}\right)(.3355ft)}{.826 \times 10^{-5}\frac{ft^2}{s}} = 205000 \approx 2 \times 10^5$$

Find the relative roughness: