Example 1-5: Pressure Pipe Friction Losses

Use the FlowMaster program to compare the head loss computed by the Hazen-Williams equation to the head loss computed by the Darcy-Weisbach equation for a pressure pipe having the following characteristics: 12-in diameter cast iron pipe (new) one mile in length with a flow rate of 1,200 gallons per minute (with water at 65°F).

Solution

Although there are no elevations or pressures given, these values are not needed to determine the head loss in the pipe. Setting up FlowMaster to solve for the "Elevation at 1" allows us to use zero elevation and zero pressure assumptions and fill in the rest of the pipe characteristics.

For the Hazen-Williams equation, a *C* coefficient of 130 is assumed. This value results in 18.8 ft of head loss (which agrees with the computed 18.8-ft elevation at point 1). Using Darcy-Weisbach, a roughness height of 0.00085 ft is assumed. The solution indicates a head loss of 18.9 ft, which is only a 0.1-ft difference from the value predicted by Hazen-Williams.

Discussion

If the same system is analyzed with 2,000 to 3,000 gallons per minute of flow, however, the difference in head loss between the two equations becomes almost 10 feet.

Why such a big difference? For starters, the two methodologies are completely unrelated, and the estimated roughness coefficients were taken from a list of approximate values. If the Hazen-Williams equation is used with a roughness value of 125, the results are much closer. This difference should emphasize the fact that models are only as good as the data that is input into them, and the engineer needs to fully understand all of the assumptions that are being made before accepting the results.

1.6 Open-Channel Flow

Open-channel flow analysis is more complex than pressure flow analysis because the flow area, wetted perimeter, and hydraulic radius are not necessarily constant as they are in a uniform pipe section under full-flow conditions. Because of this considerable difference, additional characteristics become important when dealing with open-channel flow.

Uniform Flow

Uniform flow refers to the hydraulic condition in which the discharge and cross-sectional area (and therefore velocity) are constant throughout the length of the channel. For a pipe flowing full, the only required assumptions are that the pipe be straight and have no contractions or expansions. For an open channel, additional assumptions include: