**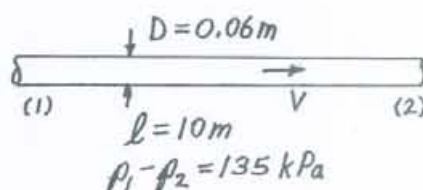8.48** Water flows through a horizontal 60-mm-diameter galvanized iron pipe at a rate of 0.02 m³/s. If the pressure drop is 135 kPa per 10 m of pipe, do you think this pipe is (a) a new pipe, (b) an old pipe with a somewhat increased roughness due to aging, or (c) a very old pipe that is partially clogged by deposits? Justify your answer.



For the horizontal pipe $(z_1 = z_2)$ with $V_1 = V_2$ the energy equation

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + f\frac{\ell}{D}\frac{V^2}{2g} \quad \text{reduces to} \quad p_1 - p_2 = f\frac{\ell}{D}\frac{1}{2}\rho V^2$$

or

$$135\times10^3 \frac{N}{m^2} = f\frac{10m}{0.06m}\frac{1}{2}\left(999\frac{kg}{m^3}\right)\left(7.07\frac{m}{s}\right)^2, \quad \text{or} \quad f = 0.0324$$

where we have used $V = \frac{Q}{A} = \frac{0.02\frac{m^3}{s}}{\frac{\pi}{4}(0.06m)^2} = 7.07\frac{m}{s}$

With $Re = \frac{VD}{\nu} = \frac{(7.07\frac{m}{s})(0.06m)}{1.12\times10^{-6}\frac{m^2}{s}} = 3.79\times10^5$ and $\frac{\varepsilon}{D} = \frac{0.15\ mm}{60\ mm} = 2.5\times10^{-3}$

for a new galvanized iron pipe (see Table 8.1), the friction factor should be (see Fig. 8.20) $f = 0.0255$. Since this is less than the actual value $f = 0.0324$, the pipe is not a new pipe.

With $Re = 3.79\times10^5$ and $f = 0.0324$ we obtain from Fig. 8.20 a relative roughness of $\frac{\varepsilon}{D} = 0.006$. This is approximately twice the roughness of a new pipe — certainly quite possible. A very old partially clogged pipe would have considerably greater head loss. Thus, the pipe is an old pipe with somewhat increased roughness.