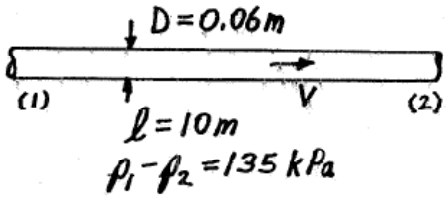
8.36 Water flows through a horizontal 60-mm-diameter galvanized iron pipe at a rate of 0.02 m^3/s. If the pressure drop is 135 kPa per 10 m of pipe, do you think this pipe is **(a)** a new pipe, **(b)** an old pipe with a somewhat increased roughness due to aging, or **(c)** a very old pipe that is partially clogged by deposits? Justify your answer.



For the horizontal pipe ($z_1=z_2$) with $V_1=V_2$ the energy equation $\frac{p_1}{\gamma}+\frac{V_1^2}{2g}+z_1=\frac{p_2}{\gamma}+\frac{V_2^2}{2g}+z_2+f\frac{\ell}{D}\frac{V^2}{2g}$ reduces to $p_1-p_2=f\frac{\ell}{D}\frac{1}{2}\rho V^2$

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

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.