A fluid flows through a horizontal 0.1-in.-diameter pipe. When the Reynolds number is 1500, the head loss over a 20-ft length of the pipe is 6.4 ft. Determine the fluid velocity.

\[ h_L = f \frac{k}{D} \frac{V^2}{2g} , \text{ where since } Re = 1500 < 2100 \text{ the flow is laminar.} \]

Thus, \( f = \frac{64/Re}{64/1500} = 0.0427 \) so that \[ 6.4 \text{ ft} = 0.0427 \times \frac{20\text{ ft}}{(0.1/12\text{ ft})^{\frac{2}{5}}} \frac{V^2}{2(32.2\text{ ft/s})} \]

or \[ V = \frac{2.01 \text{ ft}}{\frac{3}{5}} \]

A viscous fluid flows in a 0.10-m-diameter pipe such that its velocity measured 0.012 m away from the pipe wall is 0.8 m/s. If the flow is laminar, determine the centerline velocity and the flowrate.

For laminar flow in a pipe

\[ U(r) = V_c \left[ 1 - \left( \frac{2r}{D} \right)^3 \right] , \text{ where } D = 0.1 \text{ m and } U = 0.8 \text{ m/s} \]

Thus, \( 0.8 \frac{m}{s} = V_c \left[ 1 - \left( \frac{2(0.038m)}{0.1m} \right)^3 \right] \) or \( V_c = 1.89 \frac{m}{s} \) so that \[ Q = \frac{\pi}{4} D^2 V = \frac{\pi}{4} D^2 (0.5 V_c) = \frac{\pi}{4} (0.1m)^2 (0.5)(1.89 \frac{m}{s}) = 7.42 \times 10^{-3} \frac{m^3}{s} \]