8.38 Determine the thickness of the viscous sublayer in a smooth 8-in.-diameter pipe if the Reynolds number is 25,000.

\[ \delta_s = \frac{5\nu}{u^*}, \text{ where } u^* = \left( \frac{\tau_w}{\rho} \right)^{1/2} \text{ and } \tau_w = \frac{\Delta p}{4L}. \text{ Since } \Delta p = \frac{fL}{D} \frac{1}{2} \rho V^2 \]

we obtain \( \tau_w = \frac{6fV^2}{8} \) and \( u^* = \sqrt{\frac{f}{8}} V \)

Thus,

\[ \delta_s = \frac{5\nu}{\sqrt{\frac{f}{8}} V} = \frac{5\nu D}{\sqrt{\frac{f}{8}} V D}, \text{ or } \delta_s = \frac{5D}{Re \sqrt{\frac{f}{8}}} \] (1)

From Fig. 8.20, for a smooth pipe with \( Re = 2.5 \times 10^4 \), \( f = 0.024 \)

Thus, from Eq. (1)

\[ \delta_s = \frac{5 \sqrt{8} (\frac{1}{2^2} ft)}{2.5 \times 10^4 \sqrt{0.024}} = 0.00243 ft \]