

8.38

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

$\delta_s = \frac{5\nu}{u^*}$, where $u^* = \left(\frac{\tau_w}{\rho}\right)^{1/2}$ and $\tau_w = \frac{D\Delta p}{4L}$. Since $\Delta p = f \frac{L}{D} \frac{1}{2}\rho V^2$
we obtain $\tau_w = \frac{\rho f V^2}{8}$ and $u^* = \sqrt{\frac{f}{8}} V$

Thus,

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

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

Thus, from Eq. (1)

$$\delta_s = \frac{5\sqrt{8} \left(\frac{8}{12} \text{ ft}\right)}{2.5 \times 10^4 \sqrt{0.024}} = \underline{\underline{0.00243 \text{ ft}}}$$