8.33

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

$$\delta_{s} = \frac{5\nu}{U^{*}}, \text{ where } U^{*} = \left(\frac{T_{W}}{\rho}\right)^{\frac{1}{2}} \text{ and } T_{W} = \frac{D\Delta\rho}{4L}. \text{ Since } \Delta\rho = f\frac{L}{D}\frac{1}{2}\rho V^{2}$$
we obtain $T_{W} = \frac{\rho f V^{2}}{8} \text{ and } U^{*} = \sqrt{\frac{f}{8}} V$
Thus,
$$\delta_{s} = \frac{5\nu}{\sqrt{\frac{f}{8}} V} = \frac{5\nu D}{\sqrt{\frac{f}{8}} VD}, \text{ or } \delta_{s} = \frac{5D}{Re\sqrt{\frac{f}{8}}}$$
(1)

From Fig. 8.20, for a smooth pipe with $Re = 2.5 \times 10^4$, f = 0.024Thus, from Eq.(1) $\delta_S = \frac{5\sqrt{8}}{2.5 \times 10^4 \sqrt{0.024}} = 0.00243 \text{ ft}$

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