

6.89

6.89 It is known that the velocity distribution for steady, laminar flow in circular tubes (either horizontal or vertical) is parabolic. (See Video V6.6.) Consider a 10-mm diameter horizontal tube through which ethyl alcohol is flowing with a steady mean velocity 0.15 m/s. (a) Would you expect the velocity distribution to be parabolic in this case? Explain. (b) What is the pressure drop per unit length along the tube?

(a) Check Reynolds number to determine if flow is laminar:

$$Re = \frac{\rho V (2R)}{\mu} = \frac{(789 \frac{\text{kg}}{\text{m}^3})(0.15 \frac{\text{m}}{\text{s}})(0.010 \text{ m})}{1.19 \times 10^{-3} \frac{\text{N}\cdot\text{s}}{\text{m}^2}} = 995 < 2100$$

Thus, the flow is laminar and velocity distribution would be parabolic. Yes.

(b) Since the flow is laminar

$$V = \frac{R^2}{8\mu} \frac{\Delta P}{L} \quad (\text{Eq. 6.152})$$

so that

$$\frac{\Delta P}{L} = \frac{8\mu V}{R^2} = \frac{8 (1.19 \times 10^{-3} \frac{\text{N}\cdot\text{s}}{\text{m}^2})(0.15 \frac{\text{m}}{\text{s}})}{(\frac{0.010 \text{ m}}{2})^2}$$

$$= \underline{\underline{57.1 \frac{\text{N}}{\text{m}^2} \text{ per m}}}$$