

1.

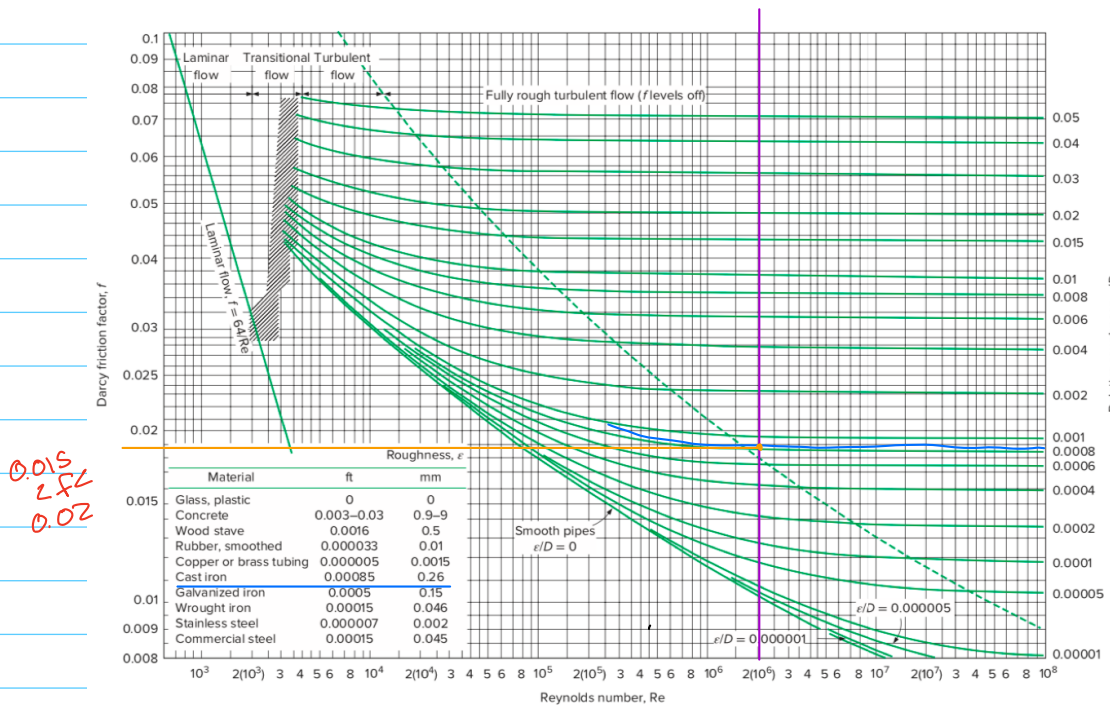


FIGURE A-27

The Moody chart for the friction factor for fully developed flow in circular pipes for use in the head loss relation $\Delta P_L = f \frac{L}{D} \frac{\rho V^2}{2}$. Friction factors in the turbulent flow are evaluated from the Colebrook equation $\frac{1}{\sqrt{f}} = -2 \log_{10} \left(\frac{\epsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f}} \right)$.

$$\text{Cast iron}$$

$$\epsilon = 0.26 \text{ mm}$$

$$D_{\text{outer}}$$

$$30 \text{ cm} = 300 \text{ mm}$$

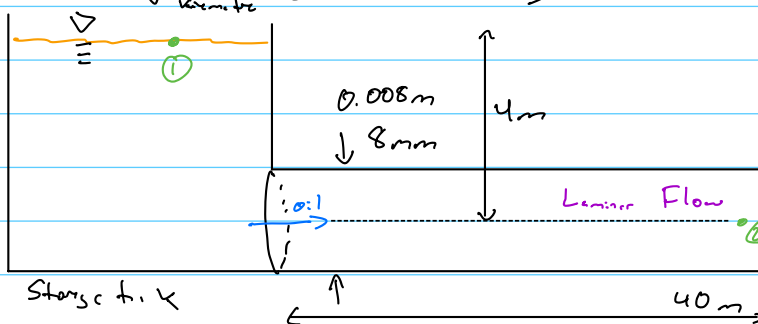
$$\frac{\epsilon}{D} = 0.00087$$

$$Re = 2 \times 10^6$$

$$3. \quad 0.1 \text{ m} \cdot \rho_{\text{air}} = 850 \frac{\text{kg}}{\text{m}^3}$$

$$V_{\text{kinetic}} = 0.00062 \frac{\text{m}^2}{\text{s}}$$

$$\mu_{\text{dynamic}} = \sqrt{V_{\text{kinetic}} \cdot \rho} = 0.00062 \frac{\text{m}^2}{\text{s}} \cdot 850 \frac{\text{kg}}{\text{m}^3} = 0.527 \frac{\text{kg}}{\text{m} \cdot \text{s}}$$



$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2$$

$$V_2 = \sqrt{2gz_1}$$

$$= \sqrt{2(9.81 \frac{\text{m}}{\text{s}^2})(4 \text{ m})}$$

$$= 8.8589 \frac{\text{m}}{\text{s}}$$

$$\Delta P_2 = \frac{32 \mu L u_{\text{avg}}}{D^2} = \frac{32 (0.527 \frac{\text{kg}}{\text{m} \cdot \text{s}}) (40 \text{ m}) (8.86 \frac{\text{m}}{\text{s}})}{(0.008 \text{ m})^2} = 433844.00 \frac{\text{kg}}{\text{m} \cdot \text{s}^2}$$

$$\Delta P_2 = 43384.400 \text{ kPa}$$

$$V_2 = 8.8589 \frac{\text{m}}{\text{s}}$$

$$Re = \frac{\rho u_{\text{avg}} D}{\mu} = \frac{850 \frac{\text{kg}}{\text{m}^3} \cdot (8.8589 \frac{\text{m}}{\text{s}}) (0.008 \text{ m})}{0.527 \frac{\text{kg}}{\text{m} \cdot \text{s}}} = 114.3084$$

$$Re = 114.3084$$