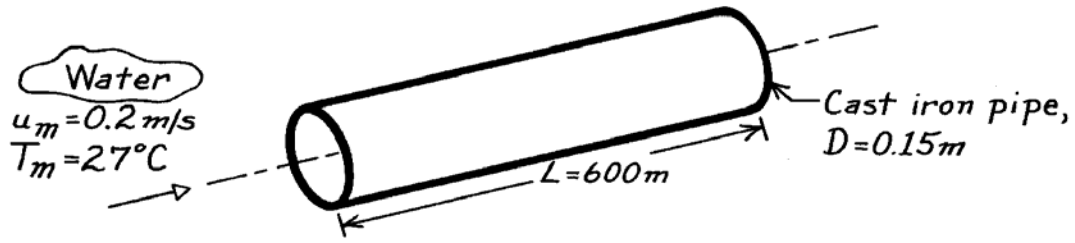
PROBLEM 8.2

KNOWN: Temperature and mean velocity of water flow through a cast iron pipe of prescribed length and diameter.

FIND: Pressure drop.

SCHEMATIC:



ASSUMPTIONS: (1) Steady-state conditions, (2) Fully developed flow, (3) Constant properties.

PROPERTIES: *Table A-6*, Water (300 K): $\rho = 997$ kg/m^3, $\mu = 855 \times 10^{-6}$ N·s/m^2.

ANALYSIS: From Eq. 8.22, the pressure drop is

$$\Delta p = f \frac{\rho\, u_m^2}{2D} L.$$

With

$$Re_D = \frac{\rho\, u_m D}{\mu} = \frac{997 \text{ kg/m}^3 \times 0.2 \text{ m/s} \times 0.15 \text{ m}}{855 \times 10^{-6} \text{ N} \cdot \text{s/m}^2} = 3.50 \times 10^4$$

the flow is turbulent and with $e = 2.6 \times 10^{-4}$ m for cast iron (see Fig. 8.3), it follows that $e/D = 1.73 \times 10^{-3}$ and from Eq. 8.20 (or Fig. 8.3)

$$\frac{1}{\sqrt{f}} = -2.0 \log\left[\frac{e/D}{3.7} + \frac{2.51}{Re_D \sqrt{f}}\right] \qquad f = 0.027$$

Hence,

$$\Delta p = 0.027 \frac{997 \text{ kg/m}^3 (0.2 \text{ m/s})^2}{2 \times 0.15 \text{ m}} (600\text{m})$$

$$\Delta p = 2154 \text{ kg/s}^2 \cdot \text{m} = 2154 \text{ N/m}^2$$

$$\Delta p = 0.0215 \text{ bar.} \qquad <$$

COMMENTS: For the prescribed geometry, $L/D = (600/0.15) = 4000 >> (x_{fd,h}/D)_{turb} \approx 10$, and the assumption of fully developed flow throughout the pipe is justified.