

10.67 What diameter of cast-iron pipe is needed to carry water at a rate of 10 cfs between two reservoirs if the reservoirs are 2 mi apart and the elevation difference between the water surfaces in the reservoirs is 20 ft?

Solution:

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$$

$$z_1 = z_2 + f \frac{L V^2}{D 2g}$$

Since $Q = VA$ $V = \frac{4Q}{\pi D^2}$ $V^2 = \frac{16Q^2}{\pi^2 D^4}$

$$20 = f \frac{L}{D} \frac{16Q^2}{\pi^2 D^4} \frac{1}{2g}$$

$$D^5 = fL \frac{16}{20\pi^2} \frac{Q^2}{2g} = 1329f$$

Given f , e.g., $f = 0.02$

$$D = 1.93 \text{ ft}$$

$$V = 3.43 \text{ ft/s}$$

$$\text{Re} = \frac{VD}{\nu} = 5.5 \times 10^5$$

$$k_s/D = 0.015$$

$f = 0.0175$ from Moody diagram

$$D^5 = 0.0175 \times 1329$$

$$D = 1.88' = 22.5''$$

Therefore use $D = 24''$ or 2' pipe