8.85  When water flows from the tank shown in Fig. P8.85, the water depth in the tank as a function of time is as indicated. Determine the cross-sectional area of the tank. The total length of the 0.60-in.-diameter pipe is 20 ft, and the friction factor is 0.03. The loss coefficients are: 0.50 for the entrance, 1.5 for each elbow, and 10 for the valve.

\[
\frac{\rho}{\gamma} + z_1 + \frac{V_1^2}{2g} - h_L = \frac{\rho}{\gamma} + z_2 + \frac{V_2^2}{2g}
\]

where

\[
p_1 = \rho_2 = 0, \quad z_2 = 0, \quad z_1 = 3f + h, \quad V_1 = 0, \quad V_2 = V \text{ and } h_L = \left(f \frac{L}{D} + \sum K_i \right) \frac{V_1^2}{2g}
\]

with \( \sum K_i = 0.5 + 5(1.5) + 10 = 18 \)

Thus,

\[
z_1 = h_L + \frac{V_1^2}{2g} = \left(f \frac{L}{D} + \sum K_i \right) \frac{V_1^2}{2g}
\]

Consider the flow when \( h = 1.5 \) ft so that \( z_1 = 4.5 \) ft

Hence,

\[
4.5 \text{ ft} = (0.03 \frac{20H}{9.81H} + 18 + 1) \frac{V^2}{2(32.2 H^3 \text{ ft}^3)}
\]

or

\[
V = 3.06 \frac{ft}{s} \quad \text{so that} \quad Q = AV = \pi \left(0.6 \frac{ft}{s}\right)^2 \left(3.06 \frac{ft}{s}\right) = 0.00601 \frac{ft^3}{s}
\]

But \( Q = A_{\text{tank}} \left(-\frac{dh}{dt}\right) \)

where from the graph

\[
\frac{dh}{dt} \approx \frac{-1ft}{250s} = -0.004 \frac{ft}{s}
\]

Hence,

\[
0.00601 \frac{ft^3}{s} = A_{\text{tank}} \left(0.004 \frac{ft}{s}\right)
\]

or

\[
A_{\text{tank}} = 1.50 \text{ ft}^2
\]