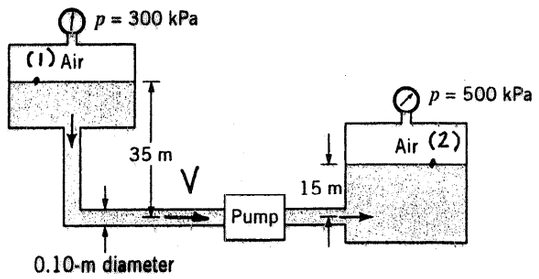
5.94

5.94 Water is pumped steadily through a 0.10-m-diameter pipe from one closed, pressurized tank to another as shown in Fig. P5.94. The pump adds 4.0 kW to the water and the head loss of the flow is 10 m. Determine the velocity of the water leaving the pipe.



■ FIGURE P5.94

From the energy equation,

(1) $\frac{p_1}{\gamma} + z_1 + \frac{V_1^2}{2g} + h_s - h_L = \frac{p_2}{\gamma} + z_2 + \frac{V_2^2}{2g}$, where $z_1 = 35\,m$, $z_2 = 15\,m$, $V_1 = 0$, $V_2 = 0$, and $h_L = 10\,m$.

Also, $h_s = \frac{\dot{W}_s}{\gamma Q} = \frac{4 \times 10^3 \frac{N \cdot m}{s}}{(9.80 \times 10^3 \frac{N}{m^3})Q} = 0.408/Q$, where h_s ~ m when Q ~ m^3/s.

Thus, Eq. (1) becomes

$$\left(\frac{300 \times 10^3 \frac{N}{m^2}}{9.80 \times 10^3 \frac{N}{m^3}}\right) + 35\,m + \left(\frac{0.408}{Q}\,m\right) - 10\,m = \left(\frac{500 \times 10^3 \frac{N}{m^2}}{9.80 \times 10^3 \frac{N}{m^3}}\right) + 15\,m$$

which gives

$$Q = 0.0392 \frac{m^3}{s} = AV$$

Hence,

$$V = \frac{Q}{A} = \frac{0.0392 \frac{m^3}{s}}{\frac{\pi}{4}(0.1m)^2} = \underline{\underline{4.99 \frac{m}{s}}}$$