$$(12)(\pi)(0.08^2)/4 = (0.10)(0.3016) + V_2(\pi)(0.08^2)/4 \qquad \mathbf{V_2 = 6\ m/s} \quad \textit{Ans.}\ \text{(b)}$$

(c) Setting the outflow V2 to 9 m/s, the wall suction velocity is,

$$(12)(\pi)(0.08^2)/4 = (v_w)(0.3016) + (9)(\pi)(0.08^2)/4 \qquad \mathbf{v_w = 0.05\ m/s = 5\ cm/s}\ \textbf{\textit{out}}$$

3.11 A room contains dust at uniform concentration $C = \rho_{dust}/\rho$. It is to be cleaned by introducing fresh air at an inlet section A_i, V_i and exhausting the room air through an outlet section. Find an expression for the rate of change of dust mass in the room.

Solution: This problem is very similar to Prob. 3.9 on the previous page, except that here $C_i = 0$ (dustfree air). Refer to the figure in Prob. 3.9. The dust mass relation is

$$\left.\frac{dM_{dust}}{dt}\right|_{system} = 0 = \frac{d}{dt}\left(\int_{CV} \rho_{dust}\, d\upsilon\right) + C_{out}\dot{m}_{out} - C_{in}\dot{m}_{in},$$

$$\text{or, since } C_{in} = 0, \text{ we obtain } \left.\frac{dM_{dust}}{dt}\right|_{CV} = \mathbf{-C\rho A_o V_o} \quad \textit{Ans.}$$

To complete the analysis, we would need to make an *overall* fluid mass balance.

3.12 The pipe flow in Fig. P3.12 fills a cylindrical tank as shown. At time t = 0, the water depth in the tank is 30 cm. Estimate the time required to fill the remainder of the tank.

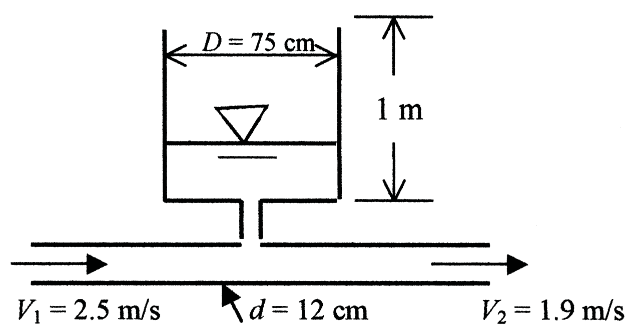

Fig. P3.12

Solution: For a control volume enclosing the tank and the portion of the pipe below the tank,

$$\frac{d}{dt}\left[\int \rho\, dv\right] + \dot{m}_{out} - \dot{m}_{in} = 0$$

$$\rho\pi R^2 \frac{dh}{dt} + (\rho A V)_{out} - (\rho A V)_{in} = 0$$

$$\frac{dh}{dt} = \frac{4}{998(\pi)(0.75^2)}\left[998\left(\frac{\pi}{4}\right)(0.12^2)(2.5-1.9)\right] = 0.0153\ m/s,$$

$$\Delta t = 0.7/0.0153 = \mathbf{46\ s} \quad \textit{Ans.}$$
