$$(12)(\pi)(0.08^2)/4 + (0.10)(0.3016) = V_2(\pi)(0.08^2)/4 \qquad \mathbf{V_2 = 18\ m/s} \quad \textit{Ans.}\ (b)$$

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

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

P3.11 The inlet section of a vacuum cleaner is a rectangle, 1 inch by 5 inches. The blower is able to provide suction at 25 cubic feet per minute. (*a*) What is the average velocity at the inlet, in m/s? (*b*) If conditions are sea level standard, what is the mass flow of air, in kg/s?

Solution: (*a*) Convert 25 ft^3/min to 25/60 = 0.417 ft^3/s. Then the inlet velocity is

$$V_{inlet} = \frac{Q}{A_{inlet}} = \frac{0.417\ ft^3/s}{(1/12\ ft)(5/12\ ft)} = 12.0\frac{ft}{s} \times 0.3048\frac{m}{ft} = \mathbf{3.66}\ \frac{m}{s} \qquad Ans.(a)$$

(*b*) At sea level, ρ_{air} = 1.2255 kg/m^3. Convert 25 ft^3/min to 0.0118 m^3/s. Then

$$\dot{m}_{air} = \rho_{air} Q = (1.2255\frac{kg}{m^3})(0.0118\frac{m^3}{s}) = \mathbf{0.0145}\ \frac{kg}{s} \qquad Ans.(b)$$

P3.12 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.

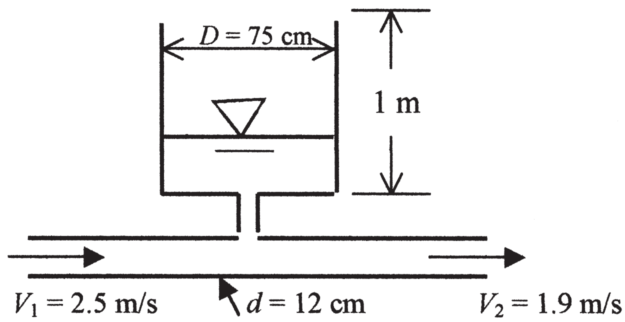

Fig. P3.12

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

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

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

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

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