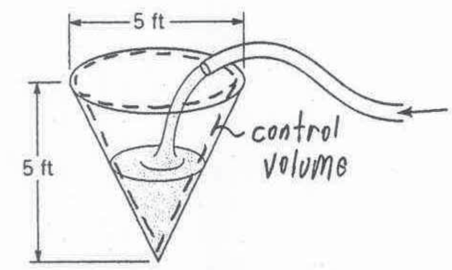
5.27

5.27 Estimate the time required to fill with water a cone-shaped container (see Fig. P5.27) 5 ft high and 5 ft across at the top if the filling rate is 20 gal/min.



■ FIGURE P5.27

From application of the conservation of mass principle to the control volume shown in the figure we have

$$\frac{\partial}{\partial t}\int_{CV} \rho \, d\forall + \int_{CS} \rho \vec{V} \cdot \hat{n} \, dA = 0$$

For incompressible flow

$$\frac{\partial \forall}{\partial t} - Q = 0$$

or

$$\int_0^{\forall} d\forall = Q \int_0^{t} dt$$

Thus

$$t = \frac{\forall}{Q} = \frac{\pi D^2 h}{12\,Q} = \frac{\pi (5\text{ ft})^2 (5\text{ ft})\left(1728\ \frac{\text{in.}^3}{\text{ft}^3}\right)}{(12)\left(20\ \frac{\text{gal}}{\text{min}}\right)\left(231\ \frac{\text{in.}^3}{\text{gal}}\right)}$$

and

$$t = \underline{\underline{12.2\text{ min}}}$$