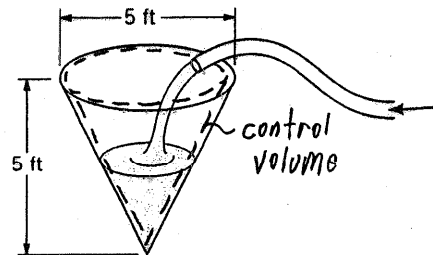


5.22

5.22 Estimate the time required to fill with water a cone-shaped container (see Fig. P5.22) 5 ft high and 5 ft across at the top if the filling rate is 20 gal/min.



■ FIGURE P5.22

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

$$\frac{\partial}{\partial t} \int_{cv} \rho dV + \int_{cs} \rho \vec{V} \cdot \hat{n} dA = 0$$

For incompressible flow

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

or

$$\int_0^V dV = Q \int_0^t dt$$

Thus

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

and

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