Thus, the critical velocity is equivalent to the overflow rate or surface loading rate. A common basis of design for discrete particle settling recognizes that the flow capacity is independent of the depth.

For continuous-flow sedimentation, the length of the basin and the time a unit volume of water is in the basin (detention time) should be such that all particles with the design velocity v_c will settle to the bottom of the tank. The design velocity, detention time, and basin depth are related as follows:

$$v_c = \frac{\text{depth}}{\text{detention time}} \tag{5–26}$$

In actual practice, design factors must be adjusted to allow for the effects of inlet and outlet turbulence, short circuiting, sludge storage, and velocity gradients due to the operation of sludge-removal equipment. These design factors are discussed in Sec. 5–7. In the above discussion ideal settling conditions have been assumed.

Idealized discrete particle settling in three different types of settling basins is illustrated on Fig. 5–22. Particles that have a velocity of fall less than v_c will not all be removed during the time provided for settling. Assuming that the particles of various sizes are uniformly distributed over the entire depth of the basin at the inlet, it can be seen from an analysis of the particle trajectory on Fig. 5–23 that particles with a settling velocity less than v_c will be removed in the ratio

$$X_r = \frac{v_p}{v_c} \tag{5–27}$$

where X_r is the fraction of the particles with settling velocity v_p that are removed.

In most suspensions encountered in wastewater treatment, a large gradation of particle sizes will be found. To determine the efficiency of removal for a given settling time, it is necessary to consider the entire range of settling velocities present in the system. The settling velocities of the particles can be obtained by use of a settling column test. The particle settling data are used to construct a velocity settling curve as shown on Fig. 5–24.

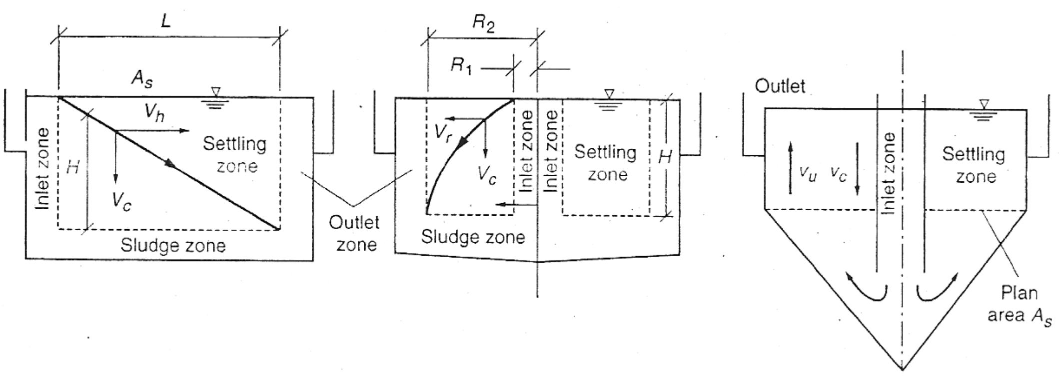

Figure 5–22

Definition sketch for the idealized settling of discrete particles in three different types of settling basins: (a) rectangular, (b) circular, and (c) upflow. *(Crites and Tchobanoglous, 1998.)*