method of analysis is illustrated in Sec. 8–7 in Chap. 8, and additional information may be found in the following references: Dick and Ewing (1967); Dick and Young (1972); Keinath (1989); Wahlberg and Keinath (1988); and Yoshika et al. (1957).

Compression Settling

The volume required for the sludge in the compression region can also be determined by settling tests. The rate of consolidation has been found to be proportional to the difference in the depth at time t and the depth to which the sludge will settle after a long period of time. The long-term consolidation can be modeled as a first-order decay function, as given by Eq. (5–43).

$$H_t - H_\infty = (H_2 - H_\infty)e^{-i(t-t_2)} \qquad (5\text{–}43)$$

where H_t = sludge height at time t, L
H_∞ = sludge depth after long settling period, on the order of 24 h, L
H_2 = sludge height at time t_2, L
i = constant for a given suspension

Stirring serves to compact solids in the compression region by breaking up the floc and permitting water to escape. Rakes are often used on sedimentation equipment to manipulate the solids and thus produce better compaction.

Gravity Separation in an Accelerated Flow Field

Sedimentation, as described previously, occurs under the force of gravity in a constant acceleration field. The removal of settleable particles can also be accomplished by taking advantage of a changing acceleration field. A number of devices that take advantage of both gravitational and centrifugal forces and induced velocities have been developed for the removal of grit from wastewater. The principles involved are illustrated on Fig. 5–30. In appearance, the separator looks like a large diameter cylinder with a conical bottom. Wastewater, from which grit is to be separated, is introduced tangentially near the top and exits through the opening in the top of the unit. The liquid is removed at the top. Grit is removed through an opening in the bottom of the unit.

Because the top of the separator is enclosed, the rotating flow creates a free vortex within the separator. The most important characteristic of a free vortex is that the product of the tangential velocity times the radius is a constant:

$$Vr = \text{constant} \qquad (5\text{–}44)$$

where V = tangential velocity, LT^{-1} (m/s)
r = radius, L (m)

The significance of Eq. (5–44) can be illustrated by the following example. Assume the tangential velocity in a separator with a 1.5 m (5 ft) radius is 0.9 m/s (3 ft/s). The product of the velocity times the radius at the outer edge of the separator is equal to 1.35 m^2/s (15 ft^2/s). If the discharge port has a radius of 0.9 m (1 ft), then the tangential velocity at the entrance to the discharge port is 4.5 m/s (15 ft/s). The centrifugal force experienced by a particle within this flow field is equal to the square of the velocity divided by the radius. Because the centrifugal force is also proportional to the inverse of the radius, a fivefold decrease in the radius results in a 125-fold increase in the centrifugal force.