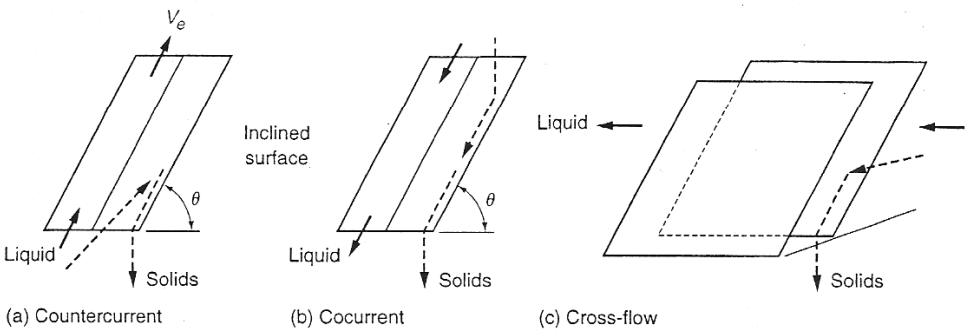
Figure 5–26

Alternative flow patterns through tube settlers: (*a*) countercurrent with respect to the movement of solids, (*b*) cocurrent with the respect to the movement of solids, and (*c*) cross-flow. *(AWWA, 1999.)*



Inclined settling systems are generally constructed for use in one of three ways with respect to the direction of liquid flow relative to the direction of particle settlement: (1) countercurrent, (2) cocurrent, and (3) cross-flow. The flow patterns are shown schematically on Fig. 5–26.

Countercurrent Settling. With countercurrent flow, wastewater suspension in the basin passes upward through the plate or tube modules and exits from the basin above the modules (see Fig. 5–25*a*). The solids that settle out within the plates or tubes move by gravity countercurrently downward and out of the modules to the basin bottom (see Fig. 5–25*c*). Tube settlers are mostly used in the countercurrent mode.

In countercurrent settling, the time t for a particle to settle the vertical distance between two parallel inclined surfaces is (AWWA, 1999):

$$t = \frac{w}{v \cos \theta} \tag{5-33}$$

where w = perpendicular distance between surfaces, L (m)
v = settling velocity, LT^{-1} (m/s)
θ = angle of the surface inclination from the horizontal

The length of surface L_p needed to provide this time, if the liquid velocity between the surfaces is v_θ, is

$$L_p = \frac{w(v_\theta - v \sin \theta)}{v \cos \theta} \tag{5-34}$$

By rearranging this equation, all particles with a settling velocity v and greater are removed if

$$v \geq \frac{v_\theta w}{L_p \cos \theta = w \sin \theta} \tag{5-35}$$

When many plates or tubes are used

$$v_\theta = \frac{Q}{Nwb} \tag{5-36}$$

where Q = flowrate, L^3T^{-1} (m^3/s)
N = number of channels made by $N+1$ plates or tubes