Sedimentation

Sedimentation, or clarification, is the processes of letting suspended material settle by gravity. Suspended material may be particles, such as clay or silts, originally present in the source water. Suspended material or floc is typically created from materials in the water and chemicals used in coagulation or, in other treatment processes, such as lime softening (see Lime Softening chapter).

Sedimentation is accomplished by decreasing the velocity of the water to a point which the particles will no longer remain in suspension. When the velocity no longer supports the particles, gravity will remove them from the water flow.

PARTICLE SIZE

The size and type of particles to be removed have a significant effect on the operation of the sedimentation tank. Sand or silt can be removed very easily because of their density. The velocity of the water-flow channel can be slowed to less than one foot per second and most of the sand and silt will be removed by simple gravitational forces. In contrast, colloidal material (small particles that stay in suspension and make the water seem cloudy) will not settle until the material is coagulated and flocculated by adding a chemical, such as iron salt or aluminum sulfate.

The shape of the particle also affects its settling characteristics. A round particle, for example, will settle much more readily than a particle that has ragged or irregular edges. All particles also tend to have a slight electrical charge. Particles with the same charge tend to repel each other. This repelling action keeps the particles from congregating into flocs and settling.

WATER TEMPERATURE

When water temperature decreases, the rate of settling becomes slower. The result is that, as the water cools, detention time in the sedimentation tank must increase and the operator must make changes to the coagulant dosage to compensate for the decreased settling rate. In most cases, temperature does not have a significant effect on treatment. A water treatment plant has the highest flow demand in the summer when the temperatures are highest and settling rates are the best. When water is colder, the flow in the plant is at its lowest and, in most cases; detention time in the plant is increased so floc has time to settle in the sedimentation basin.

CURRENTS

Several types of water currents may occur in the sedimentation basin. Density currents are caused by the weight of solids, the concentration of solids, and the temperature of the water. Eddy currents are produced by the velocity and flow of the water coming into the basin and leaving the basin. Currents can be beneficial in that they promote sedimentation of the particles. However, currents also tend to distribute floc unevenly throughout the basin; as a result, do settle at an even rate. Current problems can be reduced by proper design of the basin and installation of baffles can help prevent currents from short circuiting the basin.

SEDIMENTATION BASIN ZONES

Most sedimentation tanks are divided into these separate zones:

Inlet Zone

The inlet or influent zone should distribute flow uniformly across the inlet to the tank. The normal design includes baffles that gently spread the flow across the total inlet of the tank and prevent short circuiting in the tank. (Short circuiting is the term used for a situation in which part of the influent water exits the tank too quickly, by flowing across the top or along the bottom of the tank.) The baffle is sometimes designed as a wall across the inlet, with holes perforated across the width of the tank.

Settling Zone

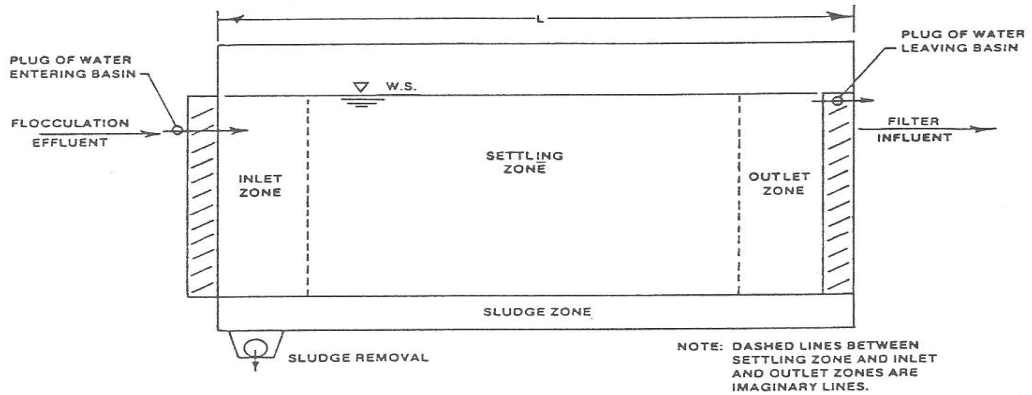
The settling zone is the largest portion of the sedimentation basin. This zone provides the calm area necessary for the suspended particles to settle.

Sludge Zone

The sludge zone, located at the bottom of the tank, provides a storage area for the sludge before it is removed for additional treatment or disposal. Basin inlets should be designed to minimize high flow velocities near the bottom of the tank. If high flow velocities are allowed to enter the sludge zone, the sludge could be swept up and out of the tank. Sludge is removed for further treatment from the sludge zone by scraper or vacuum devices which move along the bottom.

Outlet Zone

The basin outlet zone (or launder) should provide a smooth transition from the sedimentation zone to the outlet from the tank. This area of the tank also controls the depth of water in the basin. Weirs set at the end of the tank control the overflow rate and prevent the solids from rising to the weirs and leaving the tank before they settle out. The tank needs enough weir length to control the overflow rate, which should not exceed 20,000 gallons per day per foot of weir.



Sedimentation basin zones

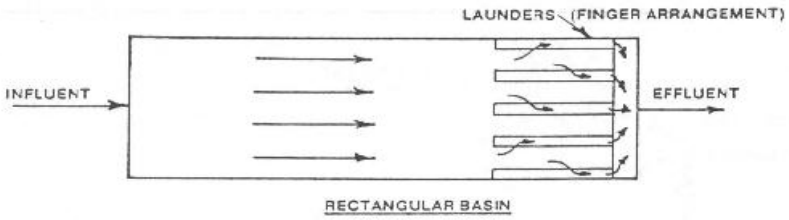
SELECTION OF BASIN

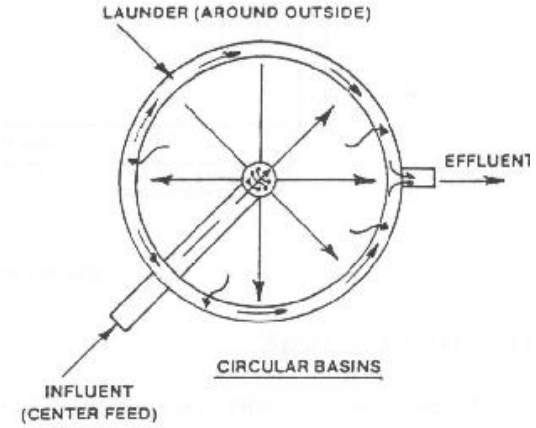
There are many sedimentation basin shapes including rectangular, circular, and square.

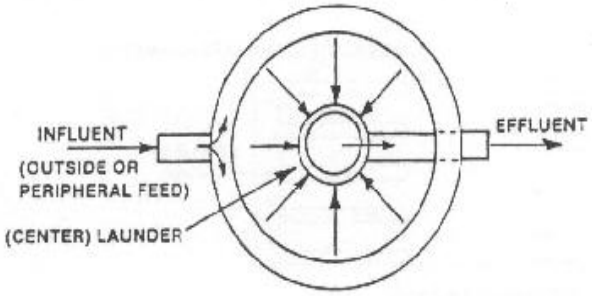
Rectangular Basins

Rectangular basins are commonly found in large-scale water treatment plants. Rectangular tanks are popular as they tend to have:

- High tolerance to shock overload
- Predictable performance
- Cost effectiveness due to lower construction cost
- Lower maintenance
- Minimal short circuiting

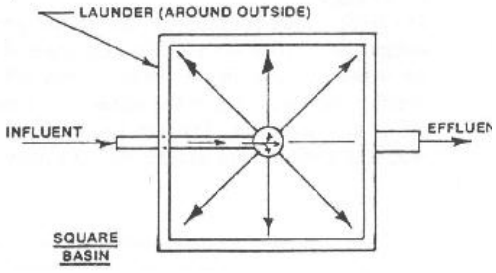






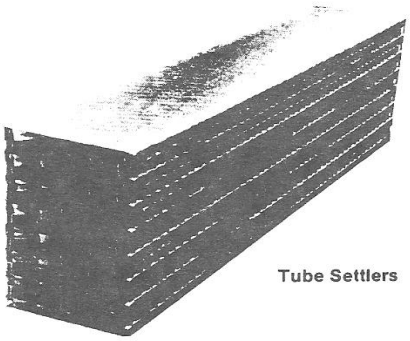
Circular and Square Basins

Circular basins are often referred to as clarifiers. These basins share some of the performance advantages of the rectangular basins, but are generally more prone to short circuiting and particle removal problems. For square tanks the design engineer must be certain that some type of sludge removal equipment for the corners is installed.

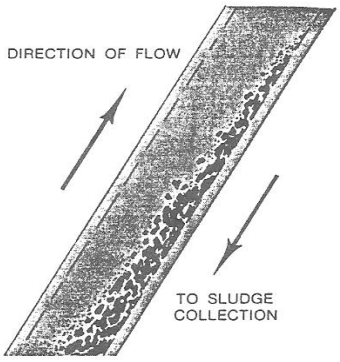


HIGH-RATE TUBE SETTLERS

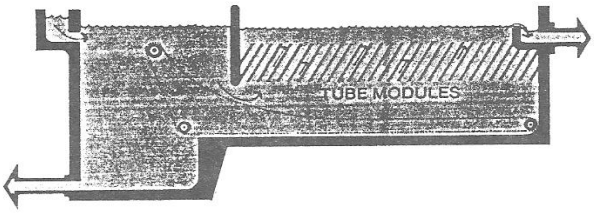
High rate tube settlers are designed to improve the characteristics of the rectangular basin and to increase flow through the tank. The tube settlers consist of a series of tubes that are installed at a 60 degree angle to the surface of the tank. The flow is directed up through the settlers. Particles have a tendency to flow at an angle different than the water and to contact the tube at some point before reaching the top of the tube. After particles have been removed from the flow and collected on the tubes, they tend to slide down the tube and back into the sludge zone.



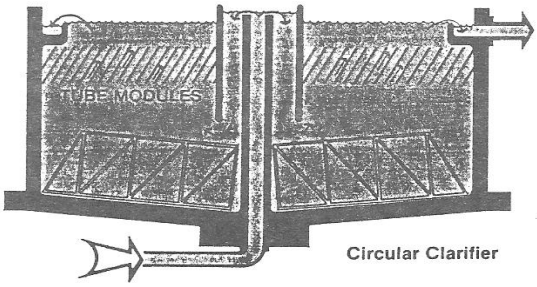
Tube Settlers



Counter-Current Flow in Tubes



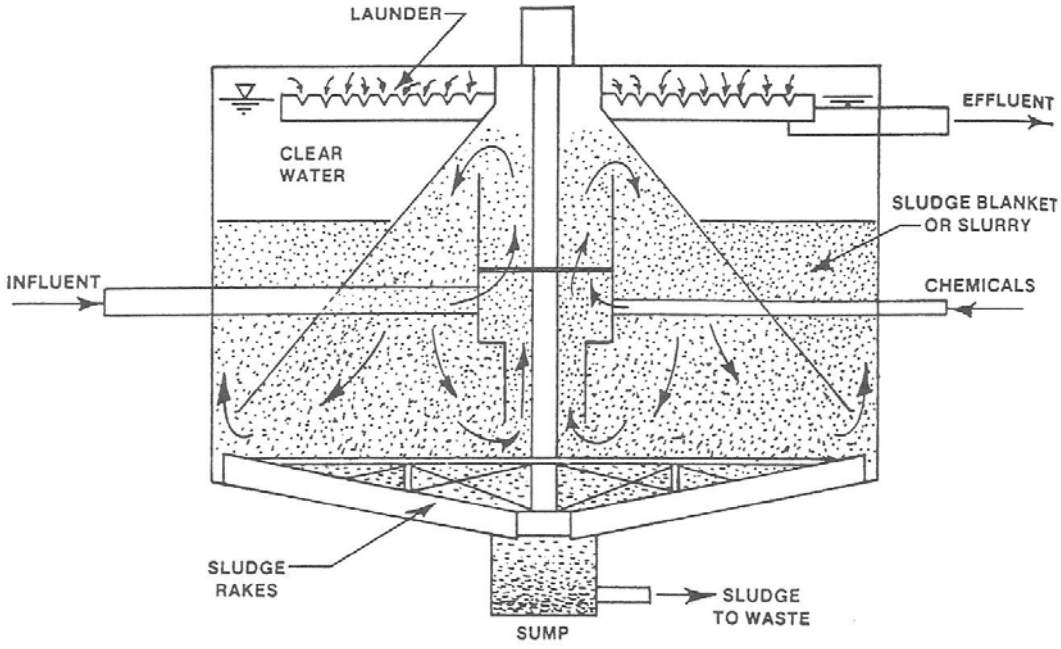
Rectangular Clarifier



Circular Clarifier

SOLIDS CONTACT UNIT

A solids contact unit combines coagulation, flocculation, and sedimentation in one unit. These units are also called upflow clarifiers or sludge-blanket clarifiers. These units are used primarily with lime-soda ash to settle floc formed during water softening. Flow is usually in an upward direction through a sludge blanket or slurry of flocculated suspended solids.



Solids-contact unit

NOTES: