1. SEDIMENTATION

Sedimentation (settling) is the separation of suspended particles that are heavier than water. The sedimentation of particles is based on the gravity force from the differences in density between particles and the fluid. Sedimentation is widely used in wastewater treatment systems. A successful sedimentation is crucial for the overall efficiency of the plant. Common examples include the removal of;

- Grit and particulate matter in the primary settling basin (settling tanks that receive raw wastewater prior to biological treatment are called primary tanks, for sedimentering).
- Sludge from the bioreactor (activated sludge process).
- Chemical flocks in the chemical step.

1.1 Types of sedimentation

There are four types of sedimentation processes

TYPE 1 (discrete particle settling)	➢ settling of discrete particles in dilute suspensions ➢ particles have no tendency to flocculate ➢ they settle as individual entities and there is no significant interaction with neighboring particles	**Example:** ➢ removal of grit and sand in wastewater treatment
TYPE 2 (flocculant settling)	➢ settling of flocculant particles in dilute suspensions ➢ as particle settle and coalesce with other particles, the sizes of particles and their settling velocity increases	**Examples:** ➢ removal of SS in primary sedimentation tanks of WWTP(Waste Water Treatment Plant) ➢ settling of chemically coagulated waters
TYPE 3 (hindered settling) or (zone settling)	➢ settling of intermediate concentration of flocculant particles ➢ particles are so close together that interparticle forces are able to hold them in fixed positions relative to each other and	**Example:** ➢ biological floc removal in secondary settling basins of WWTP

	the mass of particles settles as a zone at a constant velocity	
TYPE 4 (compression settling)	➢ settling of particles that are of such a high concentration that the particles touch each other and settling can occur only by compression which takes place from the weight of particles	**Examples:** ➢ occurs in the bottom of deep secondary clarifiers ➢ in sludge thickening facilities

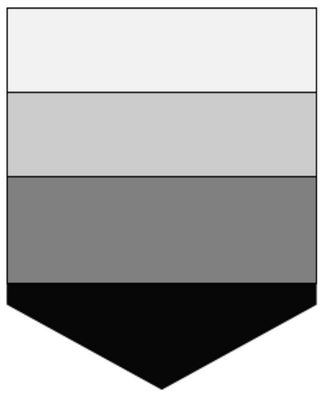

Fig: Settling phenomena in a clarifier

1.2 Factor affecting sedimentation

1.2.1 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.

1.2.2 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.

1.2.3 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.

1.3 Sedimentation Basin

1.3.1 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.

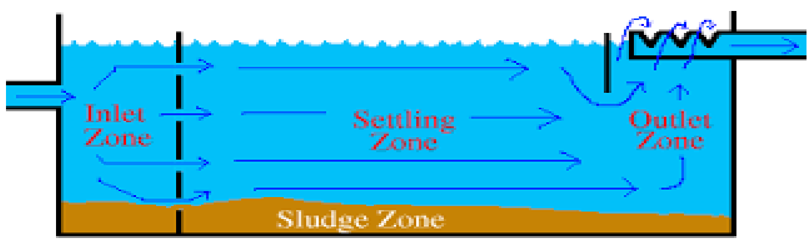

Fig: Sedimentation basin zones

1.4 Application of sedimentation

Sedimentation is used in water and wastewater treatment plants

Water Treatment

- ✓ Prior to filtration of surface water
- ✓ Prior to filtration of coagulated-flocculated water
- ✓ After adding lime and soda ash In softening of water
- ✓ In iron and manganese removal plants after treating the water

Wastewater Treatment

- ✓ Removal of SS in primary sedimentation basins
- ✓ Removal of biological floc in activated sludge processes (final sedimentation basin)
- ✓ In tertiary treatment
- ✓ Removal of humus after trickling filters (final sedimentation basins)