WATER CONTINUED

Types of Settling

Type I: ***Discrete particle settling*** - Particles settle individually without interaction with neighboring particles.
Type II: ***Flocculent Particles*** – Flocculation causes the particles to increase in mass and settle at a faster rate.
Type III: ***Hindered or Zone settling*** –The mass of particles tends to settle as a unit with individual particles remaining in fixed positions with respect to each other.
Type IV: ***Compression*** – The concentration of particles is so high that sedimentation can only occur through compaction of the structure.

Types of Settling Tanks

- Sedimentation tanks may function either intermittently or continuously.The intermittent tanks also called quiescent type tanks are those which store water for a certain period and keep it in complete rest. In a continuous flow type tank, the flow velocity is only reduced and the water is not brought to complete rest as is done in an intermittent type.
- Settling basins may be either long rectangular or circular in plan. Long narrow rectangular tanks with horizontal flow are generally preferred to the circular tanks with radial or spiral flow.

Long Rectangular Settling Basin

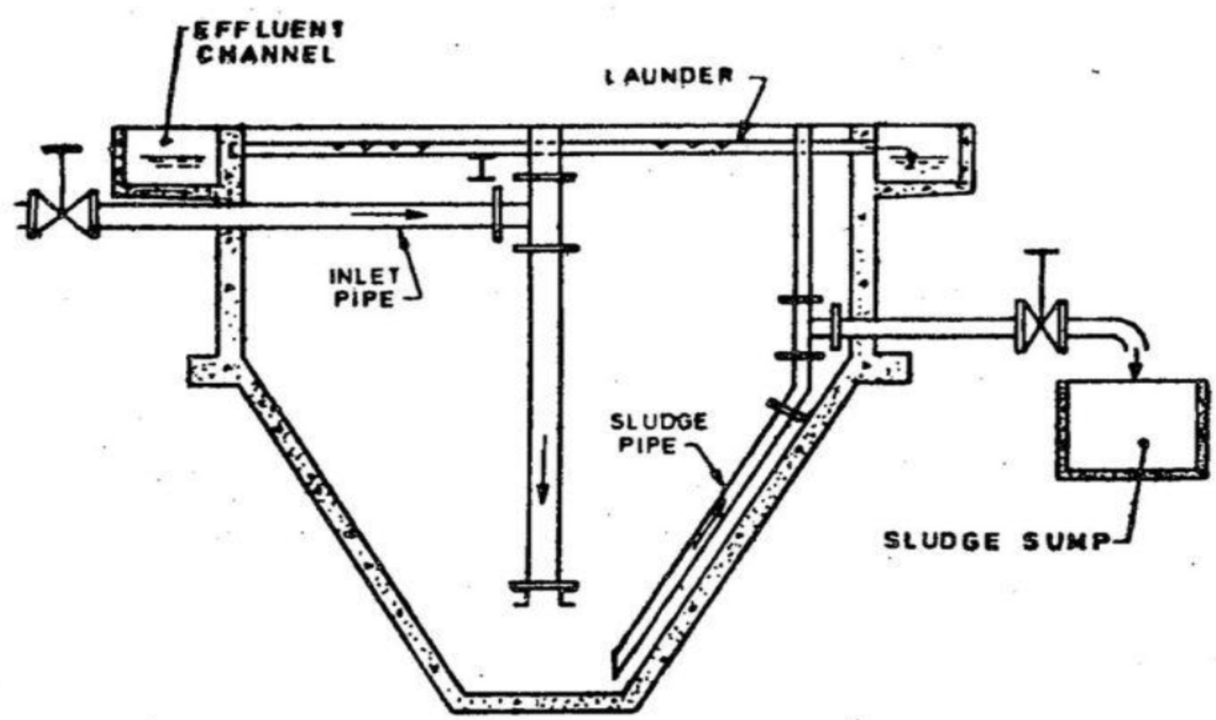
- Long rectangular basins are hydraulically more stable, and flow control for large volumes is easier with this configuration.
- A typical long rectangular tank have length ranging from 2 to 4 times their width. The bottom is slightly sloped to facilitate sludge scraping. A slow moving mechanical sludge scraper continuously pulls the settled material into a sludge hopper from where it is pumped out periodically.

A long rectangular settling tank can be divided into four different functional zones:
Inlet zone: Region in which the flow is uniformly distributed over the cross section such that the flow through settling zone follows horizontal path.
Settling zone: Settling occurs under quiescent conditions.
Outlet zone: Clarified effluent is collected and discharge through outlet weir.
Sludge zone: For collection of sludge below settling zone.

Design Details

1. Detention period: for plain sedimentation: 3 to 4 h, and for coagulated sedimentation: 2 to 2.5 h.
2. Velocity of flow: Not greater than 30 cm/min (horizontal flow).

3. Tank dimensions: L:B = 3 to 5:1. Generally L= 30 m (common) maximum 100 m. Breadth= 6 m to 10 m. Circular: Diameter not greater than 60 m. generally 20 to 40 m.
4. Depth 2.5 to 5.0 m (3 m).
5. Surface Overflow Rate: For plain sedimentation 12000 to 18000 L/d/m2 tank area; for thoroughly flocculated water 24000 to 30000 L/d/m2 tank area.
6. Slopes: Rectangular 1% towards inlet and circular 8%.



FILTRATION

The resultant water after sedimentation will not be pure, and may contain some very fine suspended particles and bacteria in it. To remove or to reduce the remaining impurities still further, the water is filtered through the beds of fine granular material, such as sand, etc. The process of passing the water through the beds of such granular materials is known as Filtration.

How Filters Work: Filtration Mechanisms

There are four basic filtration mechanisms:

sedimentation : The mechanism of sedimentation is due to force of gravity and the associate settling velocity of the particle, which causes it to cross the streamlines and reach the collector.

Interception : Interception of particles is common for large particles. If a large enough particle follows the streamline, that lies very close to the media surface it will hit the media grain and be captured.

Brownian diffusion : Diffusion towards media granules occurs for very small particles, such as

viruses. Particles move randomly about within the fluid, due to thermal gradients. This mechanism is only important for particles with diameters < 1 micron.
Inertia : Attachment by inertia occurs when larger particles move fast enough to travel off their streamlines and bump into media grains.

Filter Materials

Sand: Sand, either fine or coarse, is generally used as filter media. The size of the sand is measured and expressed by the term called effective size. *The effective size*, i.e. D_{10} may be defined as the size of the sieve in mm through which ten percent of the sample of sand by weight will pass. The uniformity in size or degree of variations in sizes of particles is measured and expressed by the term called *uniformity coefficient*. The uniformity coefficient, i.e. (D_{60}/D_{10}) may be defined as the ratio of the sieve size in mm through which 60 percent of the sample of sand will pass, to the effective size of the sand.

Gravel: The layers of sand may be supported on gravel, which permits the filtered water to move freely to the under drains, and allows the wash water to move uniformly upwards.

Other materials: Instead of using sand, sometimes, anthrafilt is used as filter media. Anthrafilt is made from anthracite, which is a type of coal-stone that burns without smoke or flames. It is cheaper and has been able to give a high rate of filtration.

Types of Filter

Slow sand filter: They consist of fine sand, supported by gravel. They capture particles near the surface of the bed and are usually cleaned by scraping away the top layer of sand that contains the particles.
Rapid-sand filter: They consist of larger sand grains supported by gravel and capture particles throughout the bed. They are cleaned by backwashing water through the bed to 'lift out' the particles.
Multimedia filters: They consist of two or more layers of different granular materials, with different densities. Usually, anthracite coal, sand, and gravel are used. The different layers combined may provide more versatile collection than a single sand layer. Because of the differences in densities, the layers stay neatly separated, even after backwashing.

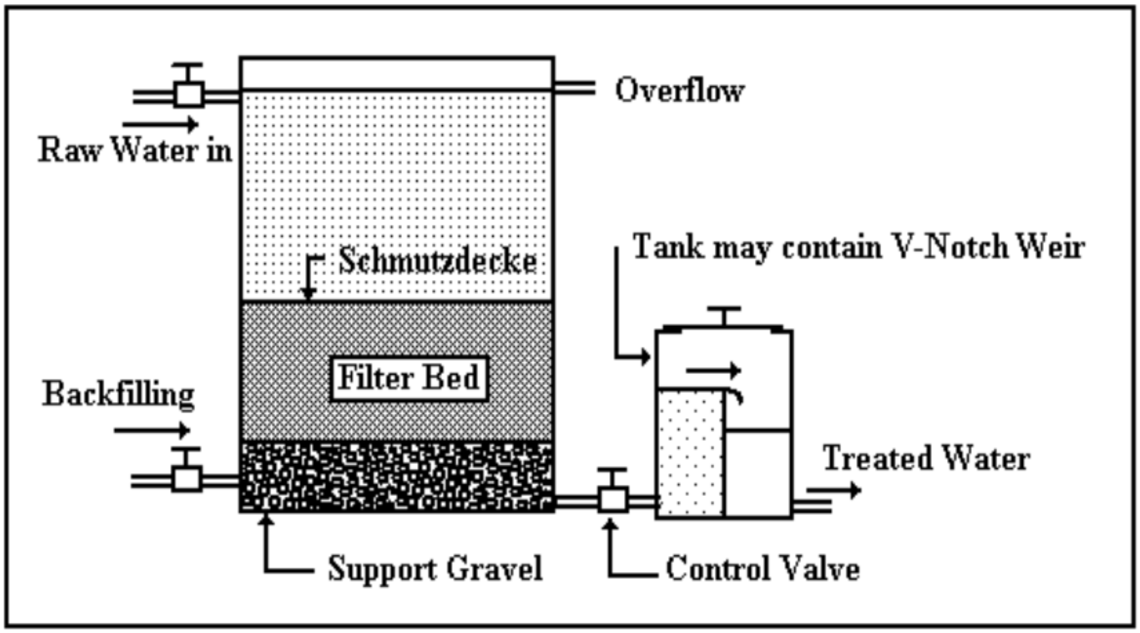
Principles of Slow Sand Filtration

- In a slow sand filter impurities in the water are removed by a combination of processes: sedimentation, straining, adsorption, and chemical and bacteriological action.
- During the first few days, water is purified mainly by mechanical and physical-chemical processes. The resulting accumulation of sediment and organic matter forms a thin layer on the sand surface, which remains permeable and retains particles even smaller than the spaces between the sand grains.
- As this layer (referred to as “Schmutzdecke”) develops, it becomes living quarters of vast numbers of micro-organisms which break down organic material retained from the water, converting it into water, carbon dioxide and other oxides.
- Most impurities, including bacteria and viruses, are removed from the raw water as it passes through the filter skin and the layer of filter bed sand just below. The purification mechanisms extend from the filter skin to approx. 0.3-0.4 m below the surface of the filter bed, gradually

decreasing in activity at lower levels as the water becomes purified and contains less organic material.

- When the micro-organisms become well established, the filter will work efficiently and produce high quality effluent which is virtually free of disease carrying organisms and biodegradable organic matter.

They are suitable for treating waters with low colors, low turbidities and low bacterial contents.



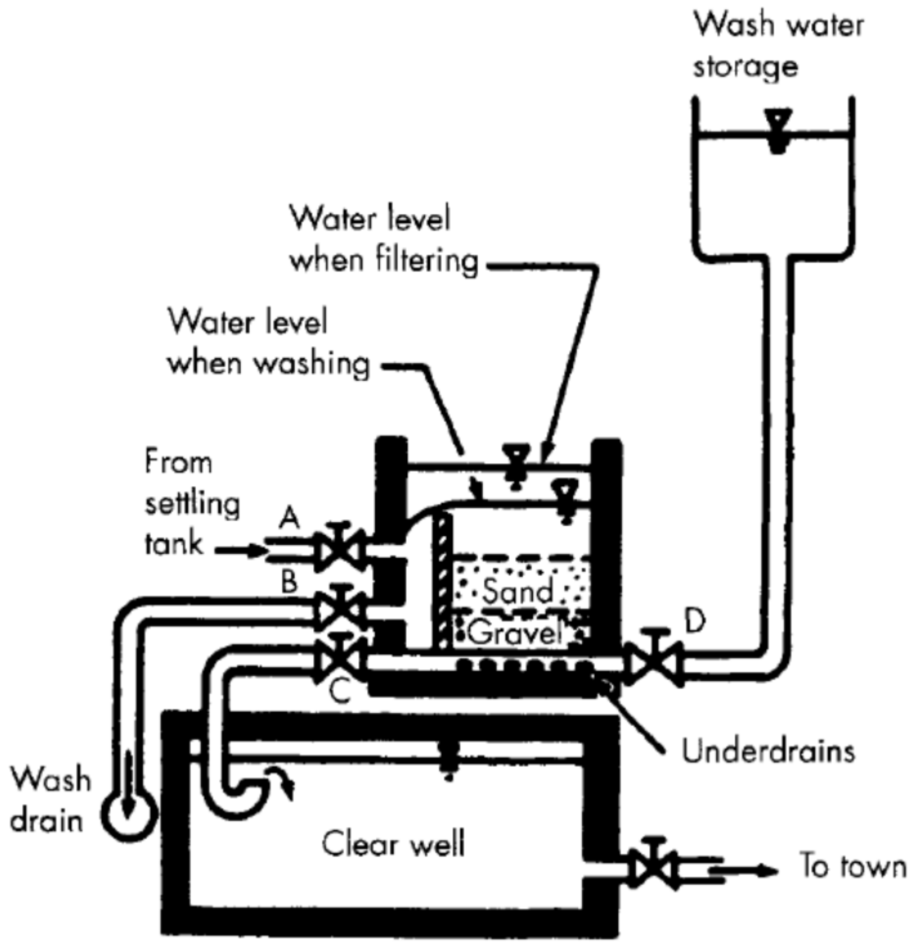
Rapid sand filter

- The movement of water into the ground and through soil particles, which helps in filtering the groundwater, and this principle is applied to water treatment.
- In almost all cases, filtration is performed by a rapid sand filter.
- As the sand filter removes the impurities, the sand grains get dirty and must be cleaned.
- The process of rapid sand filtration therefore involves two operations:

1. filtration and
2. backwashing.

Figure shows a cutaway of a slightly simplified version of the rapid sand filter.

Water from the settling basins enters the filter and seeps through the sand and gravel bed, through a false floor, and out into a clear well that stores the finished water. Valves A and C are open during filtration.



- The cleaning process is done by reversing the flow of water through the filter.
- The operator first shuts off the flow of water to the filter, closing valves A and C, then opens valves D and B, which allow wash water (clean water stored) in an elevated tank or pumped from the clear well) to enter below the filter bed.
- This rush of water forces the sand and gravel bed to expand and pushes individual sand particles into motion, rubbing against their neighbors.
- The light colloidal material trapped within the filter is released and escapes with the wash water.
- After 10 to 30 minutes of washing, the wash water is shut off and filtration is resumed.

Sand Filters vs. Rapid Sand Filters

- ***Base material:*** In SSF it varies from 3 to 65 mm in size and 30 to 75 cm in depth while in RSF it varies from 3 to 40 mm in size and its depth is slightly more, i.e. about 60 to 90 cm.
- ***Filter sand:*** In SSF the effective size ranges between 0.2 to 0.4 mm and uniformity coefficient between 1.8 to 2.5 or 3.0. In RSF the effective size ranges between 0.35 to 0.55 and uniformity coefficient between 1.2 to 1.8.
- ***Rate of filtration:*** In SSF it is small, such as 100 to 200 L/h/sq.m. of filter area while in RSF it is large, such as 3000 to 6000 L/h/sq.m. of filter area.
- ***Flexibility:*** SSF are not flexible for meeting variation in demand whereas RSF are quite flexible for

meeting reasonable variations in demand.

- ***Post treatment required:*** Almost pure water is obtained from SSF. However, water may be disinfected slightly to make it completely safe. Disinfection is a must after RSF.
- ***Method of cleaning:*** Scrapping and removing of the top 1.5 to 3 cm thick layer is done to clean SSF. To clean RSF, sand is agitated and backwashed with or without compressed air.
- ***Loss of head:*** In case of SSF approx. 10 cm is the initial loss, and 0.8 to 1.2m is the final limit when cleaning is required. For RSF 0.3m is the initial loss, and 2.5 to 3.5m is the final limit when cleaning is required.