

Unit operations:

Physical unit operations:

- Change is brought about by means of or through the application of physical forces
- Evolved directly from observations of the physical world
- The physical unit operations most commonly used are:
 - Screening
 - Comminution
 - Flow equalization
 - Mixing
 - Flocculation
 - Sedimentation
 - Flotation
 - Filtration

Application of physical unit operations in wastewater treatment:

Operation	Application
Screening	Removal of coarse and settleable solids by interception
Comminution	Grinding of coarse solids to a more or less uniform size
Flow equalization	Equalization of flow and mass loading of BOD and suspended solids
Mixing	Mixing of chemicals and passes with wastewater, and maintaining solids in suspension
Flocculation	Promotes the aggregation of small particles into large particles to enhance their removal by gravity sedimentation
Sedimentation	Removal of settleable solids and thickening of sludges
Flotation	Removal of finely divided suspended solids of particles
Filtration	Removal of fine solids remaining after other treatment
Micro screening	Same as filtration. Also removal of algae

Screening:

- Screening is a unit operation that separates materials in and/or water (found in different sizes) from water and from entering water treatment facilities and mains.
- The unit involved is called a screen.

Classification of screens:

Screens are generally classified into three based on the size of their openings in the screening element and mechanism of removal.

- Coarse screens
- Fine screens
- Micro screens

Coarse screens

Coarse screens have a clear openings ranging from 6 to 150 mm (0.25 to 6 in). It consists of parallel bars, rods or wires, wire mesh or a perforated plates with openings generally of circular or rectangular shapes. So it is also call as “bar rack” and used to remove coarse solids such as rags and large objects that may clog or cause damage to other appurtenances. Based on the **Wastewater Screening** method used to clean them, coarse screens are classified into two:

- Hand cleaned screens
- Mechanically cleaned screens

Fine screens:

In **Wastewater Screening**, Fine screens have clear openings less than 6 mm. They consisted of perforated plates, wire cloth, wedge wire elements that have smaller openings. They are also used to remove the fine solids present in the primary effluent. Fine screens are classified as:

- Static (fixed) wedge wire screen
- Rotary drum screen
- Step type screen

Microscreens Wastewater Screening:

They are rotating drum screens which have a variable low speed (upto 4 r/min), which is continuously backwashed operating in gravity flow conditions. The filtering fabrics used should have a openings ranges from 10 to 35 μ m and fitted on the periphery of the drum. The influent enters through drum lined with fabric. The solids retained are collected through backwashing and transported for disposal.

Types of screens:

There are many types of screens that can be used in water and wastewater treatment processes of which:

1. Bar or rack screens: Bar screens composed of parallel bars. Bars usually vertical or inclined
2. Band screens: Consists of a perforated belt passes over an upper and lower roller
3. Perforated plate screen: Consists of a fixed band of perforated screens
4. Wing screens: It has radial vanes which rotate on a horizontal axis
5. Disk screens: Circular perforated disk, with or without supporting bars
6. Grating screens: Consists of two sets of parallel bars
7. Mesh screens: Mesh screens composed of a fabric with mesh size depend on floating and suspending matter.

Sedimentation:

- **Sedimentation** is a physical [water treatment](#) process using [gravity](#) to remove [suspended](#) solids from water.

- Solid particles entrained by the turbulence of moving water may be removed naturally by sedimentation in the still water of lakes and oceans.
- Settling basins are ponds constructed for the purpose of removing entrained solids by sedimentation.
- Clarifiers are tanks built with mechanical means for continuous removal of solids being deposited by sedimentation.
- Clarification does not remove dissolved species. Sedimentation is the act of depositing sediment.

Common examples of application:

The removal of:

- Grit and particulate matter in the primary settling basin.
- Sludge from bioreactor
- Chemical flocs in the chemical steps

Clarification and sludge separation are the primary function of a settler or sedimentation tank.

Depending on the particles concentration and the interaction between particles, four types of settling can occur:

- Discrete particle settling: removal of sand particles
- Flocculent settling
- Hindered (Zone) settling
- Compression

Page-202, Table 6-7, Ch: Physical Unit Operations, Book: Wastewater Engg.,
Page-202.

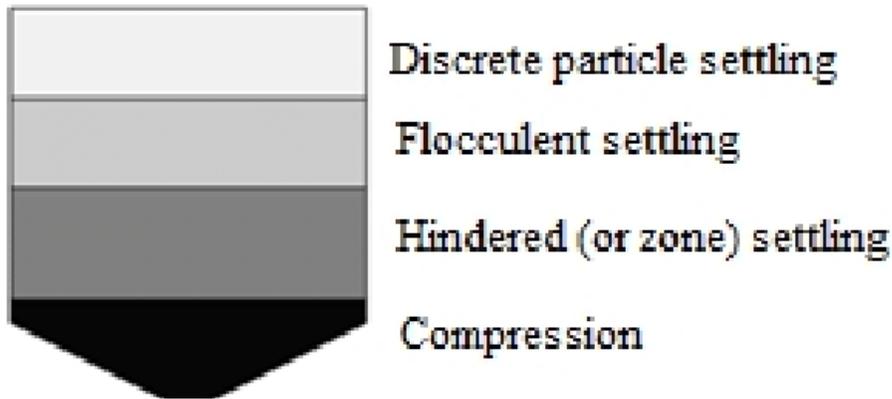


Figure: Settling phenomena in a clarifier.

Flotation:

- Is a unit operation used to separate solid or liquid particles from a liquid phase.
- By introducing fine gas (usually air) bubbles into the liquid phase
- The bubbles attached to particulate matter
- Particles having higher density than the liquid can be made to rise
- The rising of particles with lower density can also be facilitated, e.g., oil suspension in water.
- Flotation is principally used to remove
 - Suspended matter
 - To concentrate biological sludge
- Flotation Vs Sedimentation
 - Removed completely
 - Very small or light particles (that settle slowly can be removed completely)
 - In a short time

Methods:

- Dissolved-air flotation: Air injection while the liquid under pressure
- Air-flotation: Aeration at atm pressure
- Vacuum flotation: Saturation with air at atm, followed by application of vacuum to the liquid

- Chemical additives: Degree of removal can be enhanced through the use of various CA in all systems above. Inorganic chemicals, such as the aluminum and ferric salts and activated silica are commonly used.

Filtration:

- Principal unit operations used in the treatment of potable water
- Filtration effluents from wastewater –treatment process is a relatively recent practice
- Is used to remove
 - Supplemental suspended solids from wastewater effluent of biological and chemical treatment processes
- Chemically precipitated phosphorus

Filtration operation:

- Complete filtration involves two phases:
 1. Filtration: By passing the wastewater through a filter bed
 - Filter bed composed of granular material with or without the addition of chemicals
 - In granular filter bed suspended solids are removed
 - Ends when suspended solids start to increase or when a limiting head loss occurs.
 2. Backwashing:
 - Either of these conditions is reached, filtration is terminated and filter must be backwash
 - Is done by reversing the flow through the filter

Filtration process variables:

The principal variables are:

- Influent characteristics
 - Suspended solids concentration
 - Floc or particle size and distribution

- Floc strength
 - Floc or particle charge
 - Fluid properties
- Filter Medium characteristics
 - Grain size
 - Grain size distribution
 - Grain shape, density and composition
 - Medium charge
- Filtration rate
- Filter bed depth
- Filter bed porosity
- Allowable head loss