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Clarification Process

Clarifiers are primarily used in the water and wastewater treatment industries to separate solids from liquids in effluent streams.

Settling tank or Sedimentation tank

Sedimentation tank, component of a modern system of water supply or wastewater treatment. A sedimentation tank allows suspended particles to settle out of water or wastewater as it flows slowly through the tank, thereby providing some degree of purification. A layer of accumulated solids, called sludge, forms at the bottom of the tank and is periodically removed. In drinking-water treatment, coagulants are added to the water prior to sedimentation in order to facilitate the settling process, which is followed by filtration and other treatment steps. In modern sewage treatment, primary sedimentation must be followed by secondary treatment (e.g., trickling filter or activated sludge) to increase purification efficiencies. Sedimentation is usually preceded by treatment using bar screens and grit chambers to remove large objects and coarse solids.

Criteria for sizing clarifier (settling tank) are:

- Overflow rate (surface settling rate)
- Tank depth at the side wall
- Detention time

A) Overflow rate (Surface Settling Rate)

- defined as the average daily flow rate divided by the surface area of the tank

$$V_o = \frac{Q}{A}$$

Where,

Vo = overflow rate (surface settling rate)
Q = average daily flowrate (m^3/day)
A = total surface area of the tank (m^2)

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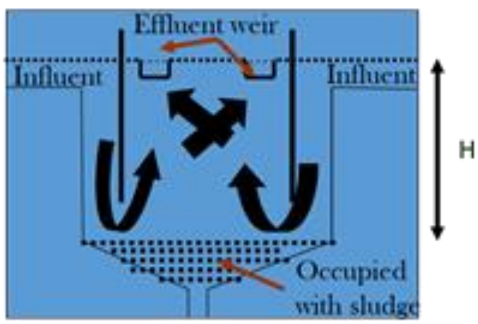
B) Depth of Tank

- taken as the water depth at the side wall measuring from the tank bottom to the top of the overflow weir.
- then exclude that additional depth resulting from slightly sloping bottom that is provided in both circular and rectangular clarifiers.



C) Detention Time

- is compute by dividing tank volume by influent flow.

Where,

$$t_d = \frac{V}{Q}$$

Where,

td = detention time
V = tank volume
Q = average daily flowrate

Flotation

- Use for the removal of lighter SS, oil & grease.
- Also for the SEPARATION (separate both the fine solid and a liquid particles from the liquid phase) and CONCENTRATION OF SLUDGE
- The separation of particles takes place near the top of the tank, at the surface level of liquid.
- Thus, the operation is just the opposite of that of gravity sedimentation where particles get removed at the bottom of the tank.

Floatation Systems

Depending on the method of forming the air bubbles in the tank or recycling the waste floatation is achieved by any one of the following systems:

Systems Based on Formation of Air Bubbles

- Air Floatation : air bubbles are formed by introducing the air in the form of gas phase directly into the liquid phase either by a revolving impeller or through air diffusers at the atm pressure.
- Vacuum flotation: ww is first saturated with air either directly in the aeration tank or by introducing air at the pump side. Then partial vacuum is applied so that dissolved air can come out of solution as minute bubbles. The air bubbles and particles attached to them then rise to the surface forming a scum blanket.
- Dissolved air flotation : flotation is achieved first by dissolving the air in the ww or in a portion of treated effluent (liquid) under high pressure in the pressurizing or retention tank and then reducing the pressure of he ww through a pressure-reducing valve to atmospheric level during feeding it to the flotation tank to form the rising air bubbles.

Filtration

- Employ for the removal of SS, following coagulation in physical-chemical treatment or as tertiary treatment following the biological WW treatment process
- SS are removed on the surface of the filter staining and through the depth of a filter by both staining and adsorption.
- The efficiency of filtration process is a function of;
- The conc and characteristics of the solid in suspension
- Characteristic of a filter media & other filtration aid
- The method of a filter operation

MATERIAL	SHAPE	RELATIVE DENSITY	POROSITY (%)	EFFECTIVE SIZE (mm)
Silica sand	Rounded	2.65	42	0.4-1.0
Silica sand	Angular	2.65	53	0.4-1.0
Ottawa sand	Spherical	2.65	40	0.4-1.0
Silica gravel	Rounded	2.65	40	1.0-5.0
anthracite	Angular	1.5-1.7	55	0.4-1.4
garnet	angular	3.1-4.3	46	0.2-0.4

Membrane Process

Membrane filtration typically utilizes a selectively-permeable membrane to separate oligomers of different molecular sizes. The advantages of using this method are retained structural integrity of PAs at room temperature, simplicity, and decreased production of laboratory waste. The disadvantages are the high cost of the membrane and slow filtration speed. According to pore size or molecular weight cutoff, filtration membranes are classified into different types, such as microfiltration, ultrafiltration, nanofiltration, and reverse osmosis membranes

Microfiltration (MF)

In microfiltration, suspended solids, bacteria and fat globules are normally the only substances not allowed to pass through. Microfiltration is a membrane filtration method where a membrane filter is placed with a pore size of 0.10 to 1.0 micron. The effect of microfiltration at PB is based on a pressure difference. This pressure difference occurs between the liquid that contains all harmful particles, substances and bacteria, and the filtered liquid. With a required pressure of 0.1 to 2.5 bar, the contaminated liquid is pressed through the membrane. Thanks to the pore size of the membrane, all undissolved substances, particles and bacteria (with a pore size greater than 0.10 microns) will be removed from the liquid. A microfiltration membrane filter is often used as pre filter for ultrafiltration.

Ultrafiltration (UF)

Ultrafiltration involves using membranes in which the pores are larger and the pressure is relatively low. Salts, sugars, organic acids and smaller peptides are allowed to pass, while proteins, fats and polysaccharides are not. Ultrafiltration removes substances in a liquid with the aid of a pressure difference. Where microfiltration is only able to reduce bacteria from liquids, an ultrafiltration membrane can also reduce unresolved viruses from liquids. The membrane filter of ultrafiltration contains pores with a size of 0.01 to 0.10 microns. With a required pressure of 0.5 to 2.5 bar, the contaminated liquid is pressed through the membrane. Ultrafiltration gives PB the ability to reduce the bacteria to LOG 6 and viruses to LOG 4 from drinking water with membrane filtration, without the risk of growth.

Nano filtration (NF)

Nanofiltration allows small ions (eg minerals) to pass through while excluding larger ions and most organic components (eg, bacteria, spores, fats, proteins, gums and sugars). If nanofiltration is used as a filtration method, not only undissolved substances, but also dissolved substances like chalk and PFAS can be removed. Micropollutants and polyvalent ions are removed from the liquid using a membrane with a pore size of 0.01 to 0.001 micron and a required pressure of 5 to

15 bar. PB delivers nanofiltration as well, contact one of our specialists for more information on nanofiltration.

Nanofiltration (NF) VS Reverse osmosis (RO)

Nanofiltration is not as fine a separation process as reverse osmosis, and uses membranes that are slightly more open.

Reverse osmosis (RO)

Reverse osmosis uses the tightest possible membrane in liquid separation. In principle, water is the only material that can permeate the membrane. All other materials (bacteria, spores, fats, proteins, gums, salts, sugars, minerals etc.) will be unable to pass through. With reverse osmosis, we hardly speak of membrane filtration anymore. Reverse Osmosis is very similar to distillation. The reverse osmosis membrane filter has a pore size of less than 0.001 microns. This pore size is very small, so that a separation based on diffusion takes place. With a required pressure of 10 to 70 bar, both micro-impurities, polyvalent ions (dissolved substances) and single ions (dissolved salts) are removed from the liquid. Only gases and low-molecular substances can (partially) pass through the membrane filter of reverse osmosis.

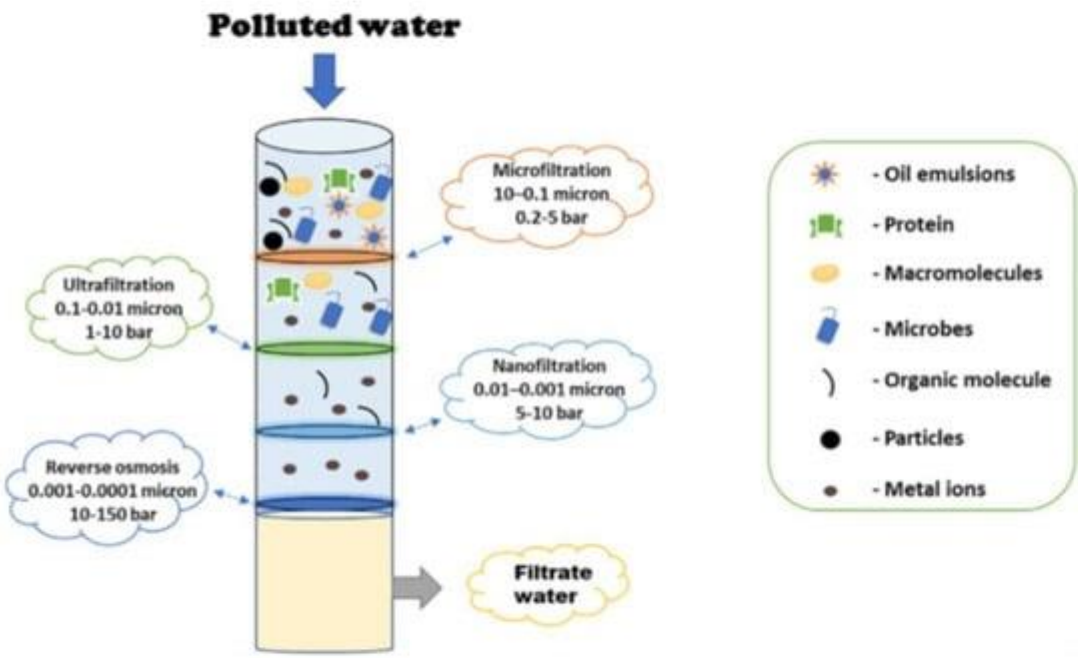
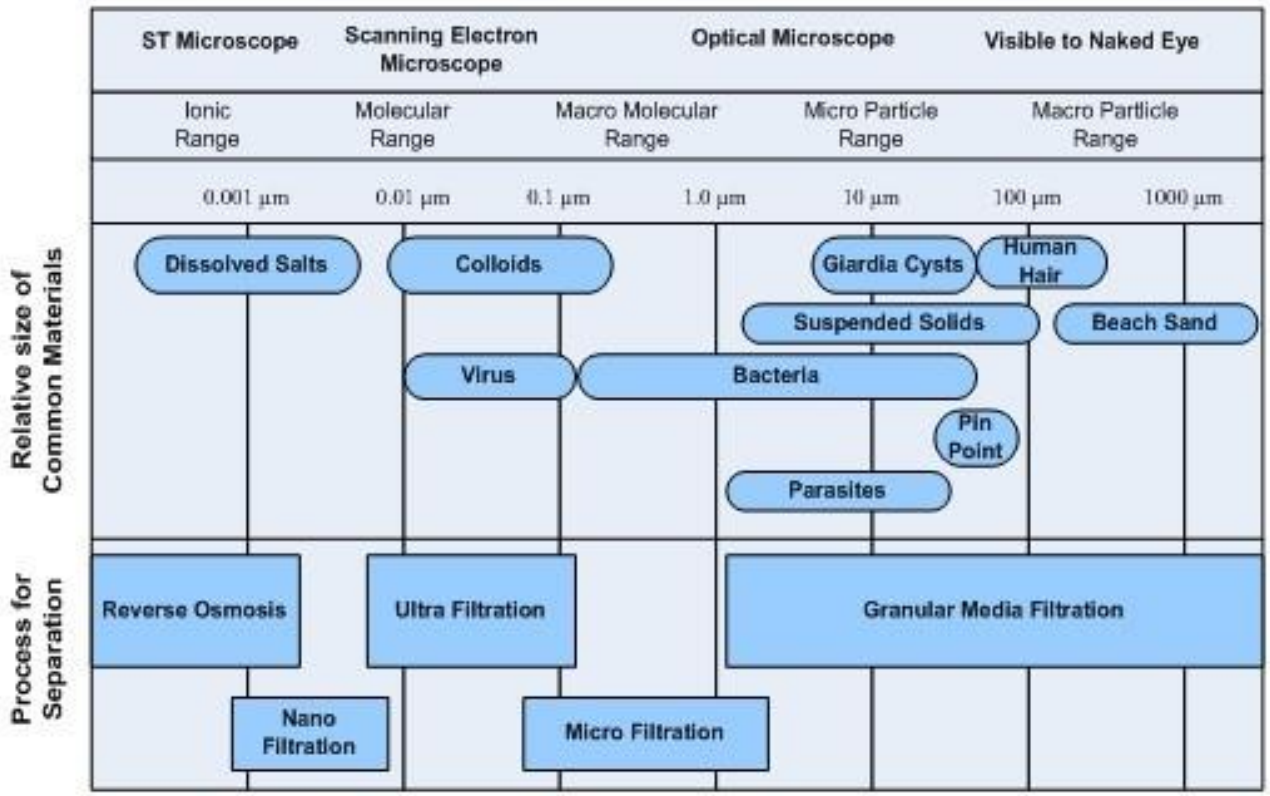


Figure below gives details on the size of particles of interest in water treatment and the separation processes which can be used in their removal.



Advantages of membrane filtration

There are many advantages of membrane filtration used in the industry where the following advantages are crucial considerations:

Flexibility

The wide scope of diverse filtrations methods ensures that the best solution for your separation challenge is available in the industry.

Lower costs

One of the biggest advantages of membrane filtration is that this method is often less expensive than other technologies. This is because of the lower installationand energy costs. In addition, membrane filters do not result in a filter cake, therefore there are no costs for removal or disposal of the residue.

High quality of end product

This separation method perform on the basis of molecular size. This results in a high quality of the end product liquid. Membrane filtration makes it easy to make your end product comply with the strict requirements from the authorities.

Physical barrier

With Ultrafiltration you always have a physical barrier, even when the power is off. This ensures the safety of water in any conditions and lowers the downtime during maintenance.