Solids & Suspensions

Discrete Particles

Particles do not change size, shape & SG over time.

Discrete particles have a little tendency to flocculate or coalesce upon contact with each other. Hence, they do not change their size, shape, specific gravity during setting.

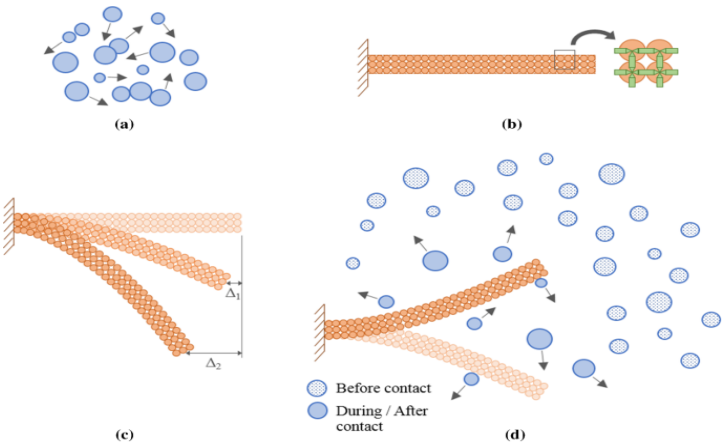


Figure: Discrete Particles

Any matter is made up of very tiny discrete particles which can also be called as building block matters. The particles can be atoms, ions or molecules.

Flocculating Particles

Particles change size, shape & SG over time (as they aggregate or coalesce)

Generally, flocculation in physical chemistry the separation of solid particles from a liquid to form loose aggregations or soft flakes. These mentioned flocculates are easily disrupted, being held together only by a force analogous to surface tension of a liquid.

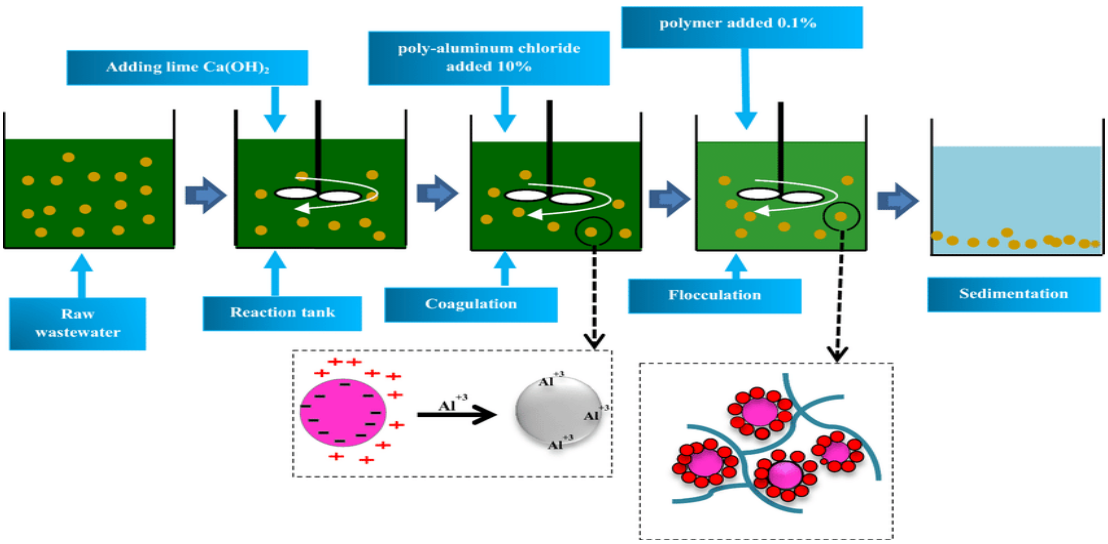


Figure: Flocculation

Aluminium sulphate or alum (Al2SO4), Ferric Chloride (FeCl3), Ferric Sulphate (Fe(SO4)3) are the most commonly widely used flocculants. They have the long history of using for removing the colloidal particles from water and waste water.

Flocculants

Flocculating agents or Flocculants are generally chemicals. They promote flocculation by forming a floc. Colloids and suspended particles in liquid undergo flocculation by flocculating agent.

Aluminium Sulphate or alum (Al2SO4),
Aluminium Chloride (AlCl3)
Aluminium Chlorohydrate
Poly Aluminium chloride
Ferric Chloride (FeCl3),
Ferric Sulphate (Fe(SO4)3)
Sodium Aluminate

Flocculants can affect the pH level of water. It can start at pH-7.0 for best.

Polymers are very much useful as flocculants. Polymers are robust molecules & sometimes they carry charges. They are very large particles. So, the small particles can get trapped in the curves of the polymer causing them to accumulate a heavy mass. This can prevent the retention in solution.

Dilute Suspensions

If concentration of particles in suspension is in-sufficient to displace water as the particle settle.

Figure Dilute Suspension

Concentrated Suspensions

If concentration of particles in suspension is sufficient to displace water as the particle settle

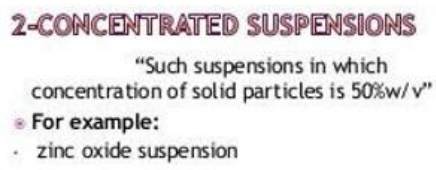
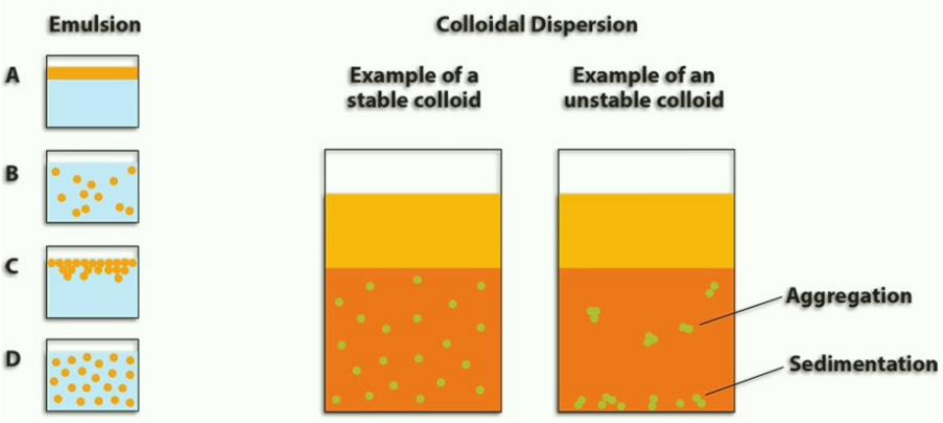


Figure: Concentrated Suspension

Colloid

Colloid is a substance [microscopically], which can be dispersed throughout another substance. These particles can pass through a filter paper but these particles cannot pass through a semi-permeable membrane.

Colloid is a mixture in which one substance containing microscopically dispersed insoluble particles; which is suspended throughout another substance.
Some other definitions dictate that, the particle must be dispersed in a liquid. While others extend the definition to include substances like aerosols and gels.



Types of colloid mixtures.
Combining different substances can result in 05-main types of colloid mixtures…

- Aerosols
- Foams
- Emulsions
- Sols
- Gels

It is also to say that, some of these colloids naturally exist in the world, while others are manmade products.
Colloids typically don't separate into their individual components over the time.

Milk is a colloid substance. It consists with tiny butterfat globule suspended throughout the liquid. Whipped cream is also a colloidal substance too.

Diffusion

The movement of anything (atoms, ions, molecules, energy) from its higher concentration to its lower concentration is termed as diffusion.

Figure: Diffusion

Types of Diffusion

- Molecular Diffusion
- Browinian Diffusion
- Turbulent Diffusion

Diffusion helps in movement of substances in and out of the cells. The molecules generally moves from its higher concentration to its lower concentration. The movement continues until the concentration becomes equal throughout the liquid and gases.

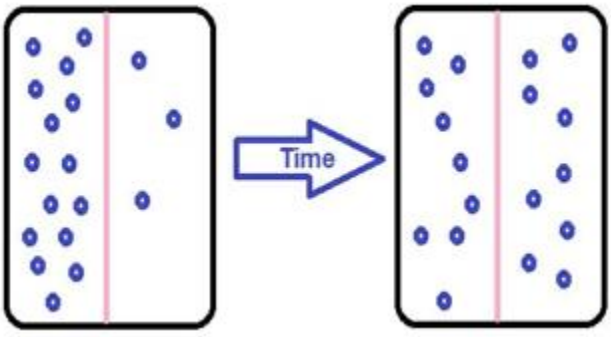


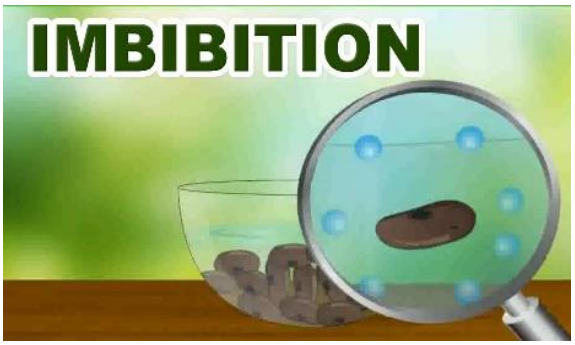
Figure: Diffusion

Examples of Diffusion

- Perfume smells
- CSD bottle opening & CO2 diffuses in air.
- Bad odor
- Tea bags dipping in hot water

Imbibition

Imbibition is a type of diffusion where the water is absorbed by solid particles namely colloids by causing and enormous increasing in volume.



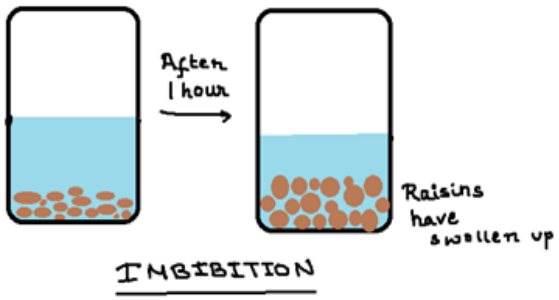


Figure: Imbibition

Imbibition means the "Liquid absorbing for Dry Colloid or Semi Dry Colloid Materials". If we place the end of a dry wood into water, then the wet part will absorb some water on to it. The process on which the dry wood gets water is called imbibition.

Cellulose, starch, gelatin etc. are hydrophilic material. They can absorb water when they touch water. They get squeezed in absence of water. Cell wall, protoplasm is also colloidal. Hence, they get water trough imbibition process.

Imbibition is a great process of water absorbing.

Osmosis:

Physical process by which a liquid starts to diffuse through a semi-permeable membrane when there is a difference in concentration of certain solutes. Osmosis is a process where no energy is required.

Semi-permeable membrane = the membrane that is permeable to water but not for solute.

From the below figure, the osmosis process can easily be understood. The general physics is that; a less concentrated solution must have a natural tendency to migrate to higher concentrated solution. From the figure, it is clear that two different concentrated sugar solution is separated by a semi permeable membrane. After a certain period of time, the solvent from the lower concentration migrated to the higher concentrated parts; hence the volume level gets increased.

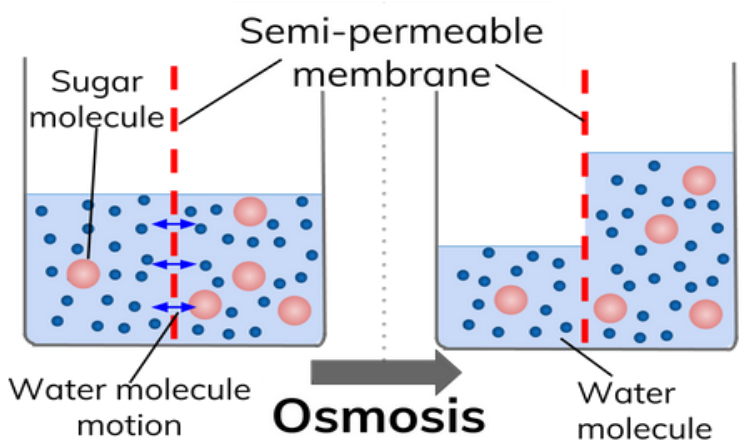


Figure: Osmosis

Basically, osmosis is the diffusion of water or other solvents through a semi-permeable membrane.
When a solution is kept separated from the pure solvent by a semi-permeable membrane, the solution will become more dilute by absorbing solvent through that semi-permeable membrane.

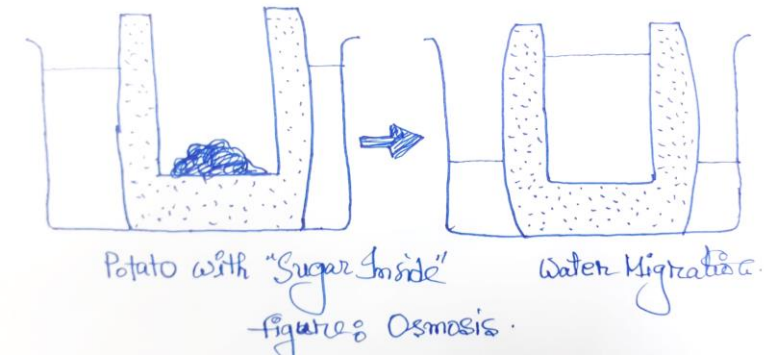


Figure: Osmosis [in potato]

A hydrostatic pressure is required for resisting the movement of solvent molecules is called the osmotic pressure. The osmotic pressure in an ideal solution is affected by temperature and volume.

Semi Permeable Membrane:

Semi permeable membrane is a membrane which allows the passing of some selective molecules and atoms. It means that, all items are not allowed for passing through the semi permeable membrane.

Types of osmotic condition

- Hypertonic condition
- Isotonic condition
- Hypotonic condition

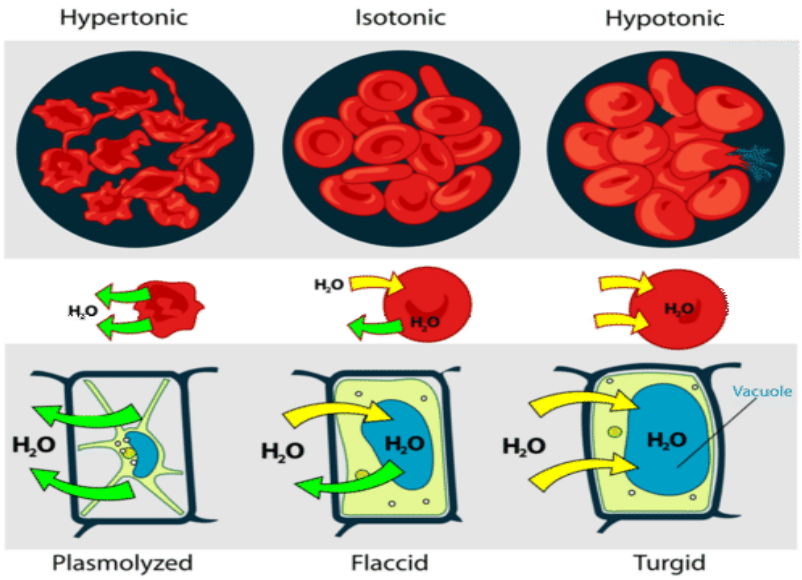


Figure: Hypertonic, Isotonic, Hypotonic condition

In a hypertonic solution a body cell will lose water from itself and finally the body cell gets squeezed.
In an isotonic solution a body cell will be stable as water movement inside and outside is stable.
In a hypotonic solution a body cell will gain water through osmosis & finally can blast.

Osmosis is a very important natural occurring process. Osmosis is a solvent transferring process. In this process the solvent tends to migrate to a stronger concentration from its lower concentration.

Reverse Osmosis

Reverse osmosis is a process by which pressure is applied to take out water from its low concentration to its high concentration.

Basically, reverse osmosis is a special type of filtration process where a semi-permeable, porous membrane is used which allows only pure water to pass through it by filtering the larger molecules of impurities.

It was early noted that, osmosis is a process where no energy is required. It means that if we want a reversal process then we must need to apply a force against it.

Reverse Osmosis Membrane is such kind of membrane which allows only water molecule to pass through it. As the osmosis process is non force activities, so for the reverse osmosis a high pressure is applied to perform the process.

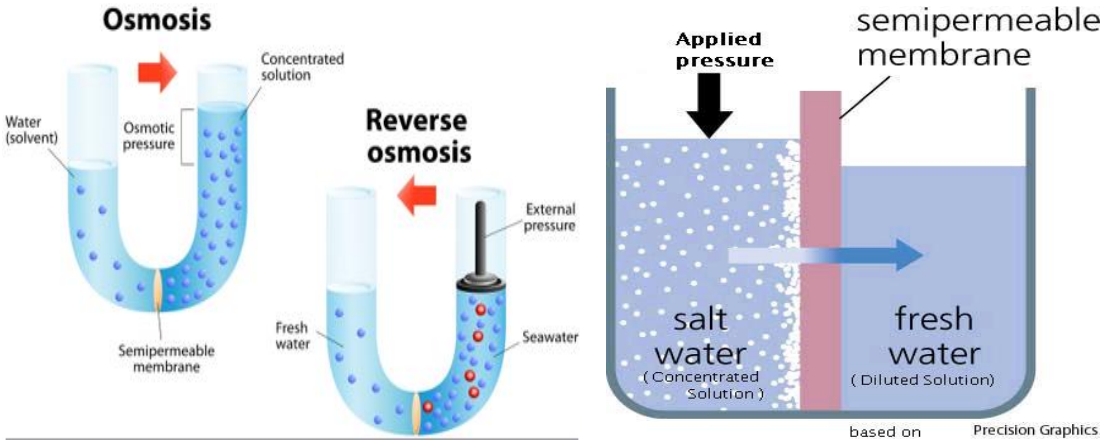


Figure: Reverse Osmosis

In industry, reverse osmosis is used to get very low hardened water.

Reverse osmosis generally works by reversing the principle of genuine osmosis. Suppose, a salt solution is taken and the solution is subjected to be pressurized and pressed against a semi-permeable membrane. When the applied pressure is greater than the osmotic pressure, then water molecule gets reversed from its high concentration to its low concentration.

During reverse osmosis, 99% of dissolved salt particles, colloids, micro-organisms etc. can be removed. Mentioned contaminants are separated by the RO-membrane on the basis of size and charge. Reverse osmosis cannot remove gases as they are not highly ionized [eg. CO2]

Reverse Osmosis Function:

In a reverse osmosis plant a high pressure pump is used. This high pressure pump force's the water across the semi permeable membrane of RO system. This forcing will leave all around 95% - 99% of dissolved salt into the rejected/concentrated water. the amount of pressure required depending on the salt concentration of feed water. The fact is that; the more concentrated feed water will require the more pressure for RO system.

Permeate Water = The water that is demineralized or deionized in the process.
Reject/Concentrated Water = The water that contains concentrated contaminants & do not pass through the RO system.

Differences in between Osmosis & Reverse Osmosis

Osmosis	Reverse Osmosis
Natural process	Artificial pressurized process
Works along the potential gradient	Works against the potential gradient
Works aligning with osmotic pressure	Works against osmotic pressure
Water movement from its high concentration to its low concentration	Water movement from its low concentration to tis high concentration

Solids & Suspensions Removal:

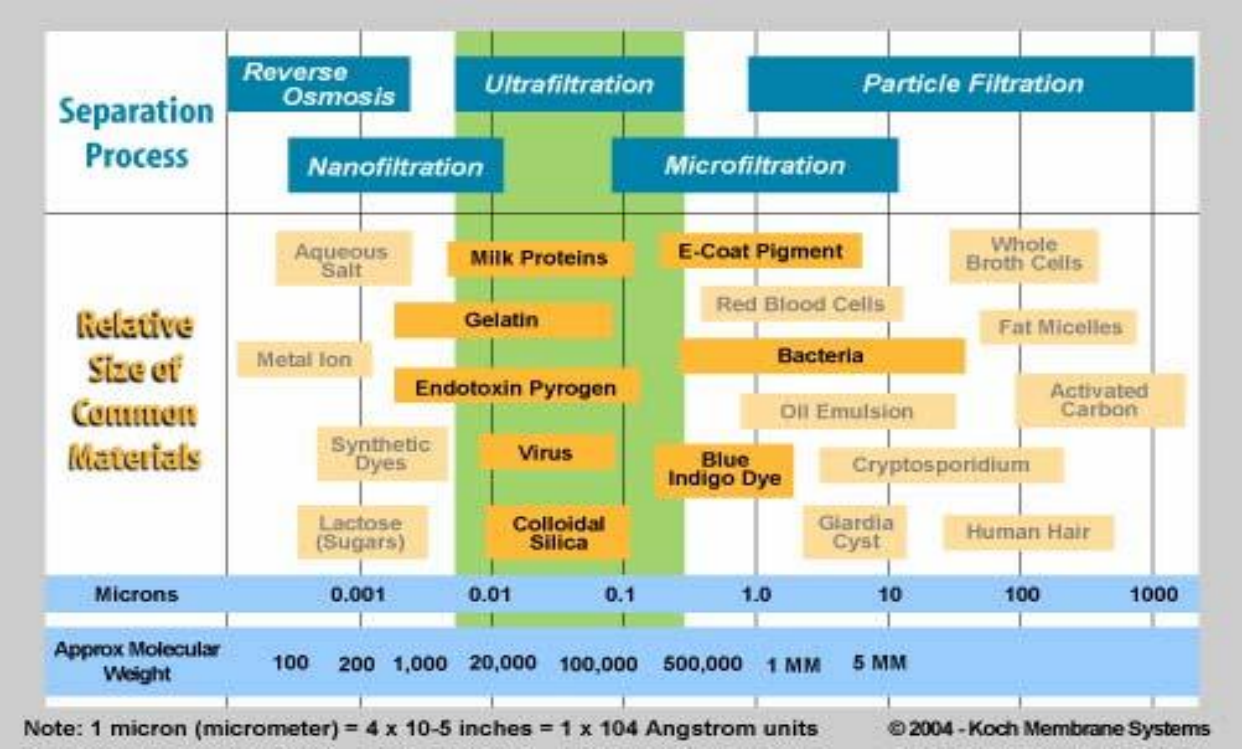


Figure: Solids & Suspensions Removal

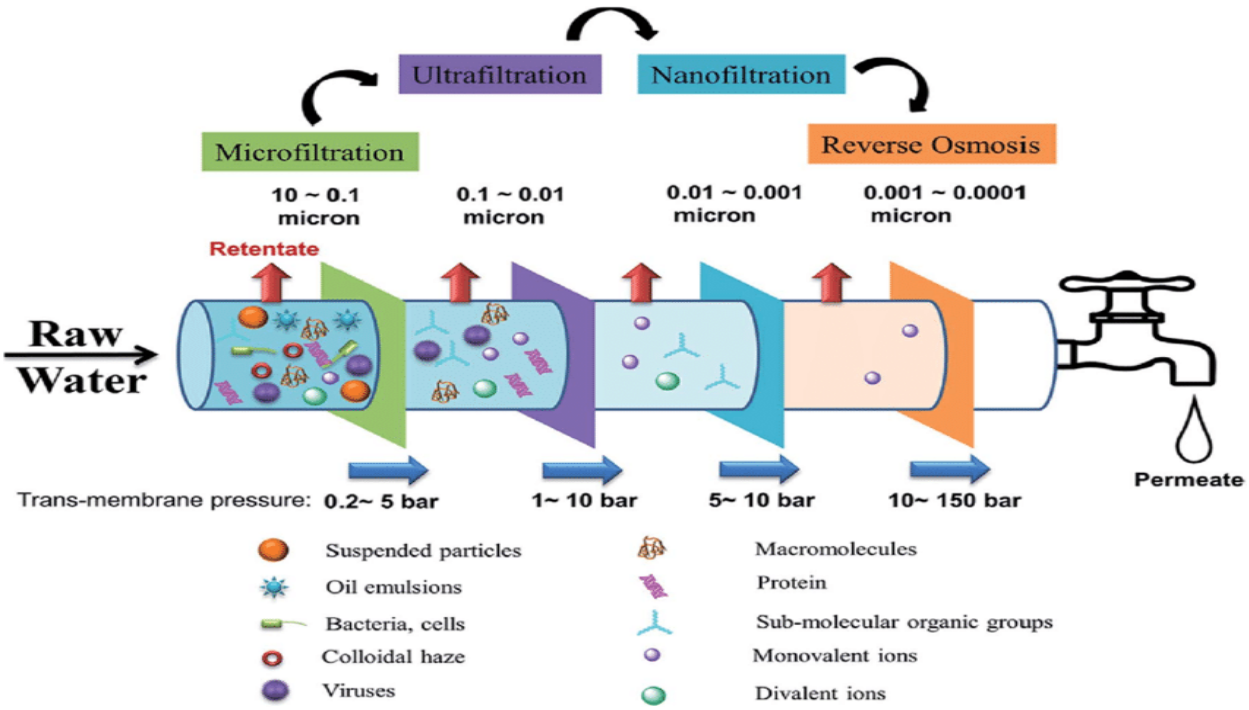


Figure: Solids & Suspensions Removal

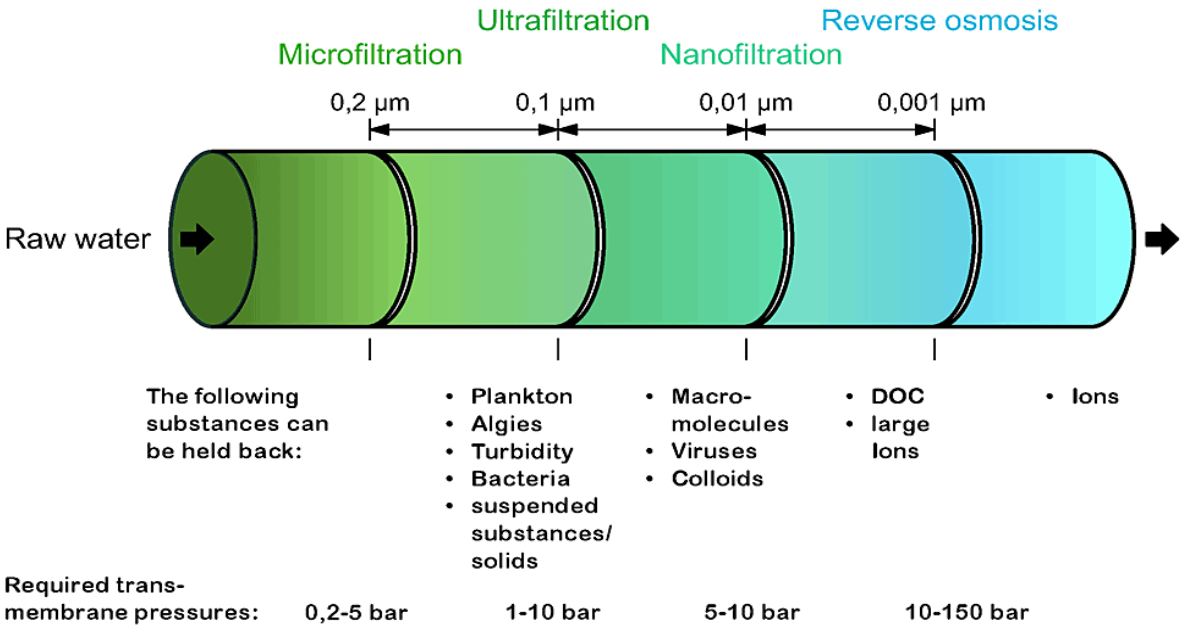


Figure: Solids & Suspensions Removal

Solids & Suspensions Removal:

Figure: Solids & Suspensions Removal

Figure: Industrial RO System

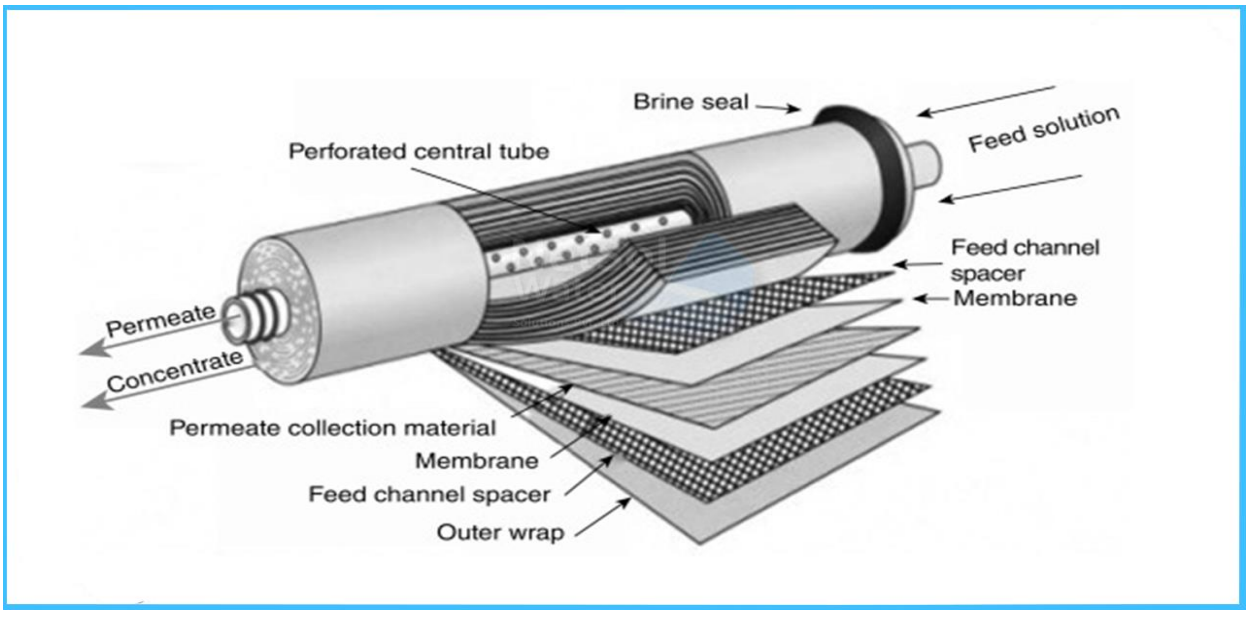


Figure: Reverse Osmosis Membrane

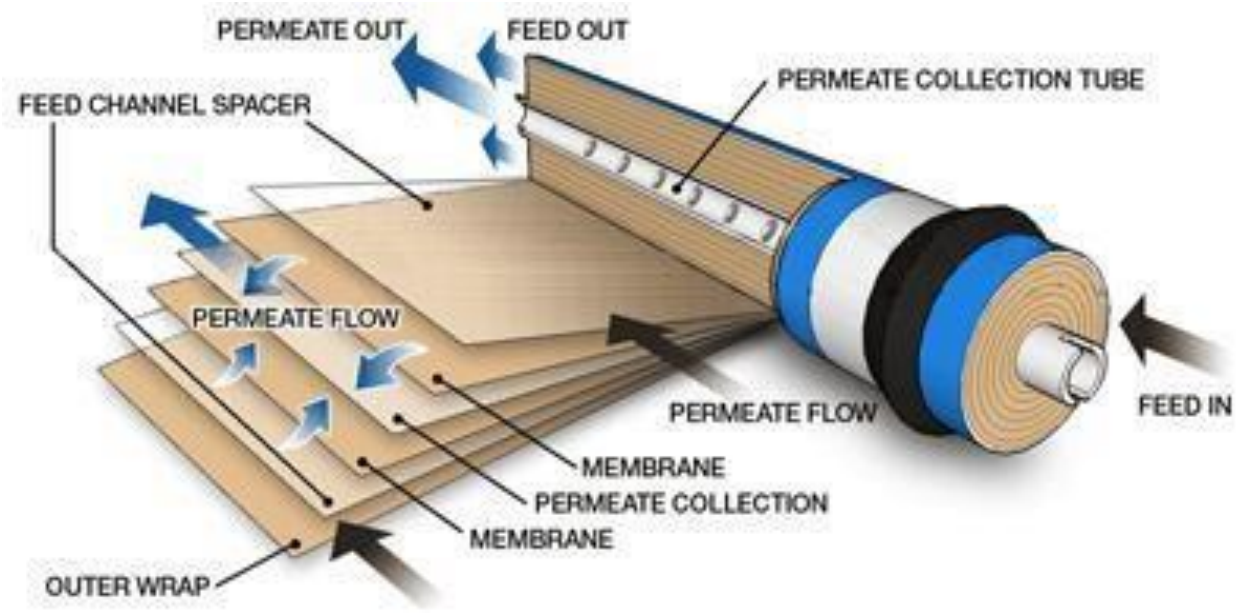


Figure: Reverse Osmosis Membrane