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Membrane Processing Technology: A Review Article

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***Abstract*:- The membrane technology is used in separation, concentration, filtration and extraction processes widely in industries. Membrane technology uses simple and specially designed semi-permeable membranes to carry out various applications. It requires minimal energy usage thus considered a green technology. It carries out the process by using a basic concept that any substance flows or moves from a higher concentration gradient to a lower concentration gradient until the equilibrium is attained, even the opposite is possible but by applying some external energy. This technology is regarded to be highly efficient and novel. There are various techniques under this membrane process technology that depends upon various operations and process based on the requirement of desirable output. There are lots of research and development taking place under this field.**

Keywords:- Separation, Semi-permeable, Concentration gradient, Equilibrium, External energy.

I. INTRODUCTION:

Membrane process technology is used to carry out membrane separation process. It is used to selective separate ions using a semi-permeable membrane along with some driving force. The most widely used semi-permeable membranes are derived synthetically. Examples of synthetically derived semi-permeable membranes are: Cellulose acetate, Nitrocellulose, Polyacrilonitrile etc. These semi-permeable membranes are biologically inert. They are categorized as reverse osmosis, ultrafiltration, microfiltration and dialysis.

II. REVERSE OSMOSIS:

Reverse osmosis is a membrane process widely used in water purification process. It is a concentration process. It is used to remove and lessen the amount of undesirable molecules, ions, larger sized molecules from drinking water. This process is also used in desalinating sea water to drinking water and landfill leachate purification.

This process concentrates on the concentration of solvent and not solute. This method can also be named as forced osmosis. In osmosis process, the solvent moves from higher solvent concentration and having lower solute concentration to a lower solvent concentration and having higher solute concentration due to water potential acting as the driving force through a semi-permeable membrane and creates a pressure known as osmotic pressure.

But in case of reverse osmosis process, the solvent is forced to move from a lower solvent concentration to a higher solvent concentration through a selectively permeable membrane under the influence of an external pressure and this external pressure should be higher than that of osmotic pressure. The membrane pore size is usually very small due to which only water is mostly able to pass through them. The membrane used can be a single membrane or a composite membrane. This process is usually carried out at temperatures ranging from 40-80 ^{o}C at 700 psig and 100 MW cutoffs. The most widely used membrane is cellulose acetate.

III. ULTRAFILTRATION:

It is a separation and filtration process. In this process the membrane pore size is larger than compared to RO allowing some selected solute particles to move across the membrane along with water. This process is used in dairy industry in ultrafiltration of skim milk.

It allows minerals and lactose to pass through and retains proteins and fats. It also uses external pressure to carry out the filtration process. The membrane used here is generally polysulfone membranes. This process is carried out at a temperature ranging from 50-70 ^{o}C at 40 psig and 10,000 MW cutoffs. Diafiltration is an advanced type of ultrafiltration.

IV. MICROFILTRATION:

Microfiltration is a process of separating large molecules as well as microbes from the liquid. It can be done with combining ultrafiltration process prior to microfiltration in order to remove suspended particles and carry out the process efficiently.

It is used in secondary waste water effluent treatment, cold sterilization, dairy processing, and petroleum refining, clarification, separation and purification process. The factor that limits microfiltration and other membrane process is fouling. Fouling is the accumulation of separated particles that accumulate over the semi-permeable membrane with time, which causes less efficient separation.

To resolve this factor, either the semi-permeable membrane should be replaced with a new one or treat the semi-permeable membrane with some chemicals to remove the built up layer and reuse the membrane. The semi-permeable membranes used are made polyamide, polyvinylidene fluoride etc.

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V. DIALYSIS:

Dialysis is the process of purifying an impure solvent using a semi-permeable membrane and a dialysate. This process finds its use in blood purification process where the kidney has lost its purifying capacity from 70-90%. In this process the impure blood is passed through a dialyser and the salts and impurities in the blood are diffused to the dialysate leaving the blood pure.

The semi-permeable membrane used is selectively permeable to only salts such as sodium, potassium etc and impurities. The larger molecules such as red blood cells, white blood cells etc are not able to diffuse through the pores because of smaller pore size of the semi-permeable membrane used. This method of purifying blood is considered effective. The membranes currently used in dialysis are cellulose, substituted cellulose and synthetic noncellulose.

Electrodialysis is a membrane technology that works on the principle of dialysis but the driving force across the membrane is under the influence of electric potential. The semi-permeable membranes used are either cation or anion selective. The cation selective membranes are negatively charged hence allows only positively charged ions to pass through.

Similarly, the anion selective membranes are positively charged hence allows only negatively charged ions to pass through. These membranes can also be used in combination. The membranes used are sulphonated polystyrene, polystyrene with quaternary ammonia etc. These membranes are placed between two electrodes that induce charges in the membranes which further in turn creates an electric potential. This method is also used in food industries, water reuse plant, water de-mineralization process and purification process.

VI. CONCLUSION:

All membrane processing techniques mentioned above carries out operations using membranes. They differ in the driving force and the pore size of the membranes. The membranes used are also called as selectively-permeable membranes. They membrane process can be used in combination with other process. They don't cause pollution, and consume less energy. They are widely used in industries.

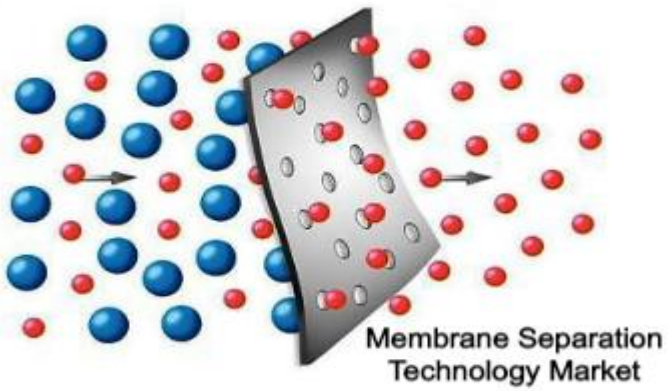

Fig 1: Membrane separation

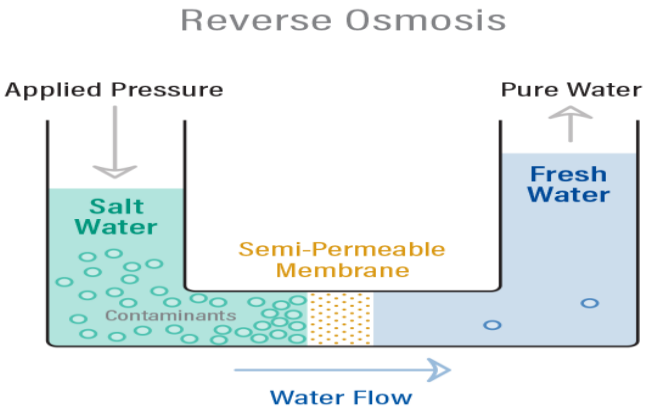

Fig 2: Reverse osmosis

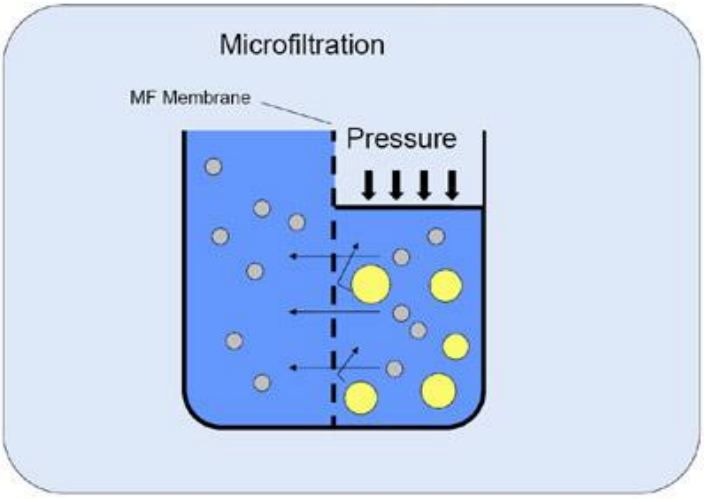

Fig 3: Microfiltration

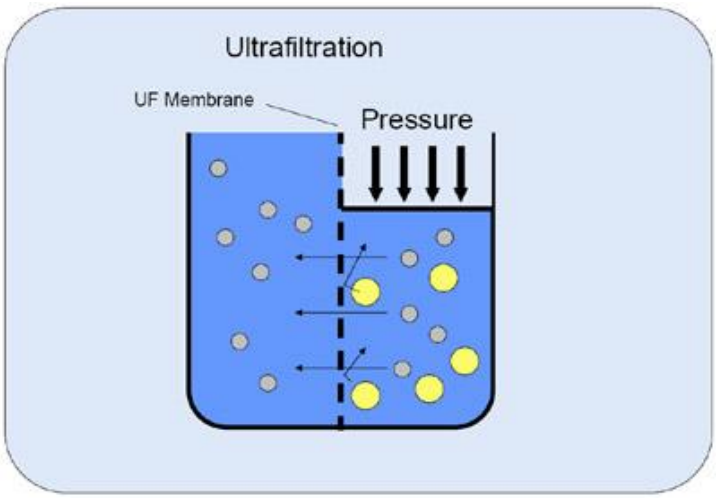

Fig 4: Ultrafiltration

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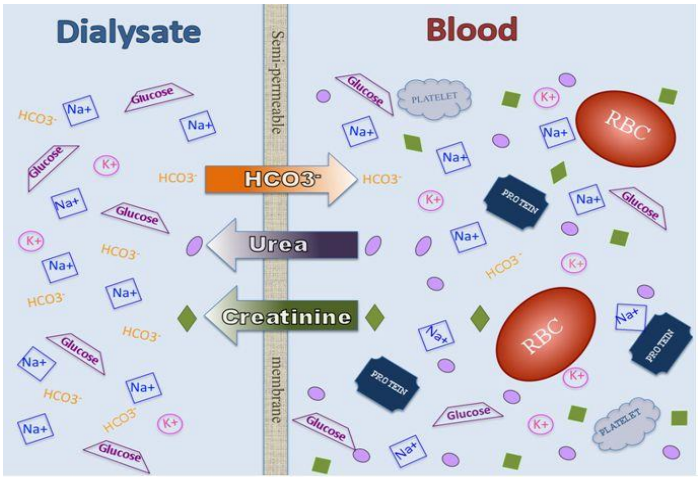

Fig 5: Dialysis

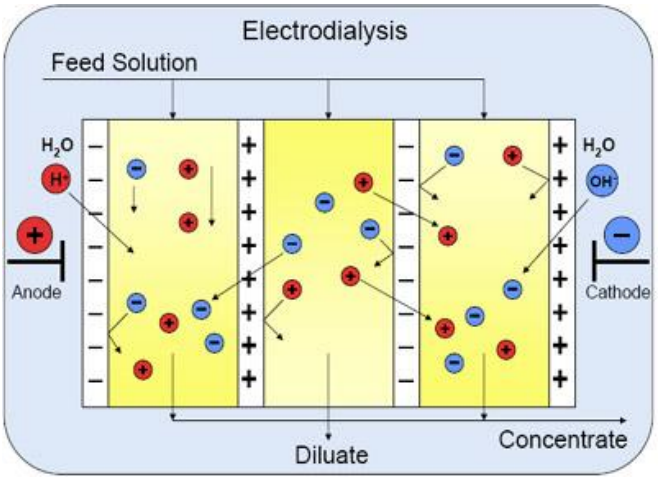

Fig 6: Electrodialysis

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