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Membrane separation

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Outline

- Ultrafiltration
 - Introduction
 - Membrane module
 - Polymer used in membrane manufacturing
 - Fouling of membrane
 - UF membrane preparation methods



Uses of membrane filtration

1. Changing pattern of milk consumption is stressing on individual use of its components.
2. Whey which has high BOD value is being efficiently concentrated form protein . Then, the lactose in the permeate solution can also be handled by RO.
3. It saved energy in transportation, due to concentration.
4. Cheaper method of drying. Pumping is involved, as against evaporation of moisture.
5. Possibility of incorporating whey proteins into cheese.
6. Pollution due to whey is controlled, as whey contains lactose.
7. Milk also can be concentrated without damage to protein or changing flavour unlike in concentration and drying.
8. Other industrial uses, like water purification, fractionation & concentration in Food and Pharmaceuticals, recovery of various components of waste for further use.

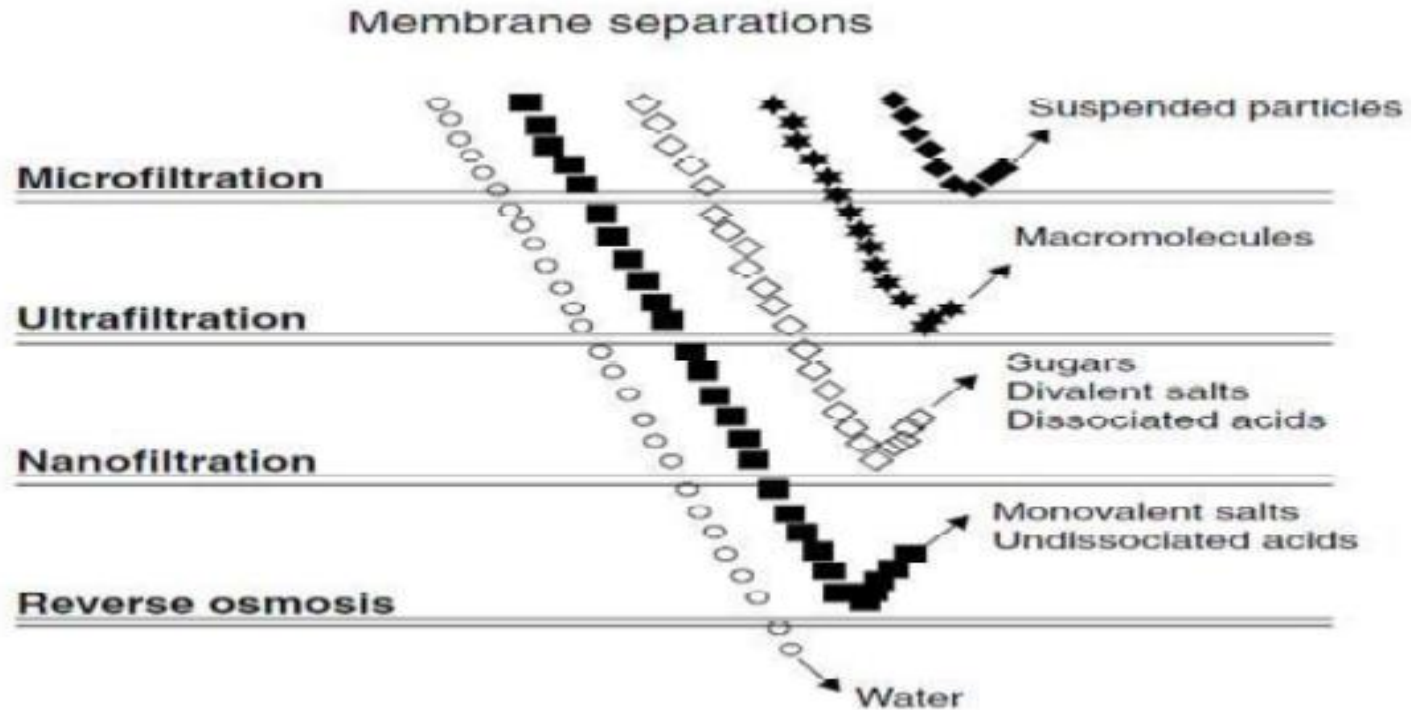


Fig. Types of membrane separations



Membrane : A membrane can be defined as a phase which acts as a barrier to flow of molecular or ionic species between other phases that it separates. It is either dry solid, a solvent swollen gel, or a liquid that is immobilized.

Semipermeable membrane: A membrane which allows some molecules to pass and retains other according to their size.

Composite membrane or thin film : Thin filtering layer built on to the support layer and the two layers are of different materials.

Asymmetric Membrane: Chemically of the same material throughout but physically is of different structure on its two sides.

Membrane cut off: Molecular weight above which 100 % (in practice 95%) of a solute is retained by the membrane.

Permeate: The filtrate, the liquid passing through the membrane.

Concentration Factor: The volume reduction achieved by concentration.

Initial volume of feed Final conc. of component retained



Retention Factor: It specifies the ability of a membrane to retain that molecule.

$$C_f - C_p$$

$R = \frac{C_f - C_p}{C_f - C_p}$ where, C_f = Conc. of molecule in feed

$C_f - C_p = C_p$ permeate

In Batch process where the concentrations are continually changing, R varies and then the realistic value can be,

$\ln(C/C_0) = R \ln(V_0/V)$ where, C_0 = Initial concentration at V_0

C = Conc. at any other volume V



Characteristics:

Membrane	Asymmetrical
Thickness	150 – 250 μm
Thin film	1 μm
Pore size	0.2 – 0.02 μm
Rejection of	Macro molecules, proteins, polysaccharides, vira
Membrane materials	Ceramic, PSO, PVDC, CA, thin film
Membrane module	Tubular, hollow fibre, spiral wound, plate-and-frame
Operating pressure	1-10 bar
Mechanism of membrane retention	Molecular screening
Typical flux	30 – 300 $\text{lit}/\text{m}^2\text{h}$



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Membrane Modules

1. Tubular module
2. Hollow fibre
3. Spiral wound
4. Plate and frame design

Polymers used in membrane manufacturing

1. Cellulose acetate
2. Polyamide membranes
3. Polysulfone membranes
4. Ceramic membranes



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U.F. membrane preparation methods:

- Phase inversion
- Thermal inversion
- Dynamic membrane
- Ultrathin composite membranes
- Track – etched membranes

Disadvantages:

- As the surface of membrane is not smooth, building of scale leads to idle environment for bacterial growth.
- The voids provide space for growth of micro-organisms.
- Disassembly of the UF equipment for manual cleaning is not practical due to high surface area involved.



Applications:

1. Separation and fractionation of individual milk proteins from lactose and minerals.
2. Enzyme recovery in various operations like lactose hydrolysis using lactase.
3. Fractionation of cheese whey
4. Pre – concentration of milk for cheese manufacturing.
5. Sugar refining
6. Vegetable protein processing, e.g. soy proteins
7. Concentration of egg white
8. Animal products industry, e.g. gelatin
9. Biotechnology applications
10. Fruit juices & other beverages.



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Thank you