

MMS
Membrane Systems

Membrane Dictionary 2019



Some of the terms and definitions commonly used in membrane research and practice are given below:

Apparent rejection coefficient (Ra): This equals one minus the ratio of concentrations of a component in the permeate stream and in the bulk feed

Apparent sieving coefficient (Sa): This is the ratio of the concentrations of a component in the permeate stream and in the bulk feed

Asymmetric (anisotropic) membrane: A composite membrane, consisting of two or more structural planes of non-identical morphologies

Backflush: Temporary reversal of the direction of the permeate flow, used mainly to un-block membrane pores

Boundary layer: Fluid layer in contact with solid surface, where the flow velocity is lower than in the bulk fluid

Bubble point: Transmembrane pressure, at which bubbles first appear on the downstream surface of a porous membrane immersed in an appropriate liquid as pressure is applied to the upstream side

Buffer exchange: Change of buffering species by diafiltration

Cake layer: A layer made up of rejected and subsequently deposited particles on the upstream face of a membrane

Cascade ultrafiltration: Multi-stage ultrafiltration, analogous to multistage distillation

Clarification: Removal of particles

Co-current flow: Flow pattern in a membrane module, whereby the fluids on both sides of the membrane move parallel to the membrane surface in the same direction

Completely mixed (perfectly mixed) flow: Flow pattern in a membrane module, in which fluids on both sides of the membrane are individually well mixed

Composite membrane: Membrane made up of chemically or physically distinct layers (e.g. asymmetric membrane)

Concentration (process): Removal of solvent from a solution to increase the solute concentration

Concentration polarisation: Accumulation of higher levels of solute close to the membrane surface in comparison to the well-mixed bulk feed

Concentration factor: Ratio of the concentration of a component in the retentate to that in the feed

Continuous membrane column: Membrane modules arranged analogous to that of stages in a distillation column (also called cascade membrane filtration)

Counter-current flow: Flow pattern in a membrane module, in which the fluids on both sides of the membrane move parallel to the membrane surface but in opposite directions

Critical flux: Permeate flux below which fouling is not severe

Cross-flow. Flow pattern in a membrane module, in which the fluid on the upstream side moves parallel to the membrane surface while the fluid on the downstream side moves away in a direction normal to the membrane surface

Dead-end flow: Flow pattern in a membrane module, where the feed flows towards the membrane in a normal direction while the permeate flows away from the membrane, also in a normal direction

Dean vortex: Vortex formed due to flow instability in curved flow passages

Dense {non-porous} membrane: Membrane with no detectable pores

Desalting: Removal of salts from protein solutions by diafiltration

Diafiltration: A simple ultrafiltration process, in which low molecular weight contaminating solutes are removed from solutions of biopolymers, such as proteins, accompanied by continuous replacement of solvent lost with the permeate

Diffusivity: A measure of the ability to undergo diffusive transport *Dynamic membrane:* An active layer that is formed on the membrane surface by the deposition or accumulation of rejected species

Electrostatic double layer: Layer formed around charged macromolecules and charged surfaces by ionic species present in solution

Electroultrafiltration: Ultrafiltration facilitated by an electric field

Fouling: Deposition or adsorption of particulate or dissolved substances on the external membrane surface, at the pore openings, or within the pores leading to loss of efficiency

Gel layer: A gelatinous fouling layer formed by rejected colloidal material on the membrane surface

Hindered transport: Hindered diffusion and convection through a membrane, due to retarding forces such as electrostatic interactions and drag forces

Hollow fibre: A fine tubular membrane

Homogeneous membrane: Membrane with essentially the same structural and transport properties throughout its thickness (also referred to as isotropic membrane)

Hydraulic permeability: The water flux divided by applied transmembrane pressure

Intrinsic membrane rejection: Rejection of a solute by a native membrane

Intrinsic rejection coefficient (R_i): This equals one minus the ratio of concentrations of a component in the permeate and that on the wall of the upstream side of the membrane

Intrinsic sieving coefficient (S_i): This is the ratio of the concentrations of

a component in the permeate and that on the wall of the upstream side of the membrane

Laminar flow: Fluid flowing slowly and smoothly with the fluid streamlines parallel to each other

Leaching: Removal of specific species from polymer films to produce the membrane pores

Limiting flux: Maximum achievable permeate flux for a given hydrodynamic condition

LRV: Log Removal Value, which is a measure of the efficiency of removal of particulate matter by microporous membranes

Mass transfer coefficient: This is the measure of diffusive velocity of a

solute within a region, such as a film, and is obtained by dividing the diffusivity by the diffusive path length

Maxwell-Stefan modelling: Analysis of membrane transport using

Maxwell-Stefan equation

Membrane ageing: Change in membrane transport properties over a period

of time due to physical, chemical or structural alterations

Membrane casting: Preparation of a membrane using a solution of the membrane-forming polymer

Membrane conditioning (pretreatment): Process carried out on a membrane after its preparation, in order to improve its properties

Membrane module (cell): Device within which the membrane elements (such as flat sheet and hollow fibre) are housed

Membrane reactor: A reactor employing a membrane either for retention

of specific species or for immobilising the catalyst

Microfiltration: A pressure driven membrane based separation process primarily used for the separation of particles from fluids

Molecular-weight cut-off (MWCO): Molecular weight of a solute corresponding to a 90 percent rejection coefficient ($R_a = 0.9$) for a given membrane

Nanofiltration: A pressure driven membrane based separation process primarily used for the separation of medium sized molecules

Observed transmission ($TO(>)$): This is the ratio of the concentration of a component in the permeate and that in the feed (same as apparent sieving

coefficient)

Oscillatory flow: Oscillation of feed flow to minimise concentration polarisation and thus increase permeate flux

Osmotic pressure: Pressure exerted due to difference in solute concentration between two distinct zones

Permeability: This is defined as a transport flux per unit transmembrane driving force

Permeate: Stream containing the species that have penetrated the membrane (also called filtrate)

Permeate flux: Volume or mass of liquid crossing the membrane per unit area per unit time

Pore tortuosity: Ratio of actual pore length to membrane thickness

Porosity: Ratio of void space to total membrane volume in porous membranes

Pressure pulsing: The use of periodic negative transmembrane pressure, in order to improve permeate flux in ultrafiltration processes

Real or intrinsic transmission (r): This is the ratio of the concentrations of a component in the permeate and that on the wall of the upstream side of the membrane (same as intrinsic sieving coefficient)

Relative recovery (77): The amount of a component collected in a useful product stream divided by the amount of that component entering the process

Retentate: The stream leaving the feed side of a cross-flow membrane module or the material left within the feed side in the case of dead-end filtration

Reverse osmosis: A pressure driven membrane based process primarily used for the separation of small molecules

Selectivity (t/;): This represents the efficiency of solute separation, which in binary solute fractionation equals the ratio of observed transmissions for the two solutes

Self-rejection: Rejection of solute due to electrostatic repulsion by membrane bound solute molecules

Skin layer: A thin layer which is located at the upstream face of an asymmetric membrane and which is primarily responsible for determining selectivity and permeability

Sieving coefficient: A measure of the transport of a specific solute through a membrane, usually obtained by dividing the concentration in the permeate by a characteristic upstream concentration (e.g. bulk or wall)

Solute flux: Mass or number of moles of solute crossing the membrane per unit area per unit time

Streaming potential: A transmembrane electrical potential, which arises from the coupling between flux of charged species and solvent through the pores

Tangential flow: Flow of feed parallel to the membrane surface (similar to cross-flow)

Taylor vortex: Vortex formed in the annulus of two concentric rotating cylinders

Transmembrane pressure (AP): The applied driving force for convective material transport through a membrane (average pressure difference between the upstream and downstream sides of the membrane)

Tube inserts: Turbulence promoters introduced within tubular membranes

to improve efficiency of filtration

Turbulent flow: Fluid flow comprising eddies and whorls (vortices), usually observed at high flow rates

Ultrafiltration: A pressure driven membrane based separation process primarily used for the separation of macromolecular substances

Volumetric permeate flux: The volume of permeate collected per unit time per unit membrane surface area

Wall shear rate: This is the liquid shear rate at the membrane surface

Zeta potential: An electrical potential, which is a measure of surface charge