COMPARISON OF MEMBRANE PROCESSES

Process	RO	NF	UF	MF	CF	
Examples of Common Constituents In Water	Metal Ions	Sugar	Virus, Pyrogen, Colloidal Silica	Carbon Fines	Bacteria	
Approx. Molecular Weight Cut-Off*	100	200	20,000	100,000	500,000	
Microns	0.0001	0.001	0.01	0.1	1.0	10.0

RO: Reverse Osmosis

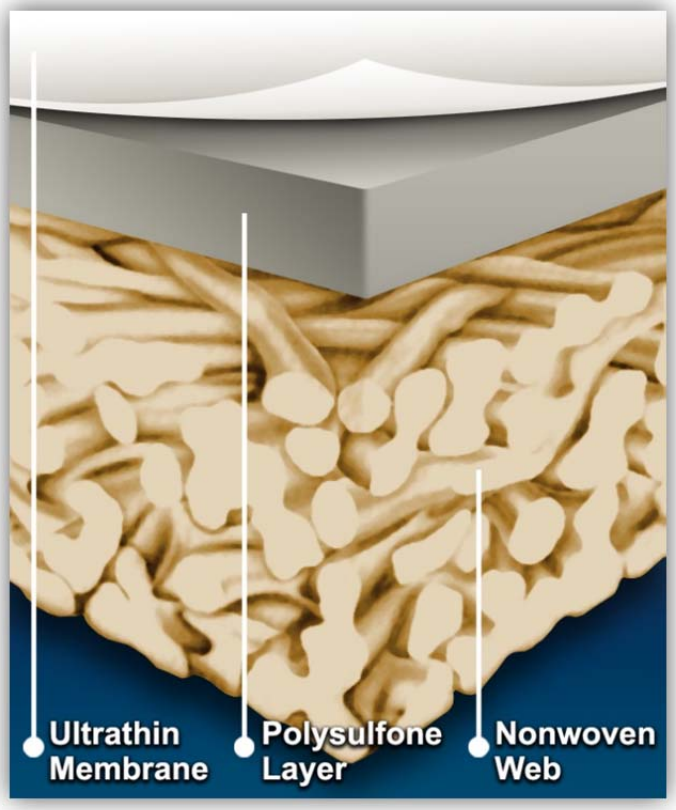
NF: Nanofiltration

UF: Ultrafiltration

MF: Microfiltration

CF: Conventional Filtration

* Used for sizing organics



APPLIED MEMBRANES INC.®

MICROFILTRATION (MF)

Microfiltration removes particles in the range of approximately 0.1 to 1 micron. In general, suspended particles and large colloids are rejected while macromolecules and dissolved solids pass through the MF membrane. Applications include removal of bacteria, flocculated materials, or TSS (total suspended solids). Transmembrane pressures are typically 0.7 bar (10 PSI).

ULTRAFILTRATION (UF)

Ultrafiltration provides macromolecular separation for particles in the 20 to 1,000 Angstrom range (up to 0.1 micron). All dissolved salts and smaller, molecules pass through the membrane. Items rejected by the membrane include colloids, proteins, microbiological contaminants, and large organic molecules. Most UF membranes have molecular weight cut-off values between 1,000 and 100,000. Transmembrane pressures are typically 1 to 7 bar (15 to 100 PSI).

NANOFILTRATION (NF)

Nanofiltration refers to a speciality membrane process which rejects particles in the approximate size range of 1 nanometer (10 Angstroms), hence the term "Nanofiltration." NF operates in the realm between UF and reverse osmosis. Organic molecules with molecular weights greater than 200-400 are rejected. Also, dissolved salts are rejected in the range of 20-98%. Salts which have monovalent anions (e.g. sodium chloride or calcium chloride) have rejections of 20-80%, whereas salts with divalent anions (e.g. magnesium sulfate) have higher rejections of 90-98%. Typical applications include removal of color and total organic carbon (TOC) from surface water, removal of hardness or radium from well water overall reduction of total dissolved solids (TDS), and the separation of organic from inorganic matter to specialty food and wastewater applications. Transmembrane pressures are typically 3.5 to 16 bar (50 to 225 PSI).

REVERSE OSMOSIS (RO)

Reverse osmosis is the finest level of filtration available. The RO membrane acts as a barrier to all dissolved salts and inorganic molecules, as well as organic molecules with a molecular weight greater than approximately 100. Water molecules, on the other hand, pass freely through the membrane creating a purified product stream. Rejection of dissolved salts is typically 95 to greater than 99%. The applications for RO are numerous and varied, and include desalination of sea water or brackish water for drinking purposes, wastewater recovery, food and beverage processing, biomedical separations, purification of home drinking water and industrial process water.

Also, RO is often used in the production of ultrapure water for use in the semiconductor industry, power industry (boiler feed water), and medical/laboratory applications. Utilizing RO prior to Ion Exchange (IX) dramatically reduces operating costs and regeneration frequency of the IX system. Transmembrane pressures for RO typically range from 14 bar (200 PSI) for brackish water to 69 bar (1,000 PSI) for sea water.

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