Definition and Comparison between Nanofiltration and Reverse Osmosis Desalination Technologies

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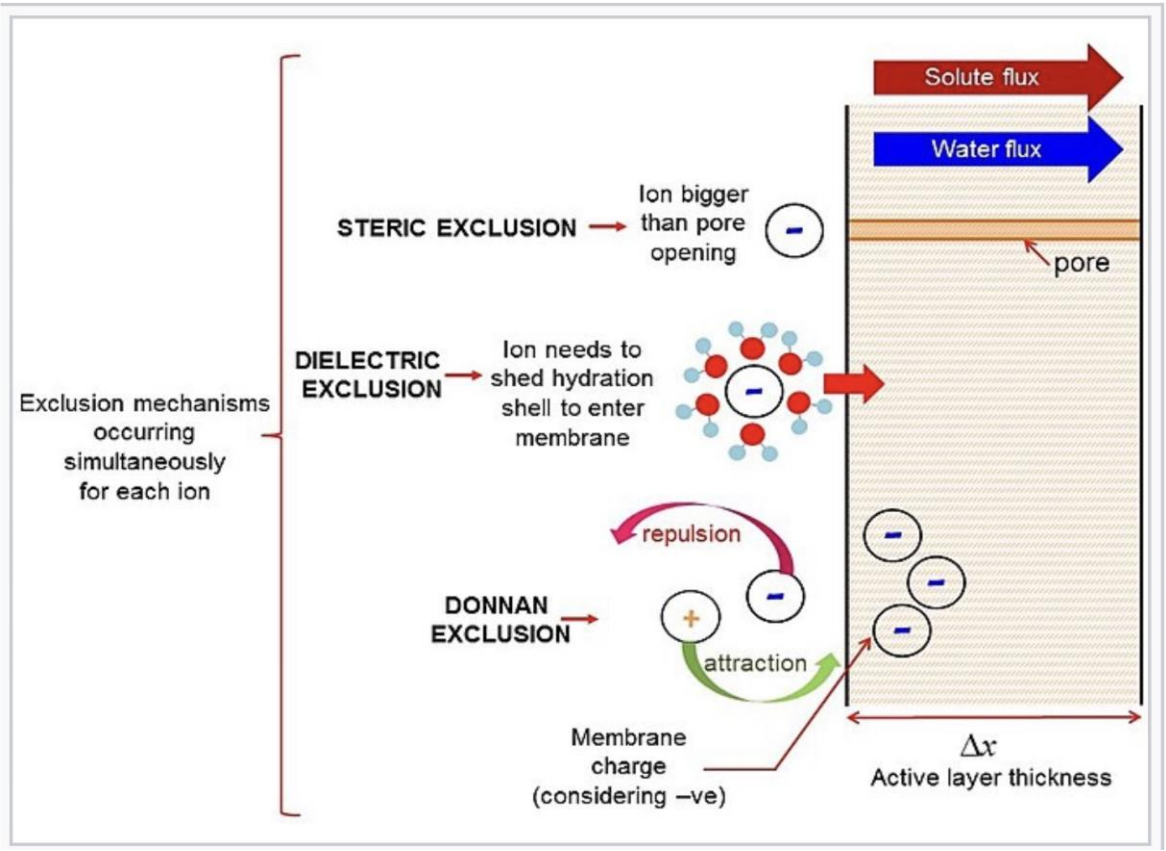
Both RO and NF are pressure driven, selective membrane permeation processes. Their system designs are usually conducted by the same software. Their most common configuration is the spiral wound form.

Both technologies reject efficiently inorganic, organic, and biological solutes, micro-organisms as bacteria and viruses and, evidently, suspended solids.

However, there are some basic differences between NF and RO membranes which result in differences in behavior. While NF membranes are porous with pores diameter in the nano-range (1nanometer = 10^{-9} meter) and carry a strong ionic charge, usually negative, those of RO are neutral and non-porous.

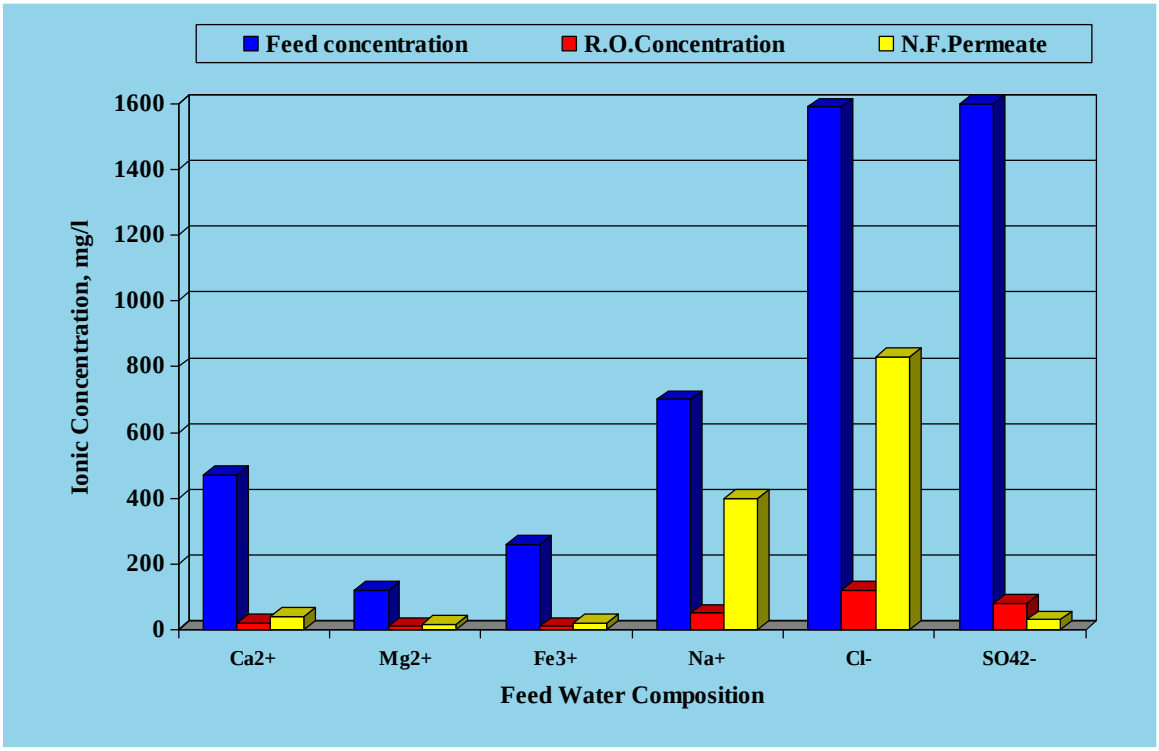
In view of this structure of NF membranes their exclusion mechanism is rather complex it includes, (Fig. 1).



1. Steric exclusion when particle size is bigger than pore diameter, but mainly
2. Dielectric exclusion due to dielectric constant across the membrane surface with ionic charges on the membrane and ions on membrane surface solution with their protective water of hydration.
3. Donnan exclusion due to the strong surface charge of the membrane and its interference with the solute ionic charges.

Upon comparison between NF and RO (Fig. 2) we observed that NF ion rejection is as strong as that of RO for divalent and polyvalent ions species but quite lower than RO rejection in case of monovalent ions.

Comparision between Individual Ionic Rejection by RO and NF in Salt Mixture Solution



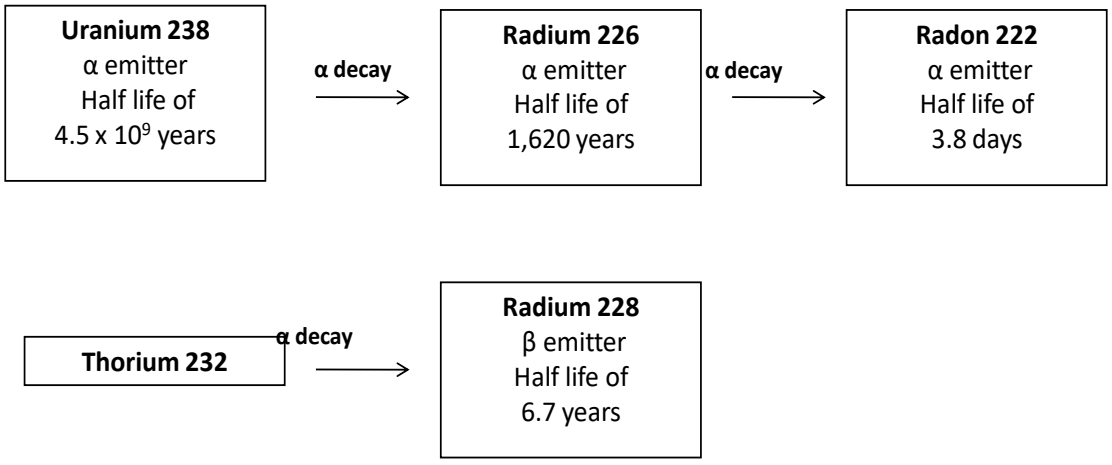
M.Gamal Khedr, Euromembranes International Conference, Hamburg (2004)

This defect, in fact, gives advantage to NF over RO. The rather free permeation of monovalent ions which usually represent the most important part of TDS ions, results in lower opposite osmotic pressure than in RO and, **therefore, NF takes place at much lower feed pressure, i.e. requires lower energy consumption.**

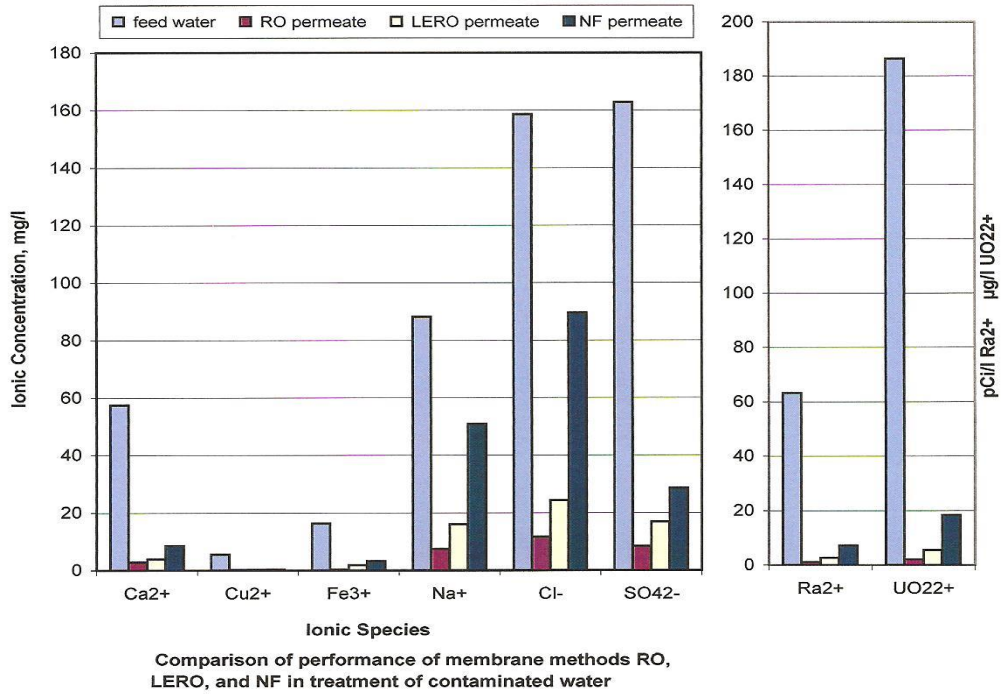
If the raw water is contaminated by the problem making polyvalent ions as hardness components, heavy metal cations or radioactive isotopes but of low total salinity NF is advantageous .On the other hand, if the total salinity is high we apply RO.

As an example, most of the ground water sources in Saudi Arabia are contaminated by radioisotopes from Uranium and Thorium NORM series (naturally occurring radioactive materials). We have U238, Ra226 & 228, and Rn the radioactive gas (both RO and NF do not reject dissolved gasses. Rn is to be removed by aeration or chemical dissolution). Thorium 232 is of very low solubility but its disintegration product is soluble, (Fig 3).

Naturally Occurring Radioactive Materials (NORM)



We compared the performance of conventional RO, Low Energy RO, and NF in treat of synthetic water which contain Cu as heavy metal cation, hardness components and radioactive radium 226 & 228 and uranyl cation, (Fig 4).



Comparison of performance of membrane methods RO, LERO, and NF in treatment of contaminated water

Once again, NF enabled, at quite lower pressure than that of RO, efficient rejection of these contaminants to the level permissible in drinking water according the norms of the US-EPA,(environmental protection agency) of 5 pC_i/L for combined Ra and 20 ppb for U238, and the World Health Organization.