

ABOUT REVERSE OSMOSIS (RO)

WHAT IS REVERSE OSMOSIS (RO)? (SUMMARY)

Reverse Osmosis (RO) is a membrane separation process in which feed water flows along the membrane surface under pressure. Purified water permeates the membrane and is collected, while the concentrated water, containing dissolved and undissolved material that does not flow through the membrane, is discharged to the drain.

The key requirements of Reverse Osmosis (RO) process are a membrane and water under pressure. Other requirements include prefiltration to remove suspended impurities and carbon to remove chlorine (damages the membrane).

Most membranes remove 90-99+ % of the dissolved impurities depending on the impurity and the composition of water.

Reverse osmosis systems (RO Systems) remove salts, microorganisms and many high molecular weight organics. System capacity depends on the water temperature, total dissolved solids in feed water, operating pressure and the overall recovery of the system.

BENEFITS OF REVERSE OSMOSIS (RO)

REVERSE OSMOSIS RO SYSTEM REMOVES UP TO 99% OF TOTAL DISSOLVED SOLIDS

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ADVANTAGES OF REVERSE OSMOSIS OVER CONVENTIONAL PROCESSES

Compared with other conventional water treatment processes, reverse osmosis has proven to be the most efficient means of removing salts, chemical contaminants and heavy metals, such as lead, from drinking water. For waters with total dissolved solids of 200 or more, reverse osmosis is less expensive than ion exchange. Even at total dissolved solids of less than 200, it is preferred over ion exchange for removal of silica and organics. Compared with distillation, reverse osmosis use only a fraction of the total energy and does not have high temperature problems or scaling and corrosion. Today reverse osmosis systems have proven to be the most economical and efficient means of improving the quality of water.

SIMPLE TO OPERATE AND MAINTAIN

Our reverse osmosis systems come assembled, factory tested and in ready-to-operate condition. They are designed for efficiency and are simple to operate and maintain. Besides regular monitoring and periodic membrane cleaning, membranes need to be changed every one to three years depending on water quality, size of the system and pretreatment. Pumps also require routine maintenance.



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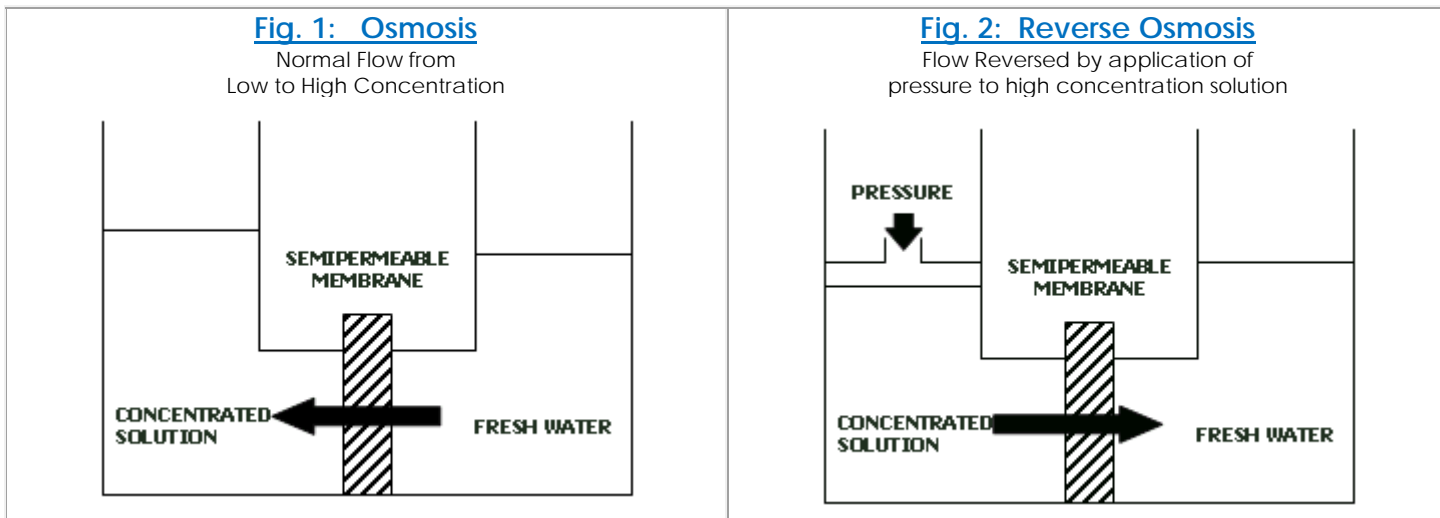
TECHNICAL ARTICLE: WHAT IS REVERSE OSMOSIS?

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Before discussing membrane properties and performance, it is appropriate to define and discuss reverse osmosis briefly.

Osmosis can be defined as the spontaneous passage of a liquid from a dilute to a more concentrated solution across an ideal semipermeable membrane which allows the passage of the solvent (water) but not the dissolved solids (solutes). (See Fig. 1.) The transfer of the water from one side of the membrane to the other continues until the head or pressure (**P**) is large enough to prevent any net transfer of the solvent (water) to the more concentrated solution. At equilibrium, the quantity of water passing in either direction is equal, and the pressure (**P**) is then defined as the osmotic pressure of the solution having that particular concentration of dissolved solids.

If a piston is placed on the more-concentrated solution side of a semipermeable membrane (see Fig. 2) and a pressure, **P**, is applied to the solution, the following conditions can be realized: (1) **P** is less than the osmotic pressure of the solution and the solvent still flows spontaneously toward the more concentrated solution; (2) **P** equals the osmotic pressure of the solution and solvent flows at the same rate in both directions, i.e., no net change in water levels; (3) **P** is greater than the osmotic pressure of the solution and solvent flows from the more concentrated solution to the "pure" solvent side of the membrane. Condition (3) shown in Fig. 11-2, represents the phenomenon of reverse osmosis.



The osmotic pressure of a solution increases with the concentration of a solution. A rule of thumb, which is based on sodium chloride, is that the osmotic pressure increases by approximately 0.01 psi for each milligram/liter. This approximation works well for most natural waters. However, high-molecular-weight organics produce a much lower osmotic pressure. For example, sucrose gives approximately 0.001 psi for each milligram/liter.

Several methods are available for measuring the osmotic pressure. It can be calculated from the depression of the vapor pressure of a solution, by depression of the freezing point, and by the equivalent of the ideal gas law equation. Some calculated values for common components are listed in Table 1. Several devices are commercially available for direct measurement of the osmotic pressure. These measure the pressure necessary to stop the flow of water through a membrane.

The procedure that we use to measure the osmotic pressure of a solution is to measure the water flux through a module under operating conditions at several pressures. If a plot of water flux versus pressure is extrapolated to zero water flux, the intercept is the osmotic pressure. This gives the effective osmotic pressure, including any concentration polarization. Care must be taken to either maintain constant recovery or correct for the variation in concentration.

Attempting to measure the osmotic pressure of a solution directly by operating at a pressure just sufficient to obtain zero flow is impractical because the membranes are not perfect semipermeable membranes. This technique would measure the difference in osmotic pressure between the feed and product water. At low pressures the salt rejection is relatively poor, so that a false osmotic pressure somewhat lower than the real value would be determined.

Table 1: Typical Osmotic Pressure at 25°C (77°F)

Compound	Concentration mg/liter	Concentration moles/liter	Osmotic Pressure PSI
NaCl	35,000	0.6	398
NaCl	1,000	0.0171	11.4
NaHCO3	1,000	0.0119	12.8
Na2SO4	1,000	0.00705	6
MgSO4	1,000	0.00831	3.6
MgCl2	1,000	0.0105	9.7
CaCl2	1,000	0.009	8.3
Sucrose	1,000	0.00292	1.05
Dextrose	1,000	0.00555	2.0

Note: Based on the above data for commonly present ionic species, a useful rule of thumb for estimating osmotic pressure of a natural water supply requiring demineralization is 10 psi per 1,000 mg/l (ppm).



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