

The Process of Reverse Osmosis

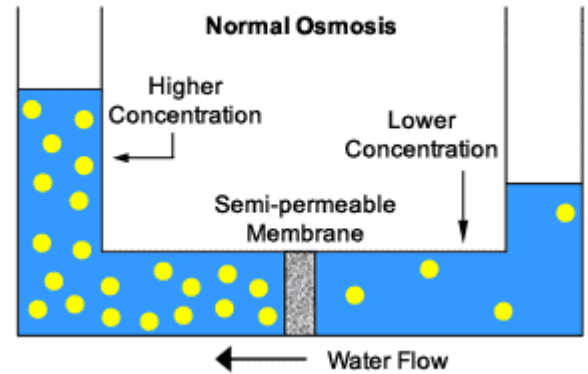
Keep reading to discover the how and why of reverse osmosis or jump to:

[Selecting a reverse osmosis system](#)
[Factors affecting RO performance](#)

To understand how reverse osmosis purifies water, you must first understand the process of osmosis.

Osmosis is a physical force. It is the natural tendency of water with a low concentration of dissolved particles to move across a semi-permeable membrane to an area of water with a high concentration of dissolved particles. The water will try to reach an equilibrium on both sides. I.e. both sides of the semi-permeable membrane will have the same concentration of dissolved particles. This is how plants absorb nutrients from the soil.

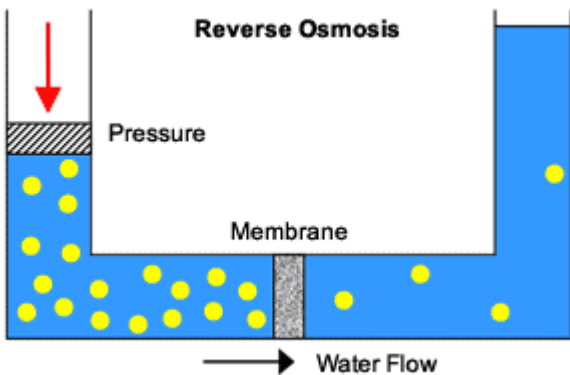
Picture a tea bag placed in a mug of hot water. (The tea bag is the semi-permeable membrane). At first, the water is free of tea. However, with time, the tea will appear to seep from the tea bag into the mug. This is the process of osmosis. If you were to leave the tea bag in the mug for long enough, the concentration of tea inside the teabag would equal the concentration of tea outside the teabag.



Now for reverse osmosis

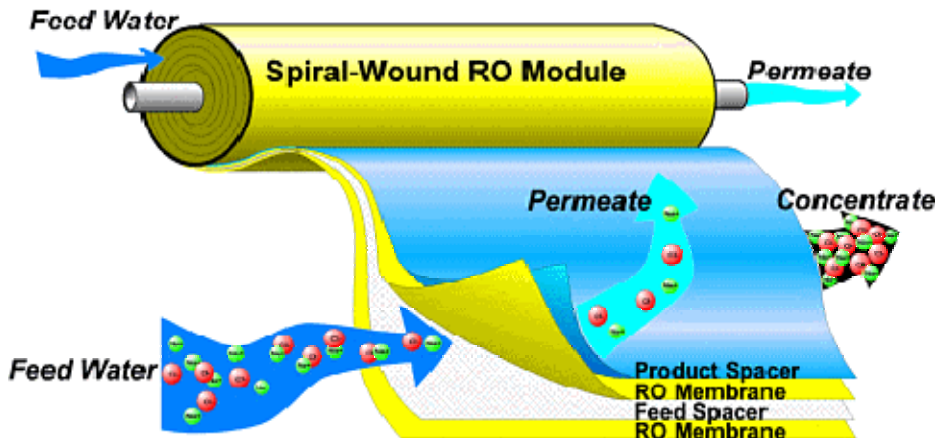
The process of **reverse osmosis** requires that the water be forced through a semi-permeable membrane (the tea bag from the previous example) in the opposite direction of the natural osmotic flow; leaving the dissolved particles in the more highly concentrated solution.

In order for reverse osmosis to occur, the amount of force or pressure applied must exceed the osmotic pressure.



A semi-permeable membrane is at the heart of a reverse osmosis system

Reverse osmosis works through a technique called *membrane separation*. The membrane is permeable only to water molecules.



Two types of Membranes:

CTA membrane - cellulose triacetate

TFC membrane - thin film composite

[Click here to see the difference.](#)

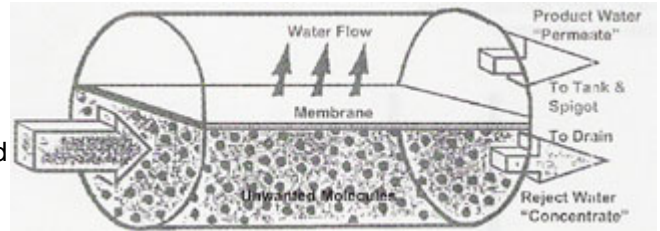
Raw water enters a module housing the membrane system. The water is forced against the semi-permeable membrane and only clean water molecules pass through the pores in the membrane. Impurities are rejected and flushed away.

Crossflow Filtration

While the principles of reverse osmosis are simple the process can not run indefinitely unless steps are taken to ensure the membrane does not become clogged by impurities.

To significantly reduce the rate of membrane fouling, reverse osmosis systems employ **crossflow filtration**.

In conventional filtration, the entire water solution to be filtered is pumped through the filter media and all contaminants too large to pass through the pores of the membrane are trapped or retained on the surface.



In crossflow filtration, two exit streams are generated -- a "concentrate" stream (reject water) containing those material which are rejected or do not pass through the membrane, and the "permeate" stream (product water) which has been pumped through the membrane, and passes to the tank.

The comparative size of particles

Various mineral salts, heavy metals, particular matter, some organic molecules, bacteria and even viruses are rejected or repelled by the membrane surface based on their molecular or atomic weight. A second barrier, such as ultraviolet light, should be used if bacteria are present.

The ability of the membrane to reject or repel dissolved particles, while allowing water to readily permeate, is based on the incredibly small size of the multitude of pores that penetrate its surface. **Such pores are able to reject substances as small as 0.0005 microns.**

A micron (*m*) is a metric unit of length equal to a millionth of a meter, or 0.00003937 inch. A human hair is approximately 75 *m* in diameter. The smallest particle that can be seen with the naked eye is 40 *m* across. The smallest bacteria is about 0.22 *m* while a virus is even smaller at 0.01 *m*.

Reverse Osmosis will remove the following contaminants:

Contaminant	% nominal rejection	Contaminant	% nominal rejection
Aluminum	96-98	Ammonium	80-90
Bacteria	99+	Borate	30-50
Boron	50-70	Bromide	90-95
Cadmium	93-97	Calcium	93-98
Chloride	92-95	Chromate	85-95
Copper	96-98	Cyanide	85-95
Fluoride	92-95	Hardness Ca & Mg	93-97
Iron	96-98	Lead	95-98
Manganese	96-98	Magnesium	93-98
Mercury	94-97	Nickel	96-98
Nitrate	90-95	Orthophosphate	96-98
Phosphate	95-98	Polyphosphate	96-98
Potassium	93-97	Radioactivity	93-97
Silica	80-90	Silicate	92-95
Silver	93-96	Sodium	92-98
Sulfate	96-98	Thioisulfate	96-98
Zinc	96-98		

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