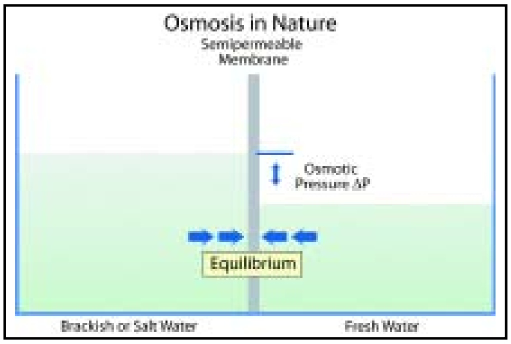
Fundamentals of Reverse Osmosis

"Reverse osmosis explained"

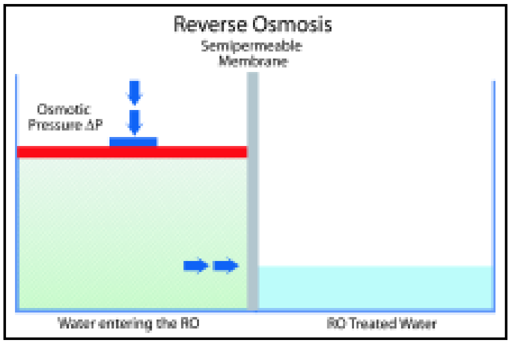
Reverse osmosis is the opposite of the osmosis process that occurs in nature. Osmosis is the passage of a liquid through a semi-permeable membrane. In nature, osmosis drives a liquid with a low level of dissolved solids (usually water) through a semi-permeable membrane into a solution of higher dissolved solids concentration. It continues until the osmotic pressures of both liquids have equalized. This natural process tends to mix the concentrations of the solutions on both sides of the membrane. The natural osmosis process, therefore, works great in pushing the more concentrated tree sap up to the tallest leaves of an oak tree, but it uses up pure water to do it.



To treat water using the osmotic process, the natural forces of osmosis must be reversed. In the reverse osmosis process, the water from a liquid with a high concentration of dissolved solids is forced to flow through the membrane to the low concentration side where this water can be collected. The process is achieved by applying enough pressure to overcome the natural osmotic pressure forces on a membrane. The semi-permeable membranes used in the process are engineered to only allow the passage of the water molecule. The result is high quality water.

"How it works"

The heart of the RO system is the semi-permeable membrane which acts as a molecular filter to remove up to 99% of all dissolved solids.* The semi-permeable membrane allows water molecules to pass through while blocking other salt molecules. So as pressure is applied to the concentrated solution, water is forced through the membrane from the concentrated side to the dilute side. The dissolved and particular materials are left behind.



Water molecules penetrate the thin layer of the membrane and diffuse through it molecule by molecule. Dissolved salt ions do not diffuse through this layer because the solubility of the salt ions is much less than that of the water. Thus, the water moves through more readily and separation from the other molecules present occurs. The driving force is furnished by both the pressure and the concentration differentials across the membrane. For water, the pressure effect is the most important, and for dissolved mineral ions the concentration difference is most important. Therefore, increases in pressure increase the product water flow without a corresponding decrease in the quality of the product water. This process removes up to 99% of most dissolved mineral salts, virtually all of the particulate matter, and many dissolved organic compounds.

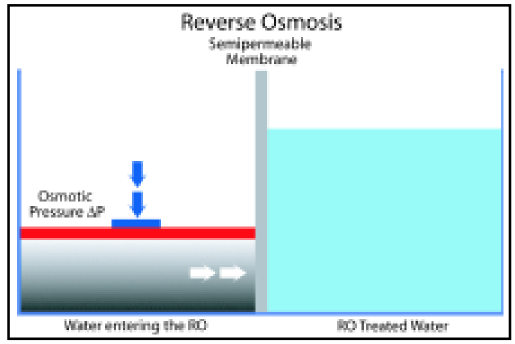
The semi-permeable membrane must be made of a highly durable material since it must withstand pressure higher than the pressure differential between the concentrated side and the diluted side of the membrane which can be very high – as in the case of seawater, where it is up to 350 psi (25 kg/cm^2).

Culligan

Fundamentals of Reverse Osmosis

Some RO systems utilize line pressure only and therefore must be maintained at 40-70 psi to keep a driving force across the membrane to produce high quality, low mineral content water. The recovery rate on these systems is typically 20%-30%.

Larger RO systems utilize a pressure pump to maintain the driving force. These systems normally use pumps that maintain 125-250 psi. The recovery rate for these systems is typically 25%-75%.



Example of a line pressure reverse osmosis system

The correct choice in pretreatment is very important as it influences the quality and quantity of the product water, and above all, the life-span of the membrane. Improperly pretreated systems can experience scaling and/or fouling which will greatly reduce the capacity and life of the membrane.

With increasing operating pressure and temperature of the feed water, the capacity of the RO system also increases. The rated output of the system is typically based on a feed water temperature of 77° F (25° C). Colder water reduces the output of the system so it must be sized based on the lowest expected feed water temperature. Fouling can also cause substantial losses, depending on the characteristics of the feed water, if not properly addressed.

“Typical uses for reverse osmosis”

Ultra-fine filtration of water for: drinking water applications, food & beverage service, ice production/ drinking water, humidification, boiler pretreatment, vehicle wash and water jet cutting machines.

Untreated water can cause: poor tasting food and beverages, improperly carbonated beverages, cloudy ice cubes, increased costs, spotted dishware, spotted vehicles, increased scale, increased maintenance costs and increased utility bills.

*Not all substances removed or reduced by reverse osmosis are necessarily in your water. RO systems should not be used with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.

Culligan International has been in the water treatment business since 1936. Headquartered in Northbrook, Illinois, Culligan has over 800 company-owned and franchise dealers in North America. Culligan offers a wide range of water treatment services for consumers and businesses. From softening and filtering to reverse osmosis and bottled water, Culligan is the leading water expert in the field of water treatment. This educational piece is provided by Culligan as a service to clients and companies in the commercial and industrial arena. Please contact us at 1-800-CULLIGAN for more information or visit us at www.culligan.com/commercial.

Culligan
Trust the Water Experts®

www.culligan.com/commercial - 1-800-CULLIGAN

Printed in the USA (10/04) - MOORE PART NO. 46925