



# TECHNICAL MANUAL

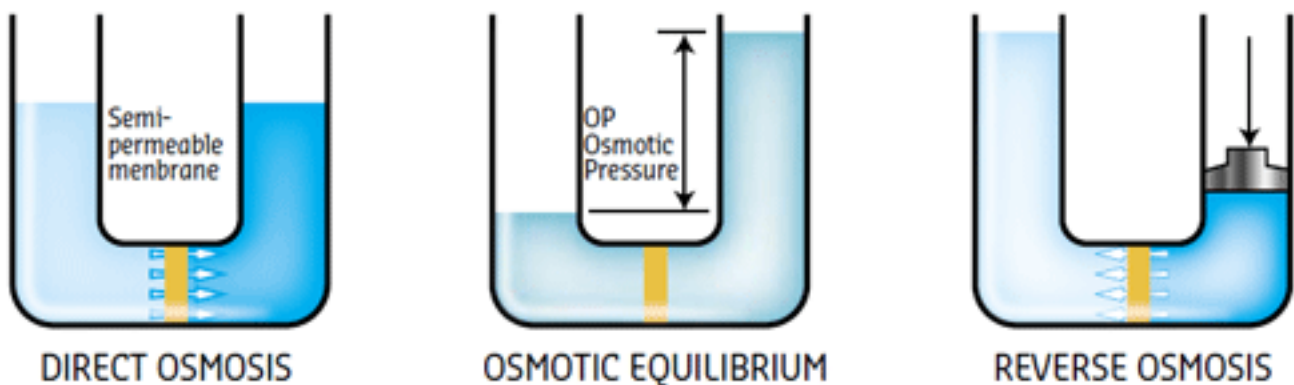
*"PRINCIPLES OF REVERSE OSMOSIS"*



# PRINCIPLES OF REVERSE OSMOSIS

## PRINCIPLE OF OPERATION

To explain the principle of reverse osmosis, you must first understand the phenomenon of osmosis. The definition of the encyclopedia is: "Osmosis is the movement of a solvent through a semi-permeable membrane (such as those of living cells) immersed in a high solute solution that tends to equal the solute concentration on the two sides of the membrane". In fact, in nature, when two solutions having different concentrations are separated by a semi-permeable membrane, i.e. it is able to selectively exchange only one substance (example: solvent but not solute), an osmotic pressure establishes itself between the two solutions, allowing the solvent to migrate spontaneously from the less concentrated to the more concentrated solution. Consider the following illustrations:



### ***Reverse Osmosis operating principle***

The glass on the left is filled with water and the tube is semi-submerged in the water. As we can see, the water level in the tube is the same as the level in the glass. In the second figure, the lower end of the tube was closed with a semi-permeable membrane and the tube was partially filled with a saline solution and immersed. Initially, the level of saline and water is equal, but after a while the liquid level in the tube rises. This rise is due to osmotic pressure.

In the figure above, the semipermeable membrane lets the water molecules pass but not the dissolved salts.

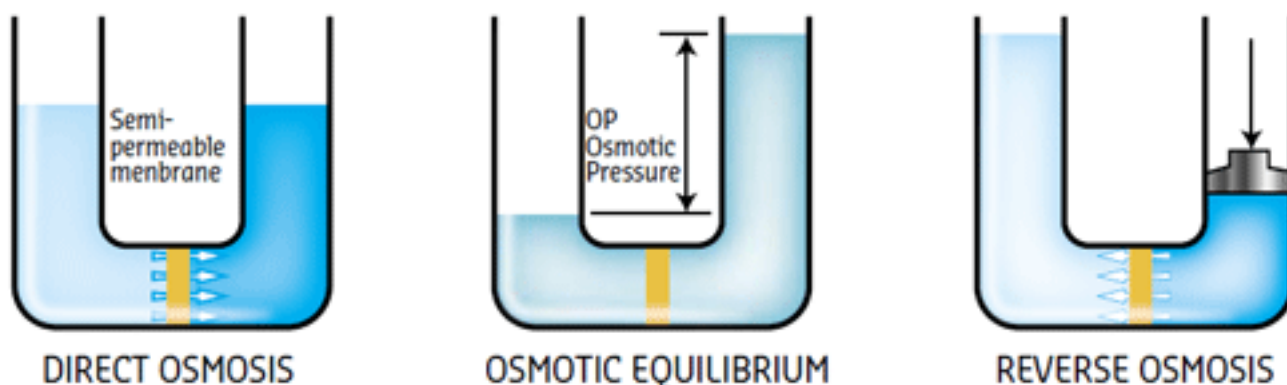
The level of the saline solution increases until one of the following situations occurs:

- the saline concentration becomes the same on both sides of the membrane
- the height increase of the saline column (now diluted solution) exerts a pressure on the membrane equal to the osmotic pressure

At this point, osmosis no longer has visible effects.

It is a phenomenon that takes on a significant biological importance as often cell membranes behave as semi-permeable to organic molecules or salts, and the exchange between biological fluids and cells often occurs in osmosis.

In reverse osmosis, by applying a higher pressure than the osmotic pressure to the concentrated solution, the natural flow direction between two saline solutions separated by a semi-permeable membrane is reversed.



### ***Reverse Osmosis operating principle***

Semi-permeable membranes, which are made of synthetic material and packaged in well-defined modules (see Figure 2), are the means through which this process is made possible. The water to be treated enters the separation module with a sufficient pressure to squeeze the membranes. A part of the water passes through and is collected, free of salts (permeate), in the appropriate collection environment. The rest of the water, which is more concentrated, exits the module after passing completely through it. A minimum continuous flow of concentrate is essential to ensure the flow of possible deposits and the absence of salt precipitation.

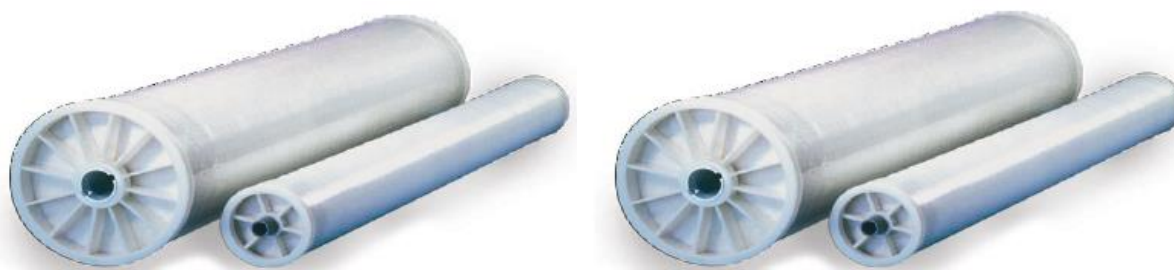


Fig.2 Various types of membrane modules

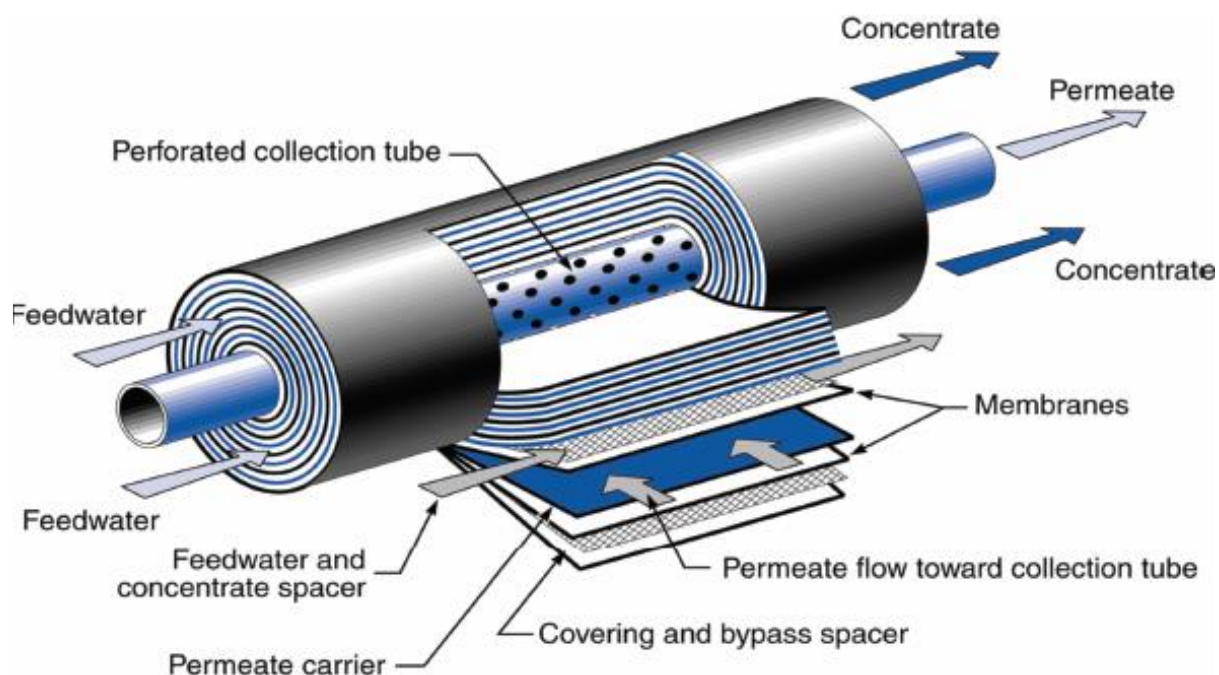
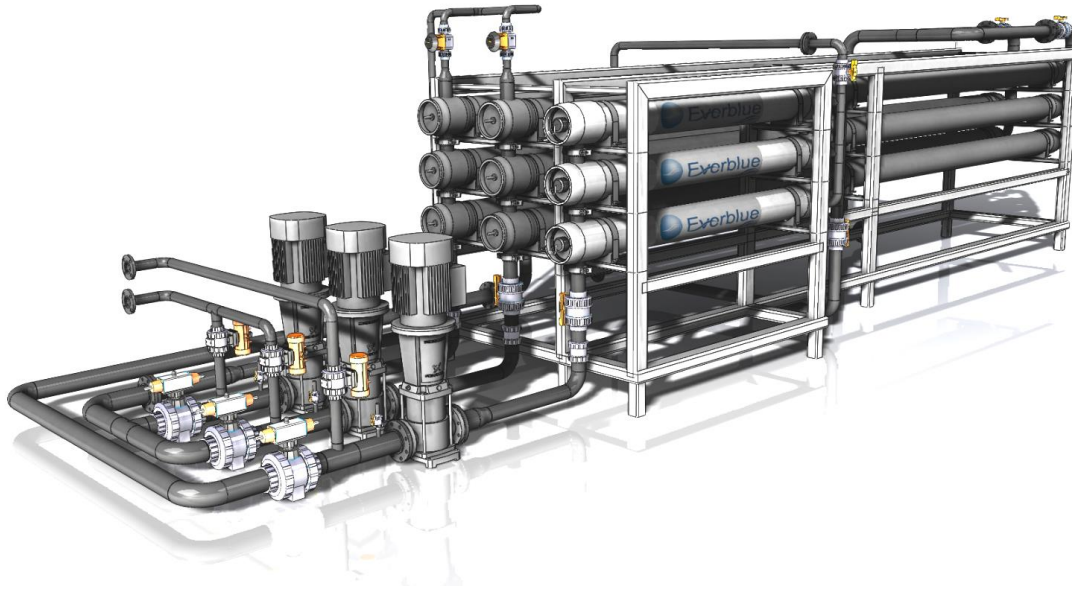


Fig.4 Example of sectioned membrane

The idea of using reverse osmosis to obtain very low salt water content has come to fruition in recent decades thanks to the development of advanced technologies and membrane studies. Membranes have been studied to be used in existing systems by pumping through special modules containing spiral wound membranes. Water coming from sources of different nature (sea water, surface water, or well water) is separated from the salts, collected at the output of the plant and destined for a variety of purposes, such as for human consumption, food and pharmaceutical industries, or used in industrial plants such as turbines or boilers whose proper functioning is greatly influenced by the formation of salt deposits.

If the water supply contains substances upstream the system that can reduce the membrane performance or completely damage it, an appropriate pretreatment unit is installed.

Pretreatment of reverse osmosis plants can be accomplished in different ways depending on the source of feedwater, its analysis, and the volume to be treated.



The different configurations of reverse osmosis systems and the descriptions of the different types of pretreatment are described in the specific EVERBLUE TECHNICAL MANUALS.



*Reverse Osmosis Plant*



## **FIELDS OF APPLICATION**

The performance of these systems has been greatly improved over time thanks to the use of high-efficiency membranes and specific chemicals which wash them and reduce the deposition of salts on the membranes. This reduces the frequency of membrane washing and replacement.

The success achieved by advanced technology that can reduce production costs, such as reverse osmosis, stimulates interest in extending the use of this process to all those areas that require a safe answer to the need for purified water.

The reverse osmosis plants can treat the following types of water:

- Sea water
- River water
- City water
- Underground water
- Industrial water
- Industrial waste water

The permeate produced by the reverse osmosis plant can be used for the following applications:

- Ultrapure water
- Rinse water for semiconductor and liquid crystal industries
- Pure water
- Boiler water
- Industrial water
- Pharmaceutical water
- Water for beverages
- Water for food industries





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