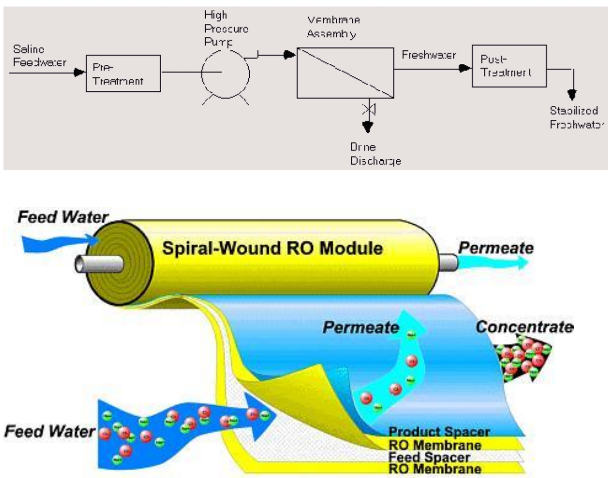
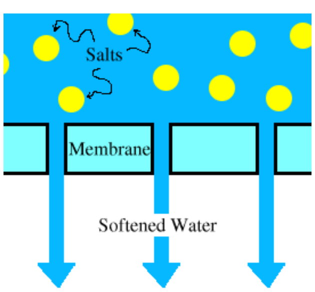
REVERSE OSMOSIS (RO) water treatment process involves water being forced under pressure (Osmatic Pressure) through a semipermeable membrane. Temporary and permanent hardness , Total Dissolved Soilds (TDS), Microorganisims and other bio germs contained in water are captured while the water is passed through the membrane.

Some Standard Membranes: Filmtec Membrane, Hydronatics Membrane, Torry membrane and Koch Membrane. The Reverse Osmosis water treatment Process is generally used for desalination of Sea water treatment and Brackish Water Treatment for its conversion into potable water. Simple flow diagram of Reverse Osmosis systems is shown below.



Flow Diagram of a Reverse Osmosis System

In RO, feed water is pumped at high pressure through permeable membranes, separating salts from the water. The feed water is pretreated to remove particles that would clog the membranes. The mechanism of Reverse Osmosis water treatment plant is shown below

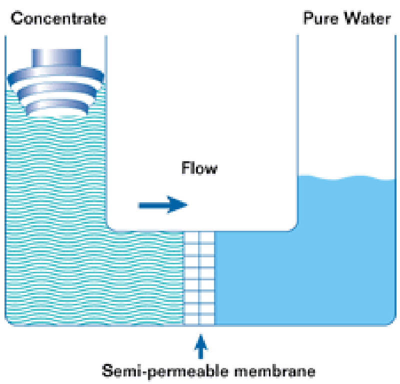


Mechanism Of Reverse Osmosis Plant

The quality of the water produced depends on the pressure, the concentration of salts in the feed water, and the salt permeation constant of the membranes. Product water (permeate) quality can be improved by adding a second pass of membranes, whereby product water from the first pass is fed to the second pass.

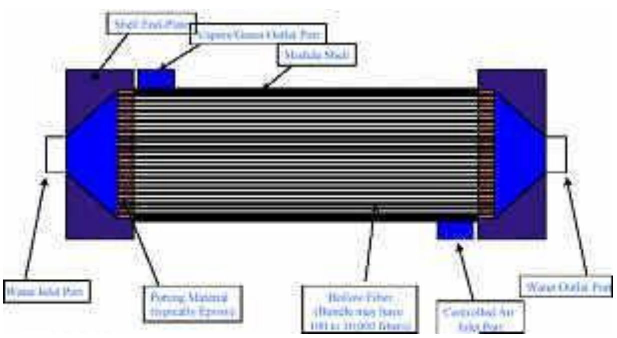
Membrane Type and Materials

The membrane can be defined essentially as a barrier, which separates two phases and restricts transport of various chemicals in a selective manner. A membrane can be homogenous or heterogeneous, symmetric or asymmetric in structure, solid or liquid, can carry a positive or negative charge or be neutral or bipolar. Transport through a membrane can be effected by convection or by diffusion of individual molecules, induced by an electric field or concentration, pressure or temperature gradient. Membrane filtration are categorized according to their pore sizes as microfiltration, ultra filtration, nano filtration and reverse osmosis. Micro filtration uses the largest pore size, reverse osmosis the smallest. RO membranes have pore diameters ranging from 5 to 15 A degree (0.5 nm to 1.5 nm). The extremely small size of RO pores allows only the smallest organic molecules and unchanged solutes to pass through the semi-permeable membrane along with the water. The membrane thickness for reverse osmosis may vary from as small as 100 micron to several millimeters. The first commercially available membranes, developed in the mid 1960s, were made of cellulose acetate (CA) manufactured in flat sheets. Modern CA membranes are modifications of the cellulose acetate structure, including blends and different surface treatments, and are called cellulose or symmetric membrane. Non-cellulose membranes, called thin-film composite membranes, have been developed since the 1970s. These include poly amide membranes with relatively thick asymmetric poly amide support structures and composite membranes with thin-film poly amide or other membrane materials on a porous support structure. Almost all RO membranes are made of polymers, cellulose acetate and matic polyamide types rated at 96%-99+% salt rejection. RO membranes are generally of two types; (i) asymmetric or skinned membranes and (ii) thin film composite (TFC) membranes. The support material is commonly poly sulfones while the thin film is made from various types of poly amines, polyureas, etc.



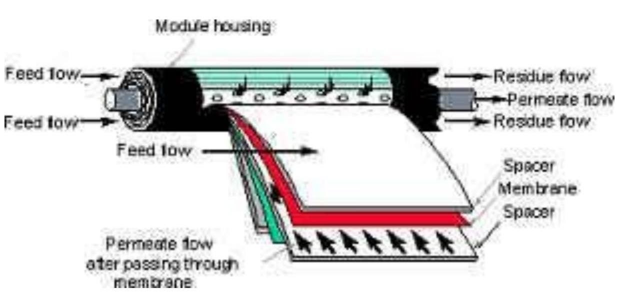
Advantages and Disadvantages of different types of Membranes Each membrane material has advantages and disadvantages. The CA-based membranes are now generally the least expensive. Use of CA membranes generally requires chlorinated feed water and higher operating pressures than those needed by the composite membranes. Composite membranes generally operate over wider pH and temperature ranges than CA membranes. In some cases these operating characteristics of composite membranes result in savings in electric power and chemical costs. Their greater pH tolerance provides additional advantages in cleaning for some applications. Sensitivity to chlorine and other strong oxidants in the feed water is a disadvantage of polyamidebased membranes. Membrane Configurations RO membranes are in several different configurations: <(i) hollow-fibre, (ii) spiral-wound, (iii) tubular, and (iv) plate and-frame. In the recent years, hollow-fibre and spiral-wound configurations have become the standard for RO water treatment. The predominance of the spiral wound configuration has resulted from recent advances in membrane technology, which has been more easily translated into commercial flat-sheet membranes than into the hollow-fibre configuration.apes and structures, different types of membrane modules are available. The membrane and module development has lessened the effects of physical compaction and has brought forth spiral membrane modules capable of operating at pressures in excess of 50 bar (50 ksc.2 bar). The technoeconomic factors for the selection, design and operation of membrane modules include cost of supporting materials and enclosure (pressure vessels), power consumption in pumping and ease of replacing.

The Below Image shows the hollow fibre membrane



Hollow Fibre Membrane

The Below Image shows the Spiral Membrane



Spiral Membrane

RO can meet most water standards with a single-pass system and the highest standards with a double-pass system. RO rejects 99.9+% of viruses, bacteria and pyrogens.

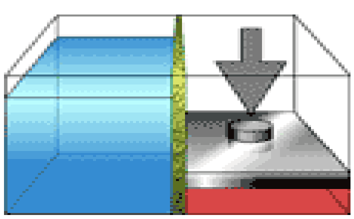
Pressure, on the order of 14 to 70 bar, is the driving force of the RO purification process. It is much more energy efficient compared to heat-driven distillation and more efficient than the strong chemicals required for ion exchange. No energy-intensive phase change is required.

Pretreatment Processes

Pretreatment processes are needed to remove substances that would interfere with the desalting process. Algae and bacteria can grow in both RO and distillation plants, so a biocide usually, less than 1 mg/ L chlorine is required to clean the system.

Reverse Osmosis Plant Capacity : 2000 m3/day

Some RO membranes cannot tolerate chlorine, so dechlorination techniques are required to remove the residual chlorine. Ozone or ultraviolet light may also be used to remove marine organisms. If ozone is used, it must be removed with chemicals before reaching the membranes. The type of pre-treatment required depends on the feed water characteristics, membrane type, and system design parameters. Pre-treatment requirements can be minimal, such as cartridge filtration of well water, or extensive, such as conventional coagulation, sedimentation, and filtration of surface water supply to remove suspended solids. Scale inhibitors such as sodium hexa metaphosphate or proprietary chemicals are also added to reduce carbonate and sulphate scale potential. Pump System



Princeple of RO

The pump system raises the pressure of the pre-treated feed water to the level required for operation of the desalting system. For RO, the pump system discharge pressure typically is about 10 – 30 kg/cm2 for low- TDS and brackish-water systems and 60 to 90 kg/ cm2 for seawater systems. The pump system for RO might also include energy recovery devices, particularly for seawater systems. Post Treatment Removal of the gases is normally accomplished by stripping in a forced draft packed column. In the most cases, carbon dioxide must be removed to stabilize the RO product water. If hydrogen sulphide is present, degassing of the product water is usually done to control odour and minimize the amount of disinfectant (e.g., chlorine). The final product-water pH is often adjusted by caustic soda, soda ash, or lime. A non-corrosive water can be produced by using these alkaline chemicals and, in some cases, other chemicals and blending with raw or other water supplies that may also feed the distribution system.

Maintenance

The following are the maintenance requirements of RO plants:

- The filters for pretreatment of feed-water at RO plants must be cleaned every few days (backwashed) to clear accumulated sand and solids.

- The RO membranes must be cleaned approximately four times a year and must be replaced every three to five years.

Advantages of Reverse Osmosis Plants Advantages of Reverse Osmosis plants over distillation include:

- RO plant feed-water generally does not require heating, so the thermal impacts of discharges are lower;

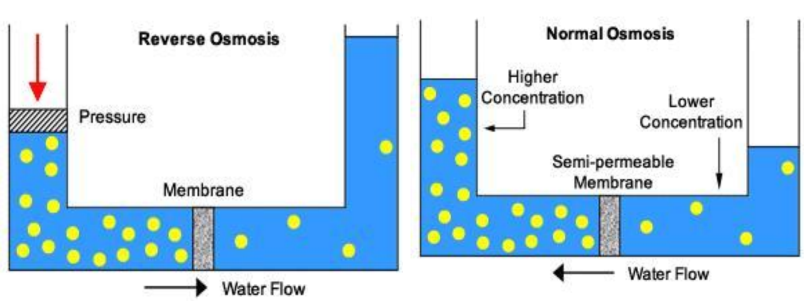
- RO plants have fewer problems with corrosion;

- RO plants usually have lower energy requirements;

- RO plants tend to have higher recovery rates-about 45% for seawater;

- RO process can remove unwanted contaminants, such as trihalomethane-precursors, pesticides, and bacteria; and

- RO plants take up less surface area than distillation plants for the same amount of water production.



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