TECHNICAL MANUAL

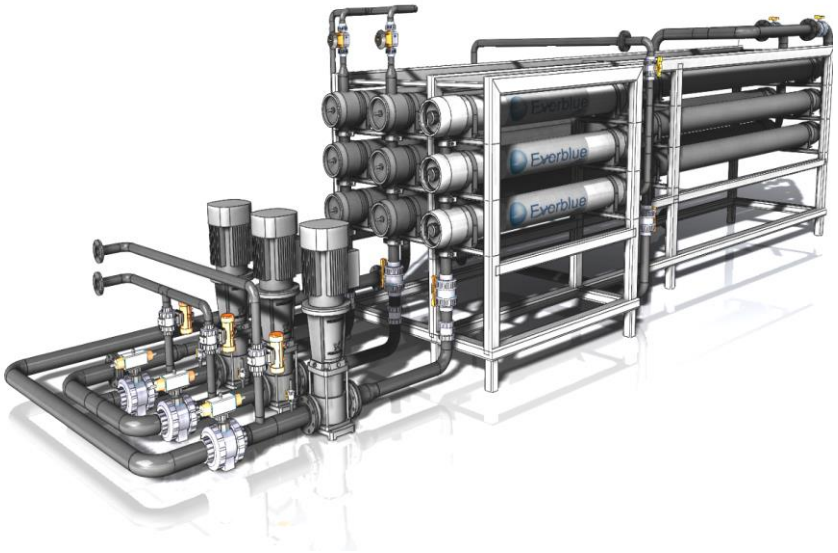
“REVERSE OSMOSIS PLANTS”

REVERSE OSMOSIS PLANTS

Once we understand the reverse osmosis process, the next step is the study of reverse osmosis plants, in particular it is important to know what the essential components.

Reverse osmosis systems can always be divided into five fundamental parts:

- **Chemical Pre-treatment**
- **Filtration System**
- **Membrane System**
- **Membrane Washing System**
- **Final Treatment**



Reverse Osmosis Plant in Alicante (Spain)

Chemical Pre-treatment

Chemical pre-treatment is necessary to improve the quality of reverse osmosis membranes feedwater through the following processes:

- **Coagulation / flocculation - to reduce the amount of suspended solids**
- **Biocide dosage - to eliminate the bacterial charge**
- **Antiscalant dosage - to inhibit the precipitation of salts**

The above processes are described in EVERBLUE'S specific TECHNICAL MANUALS.

Plant with EVERBLUE'S antisclant

Antiscalant EVERBLUE

Filtration System

The filtration system can consist of several different equipment according to type, features and dimensions. The choice of the right filtration system depends on:

- **type of water to be treated (brackish water, sea water, civil or industrial wastewater)**
- **water analysis**
- **sampling point (surface or well)**
- **flow rate / volume of water to be treated**

The choice of components and materials required for the construction of filtration systems is also determined by the type of water produced by the membrane system.

The most common filtration system used as pre-treatment for reverse osmosis plants are:

- sand filters (1)
- self-cleaning filters (2)
- cartridge filters (3)
- ultrafiltration modules (4)

The filtration systems used as a pre-treatment in reverse osmosis systems are described in EVERBLUE'S specific TECHNICAL MANUALS.

Sand filters (1)

Photo of Reverse Osmosis pre-treatment with sand filters

Self-cleaning filters (2) and ultrafiltration modules (4)

Photo of a reverse osmosis pre-treatment with self-cleaning filters and ultrafiltration modules

Cartridge filters (3)

Photo of Reverse Osmosis pre-treatment with cartridge filter housings

Membrane system

The membrane system is the heart of the reverse osmosis plant. It includes membranes or modules and their pressure vessels. Reverse osmosis membranes are divided into two fundamental categories:

- Brackish Water Membranes (BW - Brackish Water)
- Seawater Membranes (SW - Sea Water)

The division of the membranes also determines the category of reverse osmosis plants:

- Brackish Water Membranes (BW - Brackish Water) = Brackish Water Systems
- Seawater Membranes (SW - Sea Water) = Sea Water Systems.

Brackish water membranes (BW - Brackish Water) and seawater membranes (SW - Sea Water) are also used in the treatment of wastewater.

Water analysis, in addition to determining the choice of chemical pre-treatment and filtration systems, also determines the choice of membranes and the operating pressure of the reverse osmosis system and as a consequence also the choice of the high pressure pumps and energy recovery systems (only on water systems or for plants with pressures above 15/18 bar).

Photo of Reverse Osmosis System

The descriptions of reverse osmosis membrane systems are listed in EVERBLUE'S specific TECHNICAL MANUAL

Membrane washing system

Even with accurate precautions, effective pre-treatment and proper maintenance of the plant, a progressive blockage of membranes may occur over time.
The membrane clogging period depends on the efficacy of the pre-treatment system and the effectiveness of the antiprecipitating product used.
There are only a few plants where washing and plant procedures are never necessary and these operations need to be carried out only once a year or even once every two years.
However regular washing is recommended at least once a year to keep the membranes in perfect efficiency.

In case of problems on the plant it is essential to wash the membranes in the initial clogging stage.
Washing is recommended when one or more of the following parameters changes by 10-15%:

- increased permeate conductivity

- increased pressure difference

- increased feed pressure

- decrease in production

If the systems performance decreases more than 30%, it is often impossible, with normal procedures, to bring the plant back to optimal conditions and in some cases, irreversible damage to the membranes may occur during washing operations.

The deposits on the surface of the membranes can cause a loss of flow, an increase of the pressure difference (Delta P), a higher conductivity of the water produced, resulting in an increase in feed pressure in order to maintain constant production plant, or a combination of these effects.

EFFECTS OF THE MOST COMMON DEPOSITS ON THE SYSTEM'S PERFORMANCE

DEPOSITS	REJECTION	DIFFERENTIAL PRESSURE	PRODUCT FLOW RATE
Calcium and other inorganic deposits	10 – 25% increase	10 – 40% increase	< 10% decrease
Metal oxides and hydroxides	> 2 x rapid increase	> 2 x rapid increase	20-40% decrease
Colloids	>2x gradual increase	>2x gradual increase	> 50% decrease
Biofilm	Variable depending on permeability	> 2 x rapid increase	> 50% decrease

The most common deposits found on the membranes used in water treatment are:

- calcium carbonate and inorganic deposits

- oxide and iron hydroxide

- colloidal substances

- organic and biofilm substances

Other precipitates and deposits such as calcium fluoride, barium sulphate, humic acids, and silica are less frequent but often difficult to remove.

Biofilm is the most common cause of loss of membrane performance.
This deposit is mainly due to the accumulation of extracellular polysaccharide substances (EPS) secreted by microorganisms (bacteria, fungus, mold) introduced into the membranes by/through feedwater or developed within the system.
The recommended washing program requires a disinfection to be performed in three distinct phases.

Inorganic precipitates. The increase in saline concentration, during food / concentrate (waste) passage on the membrane surface, facilitates precipitation especially at the terminal end of the plant.
The use of an effective antiscalant prevents this type of deposits.
Precipitates, normally found on the membranes, include calcium carbonate, calcium sulphate and barium and magnesium silicate.

It is therefore important to emphasize that in order to prevent membrane problems and reduce the number of washings, it is always necessary to design an adequate and complete pre-treatment system because the efficiency of the reverse osmosis system depends on it.

All reverse osmosis systems with 4 "and 8" membranes must be equipped with washing systems.

Photo of Reverse Osmosis Washing System

The washing process of reverse osmosis modules and information related to membrane cleaning system are described in the specific TECHNICAL MANUAL of the membrane manufacturers.

Final treatment

Some osmosis systems are complemented by the final systems for the treatment of water produced by the membranes.
The final treatments are different depending on the use that is made of the water produced.

The descriptions of the final treatments are listed in EVERBLUE'S specific TECHNICAL MANUAL.

Via Alberto Zanrè, 16 – Loc. Gotra - 43051 Albareto (PR)

Contatti: +39 0525 1920100 – info@everblue.it – www.everblue.it