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Geoscience and Technology Consulting

DISSALATORI A RECUPERO ENERGETICO

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INDICE

1. INTRODUCTION

The widest and richest water resource of the Earth planet is sea water; it represents 94% of the whole water of the Earth planet. Its availability is neither limited nor conditioned by climatic changes, seasons cycle or politics of superpowers.

Sea water to freshwater transformation is naturally performed by the planet scale sundriven distillation process of evaporation, cloud growth and rain (or snow) fall.

Freshwater quality naturally "distilled" this way is controlled by the quality of the atmosphere it interact with: the whole process is threatened by the presence of any airborne pollutant.

Together with the evaporation-condensation process there is another natural process, much more efficient and refined, to get freshwater from the sea: it is the way all marine animals (whose blood is not salty) produce their "own" freshwater. This is a very special kind of chemical filtration, made by membranes of the biological cells.

Such physical-chemical process can be industrially reproduced and is called **reverse osmosis (RO)** and to be performed it needs energy.

2. REVERSE OSMOSIS

Reverse osmosis is a desalination and/or water purification process based on semi permeable membranes properties.

Sea water is brought and kept at high pressure against one side of specially formulated membranes; on the other side of the membrane freshwater is collected. The physic process of reverse osmosis is not particularly energy demanding in itself, but to get it working we need to bring a lot of row sea water to high pressure: such pressurization process needs a much higher amount of energy.

Most of nowadays RO desalination plants readily available off the shelf require (and waste) huge amounts of energy: the reason is quite trivial: RO technology developed in USA before the first oil crisis and fast spread in the middle east, where a lot of locally produced energy (oil) was available almost at no cost. A big industry, uncaring energy costs, developed on such a market, and big industrial systems technological inertia is proverbial.

Only in very recent times an innovative, intrinsically highly efficient, technology has been developed to recover up to 98% of the energy involved (and previously wasted) in the pressurization process (Fig 1).

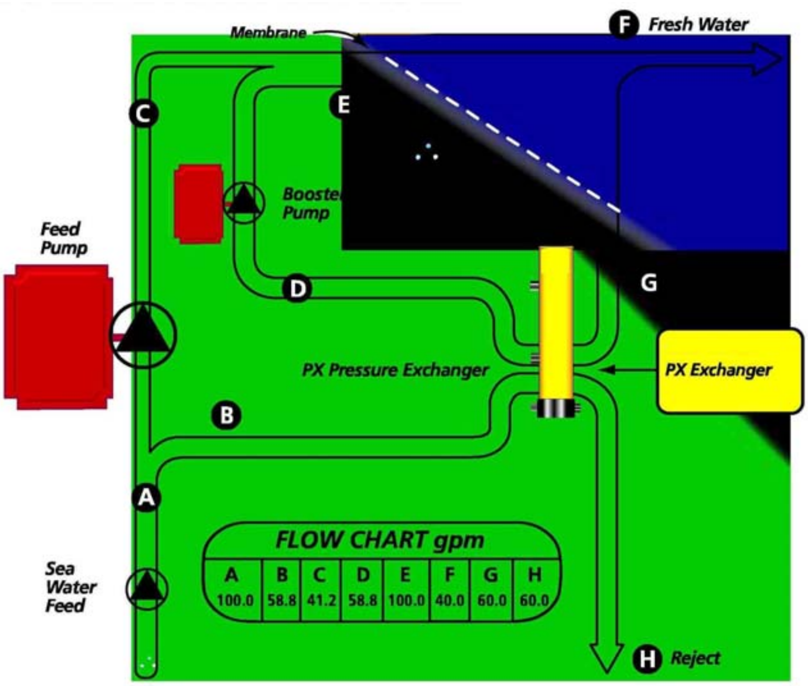

Fig 1 – Flow chart at the highest membrane rejection (60%)

The **Energy Recovery Reverse Osmosis Desalinators** (**ERROD**) quickly achieved very high efficiency and reliability thanks to the use of specially formulated ceramic compounds and high tech extremely low tolerance component dimensioning.

It have been developed, and is now available, as highly efficient modular units, to fulfil desalination demands of a small farm as well as those of a big town.

The modular ERROS units are composed by sub modules, to allow precise size to demand fitting, and they can be assembled in groups, to fulfil big concentrated demands.

3. ENERGY RECOVERY REVERSE OSMOSIS 1000 m^3/day MODULE

The ERROD 1000 module (Fig 2) is assembled and works in a couple of 40’ standard containers, cutting down to a bare minimum logistical handling, installation and eventual reallocation problems.

One container is for row sea water filtration and fresh water post treatment, the other is for the properly said desalinator, that is composed by

1. High pressure row sea water pump
2. Osmotic membranes group
3. Ceramic pressure recovery groups
4. Energy recovery buster pumps
5. Automatic module monitoring and managing units

Row sea water is fed to the module by an external pump (or pumps system) drawing directly from sea water or (generally preferable option) from a seashore neighbour borehole; thus taking advantage from natural filtration capability of underground porous layers. The row water reaches filtration pre-treatment section end then the properly said desalinator.

Two streams came out from the ERROD: the “brine” (salinity roughly double of intake sea water) and fresh water (total dissolved salts lower then 100 PPM)

Brine is returned to the sea, fresh water is neutralized and remineralized (post treatment, necessary as RO water is too pure for human consumption) and sent to storage reservoirs or directly to the distribution net.

Site logistics, row water quality, fresh water use will dictate best dimensioning and technology for filtration, post treatment and storage.

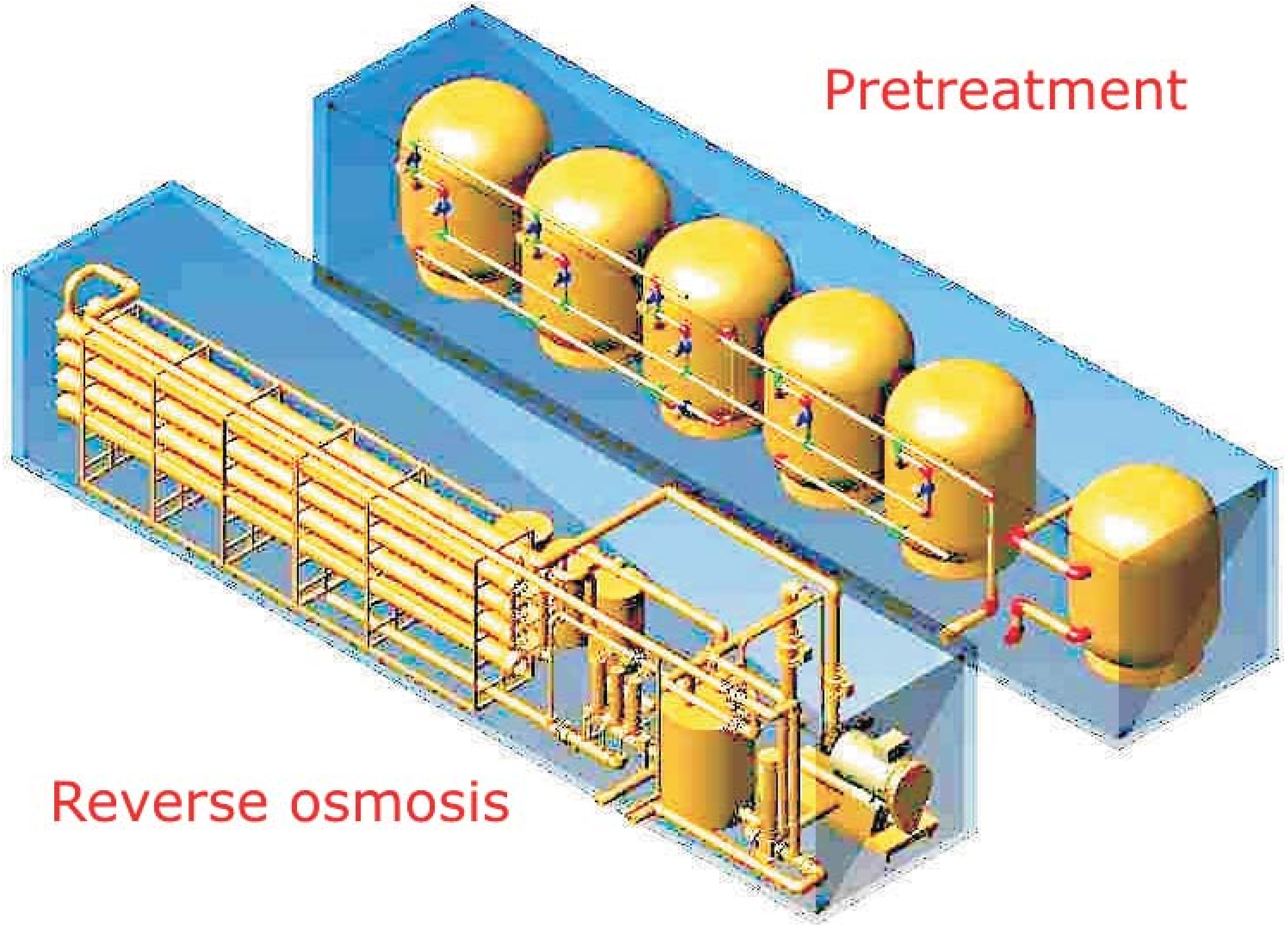

Fig. 2 - Schematic components arrangement in the standard 40’ containers.

4. ADVANTAGES OF ENERGY RECOVERY MODULAR RO DESALINATORS

With respect to first generation, classical RO desalinators , the implementation of energy recovery and modularity make the difference: energy saving of at list 70%, and precise demand fitting size.

Multiple modular movable systems are preferable up to a 25,000 m^3/day size to single, big, fixed plant for many reasons, most relevant of which are:

1. Easy to schedule maintenance without the need to stop the whole plant.
2. Plant can be fractionated finely tuning it to user density distribution, minimizing net implementation and maintenance costs together with its vulnerability.
3. Drastic reduction to the environmental impact typical of fixed single plant: no permanent soil occupation, no cementification, visual impact easily mitigated.
4. Possibility to resize the system to increasing or decreasing demand without complete overhaul and redesign.
5. Possibility to relocate partially or totally the plant for logistical or seasonal occurrences.
6. Drastic abetment of disposal costs of chemicals for routine membrane maintenance and regeneration.

5. PROJECT STARTUP CHECKLIST

A. Plant design

- Logistics survey
- Site optimization for modules
- Users spatial distribution analisys
- Row sea water feeding net design and optimization
- Distribution net optimization
- Post treatment design and optimization, storage dimensioning and siting

B. Installation

- Feeding system realisation (well, sea water intakes etc)
- Modules bases realisation
- Modules placement and connecting
- Eventual post treatment modules placement
- Tanks farm realization

C. General test and refinement trimming

6. TECHNICAL SCHEDULE

Plant lifetime	20 years
TDS raw sea water	max 50 g/l
Rejection ratio	60% at max salinity
TDS desalinated water	< 100 mg/l
TDS water rejected to sea	max 90 g/l
Row sea water demand	max 60 l/sec
Sea water input pressure	> 304 KPa (3,0 Kg/cm^2)
Productivity	1.000 m^3/day
Efficiency	90%
Operation	365 days/year
Annual productivity	328.500 m^3
Power consumtion	2.80 kWh/m^3
Power demand	120 kW
Membrane lifetime	5 years
Membrane consumtion	84 unit/plant
External components[1]	Row sea water intake and feeding to modules Fresh water tank farm Brine returning net

[1] dimensioning and external components details should be defined only after the time-spatial demand distribution and plant logistic conditions are known

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