

Desalination chemical impact on Oceans

PECC Noumea Seminar

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Ressources, territoires, habitats et logement
Énergies et climat Développement durable
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A tremendous growth in desalination

- Over the past several decades, tremendous growths in human populations and industrial activities have resulted in a significant demand for fresh and clean water.
- To meet these challenges in our thirsty world, it is critical to find a new alternative of water resource as the natural water resources have almost vanished. In spite of the high cost of desalinated water, a significant quantity is already being produced to meet the demand for freshwater worldwide. Desalination could hold the key for new freshwater resources.

Energy for Water

Desalination of seawater for water supply in the
Mediterranean

A survey for the Plan Bleu

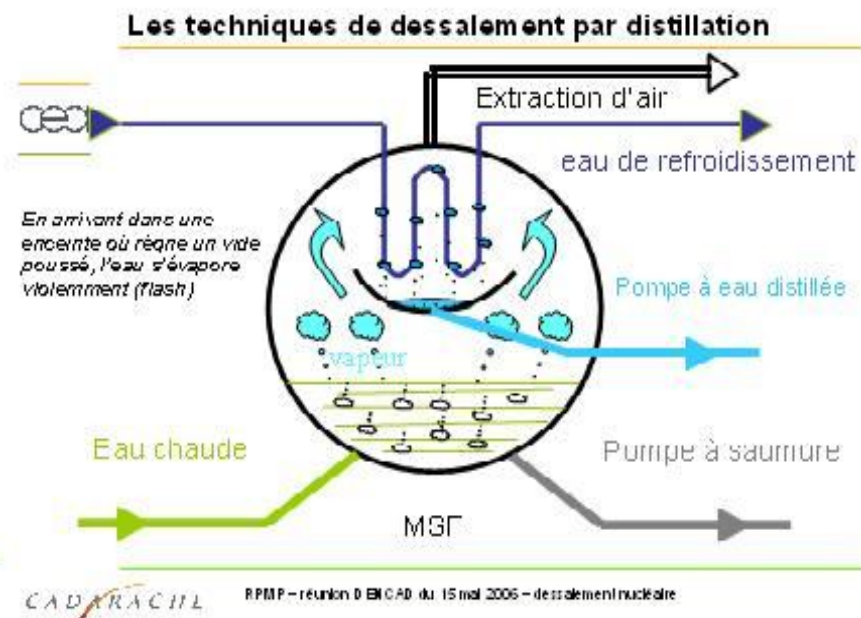
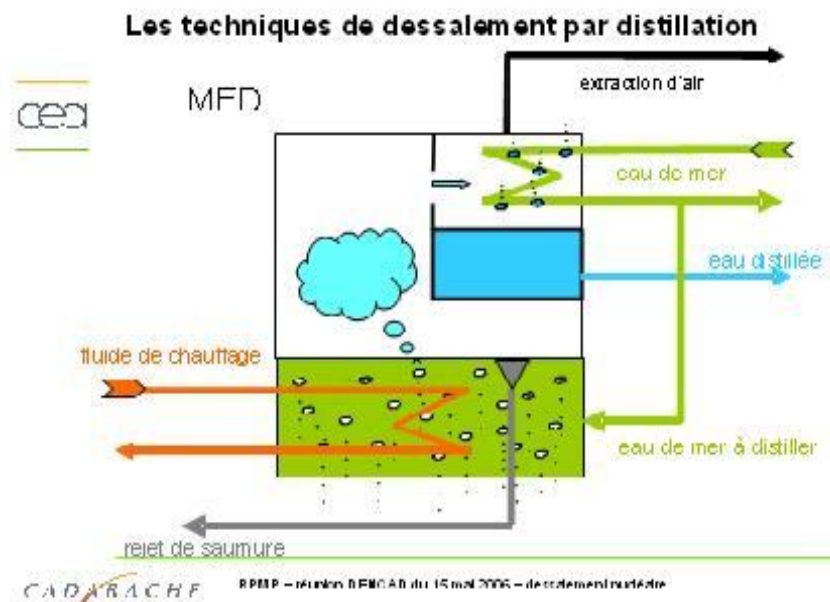
www.planbleu.org

Energy, Water Desalination & Climate Change in the
Mediterranean

Energy for Desalination in the Mediterranean

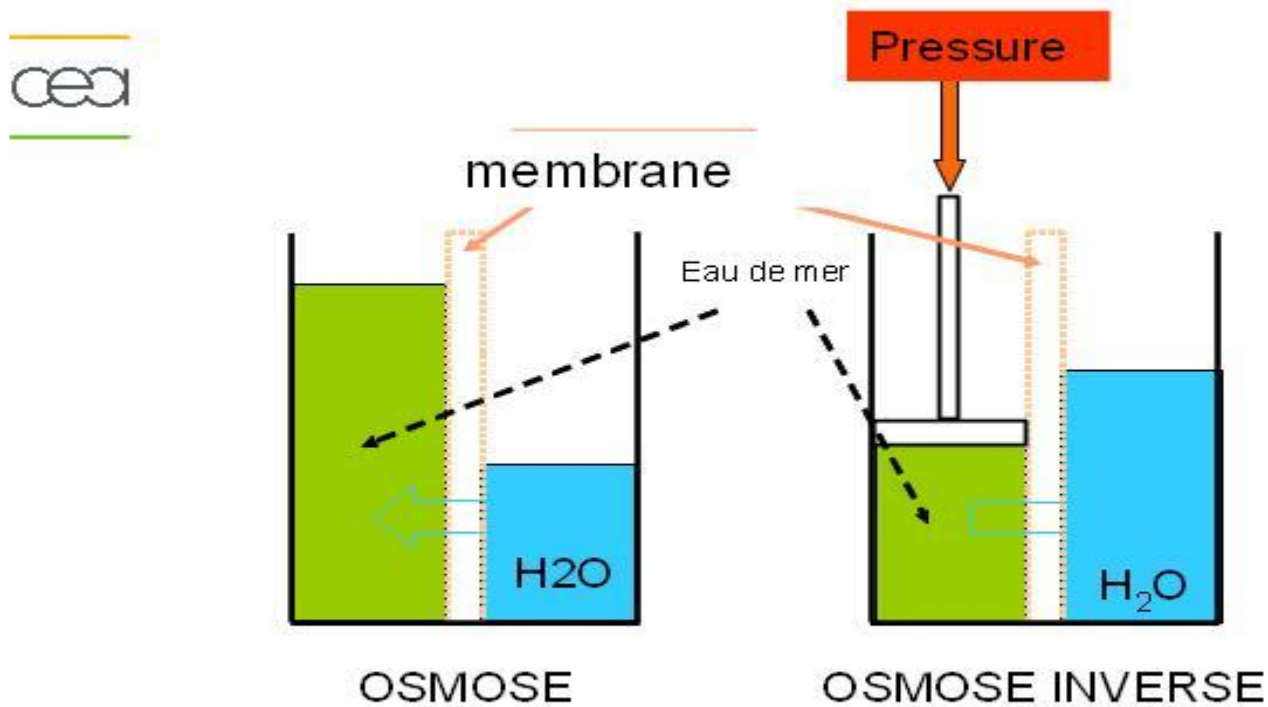
For desalination alone, a volume of desalinated water of 30 million m³/d in the Mediterranean by 2030, with a ratio of 3.3 kWh/m³, would amount to an electric output dedicated to desalination of 5000 MWe, which is 8 to 10 gas combined cycle power plants, or 4 to 5 nuclear units.

Desalination by Distillation



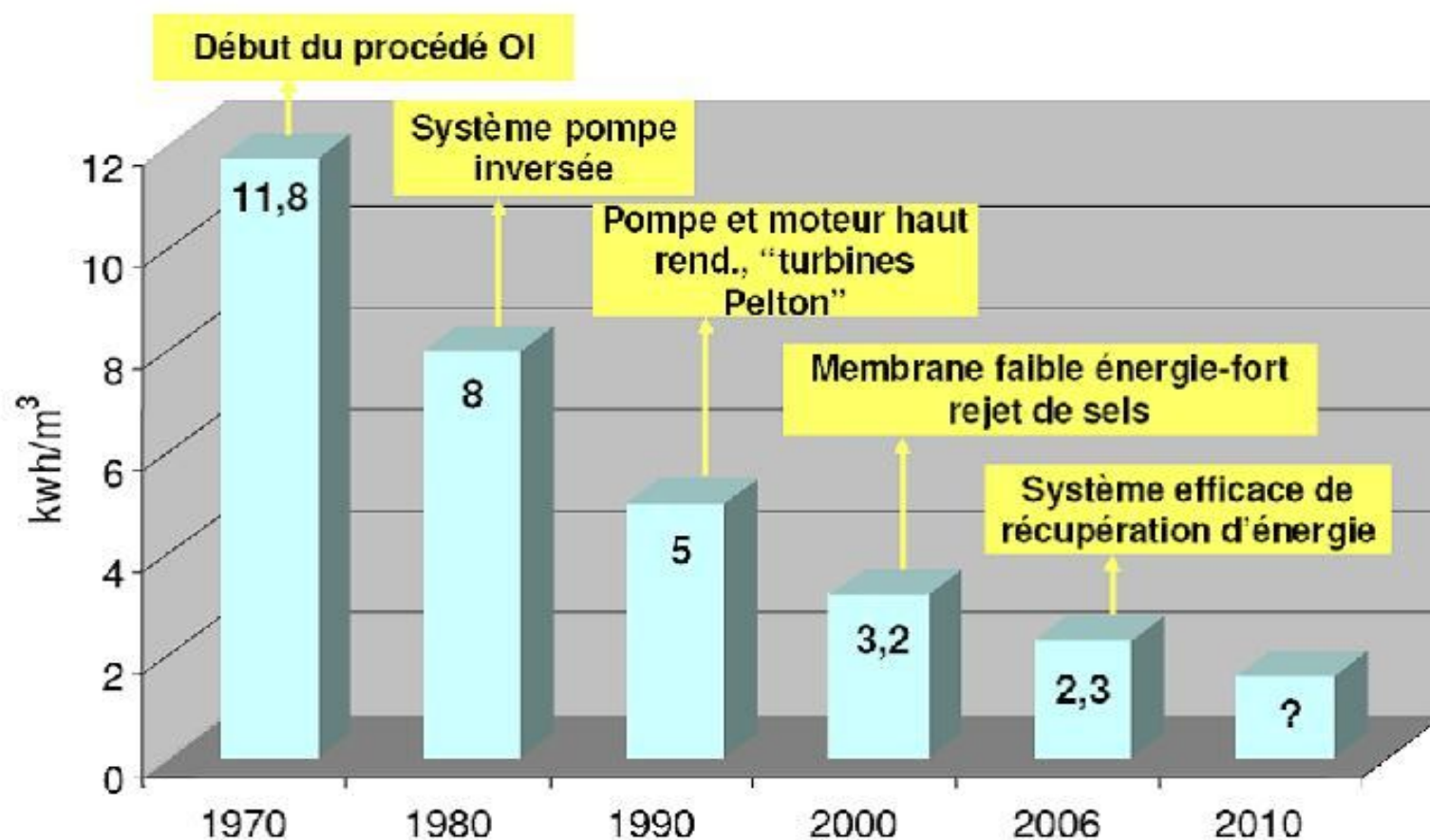
Reverse Osmosis desalination

Osmosis techniques for desalination



CADARACHE RPM

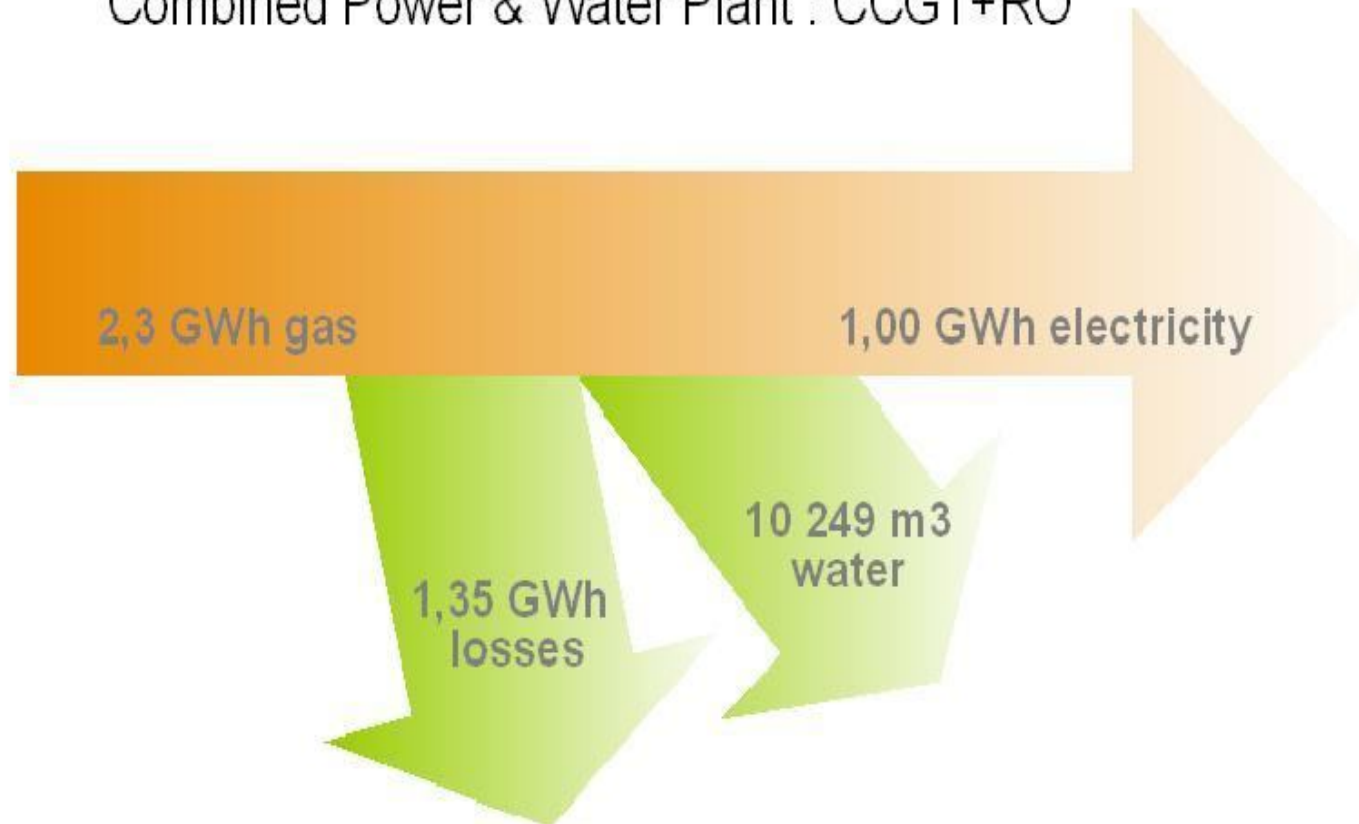
Improvement in RO energy efficiency



Source : présentation de Mme Véronique Bonnelie (DEGREMONT)-coûts de dessalement

« Smart » association of Power Generation and Desalination can save a lot of energy

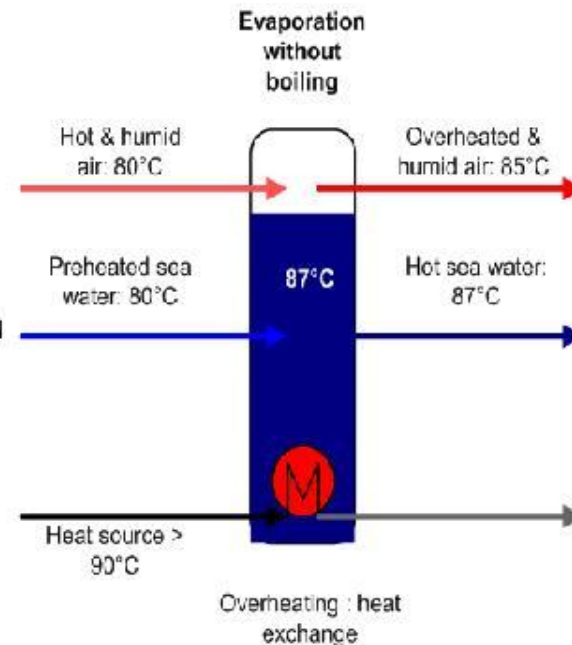
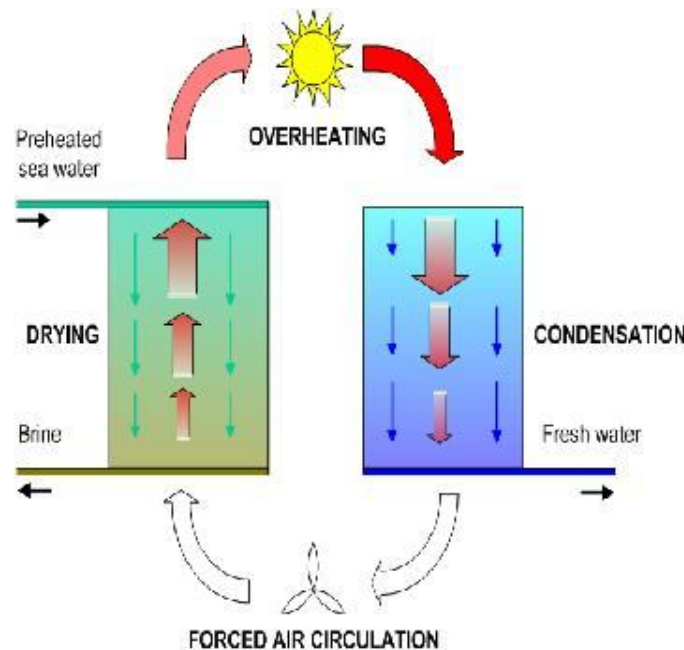
Combined Power & Water Plant : CCGT+RO



Total = 2,3 GWh of gas used, i.e. **12 % of energy savings throughout the system**

→ The RO & CCGT combination is the most efficient

TMW Innovative idea of MEDC technology (multiple-effect drying & condensation) : « natural » desalination



- Evaporation under atmospheric pressure without boiling

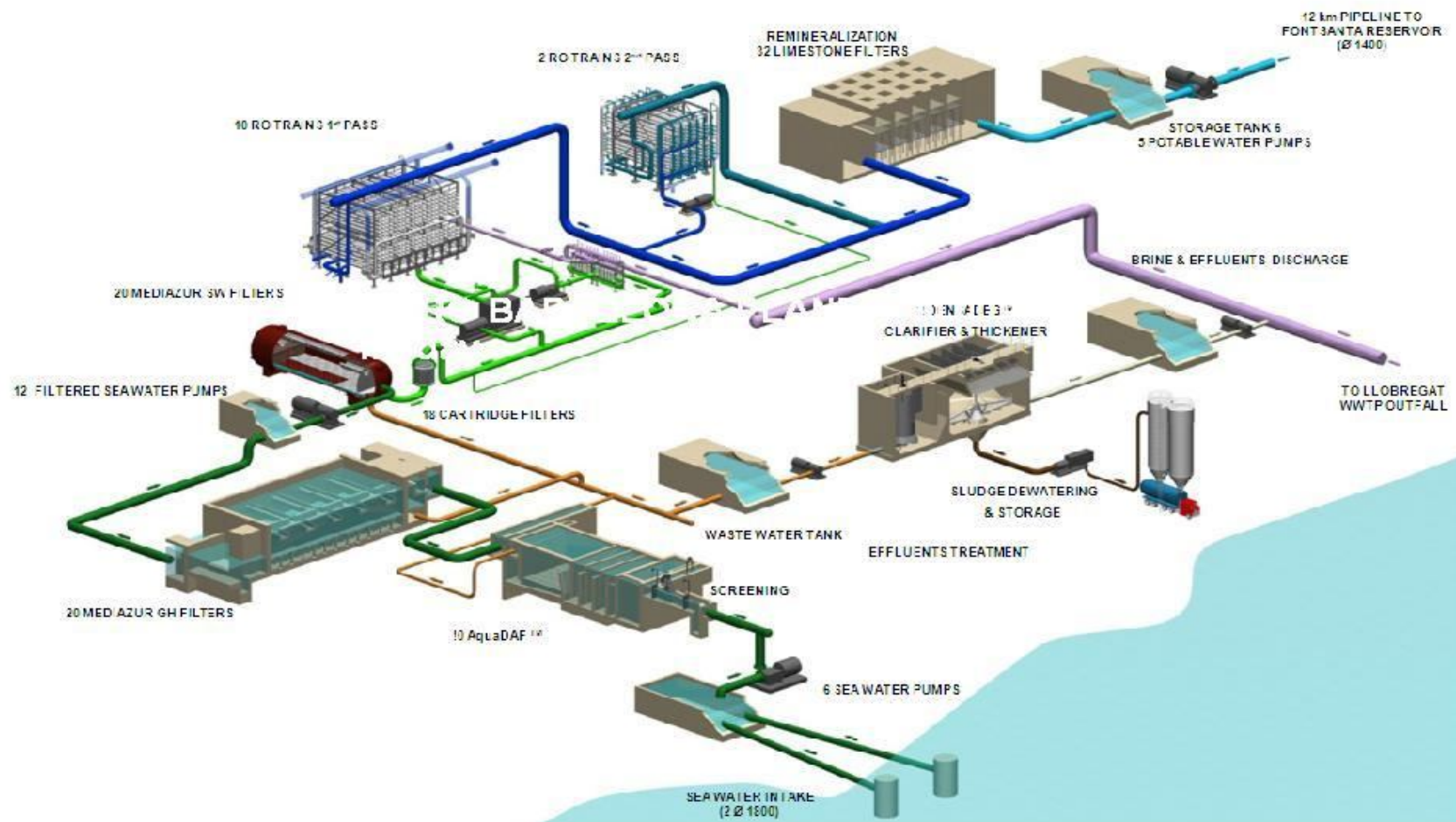
- One mobile part: a fan (< 0.2 kWh/m³)

- Low temperature heat (90 – 120 °C)

- Plastic material only

3MW

SWRO BARCELONA PLANT : 200,000 m³/day



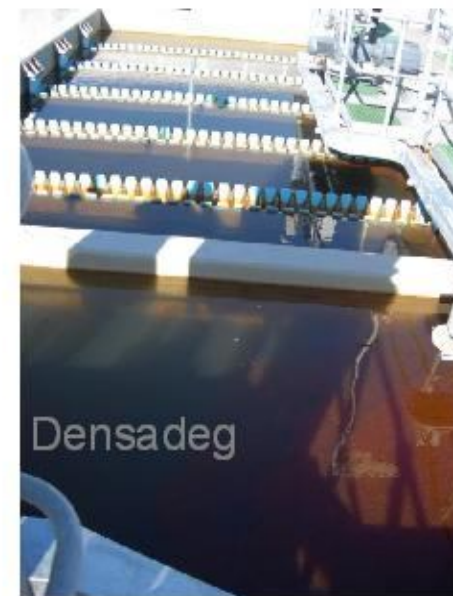
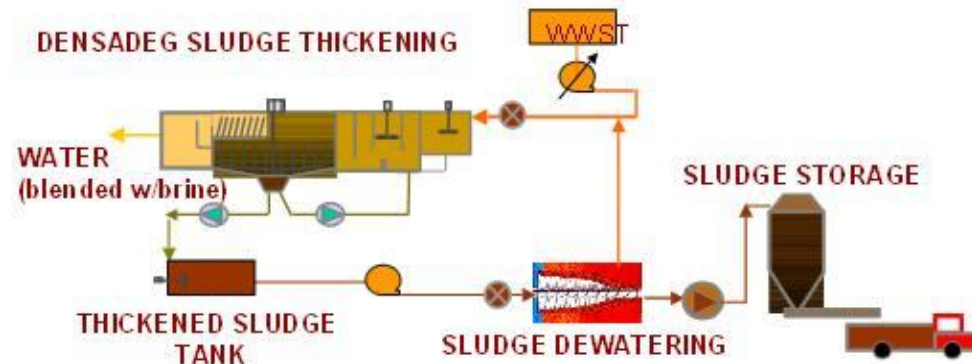
DESALINATION & ENVIRONMENT – R.O. PERTH

- Energy
- Sludge treatment
- Brine discharge

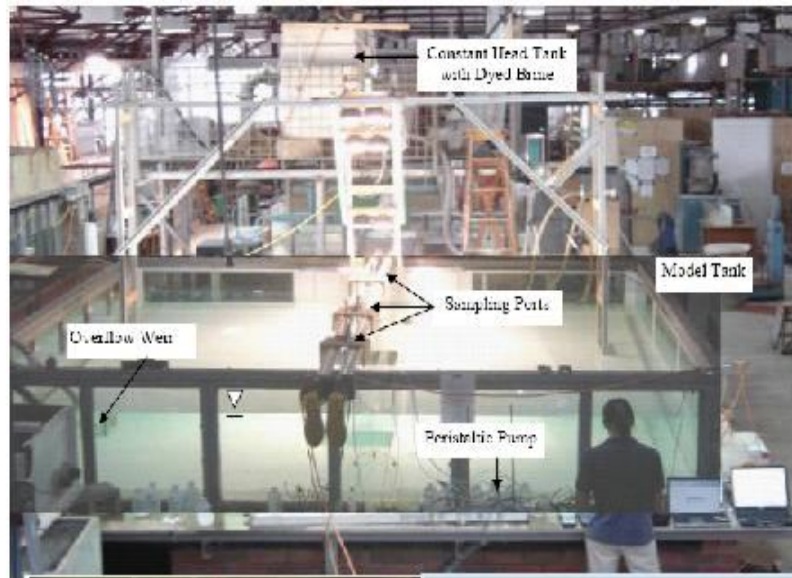


SLUDGE TREATMENT

- From Filters Backwash & Membranes Cleaning
- Thickening, Clarification & Dewatering
- Solid cake for Landfill Disposal
- Water Effluent:
 - Clarified & Blended with Brine, $SS < 1 \text{ mg/l}$



BRINE DISCHARGE



University water expert declares Cockburn Sound's delicate marine life in no danger from salty discharge

Dye test clears desal plan

AMANDA BAYKS

• Periodical verification of brine disposal efficiency

• Survey of the brine discharge impact on the environment

The dye test was held from the research centre, which has been commissioned by the Water Corporation to investigate the impacts of the desalination plant. The test was held by the Department of Environment and Conservation as part of the water utility's bid to relax some of the most rigorous conditions of its operating licence.

included monitoring and sample collection from the discharge point. The test was held in the presence of the Water Corporation, the Department of Environment and Conservation, and the University of Western Australia.

Professor Imberger said the test was held to ensure the discharge of brine from the plant would not harm the marine life in Cockburn Sound. He said the test was held to ensure the discharge of brine from the plant would not harm the marine life in Cockburn Sound.

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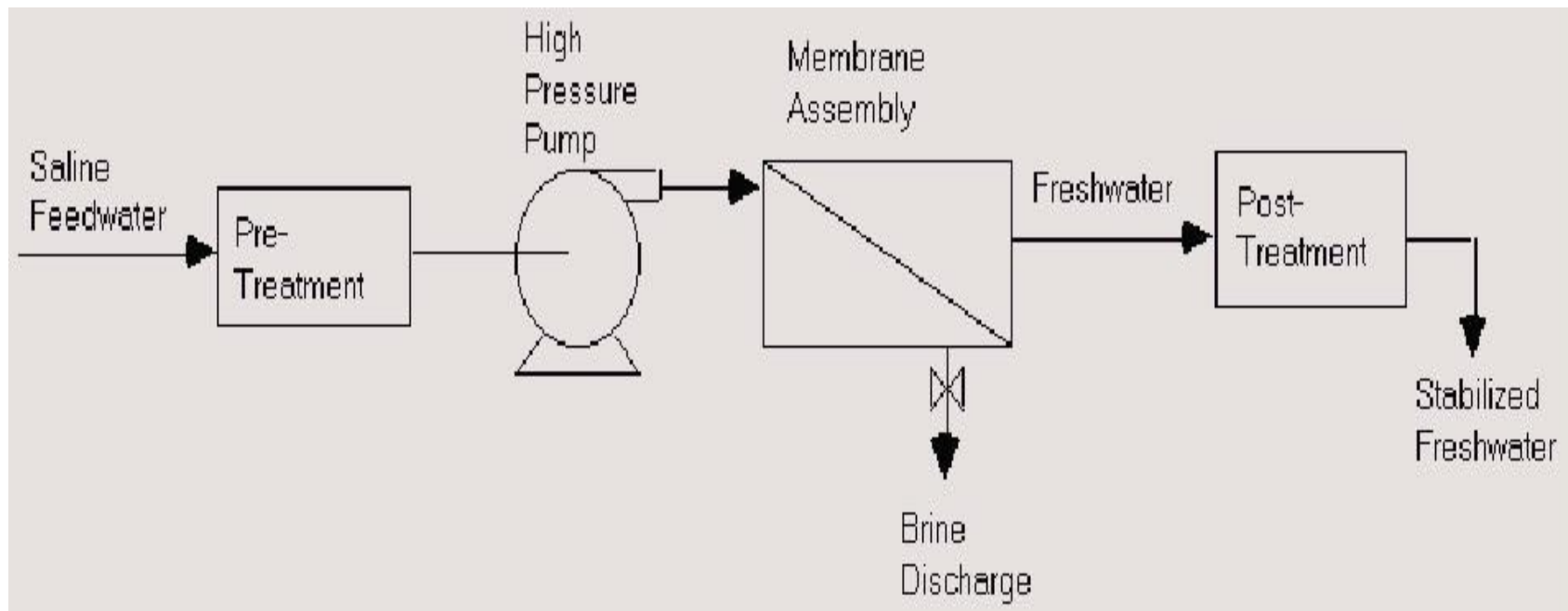
Monitoring buoys will relay the dissolved oxygen levels, temperature and conductivity levels in Cockburn Sound in real time. Data is sent to the plant site via GSM Mobile and radio.

Water expert Dr. David Imberger (right) and research vessel from the desalination plant (left) were, above, at the test site in Cockburn Sound. Photo: 18/11/11

What is brine discharge?

- Brine discharge is the fluid waste from a desalination plant, which contains a high percentage of salt and dissolved minerals. It returns to the sea and spreads according to different aspects.
- Two different types of the brine discharge are used in the desalination plant: water channel and pipeline.

Membrane Brine discharge



Impact of discharge brine

- The impacts on marine life are primarily due to almost doubling the salt concentration and the total alkalinity.
- The heavily concentrated brine solution discharged into the sea from the desalination plant has the potential to kill marine organisms and cause damage to the marine population.

Potential impacts of brine discharge on marine life

- Environmental impacts to the surrounding area, especially to marine life due to the highly concentrated brine discharge that diffuses back into the ocean.
- High level of salinity and total alkalinity and alteration to the temperature.
- Potentially considerable influence on the marine organisms such as the development of species, survival of larva and breeding, and reproductive traits.

Chemical materials used in a pretreatment stage of desalinated seawater

- Chemical materials used in a desalination facility in order to treat the seawater from some of the blots (several sorts of substances that are found in seawater and can plug the membrane), and some odd materials that used in the cleaning stage.
- Sodium hypochlorite NaOCl or free chlorine is used for chlorination.
- Ferric chloride FeCl_3 or Aluminum chloride AlCl_3 is used as disinfectants for flocculation of suspended matter from the water.
- Sulfuric acid H_2SO_4 or Hydrochloric acid HCl is used to adjust the Ph of the seawater.

Chemical materials used

in a pretreatment stage of desalinated seawater

- SHMP (sodium hexameta phosphate) (NaPO_3)₆ and similar materials have been used to prevent scale formation on the pipes and on the membrane.
- Sodium bisulphate NaHSO_3 is used in order to neutralise any remains of chlorine in the feed water.
- Crystalline acid EDTA (ethylenediaminetetraacetic acid) $\text{C}_{10}\text{H}_{16}\text{N}_2\text{O}_8$ is used in order to remove the carbonate deposits.
- Citric acid $\text{C}_6\text{H}_8\text{O}_7$, EDTA and Sodium polyphosphate NaPO_3 - weak acid detergents, to clean the membrane, 3 to 4 times a year.

Environmental impact of desalination plants

- Impact will vary depending on several factors:
 - 1. The location of desalination plant
 - 2. The location of the inlet and outlet
 - 3. The method used in the desalination facility and the outlet (water channel and pipeline)

Brine Output (Spain WWF)



Brine discharge plume current

- The discharge brine might be sent directly into the ocean or sea or combined with other discharge; several factors can play a large role in the discharge plume and the diffusion into the seawater. The influencing features are:
 - 1. Wind direction and speed. This aspect has a large impact on the diffusion of the discharge brine into the ocean, which can dilute this highly concentrated plume with seawater in a short distance.
 - 2. Wave height and speed. This factor could play a major role in the dispersion of the seawater properties by producing significant effects at higher levels on the ambient environment.
 - 3. Bathymetry and the tidal mean and average. According to some scientific research; the brine discharge will have a minimum impact on changing the physical properties. Peak Salinity and alkalinity changes will occur during the high tide in a shallow depression.

Concerns and questions : Desalination plants could have several impacts on the surrounding environment

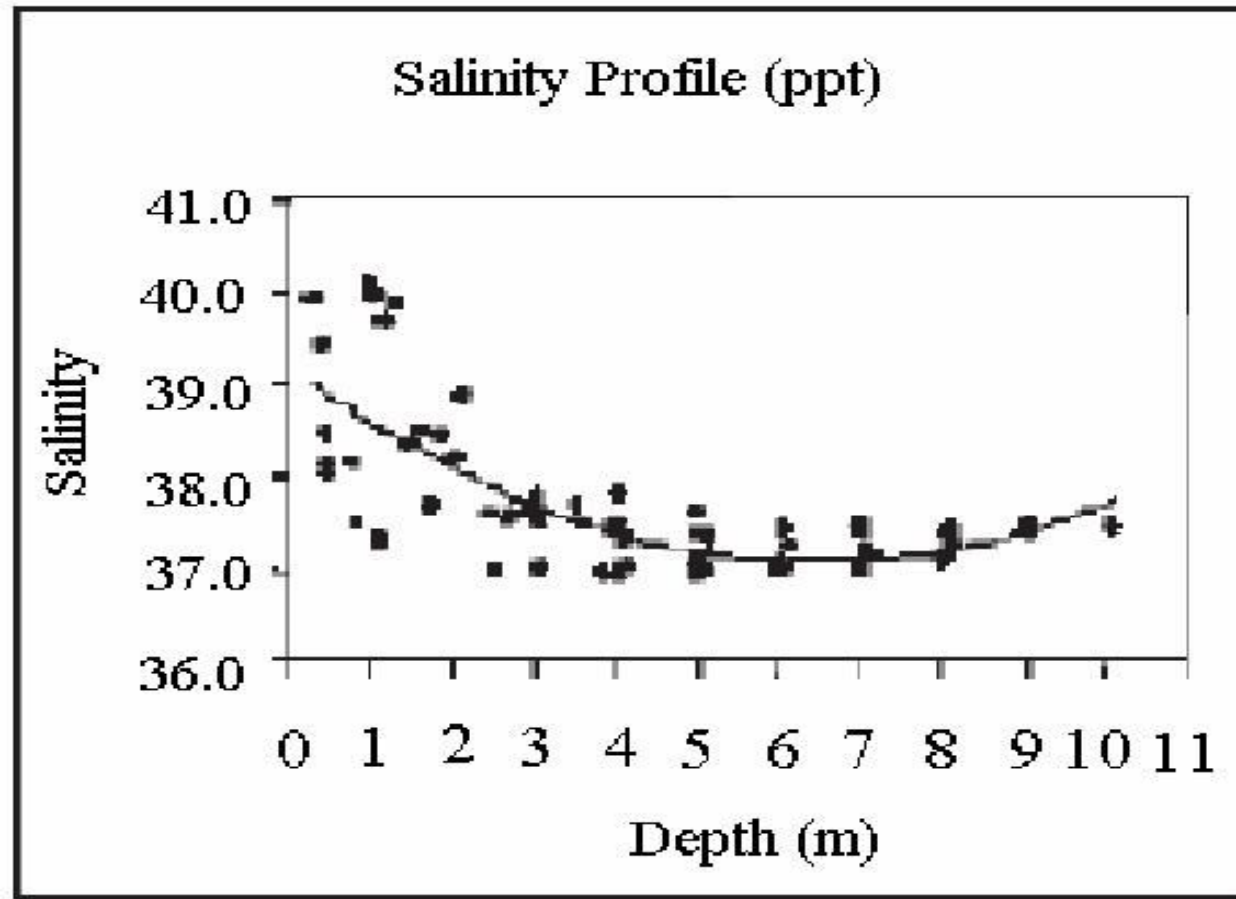
- The major concern of these impacts surrounds the outfall brine discharge because of its physical and chemical features. High salinity, high temperature and high total alkalinity of the discharge brine could have several positive and negative impacts on the surrounding environment.
- The impact of brine discharge on marine life is low when compared with the high physical and chemical changes to the seawater.
- It would be desirable to model the plume and to undertake an intensive biological and ecological monitoring program to keep a healthy coastal marine life.

The impact of changes to salinity on the marine environment

- The salinity around the outlet discharge varies from about 80 ppt to reach the actual seawater salinity 35-36 ppt in balance with the surrounding environment.
- Changes to salinity can play a significant role in the growth and size of aquatic life and the marine species disturbance. Changes in the salinity can play two opposite roles on the marine organisms' existence; it can be of benefit for some of these organisms such as shellfish and at the same time can have an adverse impact on other species. Knowledge of tolerance limits of marine life to different salinity degrees is an important aspect.
- It may influence the development of species and the propagation activity and faster individual growth, Survival of larval stages of animals and life expectancy (shorter or longer generation time). Population density of organisms (higher or lower population growth rate), Breeding of species and reproductive traits.

Salinity Profile

This figure presents the distribution of the seawater salinity from the surface to 11 meters depth in the ambient of the outfall of Barke desalination plant



Recommendations 1

- Salinity, temperature and total alkalinity fluctuations, as a consequence of the brine discharge of the desalination plant, can play a considerable role in determining the abundance and distribution of flora and fauna's species.
- Hypothesis needs to be clarified and verified in order to determine the positive and negative impacts on the ambient environment.
- New data should be generated to determine this.
- Modeling the plume of the brine discharge will be desirable in order to illustrate the diffusion area.
- Long term monitoring of the conditions proposed in relation to temperature, salinity and alkalinity at the site of the desalination discharge outlet vicinity during the desalination process is recommended.

Recommendations 2

- This would allow the verification of the appropriate distribution of the discharge plume into the seawater and the impact of the above factors on the aquatic organisms could be better understood.
- A manual water sampling program needs to be undertaken in the area of the desalination outfall discharge.
- Examination of the water quality of concentrated brine discharge is required with respect to these three factors to determine the possible harm they could cause to the environment.

Implementation of a plan of environmental management of effluents

- Allowing best prevention of impacts, and their minimisation to an acceptable level.
- A preliminary analysis of the existing situation and of the sensitivity of the ecosystem downstream of the effluents is required for large-scale projects, within the framework of the environmental impact assessment study.
- For projects with potentially significant impacts, the implementation of an environmental management plan is necessary:

Monitoring water quality downstream (temperature, oxygen and toxic pollutants content) and implementation of the measures likely to minimize the direct impact on the ecosystems due to brine disposal.

- Several surveys provide some evidence that the influence of discharge for desalination plant can be controlled in terms of environmental impact to the aquatic flora and fauna species.

BRINE DISCHARGE SURVEY

