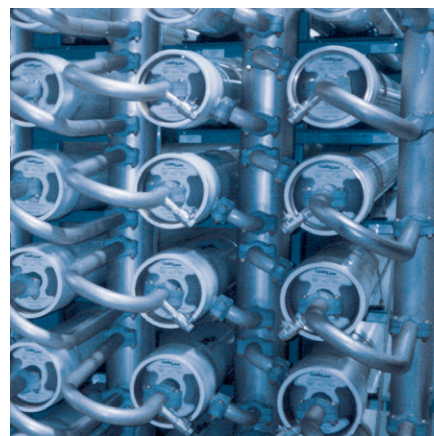
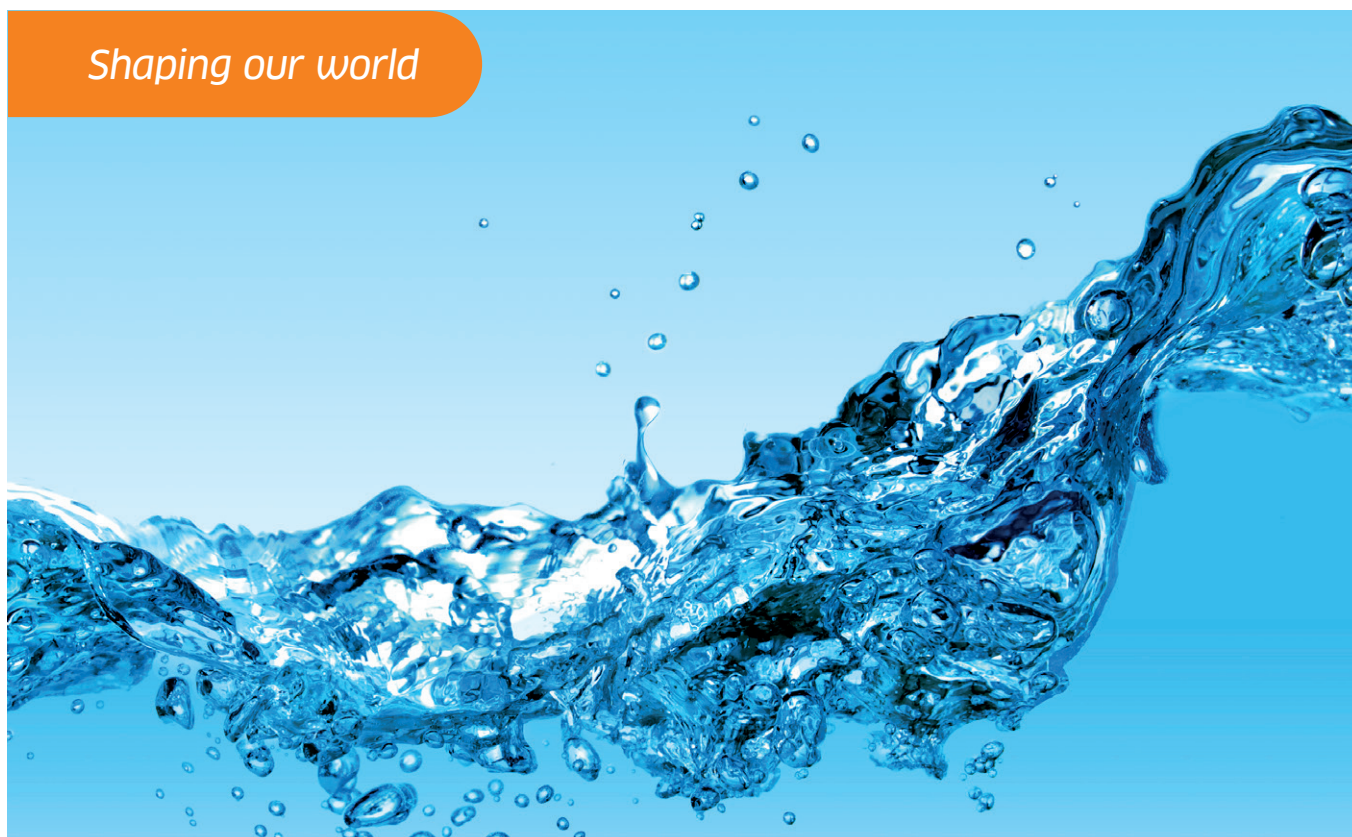


WATER DESALINATION

Shaping our world



About Water

Desalination

Fresh Water is Essential for Life

Water is necessary for life. We need fresh water for drinking every day. But we also need it for washing ourselves, our dishes and clothes. Beside personal use, fresh water is used in many industrial processes. In many countries agriculture is the number one consumer.

Fresh Water is Scarce in many Places of the World

As reported in the World Water Development Report, almost one billion people in the world are without access to clean water. More than two billion are lacking the minimum sanitary facilities. Reasons for this are the increasing population density and diminishing ground water resources.

Scarcity of fresh water can be overcome by desalination of saline water.

A Young but Well-Established Technology

By installation of many large scale desalination plants in arid regions worldwide, considerable improvements were achieved in recent years, showing the enormous potential of this technology.

The commercial application of sea water desalination started in the late 1950's in the Middle East. Since then it has experienced a tremendous growth.

Today some countries in the Arabian Gulf satisfy more than 90 % of their water demand by sea water desalination. It is a fact that some countries in the region would not exist in their present appearance without sea water desalination.

Tractebel in Water Desalination

Tractebel entered into the desalination business in the 1980's when it became standard in arid regions to utilise the waste heat of thermal power plants for sea water desalination.

Our experts have comprehensive know-how, broad experience and familiarity with the most recent technological developments. Tractebel stands for tradition and innovation as well as for quality and efficiency.

Services in all Project Phases

We provide services in all phases of a project, from project developments through plant commissioning and subsequent monitoring of operation and maintenance.



Quality control in front of a reverse osmosis train

Our Services

- Analysis of local boundary conditions (infrastructure and financial)
- Feasibility studies (technical and economic)
- Environmental impact studies
- Project assessment for investors
- Conceptual / basic engineering
- Optimised greenfield / brownfield integration of desalination plants into power plants
- Elaboration of plant specifications
- Evaluation of bids
- Assistance in contract negotiation
- Site supervision
- Supervision of commissioning
- Organisation of operation and maintenance

Two Approaches to Desalination

Distillation Processes – Modest and Robust

For centuries it has been known that salt can be removed from water by boiling, condensing the generated steam and collecting the condensate.

This extremely energy consuming 'single stage distillation' has been further developed to multi stage flash (MSF) and multi effect distillation (MED) processes, which minimise the thermal energy input by counter-current heat exchange between the condensing steam and the incoming seawater.

In practice, the energy consumption is reduced by a factor of eight compared to a single stage process without heat recovery; much higher values are possible.

Today most large-scale distillation plants use the waste heat of thermal power plants as a heat source. The combination of water and electricity generating plants is very economic and hence interesting to investors. Large plants have capacities of 500,000 m³/day or higher. This is the flow rate of a small river.

Membrane Processes – Modular, Cost and Energy Efficient

If salty and fresh waters are separated by a semi-permeable membrane the fresh water will permeate through the membrane to the salty water side. This process is called osmosis.

The pressure difference where the flow comes to a stand still is called the osmotic pressure. If the pressure

on the salty side is higher than the osmotic pressure, the water flow will be reversed from the salty to the fresh water side leaving the salt behind, thus giving this desalination process its name: reverse osmosis, RO. The principle of reverse osmosis is shown below.

In an RO plant, the high pressure pump is the main energy consumer. The necessary pressures for the RO process are between 60 and 80 bar for sea water desalination.

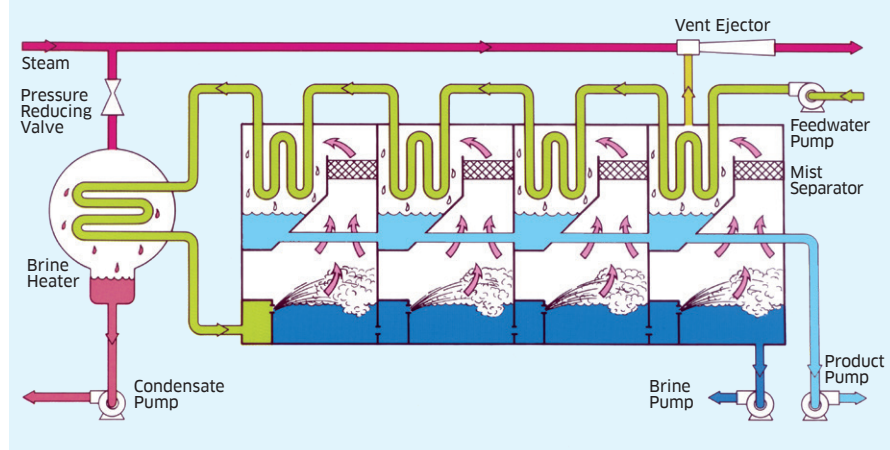
Today the most common types of RO membrane modules are 'spiral wound' and 'hollow fiber'. They are located in standardised pressure vessels, which form the core part of each RO desalination plant. By arranging the pressure vessels in separate stages and passes, the recovery ratio and the product purity can be improved respectively.

Tractebel has the expertise and software tools for optimizing the design configuration according to the individual needs of the client.

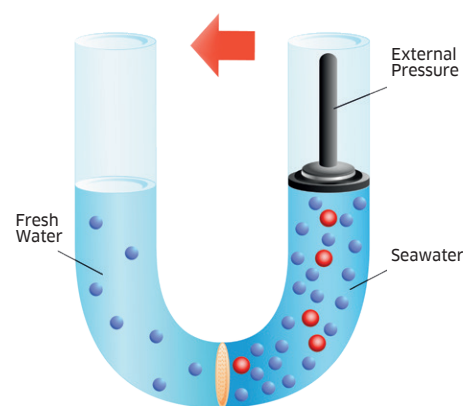
Factors for the different approaches*	Distillation process	Membrane process
Investment cost	–	+
Environmental impact	–	+
Sensitivity to problematic feed water	+	–

*Factors have to be reviewed for every particular plant. Tractebel is your partner for the evaluation of the technology serving best your technical and financial requirements.

Schematics of an MSF desalination plant



Reverse Osmosis



Energy and Environmental Impact

Solutions for Energy Consumption

The energy consumption of a desalination plant is determined during the concept design phase. For distillation plants, the optimum number of stages is found by weighting energy costs against investment costs.

For RO desalination plants, the energy consumption is minimised by an optimised arrangement of two or more passes and stages of RO stacks and by a suitable energy recovery system (Pelton turbines or pressure exchangers).

In remote locations and on smaller islands, renewable energy sources are an interesting alternative to fossil fuels. Some remote RO plants are powered or supported by wind turbines. Distillation processes can be powered by steam extraction of solar thermal power plants and waste heat from geothermal power plants.

Tractebel provides a separate department specialised in renewable energy.

Solutions to Minimise Environmental Impact

Today desalination plants should and can be built with minimum environmental impact. Aspects to be considered are water intake and discharge, brine temperature, discharged chemicals, energy consumption, noise and landscaping. We have answers to all questions arising in this area.

Before the water intake and discharge structures are designed, the natural currents at the shore-line need to be investigated and understood. Potential environmental impacts due to elevated temperature and salinity of brine discharged from desalination plants have to be minimised by adjusting the process design parameters accordingly and allow for compliance with local environmental regulations.

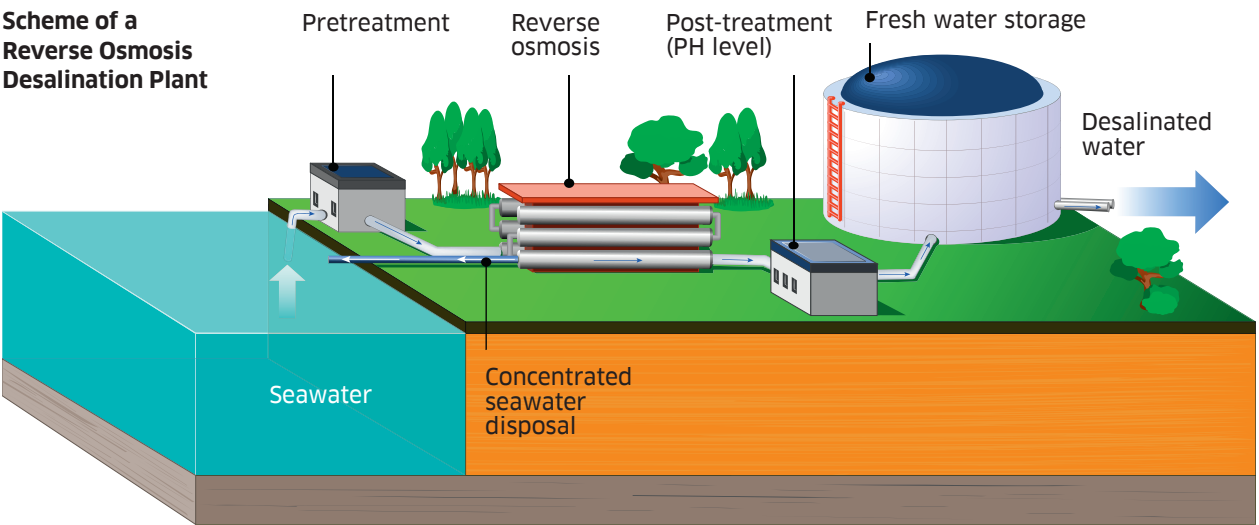
Solutions for Water Pre-Treatment

The lifetime of RO membranes can be dramatically increased if a modern seawater pre-treatment including dissolved air flotation (DAF) and/or ultrafiltration (UF) is applied. This can significantly reduce the O&M cost for membrane replacement and increase the overall plant availability.



Pelton turbine for energy recovery.

Scheme of a Reverse Osmosis Desalination Plant



Benefit from our Experience

More than

25 years

of experience with
desalination projects

Installed capacity of
more than

550 MIGD

(2.5 million m³/day)
of potable water

Tractebel worked
on almost

12%

of the worldwide
desalination capacity

Our References

- Jebel Ali power and desalination station in Dubai
- Shuweihat and Al Taweelah in Abu Dhabi
- Azour North IWPP, Phases 1 + 2 in Kuwait
- Al Kheiran IWPP in Kuwait

Our services vary from feasibility studies to commissioning.

A complete list of references is available upon request.

Our Principles

Desalination plants planned or implemented by Tractebel International are characterised by:

- Lowest water production costs
- Highest availability and reliability
- Least environmental impact

What can we do for you?

You want to

- Increase your water producing capacity?
- Plan a new desalination plant?
- Extend the capacity of an existing desalination plant?
- Compare the drilling for new water resources with desalination of sea or brackish water?

Contact us and let's discuss the alternatives you have to achieve your goal including

- Different desalination technologies
- Capacity: from small installations to large plants
- Engineering services for complete plants or separate plant components

Applications

Desalinated water supplied to

- Municipal fresh water storage and distribution networks (after conversion to potable water)
 - The chemical industry and other industries
 - Power plants as process water
- The raw water can be sea, brackish, surface or waste water.

Clients

- Municipalities
- National or regional water authorities
- Project developers
- Owners or operators of industrial plants
- Studies performed for institutions such as the World Bank and for investment banks



Inside a reverse osmosis desalination plant.

We are Tractebel

Tractebel provides a full range of engineering and advisory services throughout the life cycle of its clients' projects, including design and project management. As one of the world's leading engineering and advisory companies and with more than 150 years of experience, it's our mission to actively shape the world of tomorrow. With about 5,000 experts and presence in more than 70 countries, we are able to offer our customers multidisciplinary solutions in energy, water and urban.

Since December 2014, Tractebel Engineering GmbH (former Lahmeyer International) belongs to Tractebel and thus is part of the international ENGIE group headquartered in Paris. Tractebel (Brussels, Belgium) and Tractebel Engineering GmbH (Bad Vilbel near Frankfurt, Germany) cooperate on numerous international projects as one company.

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