

Water Desalination

About water

Water is the cradle of life

More than a billion years ago the first living organisms showed up in the water. It was only several million years later when they learned how to make a living on the dry land. Is this the reason why we are still fascinated by lakes, rivers and the ocean?



Water is essential for life

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



Water is scarce in many places of the world

As reported at the world summit in Johannesburg in 2002 more than one billion people in the world are without access to clean water. More than two billion are lacking the minimum sanitary equipment. These figures are steadily increasing and they will continue to do so if no action is taken. Reasons for this are the increasing population density and diminishing ground water resources.



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

Desalination

A young but well established technology

The commercial exploitation of sea water desalination started in the late 1950's in the Middle East. Since then it has experienced a tremendous growth, and 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 without sea water desalination.

One goal, two approaches

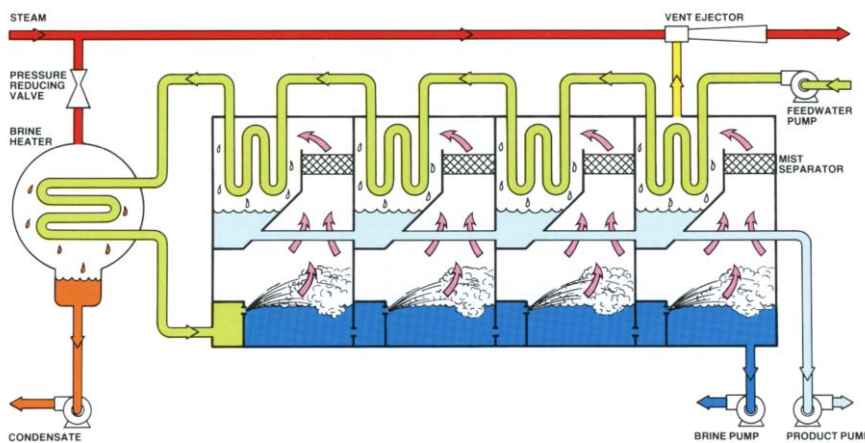
The purification of salty water can be achieved by two completely different physical principles, by distillation and by filtration through membranes. Both technologies have their specific advantages, and the decision for the right one should be based on a careful analysis of the local conditions.



Burj al Arab Hotel, Dubai

Distillation processes - modest and robust

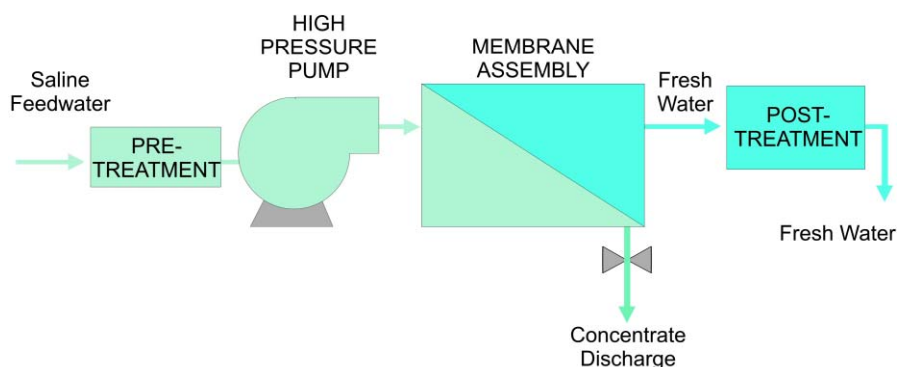
Since centuries it is known that salt can be removed from water by boiling, condensing the generated steam and collecting the condensate. Because this so-called 'single stage distillation' is very energy consuming, multi stage processes like the multi stage flash (MSF) and multi effect distillation (MED) have been developed. In the MSF process the heat of the condensing steam is utilised to bring the incoming sea water to boiling point. In practice the energy consumption is reduced by factor of 8 compared to a single stage process without heat recovery; much higher values are possible. Nowadays almost all distillation plants use the waste heat of thermal power plants as a heat source. These combined water and electricity generating plants are very economic and hence interesting investments. They represent almost 80% of the world's sea water desalination capacity. Large plants have capacities of 500 000 m³/day or higher. This is the flow rate of a small river.



The principle of Multi Stage Flash Distillation, MSF



MSF Desalination Plant Hidd in the Kingdom of Bahrain



Principle set-up of a RO desalination plant

Membrane processes - modular, cost and energy efficient

If salty and sweet waters are separated by a semi permeable membrane the sweet water will permeate through the membrane to the salty water's 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 sweet water side leaving the salt behind, thus giving this desalination process its name: reverse osmosis, RO. The principal of a RO plant is shown above. The high pressure pump is the main energy consumer in a RO plant. The necessary pressures for the RO process are between 60 and 80 bar for sea water desalination.

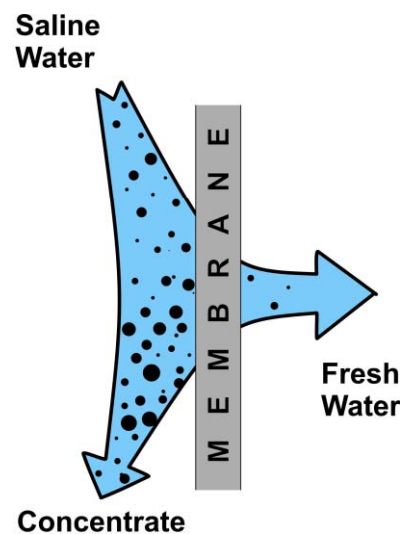
The most common type of RO membranes today are the spiral wound and the hollow fibre. They are located in standardised pressure vessels (PV), which form the core part of each RO desalination plant. By arranging the PV's in stages (brine or product staging) the recovery ratio or the purity of the product can be improved.

Lahmeyer International has the expertise and software tools for optimising the staging according to the individual needs of the customer.

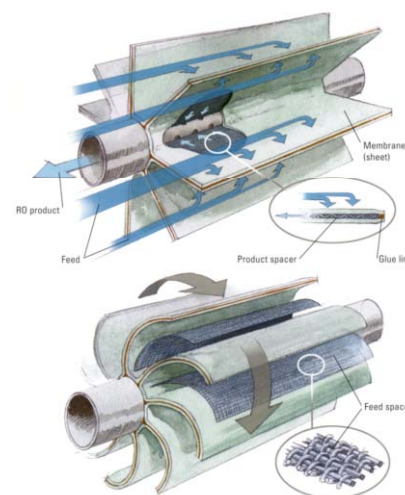
The investment costs of RO plants are lower than those of the distillation processes. Furthermore the environmental impact is lower in most cases. But on the other hand the sensitivity to problematic feed water is higher. Lahmeyer International is your partner for the evaluation of which technology to select.



Stack of pressure vessels



Flow pattern in a membrane operating in cross flow mode



Spiral wound membrane

Our concepts for dealing with some key issues

Energy

The energy consumption of a desalination plant is determined during the concept design phase. At distillation plants the optimum number of stages is found by weighting energy costs against investment costs. A typical value for the energy demand of a MSF plant is $4 \text{ kWh}_{\text{el}}$ plus $60 \text{ kWh}_{\text{th}}$ per m^3 of distillate.

For the RO desalination plants the energy consumption is minimised by an optimised arrangement of two or more stages of RO stacks and by a suitable energy recovery system (Pelton-turbines or pressure ex-changers). A typical value for the energy demand of a RO plant is 4 to $5 \text{ kWh}_{\text{el}}$ per m^3 of permeate.

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. Lahmeyer International provides a complete department specialised in renewable energies.



Wind turbines



Solar collector

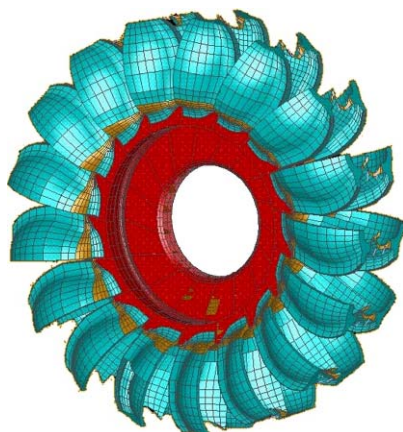
Environment

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

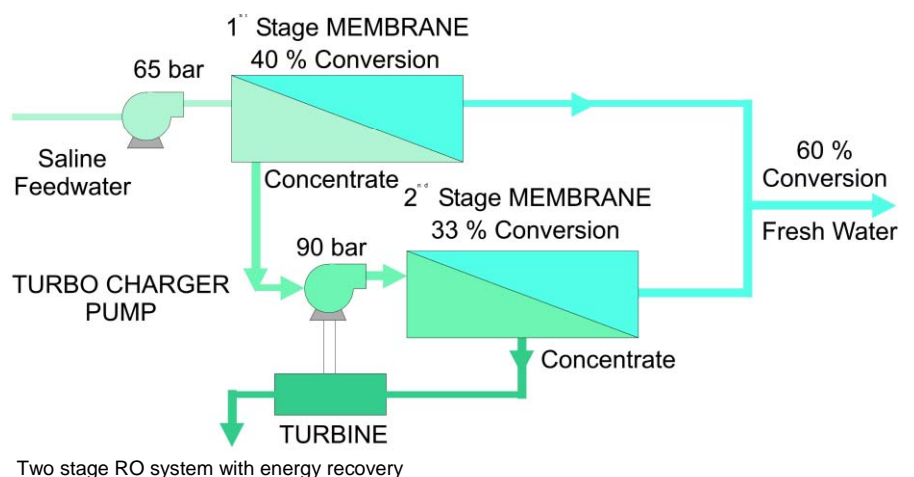
Before the water intake and discharge structures are designed the natural currents at the shoreline need to be investigated and understood. The discharged brine of distillation plants might need to be diluted before returned to the sea in order to decrease its temperature to an acceptable level.

The use of chemicals in RO plants can be dramatically reduced if a modern pre-treatment such as ultra filtration, UF is applied. Beside the ecological benefits of a lower concentration of chemicals in the brine, the savings in cost are another benefit for the plant owner.

Many operational RO plants are unnecessarily loud. A well engineered energy absorbing interface with the foundation and an acoustically designed casing of the pumps can bring noise emissions down to reasonable values, resulting in longer lifetime of the equipment and highly appreciated by the operating staff.

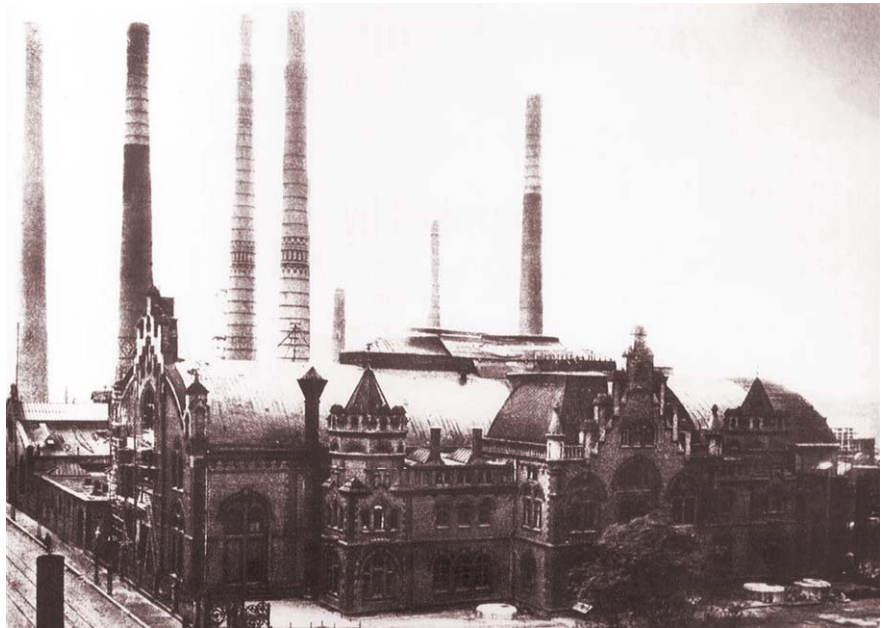


Pelton Turbine for energy recovery



Lahmeyer International In Water Desalination

Lahmeyer International (LI) is one of the most well known engineering consulting companies in the world. Its history reaches back to the year 1890 when Wilhelm Lahmeyer implemented the first thermal power plant in Germany. Since then the company has been involved in power projects with a total capacity of more than 50,000 MW. Lahmeyer entered into the desalination business in the 1980's when it became standard in arid regions to utilise the waste heat of many thermal power plants for sea water desalination. Our experts have comprehensive know-how, broad experience and familiarity with the most recent technological developments. Lahmeyer International stands for tradition and innovation for quality and efficiency.



Power plant in Essen, Germany 1898

Services in all project phases

We provide services in all phases of a project, from project development through to plant commissioning and the subsequent monitoring of the operation and maintenance. Regardless if a pre-feasibility study is needed as a first step of a project or if the operation and maintenance strategy of an existing plant should be reviewed and improved - our experts can support our customers with their know-how and experience. The following list indicates the range of services that Lahmeyer International offers:

Our Services:

- Analysis of local boundary conditions (infrastructure and financial)
- Feasibility studies (technical and economical)
- Environmental impact studies
- Project assessment for investors
- Basic engineering
- Optimized 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
- Organization of operation and maintenance

Lahmeyer International has been involved in many of the major desalination plants around the world since the early days of this technology. Water utilities all over the globe rely on our long standing experience in engineering, project management, contract negotiation and site supervision.



Our experiences

In the last 25 years Lahmeyer International has been involved in desalination projects with a total capacity of more than 550 MIGD (more than 2.5 million m³/day). This represents almost 10 % of the world wide installed desalting capacity. Our reference list includes most of the major desalination projects, latest technologies and all sizes e.g. Jebel Ali Power and Desalination Station in Dubai, Shuweihat and Al Taweelah in Abu Dhabi and Raslaffan in Qatar. Our input varies from feasibility studies to commissioning. A complete list of references is available upon request.

Covered Technologies

Lahmeyer International covers both desalination technologies, Distillation and Reverse Osmosis, RO. The capacities range from small plants for the supply of remote towns or camps with several hundred m³ per day to the largest plants with more than 100,000 m³ per day. Engineering is performed for complete plants but, if desired, also separately for major plant components.

Applications and customers

The desalinated water in many cases is supplied to municipal pipelines as potable water. But we also are involved in demineralisation plants for power plants or the chemical industry. The raw water can be sea, brackish, surface or waste water.

Our customers are municipalities, national or regional water authorities and owners or operators of industrial plants. Studies are often performed for institutions such as the World Bank and their affiliates and for investment banks.



Our principles

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

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

These goals which look contradictory at the first glance can be achieved because our experts always keep close contact with the leading research and development institutions world wide. New developments are observed and analysed. When they have proven to be ready for commercial application we will consider them. Customers with Lahmeyer International at their side will never get a plant with yesterday's technology.

You are welcome!

You are planning to increase your water producing capacities? You are planning a new desalination plant? You want to extend the capacities of an existing desalination plant? You want to compare the drilling for new water resources with the desalination of sea or brackish water?

Contact us, and let's discuss your problems.

You are welcome!



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Photographic evidence:
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