

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 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 facilities. 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 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.



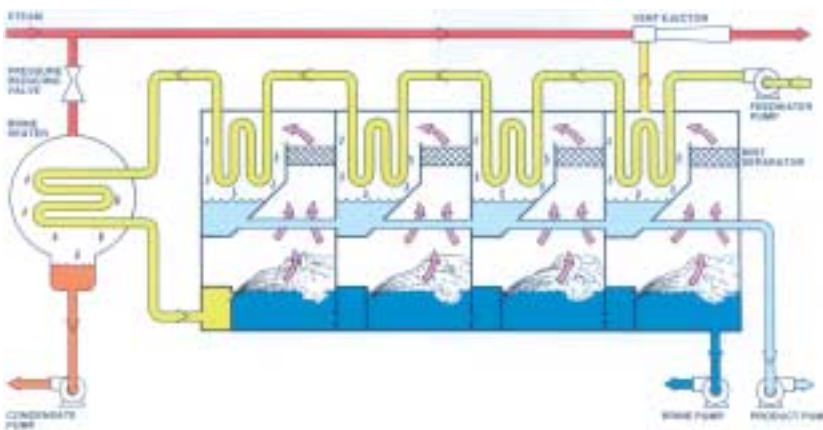
Burj al Arab Hotel, Dubai

## One goal, two approaches

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

## Distillation processes – modest and robust

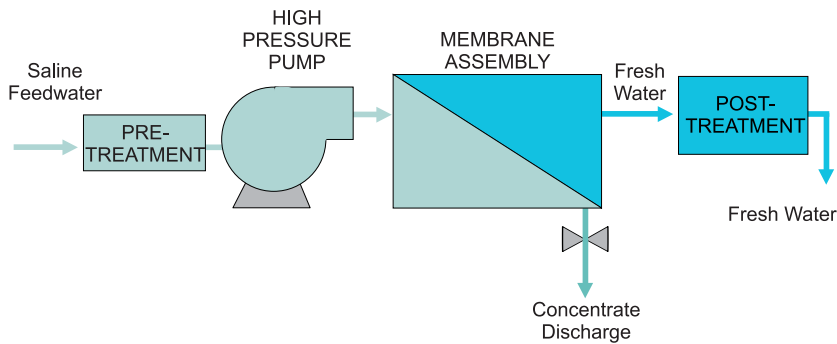
Since centuries it is known that salt can be removed from water by boiling, condensing the generated steam and collecting the condensate. This extremely energy consuming 'single stage distillation' is further developed to multi stage flash (MSF) and multi effect distillation (MED) processes. In the MSF 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 a factor of eight compared to a single stage process without heat recovery; much higher values are possible. Today almost all 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. They represent almost 80% of the world's sea water desalination capacity. Large plants have capacities of 500 000 m<sup>3</sup>/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 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.

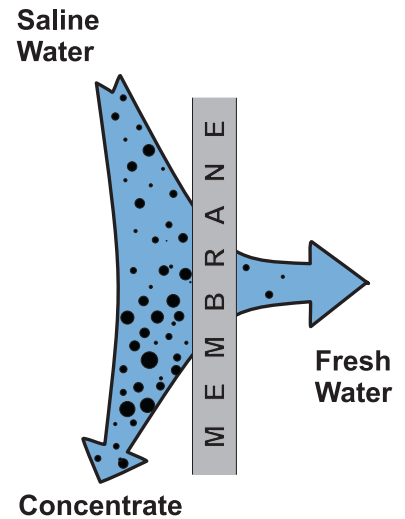
The most common type of RO membranes today are the spiral wound and the hollow fibre. They are located in standardised pressure vessels, which form the core part of each RO desalination plant. By arranging the pressure vessels in stages (brine or product staging) the recovery ratio or the purity of the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

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

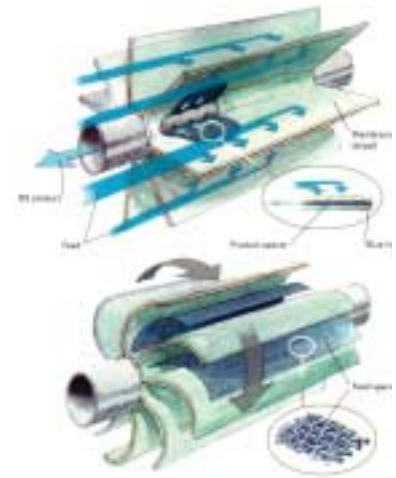
The investment costs of RO plants are lower than those of the distillation processes. Furthermore the environmental impact is lower in most cases. But on the other hand the sensitivity to problematic feed water is higher. Lahmeyer International is your partner for the evaluation of the technology serving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



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. For distillation plants the optimum number of stages is found by weighing energy costs against investment costs. Typical values for the energy demand of a MSF plant are 3–4 kWh<sub>el</sub> plus 60 kWh<sub>th</sub>/m<sup>3</sup> of distillate.

For 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 exchangers). A typical value for the energy demand of a RO plant is 4–5 kWh<sub>el</sub>/m<sup>3</sup> 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 separate department specialised in renewable energies.



Wind turbines



Solar collector



Pelton turbine for energy recovery

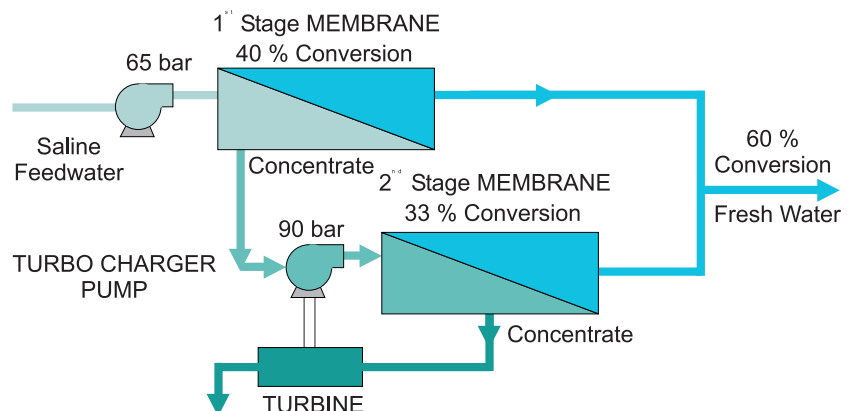
## Environment

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 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 is applied. Besides the ecological benefit of a lower concentration of chemicals in the brine, the saving in cost is another benefit to the plant owner.

Many operational RO plants are unnecessarily noisy. 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 high appreciation by the operating staff.

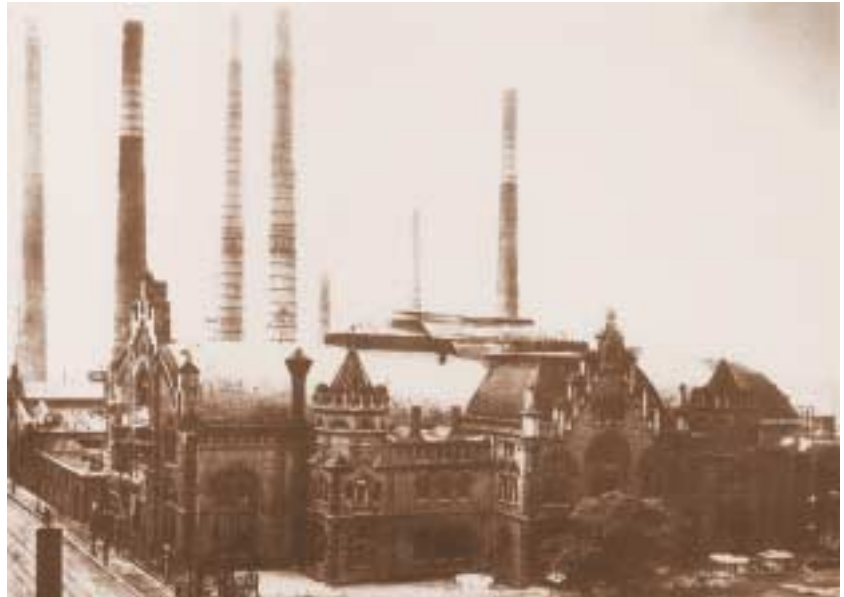


Two stage RO system with energy recovery

# Lahmeyer International

## In Water Desalination

Lahmeyer International is one of the most recognized consulting engineering 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 International 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. 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 plant commissioning and subsequent monitoring of operation and maintenance. Whether a pre-feasibility study is needed as a first step of a project or 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.

#### Our Services:

- Analysis of local boundary conditions (infrastructure and financial)
- Feasibility studies (technical and economic)
- 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
- Organisation 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 experience

In the last 25 years Lahmeyer International has been involved in desalination projects with a total of more than 550 MIGD (more than 2.5 million m<sup>3</sup>/day). This represents almost 10 % of the world wide installed desalination capacity. Our reference list includes most of the major desalination projects e.g. Jebel Ali power and desalination station in Dubai, Shuweihat and Al Taweelah in Abu Dhabi and Raslafa in Qatar. Our services vary from feasibility studies to commissioning. A complete list of references is available upon request.



## Technology know-how

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 cubicmetres per day to the largest plants with more than 100 000 m<sup>3</sup>/day. Engineering is performed for complete plants but, if desired, also separately for major plant components.

## Applications and clients

Desalinated water in many cases is supplied to municipal pipelines as potable water; furthermore to demineralisation plants for power stations or the chemical industry. The raw water can be sea, brackish, surface or waste water. Our clients are municipalities, national or regional water authorities and owners or operators of industrial plants. Studies are performed for institutions such as the World Bank and its 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. Clients 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 capacity?  
You are planning a new desalination plant?  
You want to extend the capacity 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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