

Landmark Desalination Plant in the Kingdom of Saudi Arabia

Producing 192,000 cubic meters of highly purified water daily

According to statistics released by the United Nations, the Earth's population surpassed the seven billion mark in October of 2011. This population explosion has the potential to exacerbate a number of global problems, in particular those related to the environment, food production and fresh water supply.

The problem of supplying sufficient fresh water to a rapidly growing population is especially acute not only because of the need for more potable drinking water, but also because more water will be required for agricultural and industrial purposes as the global economy expands. Since almost all water on the planet—some 97.5% of the total—is seawater, there is an obvious solution to the pressing issue of water supply: convert plentiful seawater into useful fresh water. The problem is how to do this efficiently.

The seawater desalination market has seen rapid growth in the last ten years and is forecast to grow threefold over the next ten. The Middle East accounts for about half of the entire global market for desalination products and services and is expected to remain the world's leading consumer.

Just 5mg of Dissolved Solids per Every Liter of Water Produced

*High purity achieved through
three-stage reverse osmosis*

The Kingdom of Saudi Arabia is currently the world's leading producer of desalinated water. With desert covering much of the Kingdom of Saudi Arabia, fresh water has always been a scarce commodity, but demand is growing, in particular from industry, and groundwater resources are rapidly running dry. This situation has led the Kingdom of Saudi Arabia to invest heavily in seawater desalination well ahead of others in the region,

driving the search for more efficient desalination methods.

At the start of 2009, a new power and desalination plant located on the Kingdom of Saudi Arabia's Red Sea coast came online, owned by the Kingdom of Saudi Arabia's Independent Water and Power Producer (IWPP), Rabigh Arabian Water and Electricity Company (RAWEC), whose shareholders included a consortium of Marubeni Corporation, JGC Corporation, Itochu Corporation (all of Japan) and ACWA Power Projects (the Kingdom of Saudi Arabia). The plant supplies electricity, water and steam to Petro Rabigh, a nearby petrochemical complex jointly owned

by Japan's Sumitomo Chemical and the Kingdom of Saudi Arabia's national oil company, "Saudi Aramco." MHI secured the contract for the engineering, procurement and construction of the plant, as well as manufacturing of the main equipment.

What sets this new power and desalination plant apart from other such projects is the process used to desalinate seawater. Instead of multi-stage flash evaporation — the conventional approach whereby seawater is heated and then distilled — the large MHI plant utilizes a process called three-stage reverse osmosis (RO). This involves the use of pressure to force seawater through a series of three semi-permeable membranes in the removal of salt and other dissolved minerals. The technology of this plant affords several important advantages over evaporation, including lower environmental impact and lower cost.

Despite the merits of RO methods, evaporation methods have until now prevailed in the supply of desalinated water for industrial use, primarily due to the comparative ease at which they can produce water of high purity. The major drawback of evaporation, however, is the enormous amount of steam necessary to convert seawater into distilled water. This places limits on the output of the power plant and also makes it difficult to adjust the amount of water produced in response to demand. In addition, construction costs are high because of the large

Power and desalination plant
for RAWEC on the shore
of the Red Sea
(Jidda, the Kingdom of Saudi Arabia)

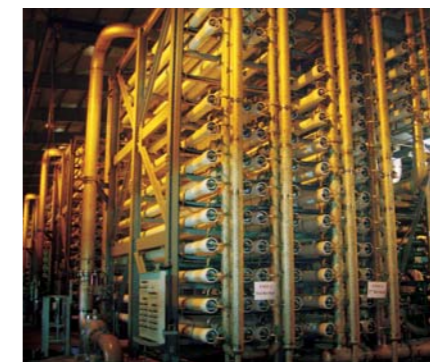
Expertise Learned Through Shipbuilding and other Operations

Strengths in seawater-related know-how

Governments and private companies considering the introduction of desalination plants look for technological functionality together with dependable support services after operations begin. One of MHI's strengths is its extensive technology development experience gained through more than a century in the shipbuilding industry, as well as in building the world's first large-scale RO desalination plant. MHI's research in the shipbuilding sector has yielded a wealth of knowledge in areas such as corrosion prevention, selection of materials for pumps and piping, and prevention of membrane fouling and blockage caused by marine organisms and plankton. This accumulated know-how provides a solid foundation for desalination facility operations.

As the Earth's supplies of fresh, usable water remain limited, seawater desalination continues to attract interest all over the world, with mainly builders and water utility companies from Europe and Asia aggressively entering the business in recent years. Yet seawater is not constant around the world: seas in the Middle East tend to have higher salinity than the seas around Japan, for example. There are also issues related to the microbes found in seawater from different areas, as well as varying temperatures by location and season. Furthermore, in the case of industrial water, different levels of water quality are required for different industrial processes. MHI is in a league of its own when it comes to seawater science and engineering, which allows it to provide desalination plants suited to local environmental conditions and customer requirements.

MHI has one further unique advantage: it is the only company in the world with complete in-house resources and know-how to design, build and provide turnkey solutions that include both desalination facilities and power plants. In the near future, desalination plants will offer a full realm of possibilities targeting rapid development: CO₂-free seawater desalination plants that use renewable energy will be built with the associated power plants, as well as other industrial plants and facilities, and even "smart city" urban infrastructure improvements, in which they will be combined with other urban functions. MHI stands ready to capitalize on its unique strengths to meet these needs.



Three-stage reverse osmosis equipment



Majed Halawi, Message to MHI

Rabigh Arabian Water and Electricity Company (RAWEC) was created in 2005 to develop, own and operate the Rabigh Independent Water, Steam and Power Project (IWSP). In early 2005, RAWEC solicited a proposal from MHI for the Engineering, Procurement and Construction (EPC) contract for the Rabigh IWSP. We had specific requirements in terms of operating scenarios, plant availability and reliability, which only MHI was able to meet and satisfy the off-taker's overall terms and conditions as well.

Independent Water and Power Producer (IWPP) Projects are all about risk allocation between owners and contractors. By agreeing to guarantee all operating scenarios, MHI reduced the risk exposure for our shareholders, which greatly inspired our confidence.

There are a number of different operating scenarios whereby the facility is dispatched at certain load profiles. A prime consideration was whether the contractor could analyse and accommodate what would happen in these scenarios.

Another critical factor was MHI's experience. The EPC contractor needed to have a proven track record in the field, and MHI was the only turnkey contractor that had experience with a utility provider within a petrochemical complex—a very similar facility to ours.

The project had two main requirements. First was the reliability and availability of supply to the Rabigh petrochemical complex. Second, given the investment and stakes involved, the reliability of the equipment was critical. The fact that it is in a petrochemical complex required engineering skills that could only be found among the top level of contractors.

The facility provides three major products: power, water and steam. The contractor's ability to integrate these functions was critical. We knew MHI's design was of superior quality; others would be hard pressed to manage a design of this complexity. Ultimately, three proposals stood out, but MHI's was in a class of its own.

I am pleased to say that our expectations have been more than met. We have not had any equipment-related availability problems since start up, and MHI's reverse osmosis desalination technology certainly produces exceptionally high purity water.

Above all, MHI is rare in being a truly considerate contractor. This was extremely important in our selection. They would not leave the site until everything was right. Nobody is infallible, but the difference is that MHI keeps working until they make it right. What's more, their senior management are always accessible. They take great pride in their manufacturing ability; their reputation is important to them, and they will do what it takes to maintain it.

We felt MHI was right for this project, and we were right to select them: it all works beautifully.

Majed Halawi
Executive Managing
Director
Rabigh Arabian Water
and Electricity Company

