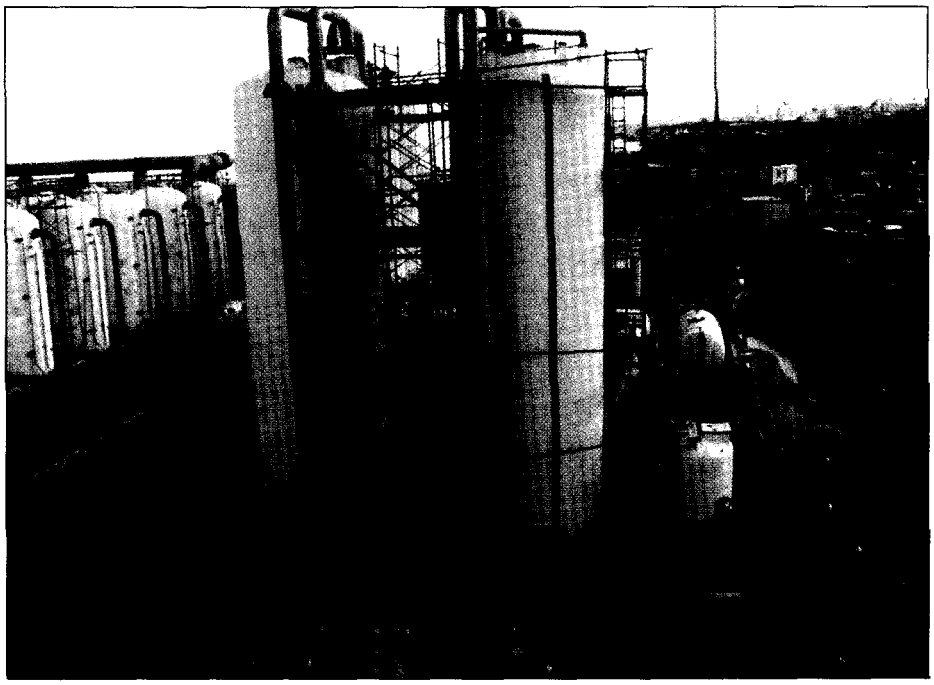
Desalination:
Panacea to World's Fresh Water Woes?

By Shrikant Ahirrao

The construction of three plants in Africa and China, including Africa's largest seawater desalination plant in Algeria, have been the latest ventures of GE Water and Process Technology. Technologies like SWRO, EDR and UF are used in these projects for the treatment of seawater and brackish water.



With the world's fresh water demand poised to exceed supply by 56% within 10 years, water authorities and governments around the world are turning to seawater treatment to meet the rising demand.

The following case studies throw light on the practical side of using modern treatment technologies like seawater reverse osmosis(SWRO), electro-dialysis reversal(EDR) and ultrafiltration(UF) for seawater and brackish water pre-treatment

Seawater desalination: Case study I

Africa's largest seawater desalination plant eases water scarcity for the City of Algiers, Algeria.

The challenge

Over the past decade Algeria has experienced a dramatic demographic shift as large numbers of rural dwellers migrate to cities. Urban residents now account for about 60% of the nation's population, placing a major strain on infrastructure and water supplies. In Algiers, the nation's capital, water scarcity caused by demand, drought and an aging, leaky distribution system left residents and businesses facing frequent water rationing, often receiving water only once in three days. With very few surface water sources to rely on, the Algerian government has invested heavily in new dams to improve its rain catchment capabilities, but drought conditions have persisted for many years and the dams have not produced a significant increase in the nation's water reserves. The city of Algiers has also embarked on an extensive rehabilitation of the water distribution system, which has cut water losses from 40% to less than 25%. Despite the improvements, Algiers still suffered from dire water shortage.

The solution

To alleviate the water shortage, Algiers needed to find a sustainable, long-term water supply that could meet the expanding urban water demand. With limited surface and groundwater sources available, the Mediterranean Sea proved to be the only abundant source of water. Desalination technology would enable Algiers to use the sea as a virtually unlimited source of raw water that can be reliably and cost-effectively converted to fresh potable water.

In an international tendering process involving leading global desalination companies, the Hamma Water Desalination SPA, a special project company, lead by GE water and process technologies, was selected to design, build, own and operate(DBOOT) the 200,000m^3/day (53MGD) Hamma Seawater Desalination Plant(SWDP), a RO seawater desalination facility that would significantly alleviate water scarcity in Algiers. Completed on time and on budget in 24 months the Hamma SWDP uses GE's advanced ecomagination-certified RO membranes for providing as many as two million residents of Algiers with reliable and drought-proof supply of fresh water.

The result

The Hamma Water Desalination(HWD) plant is also Africa's first RO desalination plant to be funded by public and private investment. The special project company, Hamma Water Desalination, SPA, combines 70% funding from GE with 30% from the state owned Algerian Energy Company. The overseas private investment company, which helps US businesses invest in new and emerging overseas markets, financed $200mn towards the project. Private or public/private structured financing arrangements are increasingly replacing, traditional government-only funded large-scale water projects. This new approach is opening up new opportunities for constructing and operating the much needed water projects. In the case of Hamma seawater desalination plant, GE provides unique project delivery, financing capabilities and a turnkey water treatment solution that includes best-in-class technologies, operation, maintenance and financing. The plant was constructed on a brown-field site just east of the Port of Algiers. Although, the water quality in this part of the bay can be affected by ship traffic and port activities, the site is ideal for its proximity to the city's water distribution network, power grid and transportation routes.

GE is responsible for the ongoing operations and maintenance of the plant. The facility will draw seawater through two 550m direct intake pipes to a pre-treatment system, where it enters a lamella clarifier and have coagulants added to help remove suspended solids and reduce biological challenges of the raw water. Seawater is affected by seasonal dynamics, biological blooms and turbidity affects from a working port. Following flocculation and settling, the water will pass through a dual media filter and enter a clear well. Water from the clear well will be pumped through five-micron cartridge filters before being distributed among nine trains of single-pass RO membranes.

Remineralisation and disinfection will be the final steps in the process before the water can enter the city's distribution system. The robust process is designed to handle the potential variability in the raw water quality. Moreover, the advanced membrane process offers operational and economic advantages over alternatives like thermal desalination processes, including reduced energy consumption and lower chemical requirements. The finished water is guaranteed to meet the following parameters:

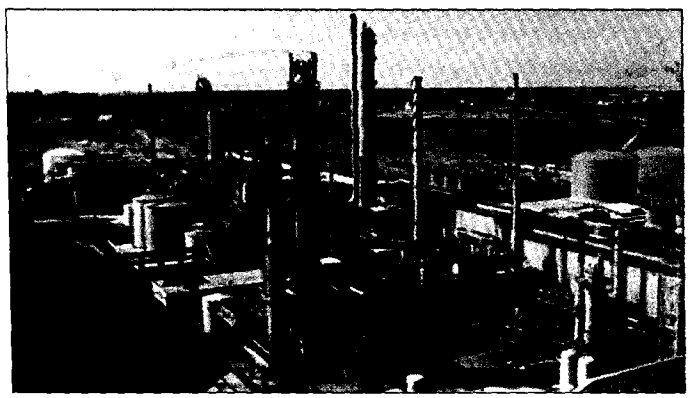
- Total dissolved solids of less than 500mg/l
- Alkalinity of up to 65ppm
- Total hardness of between 50–65ppm
- pH of 8–8.5

RO technology, once used only for relatively small, specialised pure water applications, is gaining wider acceptance as a mainstream water treatment solution in large-scale plants of unprecedented sizes. The cost of producing water with RO membranes has fallen by more than 80% in the last 20 years, making seawater desalination an increasingly affordable option for nations such as Algeria who have to cope with increasing water stresses caused by growing populations, expanding economies and climate change.

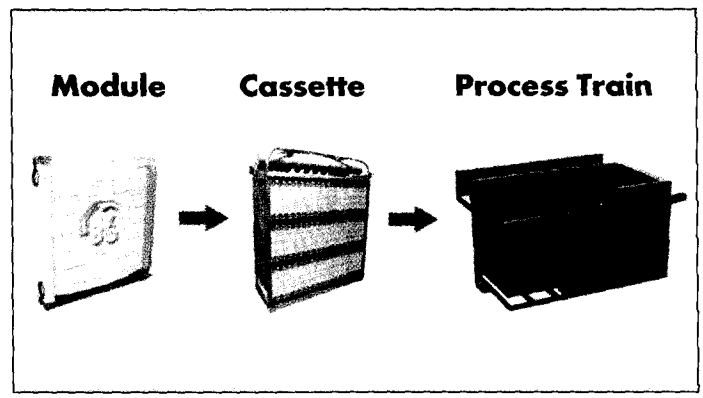
Brackish water desalination using EDR: Case study II

Ensuring a continuous supply of high quality boiler feedwater for fertiliser production.

Brackish water, containing minerals and salts typically less than 5,000ppm total dissolved solids(TDS), can be economically



Egyptian fertiliser company



Zeeweed UF

treated with RO and electro-dialysis reversal(EDR) systems. Effective mineral and salt removal converts previously unusable waters to high-purity resources for drinking, irrigation or industrial process uses.

The challenge

Abu Qir, the leading Egyptian company with fertiliser operations from El Tabia, 25km(16 miles) east of Alexandria. The firm utilises hydrocarbon feed stocks for manufacturing nitrogen-based fertiliser products including ammonia, urea, nitric acid and ammonium nitrate.

In the early 1990s, Abu Qir began to experience decreased operational productivity, resulting from the high degree of variability of TDS in their raw water. Their existing demineralisation plants, used for producing water for feeding the boilers, were simply unable to efficiently handle the high chlorides and high organic load in the raw water. Abu Qir required a superior water treatment alternative.

The solution

After extensive research on a range of alternatives to increase their fertiliser plants' demineralisation capacity—including using EDR, RO and adding additional ion exchange units, Abu Qir's water treatment specialists selected GE Water and Process Technologies' EDR system.

The results

In addition to eliminating the possibility of a shortage of boiler feedwater in Abu Qir's fertiliser plants, GE's membrane based EDR system offered other significant benefits. Most notable was a 60% decrease in acid and caustic regeneration chemicals consumption, which translated into annual cost savings of approximately US $600,000. Additional benefits included improved safety of operations and reduced manpower requirements. In addition, EDR's high water recovery allowed for a reduction in the amount of discharged water.For Abu Qir, GE's advanced membrane technology has played a critical role in ensuring uninterrupted fertiliser production.

Some more reference plants for EDR :

ATLL Barcelona, Spain

GE EDR produces up to 52.8MGD (200,000m^3/day) or 20% of the water for Greater Barcelona. The technology also helps providing a consistent source of safe drinking water by reducing dissolved solids and trihalomethane precursor organic particles.

Magna Water Company, Utah, USA

A 6MGD(22,727m^3/day) GE EDR system removes dissolved solids and harmful arsenic and perchlorate from the community's well water.

City Of Suffolk, VA, USA

The fluoride reduction project currently undergoing a 46% expansion to 13.6MGD(51,515m^3/day), will be the second largest EDR facility in the world and will operate at 94% water recovery.

UF for seawater pre-treatment: Case study III

Yuhuan power plant

Application: UF of seawater for RO pre-treatment

Capacity: 20MGD(76,800 m^3/d)

Location: Zhejiang Province, China

The problem

Recent industrial and urban growth in China has led to an explosive increase in energy demand. While this is good news for the country's power producers, a continual decline in freshwater supply has put undue pressure on the industry. With the existing freshwater supply being depleted at a rapid pace, the government is placing restrictions on its use and charging increasingly higher fees. Clearly, future industrial growth will depend upon the country's ability to find alternative sources of water. One solution is to use desalinated seawater for industrial applications, thereby reducing the demand on groundwater and surface water supplies.

Huaneng Power International, one of China's largest independent power producers, is doing just that. Located in Zhejiang Province, the Huaneng Yuhuan Power Plant will draw seawater from the East China Sea. After desalination, the treated water will be separated into two streams for use at the plant as boiler feedwater and potable water. Any surplus potable water will be sold to the community. Given the high levels of impurities in seawater, and the detrimental effects of fouling on RO membranes, effective pre-treatment is vital. The company is turning to immersed membrane technology for cost-effective, high quality pre-treatment of seawater for its RO desalination system.

The solution

Zenon Membrane Solutions, part of GE water and process technologies, Zeeweed immersed UF membranes were selected for the Yuhuan Power Plant. The Yuhuan plant is a significant project, for a number of reasons. The Zeeweed system is one of the largest uf pretreatment installations of its kind, producing just over 20MGD (76,800m^3/d) of feedwater for the power plant. This plant will be the first in China to generate 1,000MW per generator, and is also the country's first ultra-super critical, coal-fired plant.

While RO is a common and effective method of desalination, it requires aggressive pre-treatment to ensure stable operation. At a minimum, RO membranes require a feedwater turbidity of less than 1.0ntu, and a silt density index(SDI) of less than 4.0. If the feedwater quality does not meet these requirements, the RO membranes will foul rapidly causing reduced efficiency and higher operating costs through more frequent cleanings, and increased membrane replacement costs. Therefore, proper pre-treatment is

considered paramount to protect expensive RO systems and to ensure efficient operation.

Conventional pre-treatment methods typically incorporate a complex system of coagulation, flocculation, media filtration, and cartridge filtration, combined with chemical addition. Such methods, however, must be continuously optimised to deal with fluctuating influent characteristics. With a nominal pore size of 0.02 microns, Zeeweed UF membranes provide a physical barrier to particulate matter, producing high quality water regardless of the seawater turbidity. Membrane technology represents a superior method of RO pre-treatment, providing stable and consistent feedwater quality and substantial resistance to system upsets.Zeeweed UF membranes also offer high performance in a smaller footprint than granular filter media or pressurised MF systems. Zenon membranes are configured in modular cassettes that are ideal for retrofitting or expanding plants that are currently using conventional pre-treatment systems.

The high surface area offered by Zeeweed UF membranes can ease space constraints during expansions or retrofits, and provide savings in land acquisition and capital costs. These benefits, combined with ease of cleaning, higher RO membrane operating flux, and reduced downtime, maintenance, and operating costs, make Zeeweed Immersed UF membrane technology a compelling choice for RO pretreatment.

Process overview

The pre-treatment system at the Yuhuan power plant - consists of enhanced coagulation clarifiers and six trains of Zenon Zeeweed 1,000 hollow fibre membranes. The pre-treated RO feedwater quality is exceptional; with SDI less than 2.5 (ninety percent of the time), turbidity less than 0.1NTU, and total suspended solids (TSS) less than 0.5mg/l. Seawater is first pumped into four clarifiers where enhanced coagulation helps to remove settleable organic and floatable solids. The clarified water, after screening, - flows to six individual membrane trains, each providing an average day flow of 533 m^3 per hour(2,350gpm). The UF system piping is designed for a future capacity of 640m^3/hour/train(2,800gpm), to allow for possible expansion. The Zeeweed UF membrane cassettes are immersed directly in the process tanks. A low pressure vacuum applied to the membranes - draws the water through the microscopic pores and into the hollow fibers. The membranes form a physical barrier against suspended particles and colloidal materials. Rejected particles remain in the process tank and are periodically removed by backwashing.

About the Author

Shrikant Ahirrao is currently GM-Sales, GE Water and Process Technologies. He has about 18 years of industrial experience in various capacities, across the globe.

For further information on the author, write to us at content@eawater.com