

The water cycle

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Water recycling is beginning to garner increased attention in the Middle East, as fears over sustainability of supply grow

There's no escaping it – fresh water is a scarce commodity in this part of the world. The Middle East and North Africa region is home to 6.3 per cent of the world's population, but just 1.4 per cent of the world's renewable fresh water. Faced with an ever-steepening struggle to meet burgeoning demand in rapidly expanding region, water-stressed states are turning to innovative methods to quench their thirst.

Desalination has been around since the 1950s, and the development of reverse osmosis membrane technology in the 1990s has led to the Middle East leaning heavily on the process. Recently, concerns over the cost of desalination – both financially and environmentally – have led to a shift in attention from reverse osmosis elements, recovery rates, and improving rejection and flux rates, all of which have seen significant improvement, to an emphasis on feasibility in terms of operation and maintenance costs.

Looking at the technology in currently installed plants, multistage flash (MSF) and reverse osmosis (RO) dominate the market. In the Gulf region the majority of plants fall under thermal processes such as MSF and multi effect distillation, but Sasidhar Chidanamarri, Program Manager Environmental and Building Technologies Practices, South Asia and Middle East at Frost and Sullivan, is confident that RO technology will gradually eat away at the market share of thermal technologies.

“With the technical advancement and various researches, RO is gaining importance in the market for its lesser energy consumption,” he says. “It has a much higher yield compared to MSF, and this means that for the same output, the intake of seawater is only one third in the RO systems, decreasing the power and other costs associated with pumping seawater to the plant and disposing of the spent brine.”

With the industry under constant pressure to reduce overheads, especially energy costs in the 3.5 to 5kWh/m³ range, constant development is helping this trend to make the process become more cost effective. One method enjoying increasing success is energy recovery; an attempt to reduce the electricity consumption for every cubic metre of water that’s desalinated.

“There are currently two types of energy recovery devices (ERD) available,” says Dr Murat Sarioglu, principle process engineer at MWH. “One is the piston-type exchangers, which have large chambers and piston control equipped with valves to adjust flow in the chambers. The second type is the isobaric energy recovery devices, which are based on positive displacement of the high pressure in the concentrate stream.”

Due to the isobaric ERD’s simple application, lack of pistons and small chambers it’s been the recent solution of choice for the industry and, as Sarioglu points out, its 97-98 per cent efficiency rate also shows the isobaric ERD capable of reducing a plant’s energy requirement by between 50 and 60 per cent. Energy efficiency can also be attained using Variable Frequency Drives, according to Chidanamarri.

“VFDs are also making RO desalination a cost-effective and energy efficient solution,” he says. “VFDs control the engines joined to high-pressure pumps during the membrane separation process, where energy requirement is high. Therefore, accurate control of pumps and customisation of the operating point based on the seawater characteristics is pivotal to enhance energy efficiency of a desalination plant.”

He also points out that an RO/MSF hybrid is a possible process for schemes implemented in the future, which would have significant advantages including small seawater intake, optimisation of feed water for the RO plant by using cooling water from the heat rejection section of the MSF, extension of membrane life and also, crucially, low water production cost.

Vikrant Sarin, Manager of Technology and Business Development at Aquatech, also tips this hybridisation of thermal and RO as a big player in future desalination.

“This trend has started in the Middle East, and it’s picking up very fast,” he says, explaining: “It involves utilising the heat of the flue gases of a power plant as a source of energy input for a thermal desalination unit. Heat from the reject stream from the thermal desalination unit is then utilised in heating the inlet of the RO plant, thus improving efficiency in terms of permeate recovery.”

The reject from the RO plant is also used as input to the thermal unit, as the water is already conditioned for preventing scale formation, and water produced from this combination can be

made to vary depending on demand – not an option previously available with standalone thermal systems.

“In terms of specific technology for the purification of water, nanotechnology could be the next big thing for desalination,” says Sarioglu. “Currently a new desalination process based on ion concentration polarisation (ICP) is under research and development. This method employs an electrochemical transport phenomena based on ion selectivity when the water is passed through ion-selective membranes (nanoporous).”

At the moment this method of desalination is currently foreseen to be useful to small applications, but intensive research and engineering may change this outlook.

Thin film nanocomposite (TFN) membranes are also tipped as a potential big player in future desalination, providing the ability to produce good or even better water quality at a lower pressure compared to conventional membranes. The technology’s low-fouling potential, cleaning simplicity and resistance to microbial adhesion are also key elements that could see TFN taking a significant market share in the future.

“I would rate membrane fouling at the same level of challenge as high costs for the desalination industry,” says Sarioglu. “Substantial effort is still being put in to membrane fouling and characterisation, which remain huge challenges for the operation of the SWRO and BWRO plants, with main topics being biofouling, silica fouling and the impact of flux and pressure on fouling.”

High demands

“However, in my view the biggest challenge the industry faces at the moment is high energy demands, and therefore high operating and maintenance costs,” says Sarioglu, “but overall I think the use of renewable energy sources is the future for reducing energy costs.”

It’s a view that’s echoed throughout the industry – technology developed to make plants more efficient is a valuable asset during traditional energy use, but a switch to renewable energy could see an unprecedented drop in operating costs for plants.

“The use of renewable solar energy for plant operation is a key technological trend at the moment in the desalination market,” says Chidanamarri. “Solar energy received on each square kilometer of desert land is sufficient to desalinate 165,000 cubic metres of water per day.” Clearly, the Middle East’s climate and landscape lend themselves to such a development.

Sarioglu agrees, commenting that widening the application of desalination plants powered by renewable energy sources could significantly reduce operating and maintenance costs of SWRO plants.

“A SWRO plant in Perth, Australia is connected to a wind power plant consisting of 48 turbines,” he says. “In the Middle East there is great potential for solar energy to power SWRO plants.”

A saving on energy costs is just the start, though. “The solar desalination technology will be gaining a huge importance in the coming years in the MENA region as it makes desalination inexpensive,” says Chidanamarri, “but moreover the developer can also avail carbon credits which can be sold or traded with other industries that are polluting above the emissions norm.”

“If proper regulatory frameworks and laws are implemented by the governments with incentives involving carbon trade programmes,” adds Sarioglu, “then industry will be positively affected in addressing and dealing with environmental impacts and mitigating their effects. The people living in the Middle East, and hence the consumers, will have the benefit of coping with climate change, and hence rise of environmental awareness.”

With these technologies seeing the developer or concessionaire incurring lower operating expense - and therefore a lower lifecycle cost - over the 25-30 year concession period, the higher initial capital cost is likely to be far outweighed by lower energy consumption, improved life of membranes, reduced use of chemicals to prevent fouling and scaling, and a smaller carbon footprint. To the consumer these trends are nothing but good news – put simply, better water quality and lower tariffs.

While stepping up production of potable water through desalination is certainly one answer to the Middle East’s ever-increasing demand, the concept of recycling the water we’ve already got is beginning to garner increased attention, too.

“Previously, the focus was more on desalination, which was seen as a panacea to the alarming water crisis faced by the GCC countries,” says Chidanamarri. “Now, the trend is shifting to the reuse of treated sewage, not only for gardening and flushing purposes, but also for industrial and residential use. The region has a lot of potential as recycled water can be widely used in district cooling and landscaping, but building such massive infrastructure in the water and wastewater sector requires huge funds.”

“Earlier, funding projects in the Middle East was a major hurdle in the growth of infrastructure projects, but now that governments have accumulated huge reserves owing to high crude oil prices, this is enabling them to infuse funds and stimulate the economies.”