ARTIKEL

WATER

Desalination Improvements Spice Investment Potential

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The process of taking the salt out of seawater, or desalination, is as old as human civilization. Socrates taught students how to distil seawater to obtain fresh water. Sailors have been applying similar methods for over 2.000 years. Solar ponds that were developed to harvest salt have let nature do the distilling for thousands of years already. The sun's heat was used to desalt seawater, which served as the drinking water for troops during the siege of Alexandria in the days of Julius Caesar.

Currently only about one percent of the world's potable water is derived from desalination plants, due to a long-standing strong and emotional opposition to large-scale introduction of desalination. The percentage for industrial use is even lower, while the percentage of irrigation water is practically zero.
Historically, desalination has been considered:

- merely a "technical fix"
- as requiring an unacceptable level of fossil fuels
- too costly, too large in scale, and too technical for universal solutions
- an impediment to awareness raising and efficient water management. In addition, it does not fit in with the traditional water supplier's culture.

Thus, the total capacity in 2000 was about 26 million cubic metres per day, up from 20.3 million cubic metres per day in 1995. Of this total capacity, about 60% comes from seawater and 40% from brackish water.

Coastal water shortages: so near and yet so far

However, as an imminent shortage of drinking water in many coastal regions and megacities quickly emerges as a major natural resource issue of this century, the abundance of salt water presents an obvious opportunity for reassessing desalination as a solution to providing an adequate, sustainable drinking water supply. Furthermore, major breakthroughs in desalination technologies are and will continue to be so substantial that its contribution to solving major worldwide water issues, including water for food production, drinking, industrial use and natural ecosystems, can no longer be ignored by policy makers. Desalination technology should no longer be considered some kind of forbidden fruit.
In fact, the desalination market has already become an annual billion-dollar business, which will continue to grow to at least five billion dollars per year in the coming decade. Recent and potential desalination developments indicate that there will be a substantial increase in the use of these technologies to produce pure and fresh water from seawater and brackish water, but also from wastewater. It is difficult to predict the precise future shares of desalination and recycling in the water market, but the strategic opportunities are impressive.

The major impetuses for these opportunities are:

- Growing populations along the many coastal regions of the world. By 2025, megacities in these areas may very well be home to some five billion people. Providing this population with desalinated seawater would avoid putting undue pressure on the amount of water available for agriculture and for the minimal water needs of ecosystems, all of which is a subject of great concern at world water seminars
- Breakthroughs in the reduced energy requirement and investment costs for desalination
- Processes, resulting in cost levels of US$0.40 to US$0.80/m3 before distribution. This is much lower than its level of 10 years ago of approximately US$3.00 to US$5.00, and of US$1.50 to US$2.50/m3 only three to five years ago. At the same time, the real costs of traditional water supplies are on the increase, and in many cases have already surpassed this cost figure.

The energy question

The main desalination technologies were first implemented in the 1960s and 1970s. They are either based on the principle of seawater evaporation to separate water from salt, or on the use of semi-permeable membranes, where salty water is forced through a membrane that prevents the salt from passing through. The first method requires heat and boilers, while the second requires pressure and pumps. Thus, both methods require some form of energy.
Among the numerous existing desalination technologies there are currently five major applications. Three apply to the evaporation method - Multi-Stage Flash (MSF), Multi-Effect Distillation (MED), and Vapour Compression (VC) - while membrane separation processes have two applications - Reverse Osmosis (RO) and Electrodialysis Reversal Process (EDR). In just the past three years, all of these technologies have developed energy recovery systems, higher process efficiencies, new or improved construction materials, dramatic decreases in membrane prices, high-tech ultra- or micro-filtration for pre-treatment, the use of waste energy from other processes, and the use of low-grade energy from electricity generating plants, all contributing to substantially decreased energy use.
In the days when energy was cheap and desalination applications limited, little attention was paid to the energy consumption involved in the process. Energy use for evaporation methods like MSF, including pumping work, could be as high as 400 Megajoules/m3 for desalinating seawater containing 3.5% salt. It can

now be as low as 200 Megajoules/m3 using MED and co-generation with adjacent power plants. The reverse osmosis method requires significantly less energy than does the evaporation method. In the early days, maximum consumption was about 12kWh/m3 from seawater containing 3.5% salt. However, by introducing energy recovery systems this was reduced to 7kWh/m3. In the newest RO plants, the energy requirement has been reduced to between 4 and 5kWh/m3 and further reductions to 3kWh/m3 are foreseen with additional technical improvements.
If one wants to compare these kWh/m3 data for RO with the caloric requirements for evaporation, MSF operates in an equivalent of the range between 15 and 25kWh/m3 and MED at around to 10 kWh/m3, depending on process temperatures. Overall, it is clear that energy consumption for desalination has declined substantially in the last five years. For very large units, when used in conjunction with power generation, MSF still has cost advantages for seawater desalination. MED has an advantage over MSF for medium- to large-sized plants, because of its up to 25% lower power requirements, while RO has the advantage of being competitive in all sizes, but still remains dependent on the availability of electricity from fossil fuels. For brackish water, RO consumes even less energy in direct proportion to the salt content. For the evaporation methods, consumption remains at about the same level as for seawater conversion, effectively ruling out this desalination method for brackish water. Although the eyes of the world are focused on the energy equation of the improved desalination technologies, the investment and operating costs constitute a second major factor in the successful introduction of these technologies on a broader scale. Through upgraded designs and the improved energy efficiencies, the various desalination technologies can currently deliver fresh water from the sea at costs that range from US$0.40 to US$0.80/m3, whilst fresh water from brackish water can now be produced at the rate of US$0.10 to US$0.20/m3, depending on the salt content. An important factor in the expansion of desalination plants is the combination of water and power generation, the so-called IWPP (Independent Water and Power Projects), where large-scale evaporation (MSF) has become competitive with RO, leading to water prices of US$0.50 to US$0.70/m3 and energy prices of US$0.025/kWh. While exact cost figures for the various types of desalination vary according to location, saline levels and available types of energy, the cost per cubic metre is today approaching the cost level of producing fresh water from ground and/or surface water, which in western countries is in the order of US$0.50/m3.

Cutting desalination costs

However, the costs of traditional methods of extracting and purifying surface water and ground water are increasing around the world. The reasons? Increased scarcity, ground water depletion, deeper wells, higher purification costs, increasing distances from natural water resources, increased energy costs, increased ground water taxes, and increasing distances to transport the water. If the ecological costs of deeper wells and depleting surface water resources were taken into account, the cost picture would look worse. In many areas of the world, subsidized consumer prices do not reveal the true costs necessary to produce fresh water from traditional sources, but my guess is that true costs will be applied more and more frequently in the future, especially for municipalities and megacities. As desalination costs progressively undercut the level of the real costs of traditional methods of producing fresh water, this will contribute to increased investments in desalination plants, especially in coastal areas with megacities. In the future, the price ceiling for water will probably be determined by the desalination technologies with the overall lowest costs.

The marketplace

As scarcity and costs increase, the marketplace will begin searching for alternatives to rising costs. These include shifting from supply to demand management, increased efficiency, seasonal storage, reuse of sewage effluent, distributing various qualities of water based on its utilization, additional renewable water resources, transfer of water from region to region, importation of water and desalination of seawater. Until quite recently, desalination was always last on the list. However the evolving state of the art, as we noted earlier, will propel it upwards, at least in the coastal regions. And we mustn't forget that 70% of the world population lives within 50 miles of the world's seas and oceans. The following is an interesting illustration of the growing competitiveness of desalination technology near the coastlines. Recently, details were published about negotiations between Turkey and Israel concerning the shipping of water from the Manavgat River in Anatolia to the port of Ashkelon. They agreed on a price of US$0.15/m3, but shipping costs of between US$0.80 to US$0.90/m3, prevented the deal from going through. Meanwhile, the bids for the Build-Own-Operate-Transfer desalination project at Ashkelon have set the price at below US$0.60/m3, thus providing a cheaper, safer source. In the meantime, both projects have been approved. Other recent decisions on desalination plants near coastlines and with capacities of between 100.000 and 150.000 m3/day and water cost prices of between US$0.50 and US$0.70/m3 have been made in Singapore, Shandong Province in China, Carboneras in Spain, Shuheiwat in UAE, Batmah Coast in Oman, Perth in Western Australia and on the island of Taiwan. In 1990, the Gulf States had more large-scale desalination plants than the rest of the world combined. Saudi Arabia, for example, currently has 20% of the world's large-scale plants and will place further orders for more plants for the next twenty years, to the tune of US$50 billion. But in fact, the majority of existing and projected desalination capacity today is of the very large-scale variety. According to recent market projections, with the increase in experience and improved techniques, this trend will increase, spreading to other coastal regions in Asia and Africa. Recent market projections show that new desalination plants could be supplying up to 120 million m3/day by 2025 in the 18 driest countries in the world, where water supply per capita falls well short of daily demand. As for the rest of the world, forecasts are difficult to make, but the potential is immense.
But it is not just large-scale installations that will be entering the market. Reverse osmosis has the advantage of being applicable to both large and small-scale needs and is already in use in various capacities in the shipping industry, horticulture, and in small industries and communities.
The largest market for desalination will be for supplying drinking water, which will most likely be supplied by MSF and RO processes. The second largest demand will be for industrial water, which will most likely be supplied by MED and RO, if there are no further major developments on the desalination horizon. Not only are the improved technologies becoming competitive in converting seawater to fresh water, but they can also be applied to producing clean water from wastewater. This process is still under development, but as the prices for water go up, reuse technologies will be applied more and more frequently as large-scale recycling projects in the water management sector can supply water at prices that will compete with traditional water supplies. These complementary trends of reuse and desalination will most probably revolutionize the future of the water supply industry in many parts of the world.

Financing desalination investments

Until recently, investments in desalination capacities were heavily funded by local and regional players. However, with the expected sharp increase in demand for desalinated water in the Middle East, Mediterranean, Europe, Africa, Asia and the Americas, the volume of financing required will necessarily lead to an enlarged lender base.

A recent two-day symposium in London on the financing of desalination projects, organized by the International Desalination Association (IDA) furnished a wealth of information on the latest developments in attracting private sector participation in the desalination sector.
New government guidelines by the Supreme Economic Council in Saudi Arabia for private sector participation in large desalination plants are soon to be issued, leading to the privatization of the Saline Water Conversion Corporation (SWCC). Build, Own and Operate (BOO) and Build, Own, Operate and Transfer (BOOT) schemes are emerging as a means to attract private capital, not only in Saudi Arabia, but also in Oman, Abu Dhabi, Qatar and Kuwait and are a foretaste of future developments in other parts of the world. Whereas private sector financing has become accepted practice in the power industry, the water sector should now move in the same direction.

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