Desalination Today

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Desalination is a water treatment process that removes salts from the water. One of the earliest forms of water treatment, its use is worldwide. Some of the applications of desalination include:

- Municipal desalting of brackish or seawater for drinking water production.
- Industrial and commercial applications for producing high purity water, boiler feedwater, process water, bottled water.
- Zero discharge applications that produce water for pharmaceutical, electronics, bio/medical, mining, power, petroleum, beverage, tourism and pulp/paper industries.
- Rigorous treatment of wastewater for reuse applications.

Desalination Technologies

Today, desalination has become a proven water treatment process. And, as the cost of desalination decreases as compared to the other conventional treatment means, it is developing into a price-competitive water treatment option for more and more communities.

At the end of 2001, an estimated 9,400 land-based desalting plants with capacity greater than 100 cubic meters per day (26,400 gallons per day) had been installed or contracted for installation throughout the world. According to the July 2002 International Desalination Association Worldwide Desalting Plant Inventory, worldwide installed capacity is now more than 8.5 billion gallons per day.

Desalination processes that use membrane technologies such as reverse osmosis (RO), nanofiltration (NF), electrodialysis (ED) and electrodialysis reversal (EDR) employ semi-permeable membranes to separate the feedwater into a high-purity product stream and a high-saline concentrate stream. RO and NF are pressure-driven processes that pump feedwater at sufficient pressure to overcome the osmotic pressure of the saline feedwater and that provide sufficient driving pressure to permeate water across the membrane surface, leaving the higher salinity concentrate water behind. RO and NF membranes are configured in spiral-wound elements (see Figure 1), and multiple elements are placed in series in a membrane vessel.

ED and EDR utilize electrical potentials to attract positive and negative ions from the saline feedwater, leaving behind the lower-salinity product water. ED and EDR membranes are configured in flat sheet modules. Membrane technologies are used in seawater, brackish water, wastewater, ultrapure, and many other industrial water applications. Desalination processes using thermal technologies, such as multistage distillation (MSF), multiple effect distillation (MED) and vapor compression (VC), utilize heat and reduced pressure to vaporize and condense pure water from seawater. Thermal desalination is also used in industrial applications.

Thermal technologies account for about 48 percent of worldwide desalting capacity with multistage flash distillation providing about 83 percent of that quantity. Membrane technology accounts for the remaining 52 percent of the worldwide desalination capacity with RO contributing 84 percent of that quantity.

Historically, thermal technologies are more mature, with the ancestors of today's technologies being developed in the 1920s and 1930s. ED technology dates from the 1940s and RO applications from the 1970s. EDR was an offshoot of ED, which came on the scene in the 1950s. Similarly, NF developed from RO technology in the late 1980s.

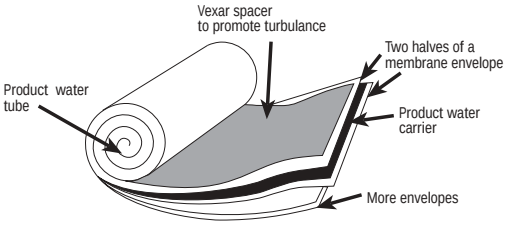

Figure 1. Spiral-wound configuration used in reverse osmosis and nanofiltration membranes.

Desalination Around the World

In the United States, membrane processes are the preferred technology, as they are more energy-efficient than thermal technologies. Thermal technologies are used primarily in the Middle East region, in cogeneration facilities that generate power and desalinated water. In these facilities, the energy to fuel the desalination process is a by-product of the power generation. Figure 2 demonstrates the distribution of installed desalination capacity by region on a global basis. As the figure indicates, the Middle East region leads the world in installed capacity, but North America and Europe now have significant desalination capability. Large-scale seawater desalination plants are now popping up in areas outside the Middle East region, including the Caribbean, Singapore, Israel and Hong Kong. All of these new large-scale plants are utilizing RO membrane technology. Domestically, Figure 3 demonstrates the distribution of technology in the U.S. desalination market. RO is the market leader, and continues to gain market share as large-scale seawater facilities using RO are now being developed here at home.

Desalination of brackish water sources has been the basis for most U.S. desalting for the past 30 years, but that is beginning to change at a fast pace, as the pricing for seawater desalination becomes cost-competitive with more conventional water

supply options for water-short coastal communities. The first large-scale seawater desalination plant began operating in March 2003 in Tampa, Fla, and, at full capacity will produce 25 million gallons per day (mgd) with expansion potential to 35 mgd. Earlier, smaller seawater plants are located in Key West, Fla. and Santa Barbara and Catalina Island, Calif. Additional large-scale facilities are in the planning or development stage in Florida, California and Texas. For large-scale facilities (20 mgd or larger) cost is now in the range of $2.00-$2.80 per 1,000 gallons of water produced. Brackish water desalination is considerably lower in cost, depending on the salinity and disposal options for the concentrate waste stream. For brackish water of salinity ranging from 1,000-5,000 milligrams per liter using surface disposal for concentrate discharge, the cost is approximately $0.75-$2.00/1,000 gallons of water produced. The capital cost for desalination projects is described in Table 1. Note that the range of cost is considerable, and is site- and capacity-specific.

Desalination Challenges in the Southwest

All desalination applications used today create a high purity product stream and a high saline concentrate waste stream. Disposal of the concentrate stream presents one of the biggest challenges to the use of desalination at inland sites. In seawater applications, disposal of the concentrate to the ocean is typical. For inland brackish facilities, concentrate disposal is generally to a surface water body but can include deep well injection, or disposal to a publicly owned treatment works. Other methods of disposal, including discharge to saline wetlands and enhanced evaporative techniques, have been studied, but nothing has been found to be economically and environmentally viable at this time. The U.S. Bureau of Reclamation and communities in Arizona, Nevada, Texas, and California have joined together to address this challenge.

Desalination in the southwestern United States is being used on a limited basis in small-to-medium facilities and is presently being evaluated by a number of communities in New Mexico, Texas, Arizona, California and Nevada for use on a large scale. As mentioned above, the biggest challenge for communities in the land-locked southwestern communities is concentrate disposal. Saline aquifers and surface water sources offer a significant resource of "new" water supplies for southwest communities needing to augment their future water supplies. In fact, some of these communities have no future water source other than desalination and water reuse. Therefore, it is critical that we find environmentally friendly and cost-effective concentrate disposal solutions to offer these communities.

Overall, desalination of seawater, brackish water and wastewater is growing as a method to augment water supplies in the United States and around the world. Desalination using membrane technology is growing at a rate of approximately 11 percent per year by installed capacity. As the cost for desalination continues to decrease, particularly in comparison to developing traditional methods of water supply, more and more communities will turn to this alternative to help them solve their water supply challenge.

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Capital Cost for Seawater and Brackish Water Desalination Plants

	Total Installed Cost, $ per gal/day of production capacity
Brackish water desalination plants	0.95-4.50
Seawater desalination plants	2.80-5.00

Table 1:Capital costs for desalination projects.

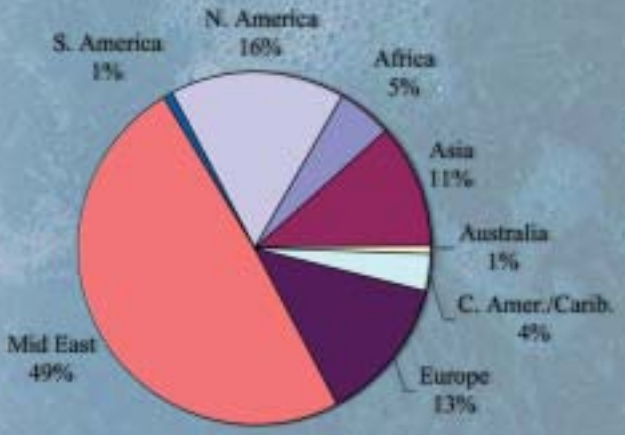

Figure 2. Distribution of installed desalination capacity by region. Source: Aqua Resources International from IDA/Wagnick Inventory, 2002.

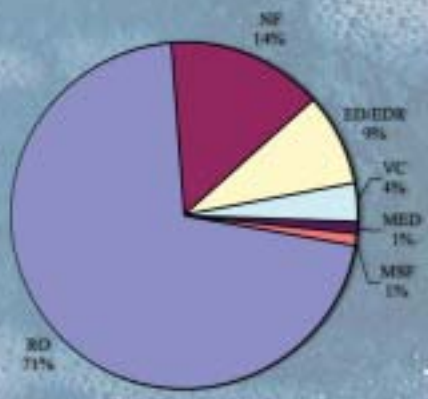

Figure 3. Distribution of desalination technology used in the United States by installed capacity. Source: Aqua Resources International from IDA/Wagnick Inventory, 2002.