TECHNOLOGY UPDATE

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Desalination in America

Contrary to the belief of many, desalination is not new to the Americas.

The largest growth in global desalination has taken place in the Arabian Gulf, which often makes it seem like a distant solution. We often hear that only oil rich states such as Saudi Arabia can afford such technology, but this is far from the truth. While we may not be facing desertification, the stress on our traditional water supplies is making desalination increasingly widespread much closer to home. The reality is that when utilization of traditional water sources is maximized, desalination (and related applications such as reuse and recycle) become key components of sustained development.

The International Desalination Association (IDA) tracks approximately 10,000 desalination facilities worldwide. Each of these facilities has at least one machine capable of producing more than 13,210 gallons per day (50 m^3/d) using one of several desalination processes. More than 24 percent of these are located in North America but most surprising is that almost 2,000 are in the United States. The exact operating status of all these units is difficult to say, but a steady number of new systems for new projects keeps being added to the database.

On average there are 50 to 75 significant desalination projects per year in the United States with an average capacity of approximately 1 million gallons per day. The majority of these projects utilize membrane processes such as nanofiltration (NF) or reverse osmosis (RO). There also are other processes used for specific applications including vapor compression (VC), which is more robust than RO and can be used for higher salinity situations such as meeting zero liquid discharge requirements with water chemistry that prohibits membrane processes.

This steady growth in the use of desalination goes back a long way. Many people may recall that Key West had desalination units installed in the 1960s using the multi-stage flash (MSF) process and then again in the 1980s using the RO process. Not many people know that the first desalination unit was installed there in 1861 and operated until the 1900s. The modern road access to Key West has allowed the water supply to be piped down to the island but only so long as South Florida has sufficient water.

The U.S. Virgin Islands do not have the luxury of considering a pipeline and have utilized desalination for almost 50 years. Other islands have an even longer history of continuous desalination for municipal water supply; the islands of Aruba and Curacao both recently celebrated 70 years of desalination.

North American companies have been and continue to be at the forefront of the science and technology of desalination and water reuse. Today American and Canadian companies are world leaders in membrane technology and also in the technology and application of reuse and recycling.

This multiple-effect vapor compression distillation system is in operation in Abu Dhabi in the Middle East. Many similar units are being installed across the United States to produce drinking water from sea water.

Processes and Technology

The technology today can be focused on providing the best solution for each application. As an example, thermal desalination processes can utilize waste heat from petro-chemical facilities or power plants, increasing overall thermo-dynamic efficiency of the "host" process and yielding excellent economics. This can be a wonderfully holistic approach to desalination and is applied in several Caribbean installations.

Membrane processes are unrivaled for treatment of brackish waters and seawater. They work particularly well for stand-alone "water only" situations.

Hybrid process designs also are becoming more common.

- Mechanical vapor compression can be used to treat the brine reject from RO plants increasing system water recovery.
- Seawater RO and distillation process (MSF or MED/TVC) can be utilized in cogeneration facilities yielding improved economics via enhanced utilization with fluctuating water to power demand ratios. (An Asian manufacturer is participating in the first major project of this type in the Middle East.)

RO is a type of membrane process that could be considered as "pressure driven," but there are several types of membranes that can be used with different results. The toughest application for membranes is to remove salt; seawater membranes are different from brackish membranes. A less difficult pressure membrane application is the removal of other ion species (which are not classically considered salt) or small suspended particulates. An example of this is known as NF, which can be used to remove ions that are larger and have higher molecular weights than salts and also other materials such as viruses and bacteria.

Other types of membranes can be used to remove troublesome particulate matter, and these systems are known generically as membrane filtration. "Dual membrane systems integrating the use of porous, low pressure-high flux microfiltration (MF) pretreatment with reverse osmosis are able to effectively treat secondary sewage to meet ultrapure water standards and may more accurately be described as 'repurification' systems," says Tom Pankratz, author of *Environmental Dictionary & Directory*. While this membrane reuse application has been widely utilized for wastewater and some brackish water desalination, it now is beginning to find use in higher salinity applications. Pretreatment continues to be the Achilles' heel of SWRO systems and MF (or NF) certainly shows promise as a process improvement; the economics now are being evaluated.

A new class of hybrid process utilizes NF as a pretreatment for thermal desalination processes allowing the distillation to occur at temperatures that previously would have led to the deposition of process-inhibiting mineral scale.

The Future

The desalination industry not only continues to grow but, more importantly, it moves from an obscure technical possibility to mainstream, accepted practice. There are many technical measures of the improved technology and economics of desalination, but nonscientific analyses also are possible. Whether referred to by the industry terminology, desalination, or the more common usage of desalinization, the word is out: desalination is viable. People are beginning to get the message on a large scale via mass media.

Not a desalination conference goes by without more discussion about desalinated total water costs (TWC) and what is the best metric to compare TWC and overall economics. The scope of one project may differ greatly from another. There is great variation from locale to locale in the value of energy and the cost of capital. Comparing water costs often is "apples and oranges." Continued construction of large-scale desalination projects in preference to traditional water treatment as the method of choice is proof of the economics.

Trinidad, where the largest seawater desalination plant in the Americas recently was commissioned, considered desalination and traditional water sources. Many people in Trinidad feel their traditional source of water from the mountains to be adequate. However, the cost of pipelines and the environmental impact of dams could not compete with desalination or the potential for drought.

In the United States, water-rich central states provide water across multiple state

borders to reach the arid southwest. Transportation of water in this manner requires a large capital investment and significant operating cost. These arrangements are not drought proof, especially if the drought were to be "politically" created. The water rich regions currently providing water to the southwest are beginning to reconsider this practice as their water wealth dwindles.

The political sensitivity of water transportation is more critical when national borders are crossed. In these cases, even when water is abundant, it can be denied for political reasons. A desalination facility was built at the U.S. Naval Base at Guantanamo Bay when the government of Cuba stopped the flow of fresh water for political reasons. Much of the local water supply for Singapore comes from neighboring Malaysia—a desalination solution is planned to create water self-sufficiency for Singapore.

Tampa Bay, Fla., has a 25 million gpd desalination project that will be operational by the end 2002. This project has attracted a lot of attention, specifically about the cost of water that is less than $2.00/1,000 U.S. gallons. Environmental concerns about the use of a bay rather than open seawater failed to convince the courts of their merit, so the project proceeds. The environmental issues related with developing traditional water sources was a less publicized concern. It was the overall economics and drought proof operation that led to successful selection of desalination.

The unavoidable fact is that desalination is competitive and is being implemented in more diverse locations. The naysayers can no longer claim desalination is possible only in oil rich nations. In June 2002, the island of Aruba celebrated 70 years of desalination. Today, Aruba prospers mainly from tourism, which relies entirely on desalination on an otherwise very arid island. "Many people all over the world know of the local nickname for our very pure water, Balashi Cocktail," said Filomena Marchena, the desalination superintendent.

One of the things that has made the recent growth possible is the incorporation of "financial engineering" into desalination projects. For decades, desalination systems were financed like other pieces of process equipment—industrial bank loans that typically have a five-year repayment schedule. We now have the situation where bond financing (or other long-term financial instruments) has greatly reduced the cost of desalinated water and allow "apples to apples" comparisons with traditional water sources. The durability of the equipment and stability of the processes have reached the point where investors in utilities now can consider desalination as a viable investment.

Financial engineering in desalination is the true milestone achieved by the Tampa and Trinidad projects. Further evidence of this is in the privatization of large power and desalination projects in UAE and Qatar. These same financing models are being utilized for the upcoming projects in Israel, Singapore and Australia. These projects will become milestones, not for technical reasons, but rather for being commercial breakthroughs for new models of public-private cooperation on large-scale utility projects.

Desalination now is at the point the electricity-generating industry reached decades ago. Access to new types of financing and the resulting benefits lead directly from being able to compete as the water supply for large municipalities and the ability to reflect upon decades of reliable desalination.

As populations continue to grow and migrate to coastal regions, desalination someday will be a word on the lips of most Americans. WQP

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