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Innovations Solutions Within The Water Industry: Desalination

The world's population is expected to increase by 50 percent by 2050, but only one percent of the earth's water is freshwater that is ready for drinking, and the number of regions experiencing droughts and water shortages is growing.[1] Considering these facts, one of our most critical questions for the future centers on how all people will have access to clean drinking water. With 97 percent of the earth's water consisting of seawater, one viable solution is desalination.

Desalination, the removal of salt from brackish (saline) water or seawater, has been successfully implemented around the world and has proven to meet the needs of residents that would otherwise have no local access to drinking water. Though not widely used at a large scale in the U.S., desalination is beginning to make headway across the country, particularly in arid coastal regions. Seawater "desal" is now playing an increasingly important role in the U.S., which is why it is critical to understand what it involves and how it will affect us on an environmental, economical and practical level.

BACKGROUND

The need for water supply solutions in the U.S. becomes clear when laying out some of the challenges facing our country:

- The U.S. is the only industrialized nation whose population is growing significantly. Whereas the population of Europe is expected to decrease by 10 percent by 2050, that of the U.S. is expected to increase by one third.[2]
- The population is growing fastest in areas where water is scarcest.[3]
- The U.S. water supply system is threatened by population growth and climate change. A report from the Government Accountability Office in 2003 anticipates that by 2013, about 36 states will experience water shortages.[4]

[1] Center for Environment and Population Report. US National Report on Population and the Environment. http://www.cepnet.org/documents/USNatlReptFinal.pdf. 2006
[2] Center for Environment and Population Report. US National Report on Population and the Environment. http://www.cepnet.org/documents/USNatlReptFinal.pdf. 2006
[3] Grumbles, Benjamin H. *Congressional Testimony*. 21st Century Water Commission. 8 Nov. 2007

- The U.S.'s largest sources of freshwater – the Great Lakes, the Ogallala Aquifer and the Florida Everglades – are under increasing pressure. The Everglades, for example, has shrunk to one-half its original size in the past century.[5]

Some experts note that "America's relatively high population growth and high rates of resource consumption and pollution make for a volatile mixture resulting in the largest environmental impact per capita…in the world."[6] It is clear that in order to meet rising demand for a dwindling resource, water providers must find new sources of supply to increase capacity while remaining environmentally sensitive.

Desalination, though not intended to address all water scarcity issues, provides one solution in addressing these supply concerns. With 58 percent of the source water for desal plants based on seawater, desal is primarily used in coastal communities.[7] While current global output of desalinated water is only about 0.1 percent of total drinking water, a recent report by Global Water Intelligence noted that the worldwide desalination industry is expected to grow 140 percent over the next decade. That growth will require $25 billion in capital investment by 2010.[8] Indeed, total global capacity has grown by 47 percent in the past five years alone.[9] Responding to the increase in demand for water, desalinated seawater currently accounts for water production of 24.5 million cubic meters of water per day worldwide.[10]

EXPLAINING DESALINATION

It is clear that desalination is effectively supplying communities across the globe with their drinking water and that this technology will continue to grow. But further explanation is needed as to what exactly desal is and how it works. There are different methods and technologies employed, depending on the type of desal process at hand. Two-thirds of all desal plants use thermal technology, a process predominantly employed by plants in the Middle East, where heat is easily harnessed.[11] However, this paper will focus on explaining membrane technology, as the vast majority of plants in the U.S. and elsewhere outside the Middle East use this process.

When discussing membrane technology, the most commonly used process for desalination is reverse osmosis (RO). Prior to RO treatment, particles and other compounds must be removed from the sea or brackish water source. This partially treated water is then pumped at high pressure through a semi-permeable RO membrane, which allows water molecules to pass through while trapping the salts within. Two things result from this process: clean drinking water and brine, a leftover concentrate of salty water that is typically released into the ocean. The clean drinking water will undergo a post treatment disinfection and stabilization process before being delivered to customers for consumption.

It is important to note, while relying on the same technology, reverse osmosis desal plants are not all the same. Variable factors such as feedwater salinity, logistical outlay and the surrounding environment require tailored pretreatment solutions in order to produce drinking water. While the solution vary, many of the challenges raised by desal remain the same.

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[4] GAO, *Freshwater Supply: States' View of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages.* July 2003

[5] Center for Environment and Population Report. US National Report on Population and the Environment. http://www.cepnet.org/documents/USNatlReptFinal.pdf. 2006

[6] Center for Environment and Population Report. US National Report on Population and the Environment. http://www.cepnet.org/documents/USNatlReptFinal.pdf. 2006

[7] Latteman, Sabine & Thomas Hoepner. *Environmental impact and impact assessment of seawater desalination*. Institute for Chemistry and Biology of the Marine Environment. 2006

[8] Global Water Intelligence. *Desalination Markets 2007: A Global Industry Forecast.* December 2006

[9] Credit Suisse, *Water*, The New Perspective Series, 02 June 2007

[10] Latteman, Sabine & Thomas Hoepner. *Environmental impact and impact assessment of seawater desalination*. Institute for Chemistry and Biology of the Marine Environment. 2006

[11] Latteman, Sabine & Thomas Hoepner. *Environmental impact and impact assessment of seawater desalination*. Institute for Chemistry and Biology of the Marine Environment. 2006

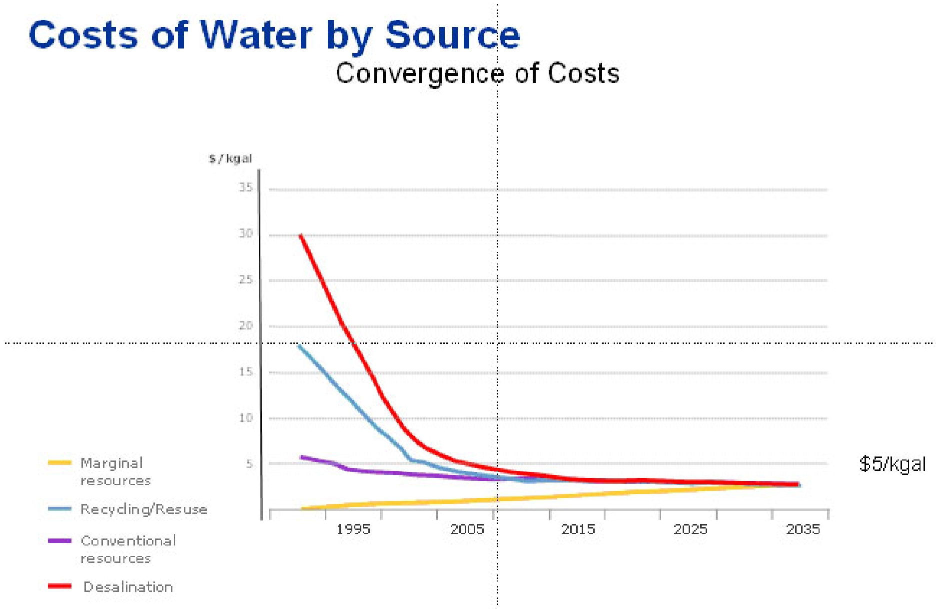
UNDERSTANDING THE CHALLENGES

There are a series of questions regarding the viability of desal, but many of these result from dated or contradictory information. This section will examine and address some of these challenges.

Energy Use

The general concern is that desalination plants consume vast amounts of energy to produce drinking water, rendering them inefficient. While energy consumption was an obstacle in the past, newer, improved technologies have addressed this problem in two ways. First, membranes today are more efficient, meaning they can do the same task with lower energy input. Second, the energy used can also be leveraged. Water is still under a lot of pressure after it passes through the membrane, so the pressure can be harnessed and recycled back to the plant as energy. Whereas it used to take an osmotic pressure of 700 psi (pound per square inch)[12] to produce drinking water, today the average is at about 420 psi.[13]

Membrane technology improvements coupled with the ability to recover energies in the treatment process and use energy efficiently means that the cost of desal is actually converging with the cost of other water treatment options.[14] See table, below.



Source: American Water, 2007

One significant development involves linking desal plants [Note: this is potentially true for all types of water treatment] to renewable energy sources such as hydroelectric, solar and wind. This is unique to the water industry, as drinking water can be stored for future use. There is no efficient storage mechanism for electricity, for example. Thus, if the wind blows at night (a time of low energy consumption), the energy generated can be used to power a desal plant and the resulting water can be stored in a reservoir. As a result, desal plants can become even more energy efficient.[15]

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[12] Pound per square inch: pressure resulting from one pound-force applied to an area of one square inch.
[13] Black, Harvey. *Desalination – Saltwater works.* Chemistry and Industry. Vol. 15. 13 Aug. 2007
Note: 420 psi refers to the average. The range can greatly differ depending on the salinity level of the water as well as other factors.
[14] Young, John. Chief Operating Officer, American Water. Interview. 11 Nov. 2007.
Credit Suisse, *Water*, The New Perspective Series, 02 June 2007
[15] It is important to note that the energy use of any desal plant correlates with the salinity of the feedwater, with more saline water requiring more filtration and thus, more energy.

Environmental Impact

Another concern regarding desal involves the overall impact desal plants have on the environment - specifically, whether the discharge of brine back into the ocean negatively affects the environment. In this case, it is important to explain what is being discharged. Desal generally operates at 50 percent efficiency. That means that two gallons of seawater yields one gallon of potable water and one gallon of brine. With the average salinity of water at 3 percent, an efficiency of 50 percent would yield brine twice as salty, or with 6 percent salinity. However, desal plants in North America and in Europe are required to dilute this mixture with regular seawater prior to discharge. In the U.S., the dilution ratio is in the range of 10 to 20 gallons of seawater for every gallon of brine, bringing the salinity down to 3.1 percent to 3.2 percent. As such, most desal plants are returning water that is only marginally more saline than the original water. In addition, the plants are careful to discharge the diluted brine in areas where the mixture can be quickly integrated into the ocean, so as to have minimal impact (i.e. in deep waters or near currents).

To make the discharge process even more efficient, desal engineers try to build their operations near energy plants. Since energy plants use seawater as a cooling mechanism and already have the infrastructure in place to draw and return seawater, desal plants located nearby can use this water to dilute the brine before sending it back into the ocean and thus, minimize additional energy and infrastructure requirements.

In some cases, desal plants can actually help ward off negative environmental impacts. In Monterey, California, a desal plant is being considered so that the community can minimize the use of a local river as a water source, thereby protecting an important habitat for fish and other species. In this situation, environmentalist were among the proponents of the desal plant, as continuing to draw from the river during low flow conditions would jeopardize its ecosystem. In this instance, desal helped a community minimize its environmental impact.

FINDING SOLUTIONS

Water industry experts are always motivated to find solutions that work for the community both on an economical and environmental level. If a community is considering a desal plant, it is usually because there are very few or no cost-effective alternatives for supplying potable water, aside from significantly decreasing water consumption or curbing community growth.

As with any solution, it is critical to asses the net impact and cost. Desalination is just part of the solution to our nation’s water challenges. Ensuring adequate supply in America also requires making people aware of just how essential water is to our every day life, educating people about conservation and promoting water saving methods. Becoming more informed about our water use habits will enable us to make better and more conscious decisions about our water use in the future.

Likewise, desalination, as a solution, needs to make sense for the community it serves. One should always “encourage a community to look at all of its options first and critically assess if desalination is the most cost effective, sustainable and environmentally friendly solution for a community,” notes John Young, Chief Operating Officer of American Water. Since desal is very site-specific, it requires a thorough examination of a community’s needs and options as well as careful planning to determine whether desal can provide the best possible solution both for the current and expected future population. One challenge to this is the water industry’s fragmented nature with over 53,000 systems across the U.S. If each system focuses solely on its own local solution, it is sometimes challenging to build a desal plant that can meet the needs of all the systems in a region. Better cooperation and consolidation of these systems can enable us to develop plants that meet a region’s needs and not just those of isolated communities. For any community considering desal, it is critical to evaluate the options and issues with relevant stakeholders before making a decision.

CONCLUSION

All solutions have their critics, and desalination is no exception. With the nation's first large-scale seawater desalination plant fully operating in Tampa and plants being planned for San Antonio and Laredo in Texas, as well as Carlsbad and Monterey in California, desal will very soon become a mainstay of the U.S. water industry. As has been demonstrated, there is a pressing need in this country to find ways to both increase sustainable capacity and conserve water. Desalination technologies can provide a water supply solution that can best serve local and regional needs. Therefore, it is essential that more people understand and focus on the benefits of desalination.