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Coastal California City Turns to Desalination to Quench Its Thirst

Sand City's new reverse-osmosis desalination facility aims to keep costs down and drinking water production up with the help of energy-recovery technology

By Larry Greenemeier | April 7, 2010 | 17

OPEN FOR BUSINESS: Sand City's new desalination facility--actually a brackish water treatment plant--is expected to produce more than 370 million liters per year of potable water through reverse osmosis filtration. Energy Recovery Inc.'s PX Pressure Exchanger is a cylindrical ceramic rotor installed within the desalination system to make the process more efficient. *Image: COURTESY OF THE CITY OF SAND CITY, CALIF./CHARLES POOLER*

When Sand City, Calif., officially opens the spigot to the state's first full-scale seawater desalination facility Wednesday, residents throughout the city will begin tapping into the Pacific Ocean as a source of drinking water. The city's goal is to provide a seamless transition so that consumers do not recognize any difference in quality or taste compared with the reservoir water that used to provide their potable water.

Although the plant has been operating for testing purposes for more than a year, it is now fully permitted by the California Department of Public Health and can be connected directly to California-American Water Company's (Cal-Am) water grid serving much of the Monterey Peninsula. If all goes according to plan, Cal-Am's water tanks, which serve Sand City as well as other communities in the area, will be pumping more than 370 million liters of water less per year from their Carmel River and Seaside Aquifer reservoirs, says City Engineer Richard Simonitch. That is because the new desalination facility—actually a brackish water treatment plant—is expected to produce that volume of potable water instead, using reverse osmosis filtration, which forces seawater through a semipermeable membrane that separates salt from water.

West coast water woes

California's water scarcity goes back nearly a century (and even served as a major plot device in Roman Polanski's 1974 film noir *Chinatown*, which is set in Los Angeles in 1937). Sand City is one of several places in California and the U.S. Southwest with limited water resources.

The state awarded Sand City $2.9 million in grant funding for the desalination plant in 2007. The funding was made possible thanks to California Proposition 50, passed in November 2002 to allow the state to borrow $3.4 billion for a variety of water projects, including those to create safe drinking water. The project as a whole cost about $11.9 million, with the city covering $9 million of that through redevelopment funds and city capital improvement funds. Cal-Am will use water produced from the desalination plant to offset their current overdrafting of the Carmel and Seaside, but as Sand City grows the city will have access to more water as needed.

Whereas more potable water is incentive enough for the desalination plant, the city has other incentives, too. California has restricted Sand City from any new building until the city increases its water supply, says City Administrator Steve Matarazzo. "There's significant urban blight in Sand City, and the city wants to redevelop those areas, which it can't do without more water," he adds. The new facility should solve that problem, given that Sand City's current water needs are only about 117 million liters per year.

Sand City, which covers only about 1.5 square kilometers of land, benefits from being located near what Matarazzo refers to as a "seawater wedge" that keeps part of the city's coastal area brackish, meaning the water is saltier than freshwater but not as briny as seawater. Since the water is less salty, it requires less energy and costs less to desalinate than would regular ocean saltwater.

Turning to reverse osmosis

The desalination plant works by drawing the brackish water in through wells that are each about 30 centimeters in diameter and 18 to 27 meters deep. The plant has four wells but uses only two at any given time. "The water in these wells is free of sea life, except microbes, by virtue of the fact that they were drilled into the sand aquifer from an inland location," Simonitch says. The sand acts as a natural filter.

Sand City's desalination plant employs reverse osmosis because it is more cost-effective than other methods of removing salt from seawater, Simonitch says. There are primarily two ways to extract drinking water from saltwater—distillation and reverse osmosis, both of which require a lot of energy. Although the actual cost of desalination varies from region to region, it can cost anywhere from just under $1 to well over $2 to produce one cubic meter (1,000 liters) of potable water from the ocean (about as much as two people in the U.S. typically use in one day), Peter Gleick, president of the Pacific Institute, wrote in a July 2008 article for *Scientific American*.* It costs about 10 to 20 cents to get that much water from a river or aquifer, he adds. Meanwhile, the average delivery price of municipal water in the U.S. is around 60 cents a cubic meter, according to the American Water Works Association.

In distillation, seawater is boiled, evaporating the water and leaving the salt. The evaporated water is collected and condensed back into liquid, according to Gleick. Reverse osmosis is less expensive than distillation and, as a result, more commonly used. A major criticism of reverse osmosis—in addition to leaving behind highly concentrated brine that can harm aquatic life if this super-salty water is put back into the ocean—is that the process is inefficient and generally wastes a lot of energy.**Adding efficiency**

Sand City says its plant addresses the brine issue by producing a solution left over from the reverse osmosis process that matches the salinity of Monterey Bay, where the solution is sent.

One way desalination facilities, including Sand City's, have tried to address the inefficiency issue is by adding energy-recovery devices into their desalination systems that boost output and cut energy consumption and costs.

The city chose PX energy recovery devices made by Energy Recovery, Inc., (ERI) in San Leandro, Calif. ERI's PX Pressure Exchanger is a cylindrical ceramic rotor installed within the desalination system. (See a video of how it works). Some of the seawater entering the system goes directly to the desalination membrane while the rest is diverted to enter one end of the cylinder. At the same time, salt-heavy concentrate (like brine, but not as strong) unable to pass through the membrane flows into the other end of the cylinder. The flow of these opposing forces entering the rotor from opposite ends spins it like a carousel, rotating 1,200 times per minute. As the rotor spins, it creates pressure that pushes the seawater toward the membrane and the concentrate out of the system. The PX Pressure Exchanger is designed to recover up to 98 percent of the energy from the stream of concentrate and feed it back to pump seawater through the membrane. Mixing between the concentrate and the seawater is minimal because the exposure time is so short, according to the company.

Sand City's desalination has two PX devices running at any given time, with two more installed as backup to provide full redundancy if the first two stop working, Simonitch says.

The pressure to find new sources of potable water has been building worldwide for years, leading some countries—Algeria, Australia, China and India, to name a few—to turn to desalination. Some areas of the U.S. have turned to desalination, including Tampa Bay, Fla., and El Paso, Tex., where local plants produce about 94 million and 104 million liters, respectively, of water per day. The world's largest desalination plant is the Jebel Ali M Station Desalination Plant in the United Arab Emirates, which is expected to be capable of producing 530 million liters of water per day when completed later this year.

The need for such facilities will only increase over time. Today, one out of six people on Earth, more than a billion, suffer inadequate access to safe freshwater, according to Peter Rogers's article "Facing the Freshwater Crisis" in the August 2008 issue of *Scientific American*. The article further states that by 2025 the freshwater resources of more than half the countries across the globe will undergo either stress or outright shortages, and that by mid-century as much as three quarters of Earth's population could face scarcities of freshwater.

**Correction (4/08/10): This article originally stated that one cubic meter (1,000 liters) of potable water from the ocean is about as much as two people in the U.S. typically drink in one day.*