When surface water is already spoken for or the amount is unpredictable, municipalities increasingly consider reverse osmosis (RO) treatment plants to produce drinking water from brackish aquifers. Industrial-size RO desalination is not new and has been proven viable by early adopters, such as the city of Cape Coral, Fla. Several states, including Texas and New Mexico, currently are using or planning RO plants to serve their water needs.

Solving corrosion issues with fiberglass reinforced plastic

The water tapped in these fossil aquifers is salty, or brackish, indicating that it contains concentrations of dissolved salts from 1,000 to 10,000 ppm. These concentrations are fairly low when compared to seawater with salt concentrations of 35,000 ppm.

In addition to the highly corrosive effects of salt, water typically contains additional corrosive substances, including minerals, organic material and high levels of acidity or alkalinity. Accordingly, the content of the aquifer’s water defines the overall design of the plant—and acquiring the water presents the first obstacle. Just getting the water out of the ground without corrosion or buildup of encrustation on the well piping is a challenge.

The city of Cape Coral is well versed in these issues. Its first production wells and RO treatment plant went into operation in 1976, and an expansion was implemented in 1985. The city went through a number of changes to its treatment plants over the years and completed another sizeable expansion to its facilities in 2010. The expansion was designed and managed by MWH Global Inc. Diversified Drilling Inc. was chosen to install the new wells, and Burgess fiberglass reinforced plastic (FRP) was installed in all 30 of the city’s RO production wells.

According to Mike Cason, a city utility staff member who has overseen the well fields for several years, the decision to install this FRP was based, in part, on its past performance.

“Burgess FRP has been installed in the city’s RO treatment plants since the 1970s,” Cason said. “The overall cost of [it] also was a decision factor, when considering installation costs, energy savings and longevity.”

Corrosion Affliction

Corrosion was and remains a major issue. The MWH project engineer cited the inert nature of FRP as a major reason for selecting the project’s casing. As an inert material, FRP is not easily degraded physically or chemically from contact with brackish water and other corroding materials. When compared with carbon steel and lower grades of stainless steel (i.e., stainless steel containing low contents of chromium, molybdenum and nitrogen), FRP performs well in these hostile environments. Finally, FRP is low residue forming as an inert material. Residues from metal pipe can clog and damage filters and membranes in RO plants. It is also important to note that FRP is non-conductive—it will not allow electricity to pass through it.

“It is normal to anticipate that stray electrical currents will exist in the vicinity of well fields, and these currents will accelerate the damaging effects of corrosion,” said licensed professional hydrogeologist Abe Kreitman. “Current may also be generated by the dissimilar minerals contained in brackish water or even by the contents of the rock surrounding the well.”

Furthermore, Florida is known as the lightning capital of the world, so it was important to consider that a lightning strike could cause catastrophic damage to metal or PVC piping in a well.

The project engineer cited the strength of FRP casing as a reason for its selection. The strength-to-weight ratio
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surpasses that of iron, carbon and stainless steel. The greater compressive strength of FRP casing enables its installation to well depths that can collapse PVC pipe.

Former Diversified Drilling employee Ralph D’Lea also cited pressure and heat resistance of Burgess FRP casing as important criterion for installation. “It takes fewer lifts of cement to grout it because of its greater collapse pressure rating and its immunity from the heat of hydration of the cement,” he said.

This significantly reduces the wait on cement to set before the next tremied lift is installed, delivering significant savings in terms of rig time, standby time and time to complete. Unlike PVC pipe, the FRP casing does not require circulation of cool water during installation and, accordingly, installs more easily and quickly.

Tallying the Benefits

In addition to quickly grouting fiberglass casing, representatives from MWH and Diversified pointed out other installation advantages. The smooth outer surface of metal pipe requires welding “cat eyes” or lugs onto the pipe in order for it to be lifted by elevators. In contrast, elevators attach easily under the “belly band” that is manufactured as part of Burgess pipe. Approximately 1 ft below the female threaded end of the casing, the first corrugation forms a ledge for easy attachment of elevators. Joints are aligned and threaded together quickly and without special welding skills. Threading two pieces of FRP pipe takes approximately nine to 10 minutes. In contrast, it takes approximately 20 minutes to weld two sections of metal pipe together.

FRP has a low friction coefficient, which helps prevent encrustation, or buildup of minerals inside column pipe. Kreitman addressed the issue of encrustation: “As minerals and other substances drop out of solution and adhere to the inside of metal column pipe, creating greater friction, it becomes increasingly difficult to pump water,” he said. “Also, the pipe diameter decreases, making pumps work harder.

The pumping level will increase due to increased friction losses, and greater energy will be expended by the pump to get water to the surface. This energy consumption can be significant. Cost per kilowatt varies across the nation from 6.1 cents in Wyoming to 18.1 cents in Connecticut, according to Energy Information Administration data released in April 2011. As a simple approximation, 1 kW equals approximately 1 hp. In a hypothetical situation, figuring an average of 12 cents per kilowatt, an additional 5 hp of energy per pump, running an 18-hour day (for 365 days), equates to an additional $3,942 in energy costs. In this scenario, a facility with 20 pumps could lose $78,000 in increased energy costs per year due to encrustation.

D’Lea has installed wells and supported the city’s RO plant for eight years. He explained some of the history of the plant, including early installations of stainless steel column pipe that had to be removed due to iron bacteria damage. In this situation, PVC column pipe was installed, but valve failure caused the water to heat (by the continuing operation of the pump). Higher temperatures caused failure of the PVC pipe due to “hourglassing.”

D’Lea also said that during the first few years, “we pulled pumps from the bottom of wells fairly often due to corrosion of the column pipe, causing the pump to separate and fall to the bottom of the well.” The installation of FRP column pipe and safety devices (e.g., flow shutoff valves) resolved these issues. The plant also could depend on the FRP to withstand the startup of high-horsepower pumps.

In the city of Cape Coral expansion, 22 production wells were installed in the North Cape RO Water Treatment Plant and eight in the Southwest RO Water Treatment Plant. FRP casing was installed in all 30 of the production wells. For these wells, 12-in. FRP casing was installed and pressure grouted from the bottom. FRP column pipe also was installed in the production wells. A Burgess custom-built adapter connected the FRP to the stainless steel fittings running to the plant. This project resulted in an additional 15 million gal of water per day.

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