Desalinating Brine From Oil and Gas Operations in Texas

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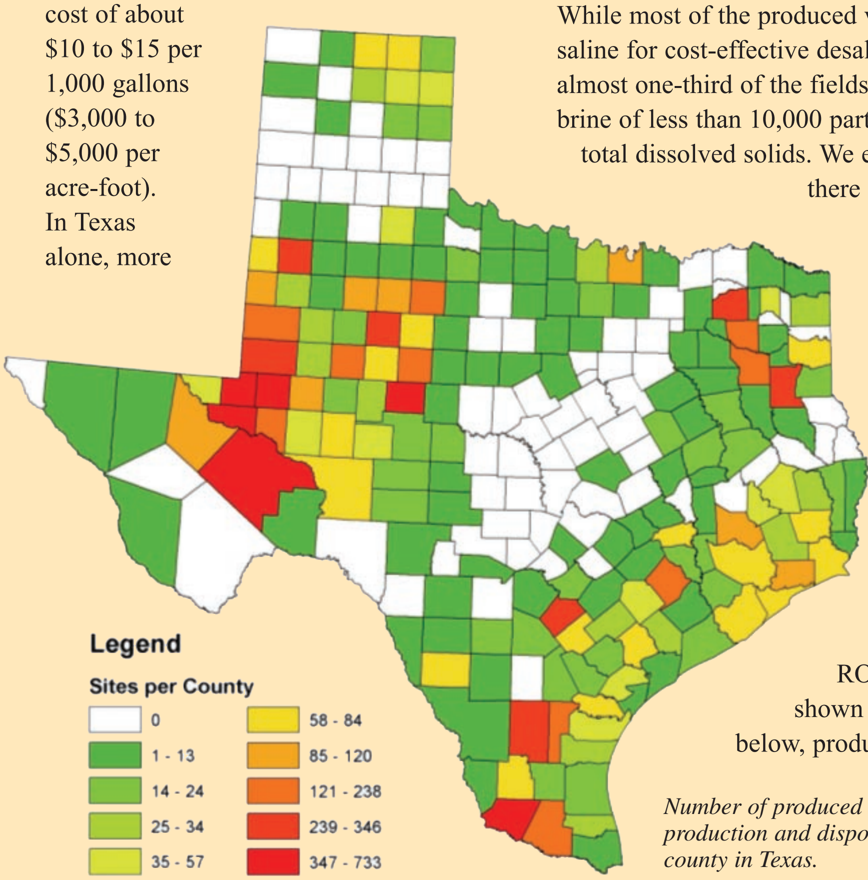
As part of its Water for Texas initiative, the Texas Water Resources Institute at Texas A&M University created a program to study the feasibility of recovering fresh water from wastewater and oil-field produced brines. The goals have been to find new sources of potable water in arid regions of the state and to avoid the loss of potentially valuable water resources by unnecessary byproduct water re-injection into oil and gas reservoirs. Led by the Department of Petroleum Engineering, research now includes activity on three different A&M campuses.

Management and disposal of produced water is a major operating expense because of the volumes involved. Currently, large producers re-inject the brine to enhance production, at a cost of about $10 to $15 per 1,000 gallons ($3,000 to $5,000 per acre-foot). In Texas alone, more than 31,000 oil-field injection wells are used to dispose over 700,000 acre-feet of brine fluids each year. Services that transport brine from the oil or gas lease to commercial disposal facilities charge as much as $50 per 1,000 gallons (about $16,000 per acre-foot) for the service.

Commercial reverse osmosis (RO) desalination technology offers the opportunity to turn some of this produced water into a useful freshwater commodity at less cost than transporting it to disposal sites. And as demand for fresh water continues to climb, the value of the resource becomes greater and greater.

Produced Water as Source Waters

Texas oil and gas production, and hence its water production, occurs primarily in the semi-arid western part of the state. While most of the produced water is too saline for cost-effective desalination, almost one-third of the fields produce brine of less than 10,000 parts per million total dissolved solids. We estimate that there are more than 1,000 sites in West Texas with brines amenable to treatment with RO. As shown in the map below, produced water operations are active in counties across much of Texas and could provide new water sources.



Number of produced water production and disposal sites by county in Texas.

The A&M Technology

The peculiarities of oil field brine, particularly with respect to the mix of heavy metals, dissolved and precipitated petroleum compounds, and dissolved salts, make RO desalination of this byproduct a challenge. The process developed by Texas A&M differs from commercial systems in three main ways.

> *Including pretreatment and waste disposal costs, the total cost of producing fresh water should range from about $4.00 to $8.00 per 1,000 gallons, including disposal costs.*

Pretreatment: Until recently, pretreatment has not been a part of most commercial desalination processes, but the characteristics of oil field brine make it an important step in this application. The pretreatment used to protect RO membranes is based upon techniques used in the oil industry to maintain the injectivity of wells that are used to force water under high pressure into the formation to aid recovery, a process known as water flooding. The injected water must be essentially free of suspended solids and treated to minimize biological activity, and chelating agents must be employed to avoid scaling.

Texas A&M's portable desalination testing unit uses microfiltration membranes to remove substances that might plug the RO membranes. Reject brine is dumped back into petroleum storage where it is either hauled to disposal wells or returned to the formation from which it was produced. As much as 70 percent fresh water can be recovered from brackish brine produced water.

RO Desalination: The desalination train has a dual-stage recirculating process that provides higher fresh water recovery than one-pass systems used elsewhere, producing less waste.

Disposal Practices: The process returns brine concentrate to the formation, avoiding transportation and disposal costs. Unlike commercial disposal facilities, oil field injection wells operate with an exemption that permits disposal of fluids (generally brine) associated with oil and gas production. Attaining this Class II permit requires a relatively simple and inexpensive filing with the Texas Railroad Commission, which oversees oil production in Texas.

The capital cost of drilling a disposal well is approximately $500,000 (for a deep well) with brine disposal costs of approximately $1.00 per 1,000 gallons of concentrate injected (W.A. Baker, Key Energy, Midland, Texas).

Cost of Produced Brine Desalination

Although RO treatment of highly saline produced water may not yet be practical, desalination of brackish produced water can be less expensive than RO desalination of seawater. More expensive pretreatment is offset by reduced disposal costs, since less waste is produced and it can be disposed of onsite. Our trials have found the operating costs of the portable units range from $2.40 to $2.90 per 1,000 gallons of fresh water delivered, based on 7 cents per kwh power cost. Maintenance and capital costs to build and lease the unit add about 10 percent to the cost over the expected three- to five-year use period. Including pretreatment and waste disposal costs, the total cost of producing fresh water should range from about $4.00 to $8.00 per 1,000 gallons, including disposal costs, based on a 10-year lifetime and allowing for maintenance and replacement. This does not include transference costs of water to and from a facility.

Users of Produced Water

Because of the dispersed locations of produced water, the most promising applications for its use are to fulfill local industrial, agricultural (such as livestock watering), and environmental needs. For example, produced water is planned to be used to enhance habitat at the McFaddin Ranch in Goliad County, Texas, by improving wetlands.

Legislation is Encouraging

The Governor of Texas and the Texas Legislature have supported desalination technology as one solution to meet the state's future water needs. A recent initiative provides funding for studies of the feasibility of inland desalination facilities. Since one of the obstacles to inland desalination is the disposal of brine concentrate, researchers are investigating whether disposal into oil and gas operations is a practical option. The Texas Water Development Board found that such disposal practices are technically sound. Texas A&M and the city of Andrews are now planning a pilot desalination project using brackish groundwater with disposal of concentrate into an adjacent water flooding operation operated by ExxonMobil.

Advancing Desalination

Cooperation, collaboration, and consultation will make desalination a more viable solution to meet future water needs of the Southwest. In addition to adopting produced-water management practices, the petroleum industry may provide other cross-cutting technologies

A&M's portable desalination unit at the old McFaddin Mercantile store near the site of the field pilot test.

and means to facilitate advancement of desalination operations, including:

- identifying other geological formations that would allow safe and effective deep-well disposal;
- tracking compositional fronts of brines injected at depth with seismic techniques now used to identify and monitor oil and gas in porous zones;
- investigating the use of offshore high-rate injection well technology for use with deep onshore disposal wells and aquifer storage and recharge;
- disposing of solid waste slurries generated in water treatment operations by slurry injection into friable formations.

It is encouraging to see how the combined efforts by many people and companies over the last ten years have brought desalination of non-resource brines from an idea to reality. The future is even more promising.

For more information, visit www.gpri.org. Contact David Burnett at burnett@spindletop.tamu.edu.