Advances in Seawater Desalination – Implication for Texas

Dhananjay Mishra[1], PhD; Brent Alspach[2]; and Sunil Kommineni[1], PhD, BCEE
1. Malcolm Pirnie Inc., Houston, TX
2. Malcolm Pirnie Inc., San Diego, CA

ABSTRACT

In the last decade, water utilities are considering and evaluating seawater and brackish water desalination to supplement the available water supplies. Momentum for desalination is driven primarily by advances in science and technology, as well as the emerging need for alternative water resources. Approximately ten water utilities from California, Florida, Texas and Hawaii were in the initial stage of studying or developing seawater desalination facilities, following on the heels of the groundbreaking project in Tampa FL.

Interests in seawater desalination have widely expanded. Desalination projects have continued to advance in Florida and Texas, and seawater desalination initiatives are now underway in the coastal states of Massachusetts, Virginia, Georgia, New York, New Hampshire and Rhode Island. Even in the interior southwest, arid and rapidly growing states such as Nevada are exploring the long-term possibility of subsidizing coastal seawater desolation plants in California as a component of water transfer agreement. Moreover, numerous seawater desalination projects in several states have been subsidized by grants from state and federal agencies, whose recognition lend increased legitimacy to these projects and acknowledge and pressing need for desalinated seawater as a water resource.

As a part of the desalination initiative, the Texas Water Development Board (TWDB) has been involved in developing replicable models of brackish groundwater desalination that illustrate the use of innovative, cost-effective technologies and solutions to issues associated with implementing desalination projects. The issues associated with seawater desalination have been expanded in breadth and depth, as well. Some of the significant issues associated with desalination include concentrate management, institutional challenges and cost of treatment/concentrate disposal. While issues such as cost and concentrate disposal continue to present ongoing challenges, the significant increase in the study of seawater desalination over the past several year has both expanded the institutional knowledge of the US water treatment industry relative to this subject and reveled more detailed and specific challenges to address, including Safe Drinking Water Act regulation and compliance, water quality challenges, (e.g. algal toxins and boron), pretreatment nuances, alternative energy sources, intake and discharge alternatives, (i.e. vs. the co-location concept), environmental concerns, distribution, and public vs. private ownership.

Keywords: Desalination, desal, membrane, concentrate management, sea water, salinity, water quality.

DESALINATION OVERVIEW

There are over 13,600 desalination plants in operation around the world, majority of them are located in the desert countries of the Middle East with a total water production capacity of approximately 6.8 billion gallons per day (Duranceau 2001, TWDB 2007). Although seawater desalination has been common practice in some parts of the world, historically it has been considered a feasible option to boost drinking water supply here in the United States. The U.S. Department of Interior, Bureau of Reclamation along with Sandia National Laboratories has created Desalination Roadmap to meet the future water demands in the United States (Sandia National Laboratories 2003). In the United States, large development is happening on the coastal areas of Florida and California (Alspach 2004).

Reverse osmosis and distillation are the two main processes widely used in desalination industry. Although these and other desalination techniques do work and have solved water shortage problems, they are too costly for many countries; distillation, for example, requires a good deal of energy input, and fuel costs can be prohibitively high. However, Seawater Reverse Osmosis (SWRO) was largely considered to be both cost prohibitive and infeasible in the US, the later factors mainly influenced by perceived difficulties associated with the permitting and concentrate management.

Facilities constructed in the past mainly in California have high operating cost. For example City of Santa Barbara CA has operating cost for SWRO is about ~ $1,100/acres feet (AF) as compared to water purchased from Metropolitan Water District of Southern California (MWDSC) that costs ~ $500/AF. The biggest impediment to seawater desalination in the US has been the expense of treatment, in terms of capital cost, operational cost of the energy driven processes. Issues such as concentrate disposal continue to present ongoing challenges. Significant studies have been done at the academia and industry level to address the issues such as water quality, environmental concerns, corrosion control, intake and discharge alternatives, and regulatory issues. Despite the concerns mentioned, high capital and operating cost, sea water desalination has evolved rapidly in the past several years from perception to solution for supplying water in populated coastal areas.

The following section provides overview on the historical impediments to seawater desalination and summarizes most significant issues associated with seawater desalination and the factors that influenced the concept to become an important for the water treatment community here in Texas, and all over the country.

REGULATORY ISSUES

Seawater desalination uses source water for which regulatory framework is not established. The seawater imposes unique challenges as compared to surface or groundwater. Seawater can be affected by several natural and anthropogenic factors which can not be controlled, predicted and/or define by models. Current regulatory considerations account for permitting in terms of number of permits required and the need for the competing objectives of thoroughness and expediency, protecting watersheds, characterizing intakes (such as surface water, ground water etc.), controlling unregulated DBPs, and achieve appropriate levels of pathogen inactivation.

ENVIRONMENTAL CONCERNS

Concentrate management and disposal drives the success of the desalination industry. Raising concern over concentrate disposal has drawn attention from scientific community and water treatment industry. Desalination industry has been increasingly knowledgeable about effective ways to mitigate this issue. The issue of concentrate management is compounded for seawater desalination as compare to brackish water desalination. Concentrate discharge from brackish ground water desalination may consider direct discharge into sanitary sewer or land application, or deep well injection. However similar options may not be available for seawater desalination due to high total dissolved solids (TDS) concentration of reject water.

Typical membrane plant treating 33,000 mg/L TDS with 50% recovery will generate concentrate at 66,000 mg/L. Venting this high level TDS water may have an adverse impact on marine ecosystem, and hence considered infeasible for many applications. Desalination plants often encounter resistance from the issues such as impact on marine organisms in the neighborhood of desalination plant, assisting power generation plant known to use more environmentally damaging technologies, promoting rapid development of coastal areas, and incentive of desalination over environmental conservation.

SITE SELECTION STRATEGIES AND DISCHARGE ALTERNATIVES

Desalination industry in 1990s considered co-locating with the coastal power plants to demonstrate the feasibility and reasonable operational cost. The existing power plant infrastructure was used to draw water form the sea and blend concentrate stream with power plant discharge to dilute the salinity prior to discharging. Over period of time several alternatives including use of blending with coastal wastewater treatment plant discharge, use of beach wells haven been considered for intake and concentrate disposal. Many more options are presently researched and evaluated to gain deeper understanding and advantages of one over other.

WATER QUALITY ISSUES

Primary goal of desalination plants are to remove dissolved and suspended solids to produce potable water. However, seawater desalination have imposed several water quality challenges such as achieving lower boron levels, minimizing algae toxicity and its impact on membrane fouling, emerging DBPs, temperature, and salinity. Advancements are being made to address these concerns.

DESALINATION IN TEXAS

In the 2002 Texas State Water Plan recommended use of desalination as the water management strategy to produce additional water supplies in the state. According to the article on *Desalination in Texas* written by Dr. Hari Krishnan of the Texas Water Development Board, in the Far West Texas Region (E) and Coastal Bend Region (N), desalination of brackish groundwater is used as a strategy, while desalination of coastal waters is recommended in the South Central Texas Region (L). Region B includes desalination in two recommended water management strategies. In addition, four other regions involved in research and development of desalination or conducting feasibility analyses for new desalination projects. Thus, a total of eight out of 16 regions have expressed their interest in desalination related projects.

Despite of challenges posed by seawater desalination, in Texas there are currently several private and public partnerships in desalination projects. In West Texas El Paso Water Utilities and Fort Bliss are collaborating to build the country's largest inland desalination plant for municipal use. The 27.5 million gallons per day (MGD) Eastside Brackish Groundwater Desalination Plant will desalinate brackish water from the Hueco Bolson aquifer and will provide about one-fourth of the city's water requirement. The funding for this proposed venture will partially come from TWDB and USEPA. On the Texas Gulf Coast near Freeport, Dow Chemical is collaborating with Poseidon Resources to build a 25 MGD seawater desalination plant with potential to expend up to 100 MGD, making it potentially the largest seawater desalination plant in the country. The City of Corpus Christi is considering a 5 MGD plant on Mustang Island using brackish groundwater, and may later build a 25-30 MGD plant in conjunction with the Barney Davis Power Station. The Southmost Regional Water Authority in Cameron county has completed a 7.5 MGD desalination plant using brackish groundwater. Brownsville PUB proposes to build a 25 MGD seawater desalination plant and moved towards evaluating technologies and conducing pilot testing as of February 2007.

SUMMARY AND CONCLUSION

Despite of high cost, challenges in meeting water quality goals and concentrate disposal, seawater desalination have rapidly become a popular in growing coastal areas. While these limitations remain major concern for seawater desalination, a significant development on various front have made it much more feasible and cost-competitive with other potential options for rapidly developing new water sources. Innovations and advancements in technology, engineering solutions, co-locations with existing coastal power plant and/or wastewater plant, need for new water resources, and creative financing have made a significant contribution in ever changing landscape of desalination industry.

This paper provides a brief overview of the current issues in seawater desalination relative: water quality, environmental concerns, regulatory issues, and site selection strategies and discharge alternatives. More detailed information relative to each of these areas is provided in the associated presentation given at the 2007 Texas Water

Conference, which is intended to be a companion tool to this paper. The presentation also briefly discusses current issues with respect to pretreatment, energy generation and usage reduction, institutional challenges, and the economics of seawater desalination (including contemporary cost estimates).

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