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Discovering Desalting

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Literature students have long suffered with the Ancient Mariner who mourned:

> Water, water, everywhere
> And all the boards did shrink;
> Water, water, everywhere,
> Nor any drop to drink.*

The sea around the thirsty Mariner, of course, was so salty that the water would have caused bodily discomfort and even harm to him had he tried to drink it.

Many Texans share the frustration of more than enough water, but not enough good quality water. The Mariner's plight is certainly understood by Texans living along the Gulf Coast, or in West Texas areas with brackish ground water, or near salt-polluted rivers such as the Red and Brazos.

Texans may not know much about boards shrinking, but many know about replacing plumbing and fixtures because of salt corrosion or about buying water softeners and extra soap. More than ever they are buying bottled water because their water supply may be hazardous to their health.

Since water treatment technology is available and since many of today's heavy growth areas are located along the Gulf Coast or in dry areas near brackish water sources, desalting appears to be a promising alternative for improving or increasing the state's water supply.

The Texas Department of Water Resources (TDWR), the state agency for planning to meet future water needs in the state, considers desalting as one way to "augment" the state's water resources. A planning document distributed by the TDWR in 1978 explains that desalting "differs from other water development programs in that it offers the

promise of developing an entirely new source of fresh water to meet increasing demands for this resource."

There are now 54 desalting plants in Texas--each producing at least 25,000 gallons per day--with a total capability of producing about 13.2 million gallons of fresh water per day. These figures compare with 481 similarly sized desalting plants in the U.S. with a total of 100.3 million gallons per day capacity. Of the 54 plants in Texas, three-fourths of which have been built since 1970, only 9 serve municipal needs while the rest provide fresh water for industry or power production.

Congress has passed two recent legislative acts which encourage desalting research and demonstration programs. These are the Water Research and Conversion Act of 1977 and the Water Research and Development Act of 1978.

Two other federal laws are creating new interest in desalting techniques: (1) The federal Water Pollution Control Act requires industries to treat wastes--which could mean desalting--before releasing the waste water into waterways. (2) The Safe Drinking Water Act of 1975 requires public water systems to meet maximum contaminant levels. Even though salt is not one of the contaminants given a maximum level, desalting methods in many cases prove to be the most economical way for systems to remove excess fluoride and nitrate in order to comply with the law.

Comparisons

In those cases where there is ample salt water, a city or industry should consider the following comparisons before deciding between a desalting plant and a more conventional method of water supply such as a new reservoir or water transport system.

1. Desalting usually means less capital investment. This is partly because desalting plants are easily expanded, therefore there is less need to build larger plants than present needs demand.

2. Desalting plants require less land area which means fewer right-of-way, surveying, and geological study delays.

3. Desalting also requires fewer water rights problems meaning fewer political and legal delays.

4. Desalting plants take less time to complete which minimizes inflation impact.

5. Desalting plants require more manufactured equipment and less construction labor.

6. Desalting is less subject to rainfall variability, so the yield is more predictable and controllable.

7. Desalting is also less variable in water quality.

The main barriers to desalting plants are economic and brine disposal problems. Desalting plants are expensive both to build and operate. They tend to be energy-intensive which may make them increasingly expensive to operate in the future. Disposal of brine is often an expensive and difficult problem, and improper disposal could permanently damage fresh water sources, land, or coastal regions of Texas.

Economics

There are many ways to produce fresh water from saline sources, but to do so at low cost is extremely difficult. The commercial price of fresh water is generally very low, so to be economically feasible, fresh water obtained from sea water must be produced at a cost that is comparable to the cost of water from alternative sources of supply. Desalting systems will not be widely adopted until treatment of brackish waters is less expensive than the alternate sources of treatment or transportation.

The U.S. Department of the Interior has sponsored research for the past 25 years to develop economically feasible desalting processes. The agency currently responsible for the Interior's desalting program, the Office of Water Research and Technology (OWRT), lists several factors which influence the cost of water produced by desalting plants. These include the size of the plant, cost of energy, methods of waste disposal, and concentration of salt in the water before treatment.

The current price of fresh water produced from sea water, according to OWRT figures, is $3.00 to $4.00 per thousand gallons; and the cost of fresh water from inland brackish sources ranges from $.80 to $1.00 per thousand gallons. As a comparison, the average cost of municipal water in Texas including distribution costs is around $.60 per thousand gallons. Volume industrial users pay much less. Desalting, however, is obviously cost-effective for industries under special circumstances, thus the development of more and more such plants.

Disposal

Disposal of the brine effluent from the desalting process is a major problem encountered in considering desalting as a source of fresh water. Salt must be disposed of in a manner that will not pollute sources of surface or ground water. There are five methods of disposal which can be considered in Texas:

1. Subsurface injection, which is assumed at the present time to be the best way to dispose of wastes from a desalting plant, is actually not a disposal process, but rather storage of the brine in underground reservoirs.

2. Evaporation ponds are allowed if properly lined and diked so that brine is not allowed to seep downward into aquifers or move into surface water courses. Pond size depends on such factors as rainfall and evaporation rate of the area as well as the concentration of the brine.

3. Direct discharge into surface water courses is not recommended, but is considered in some situations. Direct discharge into the Gulf of Mexico is the most economical method of disposal at coastal sites. Adequate data are not available, however, to calculate the effect this discharge would have on the water quality or ecology of the bays and estuaries.

4. Brine from some plants can be reused to recover useful byproducts such as magnesium, iodide, and bromide. In some instances, waste brine can be used by the oil industry for injection water in secondary oil recovery. Relatively dilute wastes from desalting inland brackish water, could be used to create or enlarge recreational or ornamental lakes.

5. Low-salt waste from desalting plants which add no salts or minerals in the desalting process is sometimes mixed with municipal effluent and discharged into the same surface water source from which it came without significantly changing the amount of salt in the water course.

Desalting Studies

The most comprehensive data on the feasibility of desalting in Texas was compiled in three studies between 1965 and 1972. These studies, which were conducted by a nonprofit research firm for the Texas Water Development Board and the Office of Saline Water, do not include reverse osmosis which has now emerged as a reliable and lower energy consumption method of desalting. They should be updated, according to John Carr, Texas Department of Water Resources, to reflect new technological advances such as reverse osmosis and also to consider new concerns on energy availability and costs.

The Texas Water Development Board studies identified Dell City as one of the communities in Texas where desalting was the best alternative for providing water to the community. Ten years and two desalting systems later, the 400 residents of Dell City could not agree more.

Dell City is located in West Texas, about halfway between El Paso and Carlsbad, New Mexico. Although there is an abundant supply of ground water suitable for growing crops, the high level of minerals in the water makes it unsuitable for drinking purposes. The main components of the water are calcium and sulfate with a total dissolved solid range from 2500 to 3000 parts per million.

Prior to the installation of the desalting plant in 1967, Dell City families used bottled water for cooking and drinking and bore extra expenses for soap, water softeners, and excessive plumbing repairs. The Texas Water Development Board studies estimate that residents spent $10 to $15 extra each month just on plumbing and appliance repairs due to corrosion and scaling caused by the poor quality water.

The first plant worked well, but was replaced by a more advanced system in 1976 to meet the community's needs for more water and also to lower operation and maintenance costs.

The new system eliminates the necessity of chemical additives as part of the desalting treatment and is more effective in treating the increasing gypsum content in the water.

Desalting Methods

Dell City residents chose the electrodialysis method of desalting which uses the membrane process to remove salt from water. Other desalting processes presently on the market are distillation, crystallization, and ion exchange.

Distillation--converting the water to steam, then condensing to pure water--is the oldest and still the most common method of desalting worldwide. This method was used on board ships over 2,000 years ago and was certainly known and understood in the Ancient Mariner's day.

Crystallization--freezing water in such a way that ice crystals are formed to separate fresh water from salt--has also been used for centuries. Even though distillation is much higher in energy cost than crystallization, both processes are high in operating costs. Neither is considered for new plants in Texas to any great extent.

The chemical--or ion exchange--method of desalting is used in home water softeners and other small-scale water treatment plants. This method adds chemicals to treat the water and thus aggravates the already difficult problem of waste water disposal. Ion exchange is lower in capital costs than other methods, but operating costs are high if water to be treated is high in salt content.

The membrane process separates fresh water and brine by forcing water or salt through some type of membrane. All desalting plants built in Texas since 1970 use one of two membrane processes: electrodialysis or reverse osmosis. Electrodialysis uses direct electrical current to attract negatively and positively charged ions, then forces them through the membranes to separate salt from the fresh water. Reverse osmosis uses pressure to force the fresh water through a membrane which separates the high quality water from the brine.

Private industries, as well as government programs, recognize the need for more efficient and durable membranes to improve the electrodialysis and reverse osmosis processes, and much research is now underway to develop new membrane technology.

Verdict Not In

In the past ten years, desalting technology has made tremendous strides in bringing costs of equipment, maintenance, and operation of plants closer to economic reality. Reductions in cost of treating salt water have been significant enough that desalting is beginning to merit serious consideration as an alternative source of fresh water.

With large-scale conversion, however, comes large-scale salt disposal problems. Although converting salt water to fresh water does not require a permit in Texas, disposal

of salt or brine, because of its potential harm to the environment, is regulated by state law. Waste disposal methods must be approved by the Texas Department of Water Resources before a desalting system can be operated.

The problem of salt disposal has not been solved as of yet and may keep technologically-sound, and economically-feasible, desalting plants on the drawing boards for years to come.

*From the "Rime of the Ancient Mariner" by Samuel Taylor Coleridge.