American Membrane Technology Association

America's Authority in Membrane Treatment

Management of Desalination Concentrate

To date, the drinking water industry has primarily focused on the use and management of freshwater supplies to meet demands. However, in several regions of the U.S., these supplies have been utilized and managed to their full capacity. Purveyors of potable water have turned to supplies of lesser quality. These include brackish groundwater, brackish surface water, waste water recycle and seawater. Treatment of these waters for potable use requires membrane desalting technologies such as reverse osmosis (RO, nanofiltration (NF) and electrodialysis reversal (EDR).

RO, NF and EDR are used worldwide and across the US and more heavily in the states of California, Florida, and Texas. One hurdle to the growing demand for membrane desalting technologies is the disposal of resulting by-products or concentrate.

Desalination water treatment plants (DWTPs) produce concentrate as they separate salts, minerals, and other dissolved constituents from the water. The separation of these constituents' results in two flow streams: 1) a purified potable stream (permeate), and 2) a stream containing the separated dissolved constituents. The latter by-product stream is typically referred to by regulators as "concentrate" and sometimes inappropriately referred to as "brine"[1]. A mass balance will show that the total dissolved solids in the permeate and concentrate streams equals the total in the feed. No materials are added during the process

Reverse Osmosis and Nanofiltration trains generate permeate and concentrate

A Boardwalk in a created marsh

By-Product Disposal Alternatives

Concentrate is commonly disposed of through one of six practices: 1) waste water treatment plant discharge, 2) surface water discharge, 3) irrigation, 4) deep well injection 5) evaporation ponds, 6) zero liquid discharge thermal processes. Each of these methods varies in complexity of permitting and costs, with waste water discharge commonly being the least complex and least costly and zero liquid discharge being the most complex and most costly.

Waste Water Treatment Discharge is dependent on the ability of the wastewater treatment plant to accept high salinity discharge both in terms of capacity as well as water quality. The biological process may also be impacted by the dissolved solids and salinity in the concentrate. The treatment plant outfall location may be affected by total dissolved solids restrictions or other limiting water quality concerns. A national pollution discharge elimination system (NPDES) permit is required and maintained by the WWTP owner. In some instances, a desalination plant is operated at a lower recovery so that the concentrate will not exceed the acceptable levels of salt for the WWTP.

Surface Water Discharge involves discharge to a point of outfall such as a bay, tidal lake, brackish canal, or ocean. The location and potential required by-product treatment prior to discharge are determined by state and regulatory agency water quality standards and bioassay toxicity testing. An NPDES

Mangroves can assist in removal of dissolved nutrients

permit is required and maintained by the DWTP owner. In a few cases a marsh has been created to take the concentrate at the head of the marsh. Water from the nearby water body is added to the marsh. As the blended water moves through the marsh, the dissolved nutrients are removed and the water quality improved. Such marshes serve a multitude of purposes including a recreational area, a robust ecosystem, nutrient filtration and removal system. Indian River County, Florida created a marsh from an abandoned citrus grove and pumps nanofiltration plant effluent into the head of the marsh. Wildlife has flourished and the quality of the discharge from the marsh is better than the river water that is blended with the concentrate at the front of the marsh.

Irrigation is sometimes used for concentrate streams relatively lower in salinity. Saline tolerant vegetation and habitat are required. This is usually determined by site-specific soil and drainage characteristics. An NPDES permit is required and maintained by the DWTP owner if run-off from irrigation is possible. With the increase of water reuse projects, RO and NF concentrate has been blended with treated waste water for irrigation and even stream augmentation. In one plant, the recovery rate of the NF system is kept lower than optimum to minimize the total level of salts in the concentrate and make it more compatible with the reuse water for distribution. In cases such as this the WWTP owner would hold the NPDES permit.

Irrigation of golf courses

Deep Well Injection is very common, especially with inland DWTPs. This method injects the concentrate deep below ground under at least one overlaying, confining geologic layer. Concentrate is confined in the injection zone. The ability to use an injection well does depend on local geology and can be an expensive alternative. The disposal wells must be double-walled, Monitoring wells are required and a redundant well is needed. Several states don't permit deep well injection.

Injection wells can be used for disposal of concentrate

Evaporation Ponds may be used to reduce or eliminate by-product flows. This method of disposal is land-intensive and requires relatively dry climates with high net evaporation rates. Solid salt mixtures are the waste product which must be characterized and disposed of accordingly as solid waste.

Zero Liquid Discharge Thermal Processes greatly reduce or eliminate the by-product liquid stream through several unit operations including evaporation, crystallization and drying. These processes are energy intensive and are very costly. Solid wastes must be characterized and disposed of accordingly.

Another promising option for use of concentrate is being investigated in El Paso Texas. The concentrate from the Kay Bailey Hutchinson Brackish water treatment plant is being piped to an adjacent facility where the minerals are recovered for additional use. Hydrochloric acid, caustic soda, magnesium sulfate and other compounds are being produced from these minerals. The recovered water is piped back to the RO plant to augment their supply and production.

Is Desalting By-Product from Drinking Water Production An Industrial Waste?

The answer to this question involves the synergy between the applications for membrane desalting and federal and state agencies responsible for developing laws and issuing National

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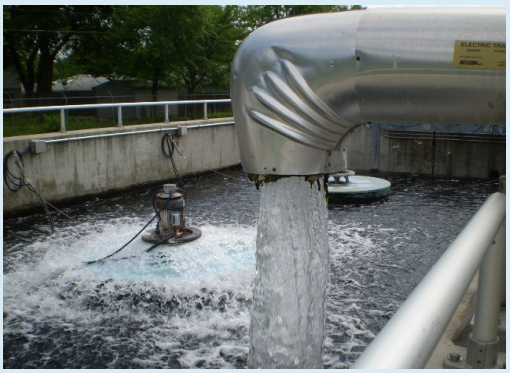

Discharge of concentrate to a mixing tank

Pollution Discharge Elimination System (NPDES) permits.

At present, the Clean Water Act does not specifically address DWTP by-products. As a result, DWTP by-products are addressed through a default classification: industrial waste. This results in a stringent and cumbersome set of regulations applied to an often-benign by-product primarily composed of constituents from a natural water body, albeit in a form that is more concentrated. Furthermore, the term "industrial waste" is alarming to the public. Often, purveyors of potable water are required to spend excessive amounts of finance and efforts educating the public about the benign nature of this by-product. This expense transfers into higher water costs for the treatment process.

The absence of science-based regulations to address DWTP by-products has resulted in an uncertain regulatory environment. The latitude available to regulatory agencies when addressing the default classification of "industrial waste" greatly limits the ability to predict the outcome of any permitting effort and further limits the ability to accurately forecast costs, suitability, environmental compatibility, and other key planning level tasks. Of particular concern are the use of surface water discharge and the issuance of an NPDES permit. Because desalting by-product is inadequately addressed in NPDES law, surface water discharge is often the most problematic yet most applicable method of discharge for larger DWTPs, which are necessary to meet water deficits.

At present, state regulatory agencies have no choice but to address DWTP by-products through industrial waste regulations. These agencies would benefit from more specific regulatory guidance regarding desalting by-product.

Surface water discharge is sometimes an option

Florida Case Study

The State of Florida recently passed legislation to streamline the permitting process for desalting by-product waters. Though incapable of amending the

Clean Water Act to reclassify the by-product out of the industrial waste program, the state was able to change the name and create permitting forms that are better suited for by-product applications.

Florida now refers to "RO concentrate" as a "potable water treatment by-product," which is still regulated under the industrial program as required by the Clean Water Act. However, the law's objective is to improve the economics of permitting desalting by-product discharge to surface waters by improving public perception and creating permit applications and permits that are best suited for this type of by-product. Nevertheless, a strong case can and should be made to amend the Clean Water Act to provide for a new, separate classification for DWTP streams and how to deal with them.

AMTA is actively involved in the legislation front and has made the change in regulations of concentrate disposal a top priority for the organization. If you are interested in this topic and want to help AMTA, please contact us.

This material has been prepared as an educational tool by the American Membrane Technology Association (AMTA). It is designed for dissemination to the public to further the understanding of the contribution that membrane water treatment technologies can make toward improving the quality of water supplies in the US and throughout the world.

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[1] Brine is water with twice the concentration of dissolved solids as seawater. Most desalting by-products do not fit this definition. The word "brine" carries a negative connotation since it is also used to refer to some wastes from the petroleum industry.