BRINE WASTE

Issues, Disposal, and Reduction

Heal the Ocean 2017

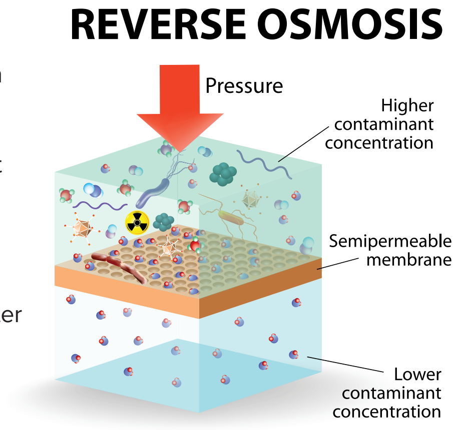
Introduction

In 2016, in response to California's extreme drought conditions, California Senator Robert Hertzberg (D-San Fernando Valley) introduced Senate Bill 163, "Renewable Water Portfolio Supply," which declared that discharging treated wastewater into the ocean is an unreasonable use of water in the state of California. The bill proposed a requirement that wastewater treatment plants (WWTPs) reuse 50% of treated wastewater by 2026, and 100% by 2036 – in other words, Zero Liquid Discharge (ZLD). The State should move toward ZLD in the long-term, and disposal of brine waste represents a significant obstacle to overcome. California should immediately dedicate more research on the issue.

SB 163 has been dropped, most likely because of the difficulty of brine disposal. This paper lays out the issues.

What is Brine Waste?

Brine waste is a byproduct of the advanced water recycling process, primarily from Reverse Osmosis (RO), in which water is forced through a semi-permeable barrier. The small pores in the RO barrier are designed to filter out molecules to let only the tiniest water molecules through. A helpful analogy is a screen door that filters out salts, viruses and bacteria the size of sand, rocks, and boulders, while allowing water molecules through the screen. The RO process results in two end-products: clean water ready to be treated by UV light and other technologies, and a liquid waste product known as brine waste (or as it is called in water recycling vernacular, "Concentrate").



©Designua/Shutterstock

The RO-filtered waste includes contaminants such as viruses and bacteria, trace pharmaceuticals and other Chemicals of Emerging Concern (CECs). However, the primary constituent of brine waste is salt. In seawater desalination, the salt in brine comes from the naturally occurring salt in ocean water. In recycled water, this high salinity comes from a variety of sources, the primary source being chloride or potassium used in water softener systems such as those installed in private homes or commercial buildings. These water softener systems utilize salts to neutralize the minerals typically associated with "hard" water, which can cause glassware to get foggy and pipes to build up deposits. Hard water can produce negative effects for appliances that use water in their function.

Due to the nature and concentration of the filtered contaminants and salts, the disposal of brine waste presents environmental problems that require advanced (and still emerging) technology.

©Quintanilla/Shutterstock

Salts and CECs

A major concern for wastewater treatment plant (WWTP) operators in meeting National Pollution Discharge Elimination System (NPDES) permit requirements is the amount of total dissolved solids (TDS) in the waste stream and in treated water. These dissolved solids are composed of the salts from water softeners and other microcompounds. Unless the highest level of recycling is employed, some constituents can pass through the treatment process. Tertiary treated water is recycled water that is specifically designated for landscape application due to its lower treatment standard than is used to produce recycled water for indirect potable reuse (groundwater recharge). Tertiary treated recycled water, colloquially known as "purple pipe" water,

Continued on page 2

Zero Discharge: Turning Something Into Nothing?

As impetus builds to increase recycled water usage throughout California, the concept of zero discharge to the ocean of treated wastewater or its byproducts has been frequently discussed.

Zero liquid discharge is a high ideal, in that it calls for producing more water reuse as well as protecting the environment. It is theoretically attainable, but cannot be achieved unless technology and scientific knowledge are accelerated. Today, brine waste either needs dilution or disposal in a toxic landfill. To achieve Zero discharge statewide, more research and attention to the issue is needed.

The best path forward may not be a mandate to reduce all discharges to Zero, but an acceleration of research, and in the meantime a tailored approach to ensure that each WWTP across the state is recycling water to a maximum potential while disposing of brine waste in an environmentally responsible manner.

How is Brine Treated and Disposed?

Brine waste disposal is dependent on the location of wastewater treatment plants, the available resources for brine transportation, and financial considerations. Disposal methods range from discharging the brine into the ocean through a "brine line" that goes out with the normal wastewater stream, to evaporation in ponds or other dewatering technologies that produce a brine salt to be disposed of in a hazardous waste landfill.

Research is limited on the reduction or elimination of CECs (Chemicals of Emerging Concern) and other contaminants in brine waste. Treatment is confined to existing methods already used in recycling water – including chlorination, ozonation, and UV radiation and other advanced technologies.

To make brine disposal more feasible, some WWTP (wastewater treatment plant) managers use brine minimization methods that range from the use of natural sources such as the sun (evaporation) to employing complex high-tech systems to draw out salts and remove more liquid from the waste stream.

Extraction of all liquid from brine waste produces a powder for disposal, which results in Zero Liquid Discharge (ZLD), which would seem to be the most environmentally friendly method of brine waste reduction. However, the energy requirements of ZLD present environmental problems of a different kind, including transportation and land disposal. Toxic landfills eventually have to be cleaned up, and all users pay their pro-rated percentage of the cleanup. The ZLD distillate must go somewhere – which means the brine waste in dry form still goes into the environment. All of these factors present formidable obstacles to Zero discharge.

DISPOSAL OPTION	DESCRIPTION OF TECHNOLOGY	BENEFITS AND CONSTRAINTS	REGION APPROPRIATENESS	LAND REQUIREMENTS
Surface Water Discharge	Direct disposal to surface water such as lakes, reservoirs, or rivers.	Low capital and O&M costs. Detailed analysis required to obtain NPDES permit.	Anywhere surface water body is available.	Small
Sewer Discharge	Direct disposal to sanitary sewer system.	Cost-effective if existing sewers and wastewater treatment plants nearby. Permitting process requires less time than NPDES. Fee typically required for disposal.	Anywhere sewer capacity is available.	Small
Deep Well Injection	Brine injected into porous subsurface rock formation.	Economy of scale required. Meticulous site evaluation needed. High capital costs.	Dependent on local geology.	Land required for injection for wellfield.
Evaporation Ponds	Pond that utilizes solar energy to reduce water content in brine solution.	Very reliable, little mechanical equipment required, economical for small volumes.	Dry climates characterized by high evaporation rates; Areas where large quantities of land available at low cost.	Large
Land Application	Full strength or dilute brine sprayed onto land as irrigation water.	Backup disposal method typically needed. Limited types of vegetation can grow with high salinity water.	Anywhere application exists.	Large

Adapted from Brandhuber et. al, 2008

Continued from page 1

can contain high TDS levels that can burn grass, such as on golf courses, as well as other sensitive vegetation. A high TDS level poses the risk of violating compliance with Title 22 of the California Code of Regulations, which sets thresholds on certain water quality criteria, such as salinity levels for purple pipe water. Treating elevated salinity raises the cost of recycled water treatment.

In addition to salts, the CECs (Chemicals/Constituents of Emerging Concern) in wastewater must be neutralized so that the discharge of wastewater into the environment does not pose a threat to nature and humans. CECs include pesticides from agriculture as well as pharmaceuticals, steroids, and chemical additives in personal care and household products. There are currently no regulations for CEC concentrations in brine waste, and it is up to individual WWTP managers to come up with their own treatment method to achieve high environmental goals while operating in a financially feasible manner.

Reducing Brine Waste at Home

A few simple changes in the household can significantly reduce the salinity of wastewater:

1. Water Softeners

If you do not own a water softener, consider not buying one in the future. Using vinegar in appliances will greatly decrease mineral buildup caused by hard water. However, if you do own a water softener, you can lessen its environmental impact by:

- Switching to a water softener that is not salt-based. The Los Angeles County Sanitary District has created a Salt Free Water Conditioning Alternatives Tool, which allows users to search through alternatives to conventional water softener systems by price, company, technology, and user rating (LACSD, 2016).* This tool is available online at: http://www.lacsd.org/wastewater/automatic_water_softeners/alternatives.asp
- Setting your water softener to the correct hardness level (most are initially programmed to the highest setting). This can save you money and also help reduce the salinity of wastewater. To cite an example, Santa Barbara has some of the hardest water in the country. The City of Santa Barbara's municipal water supply has a hardness level of 20 to 25 grains per gallon (one grain per gallon equals 17.1 milligrams per liter). Water hardness above 10.5 grains per gallon is considered "very hard" according to the US Department of Interior and Water Quality Association.
- Changing from a timer-based to a demand-based softener (one that recharges only when needed).
- Reducing your water use. The less water you use, the less salt you put down the drain.

2. Household Cleaners

Use liquid dishwasher and laundry detergents, which contain less salt than powdered versions. There are environmentally friendly cleaning products available that contain no phosphates, chlorine, sodium, chemicals, artificial fragrances, or artificial colors. Dryer sheets are friendlier than liquid fabric softeners. Overall, minimizing your use of cleaning products goes a long way to solving the problem.

About Water Softeners

The largest source of salinity in municipal wastewater comes from salt-based water softeners. In 2008, then-Assemblyman Mike Feuer (D-Los Angeles) authored **AB 1366**, which was passed in California, allowing local cities and agencies to ban self-regenerating salt-based water softeners (water softeners that automatically flush salt contents down the drain). The enactment of a ban requires a finding by the Regional Water Quality Control Board that such a ban will "contribute to the achievement of water quality objectives," and requires a municipality to have a salt and nutrient management plan for a groundwater basin. Also, the receiving wastewater plant must show that salt reduction is needed to meet its permit requirements. The ordinance can require plumbing permits, plumbing to hot water only, as well as a voluntary buy-back program.

There are several water softener systems not subject to the ban, including those that use activated carbon adsorption and filtration – or those contracted with a service that flushes the tank offsite.

Ban or no ban, homeowners interested in reducing impacts on brine waste should consider systems that do not use salt.

RECOMMENDATIONS:

- **Switch to a non salt-based water softener**
- **Set your water softener to the correct hardness level**
- **Change from a timer-based to demand-based softener**
- **Use liquid dishwasher and laundry detergents**
- **Read labels to reduce CEC input**
- **Use less water**

Reducing CECs in Brine Waste

Reducing your contribution of CECs to the waste stream is as easy as not flushing pharmaceuticals down the drain. It is also as easy as reading labels.

Avoid the following:

- Parabens*
- Phenoxy-oxynols, or phenols*
- Phthalatates*
- Salicilyic Acid, Benzoyl Peroxide, & Tretinoin
- Sodium lauryl sulfate (SLS)*
- Sunscreen chemicals: Benzophenone, oxybenzone, Ethyl p-amino-benzoic acid
- Triclosan*
- Zinc pyrithione
- Benzalkonium chloride
- Bisphenol A (bisA, BPA)*
- Butylated hydroxyanisole (BHA)*
- Coal Tar, Resorcinol, aminophenols, F D & C Colors, Hydroquinone
- Diethanol-, diethyl-, or dimethyl-amine (DEA, DEN, DMA)
- Flame retardants
- Formaldehyde
- Lead acetate
- N,N-diethyl-m-toluamide
- Nanoparticles

** Endocrine Disruptor*

© Sherry Yates Young/Shutterstock

Photo by Marie Morrisroe

Conclusion

Wastewater treatment has made giant technological leaps in the last 20 years. It wasn't so long ago that wastewater recycling was considered technologically difficult and financially infeasible, whereas today, recycled water is a fact of life not only in the state of California, but around the world. These steps have been made out of a global realization, acutely felt during California's drought, that all water is precious and finite, that it should not be wasted, and that used water should be reclaimed. In this regard, Zero Liquid Discharge is an important ideal worth striving for in wastewater management. To get there, it is important that California devote sufficient financial resources and scientific inquiry to advancing technologies for it. Zero Liquid Discharge means waste, treated or otherwise, would no longer be discharged into the ocean or our waterways, and it would be the hallmark of pristine wastewater treatment.

Much work needs to be done.

BRINE WASTE
Issues, Disposal, and Reduction
Heal the Ocean 2017

AUTHORS
Alex Bennett, *Policy Analyst*
Corey Radis, *Operations Coordinator*
Heal the Ocean

EDITOR
Hillary Hauser, *Executive Director*
Heal the Ocean

Heal the Ocean
1430 Chapala Street
Santa Barbara, CA 93101
www.healtheocean.org
805-965-7570
Info@Healtheocean.org

Design: Debbie Bellman
Printing: Graphic Traffic

IMAGE SOURCES

Reverse Osmosis Schematic (page 1):
Photo from Designua/Shutterstock, 2017

Brine Waste (page 1):
Photo from Quintanilla/Shutterstock

Disposal Methods Graphic (page 2):
Brandhuber et. al, *A Look at Conventional and Emerging Brine Disposal and Waste Minimization Technologies*

CECs (page 3):
Photo from Sherry Yates Young/Shutterstock

RESOURCES

Brandhuber, P., Cerone, J., Kwan, P., Moore, E., & Viera, A. (2008). A Look at Conventional and Emerging Brine Disposal and Waste Minimization Technologies. *HDR Waterscapes*, 19(2), 7-10.

Mickley, M. (2006) Membrane Concentrate and Disposal: Practices and Regulation. *Reclamation: Managing Water in the West*. US Bureau of Reclamation.

Mickley, M. (2009) Treatment of Concentrate. *Reclamation: Managing Water in the West*. US Bureau of Reclamation

Pérez-González, A., Urtiaga, A. M., Ibáñez, R., & Ortiz, I. (2012). State of the art and review on the treatment technologies of water reverse osmosis concentrates. *Water research*, 46(2), 267-283.

Roberts, D., Johnston, E., Knott, N. (2010) Impacts of Desalination Plant Discharges onthe Marine Environment: A Critical Review of Published Studies. *Water Research* 44(1) 5117-5128

US Department of Interior, Bureau of Reclamation. 2009. Southern California Regional Brine Management Study. *Reclamation*, 47-92.

FOR MORE INFORMATION

For more information on CECs in Household Products:
Heal the Ocean's 2010 *Pocket Guide for Chemicals of Emerging Concern*

For more information on Water Softener Alternatives:
https://saltlesswater.com/water-softener-alternatives/

City of Farmington's *Don't Pass the Salt!* Pamphlet:
http://fmtn.org/DocumentCenter/View/1190

Los Angeles County Sanitary District *Salt Free Water Conditioning Alternatives* Tool: http://www.lacsd.org/wastewater/automatic_water_softeners/alternatives.asp

Printed on 100% recycled post consumer paper