How to Manage Brine Disposal & Treatment

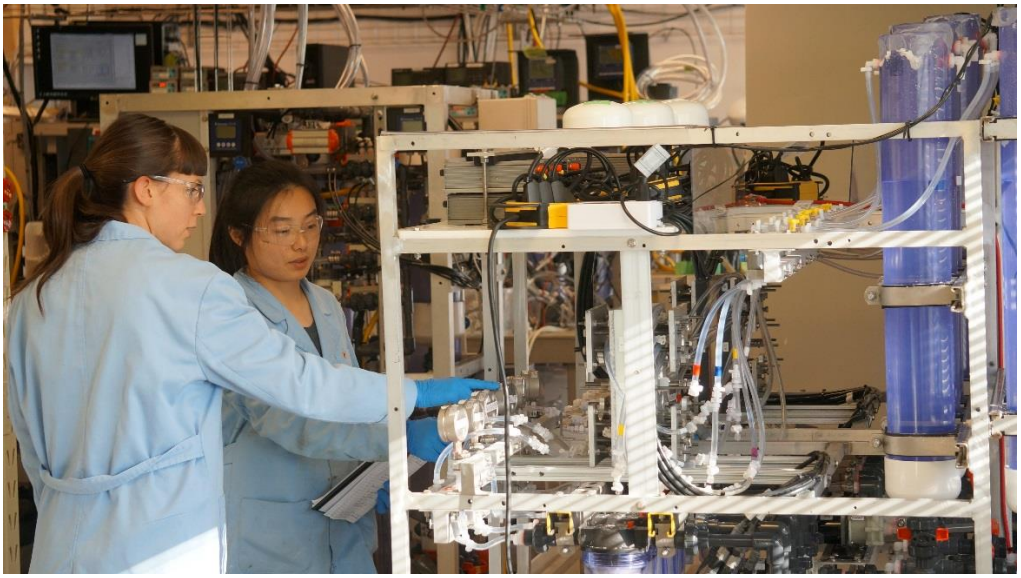
The many options for managing brine, a term for saline wastewater from industrial processes, fall under two categories: brine treatment and brine disposal. Brine treatment involves desalinating the brine for reuse and producing a concentrated brine (lower liquid waste volume), or residual solids (zero liquid discharge).

Brine disposal includes discharging brine to sewers, surface water, injection wells, or sending it to environmental service providers.

The cost and environmental impact of each option varies significantly based on many factors. Choosing management options for the waste brine requires careful consideration of applicable discharge regulations, availability of disposal methods, and the economic feasibility to treat the brine.

Understanding Your Brine Water Chemistry

Before deciding on how to manage waste brine, you should consider completing a water chemistry analysis to understand essential indicators, such as the salinity level (e.g., total dissolved solids), metals contaminants, and the scaling potential of the water (e.g., calcium and sulfate). This will assist in evaluating regulatory requirements as well as determining available options and their associated costs.



Water chemistry data provides the most value if you end up deciding to treat your brine. The chemical makeup of the water identifies the technologies that will best fit a specific brine treatment process, for example, whether you should choose thermal or membrane systems. This data enables early assessments of project feasibility and economics, as well as any pre-treatment requirements or scaling and fouling risks.

Another advantage of brine chemical characterization is that it allows you to identify opportunities for beneficial resource recovery. For example, it is possible to recover 'fertilizer water' from a waste brine. If a brine contains a mixture of sodium and hardness, electrodialysis reversal (EDR) with certain monovalent ion selective membranes could produce a water high in plant-nourishing hardness with low concentrations of the pollutant sodium. This water would have a low soil adsorption ratio (SAR) that would be valuable to the agricultural industry. Alternatively, if a brine consists mostly of sodium and chloride, it can be treated with a crystallizer to produce solids that can be used as road de-icing salts. Consider working with experts who can help you determine the most economic options for managing your brine.

Brine Treatment

Brine treatment is usually considered if discharge options are not available, brine disposal is expensive, or freshwater recovery is important. There are many technology options to concentrate brine, reduce its volume and disposal costs, or to produce solids for zero liquid discharge. Regardless of the treatment strategy you choose, it will beneficially produce freshwater.

Membrane Treatment Systems

Reverse osmosis (RO) is the membrane system most widely used to desalt brine waters. RO produces freshwater and more concentrated brine often referred to as RO brine, reject or concentrate. This brine concentrate will usually reach concentrations of dissolved salts and chemicals that will be near scaling limits. This requires treatment to relieve the scaling potential if you will use a thermal system to further concentrate the brine or to produce solids. Alternatively, you could consider

thermal systems that can operate under scaling conditions, such as seeded slurry evaporators or a SaltMaker, to eliminate the thermal pre-treatment step.

If your brine contains hydrocarbons or organics, electrodialysis reversal (EDR) may be a better fit than RO due to its lower pre-treatment requirements. EDR is a low-pressure system that fluxes salts through ion exchange membranes using an applied electrical charge. There are EDR systems that use anti-fouling ion exchange membranes, such as Saltworks' Flex EDR Organix, that can operate with hydrocarbons and organics present in the brine.

Thermal Treatment Systems

If you are considering thermal evaporative systems, maximizing freshwater recovery from lower cost membrane systems before using expensive thermal systems will deliver the best project economics. In general, there are two types of thermal systems based on their residual outputs: (1) evaporators that produce concentrated, low volume brine but do not precipitate solids; and (2) crystallizers that exceed salt saturation and produce solids. For high flow rate zero liquid discharge applications, evaporators are used to preconcentrate the brine prior to the crystallizer for final solids production. At lower flows, the waste brine can be sent directly to the crystallizer after treating with a membrane system.

The final disposal of residuals is important in determining whether additional process steps are required. If you have options for disposing of concentrated brine, it will usually not require further treatment. Evaporators are only reducing the volume of brine for final disposal, ensuring you need fewer trucks to move the brine or less capacity in disposal wells or ponds. However, depending on the treatment technology you use, additional treatment may be required for solid residuals before a landfill will accept them for disposal. Almost all landfills require solids to pass a paint filter test, while some also require analysis of pH and leachable metals. To pass a paint filter test, the solids should be dewatered until they have no free water present. Centrifuges, filter presses, and/or dryers are required to further process solids produced by conventional crystallizers to pass the paint filter test. Other crystallizers, such as the SaltMaker, have their own solids management systems that produce dewatered solids in sacks without the need for centrifuges, filter presses, or dryers.

Treatment costs increase the further you concentrate brine towards solids, which is why it is important to carefully consider all disposal and reuse options before implementing a technological solution.

Brine Disposal

Discharging Brine into Surface Bodies of Water or Sewer Systems

If your brine meets regulatory requirements, brine discharge into the nearest body of water or to sanitary sewers is usually the lowest cost option for disposal. Discharge regulations or guidelines vary widely from region to region, or are sometimes determined on a project-specific basis.

Regulations may prohibit discharge based on any of the following:

- Concentrations of certain constituents of concern (e.g., maximum limits for metals, salinity, or compounds)
- Total mass per day of certain constituents of concern
- Specific properties, such as temperature and pH
- Volumetric flow rates
- Discharges only during certain time of day

One option to comply with regulatory discharge requirements may be to dilute the brine stream with other waters requiring discharge. With sufficient dilution, this may reduce the controlled constituents to below the allowable concentration limits. If the brine stream has only one or two constituents of concern that exceed the discharge limits, you should consider selective treatment or removal of those constituents. There are low cost solutions available for removing certain constituents, such as using green sand for iron removal.

While discharging brine directly into surface water systems or sewers is often the most cost-effective solution, your organization should consider how it will impact the local environment. If regulations do not exist, studying the potential impacts of discharging the brine on local flora and fauna will help identify the benefits of treatment to protect the ecosystem or prepare for impending regulations.

Brine Disposal in the Ocean

Like discharging brine into surface bodies of water, ocean discharge is another brine disposal method that tends to be very cost effective. In southern California, there is a 'Brine Line' that allows inland plants to discharge their brine to the ocean rather than to sewer or surface waters. Due to the ocean's naturally high salinity, there are lower environmental risks of brine discharge. If you are considering installing a brine discharge line, you will need to acquire a permit. As part of the permit application, the regulatory body may ask for

environmental studies that address the impact on local marine ecology of the brine temperature, pH, salt density, and other property differences between the brine and seawater.

Deep Well Injection of Waste Brine

Waste brine can be disposed by injecting it into deep wells. These injection wells are installed thousands of feet deep into the ground, away from the upper aquifers that feed drinking water sources. The availability of injection wells is geology-dependent, so they are not available in all regions. In the oil and gas industry, abandoned oil wells are often converted into disposal wells. Recently, there have been studies that correlate deep disposal wells with increased seismic activity, as evidenced by earthquakes in Oklahoma. Deep well capacities have also reduced as regulations are requiring lower injection pressures to minimize the risk of contaminating the upper water aquifers. Moreover, securing a functioning deep well is similar to drilling for oil – you take a risk and invest capital before knowing if the underground geology will meet your expectations. It is possible that deep wells once drilled will accept very small volumes, or exceed expectations and accept more.

Brine Evaporation Ponds

Evaporation ponds are the artificial solution to inland surface water discharge of waste brine. Under the right climatic conditions, the water evaporates, allowing you to discharge more brine to the ponds. One limitation of ponds is that they require large areas of land to increase the surface area where the water can evaporate, and can represent a future environmental liability due to either animal entry or future decommissioning. If you need to recover solids for disposal or reuse, then multiple evaporation ponds may be necessary to rotate between brine evaporation and solids extraction. Evaporation also happens more quickly in warmer, arid climates. You should consider installing proper liners, preventing waterfowl poisoning from brine that contains metals, and develop an end of life closure plan if your project will be using evaporation ponds.

Brine Incineration

Waste brine can be sent to an incinerator facility, where it is typically mixed with other solid wastes for processing. Incineration evaporates the water, while the salts in the brine become part of the residual ash that requires further management. Incineration is popular in countries with limited availability of land for landfills.

Brine Management from Environmental Service Providers

There are companies that provide environmental services to accept waste brine. These companies will typically take ownership of the brine and charge on a dollars-per-gallon basis. This is an option you should consider if there are facilities nearby, although distance and transportation costs may reduce its cost effectiveness. Once the service provider takes ownership, they will use their own assets to either treat the brine or dispose of it.

Considering Your Brine Management Options? We can help.

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