A Fundamental Guide to

BRINE WASTE TREATMENT SYSTEMS

A PUBLICATION OF SAMCO TECHNOLOGIES

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Chapter One

WHAT IS BRINE WASTE, AND HOW CAN IT BE TREATED FOR REUSE OR DISPOSAL?

BRINE WASTE

What it is and how it's often treated either for reuse or disposal

If you're new to handling brine waste and are looking for more information about properly treating it for recycling or discharging, you might be wondering **"what is brine waste, and how can it be treated or disposed of?"**
This chapter provides a general overview of **what brine waste is, how it occurs or is made, and how it should be treated prior to use in production and/or discharge** so you can better understand the proper way to handle these often-problematic streams.

What is brine waste?

In general, "brine" is any solution with an extremely high concentration of salts such as sodium chloride, which can occur either naturally (as with seawater, deep-water ocean pools, salt lakes, etc.) or as a byproduct of industry. These **byproducts, or "brine waste" streams**, are typically highly concentrated salt solutions that, in some cases, contain more than twice the amount of concentrated salts than natural brine solutions. Brine waste can also carry various contaminants, which differ depending on which process the brine waste is a byproduct of.

Brine waste streams **can be some of the most** challenging to treat or discharge because their composition and purification requirements can be rather dynamic and complex.

Some **examples of brine waste created as a byproduct of industry** include:

- cooling tower and boiler effluent
- reverse osmosis (RO) and ion exchange waste/reject streams
- produced water from extracting oil and natural gas
- chlor-alkali and chemical plant waste
- acid rock and mine drainage
- food preservation and manufacturing waste streams
- desalination waste from potable water creation
- irrigation runoff

Brine waste is typically **either recycled for use in the facility's process or treated for disposal**. For example, solutions with a high concentration of salt are known to reduce thermal conductivity, so brine waste is often recycled and reused as a cooling agent for steel heat exchangers in many power plants. This type of brine is often **treated to remove dissolved oxygen** and other harmful contaminants since **brine waste can be highly corrosive to plant machinery and piping if untreated**, and the presence of dissolved oxygen and other contaminants can increase that risk.

Varying salt concentrations in the brine stream will also determine how the temperature, pressure, and other threshold limitations will need to be adjusted during production, so facilities that use brine as

part of their process often run frequent tests to ensure the relevant purification requirements are consistently met. It's an arduous process that often requires round-the-clock monitoring. For this reason, **it's extremely important to have your water treatment specialist evaluate** what the brine is being used for in addition to where and how it is being recycled and/or discharged to ensure its composition remains appropriate for the process or disposal at hand.

How do you treat brine waste?

Below, we break down a general overview of the various brine waste treatment and disposal options available and what they mean for your facility:

Recycling brine waste for reuse

As mentioned earlier in the chapter, **many industrial processes require** brine in part of their process, such as hydrometallurgy, sodium hypochlorite, lithium carbonate, and chlor-alkali manufacturing plants, to name a few. Some facilities even use leftover brine for irrigation or deicing.

Regardless what your facility is using the recycled brine waste for, keep in mind that brine leftover from production often **accumulates contaminants along the way**, such as:

- silica
- heavy metals
- hardness
- organic compounds
- sulfates, nitrates, and phosphates
- suspended solids

The brine waste can be pretreated with **coagulants, polymers, additives, and pH adjustment** to settle out many of the larger contaminants, including metals, sulfates, and other **suspended solids that can foul membranes** and cells down the production line. Other contaminants, such as **calcium, can scale equipment**, so depending on the manufacturing process and brine requirements, there are several membrane and ion exchange technologies that can prevent these issues and produce a useful brine stream adequate for your process.

For example, if a chlor-alkali plant is looking to reuse brine waste that is contaminated with metals like iron, vanadium, or manganese, they will often have trouble with the fouling of downstream equipment, which can often lead to unscheduled plant downtime and other delays. The brine stream might be treated with specialty **chelating resins that target specific metals for removal without being exhausted by sodium**, thereby removing the unwanted contaminants while preserving the salt concentration in the brine solution.

When it comes to facilities that produce lithium carbonate or lithium hydroxide, specialty ion exchange resins can be used to **remove unwanted metals and other contaminants,** and the brine stream can

then be further **treated with high-pressure membranes that can** separate out and concentrate the lithium carbonate and lithium hydroxide**,** so the technologies and methods of purification and/or separation vary greatly depending on the quality of the brine waste and the brine composition required for production.

Treating brine waste for discharge

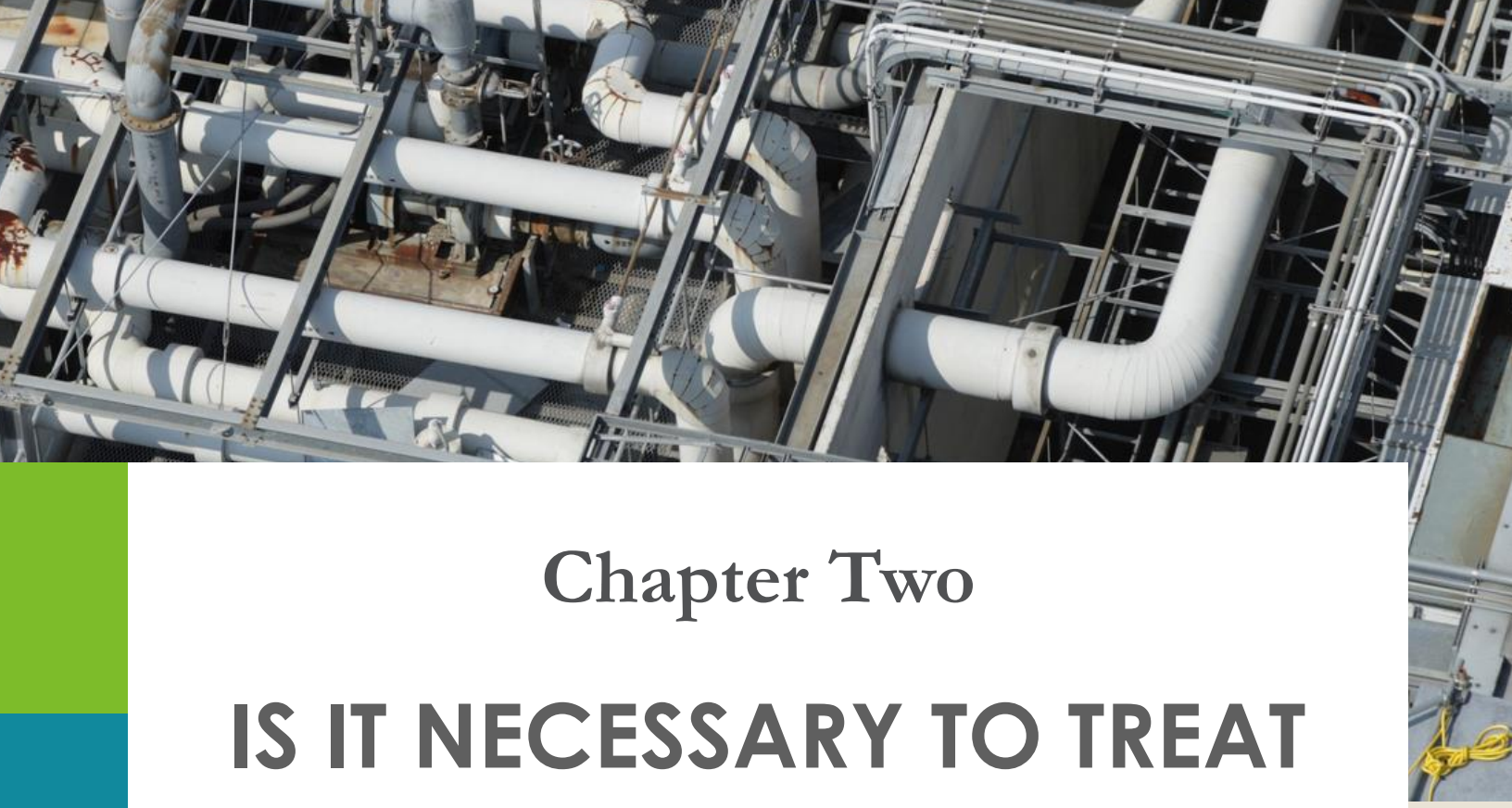
Most brines are technically considered nontoxic, but **industrial brine waste released in heavy concentrations to the environment or to local publicly owned treatment works (POTW) can cause an assortment of issues** if untreated. For example, if the waste contains more than just sodium, it can possibly harm aquatic life in local waterways. In some cases, simply diluting the brine waste prior to discharging might be a practical solution. It can also be against discharge regulations, which can cause your facility to pay a heavy fine.

Most discharge regulations will **require a reduction in the amount of sodium, total suspended solids, and contaminants** in general, which can often be treated with membrane technology such as ultrafiltration followed by reverse osmosis. Because of the high concentration of salt in brine, pretreatment is often used to help protect downstream filtration units and equipment.

Another option for treating brine waste is evaporation. This can be done in **an outdoor evaporation pond or with a technique called vacuum evaporation**. By evaporating the effluent under vacuum, the boiling point is reduced (thereby saving energy) and what's left is a

crystalized mass of salt and, separately, a purified water stream. This method can be useful for drying brine filtrates thoroughly, and it can be implemented in tandem with other treatments to boost effectiveness.

Whichever method your facility uses to treat its brine waste for discharge, **make sure it is done so in compliance with the facility's POTW or National Pollutant Discharge Elimination System permits**.



Chapter Two

IS IT NECESSARY TO TREAT BRINE WASTE BEFORE DISCHARGE OR DISPOSAL?

TREATING BRINE WASTE BEFORE DISCHARGE OR DISPOSAL

Is it necessary?

Brine waste treatment is becoming increasingly common, not only as a means of achieving compliance with rigorous discharge regulations, but also for the cost benefits that waste minimization strategies can provide. But "**is it necessary to treat brine waste before discharge or disposal?"**

In many cases, treating brine effluent is necessary, though the reasons for doing so may vary. This chapter discusses common reasons for treating brine waste and how a targeted brine waste treatment strategy might impact your facility.

What is brine waste treatment?

By definition, **brine waste treatment is a set of one or more processes used to separate out contaminants and/or adjust the salinity of a brine effluent stream**. Waste brines can arise from use as process liquids or ingredients in manufacturing, from use as regenerants for ion exchange (IX) resins, and as byproducts of various industrial processes, including desalination, boiler and cooling tower

feedwater treatment, reverse osmosis (RO), energy recovery such as fracking and acid mine drainage, among others. Because brines are used in such a wide variety of applications, waste brine treatment strategies may draw on a number of different technologies and processes.

Why treat brine waste prior to disposal?

Brine effluent will typically require some form of treatment prior to disposal, however, the specific type of treatment required will depend upon a few factors, including:

- stream content and contaminants;
- the chosen method of disposal; and
- relevant environmental and discharge regulations, standards, and limitations.

An ideal brine waste disposal strategy will balance the costs associated with each of these factors.

Brine waste stream contents

All waste brines share a high salinity (or salt concentration), but streams might vary significantly from one to the next in terms of other constituents present. This is because various materials can end up in the brine stream in the course of normal operations.

Common contaminants found in brine waste include:

- suspended solids and particles
- antiscaling agents
- heavy metals
- microorganisms
- organic material
- oil and grease

Contaminants such as these pose a threat to human health and can also damage ecosystems at the discharge site. **If toxic or hazardous materials are present in your brine stream, chances are that some form of brine waste treatment will need to be implemented**.

Brine waste discharge methods

Approaches to brine waste treatment can vary depending not only on the contents on the stream, but also on the discharge or disposal method to be used. **Brine waste treatment needs may range from minimal to intensive depending upon the chosen means of disposal**, such as:

- **Sewer discharge:** Discharging brine waste to a publicly owned treatment works (POTW), or sewer, is generally a low-cost disposal option, but access to the POTW depends upon a facility's location. Additionally, the brine stream may need to be treated to suit the discharge standards of the POTW. Depending on the volume and the size of the receiving POTW, sufficient dilution of the brine waste stream may be achieved as it is combined with all the other streams entering the POTW.

- **Surface water discharge:** Brines can be discharged to lakes, rivers, or other bodies of surface water. While a relatively low-cost solution, facilities must typically comply with regulatory guidelines when discharging to waterways, which can mean adopting treatment strategies to remove certain contaminants or adjust the salinity, sometimes by dilution. Depending on the volume and the size of the receiving body of water, it is possible that a brine waste stream may be satisfactorily diluted by all the other streams entering it. If allowed by regulatory agencies, such disposal arrangements may mean minimal/no brine treatment is necessary.
- **Evaporation:** Evaporation ponds collect spent brine and leverage solar energy to remove water content through heat exposure. They require minimal investment in terms of operations, maintenance, energy, and compliance, but can take up a large footprint. New technologies, such wind-aided intensification of evaporation (WAIV), can reduce the footprint needed for a traditional evaporation pond and speed up the evaporation process. Brine waste treatment may still be necessary if toxic contaminants are present or if there is a large volume of waste brine.
- **Recycling and reuse:** Brines are commonly recycled for additional use, including industrial cooling, acid and caustic production, and many other applications. Increasingly, industrial plants are partnering with municipalities and other external entities to recycle brine waste in innovative ways, such as leveraging cheese brine for road deicing or using brine waste for irrigation of salt-tolerant land and vegetation. Brine waste streams often need to be treated prior to reuse, though the extent of treatment needed may be minimal (e.g. removing or reducing organic contaminants).

- **Deep well injection:** Deep well injection is typically reserved for applications requiring disposal of high-volume brine waste streams, such as those produced by hydraulic fracturing operations. This controversial disposal method involves pumping spent brine into porous rock formations found deep underground and is not permitted in all states. Deep well injection requires brine waste treatment for total suspended solids (TSS), oils, and greases, so as to prevent blockages in receiving wells. Additionally, deep well injection entails substantial costs associated with drilling, permitting, and monitoring the well, making it an impractical disposal option except for certain high-volume, high-salinity waste streams.

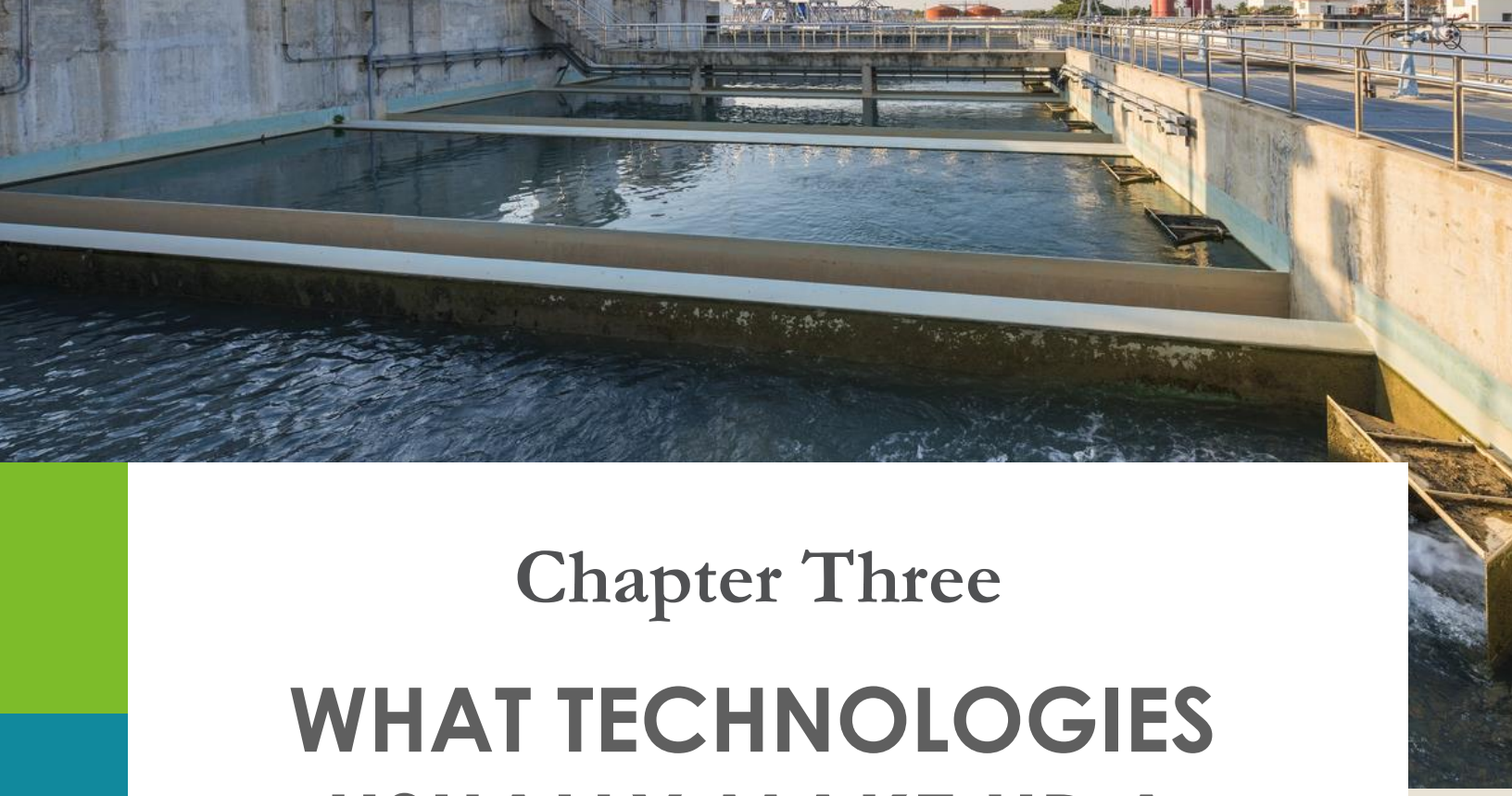
In some locations, costs for liquid waste disposal can run quite high. If this is the case, it may be worth considering zero liquid discharge (ZLD) systems, which remove all liquid components to minimize discharge volumes so as to cut costs. ZLD systems for brine waste treatment typically include a brine concentrator and crystallizer. While ZLD systems have relatively high capital and energy costs, they can more than make up for it by minimizing liquid waste disposal costs, as well as by facilitating reclamation of valuable materials.

Environmental impact and regulatory compliance

Waste brines pose risks to the environment due to their high concentrations of salts, which can harm aquatic life when improperly discharged to the sea or surface waterways and can cause significant damage to soil and vegetation on land as well. Additionally, waste brines can contain toxic chemicals that may be harmful to humans

and the environment. For this reason, disposal of waste brine is often strictly regulated and can be costly where large volumes are concerned.

It is always best to verify discharge, monitoring, and reporting requirements at your specific location to ensure that a chosen brine waste treatment solution will help your facility to stay in compliance with National Pollutant Discharge Elimination System (NPDES) permit standards or other discharge requirements. **Depending upon the conditions at your facility, an effective brine waste treatment system may be necessary to avoid hefty fines or environmental remediation costs later on.**



Chapter Three

WHAT TECHNOLOGIES USUALLY MAKE UP A BRINE WATER TREATMENT SYSTEM?

BRINE TREATMENT TECHNOLOGIES

What are common treatment technologies and how do they work?

Although **brines are sometimes used in manufacturing** (for example, during chlor-alkali processes that uses the electrolysis of sodium chloride to create chlorine and sodium hydroxide), they are **also created as an industrial byproduct or waste that can be challenging to treat and dispose of** (such as flowback water from fracking natural gas wells). Filtering and concentrating brines often generates other problematic wastes that can be difficult to treat for reuse or cause harm to the environment if improperly discharged or disposed of, so it's no surprise that brine treatment and disposal regulations have been increasingly prohibitive and difficult for industrial facilities to meet and work around.

If your facility can benefit from more information about properly treating brine waste, one of the questions you might have is **"What technologies usually make up a brine waste treatment system?"**

This chapter provides a general overview of **which technologies are commonly used to treat brine waste**, which can vary depending on what contaminants are present and whether the facility is treating the brine for discharge or recycling and/or reusing in its process.

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Brine treatment technologies

Brine waste is typically **either recycled for use in the facility's process or treated for disposal**, but these processes are rarely straightforward or practical, and can even be costly.

A typical brine treatment system might include:

Membrane filtration

One of the more cost-effective technologies for treating brine waste, membrane filtration is still widely used across various industries. When treating brine, it's common to see systems that **begin with ultrafiltration (UF) and end with reverse osmosis (RO)**.

When UF is used prior to RO, it effectively removes various contaminants while protecting downstream membranes from premature wear and fouling. UF membranes are available in pore sizes ranging from 0.001 to 0.1 µm, which means UF removes a more comprehensive range of contaminants than some other membranes (such as microfiltration) while leaving behind ions and organic compounds of low molecular weight. **UF is suited for removal of very fine particles, including proteins, colloidal silica, and silt**.

The stream is then passed through an RO system, which is a membrane technology that uses a semipermeable medium **to remove certain ions and particles from a liquid stream that are 0.0001 µm or larger, including salt**. This produces a high-quality water stream in addition to a highly concentrated stream of waste,

which can be used or discarded, depending on the needs of the facility.

This sequence of membrane treatment is effective for protecting equipment and minimizing chemical costs and system downtime for cleaning and is generally considered a low energy–consuming technology.

Evaporation and crystallization

After brine is concentrated by membrane filtration, thermal processes or evaporation are often used as the next step to dry solids. **Excess water is evaporated off, collected, and reused** (adding acid at this point will help to neutralize the solution so, when heating it, you can avoid scaling and harming the heat exchangers). **Deaeration** is often used at this phase, as well, to release dissolved oxygen, carbon dioxide, and other noncondensible gases to further protect equipment from corrosion and other harmful occurrences.

The leftover waste then goes from an evaporator to a **crystallizer, which continues to boil off all the water until all the impurities in the water crystallize and are filtered out as a solid**. This process is often used in facilities that aim for zero liquid discharge, but it's generally reserved for only facilities that require it (most likely due to stringent environmental and discharge regulations) as it is considered a costly and high energy–consuming process.

Ion exchange

Ion exchange (IX) systems are used across a variety of industries for water softening, purification, and separation purposes. These systems **separate ionic contaminants from solution through a physical-chemical process where undesirable ions are replaced by other ions of the same electrical charge**. This reaction occurs in an IX column or vessel where a process or waste stream is passed through a specialized resin that facilitates the exchange of ions.

When contaminant removal needs are highly specific, many times IX is ideal. Chelating resins are the most common type of specialty resin and are **often used for brine softening**.

Weak acid cation (WAC) exchange resins are also often used to **remove cations associated with alkalinity (temporary hardness)** and are therefore also ideal for softening brine. Facilities can also use various proprietary resins to separate contaminants, such as metals, from the brine stream to support production and manufacturing of lithium carbonate and lithium hydroxide.

Electrodialysis is also a form of ion exchange that can be used in the brine treatment system. It's a membrane process that uses positively or negatively charged ions to allow charged particles to flow through a semipermeable membrane and can be used in stages to concentrate the brine. It is **often used in conjunction with RO** to yield extremely high recovery rates. Combined, these technologies can concentrate a brine stream down to a high salinity while pulling out up to 60–80% of the water.

Other things to consider when treating brine

As mentioned previously, when looking at basic separation for a contaminated brine stream**, you will always be left, essentially, with a more purified brine** (such as a sodium chloride stream). The cost to treat a brine stream like this can be relatively low and would include treatments such as:

- membrane filtration
- precipitation
- carbon adsorption of organics
- oil and water separation

Using IX, the facility can take out easy-to-remove contaminants, which might leave you with something like a sodium chloride or brine sulfate brine stream, which is a salt stream that doesn't easily precipitate.

These technologies are relatively low cost compared to removing the salt directly out of the brine (such as with sodium chloride or sodium nitrate). In these instances, it's very difficult to remove the salts and almost always involve high-pressure membrane systems to concentrate the brines (pulling the water out of the brine).

In situations where membrane filtration won't be effective, evaporation and crystallization will help remove the water from the brine, but such thermal polishing processes are exponentially more expensive when it comes to purchasing the relative technology in addition to high operational and energy usage costs.

Essentially, by trying to solve one problem your facility can easily create another.

The only true ways to dispose of brine are to **reuse it or dilute and slowly release it back into the environment**. For example, if you have a very large river near your facility that is available of discharging your treated brine, you can slowly bleed the brine in, dissolving it back into the body of water with a minimal impact to the river. If you have a smaller stream, your facility will not be able to do this; doing so could pose catastrophic harm to the environment, killing off fish and other wildlife in the surrounding areas. In some areas, where permitted, waste brines can be deep-well injected although this option is becoming more restricted.

Facilities can reuse brine, but recycling it will concentrate it more, which would leave you discharging a smaller stream with a higher concentrate of salt and TDS.

As always, it is usually best to discuss any treatment options with a water-treatment professional who is able to analyze your facility's needs, specifically, and help you determine the best treatment options, as they can be highly individual.

Chapter Four

IN WHAT WAYS CAN A FACILITY REUSE BRINE WASTE?

HOW CAN FACILITIES REUSE BRINE WASTE?

And what are the best ways?

While used in a number of industrial processes, brines can be difficult to treat and discharge once they've reached the end of their useable life. If your plant is looking for more economical ways to manage brine waste, you might be wondering **"How can a facility reuse brine waste?"**

Today there are more instances than ever of facilities successfully reusing brine waste, however, there is still a relatively narrow set of circumstances where brines can be effectively reused. This chapter will provide an overview of the most common ways facilities recycle or reuse brine waste and point out some constraints that you may need to consider in weighing your options.

Why recycle brine waste?

There are a number of brine waste disposal options, though many of them are controlled by permits and environmental regulations. Additionally, recent public attention to issues of water scarcity and environmental responsibility have spurred increasing public and

regulatory scrutiny of popular brine disposal methods, including discharge to bodies of water as well as deep-well injection. Where discharge costs and limitations are concerned, brine waste reuse and recycling strategies can provide several benefits, such as **reducing wastewater discharge volumes** or allowing facilities to increase production volumes while staying within discharge permit limitations. Additionally, some facilities have seen a net cost savings by **supplementing fresh water demand with waste brine**, especially in regions where access to source water may be costly and unreliable.

Types of brine recycling and reuse

The feasibility and cost of brine reuse and recycling can depend on a number of factors, including facility location, brine constituents, and volume. Commissioning a treatability study is one way to get a better understanding of the salinity levels, as well as metals, total dissolved solids (TDS), and other contaminants present in your waste brine so you can better determine whether brine waste treatment for recycling and reuse is a cost-effective option.

With appropriate treatment, waste brines can be used for a number of different applications. Below, we've summarized a few of the more typical brine reuse and recycling strategies:

Acid and caustic production

Caustic soda (sodium hydroxide) and chlorine are used extensively across industries ranging from oil and petroleum refineries to pulp and paper manufacturers. Production of these chemicals involves

electrolysis of a sodium chloride brine solution, a process which involves consumption of large volumes of brine waste as well as large quantities of energy. To improve overall efficiency, acid and caustic producers have implemented brine electrolysis recovery strategies, allowing for reuse of brine waste through multiple electrolysis cycles. In other cases, mining operations and other types of facilities have successfully leveraged their brine byproducts by repurposing them for acid and caustic production. In this way, some facilities are able to consume a portion of their brine waste streams, while simultaneously producing chlor-alkali products that can be used or sold.

Softener brine recycling

Brines resulting from both ion exchange (IX) softeners and reverse osmosis (RO) systems can be treated and reused for additional IX softening cycles, thereby reducing overall water and salt consumption. Brine waste reclamation setups capture a portion of used brine, treat it (if necessary), and return it to the brine tank during IX resin regeneration. While brine recycling can be a great way to improve softener efficiency, it is generally viable only for softeners that use a high salt dose and that have a relatively high sodium chloride concentration following an active cycle. Additionally, brine reuse can result in an even more concentrated effluent that can be more difficult or costly to discharge.

Irrigation and agriculture

In some cases, waste brines can be applied to land for irrigation and agricultural purposes. Generally speaking, waste brines used for agriculture must have relatively low TDS and be free of toxic

constituents, such as heavy metals. In some regions, reuse strategies have included application of waste brines to salt-tolerant plants. Alternatively, some facilities have been able to leverage waste brines to produce liquid fertilizer, especially for brine waste streams that contain a mix of sodium and hardness. In this case, the brine is typically treated through an IX process to selectively remove sodium, while retaining hardness that is valuable to plant development.

Deicing and dust control

In an effort to cut discharge costs, some facilities have begun offering waste brines to cities and municipalities for treating roads threatened by ice, snow, and dust. Circumstances vary—meaning that different regions or municipalities may be more or less willing to accept waste brines for road treatment—because certain constituents, such as naturally occurring radioactive materials and chemicals from fracking or other processes, can be present and potentially harmful to the local environment or water supply. In some cases, however, local governments are willing to pay facilities for their waste brines, such as liquid waste brines from cheese production, mining, gas production, and other industries for use in road-treatment applications.

Recovery and sale of solid salts

Solid salts can be recovered from brines through zero liquid discharge (ZLD) systems. These typically consist of a brine concentration step, followed by crystallization, and a solids dewatering step. While ZLD technologies can be costly, they are effective in eliminating

wastewater discharge costs, and can be leveraged to produce solid salts. Brine byproduct salts can be used or sold for a variety of industrial applications, such as detergent manufacturing, dyeing, chemical production, curing, water treatment, and deicing, among other uses.

Cooling

While commonly used by power plants, oil refineries, chemical plants, and other facilities, cooling towers often consume large quantities of water. With proper treatment, recycled brine can be a great solution for reducing water use in cooling and thermal equipment. Recycling brine for this purpose will generally demand some form of cooling tower water treatment to minimize corrosion and scaling, which can include reduction of salt content, chlorides, phosphates, sulphates, and oxidizing bacteria. Recycling for cooling applications is limited by the salt concentration and other contaminates, as it inhibits heat transfer and may cause foaming.

Chapter Five

HOW MUCH DOES IT COST TO TREAT BRINE FOR REUSE AND/OR DISPOSAL?

BRINE TREATMENT SYSTEM COST FOR YOUR PLANT

Pricing, factors, etc.

When it comes to managing wastes and byproducts of industry, **brines can be some of the most challenging and costly to handle**. Certain brine treatment methods, such as desalination or zero liquid discharge (ZLD), generate a smaller volume of brine waste with even higher concentrations of salts and solids, and discharging brine without a permit or without diluting it properly can result in heavy fines and damage the surrounding environment. Industrial facilities have yet to come up with low-cost solutions for treating and or discharging brines, a challenge that industry experts expect to grow as brine waste volumes increase in the coming years. If your facility produces brine as a byproduct or waste and is trying to come up with a reasonable game plan to treat it for reuse or discharge, you're likely wondering **"How much does it cost to treat brine for reuse and/or disposal?"**

Since **there are several available ways to treat and discharge brines and the costs can vary significantly**, we'll break them down for you below, so you can compare and consider which solution might work best for your facility.

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Membrane treatment systems

One of the more cost-effective technologies for treating brine waste, membrane filtration is still widely used to treat brine across various industries. When treating brine, it's common to see systems that **begin with ultrafiltration (UF) and end with reverse osmosis (RO)**. This sequence of membrane treatment is effective for protecting equipment and minimizing chemical costs and system downtime for cleaning and is generally considered a low energy–consuming technology. Keep in mind this method will leave you with an even higher concentrated brine stream your facility will still need to manage, but the volume of waste to haul/discard will be lower, and you will also have a purified water stream that can be used.

Ion exchange

Electrodialysis is a form of ion exchange that can be used in a brine treatment system, which is useful if the brine contains organics or hydrocarbons. It's a membrane process that uses positively or negatively charged ions to allow charged particles to flow through a semipermeable membrane and can be used in stages to concentrate the brine. It is **often used in conjunction with RO** to yield extremely high recovery rates. Combined, these technologies can concentrate a brine stream down to a high salinity while pulling out up to 60–80% of the water. These can be cost-effective because little pretreatment is required.

Evaporation and crystallization

Evaporation is often used in conjunction with membrane systems to further dry the solids left behind. **Excess water is evaporated off, collected, and reused** (adding acid at this point will help neutralize the solution so, when heating it, you can avoid scaling and harming the heat exchangers). **Deaeration** is often used at this phase, as well, to release dissolved oxygen, carbon dioxide, and other noncondensible gases to further protect equipment from corrosion and other harmful occurrences.

The leftover waste then goes from an evaporator to a **crystallizer, which continues to boil off all the water until all the impurities in the water crystallize and are filtered out as a solid**. This process is often used in facilities that aim for zero liquid discharge, but it's generally reserved for facilities that require it (due to stringent environmental and discharge regulations) as it is considered a costly and high energy–consuming process. If brine volumes are low, sometimes evaporation can be eliminated and the waste can go right to crystallization, but this depends on the resources and needs of the facility.

Keep in mind, your solid waste **might also require further treatment depending on the requirements of the facility's landfill**, which could mandate a paint filter test (to determine if free liquid is present) or the removal of other contaminants. For this reason, it's extremely important to be aware of such requirements so optimal treatment options and technology sequences are considered prior to treatment and disposal.

Discharging brine into local waterways or sewers

If a facility's brine meets regulatory requirements, **discharging to the local waterways (such as the ocean or surface water) or sewer is generally considered the most cost-effective option**. The facility might be required to remove certain contaminants, such as metals, or dilute the stream prior to releasing it, but if the option is available and the facility can do it without harming the environment, the brine can be slowly bled back into the waterway. Regulations for this type of discharge typically requires a permit, and the regulations vary from state to state.

Deep well injection

In some regions, and depending on the geological makeup of the area, brines can be injected into well deep within the ground. Done properly and while complying with regulations, this can also be a viable option. There is some concern, however, about these injected brines breaching the bedrock that contains drinking water or creating unstable bedrock prone to tremors, as is the case in Oklahoma. There is also a certain risk involved, not knowing how much of the brine the wells will be able to take . . . so, while deep well injection can seem like an easy fix, facilities need to weigh all options when deciding how best to discard their brines.

The bottom line

With **basic separation technology**, the cost to filter a contaminated brine solution or stream (you're left with purified brine such as sodium chloride) is relatively low. This could include membranes, precipitation, carbon adsorption of organics, oil and water separation, precipitation for metals, and ion exchange polishing. For a **100 GPM system, you might be spending about $750,000 to $2,500,000** at the higher end. Keep in mind the stream may be recycled and used in a chlor-alkali plant.

Using **ion exchange** to pull out contaminants that can be easily removed could still leave a facility with a salt stream that doesn't easily precipitate. These technologies are relatively low cost compared to high-pressure membrane systems that are required to take the salt out of the brine. A system like this could be around **$1 to $1.5 million for a system that runs at 100 GPM**.

When membranes and ion exchange no longer economical solutions and evaporation is needed, crystallization can also be required to get the solid waste to a zero-liquid state. When you get into thermal polishing processes, the cost goes up exponentially. For example, let's say you have a 100 GPM stream in the front end of a process that facilitates oil and water separation or adsorption. **A front-end pretreatment and RO concentration treatment system could be $1 to $2 million** to create a salt stream. Then further treatment for **crystallization might be another $10 to $20 million** on top of the operating and energy costs. These processes reduce the volume of

the salts, but they are costly, high energy–consuming processes that, as mentioned prior, create other, more concentrated wastes.

Some companies have had success treating brines and selling them to manufacturers that use them in their processes, but most facilities will want to release the brines slowly to the environment where it's allowed and safe to do so.

HOW CAN SAMCO HELP?

SAMCO has over 40 years' experience in identifying appropriate brine treatment technologies to help lower costs and waste volumes while increasing product quality. For more information or to get in touch, contact us to set up a consultation with an engineer or request a quote. We can walk you through the steps for developing the proper solution and realistic cost for your system needs.

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