An Introduction to

ION EXCHANGE RESINS

A PUBLICATION OF SAMCO TECHNOLOGIES

SAMCO

SHARE THIS E-BOOK:

TABLE OF CONTENTS

SAMCO

Chapter One

WHAT ARE ION EXCHANGE RESINS AND HOW DO THEY WORK?

ION EXCHANGE RESINS

What they are and how they work

Whether you're weighing potential treatment strategies, looking for ways to get the most out of your existing ion exchange (IX) resins, or simply curious about IX chemistry, you may be asking **"What are ion exchange resins and how do they work?"**

No matter your goals, this chapter will help you make decisions on the right water treatment strategies for your facility by helping you to better understand IX resin technology and how it serves a variety of water treatment and separation needs.

What are ion exchange resins?

Ion exchange is a reversible chemical reaction where dissolved ions are removed from solution and replaced with other ions of the same or similar electrical charge. Not a chemical reactant in and of itself, **IX resin is instead a physical medium that facilitates ion exchange reactions**. The resin itself is composed of organic polymers that form a network of hydrocarbons. Throughout the polymer matrix are ion exchange sites, where so-called "functional groups" of either positively-charged ions (cations) or negatively-charged ions (anions) are affixed to the polymer network. These functional groups readily attract ions of an opposing charge.

What are the physical properties of IX resins?

The geometric shape, size, and structure of IX resins can vary from one type to the next. Most IX exchange systems employ a resin bed consisting of tiny, porous microbeads, though some systems, such as those used for electrodialysis, use a sheet-like mesh resin. IX resin beads are usually small and spherical, with a radius measuring just 0.25 to 1.25 millimeters in size. Depending upon the application and system design, the resin beads may have a uniform particle size or a Gaussian size distribution. Most applications use gel resin beads, which have a translucent appearance and offer high capacity and chemical efficiency. Macroporous resins, which are recognizable due to their opaque white or yellow appearance, are typically reserved for demanding conditions, since they have comparatively greater stability and chemical resistance.

What are IX resins made of?

The IX resin matrix is formed by crosslinking hydrocarbon chains with one another in a process called polymerization. The crosslinking gives the resin polymer a stronger, more resilient structure and a greater capacity (by volume). While the chemical composition of most IX resins is polystyrene, certain types are manufactured from acrylic (either acrylonitrile or methyl acrylate). The resin polymer then undergoes one or more chemical treatments to bind functional groups to the ion exchange sites located throughout the matrix. These functional groups are what give the IX resin its separation capabilities and will vary significantly from one type of resin to the next. The most common compositions include:

- **Strong acid cation (SAC) exchange resins.** SAC resins are composed of a polystyrene matrix with a sulphonate (SO_3^-) functional group that is either charged with sodium ions (Na^{2+}) for softening applications, or hydrogen ions (H^+) for demineralization.
- **Weak acid cation (WAC) exchange resins.** WAC resins are composed of an acrylic polymer that has been hydrolyzed with either sulphuric acid or caustic soda to produce carboxylic acid functional groups. Due to their high affinity for hydrogen ions (H^+), WAC resins are typically used to selectively remove cations associated with alkalinity.
- **Strong base anion (SBA) exchange resins.** SBA resins are typically composed of a polystyrene matrix that has undergone chloromethylation and amination to fix anions to exchange sites. Type 1 SBA resins are produced by the application of trimethylamine, which yields chloride ions (Cl^-), while Type 2 SBA resins are produced by the application of dimethylethanolamine, which yields hydroxide ions (OH^-).
- **Weak base anion (WBA) exchange resins.** WBA resins are typically composed of a polystyrene matrix that has undergone chloromethylation, followed by amination with dimethylamine. WBA resins are unique in that they do not have exchangeable ions and are therefore used as acid absorbers to remove anions associated with strong mineral acids.

- **Chelating resins.** Chelating resins are the most common type of specialty resin and are used for selective removal of certain metals and other substances. In most cases the resin matrix is composed of polystyrene, though a variety of substances are used for functional groups, including thiol, triethylammonium, and aminophosphonic, among many others.

How does ion exchange resin work?

To fully understand how IX resins work, it is important to first understand the principles of the ion exchange reaction. Put simply, ion exchange is a reversible interchange of charged particles—or ions—with those of like charge. This occurs when ions present on an insoluble IX resin matrix effectively swap places with ions of a similar charge that are present in a surrounding solution.

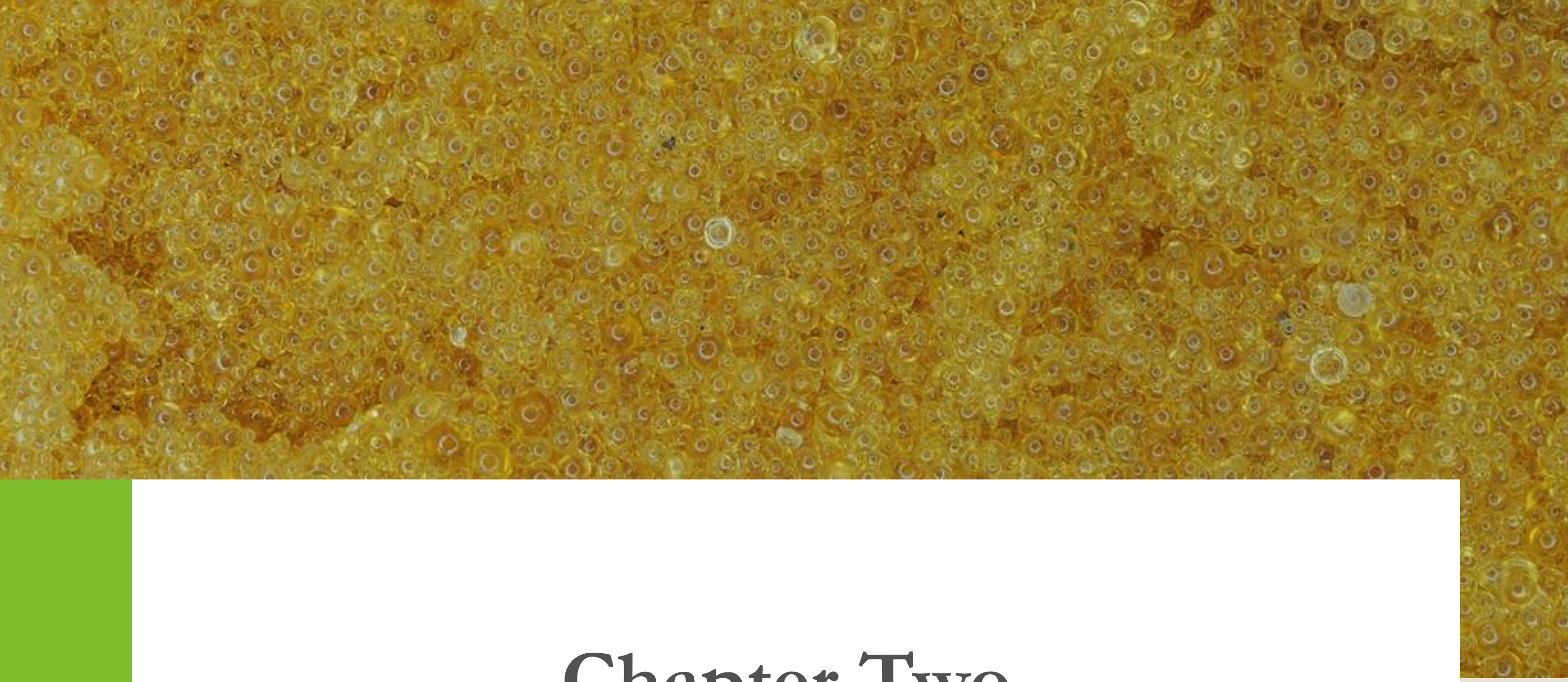
The IX resin functions this way because of its functional groups, which are essentially fixed ions that are permanently bound within the polymer matrix of the resin. These charged ions will readily bond with ions of an opposing charge, which are delivered through the application of a counterion solution. These counterions will continue to bond with the functional groups until equilibrium is reached.

During an IX cycle, the solution to be treated would be added to the IX resin bed and allowed to flow through the beads. As the solution moves through the IX resin, the functional groups of the resin attract any counterions present in the solution. If the functional groups have a greater affinity for the new counterions than those already present, then the ions in solution will dislodge the existing ions and take their place, bonding with the functional groups through shared electrostatic attraction. In general, the greater the size and/or valency of an ion, the greater affinity it will have with ions of an opposite charge.

Let's apply these concepts to a typical IX water softening system. In this example, the softening mechanism consists of a cation exchange resin where sulphonate anion (SO3–) functional groups are fixed to the IX resin matrix. A counterion solution containing sodium cations (Na+) is then applied to the resin. The Na+ are held to the fixed SO3– anions by electrostatic attraction, resulting in a net neutral charge in the resin. During an active IX cycle, a stream containing hardness ions (Ca2+ or Mg2+) is added to the cation exchange resin. Since the SO3– functional groups have a greater affinity for the hardness cations than for the Na+ ions, the hardness ions displace the Na+ ions, which then flow out of the IX unit as part of the treated stream. The hardness ions (Ca2+ or Mg2+), on the other hand, are retained by the IX resin.

What is ion exchange resin regeneration?

Over time, contaminant ions bind with all available exchange sites in the IX resin. Once the resin is exhausted, it must be restored for further use through what is known as a regeneration cycle. During a regeneration cycle, the IX reaction is essentially reversed through the application of a concentrated regenerant solution. Depending upon the type of resin and the application at hand, the regenerant may be a salt, acid, or caustic solution. As the regeneration cycle proceeds, the IX resin releases contaminant ions, swapping them for ions present in the regenerant solution. The contaminant ions will exit the IX system as part of the regenerant effluent stream and will need to be properly discharged. In most cases, the resin is rinsed to remove any residual regenerant prior to the next active IX cycle.



Chapter Two

WHAT ARE THE TYPES OF ION EXCHANGE RESINS AND WHAT APPLICATIONS DO THEY SERVE?

ION EXCHANGE RESINS

The types and relevant applications

Ion exchange (IX) is an incredibly versatile technology often utilized in industrial water treatment and selective separation. While all resins generally function on the same basic principles, there is a seemingly endless variety of IX resins available on the market today. Once you understand the basic resin types and their functions, it might be easier to narrow down the right types for your industrial facility and see how they can potentially help improve your process.

So, **“What are the different types of IX resins and what applications do they serve?”** This chapter breaks down available IX resin technologies and describes how they serve a variety of industrial water treatment and separation needs.

What are the different types of ion exchange resins?

IX resins are materials that facilitate IX reactions. They are composed of polymer matrices to which ionic “functional groups” of either positively-charged ions (cations) or negatively-charged ions (anions) are permanently bound. Some specialty resins have both types of functionality. These functional groups have a net negative or positive charge that allows them to readily attract counter ions, or ions of an opposing charge. As a liquid stream flows through the IX resin, the counter ions can be replaced by ions of a similar charge.

Broadly speaking, resins are named for the type of ions they exchange, meaning that cationic resins exchange positively charged ions, while anionic resins exchange negatively charged ions and include:

- Strong acid cation resins
- Weak acid cation resins
- Strong base anion resins
- Weak base anion resins
- Specialty resins

Now that you know the basics, we'll explore these resins in greater depth below:

Strong acid cation resins

What they are

Strong acid cation (SAC) exchange resins are among the most widely used resins. As mentioned previously, they are composed of a polymer matrix to which anionic functional groups are bound, such as sulphonate ($SO3–$). SAC resins are regenerated with either a sodium salt solution ($Na2+$) for softening applications, or with an acid ($H+$) for demineralization applications.

What they're used for

SAC resins are used extensively for softening applications, and are very effective at complete removal of hardness ions such as magnesium (Mg+) or calcium (Ca2+). They may also be used in split-stream dealkalization where two SAC beds operate in parallel, the first as a softener that produces an alkaline solution, and the second as a demineralizer (in the H+ form), with the result that alkalinity is removed from the blended stream. Certain varieties of SAC resins have also been developed for applications demanding removal of barium and radium from drinking water or other streams. SAC resins can be damaged by oxidants and fouled by iron or manganese, so care must be taken to avoid exposure of the resin to these materials.

Weak acid cation resins

What they are

Weak acid cation (WAC) exchange resins remove cations associated with alkalinity (temporary hardness). WAC resins typically employ carboxylic acid functional groups (RCOO–) and are regenerated with sulphuric or hydrochloric acid. Similar to SAC resins, WAC resins swap cations for hydrogen ions, resulting in slightly greater acidity in the treated stream.

What they're used for

WAC resins are used for demineralization and dealkalization applications. Their high affinity for divalent cations ions (Ca2+ and

Mg2+) makes them a good choice for applications demanding the removal of hardness ions associated with alkalinity. For high temporary hardness applications, a WAC resin can be used ahead of a SAC resin in a two-step IX process. Additionally, WAC resins tend to have relatively high oxidation resistance and mechanical durability, making them a good choice for streams containing oxidants such as hydrogen peroxide and chlorine, among others.

Strong base anion resins

What they are

Strong base anion (SBA) exchange resins are available in multiple varieties, including Type 1, Type 2, and acrylic or macroporous. Each type of SBA resin offers a unique set of benefits and constraints that must be matched to the application at hand.

What they're used for

SBA resins are typically used for demineralization, dealkalization and desilication, as well as removal of total organic carbon (TOC) or other organics depending on the type of resin. Type 1 SBA resins are used for selective removal of nitrates (NO_3^-), sulphates (SO_3^-), and perchlorate (ClO_4^-), for general demineralization, and for desilication where low levels of silica are required. Type 2 SBA resins are used for applications where total removal of anions is desired, where lower use of caustic is preferred, and where low silica levels are not critical to operational processes.

Weak base anion (WBA) exchange resins

What they are

Weak base anion (WBA) exchange resins are the only major type of IX resins that do not have exchangeable ions. These resins adsorb free mineral acidity (Cl and SO4). WBA resins have amine functional groups and are typically regenerated with sodium hydroxide (NaOH), ammonia (NH_3), or sodium carbonate (Na_2CO_3).

What they're used for

WBA resins are used for partial demineralization. In larger plants, WBA resin beds may be paired with SBA units for complete demineralization applications, and WBA resins are also effective as total organic carbon (TOC) barriers ahead of SBA beds. WBA is also used for acid adsorption applications involving the removal of chloride, sulphate, nitrate, and other anions associated with strong acids, though it is not effective for removal of weak acids such as silica (SiO_2) and carbon dioxide (CO_2).

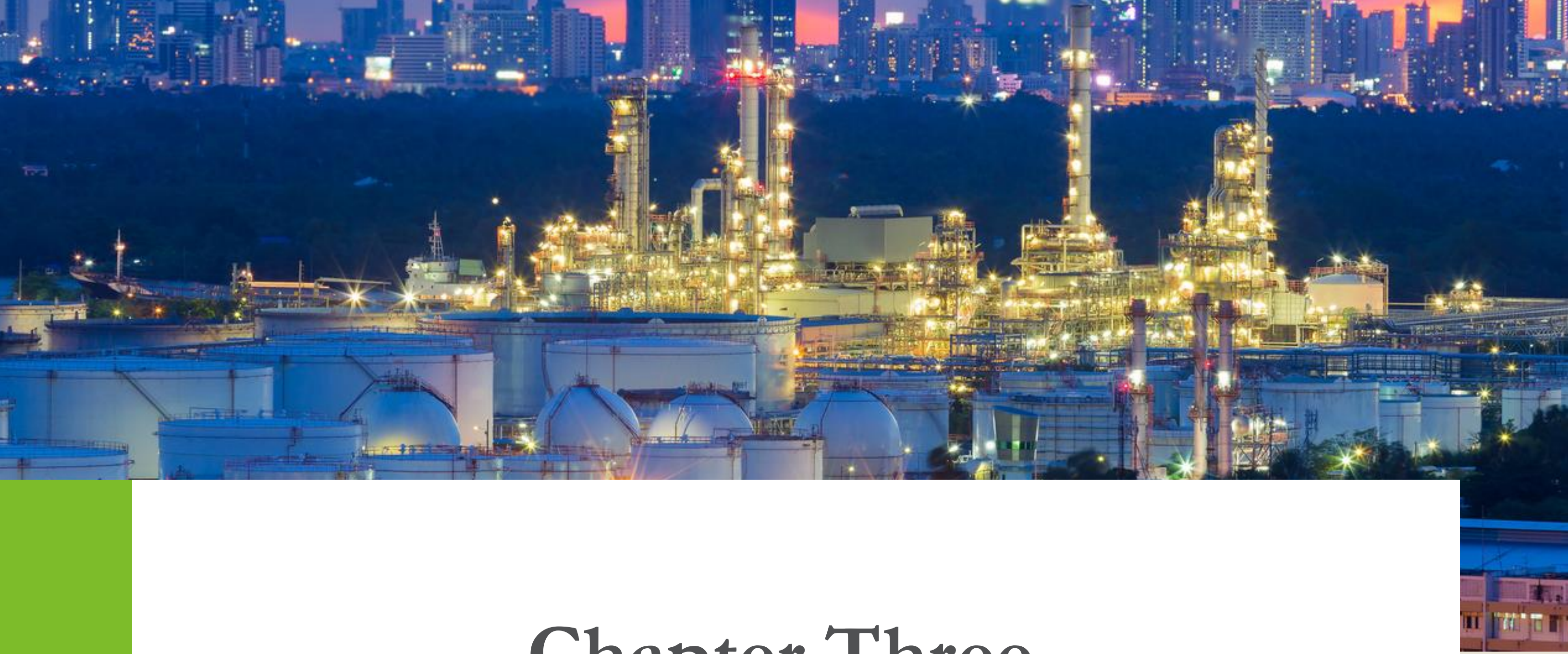
Specialty resins

What they are

As their name implies, specialty resins are used for a variety of specific applications. Chelating resins are the most common type of specialty resin, and are used for selective removal of certain metals, brine softening and other substances. Specialty resin functional groups vary widely depending upon the application at hand, and may include thiol, iminodiacetic acid, or aminophosphonic acid, and others.

What they're used for

Chelating resins are used extensively for concentration and removal of metals in dilute solutions, such as Cobalt (Co^{2+}) and Mercury (Hg^{2+}). Another type of specialty resins is magnetic ion exchange (MIEX) resins, which used for removal of natural organic matter from liquid streams.



Chapter Three

COMMON PROBLEMS WITH ION EXCHANGE RESINS AND HOW TO AVOID THEM

COMMON ION EXCHANGE RESIN PROBLEMS

What are they? How do you avoid them?

Ion exchange resins can be highly efficient with relatively low cost and energy requirements. If they are properly maintained, resin beds can last years before requiring replacement, and for highly selective removal needs in process streams, ion exchange resins can prove ideal.

Despite the many benefits of using ion exchange resins in the appropriate separation processes, challenging issues can arise. This chapter discusses some **"common problems with ion exchange resins and how to avoid them,"** ensuring your facility can keep one step ahead and remain as productive as possible.

Resin fouling

When your ion exchange treatment system begins to require more rinsing, becomes more sensitive to temperature and flow rate variations, or exhibits a decrease in effluent quality and operating capacity at a quicker-than-anticipated rate, fouled resins could be to blame.

Over time, it is natural to lose some percentage of operating ability (which varies widely depending on the type of resin and application), but if fouling is suspected, there can be several causes.

Some of the most **common resin foulants include:**

- suspended solids such as silica, iron, and manganese, these can be particles or colloidal
- oils and greases
- bacteria and algae
- organic substances

Once resins are fouled, it can be difficult and risky to clean them as some of the chemical agents and methods used in these processes can degrade the resins, making them unusable. In general, caustics are used to remove foulants from anion resins, while acids or strong reducing agents are used to remove foulants from cation resins. Similarly, surfactants are typically used to clean oil from fouled resins, though it is necessary to use care in selecting a surfactant that will not itself foul the resin, and sometimes an aggressive backwash with air scour helps.

Organic fouling is both extremely common and can be difficult to correct, although using a brine squeeze on anion resin at elevated temperatures may be effective. Preventative strategies for organic fouling include prechlorination and clarification, activated carbon filtration, applying a multistep IX with weak and strong base resins, and use of specialty IX resins.

Generally, the **best way to avoid resin fouling is to ensure proper pretreatment removes the foulants before they can become an issue in addition to using appropriate cleaning, storage, and regeneration measures** in the day-to-day operation of the ion exchange system to make sure no problematic foulants will accumulate over time.

These procedures vary widely depending on the type of resin being used as well as the purity of the feed water, etc., so be sure to consult your water treatment specialist to learn the proper steps to keeping your resins suitably maintained.

Oxidation

When oxidizing agents—such as **chlorine, chlorine dioxide, chloramine, and ozone**—come into contact with both cation and anion resins under certain conditions, they can damage the resins, leading to **capacity loss and inhibited performance**. When present in a feed stream, **oxidants degrade IX resin polymers, causing them to deform and compact over time**. This compaction obstructs the flow of liquids through the resin bed, which can compromise the overall effectiveness of the IX unit, and lead to inconsistent effluent quality due to channeling in the resin bed.

While oxidation damage to IX resins **cannot be reversed, it can be prevented** through various pretreatment measures. Common preventative measures for oxidation degradation include application of activated carbon filtration, ultraviolet irradiation, or chemical pretreatment through the application of a reducing agent.

Oftentimes, the resin manufacturer will have specific guidelines on which resins work best in certain environments. Some resins are built to withstand these degenerative chemicals at certain levels (i.e., higher crosslinked cation resins in higher concentrations of chlorine), but in general, it is best to consult with your water treatment specialist and resin manufacturer regarding the maximum temperature and oxidizing agent exposure as **certain combinations of chemicals and resins can result in potentially harmful byproducts**, such as ammonia or nitrogen gas.

Thermal resin degradation

Extremely high or low temperatures can permanently compromise the effectiveness of IX resins. Over time, thermal degradation alters the resin's molecular structure such that it is no longer able to bind with the functional groups of ions that are key to the IX reaction, resulting in compromised operational performance and shorter product life.

IX resin capacity has an inverse relationship with temperature, so **it is important to consider the recommended operational temperatures and other process conditions to minimize thermal degradation** over time. Generally speaking, cation resins are more resistant to thermal degradation than are anion resins, though both can generally withstand brief applications of high heat for occasional sterilization or other purposes. While prolonged exposure to extreme temperatures usually means a shorter useable life for IX resins, in some cases the costs of more frequent resin replacement may still not outweigh the costs of energy and equipment needed for temperature control.

Inadequate regeneration

Suboptimal IX system function can result when regenerant solutions are administered incorrectly. Sometimes regeneration methods yield varying results, even when they are implemented with the same procedure. Resin regeneration is a complex calculation, and the outcome often depends on the overall resin condition, regeneration process water quality, regenerant chemical concentration, flow rate, temperature, and contact time, to name a few. Both cation and anion resin can be scaled from improper regeneration. For example, regenerating with a too-high concentration of sulfuric acid can cause calcium sulfate scale on the resin. With some anion resins, silica can precipitate with improper caustic concentrations.

With all the possible scenarios, **following the resin manufacturer's guidelines for regenerant concentration, application time, and flow control can help prevent issues** and is advisable.

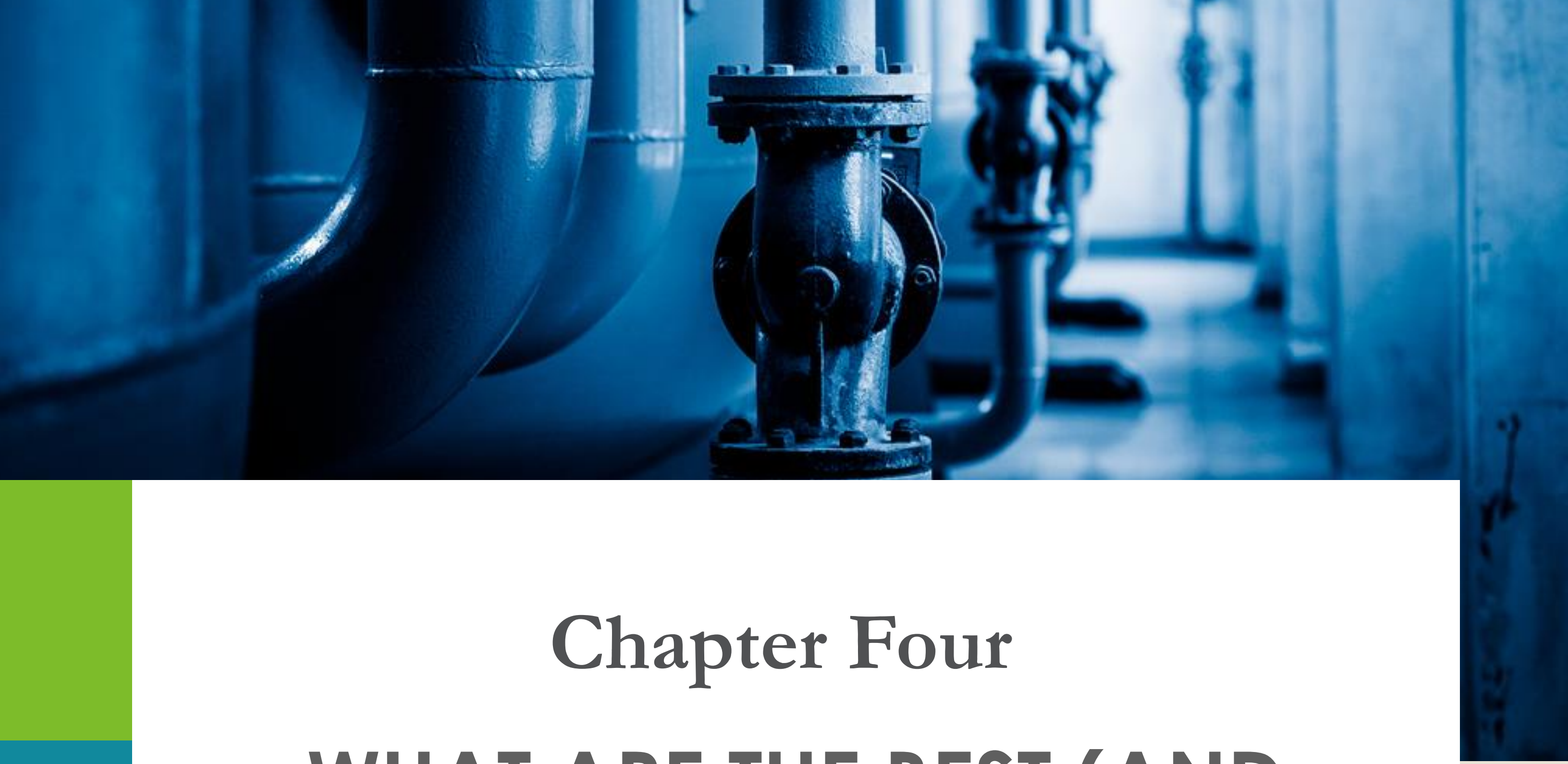
Channeling

Channeling occurs when liquids pass through the resin unevenly, carving pathways that result in the uneven exhaustion of the resin, and breakthrough of untreated solution into the effluent stream. Channeling can be caused by incorrect flow rates, failure of the distributor mechanism, inadequate backwashing, and blockages by dissolved solids or damaged resin beads.

Resin loss or migration

Resin loss occurs when resin beads flow out of an IX column, or flow from one vessel to another. There are multiple causes for resin loss, including excessive backwashing and mechanical failures in underdrain screening or other resin retention equipment. Resin loss may also result from fragmentation of resin beads due to exposure to high temperatures, chlorine, and/or osmotic shock, allowing the resin particles to pass through even intact retention screens. **Resin loss and migration reduces overall system capacity and efficiency**.

In demineralization systems, for example, the migration of cation resin into the anion unit can result in sodium leakage and excess rinse time.



Chapter Four

WHAT ARE THE BEST (AND CHEAPEST) WAYS TO DISPOSE OF ION EXCHANGE RESINS?

DISPOSING OF ION EXCHANGE RESINS

The best and most cost-effective ways

When thoughtfully applied within a water treatment system, IX offers cost-effective and efficient separation, with systems generally running for several years without major maintenance costs. Still, one must be mindful that IX resins degrade over time and must be replaced periodically to maintain system performance.

If you're wondering what happens when an IX resin reaches the end of its useable life, you might be asking **"What Are the Best (and Cheapest) Ways to Dispose of Ion Exchange Resins?"**

This chapter will discuss IX resin disposal options and how to cost-effectively maintain an IX system throughout its life cycle.

How do I know if IX resin disposal is needed?

In most industrial applications, an IX resin will last 4-10 years before system economics would favor replacement (or "re-bedding"). The service life of a resin will depend on a number of factors, including the chemical makeup of the stream to be treated, the type of IX process and resin used, how often regeneration cycles are needed, the hydraulic load of the resin, and whether any extreme process conditions exist. IX resins degrade gradually with use, making it difficult to tell exactly when they must be replaced. For most facilities, **resins should only be discarded when the output quality or loss in capacity justifies the re-bedding costs**, which can be substantial, as they include removal and disposal of old resin, and purchase and installation of new resin.

There are a few key indicators that it might be time for IX resin replacement. These include the amount of resin lost during backwash cycles, IX capacity loss of 10-20% or more, and inadequate quality in the treated stream. Still, the decision to re-bed should be made with careful cost analysis in mind. Certain changes in system performance, such as a drop in effluent quality, shorter service runs or higher chemical dosages, can be good indicators that the resin should be evaluated. Some companies provide analysis services to evaluate the salt splitting ability and physical condition of the resin and can provide you with a report to compare resin performance against new.

What are the best disposal methods for spent IX resins?

Spent IX resins are considered solid waste and are typically either buried in landfills or incinerated. Recycling of exhausted resin materials is neither common nor practical since there are few facilities capable of processing the resin materials (typically polystyrene or acrylic). No matter which disposal method is chosen, care must be taken to dispose of the resin in compliance with federal, state, and local waste management regulations.

There are a few factors that can affect which disposal options are available to your facility, as well as the overall cost of the disposal process. These include:

- ***Liquid content.*** When in active use, IX resins have significant water content. When re-bedding an IX system, care should be taken to drain away as much liquid as possible to avoid excess disposal costs.
- ***Volume of the resin and void spaces.*** Depending upon the type of resin and bed type, there may be more or less void space between resin beads. Additionally, care should be taken to minimize the size and number of containers used to transport the spent resin, and excess volume can drive disposal costs up.
- ***Resin composition and chemical activity.*** It is critical to check the Material Safety Data Sheets (MSDS) of the exhausted resin to verify whether the resin itself demands any particular disposal considerations.
- ***Resin contamination.*** While most unused resins are non-hazardous, they can be contaminated by exposure to various materials in process streams. If the resin has been exposed to any hazardous materials, such as heavy metals, then it will either need to be treated as a hazardous waste, or the toxic materials will need to be stripped out of the resin material prior to disposal.

Consideration of these and other factors will help to determine an effective disposal strategy appropriate to the processes and materials used at your facility.

How do I cut IX resin disposal costs?

IX resin replacement can be an expensive process, and disposal costs can really add to the investment. **The best way to minimize disposal costs is to minimize the volume and frequency of exhausted resin generated by your process.** Below, we have outlined some alternative approaches to consider in order to minimize IX resin disposal costs.

Optimizing IX resin service life

IX resins typically last for several years, however, if an IX system is not optimally configured, a number of problems can impact system efficiency and shorten the service life of the resin. Since IX resins are costly to replace, it sometimes pays to conduct an analysis of the resin and of general system performance. Doing so will help to uncover any underlying causes for premature resin degradation or other inefficiencies and can point you toward pretreatment or system optimization strategies that will prolong the IX resin life.

Adding new resin material

In some cases, it is possible to simply top-off an IX resin bed instead of doing a full resin replacement. Doing so will bolster system performance without the steep costs associated with disposal and replacement of a large volume of resin. Still, adding new resin to an existing bed is appropriate only to certain circumstances, such as when resin volume is lost due to leaks in the vessel or distribution system or incorrect backwash flow rates, or when damaged resin can be isolated and removed. Topping off the IX resin bed is not an ideal solution for situations where resin performance has suffered due to age, or damage from osmotic shock, oxidant exposure, or extreme temperatures.

Chapter Five

HOW MUCH DOES IT COST TO BUY, MAINTAIN, AND DISPOSE OF ION EXCHANGE RESINS?

WHAT ION EXCHANGE RESINS COST

Pricing, factors, etc.

When an industrial facility requires ion exchange technology as part of its process, it's important to not only know **how much the ion exchange resins cost** but also to factor in **expenses associated with maintaining and disposing of them**. These costs can be difficult to narrow down because of the many types of resins available on the market today (there are *thousands*) in addition to all the factors that can drive those costs up and down (such as the material or process used to make the resin, the price point designated by the manufacturing company, etc.).

Because these prices can be difficult to estimate and depend on several factors, below is a general outline of **common price ranges and what factors might cause them to fluctuate** so you can have an overall idea of what a facility might need to spend on ion exchange resins both initially and in the long run:

How much does it cost to purchase ion exchange resins?

Resin costs vary depending on the manufacturer, type, quality, and spherical size. The most common IX resins are formulated from either gel or a macroporous polymer. Generally, **gel resins are best for standard water treatment operations**, as they offer a greater capacity and regeneration efficiency. On the other hand, **macroporous resins are beneficial for aggressive conditions**, with their greater chemical and mechanical resistance making them able to stand up to high temperatures, significant osmotic shock, and/or exposure to oxidizing agents.

Once the facility's resin needs are determined (including all required performance characteristics), then the facility can calculate how many cubic feet will be needed in addition to what the regeneration system vessels, and configuration will be, which will also be a factor in cost, but on average, expect price ranges from **$40 to $200 per cubic foot for SAC/WAC resins and $130 to $200 per cubic foot for SBA/WBA resins**.

Again, these prices will vary depending on the quality and spherical size of the resin (some resins will require a larger volume than others), and keep in mind that type 1 resins tend to be less expensive than type 2, which will generally have a larger capacity.

Specialty resins tend to range anywhere from $500 to $2,000 and up per cubic foot.

How much does it cost to maintain ion exchange resins?

Keeping ion exchange resins well-maintained will help your facility get the maximum amount of service life out of them. A “normal” resin service life can be based on the number of times it’s regenerated; the more it’s regenerated, the less life the resins will have as they eventually wear out. There are also other factors that will lessen their service life:

- changes in temperature;
- shock from resin scouring;
- chemical oxidation;
- fouling;
- scaling, etc.

The frequency of all these things will determine how long the resin will last and how often you will need to purchase new resin to replenish the spent resin.

When using ion exchange as a polishing technology, a facility can opt for off-site regenerable ion exchange. This is a service provided by an outside contractor, and typically, depending on flow rates and how often you change out the resin, they can add cost anywhere from **$40 to $100 per cubic foot for off-site services**. These resin service are usually reserved for polishing applications because if the resin is changed frequently, the cost for the off-site regeneration can be more than installing a polishing technology to regenerate on-site.

One of the main things you should plan for when regenerating on-site is a **chemical-handling system to store the chemicals and feed them to the ion exchange system**. For a robust industrial chemical handling system with storage tanks, metering pumps, and forwarding pumps, cost can be around **$100,000 to $300,000** depending on the size.

How much does it cost to dispose of ion exchange resins?

For **nonhazardous resins, the costs can range from $50 to $100 a ton** to dispose. **Hazardous, on the other hand, can be over $1,000 a ton** to dispose of it. These costs will depend on the facility's location, how far it must be hauled, the location state requirements, etc.

HOW CAN SAMCO HELP?

SAMCO has over 40 years' experience helping design and engineer some of the most effective ion exchange treatment systems available. For more information about what we offer and how we can help your facility, please visit our website or contact us to schedule a consultation with one of our engineers.

WWW.SAMCOTECH.COM

ASK AN ENGINEER

CONNECT WITH US