The Storage, Transportation and Preconditioning of Ion Exchange Resins

Many conditions can affect the efficacy of ion exchange resins. This information bulletin reviews basic characteristics of resin and presents tips for maintaining resin quality during transportation and storage.
About Purolite

Purolite is a leading manufacturer of ion exchange, catalyst, adsorbent and specialty resins. With global headquarters in the United States, Purolite is the only company that focuses 100% of its resources on the development and production of resin technology.

Responding to our customers’ needs, Purolite has the widest variety of products and the industry’s largest technical sales force. Globally, we have five strategically located research and development centers and eight application laboratories. Our ISO 9001 certified manufacturing facilities in the United States of America, United Kingdom, Romania and China combined with more than 40 sales offices in 30 countries ensure complete worldwide coverage.

PREMIER PRODUCTS

The quality and consistency of our products is fundamental to our performance. Throughout all Purolite plants, production is carefully controlled to ensure that our products meet the most stringent criteria, regardless of where they are produced.

RELIABLE SERVICE

We are technical experts and problem solvers. Reliable and well trained, we understand the urgency required to keep businesses operating smoothly. Purolite employs the largest technical sales team in the industry.

INNOVATIVE SOLUTIONS

Our continued investment in research and development means we are always perfecting and discovering innovative uses for ion exchange resins and adsorbents. We strive to make the impossible possible.
The Storage, Transportation and Preconditioning of Ion Exchange Resins

Inside this General Information Guide you will find recommendations for the storage, transport and preconditioning of ion exchange resins. For more information, please contact your local technical sales person or the Purolite office closest to you, listed on the back cover.

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General Information About Resin

• Although most resins are supplied as fully swollen moist beads, some special resins are supplied in a dry or semi-dry condition and may expand considerably when rehydrated. To accommodate the increase in volume during rehydration, adequate space should be allowed in the vessel.

• Ion exchange resins are supplied in specific ion forms, and can be converted to a different ionic form through regeneration or in-service duty.

• Depending on the conversion, resins can swell, remain unchanged or shrink in volume. Some resins, such as acrylic strong base resins, also undergo irreversible swelling in the first few operating cycles. Service units must be designed to accommodate any changes that may occur.

• All ion exchange resins should undergo pretreatment prior to service — particularly resins used in food processing and potable water treatment.

• Regardless of form, Purolite ion exchange resins can be stored successfully for extended periods of time without significant deterioration as long as resin-specific transportation and storage guidelines are followed.

Shelf Life

Many factors affect the shelf life of ion exchange resins, including storage conditions, preconditioning and the intended application. To maximize shelf life, it is essential to protect the resin from extreme temperatures and direct sunlight. Covered vehicles and containers should be used for transport, and the resin should be stored in a temperature controlled, indoor warehouse. Table 1 provides a guide to the expected shelf life for Purolite resin families, in months, for common ion exchange resins and applications.
### TABLE 1 Expected Shelf Life of Ion Exchange Resins

<table>
<thead>
<tr>
<th>Resin Family</th>
<th>Ionic Form</th>
<th>Potable Water &amp; Food</th>
<th>Industrial Water Treatment</th>
<th>Nuclear Industry</th>
<th>Ultra-Pure Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong Acid Cation</td>
<td>Na⁺</td>
<td>24</td>
<td>60</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Strong Acid Cation</td>
<td>H⁺</td>
<td>n/a</td>
<td>36</td>
<td>24</td>
<td>6</td>
</tr>
<tr>
<td>Strong Acid Cation</td>
<td>NH₄⁺</td>
<td>n/a</td>
<td>24</td>
<td>12</td>
<td>n/a</td>
</tr>
<tr>
<td>Weak Acid Cation</td>
<td>H⁺</td>
<td>12</td>
<td>60</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Strong Base Anion, Type I</td>
<td>Cl⁻</td>
<td>24</td>
<td>60</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Strong Base Anion, Type I</td>
<td>OH⁻</td>
<td>n/a</td>
<td>24</td>
<td>24**</td>
<td>6</td>
</tr>
<tr>
<td>Strong Base Anion, Type II</td>
<td>Cl⁻</td>
<td>24</td>
<td>48</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Strong Base Anion, Type II</td>
<td>OH⁻</td>
<td>n/a</td>
<td>12</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Strong Base Acrylic Anion</td>
<td>Cl⁻</td>
<td>24</td>
<td>48</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Weak Base Anion</td>
<td>Free base</td>
<td>24</td>
<td>60</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Weak Base Acrylic Anion</td>
<td>Free base</td>
<td>24</td>
<td>48</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Mixed Beds</td>
<td>H⁺/ OH⁻</td>
<td>n/a</td>
<td>Up to 24*</td>
<td>24**</td>
<td>6</td>
</tr>
<tr>
<td>Chelating</td>
<td>Na⁺ or H⁺</td>
<td>24</td>
<td>60</td>
<td>n/a</td>
<td>6</td>
</tr>
</tbody>
</table>

* Dependent on storage conditions, preconditioning applied and intended application.
** XLC grade nuclear products are 12 month shelf life. Due to purity requirements of nuclear resins used in various operating systems, shelf life may vary. Contact a Purolite representative regarding questions on shelf life for nuclear grade products.

The guidelines presented in Table 1 assume that products are transported, stored and introduced in the prescribed manner. Purolite products may be successfully introduced into service in many applications even after extended periods in storage. However, if users are unsure about the exact transport and or storage conditions or where over 50% of the expected shelf life has been reached, extra precautions should be taken when first using the resin — particularly for critical or regulated applications. In these instances, we recommend additional pre-treatment before placing the resin in service.
Requirements for Packaging, Storage and Transportation

Packaging

Each Purolite resin is packaged to ensure the contents are protected from contamination and loss or uptake of moisture. If packaging is damaged or left open and resins are exposed to the atmosphere, the resin can deteriorate through a combination of physical, chemical or biological contamination. For example, hydroxide form anion resins can become carbonated from contact with carbon dioxide present in the air. No matter what type of resin, once the package is opened, the contents should be used as soon as possible, and unused resin should be resealed in a suitable, clean container. In the event of damage to bags, drums, kegs, etc., every effort should be made to repair the damage to ensure the resin is not exposed to the atmosphere.

Over time, and especially at elevated temperatures, resins may dry out. Unless re-hydration is carried out carefully, beads will crack or break.

To minimize damage, the following procedure is recommended for rewetting resins.

A concentrated brine solution is slowly introduced and left for at least 1 hour to equilibrate. Brine displacement is carried out, by reducing brine concentration by 5% on consecutive treatments. A contact time of 30 minutes is used for each successive displacement. The final 5% brine solution is then displaced and rinsed out with water. In cases where resin is very dry it is recommended that the process is optimized in the laboratory by adjusting the starting concentration of brine, temperature, rates of addition and contact time.

Note that cation resins in the hydrogen form will generate hydrochloric acid by passage of brine through the bed. Anion resin in the hydroxide form will likewise produce sodium hydroxide (caustic soda). In each case, cation resin will be converted to the sodium form and anion resin to the chloride form and will require multiple regenerations to return to the regenerated form.

Storage

Purolite recommends storing resin indoors, maintaining a temperature below 40 °C, (104 °F), and ensuring UV light (which promotes oxidation, and growth of algae and bacteria) does not contact the sealed package.

Additionally, do not store resin near a radiator, a heating appliance, or in a warm boiler house.

Although Purolite resins can withstand temperatures as low as −40 °C, (−40 °F), it is recommended that resins are stored above 0 °C, (32 °F) as successive thawing and freezing may damage the product, and/or the packaging. If resin becomes frozen for any reason, it should be left to thaw out naturally. No
attempt should ever be made to free frozen resin mechanically as this will damage the product. If resin will be handled at sub-zero temperatures, the resin may be conditioned with saturated brine to prevent freezing.

Additionally, avoid double stacking full pallets in the warehouse. If this is unavoidable due to space limitations, use pallet boards between each pallet to prevent damage to the product.

Transportation

Most Purolite resins are non-hazardous, temperature-stable materials and do not have specific temperature storage requirements. Precautions should be taken to avoid extreme temperatures during the transport of resins. If product becomes frozen during transportation, thawing should take place gradually, without any physical interference. Moving resin in their primary packaging should be avoided if possible when in a frozen state. Some products do have special storage, handling and temperature requirements. Please reference the respective Safety Data Sheet and Product Data Sheet documents.

Most of our resins are defined by the US Department of Transportation as non-hazardous. All Purolite products are Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) certified and product labels are Classification, Labeling and Packaging (CLP) compliant for international transportation. Check product Safety Data Sheets and Product Data Sheets for details on special transportation requirements.
Requirements for Resin Storage During Equipment Shut-Down

To prevent problems associated with dehydration, freezing, growth of bacteria, algae & molds, chemical stability, precipitation and corrosion, simple precautions should be taken when ion exchange equipment is shut down for an extended period.

Dehydration

For short-term storage in the service vessels, the unit should be filled with water to prevent dehydration. If draining is necessary, the vessel should be immediately sealed to prevent the resin from dehydrating.

Freezing

To reduce the chance of freezing, the vessel should be filled with dilute brine or ethylene glycol mixtures.
Growth of Bacteria, Algae and Mold

With long-term storage in the service vessels, microorganisms such as algae and bacteria can proliferate in ion exchange plants where conditions are favorable. If such growth is allowed to continue unhindered, irreversible fouling of the resin and blockage of the resin bed can occur.

To ensure the plant remains in good working order, take the following precautions prior to shut-down:

• Subject resin beds to an extended backwash to remove suspended material collected during service. Regenerate the bed to ensure the resin is in a "clean state" before conditioning for long-term storage.

• Exhaust cation beds with a 10% NaCl solution until neutral pH is achieved. Close all valves and leave resin beds immersed in the sodium chloride solution for the period of shut-down.

• Treat anion resins with 2 to 3 bed volumes (BV) of alkaline brine (10% NaCl + 2% NaOH), allowing the last bed volume to stand for several hours before displacing with a further 2 BV of neutral brine (10% NaCl). Leave the bed immersed in the sodium chloride solution for the period of shut-down.

• At the end of the shut-down, rinse NaCl from resin and, if necessary, sanitized with peracetic acid.

Note: where softeners are subject to regular shut-downs or infrequent use, Purolite C100EAg should be considered to control biological fouling due to its biostatic properties.

Chemical Stability

Strong and weak acid cation resins are stable in terms of ion exchange capacity. However, after a short time, strong acid resins can produce color throw when trace leachables diffuse from the resin matrix. Diffusion is more pronounced in hydrogen form strong acid cation resins. Therefore, in addition to classification backwash (where appropriate), the resin should be regenerated and rinsed prior to use. This process should also be used for the sodium form resin.

When treated water is intended for human consumption, for use within the food industry, or when the resins are intended for direct food processing, preconditioning should be used as specified by local, national or other regulatory authorities.
Strong base anion resins are stable in the chloride and sulfate forms. The hydroxide form, and to a lesser extent carbonate and bicarbonate forms, slowly degrade (even at room temperature) to produce some weak base functionality at the expense of the strong base groups — plus a small (almost insignificant) loss of total capacity. The degradation processes accelerate at higher temperatures and the loss of total capacity becomes significant close to or above the maximum recommended operating temperature. It is important to convert the resin to a salt form, generally chloride form, prior to shut-down or storage. This will also prevent the generation of an amine odor which develops when hydroxide form anion resins are stored.

Weak base anion resins are more stable and can be stored in either freebase or chloride form. To avoid possible bacteriological growth, the chloride form resin should be immersed in brine, as outlined above. This may be preferred for storage of used resin.

If cation or anion resins are left standing in the presence of strong oxidizing agents such as nitric acid, there is a risk of explosion. This risk is greater at elevated temperatures. Seek expert advice before storage of resins in nitrate form. For full details on safe handling of ion exchange resins or copolymers, consult the relevant Purolite material safety data sheet (See website, www.purolite.com).

Precipitation and Corrosion

Take care to choose an ionic form resin and water source for making up storage solutions to avoid precipitation within the bed. For example, high hardness in the presence of high bicarbonate or hydroxide can cause precipitation. This can block collector systems, foul the resin and cause deposits that can set up corrosion. Such problems may result from changes in temperature that occur during shutdown when contaminant ions are oxidized or become insoluble.

Care should also be taken to ensure that storage solutions are compatible with materials of construction, not only the vessel/lining, but also materials of construction for vessel components. For example, certain grades of stainless steel cannot accommodate high chloride levels.

Preconditioning Recommendations

We advise on classification backwash (where appropriate) to ensure the bed is fully classified and that the lowest pressure drop is encountered across the bed. We also recommend regeneration and additional rinsing to move trace leachables from new resin.

Be aware that when resins are first used, the ionic form required for the application is often different from the ionic form in which the resin is supplied. To convert the resin to the correct form, an initial double/triple dosage of regenerant is required to substantially convert the resin to a high state of regeneration.
Sterilization

In some industries, there is increasing end-user demand for regular, routine sterilization of the water treatment system — including the ion exchange plant. Sterilization is also required if biological contamination of a bed is suspected.

Historically, chemicals such as formaldehyde, sodium hypochlorite, hydrogen peroxide, etc. have been used. The use of formaldehyde, however, is no longer recommended due to concerns over the handling of this material, and the damage strong oxidizing agents can inflict on ion exchange resins. While hypochlorite and hydrogen peroxide solutions are still used, it is important to pay attention to concentration and contact time as these chemicals can damage the resin and cause de-crosslinking of the resin matrix. In the case of anion resins, hypochlorite and hydrogen peroxide solutions will chemically attack the resin’s’ active groups.

The sterilization chemical of choice favored by many companies is peracetic acid. A low hydrogen peroxide grade is widely available and has been shown to work very effectively on cation and anion resins without the risk of adversely affecting the performance of the bed.

A Special Note — Food Industry Recommendations

Special food-grade resins are supplied to potable water and food and beverage industries. Food-grade resins undergo special production steps in their manufacture and additional post treatment to reduce leachables that may be present and to meet specific regulatory and customer requirements.

On initial installation, Purolite recommends additional regenerations/rinsing, or in some cases special treatments to ensure the resin meets the required specifications and provides the best performance. The end user should test the water to ensure it satisfies any specific requirements for the application before placing the plant in service.

In the unlikely event of any continued concerns about taste, etc., further cycling between exhausted and regenerated forms will normally address the problem.

If additional information is needed regarding the storage, transportation and preconditioning of ion exchange resins, contact your nearest Purolite office or visit www.purolite.com.
Purolite, the leading manufacturer of quality ion exchange, catalyst, adsorbent and specialty high-performance resins, is the only company that focuses 100% of its resources on the development and production of resin technology.

We’re ready to solve your process challenges. For further information on Purolite products and services, visit www.purolite.com or contact your nearest Technical Sales Office.

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