Ion Exchange Part 2: Tips on Moving Ion Exchange Resins from Place to Place

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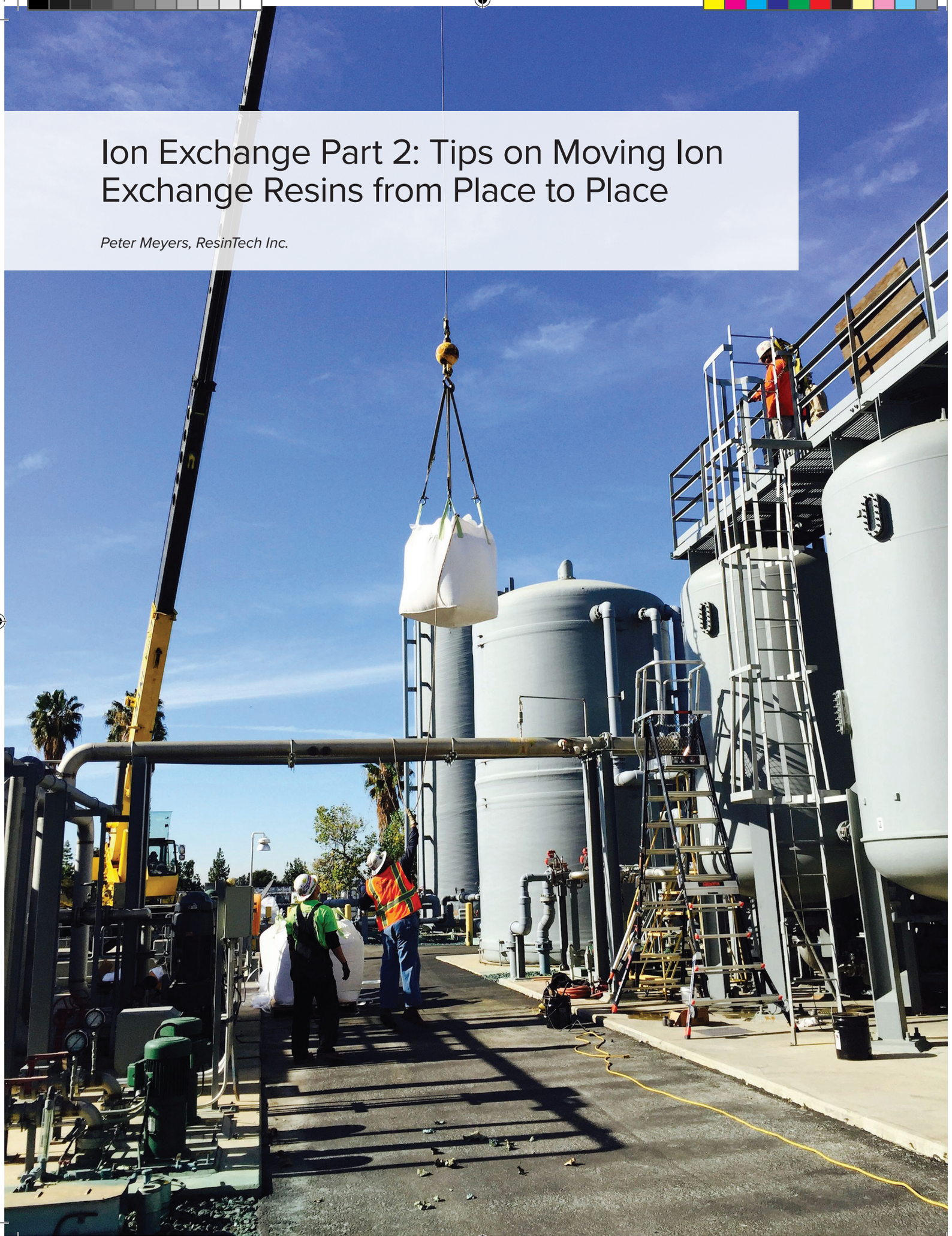

(Author's note: This article is Part 2 of a series of articles that covers various aspects of how ion exchange resins are used—not the actual applications, but rather the physical aspects of touching resins, feeling them, and caring for them. This part covers moving resins, including physical (dry) methods, slurry methods, and miscellaneous aspects of resin transfer. Part 1 examined resin storage, including new resin, used resin, and what happens to resin as it is stored under various conditions.)

Introduction

IX resins look and feel a little like sand. A bucket of resin weighs about half as much as a bucket of sand. Resins can be moved "dry" or wet and can be vacuumed. Resin slurries can be pumped, educted, or vacuumed by a variety of means. Small quantities of dry resin can be scooped up and poured into a container using a scoop or bucket. Larger quantities can be lifted by crane, hoist, or forklift and dropped into a tank. Physical methods of moving resin include the following approaches:

Bucket brigade. The bucket brigade is a very reasonable way to move smaller quantities of resin, especially when none of the slurry methods are conveniently available. In its simplest form, a worker fills a bucket from a larger container of resin (usually a drum or super sack) and then pours it into the exchange tank—either through an open manway or through a funnel. When more than one worker and bucket are available, the process can be sped up by passing buckets from one worker to the next. Although admittedly labor intensive, a surprisingly large volume of resin can be loaded rather quickly in this fashion. Figure 1 shows an example of IX resin in a bucket.

Figure 1: Bucket filled with IX resin.

Cutting bags open is another labor intensive but quick way to move resin. Simply lift the bag up to the manway, cut the bag, and pour the resin into the tank. This method has risks, especially if the worker must carry the bag up a ladder. It is also all too easy to leave pieces of the bags in the tank. When cutting bags, a single cut through the "belly of the bag," followed by grabbing the corners of the bag and shaking it is generally the most efficient and risk-free way of doing this. *(Pro tip: Keep a firm hand on the knife, and do not leave anything (like a cell phone) in your shirt pocket.)*

Figure 2 illustrates loading a bag of resin directly into an IX vessel. In the photo, workers atop a vessel are preparing to empty a bag of IX resin.

Figure 2: Workers prepare to empty a bag of IX resin atop a resin vessel at a power station.

Chutes. For larger vessels with top mounted manways, where the resin is provided in bulk sacks, a crane or hoist can be used to position the sack above the tank. The spout at the bottom of the sack is then opened, allowing the resin to drop into the tank. For vessels with side-mounted manways, this method can still be used by

fashioning a chute that is inserted into the manway and pouring the resin from the bulk sack down the chute and into the vessel.

Funnels and vacuums. Resins can also be vacuumed. This method is especially useful for smaller tanks but has been successfully employed with very large tanks where waterless loading was desired. A vacuum is applied inside the tank and the resin is sucked in, either through a hose or perhaps a funnel. Vacuum-assisted funnels are a great way to load small fiberglass tanks.

When dry loading a tank from bulk sacks, it is generally advisable to pre-fill the tank part way with water (a foot or two above the underdrain) so the water acts as a cushion, protecting the internals from possible damage. In cases where waterless loading from bulk sacks is desired, the discharge from the first sack(s) should be carefully controlled to prevent the resin from dropping "en masse" onto the internals. Once the internals are covered with resin, this extra caution is no longer needed.

Slurry Methods

Resin is readily transferred as slurry. Although slurry methods may require additional hardware, they are usually faster than dry loading methods and require less manpower.

Slurry methods of loading resin generally employ one of the following:

- Eductor syphons
- Pumps (either air diaphragm or a variety of trash pumps)
- Pressurized transfer from a pressure vessel

Eductors (ejectors) use water pressure to create a vacuum that sucks up resin and entrains it in the discharge. These devices are inexpensive and easy to use. They are not very fast and use large volumes of water. They are somewhat less prone to plugging than other slurry methods and thus are perhaps better for beginners.

A 2-inch (in) eductor using 60-gallons per minute (gpm) of motive water can transfer approximately 2 to 5 cubic feet (ft^3) per minute. Depending on motive water pressure (higher is better), eductors typically cannot suck resin up more than few feet and cannot discharge it to greater than 15 feet height. Eductors require a minimum of 40 pounds per square inch (psi) motive pressure; however, 60 psi is better, and 80 psi or more is ideal. Figure 3 shows an eductor used for moving IX resin.

Figure 3: Eductor used for moving IX resin.

Resin pumps. Slurries can be pumped by a variety of pumps. Resin pumps are very fast and efficient. Resin loading using a resin pump is simple and requires very little manual labor. However, pumping slurries can be tricky and does require attention to slurry basics. There are a few simple tricks to the process that must be learned in order to load tanks efficiently and without problems.

The two most popular types of resin pumps are double diaphragm and recessed impeller-type centrifugal pumps. Tube pumps, gear pumps, and conventional centrifugal pumps (where the impeller is not recessed) are more problematic because they have a greater tendency to fracture some of the resin beads and are also more prone to plugging.

Air- or electric-driven double-diaphragm pumps are convenient and effective. They are more prone to plugging than recessed impeller pumps and more difficult to clear when plugged. A minimum size of 1½ in is recommended, but 2 in is better.

Recessed impeller pumps (sometimes known as trash pumps) have the impeller positioned outside the flow path and work by creating a vortex that sucks up the slurry. Although not specifically designed to pump resin, they are relatively inexpensive and fairly easy to use, and they

are heavy. The best sizes are 2-in or 3-in, and cast iron is probably better than stainless steel because it is better at dissipating heat, and the stainless pumps do tend to overheat if used for more than a few minutes at a time.

Figure 4 shows an illustration of a resin bin and pump used to move IX resin into a vessel. Figure 5 shows resin being loaded into a vessel by pumping in an industrial facility.

Figure 4: Illustration of IX loading approach using a bin and pump.

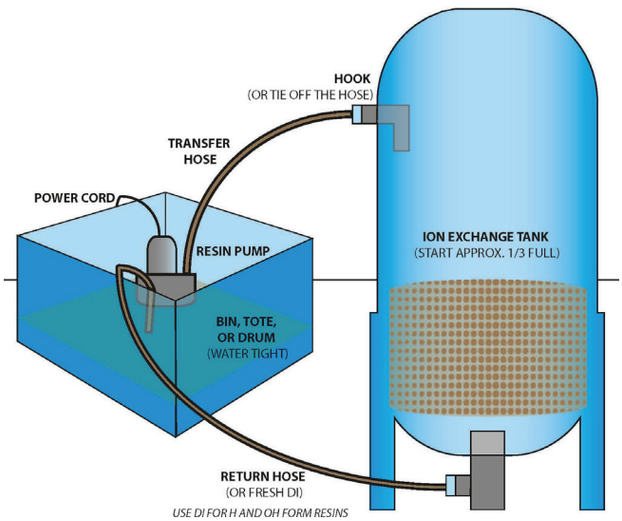

Figure 5: Loading IX resin into a vessel by pumping.

Pressurized Resin Transfer

Resin can also be transferred from the bottom (or bottom side) of a pressure vessel using water and/or air pressure. For air-water pressure transfer, the following general guidelines apply:

1. Two volumes air (at >30 pounds per square inch gauge [psig]) per volume of resin minimum.

2. One volume of water per volume of resin minimum.

3. Resin transfer sequence:

    a. Fluidize resin first by backwashing.

    b. Start water transfer first, then add air (after approximately 1 minute).

    c. Stop water but continue air when resin is approximately half transferred.
        i. Allow the vessel to drain, but keep water over the resin until almost all the resin has transferred.
        ii. Add more water as needed to maintain the resin slurry

    d. When almost all the resin and water has transferred, add more water to refill.
        i. Allow water level to rise to approximately 6 in.
        ii. Allow water level to drop until only air is flowing out the transfer line.
        iii. Cycle back and forth between filling and draining to transfer the last traces of resin from the vessel.

    e. Depressurize vessel by turning off air and water and opening vent.

Resin Slurry Fundamentals

For any slurry method, start the flow of water first and then add the resin for best results. This is especially true of pumping methods. There is some "learned technique" associated with using resin pumps, especially with granular medias that do not flow easily.

Moving resin as a slurry is generally easiest if the flow of water is established first and then the resin is introduced

into the flow. This practice greatly reduces the chance of resin plugging up the transfer line.

Transfer piping considerations. Moving granular materials by slurry and having the transfer piping plug up can be a very frustrating experience. Following a few basic principles will help prevent problems. Here are some guidelines for smoother operation:

1. Keep the slurry velocity above 4 feet per second (fps). At lower flows, the resin tends to separate out below the water. A minimum of 6 to 8 fps velocity is ideal (no upper limit except that of prudent piping design).

2. Keep the liquid-to-resin ratio at 1:1 or greater. Two volumes of water per volume of resin is ideal.

3. Small transfer lines plug easier than larger lines. Do not use anything smaller than 1-in transfer piping. Piping sized at 2 or 3 in is better.

4. Keep transfer lines as short as possible, especially if the transfer lines are 1 in.

5. Hose is good, but watch out for hose fittings that severely restrict the opening size, and avoid hose that is corrugated on the inside.

6. Pipe is good, but avoid short radius elbows or tees. Do not use piping smaller than 1½-in—you are just asking for trouble.

7. ALWAYS start the flow of water first, before adding resin to the slurry.

Dewatering Strategies

Since all wet methods of removing resin into or out of a tank involve the use of water, it is usually necessary to consider dewatering when planning for resin loading or unloading. The least amount of water needed is when unloading with a vacuum or with tank tipping. Here, the volume of water could be as little as the interstitial void volume (approximately one-half of the resin volume). However, other methods require considerably more water. Pressurized transfer and pumping methods use between 1.5 and 3 volumes of water per volume of resin. Eductors and gravity flow methods require even more water.

Hopefully, the containers the resin will be unloaded into will be self-draining (meaning they have a strainer and drain or are porous enough for the water to escape while retaining the resin). If the containers are not self-draining, it is necessary to allow for the extra water volume in planning how many containers are needed.

Dewatering bins, totes, or plastic tanks can be fitted with a drain and strainer that permit convenient dewatering. These containers are especially useful if the resin will be stored and later returned to the service vessel. Be sure to allow some extra capacity to account for excess water. These containers are generally not as convenient if the resin will be subsequently disposed of because additional steps are needed to transfer the resin into the final disposal container.

Dewatering hoppers are generally only used for permanent facilities where resin unloading and dewatering is frequently required. The hopper should have a cone angle of at least 60° (steeper is better) and should be equipped with screened drains close to the bottom of the cone. The bottom of the cone should be sufficiently elevated to position and drum or bulk sack underneath. A 6-in or larger butterfly valve placed at the very bottom of the cone permits unloading dewatered resin directly into a drum or bulk sack without any further requirement for unloading. *(Pro Tip: It helps to have an air wand that can be lowered into the tank and directed at clumps of resin that stick to the sidewall. This method permits removal of all but a few beads.)*

Dewatering wand. For drums, totes, and bins, it is fairly easy to construct a dewatering wand. This is simply a pipe with a screen over the end connected to a shop vac or other vacuum. The wand is pushed down to the bottom of the container, and excess water is vacuumed out. It helps to tip the container with the wand positioned at the low point.

Drip dry. Bulk sacks filled with water and resin are not stable and must be supported until the water drains. The last of the water pools at the bottom of the sack. Lifting the sack and allowing it to drip dry helps complete the dewatering process.

Closure

This discussion about moving IX resins is Part 2 of a multi-part work describing the physical aspects of how resins are used. Other articles in this series include an introduction to using IX resins, storage, loading, unloading, disposal, and step-by-step procedure outlines.

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