Optimizing Portable Exchange DI Plants

By Francis J. DeSilva & Larry Gottlieb. Published in Water Conditioning & Purification Magazine, August 1997.

This is the first in a series of papers that are dedicated to the optimization of the resources in portable exchange DI (PEDI) plants.

PEDI plants are designed to regenerate resins at a central location and then bring these regenerated resins out to customer's plants to provide DI water. When those tanks are exhausted, they are returned to the central regeneration facility where they are regenerated.

The economics of a PEDI operation are usually based on the amount of time a tank spends at the customer's facility. The longer the tank is in service and operating, the more the value. The longer it lasts in service, the less frequent the change outs, and the less frequent that a service representative has to visit the facility. Customer visit involve the service representative's time, the truck and its associated expenses, and materials.

Different PEDI plants have different economic driving forces. Some plants need to economize on chemical usage, while others need to save water, still others have an operation where time is of the essence and canisters must be in and out in the shortest possible time. In any case, plant optimization is a major concern.

This paper addresses the conservation of water within a plant. The techniques outlined below can be used to minimize water consumption and waste water discharge, provide a higher capacity regenerated resin, save on time, and even save on equipment by minimizing neutralization tank capacity.

The rinse step that is performed after chemical injection is the largest producer of wastewater during the regeneration process. A typical PEDI plant uses about 75 gallons of rinse water per cubic foot of resin. This amount is roughly 70% of the total volume of wastewater produced during regeneration.

Using a rinse recycle configuration during the rinsing step will slash water consumption more than 65%. The equipment required for this technique is a dedicated cation tank or hosing resin and a dedicated anion tank (weak base or strong base) for rinsing cation resins, a pump and some additional piping. It is also possible to use this technique without dedicated tanks, merely by using the separate cation and anion components to neutralize and rinse each other. See the two diagrams below.

This technique starts out like a normal rinse. Using plant water, the rinse water is sent to waste until about one or two bed volumes (7 to 15 gal/cu.ft.) have been displaced, at this point, rinse recycle can begin. Conductivity can also be used. The recommended procedure is to rinse the resin in the plant down to less than 5000 micromhos. This is 1000 ppm or about 60 grains per gallon for anion resins; for cation resins it represents 800 ppm or 50 grains per gallon. This initial rinse water goes to the neutralization tank. After rinsing to below the 5000 micromho level, the flow is diverted to the appropriate dedicated rinse resin until quality is achieved.

How low of a conductivity if achievable? Older anion resins contain organics, which will stay in the recirculation loop. Somewhere between 0.1 and 20 micromhos is where it will level off for strong base anion and cation, and 2 to 30 micromhos for weak base anion.

How often do you regenerate the dedicated rinse charge tanks? One cubic foot of ResinTech CG8 cation resin is good for about 100 to 500 cubic feet of regeneration. ResinTech SBG1P, strong base Type 1 porous anion resin is good for about 100 to 500 cubic feet of regenerations and ResinTech WBMP, weak base anion resin, is good for about 125 to 600 cubic feet of regenerations. These numbers are based on the basic capacity numbers of the dedicated rinse resins that are shown below.

Type of Resin	**Dosage**	**Capacity kgrs/cu.ft.**
ResinTech CG8	8 lbs. per cu.ft. HCL	30
ResinTech SBG1P	8 lbs. per cu.ft. NaOH	15
ResinTech WBMP	8 lbs. per cu.ft.	24

Saving Water, Managing Resources

In addition to saving purely volume of water used during regeneration, using a recirculated rinse frees up other plant resources. A recirculated resin rinse is a stand-alone operation. Two tanks are hooked up in a recirculating loop utilizing a pump. Limited operated attention is required and no additional water is needed. At this point in time, plant water and manpower become available for use in other operations. City water or demineralized water is no longer needed for constant rinsing of the DI resins and the next regeneration may be started at this time.

Many plants are limited by the process flow available to plant operators. A recirculated DI rinse allows limited plant resources such as water pressure and water flow to be utilized more efficiently and increase productivity. For example, a plant equipped with three quarter inch water service has a usable flow rate of approximately 20 gallons per minute. At this point, flow may be a limiting factor, prohibiting simultaneous operations from occurring in the plant. By using a recirculated rinse, operations are now able to be performed in parallel. Resins may be self neutralizing while a second regeneration is occurring. Since the rinse recycle is a stand-alone process, no additional water is needed and there is no demand on the inlet water service.

Higher Capacity

Additional savings may be realized by getting higher capacity from standard regenerations. Plants using city water or softened water to rinse their DI resins will use large volumes of water and exhaust some of the resin's capacity during the rinse cycle. By using a recirculated rinse, a finite quantity of water with a known quantity of salt content will be recirculated through the resins, self-neutralizing each other and rinsing up to water quality. By using a rinse recycle operation, as opposed to high conductivity rinse water, operating capacities may be increased by as much as 5%.

For those plants using demineralized makeup water, using a smaller quantity of rinse water will require less demand from their working demineralizers. Subsequently, these demineralizers will need to be regenerated less frequently, and generate less waste volume for the plant to discharge.

Equipment

The rinse recycle step, when initiated, diverts the waste rinse water from the ion exchange tank through a dedicated rinse tank and then back into the ion exchange tank. Let's look at a cation that's being rinsed. The rinse water, after its gone through the cation bed and has rinse down to a certain quality, is diverted from the waste tank to the dedicated anion rinse tank. The dedicated rinse tanks are small units that contain one to several cubic feet of resin. The rinse water goes through this dedicated rinse tank, then to a pump, which provides the motive force to push the water back through the resin that's being rinsed. Guidelines for sizing the dedicated rinse tank are shown below.

Product	**Type of Resin**	**Number of Regenerations**
ResinTech CG8	Strong Acid Cation	100 - 500 cu.ft.
ResinTech SBG1P	Strong Base Anion	100 - 500 cu.ft.
ResinTech WBMP	Weak Base Anion	125 - 600 cu.ft.

The information above details the additional equipment that is needed for rinse recycle program. One of the benefits of rinse recycle is equipment that is not needed, precisely a large neutralization, by eliminating the bulk of the waste water that's produced during regeneration, a smaller waste water tank can be used in a PEDI plant. Existing PEDI plants can now regenerate greater quantities of resin using the existing waste neutralization tank. Many times, the waste neutralization tank is the limiting factor in how much resin can be regenerated on a given day. Larger batch size of resin may also be regenerated because of the savings in waste volume.

Potential Pitfalls

Pumps used in recirculated rinse systems will have a tendency to heat the water as it is pumped around the loop. In extreme cases, if systems are left unattended water temperatures may exceed temperature limits for the materials used in the construction of the recirculated loop.

Improper sizing of recirculation pump can cause various problems as well. A pump that is too small will cause excessive rinse times, and a pump that is too large may cause cavitation in the system and damage the recirculation loop. Additionally, leaks in the system may cause water levels to fall below the resin bed and cause poor or improper rinsing of the resin.

Rinse recycle scenarios must be performed in pressure vessels. These pressure vessels need to be full of water to insure proper distribution through the tanks and to avoid chemical hideout in the pumping and piping systems.