CONTINUOUS IMPROVEMENT

Optimizing Portable Exchange DI Plants using a Rinse Recycle Scenario

By Francis J. DeSilva and Larry Gottlieb

Summary: *The rinse recycle technique can make marked improvements to existing PEDI plants including reduced waste, higher capacity and time savings. But there are a few things to bear in mind when undertaking this process.*

Resource optimization—particularly water conservation—in portable exchange deionization (PEDI) plants is a goal of many water treatment professionals. There are several techniques available that can be used to minimize water consumption and wastewater discharge volume. These techniques also provide a higher capacity regenerated resin, save on time and even save on equipment by minimizing neutralization tank size requirements.

PEDI plants are designed to regenerate portable resin tanks and then bring the tanks to customers' plants to provide DI water. When those tanks are exhausted, they are returned to the central regeneration facility.

The economics of a PEDI operation usually are based on the amount of time a tank spends at the customer's facility. The longer the tank is in service and operating, the greater the value. The longer it lasts in service, the less frequent the change-outs and the less frequently a service representative has to visit the facility. Customer visits involve the service representative's time, the truck with 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 on water consumption. Still others have an operation where time is of the essence and tanks must be in and out in the shortest possible time. In any case, plant optimization is a major concern.

Regenerating resins

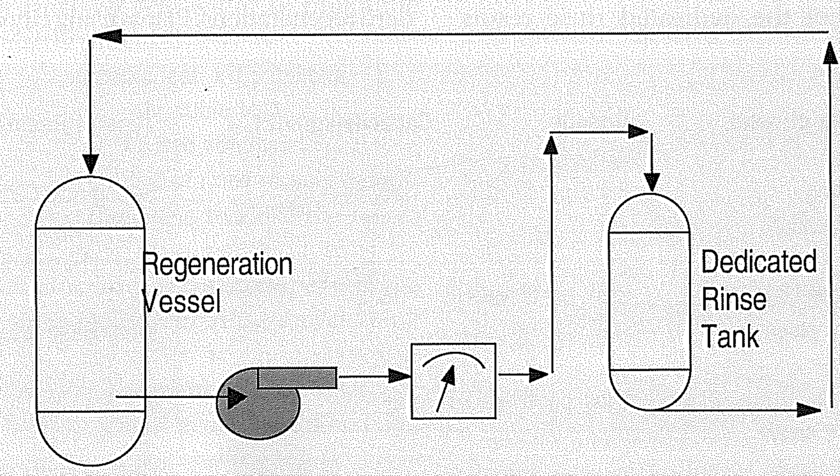
The regeneration of ion exchange resin is a four-step process: backwash, chemical injection, displacement rinse, and fast rinse to quality. The backwash introduces water counter current to purge the resin of any resin fines and reclassify the bed. Chemical injection regenerates the resin by converting it to the proper ionic form. The displacement rinse allows the final part of the chemical injection to react with the resin and slowly rinse out the bulk of the spent regenerant. The fast rinse is used to get the remaining chemical traces out of the bed and bring water quality back to a point where the unit may be put back into service.

Waste not, want not

The fast rinse step performed after chemical injection is the largest producer of wastewater during the regeneration process. A typical PEDI plant uses 50-to-75 gallons of rinse water per cubic foot of resin. This amount is roughly 70 percent 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 percent. The equipment required for this

FIGURE 1



technique is a dedicated cation exchange tank for rinsing anion exchange resin and a dedicated anion exchange tank (weak base or strong base) for rinsing cation exchange resins. A pump, conductivity meter and some additional piping are also required. It is also possible to use this technique without dedicated tanks by using the separate cation and anion components to neutralize and rinse each other. See Figure 1 for system configuration.

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 (7.5-to-15 gal/ft^3) have been displaced. At this point, the rinse recycle step can begin. Conductivity also can be used as a displacement rinse endpoint and as an indicator of when to initiate the rinse recycle step.

Longer life

How often do you regenerate the dedicated rinse tanks? The lower the conductivity achieved during the displacement rinse step, the longer the life of the dedicated rinse recycle tanks. 5,000 micromho is the maximum conductivity allowable to achieve favorable rinse recycle capacity. One cubic foot of strong acid cation exchange resin is good for about 200-to-700 ft^3 of regeneration. Strong base Type 1 porous anion exchange resin is good for about 100-to-350 ft^3 of regeneration; weak base anion exchange resin for about 125-to-550 ft^3. These numbers are based on the basic capacity numbers of the dedicated rinse resins shown in the chart below.

Saving water, managing resources

In addition to saving large volumes of water, a rinse recycle 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 operator attention is required and no additional water is needed. At this point, plant water and manpower become available for use in other operations. City 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 total water flow available. A rinse recycle configuration allows limited plant resources such as water pressure and flow to be utilized more efficiently and increase productivity. For example, a plant equipped with ¾-inch water service has a total usable flow rate of only 20 gpm, prohibiting simultaneous operations from occurring in the plant. By using rinse recycle, operations can now 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 through higher capacity from standard regenerations. Plants using city or softened water to rinse their DI resins will use large volumes of water and exhaust some of the resin's capacity during the fast rinse. By using a rinse recycle, a finite quantity of water with a known 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 percent.

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

Equipment

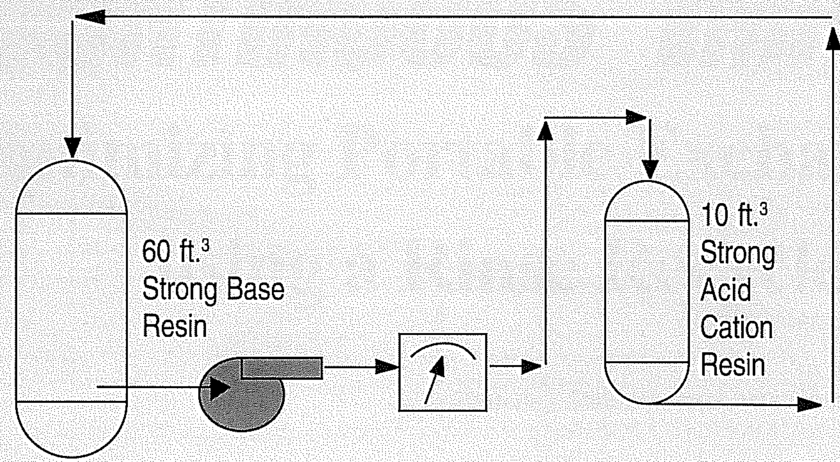
When initiated, the rinse recycle step diverts the rinse water from the waste storage tank to a dedicated ion exchange rinse tank and then back into the ion exchange regeneration vessel. The rinse water, after it has gone through the cation exchange bed and has rinsed down to a predetermined quality, is diverted from the waste tank to the dedicated anion exchange 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 that provides the momentum force to push the water back through the resin that is being rinsed. Guidelines for sizing the dedicated rinse tank are shown below.

Type of resin	Dosage	Capacity(kgrs/ft^3)
Strong acid cation	8 lbs. per ft^3 HCl	30
Strong base anion	8 lbs. per ft^3 NaOH	15
Weak base anion	8 lbs. per ft^3 NaOH	24

Type of Resin	Rinse capacity*
Strong Acid Cation	200-700
Strong Base Anion	100-350
Weak Base Anion	125-550

Cubic feet of resin rinsed per cubic feet of rinse recycle resin.

FIGURE 2



The information above details the additional equipment needed for the rinse recycle program. One of the benefits of rinse recycle is the fact that some equipment, precisely a large neutralization tank, is not needed. By eliminating the bulk of the wastewater produced during regeneration, a smaller wastewater tank can be used in a PEDI plant. Existing PEDI plants can now regenerate larger quantities of resin using an 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 sizes of resin also may be regenerated because of the savings in waste volume.

Potential pitfalls

Pumps used in rinse recycle 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 limits for the materials used in the construction of the recirculation loop.

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

An example

Technically, one cubic foot of strong acid cation resin will have the capacity to rinse recirculate at least 200 cubic feet of strong base anion resin. However, it would not be practical to have a 200 cubic foot regeneration vessel and a one cubic foot rinse recirculation tank.

A rinse recirculation tank should be sized for flow rate. Approximately 5-to-10 bed volumes of water are required to recirculate rinse resin, with a bed volume defined as 7.5 gallons of water per cubic foot of resin. It follows that an undersized pump will take a very long time to recirculate this volume of water.

For example, a 60-cubic-foot bed of anion resin has been regenerated. How big should the rinse recycle be? It will take at least five bed volumes of rinse recycle water to finish the recycle process:

60 cubic feet x 7.5 gallons per cubic foot x 5 bed volumes = 2,250 gallons of rinse recycle water.

If our goal is to rinse the resins down in 60 minutes, this means we have to pump 37.5 gallons per minute. Additionally, our rinse recycle tank must be sized to accommodate this flow rate. Therefore, a tank containing 10 cubic feet of resin should be large enough to accommodate this flow rate (see *Figure* 2).

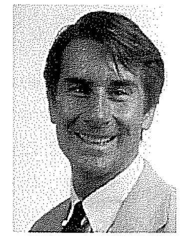
Conclusion

The rinse recycle technique can be a substantial improvement to an existing PEDI plant. This brief overview has presented guidelines for implementing this concept, but each PEDI plant has its own idiosyncrasies and priorities. Contact your resin manufacturer for specific design recommendations.❑

Editor's note

The calculations in this article were conducted based on resins supplied by ResinTech.

About the authors



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