Water Technologies & Solutions
application note

time-based regeneration practices have three possible outcomes... and two of them are bad

synopsis

Regenerating mixed-beds on a fixed time-based schedule risks contamination of polish loop resins and/or results in excessive regeneration/ degradation of resins leading to increased material and operational costs.

Many practices exist for determining when to regenerate primary mixed-bed resins and replace polish-loop resins. While no one practice can be said to work best in all applications, one approach has been demonstrated to have significant room for improvement: the fixed-schedule time-based approach. Similar to Woody Hayes' oft-quoted opinion of the forward pass—time-based regeneration has three possible outcomes, and two of them are bad (and expensive).

The absence—until now—of an on-line technology to continuously monitor the performance of primary mixed-bed resins and polish loop resins, and to provide indication of approaching exhaustion, has led to a growing practice of regenerating primary beds after a fixed time of operation.

There are three possible outcomes of this strategy:

- Regenerating too soon
- Regenerating too late
- Regenerating at just the right time

Figure 1 is an example of how one site might look at bed management. The line separating wasted resin capacity from risk exposure to the polish resins is indeed a very fine one. Every site will differ in the specifics of a defined optimum regeneration point, and so this graph is simply a general example.

Regenerating too soon results in unused (wasted) resin capacity and the entire bed is regenerated when only a fraction—sometimes a very small fraction—of resin sites has actually been populated with ionic contamination. This also results in excessive regenerations that have the consequence of promoting more rapid degradation (both physically and chemically) of the resins. These consequences of regenerating too soon have the impact of increasing operational costs, as well as material costs when resins must eventually be replaced sooner than would otherwise be necessary.

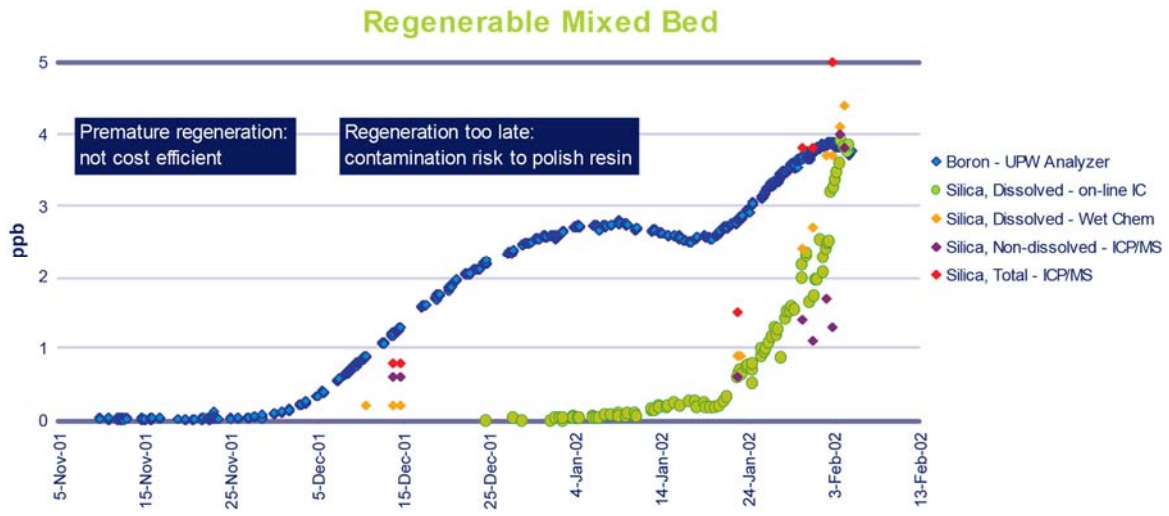

Figure 1. General Example of Resin Bed Management

Regenerating too late means that ionic contamination is released from primary beds and subsequently loads polish loop resins. This scenario is not very common as the majority of facilities relying on time-based regenerations employ a very conservative approach to the practice to avoid this very situation. However, avoiding this scenario only contributes to a greater inefficiency associated with regenerating too soon.

Regenerating at just the right fixed time frequency is exceedingly difficult, if not impossible, from a practical point of view. Many factors—variable in and of themselves—influence the capacity of a given resin to remove ionic impurities. CO_2 concentration, temperature, feed levels of contaminants, upstream treatment processes and resin age are just some of the variables that will determine the effective operational time of a resin bed. Characterization studies have been conducted with the intent of provide historical data to better identify the expected life of a resin, but the sheer number of influencing variables limits the success of this approach.

Effectively managing mixed-bed resins necessitates monitoring their actual performance. Anything short of evaluating analytical data promotes inefficiency and/or introduces unnecessary risk. Resin performance can only be monitored with success by employing analytical technology that can monitor the contaminant that first comes off of a resin bed that is approaching exhaustion, and that monitors that contaminant at part-per-trillion concentrations that preclude the possibility of contaminating downstream polish resins.

The Sievers* UPW Boron Analyzer measures boron at the low part-per-trillion levels necessary to provide the earliest indication of resin exhaustion. Silica analyzers are commonly used in this type of application; however, it has been well-documented in the literature that boron will always precede silica in being released from a mixed-bed resin approaching exhaustion. Further, relatively higher detection limits associated with on-line silica analyzers mean that by the time they produce a quantitative result, both silica and boron have been coming off the resin bed for a significant period.

Cost-effective, low-risk approaches to resin management necessitate the following:

- Continuous monitoring of potential contaminants
- Sensitivity to the first contaminants released from a resin bed nearing exhaustion
- Quantitative results at low part-per-trillion levels that preclude downstream contamination

In testing and demonstrations—both domestically and internationally—continuous on-line monitoring of boron as an alternative to time-based regeneration practices has returned significant cost savings related to reduced loading of polish loop resins as well as increased operational periods between primary regenerations with no risk of contaminant release.

conclusion

Effective resin management requires defined and measurable metrics for determining bed performance. The time-based approach provides for neither. While it can be used to successfully to prevent contamination of down-stream processes, it does so at an excessive operational cost. Only continuous, on-line monitoring of boron can provide for the same level of protection while maximizing process efficiency and minimizing operational costs.