Ion Exchange Resin *Housekeeping*

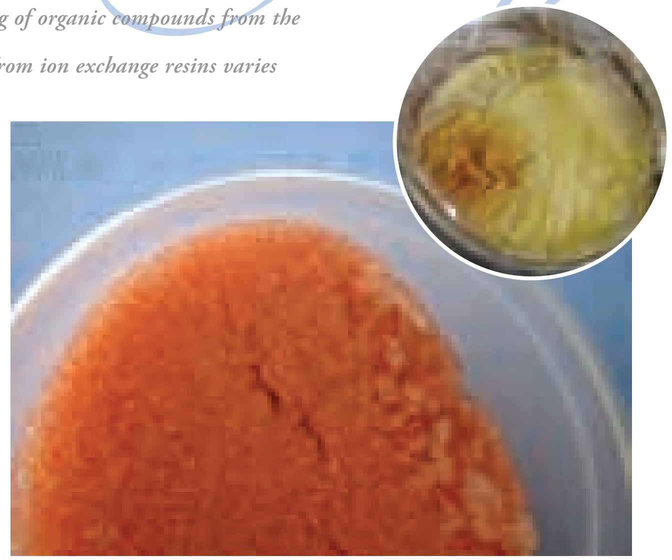
Minimizing leachable compounds from ion exchange resins

By Cliff Gilbert

One of the most common product concerns for users of ion exchange resin is the leaching of organic compounds from the resin itself. The impact of leaching from ion exchange resins varies from industry to industry.

For example, in home water softeners, color throw from ion exchange resins is usually a temporary aesthetic concern, whereas in the electric power industry, total organic carbon (TOC) leachables can seriously compromise condensate polisher function and accelerate steam generator corrosion.

Although the severity of the problem differs from industry to industry, organic leachables are unwanted in all of them. A few simple things will help operators of ion exchange systems minimize organic leachables.



Top: Discoloration caused by an improperly sealed liner.
Bottom: Close-up of discolored resin.

What are Organic Leachables?

"Leaching" is one of many terms used to describe organic compounds coming off cation and anion resin beads. Other terms include color, color throw, TOC throw, TOC leachables, extractables, sulfate throw, trimethylamine throw and organic sloughing. These terms are usually applied to new ion exchange resins and refer to compounds or very small resin fragments with the same general composition as the bulk resin bead.

For cation resins, the compounds are normally some close variant of phenolsulphonic acid or poly-sulfobenzoate esters. For the anion resins, the decomposition products include small amines like trimethylamine, dimethylamine and larger, aminated derivatives of polystyrene. Normally the level of leachables in a batch of new ion exchange resin is low because the manufacturer rinses the product extensively prior to packaging. It is not unusual for a new resin batch to have a non-detectable level of leachables at the time the product is packaged.

What Causes Ion Exchange Leachables in Storage?

Development of ion exchange resin leachables is for the most part started by an oxidation process in which atmospheric oxygen reacts with the resin to break off small subunits of the polymer chains in the plastic beads.

In addition to oxidation, there are other more subtle and complex chemical processes that also contribute to leachables. Some of these processes do not requireto lto look free oxygen. For example, the amines attached to the plastic backbone in an anion resin are not attached to the bead with equal strength. During storage, subtle chemical rearrangements may take place and these amines get detached from the resin bead. Once detached, the amine becomes a leachable.

The level of leachables in ion exchange resins increases during its time in storage. For example, a cation resin packaged and stored in a warehouse with a non-detectable level of leachables may have parts-per-million levels of leachables and visible color 90 days later. However, samples of the same resin stored in the manufacturer's quality lab in plastic bottles often will have non-detectable leachables at the end of 90 days. The difference is directly attributable to the storage conditions.

First, resin stored under laboratory conditions is kept in containers that are better oxygen barriers than commercial packaging. Secondly, laboratory samples are more likely to be stored in rooms with good temperature control. The conclusion of this is that if one controls the temperature and exposure to oxygen, this will minimize leachables production during storage.

Controlling exposure to air is probably the simpler of the two factors to control. The plastic liner used in ion exchange packaging is normally a very good barrier and prevents free air exchange into the bulk resin. It is important to ensure the liners are closed. Even slightly open bags will allow air to generate color and leachables. Examples of this are shown in the above images.

Limiting a resin's exposure to air is essentially a housekeeping matter. For example, it is important to avoid leaving opened drums or bags of resin open to the air overnight. The resin liner should be rolled shut and closed tightly to exclude excess air. A similar comment can be made for used resins.

Often when it is necessary to perform maintenance on ion exchange equipment, the tank needs to be emptied of resin. During these times, it is not uncommon to see resin get poured into bulk sacks, which do not contain plastic liners. While it is a very convenient way to empty the tank, an unlined bulk bag is not a good container for anything other than short-term storage of one to two days. The combination of excellent drainage and large surface area will encourage the development of leachables.

Temperature Control

Resin degradation processes like oxidation or deamination (loss of an anion site) accelerate at higher temperatures. For this reason, it is important to give some thought to the storage temperature. Clients who use ion exchange resin normally are only concerned about resin temperature when anion resins are being regenerated with caustic (NaOH). Most regeneration guidelines recommend a maximum temperature of 120°F.

However, while a lot of attention may be paid to the regeneration temperature, there is usually no attention paid to the storage temperature in warehouses, trucks and ocean containers. For the most part we do not know the "thermal history" of resin batches once they leave the manufacturer's plant. The general recommendation is that resin should not be stored above 90°F. However, it makes conceptual sense that high-value resins intended for sensitive applications should be stored at lower temperatures in the range of 60°F to 70°F, perhaps even lower.

Impact and Conclusion

For some ion exchange applications like water softening, leachables and color are often viewed as minor cosmetic issues that can be dealt with through rinsing or regeneration with salt. It is unlikely that paying attention to oxygen and temperature control will provide a significant benefit.

However, the same grade of resin may be used in a foodservice or laboratory cartridge where visible color throw can lead to poorly performing products and expensive inventory returns. Other applications, in the nuclear and microelectronics industries, are particularly sensitive to leachables. These industries use very high-quality, highly specified ion exchange products.

It is a common practice to use an external service supplier to pre-rinse resin before it is brought into the facility. The rinsing process reduces the leachables. For these applications it may be appropriate to review storage conditions and make improvements that will slow the rate of leachables generation. *wqp*

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