What Are The TDS Limitation for Ion Exchange Resin and Do They Matter?

Ion exchange (IX) systems are an economical means of treating liquid waste and process streams across a range of industries. Although IX can be an excellent choice for many water softening, purification, and separation applications, its performance can be less than ideal when used to treat streams with high total dissolved solids (TDS) content.

Whether you're looking for strategies to get the most out of your existing IX system, or just wondering whether IX is right for your facility, then you may be asking questions like "What are the TDS limitations for ion exchange resins?" and "Why do TDS limits matter for a facility?"

The following article will offer an overview of how IX resins work, how TDS levels can affect IX system performance, and how to avoid IX pitfalls if your streams have high TDS.

What is TDS?

Total Dissolved Solids (TDS) is a collective measure of all the molecules, ions, and colloidal particles present in a liquid stream. TDS can include any combination of inorganic and organic materials, including minerals, salts, metals, cations, and anions. TDS concentration is typically expressed either in parts per million (ppm) or milligrams per liter (mg/L).

What are ion exchange resins?

Ion exchange resin is a specialized polymeric material that is housed within an IX unit. The resin works by facilitating a physical-chemical reaction known as "ion exchange," whereby dissolved ions in the stream are replaced by more desirable ions of a similar electrical charge. Because of the nature of the process, IX resin is effective for general reduction of TDS or total suspended solids (TSS) when applied in very specific range of contaminants, however it is a cost-effective and efficient method for targeted removal of specific constituents in a stream, such as for acid separation, metals recovery, and softening applications, among others.

Over time, as an IX resin is used to treat a stream, contaminant ions will bind to the available ion exchange sites throughout the resin's matrix. As more and more of the exchange sites are occupied, the resin has less capacity to swap out the contaminant ions in the stream, and the facility must run a resin regeneration cycle to restore the resin to proper operating condition. Resin regeneration involves the application of chemical regenerants to the resin, which can consist of a salt, acid, or caustic solution depending on the resin and application, as well as rinsing and backwashing cycles. Generally, it is in a facility's best interest to take steps to minimize the frequency of regeneration cycles, since costs associated with system downtime, chemicals, and resin degradation can compromise the cost benefits of using IX as a treatment strategy.

How does TDS affect ion exchange?

IX resins are best used to treat streams with low to moderate TDS levels. This is because high TDS levels will quickly exhaust IX resins, resulting in a need for more frequent regeneration cycles. As a result, the facility will see higher costs due to greater consumption of regenerant chemicals, more downtime for regeneration, and more frequent replacement/disposal of IX resins due to accelerated degradation.

There are often no firm specifications with regard to acceptable TDS levels for IX. While IX can theoretically be used to treat streams with any level of TDS, excessive maintenance requirements and short service cycles become limiting factors for most facilities. In short, the higher the TDS, the less practical IX becomes.

For most facilities, the cost of maintaining an IX system is simply not economical for treating streams with TDS levels of 500-1000 parts per million (PPM) or more, and a facility is usually better served by either implementing a pre-treatment step, or replacing its IX system with an alternative treatment technology.