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TECHNOLOGY FACT SHEET

Ion exchange

Ion exchange is a water treatment process in which unwanted dissolved ions— like nitrate, fluoride, sulfate, and arsenic — are exchanged for other ions with a similar charge. The exchange process occurs between a solid (resin or a zeolite) and a liquid (for example RO permeate).

Ion exchangers. Source: SAMCOtech.com

Resins are very small porous plastic beads (ca. 0.6 mm) which contain invisible water measured as "humidity" or "moisture content". The structure of the resin is a polymer on which a fixed ion has been permanently attached. This ion cannot be removed or displaced; it is part of the structure. To preserve the electrical neutrality of the resin, each fixed ion must be neutralised with a counterion. This counterion is mobile and can get into and out of the resin bead.

In the process, the less desired ions in the solution are swapped for those that are considered more desirable. In case of cations (like NH4+, K+) charged ions) this is usually sodium, which is the mobile counterion (a.k.a. active groups or functional groups) on the resin surface.

The anion resin bead has fixed quaternary ammonium cations ($CH2—N^{+}(—CH_3)_3$) with often chloride as a mobile counterion.

Resins including both cation and anion exchange ions are not possible, because the fixed cations inside the resin beads would neutralise the fixed anions and no exchange with the outside world would be possible. Therefore you need separate cation exchange resins and anion exchange resins (de Dardel 2021).

Resin materials have a finite exchange capacity. Each of the individual exchange sites will become full with prolonged use. When unable to exchange ions any longer, the resin must be recharged or regenerated to restore it to its initial condition. The substances used for this can include sodium chloride, as well as hydrochloric acid, sulfuric acid, or sodium hydroxide.

Ion exchange resins are commonly used in columns. The solution to be treated flows through the resin. At the end some of the ions from the feed escape into the pure solution, and operation is stopped. a large industrial ion exchange column can contain 20,000L of resin, sometimes more (de Dardel 2021).

The primary substance remaining from the process is called "spent regenerant." It contains not only all of the ions removed, but also any extra regenerant ions, and will also have a high level of total dissolved solids. Regenerant can be treated in a municipal wastewater facility, but discharges may require monitoring (Fluence 2021).

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no. 730400. (www.systemicproject.eu).*

Read more about the recovery efficiencies, fouling and scaling, use of additives, energy requirements and costs in Chapter 2.2.4 of D 3.2 Final report on schemes and scenario's for nutrient recovery and Reuse.
www.systemicproject.eu/downloads →"project deliverables"

References

de Dardel, François. 2021. "Ion Exchange Basics." Retrieved (http://dardel.info/IX/IX_Intro.html).

Fluence. 2021. "What Is Ion Exchange?" Retrieved (https://www.fluencecorp.com/what-is-ion-exchange/).

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