

What is Ion Exchange?

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The Basics of Ion Exchange

Ion exchange is a method for decontamination and purification of water and helps to remove unwanted compounds in water.

We learn at a young age that water is made up of two atoms of hydrogen and one of oxygen. But water is much more complex than that. Contained in each drop of water are minerals and other substances that add to the chemical and physical properties of each drop—including (but not limited to) taste and smell. Some examples are calcium, magnesium, iron, manganese, sodium, hydrogen, chloride, sulfate, nitrate, hydroxide and silica. Although they are dissolved and are unable to be seen by the naked eye, these compounds exist in the water as ions.

The ions of these molecules have an electric charge. Ions with positive charges are called cations, while ions with negative charges are called anions. For example, sodium and hydrogen have positive charges (Na^+) (H^+), whereas chloride and hydroxide have negative charges (Cl^-) (OH^-). The electric charge dictates how ions are removed from water.

Cations (positively charged compounds) are removed with cation exchange resins, while anions (negatively charged compounds) are removed with anion exchange resins.

These ion exchange resins are composed of insoluble polymer beads designed with a "functional group" that attracts ions of the opposite charge. Each bead has many functional sites that exist all over the bead, from the surface to deep inside.

For example, Purolite® C100 is an ion exchange resin bead with negatively charged sulfonic functional groups. These negatively charged groups will attract cations to leave a neutral charge, and are typically supplied in either the Hydrogen (H^+) form or Sodium (Na^+) form.

The ion exchange resin bead will prefer certain cations over others, based off the ion size as well as whether it has a single positive charge (monovalent) or double positive charge (divalent). More selective species will displace the existing ions that are on the resin and send them into the effluent.

Why do we want to do this? Sometimes it is important to remove an undesirable element from water, such as hardness (also called softening), or to take out regulated contaminants (from drinking water or from industrial water). There are also times when all ions (both positive and negative) need to be removed from the water through a process called demineralization.

An analysis of water chemistry helps to determine what ions are present in the water, which then determines what ions need to be removed from the water and what ion exchange water treatment method will be used.

The ion exchange method is reversible through a process known as regeneration.

In the C100 example above, if a high concentration of sodium ions is introduced to remove the calcium, the resin bead will revert back to the sodium form. This exchange and regeneration process is how a typical water softener works.

Ion exchange resins are manufactured with many different functional groups tailored to remove a vast array of contaminants and compounds. Resin bead characteristics such as number of functional groups, moisture content, and porosity can help to determine the best ion exchange resin for water purification.