Optimized Solutions

Ion Exchange Counter Current Regeneration

Application:

ION Exchange

System Design:

Counter Current Regeneration Comparison to Co-Current Design

Date: 2020

Additional documentation:
Support reading material link to H&T web site

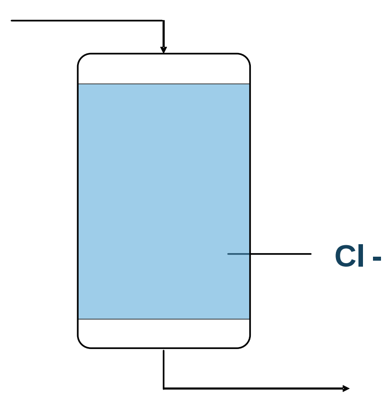
www.Hungerfordterry.com

How anion exchange works

Ion exchange replaces (or exchanges) unwanted minerals in water with less objectionable ones. Chloride and hydroxide ions are the most commonly used materials on the resin beads. As water passes through the device, the resin adsorbs anions such as sulfate, nitrate, arsenic and bicarbonates and releases chloride into the water. The exchange occurs in a pressure vessel (or tank) that is filled with the resin. When the capacity of the resin is exhausted, it is regenerated with a salt solution to restore its capacity to remove unwanted minerals again.

Capacity of an anion exchange unit

The amount of water an anion exchange device can treat depends on the concentration of the contaminants that are being removed, and the amount of regenerant (salt) that is used for regeneration. If removing nitrate, the removal capacity will depend on both the nitrate and the sulfate concentration in the water, as anion exchange resins preferentially adsorb sulfate. The sulfate will bump nitrate from the resin and into the treated water when all the exchange sites are filled. The concentration and volume of salt that is used for regeneration also affects the capacity of the resin. The usage of salt can become exponentially greater when increased capacity is required, hence the system should be designed to optimize salt usage and waste generation so that the optimum ratio of contaminant removal to salt usage is achieved.



Fully Regenerated IX Unit

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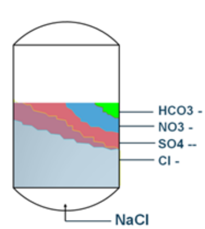
Restoring anion exchange capacity

When the capability of the resin is no longer able to remove undesirable minerals it is considered to be exhausted. The resin is then restored (or regenerated) by exposing it to a solution of brine (salt). During regeneration, brine can be exposed to the resin bed from either the top (Downflow or Co-Current Regeneration) or the bottom (Upflow or Counter Current Regeneration) of the bed.

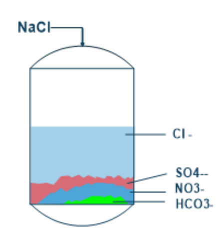
Downflow Regeneration Vs. Upflow Regeneration

The conventional regeneration process is “Downflow” Regeneration. During downflow regeneration, brine flows through the bed in the same direction as the raw water flow (top to bottom). As a result, the top of the bed receives greater exposure to brine and thus becomes the most fully regenerated portion of the bed. During the subsequent treatment run, the mineral leakage from the resin bed into the treated water stream gradually increases to the point where it is considered “sufficiently exhausted” to trigger regeneration.

The most efficient and latest regeneration process is “Upflow” Regeneration. During upflow regeneration, brine flows through the bed in the opposite direction as the raw water flow (bottom to top). As a result, the bottom of the bed receives greater exposure to brine and thus becomes the most fully regenerated portion of the bed. During the subsequent treatment run, **the mineral leakage from the resin bed *remains constant*** because the lower portion of the bed (the most fully regenerated portion) acts as a polisher to substantially eliminate the gradual mineral leakage that occurs in the older conventional down flow regeneration process. As a result, the resin delivers longer and more complete run times between regenerations, which minimize salt consumption and waste generations by virtue of the fact that the resin need not be regenerated prematurely.



Upflow Regenerated IX Unit



Downflow Regenerated IX Unit

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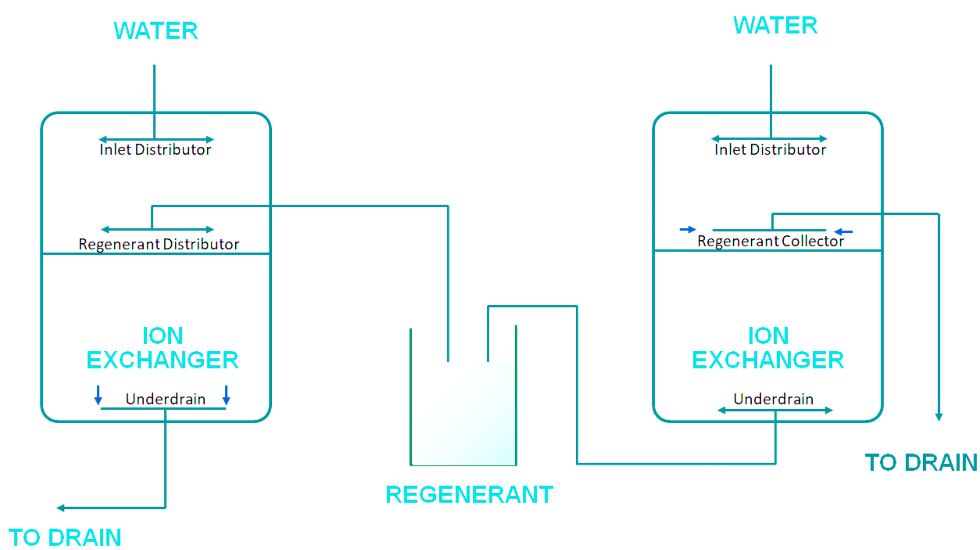
Exchange Vessel Components

In both cases, “Co-Current” & “Counter Current” regeneration systems the basic vessel internal piping configurations are the same. The function of the brine regenerant header-lateral piping system varies from distributor to collector and the underdrain may be used as regenerant distributor or as the treated water collector.



Co-Current Regeneration VS Counter Current Regeneration
Flow Diagram

Accessory Softener

An accessory water softener is included as a maintenance accessory, strictly to provide a supply of nitrate free soft water for regenerating the nitrate exchange units. We recommend this because in applications where the raw water is inherently hard (>100mg/L), we find that calcium and magnesium may precipitate within the nitrate exchange vessels during regeneration and cause the tank internal distributors to become corroded with these deposits. The use of a water softener to provide nitrate free soft water for regeneration purposes substantially minimizes this occurrence.

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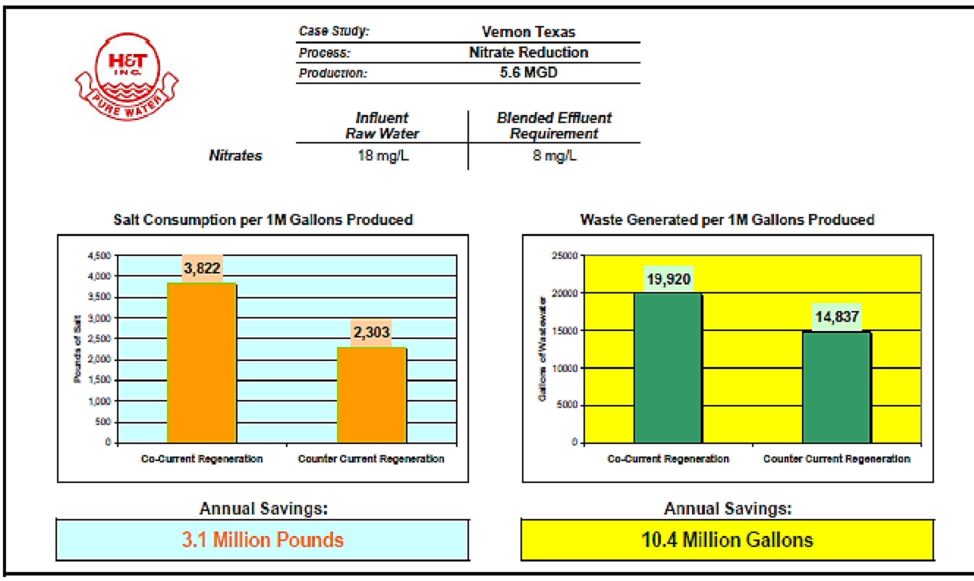
The Results

The below charts represent a water treatment system comparison of "Co-Current" and "Counter Current" designs. There is an evident reduction in both salt and water consumption using the "Counter Current" design resulting in substantial annual operational cost savings.



Since 1909 Hungerford & Terry Inc. sets industry standards in engineering, design and manufacture of innovative and efficient water treatment systems.
Systems include removal of Iron, Manganese, Arsenic, and Radium; High-efficiency / low-waste Nitrate removal; PFOS/PFAS, Color removal, Chrome-6 removal, Perchlorate removal, Degasifiers Towers, Condensate Polishers and complete Demineralizers for Boiler Feedwater for the Energy sector.