DOWEX Ion Exchange Resins

Comparison of Styrenic and Acrylic Strong Base Anion Exchange Resins for Water Treatement

Organic Removal Characteristics

Removal of naturally occurring organics, such as humic and fulvic acids, is an important function of demineralizers. High levels of organic acid intrusion to the boilers can create problems meeting the boiler chemistry guidelines, as the acids break down at high temperature and pressure.

While these naturally occurring organics are actually a class of chemicals with varying molecular weights, the removal of organic acids is consistently higher for DOWEX* 11 anion exchange resin than its acrylic counterparts. DOWEX 11 has been specially engineered with unique porosity to optimize organic removal. The new uniform particle size DOWEX 11 consistently offers 90-95% removal of naturally occurring organic material when new, and 80-85% removal after extended service. Acrylic resins, on the other hand, offer lower removal efficiencies. Typically, a level of 70% removal is considered good for acrylic anion resins.

If a mixed bed polisher is operated downstream of the anion bed, another problem can be experienced. The anion in the mixed bed polisher is likely to remove residual organics which have not been removed by the primary anion bed. This can present a significant problem with mixed bed anion fouling, since mixed beds are infrequently regenerated and thus susceptible to irreversible fouling. Replacing mixed bed anion resin is a more expensive proposition than replacing an equivalent amount of single-bed anion resin.

Silica Removal and Silica Leakage

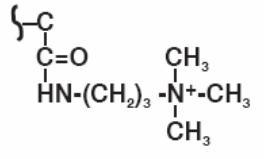
DOWEX 11 offers superior silica removal and low silica leakages in comparison to acrylic strong base anion resins. Under similar feed conditions, the acrylic anion resin will exhibit 25-50% greater silica leakage than DOWEX 11.

One of the most significant factors which contributes to silica leakage is the amount of silica remaining on the anion resin after regeneration. The higher the level of remaining silica, the higher the equilibrium leakage of silica. As a result, silica removal during regeneration is critical to low leakage values. The degree of silica removal is dependent upon two key factors: the amount of caustic used, and the temperature of the regenerant caustic (in order to solubilize the silica).

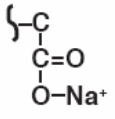
Acrylic anion resins cannot be subjected to high temperatures due to their tendency to hydrolyze the functional sites. As a result, manufacturers recommend a maximum temperature of 35°C (95°F) for normal regenerations, with an absolute maximum of 40°C (100°F). DOWEX 11 anion exchange resin can be safely regenerated at 50°C (120°F) for normal regenerations with an absolute maximum of 60°C (140°F). This higher regeneration temperature yields more complete removal of silica and lower silica leakage.

Resin Degradation: Effect on Water Quality

In addition to increased silica leakage, acrylic strong base anion resins also exhibit degradation pathways which can adversely affect water quality. The chemistry of an acrylic functional site is shown below, along with one of the degradation pathways.



Acrylic Strong Base Site



One Degradation Product

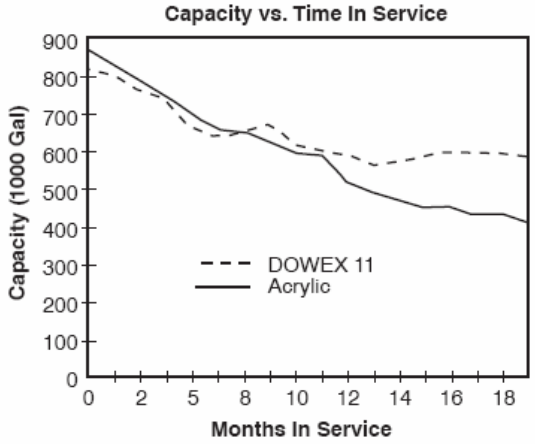
Resin Degradation: Effect on Water Quality (cont.)

Strong base anion resins employ sites which have a positive charge from a quaternary amine. This positive charge is necessary to attract anions. In a degraded acrylic anion resin, there will be some sites which have converted to a negatively charged carboxylate group. This site will then act like a cation resin, retaining the sodium from the caustic solution and slowly releasing it during the rinse and during operation of the resin. As a result, long rinses and elevated sodium throw during operation are frequently seen with acrylic resins as they age.

Styrene-divinylbenzene resins such as DOWEX 11 do not degrade to carboxylate groups. Its degradation products do not take on negative charges, and thus do not experience the same problems with sodium throw.

Resin Degradation: Effect on Operating Capacity

In addition to water quality, the operating capacity is a critical feature when comparing organic-resistant anion resins. Acrylic resins offer initially higher operating capacity than styrenic products, but this capacity advantage is lost over a period of time due to the degradation of acrylic functional sites. The graph below shows a comparison of actual operating data from a paper mill in a southern state of the U.S.



DOWEX 11 started at a slightly lower operating capacity, but within a few months the operating capacities for both products were comparable. After one year, the degradation of the acrylic functional sites had reduced the operating capacity below DOWEX 11 anion exchange resin.

A critical feature of the data above is the effect of brine cleaning on the resin. Brine cleaning was performed on both products, thus extending the life of the resins by a more gradual decline in operating capacity. If no brine cleaning was performed, the resin life for both products would be much shorter, and the effect of acrylic functional degradation would have been insignificant in comparison to the irreversible fouling of the ion exchange resins.

While the fouling tendency of the feedwater at this plant was very extreme, plants with lesser tendency to foul will find even better performance after 18 months, making the acrylic degradation an even more significant factor. Typical cleaning frequencies at most plants using organic-laden feedwaters are 2-4 times/year, depending upon the fouling characteristics of the organic sources.

DOWEX Ion Exchange Resins
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