Tech Fact

Ion Exchange Resins

Oxidation Stability of Ion Exchange Resins

Introduction

The presence of free chlorine or other oxidizing agents in the feed water will lead to resin degradation over time.

Anion exchange resins are very sensitive as oxidants attack the functional amine group resulting in loss of resin capacity and impaired performance. Oxidation of the active group can also produce carboxylic functions on the anion resins, leading to major rinse problems. Continuous exposure of anion resins to > 0.05 mg/L (ppm) free chlorine should therefore be avoided.

In the case of a **cation resin**, oxidation occurs by de-crosslinking the copolymer matrix, leading to an increase in water retention capacity and resin swelling. This results in weakening of the mechanical integrity of the resin and wet volume capacity loss. Temperature and chlorine concentration both impact the rate of de-crosslinking. While it is not possible to accurately predict resin life when other factors are considered, the following guidelines for oxidants in the feed water will maximize the life of cation exchange resins. The data are valid for a temperature of 20 °C (68 °F).

Resin type	Maximum Cl_2 mg/L	Maximum ClO_2 mg/L	Maximum O_3 mg/L
SAC gel 8 % DVB	0.2	0.1	0.2
SAC gel 10 % DVB	0.3	0.15	0.3
SAC macroporous 12 % DVB	0.4	0.2	0.35
SAC macroporous 20 % DVB	0.5	0.25	0.4

When strong acid cation resins are operated in higher oxidative environments, shorter resin life will be expected. The effect of free chlorine is additive, so the reduction in resin lifetime should be proportional to the increase in the level of chlorine in the feed. For example, if a standard gel cation treating water at 10 to 15 °C (40 – 50°F) has a lifetime of 10 years with the recommended < 0.2 mg/L free chlorine in the feed, the lifetime would be reduced to less than one year if the level of free chlorine were to increase 5 times to 1 mg/L.

Chlorine dioxide and ozone are also used in the pre-treatment of water. Chlorine dioxide, like chlorine, has a "persistent" effect, i.e. the oxidant remains in water for a long time. Ozone, on the other hand, tends to disappear rapidly.

Elevated temperature and the presence of iron or heavy metals can have a catalytic effect and increase oxidative damage to the resin.

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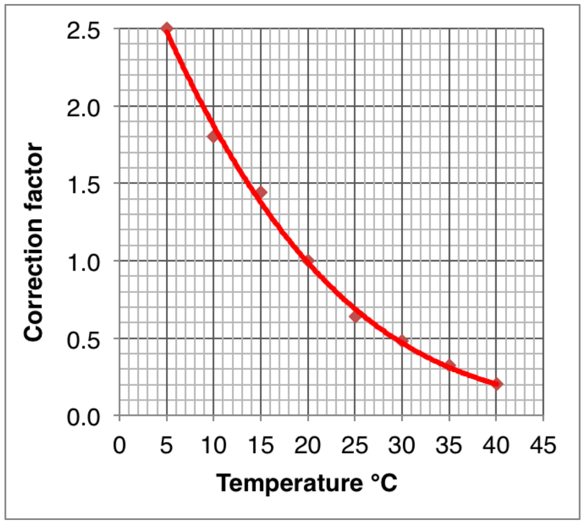
Temperature effect

At higher temperatures, the effect of oxidation increases, so the guidelines of page 1 must be corrected according to the following graph:



For instance, if a resin can accept a chlorine content of 0.2 mg/L at 20 °C, it should not be submitted to more than 0.1 mg/L at 30 °C (factor 0.5). If the temperature exceeds 40 °C, the tolerated concentration of oxidants is virtually zero.

Removing oxidants from the feed water

Excess oxidants can be neutralized with sulfite or dithionite salts or sulfur dioxide. An activated carbon filter can remove excess chlorine.

Chloramines used for disinfection of drinking water are only partially removed by activated carbon, and can damage ion exchange resins. Only sodium bisulfite or dithionite can de-chlorinate efficiently in this case.

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WARNING: Oxidizing agents such as nitric acid attack organic ion exchange resins under certain conditions. This could lead to anything from slight resin degradation to a violent exothermic reaction (explosion). Before using strong oxidizing agents, consult sources knowledgeable in handling such materials.

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