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Liquid Separations

A Selective Anion Exchange Resin That Can Remove Boron from Water and Wastewater

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Boron is readily found in the environment at fairly low concentrations mainly as boric acid or borate salts. Boron is a micronutrient required for most plants and animals, however, the range between deficiency and excess is narrow. In an industrial setting, the removal of boron from process streams, such as in the treatment of magnesium brines or in the production of ultrapure water (UPW) for the semiconductor industry, is essential. In other industrial applications, the boron selective resin can be applied to reduce and eliminate boron from discharge streams.

Boron occurrence in most natural fresh waters is at less than 1.0mg/L and in the 5.0mg/L range for seawater. There are some areas in the Southwestern US, with unique geology, that also yield higher boron levels. Levels in the 7mg/L boron have been reported. Higher concentrations are often cited as an indicator of pollution from sources like laundry detergents, boiler blowdown water, or mining operations, which may require treatment prior to discharge or before applying for agricultural uses.

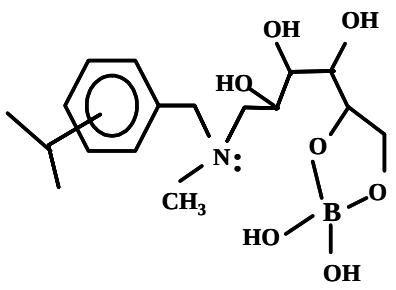
For human health, the acceptable daily intake has been suggested at 0.3mg boron per kg body weight per day. The World Heath Organization (WHO) recommends a limit of 0.3mg/L boron concentration in any form of drinking water. This limit stems from reports that continually ingesting large amounts of boron (>1.0ppm/day) can affect the central nervous system; and in extreme cases over an extended period of time, cause a syndrome called borism.

Boron is routinely measured in waters used for irrigation. Although known to be a required trace nutrient for root development, excess can reduce growth rates and crop production for a wide variety of plants. In arid areas that rely heavily on irrigation, constant water evaporation can compound the issue by concentrating the boron in the soil over time. Thus for arid areas, with limited tillable land, reduction and removal of boron from irrigation waters may be required for the sustainability of some crops. Amongst the more sensitive crops are citrus trees, which show massive leaf damage at boron levels of more than 0.3mg/L in irrigation water. Excess boron also reduces fruit yield and induces premature ripening on other species, such as kiwi.

There are a number of practical means to reduce and remove boron from water. Simple reverse osmosis (RO) membranes can remove typically 70-75% of boron found in typical drinking and cooking waters. A home or industrial distillation system can also remove boron down to very low, <0.3mg/L levels. A mixed bed single pass, non-regenerated ion exchange resin bed can all but eliminate boron from a water stream. Nevertheless, a more elegant and economic alternative, may be as boron selective resin, as it is less effected by other ions in the feed stream and can reduce the boron levels to <0.02mg/L (20ppb).

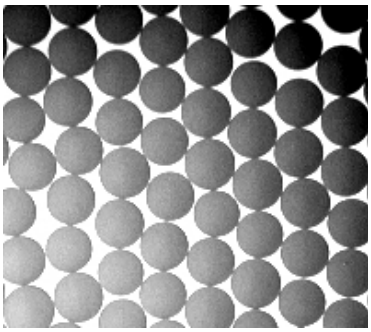
Boron selective resin (BSR) is a weakly basic anion exchange resin having n-methyl-D- glucamine functional group which is extremely selective for boron via a chelation like mechanism. This chemistry is based on the cis-diol group, which will bind the boron in a five member borate ester ring complex as illustrated in Figure 1 depicting Dow's styrenic Boron Selective Resin, XUS-43594.00. The resulting boron complex is fairly stable and can bind and hold boron at very low concentrations, even in the presence of other ions. The complex can be broken and the resin regenerated by displacing the borate with either hydrochloric (HCl) or sulfuric (H_2SO_4) acid, water rinse and then converting the resin back to the free base form by washing with sodium hydroxide (NaOH), followed by water washing to an application appropriate pH. The resin is regenerable and can be applied into a process for several hundred process cycles depending upon the quality of the in-coming feed waters.

Figure 1.



Of the various commercially available boron selective resins on the market today, Dow's XUS-43594.00 is the only one to currently carry the ANSI/NSF Standard 61 certification (Drinking Water System Components). The XUS-43594.00 is a uniformed particle sized resin as shown in Figure 2, with a particle size of 550+/-50 microns. The uniformity of this resin offers both faster uptake and elution kinetics for boron.

Figure 2.



Dow's commercially available Boron Selective Resin, XUS-43594.00 can be applied to remove and reduce boron levels over a wide range of applications, including industrial, agricultural and for high quality drinking water.

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Notice: 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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