# ENGINEERING BULLETIN

## Purolite® S108

This Engineering Bulletin discusses the use of Purolite® S108 for the selective removal of boron from aqueous solutions.

Purolite®

## PUROLITE S108 BORON SELECTIVE ANION EXCHANGE RESIN

This Engineering Bulletin reviews the properties of Purolite® S108 macroporous polystyrene based resin for removing boron from aqueous solutions such as drinking water, irrigation water, brine solutions, wastewater, and RO permeate from desalinated brackish and sea water. For more information on this product or product applications, please go to www.purolite.com or contact the closest Purolite regional office as listed on the back cover.

## INTRODUCTION

Founded in 1981, Purolite is a leading manufacturer of ion exchange, catalyst, adsorbent and specialty resins. With global headquarters in the United States, Purolite is the only company that focuses 100% of its resources on the development and production of resin technology.

Responding to the needs of our customers, Purolite has built the largest technical sales force in the industry, the widest variety of products and five strategically located Research and Development groups. Our ISO 9001 certified manufacturing facilities in the U.S.A, Romania and China combined with more than 40 sales offices in 30 countries ensure complete worldwide coverage.

### PREMIER PRODUCTS

The quality and consistency of our products is fundamental to our performance. Throughout all Purolite plants, production is carefully controlled to ensure that our products meet the most stringent criteria, regardless of where they are produced.

### RELIABLE SERVICE

We are technical experts and problem solvers. Reliable and well trained, we understand the urgency required to keep businesses operating smoothly. Purolite employs the largest technical sales organization in the industry.

### INNOVATIVE SOLUTIONS

Our continued investment in research & development means we are always perfecting and discovering innovative uses for ion exchange resins and adsorbents. We strive to make the impossible possible.

Purolite S108 is a macroporous polystyrene based resin with functional groups designed for the selective removal of boron from aqueous solutions. The resin will operate over a wide pH range and due to excellent kinetics it is effective over a wide range of boron concentrations, under different operating conditions. The presence of boron ions in water for potable and agricultural/horticultural use, even in relatively small (ppm) concentrations can give rise to significant problems. Even where concentrations of other ions are reasonably high, Purolite S108 will reduce boron concentrations by an order of magnitude.

Typical properties of Purolite S108 are shown in Table 1 below.

| Table 1 – Typical physical and chemical characteristics | |
|---|---|
| Polymer structure | Macroporous polystyrene cross-linked with divinylbenzene |
| Physical form | Spherical beads |
| Functional groups | N-methylglucamine |
| Ionic form, as shipped | Free Base – FB |
| Total capacity, FB form | 0.6 eq/L (13.1 Kgr/ft$^3$) minimum |
| Moisture retention, $Cl^-$ form | 61 – 67% |
| Particle size range | 425 – 630 µm |
| Uniformity coefficient | 1.2 maximum |
| Reversible swelling, FB → $Cl^-$ | 25% maximum |
| Specific gravity, FB form | 1.10 |
| Shipping weight | 670 – 730 g/l (41.7 – 45.6 lb/ft$^3$) |
| Maximum temperature limit | 140°F (60°C) |
| pH range (operating) | 4 – 10 |

## Purolite S108 boron removal applications

### Drinking water

Boron limits for drinking water are enforced by various national regulations. The World Health Organization (WHO) has set a provisional guideline of 0.5 mg/L maximum. Purolite S108 is approved under WRAS (Water Regulations Advisory Scheme in the UK) and also certified under NSF/ANSI 61 standard in the USA for drinking water treatment.

### Irrigation water

Boron is important as a trace element to promote plant growth. However excess concentrations of boron in irrigation water can have a toxic effect on plants.

### RO permeate from desalinated brackish and sea water

Sea water typically contains between 4 – 5.5 mg/L boron. As a weakly dissociated anion at neutral pH boron is not fully rejected by reverse osmosis membranes. Depending on the application of the treated water further post-treatment can be required.

### Brine solutions

Purolite S108 can be used to prepare boron-free magnesium chloride brines. Because these brines can contain up to 100 ppm of boron, they are unsuitable for the production of pure magnesium oxide required by the electric power and electronics industries and for the manufacture of refractory materials. Purolite S108 may also be used for the reduction of boron in brine prior to electrolysis.

Brine application of S108 will require specific operating and regenerating conditions. Contact your nearest Purolite sales office for assistance.

### Wastewater

Boron limits for wastewater are enforced by national regulations. Required limits vary from country to country and can be as low as 0.1 mg/L. Purolite S108 is ideal for cleaning wastewater in any chemical processes where the boron concentration exceeds the discharge limits. Regeneration procedures may afford some boric acid recovery.

### Semiconductor and high purity applications

When selective removal of boron is needed in high-purity applications in the microelectronics industry, UltraClean™ UCW1080 is available.

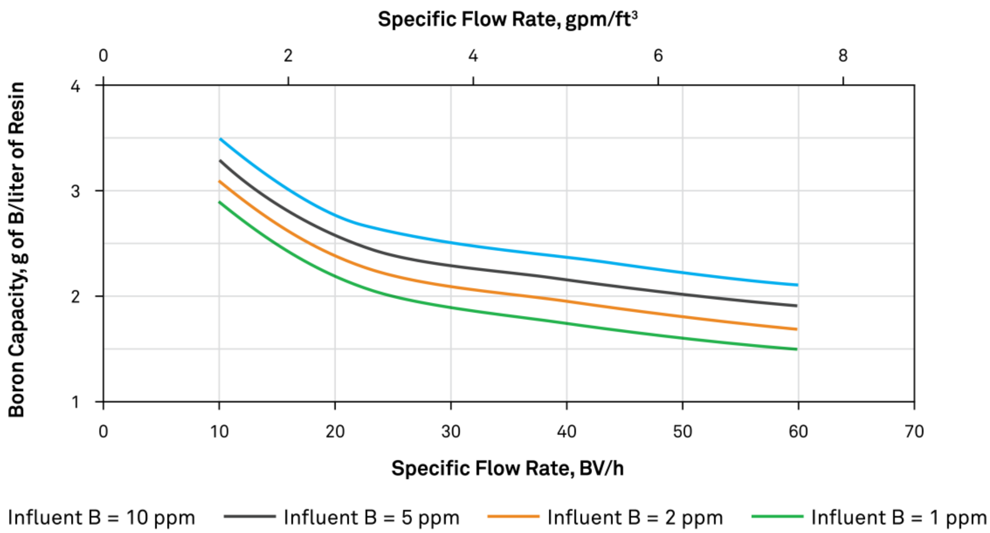
Please contact your nearest Purolite sales office for more information.

## Operating recommendations

The product is retained within a pressure vessel and the contaminated solution is pumped through the media. On exhaustion the resin is regenerated using a two-stage regeneration process. In order to achieve low boron leakages a reasonable contact time is important. Higher bed depths, increasing the contact time, can reduce the borate leakage in some applications.

The operating capacity of Purolite S108 is primarily dependent on the specific flow rate and the concentration of boron in the solution to be treated. Typical working capacities from 1 to 3.5 g/L can be achieved dependent on operating conditions. Purolite S108 can be operated at specific flow rates up to 60 BV/h but this significantly reduces the resin performance – see Figure 1 on the following page for details.

**Figure 1: Boron capacity vs. influent boron concentration and service flow rate**




To achieve very low boron leakage, counter-flow regeneration is recommended and in some cases lead-lag operation should be considered to maximize resin capacity and achieve very low boron targets. The optimum conditions for operation and regeneration depends on the individual application.

Table 2 provides information on suggested operating conditions for co-flow mode of regeneration.

## Table 2: Recommended operating conditions for co-flow regeneration

| OPERATION | RATE | SOLUTION | MINUTES | AMOUNT |
|---|---|---|---|---|
| Service | 8 – 60 BV/h<br>1 – 7.5 gpm/ft$^3$ | Raw water | | |
| Backwash | 6 – 8 m/h<br>2.5 – 3.5 gpm/ft$^3$ | Raw water | 10 - 20 | 1.5 – 2.5 BV<br>10 – 20 gal/ft$^3$ |
| Regeneration | 2.5 – 3 BV/h<br>0.3 – 0.4 gpm/ft$^3$ | 4% HCl or<br>5% $H_2SO_4$ | 30 - 40 | 50 – 60 g/L HCl<br>3 – 4 lb/ ft$^3$ or<br>65 – 80 g/L $H_2SO_4$<br>4 – 5 lb/ ft$^3$ |
| Slow rinse | 3 – 4 BV/h<br>0.4 – 0.5 gpm/ft$^3$ | Raw water or softened water | 30 -40 | 2 BV<br>15 gal/ft$^3$ |
| Conversion to free base form as required | 3 – 4 BV/h<br>0.4 – 0.5 gpm/ft$^3$ | 2% NaOH | 30 | 30 – 40 g/L<br>2 – 2.5 lb/ ft$^3$ |
| Slow rinse | 3 – 4 BV/h<br>0.4 – 0.5 gpm/ft$^3$ | Soft water | 30 - 40 | 2 BV<br>15 gal/ft$^3$ |
| Fast rinse | 10 BV/h<br>1.25 gpm/ft$^3$ | Raw water | 30 | 5 BV<br>40 gal/ft$^3$ |

Backwash expansion – minimum 50%; 75% optimum.
“Gallons” refers to US. gallons = 3.785 liters

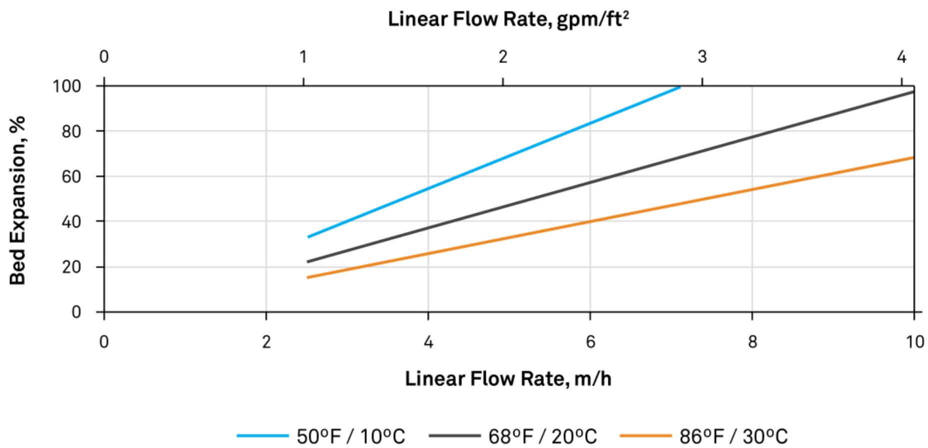
Table 3 provides suggested operating conditions when designing for counter-flow regeneration.

## Table 3–Recommended operating conditions for counter-flow regeneration

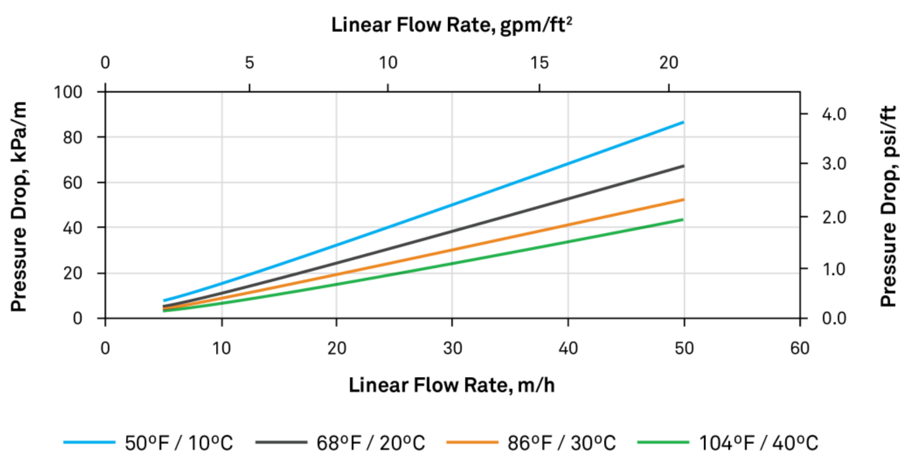
| OPERATION | RATE | SOLUTION | MINUTES | AMOUNT |
|---|---|---|---|---|
| Service | 8 – 60 BV/h<br>1 – 7.5 gpm/ft$^3$ | Raw water | | |
| Regeneration | 2.0 – 2.5 BV/h<br>0.25 – 0.3gpm/ft$^3$ | 4% HCl or<br>4% $H_2SO_4$ | 30 – 40 | 40 – 50 g/L HCl<br>2.5 – 3 lb/ ft$^3$ or<br>50 – 65 g/L $H_2SO_4$<br>3 – 4 lb/ ft$^3$ |
| Slow rinse | 2 – 2.5 BV/h<br>0.25 – 0.3gpm/ft$^3$ | Raw water or Soft water | 35 – 45 | 1.5 BV<br>10 gal/ft$^3$ |
| Conversion to free base form as required | 2 – 3 BV/h<br>0.25 – 0.4gpm/ft$^3$ | 2% NaOH | 20 – 30 | 20 – 30 g/L<br>1.25 – 2 lbs/ ft$^3$ |
| Slow rinse | 2 – 3 BV/h<br>0.25 – 0.4gpm/ft$^3$ | Soft water | 30 – 60 | 1.5 – 2 BV<br>15 gal/ft$^3$ |
| Fast rinse | 10 BV/h<br>1.25 gpm/ft$^3$ | Raw water | 20 – 25 | 3 – 4 BV<br>22 – 30 gal/ft$^3$ |

Figure 2 below provides guidance on appropriate flow rates for backwash while Figure 3 shows expected pressure drop across the resin bed for various linear flow rates.

## Figure 2 – Backwash expansion




## Figure 3 – Pressure drop



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