Application Guide

Use of Ion Exchange Resins in Hydraulic Fracking

With a focus on wastewater reduction, this Application Guide presents information on how ion exchange resins can be used to reduce levels of sulfate, hardness and boron in water used for fracking. A brief overview of the fracking process is also provided.

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About Purolite

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

Responding to our customers' needs, Purolite has a wide variety of products and the industry's largest technical sales force. Globally, we have strategically located research and development centers and application laboratories. Our ISO 9001 certified manufacturing facilities in the USA, United Kingdom, Romania and China combined with more than 40 sales offices in 30 countries ensure complete worldwide coverage.

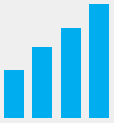
Purolite has been part of Ecolab since 2021. A trusted partner at nearly three million commercial customer locations, Ecolab (ECL) is the global leader in water, hygiene and infection prevention solutions and services. Ecolab delivers comprehensive solutions, data-driven insights and personalized service to advance food safety, maintain clean and safe environments, optimize water and energy use, and improve operational efficiencies and sustainability for customers in the food, healthcare, hospitality and industrial markets in more than 170 countries around the world.

PREMIER PRODUCTS

The quality and consistency of our products are 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. employs the largest technical sales team in the industry.



INNOVATIVE SOLUTIONS

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

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Introduction

Due to increasing demand for energy independence, hydraulic fracturing, also known as fracking, has become widely used for accessing and extracting natural gas from shale formations. The fracking process, in the most basic terms, involves drilling a wellbore into the shale formation.

Once a well is created, it is lined, and fluid — usually water based — is injected at high pressure to create fissures that increase gas permeability in the shale deposit. The fluid mixture also contains various amounts of chemical additives and sand, which acts as a proppant, to hold the fissures open and allow gas to flow up the well[1]. Each fracked well can require as much as 4–6 million gallons (15,000–23,000 m^3) of water[2]. Fresh water is preferred, but shortages in some areas, like West Texas, have necessitated use of brackish water.

Although each fracking region has different water management challenges, according to recent information, water transportation is the costliest element[3]. Due to the high cost of hauling flowback water (the used injection water that returns to the surface) to disposal wells, recycling efforts that enable the reuse of cleaned flowback water in fracking are increasing. As up to 90% of flowback water can be recycled, it presents a significant opportunity to recycle, cut costs (between $70,000 and $370,000 per well)[3] and reduce use of potable water from freshwater sources for drilling — which was estimated to be 40 billion gallons for the U.S. alone in 2012[4].

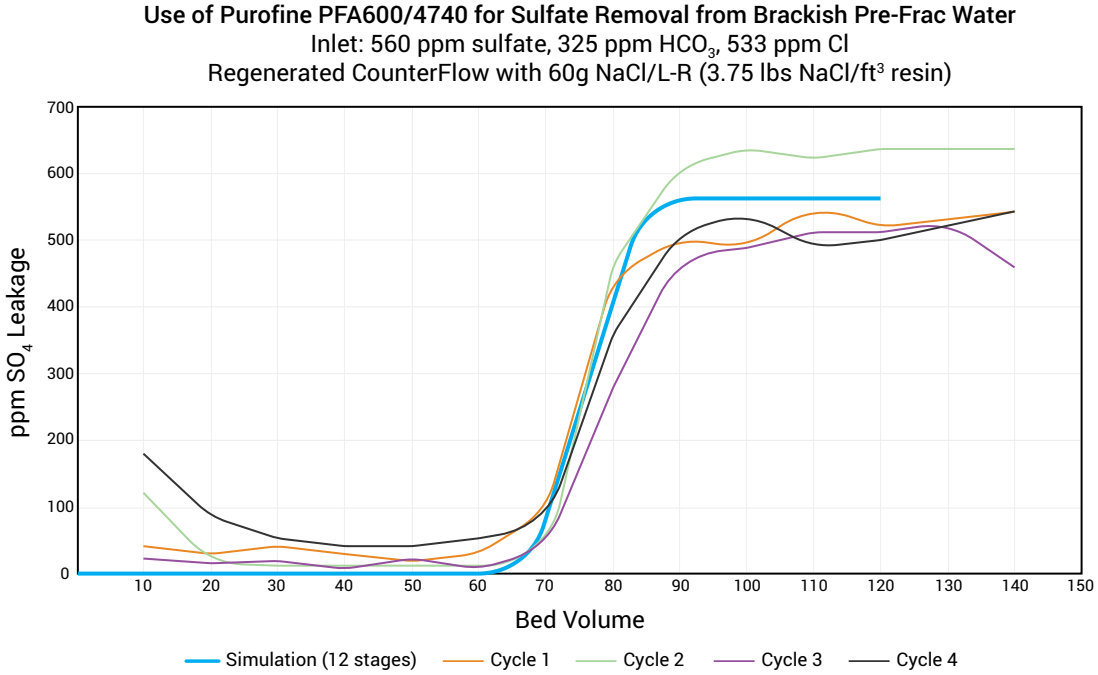
In addition to produced water, the returning flowback can contain other elements that are released during fracturing, including sulfates, boron and naturally occurring radioactive materials[2]. Ion exchange technology can effectively remove many of these elements and produce higher quality water for re-use with less potential for fouling. When recycling of water is not an option, Purolite ion exchange resin technologies will treat scale-inducing elements of fresh and brackish water, while keeping wastewater to a minimum.

TABLE 1 Applications for Ion Exchange

	Levels	Remarks
Sulfate Reduction	< 250 ppm Typical	Fresh water and brackish water used as makeup water for fracking.
Hardness Reduction	< 100 ppm Typical	Fresh and brackish water used as a makeup water for fracking, sometimes in conjunction with sulfate reduction from the same water.
Boron Reduction	< 10 ppm Critical	Flowback and produced water intended for use in additional fracking.

FIGURE 1

Data Output Comparison Between Purolite Simulation Software and Actual Laboratory Tests



Accurate predictive behaviour results between Purolite Simulation Software and actual laboratory analysis.

Sulfate Reduction

High levels of barium or strontium in the formation can result in the formation of scale down hole. Reducing sulfate in pre-frac water, typically to < 250 ppm, can help to prevent the formation of sulfate scales that would block off fissures created by the frac water and prevent the gas from traveling up the well.

A simple and effective way to reduce scaling is through the use of Purofine® PFA600 brine regenerable Type I strong base anion resin. Purolite can reliably model and estimate operating capacity and leakage using its proprietary ion exchange simulator software. Estimates using this method have been verified by actual laboratory column studies. Figure 1 is an example comparing predicted capacities and leakage versus actual laboratory column studies with the site water. As can be seen the simulator output matches closely with actual lab data. This technology enables Purolite to respond quickly to inquiries and assess the impact of an existing plant's operating performance when changes in influent water quality occur.

The simulator allows for adjustments and optimization of salt dosages and compares output for either co-flow or counter-flow regeneration. Variable inputs allow Purolite to design a treatment system to produce minimum wastewater, considering that the cost of hauling wastewater for disposal can range between $3 and $7 per barrel. As a well can produce a potential 3,400 barrels of wastewater each day, wastewater hauling costs can reach $20,000 per day[5].

For specific jobs, we can provide design information such as number of vessels, dimensions, volume of resin, resin bed depth, linear velocity and regeneration data.

Hardness Reduction

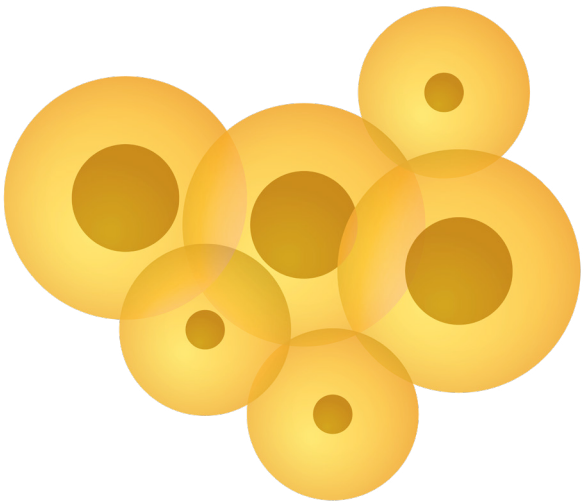
Minerals such as barium, strontium, calcium, magnesium, iron and manganese create hard water, which, in turn can produce fissure-blocking scale. Brine regenerable Shallow Shell™ SSTC80C, a strong acidic cation resin, is well established in the oil and gas industry for reducing hardness. With large volumes of resin installed in Canada, the United States and the Middle East, Shallow Shell SSTC80C is the industry standard for oil field softening. The key to SST® resin's superior regeneration efficiency is the functionalized shell and inert core structure of the resin beads, shown in the figure below.

Numerous field installations of Shallow Shell SSTC80C prove lower hardness leakage and use lower salt dosages compared to standard resins. The inert core shields the resin beads from deep penetration and fouling by iron and barium, which is often the case with conventional resin. Fouling can rapidly degrade long-term performance of standard resins, making them inefficient and costly to operate.

Our proprietary software enables Purolite to quickly evaluate capacity and leakage parameters and provide optimum recommendations.

FIGURE 2

Graphic Depiction of Bead Structure for Shallow Shell SSTC80C Resin



Uniform depth of functionality — every bead reacts at the same rate.

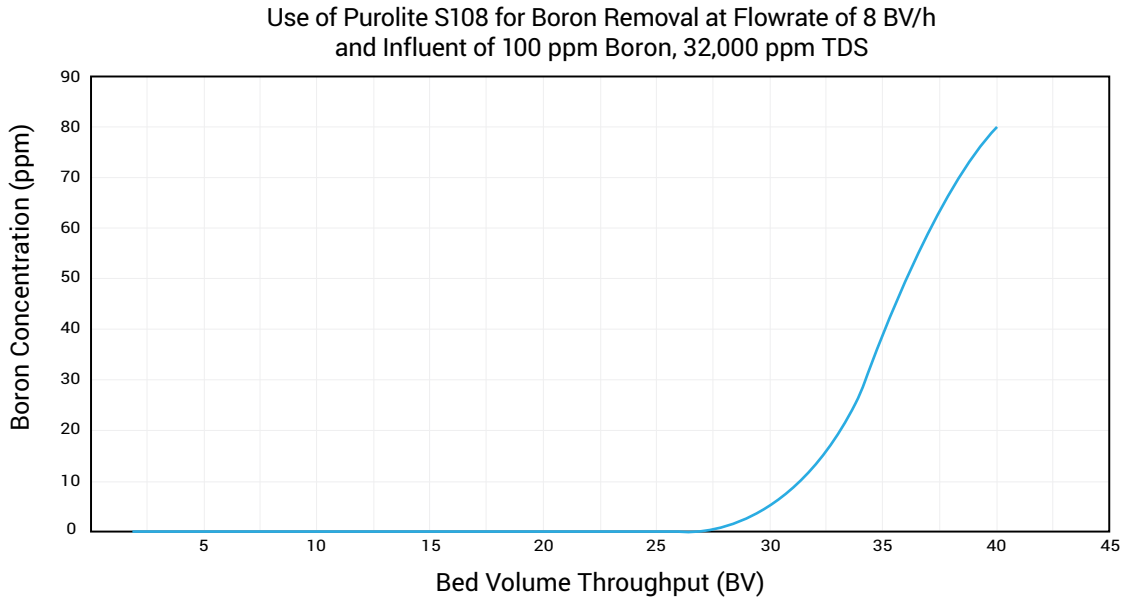
Boron Reduction

It is important to control levels of boron in flowback and produced water intended for recycle and reuse as boron interferes with gel additives contained in fracking fluid. Boron concentration in the flowback water can typically be greater than 100 ppm. Purolite S108 boron selective resin will reduce boron to < 10 ppm using a single ion exchange vessel. Operation should ideally be at an influent flowrate of about 8 BV/h (1 gpm/ft^3 of resin), with a minimum bed depth of 40 inches (approximately 1 meter) and linear velocity ranging from 20–30 m/h (8–12 gpm/ft^2 of bed area). Typical operating capacity is about 3,000 mg boron per liter of resin, or about 30 bed volumes to a boron breakpoint of 10 ppm. See Figure 3 for a typical breakthrough curve.

Regeneration is done with acid to strip boron from the resin, followed by rinsing and conversion of the resin to the free-base form using caustic soda.

FIGURE 3

Effective Reduction of Boron to a 10 ppm Breakpoint Using Purolite S108



Estimated capacity to 10 ppm boron break is approximately 3.4 grams boron per liter of resin.

Conclusion

Ion exchange technology can be used to effectively treat pre-frac, flowback and produced water, reducing transportation and disposal costs as well as the quantity of fresh water used in fracking. Although there is wide variability in water requiring treatment within each formation[6], with proper evaluation, Purolite's broad range of high-quality ion exchange resin technologies can effectively treat scale producing minerals and boron levels present in shale gas wastewater, making recycle and reuse possible.

For custom solutions, or further information, visit www.purolite.com or contact your closest Purolite regional sales office.

References

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Notes

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Purolite, a leading manufacturer of quality ion exchange, catalyst, adsorbent and specialty high-performance resins, focuses 100% of its resources on the development and production of resin technology.

We're ready to solve your process challenges. For further information on Purolite products and services, visit www.purolite.com or contact your nearest Technical Sales Office.

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