

# Engineering Bulletin

# Arsenic Removal

# for Commercial

# and Residential

# Applications

# Using Purolite

# FerrIX™ A33E

Purolite FerrIX A33E is a hybrid ion exchange resin designed for selective removal of arsenic from water. This Engineering Bulletin includes information for removing arsenic in light commercial and residential applications using both point-of-use and whole home treatment systems with Purolite FerrIX A33E.



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

Responding to our customers' needs, Purrolite has the widest 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.

Purrolite 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.



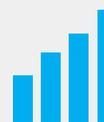
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The quality and consistency of our products is fundamental to our performance. Throughout all Purrolite plants, production is carefully controlled to ensure that our products meet the most stringent criteria, regardless of where they are produced.



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We are technical experts and problem solvers. Reliable and well trained, we understand the urgency required to keep businesses operating smoothly. Purrolite 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.

# Arsenic Removal for Commercial and Residential Applications Using Purolite FerrIX A33E

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# Purolite Arsenic Treatment Solution

Arsenic is a semi-metal element in the periodic table. It is odorless and tasteless. It enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices. Arsenic has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver and prostate. Non-cancer effects can include thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in hands and feet, partial paralysis and blindness (United States Environmental Protection Agency, 2015). On January 22, 2001, the EPA set the arsenic standard for drinking water at 0.01 mg/l or 10 parts per billion (ppb) to protect consumers served by public water systems from the effects of long-term, chronic exposure to arsenic. Water systems had to meet the new standard by January 23, 2006 (United States Environmental Protection Agency, 2022).



## Purolite FerrIX A33E

[Purolite FerrIX A33E](#) is a proprietary hybrid ion exchange resin designed for selective removal of arsenic from water. This highly porous anion resin is infused with iron oxide to allow for fast and efficient adsorption of arsenic. The porous nature of the resin beads allows for maximum utilization of the infused iron. Iron oxide adsorption treatment for arsenic in groundwater is a common removal process that involves the chemical treatment of arsenic species. In the process, arsenic adsorbs onto the iron oxide to create larger particles that can be filtered out of the water stream.

Water treatment systems incorporating Purolite FerrIX A33E resin are designed and operated using the same engineering guidelines as conventional ion exchange resins, and can be used in majority of existing lead-lag or parallel design configurations. This guide is meant to cover light commercial and residential applications for both point-of-use systems and whole home treatment systems. Although Purolite FerrIX A33E will remove both forms of arsenic that are most prevalent in water ( $As^{III}$  and  $As^V$ ), the capacity is much higher when peroxidation is included in the treatment plan. As this is an anion-based resin all oxidizing chemicals must be removed prior to the resin.

The superior strength of ion exchange beads means fines will not be generated during resin loading or the service cycle. Pressure drop will remain low and backwash will be minimized, reducing water loss and avoiding the discharge of arsenic laden fines to the sewer.

- Purolite FerrIX A33E is certified to NSF/ANSI/CAN 61 Standard
- Purolite FerrIX A33E is ideal for municipal water treatment plants as well as point-of-entry (POE) and point-of-use (POU) systems
- Purolite FerrIX A33E is not hazardous according to OSHA 29 CFR 1910.120\*

**TABLE 1** Physical and Chemical Characteristics

Characteristics	Description
Polymer Structure	Polystyrene crosslinked with divinylbenzene
Appearance	Brown spherical beads
SBC	0.5–4 %
Particle Size Range	300–1200 µm
< 300 µm (max.)	1 %
Uniformity Coefficient (max.)	1.7
Shipping Weight (approx.)	720–760 g/L (45.0–47.5 lb/ft <sup>3</sup> )
Temperature Limit	80 °C (176.0 °F)
pH limits, Operating	4.5–8.5

\* Dispose of waste and residue in accordance with the requirement of local authorities.

Arsenic is one of the hardest ions to remove from water. It has a high molecular weight and there are many factors that will impact its removal from water. One of the main factors is that phosphate ions are very similar to arsenic ions, and compete for exchange sites. If the feed water has high levels of phosphate, the capacity for arsenic removal will be much lower. Another factor that will affect the ability to remove arsenic from water is the feed pH. It is best to maintain close to neutral pH (~ 7 pH) for arsenic removal applications. At much lower pH levels, arsenic can become insoluble and lose its ionic charge. The levels of natural arsenic in water will vary from area to area with the highest levels in areas with very deep wells.

## Factors Impacting Arsenic Removal Capacity

The capacity of all granular iron media (GIM) used for arsenic removal are significantly impacted by the following factors:

- pH – increasing pH results in lower capacity
- Phosphate – competes vigorously with arsenic for exchange sites on media
- Silica – competes for exchange sites and can precipitate and/or bind with other foulants and block exchange sites
- Vanadium – competes vigorously with arsenic for exchange sites
- Other oxyanions (e.g., selenite, molybdate, antimonate, chromate) – will lower arsenic removal capacity
- Specific flow rate – gpm/ft<sup>3</sup> of media or BV/h - higher specific flowrates results in earlier breakthrough and lower capacity
- Empty Bed Contact Time (EBCT) – lower EBCT results in earlier breakthrough and lower capacity

## Essential Data Input

It is important to gather as much information as possible on the system so that “surprises” can be avoided. For example, other anions and oxyanions will compete with arsenic for removal by ion exchange resin so it is best to test for the following items prior to designing the treatment system:

- Arsenic III (ppb)
- Arsenic V (ppb)
- Vanadium (measured to ppb levels, e.g., 10 ppb )
- Phosphate (measured in ppb levels, e.g., 30 ppb )
- Silica (ppm)
- pH
- Other oxyanions (e.g., molybdate, selenite, antimonate, uranium—total all in ppb)
- Peak flowrate — gpm or lpm
- Water usage/day — GPD or LPD
- Target maximum arsenic level in treated water

Other factors that affect fouling, precipitation and oxidation, or that impact MCL limits:

- Suspended solids
- Total hardness
- Iron/manganese
- Chlorine or other oxidants
- Nitrate
- Microbiological count (if suspected to be a problem)

## Special notes

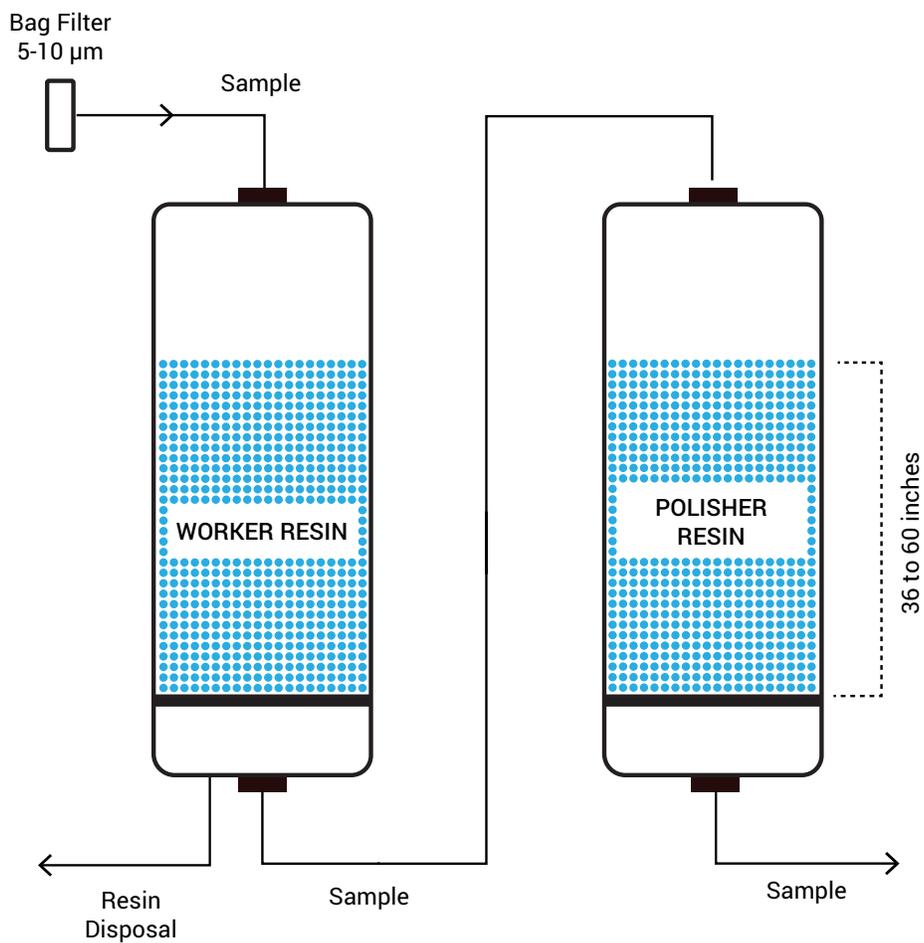
The potential exists for nitrate dumping above the MCL due to residual anion capacity in the product. If nitrate in influent is above 5 ppm as N, contact your Purolite Technical Representative.

# Equipment Design Parameters

We suggest using a lead/lag equipment arrangement to reduce the likelihood of arsenic leakage upon resin exhaustion. The lead vessel will do the majority of the arsenic removal and the lag vessel will act as a polisher removing any amounts of leakage for the lead vessel. On exhaustion of the lead vessel, replace the lead with the lag vessel and put fresh resin in the lag position:

**FIGURE 1**

## Lead/Lag Design

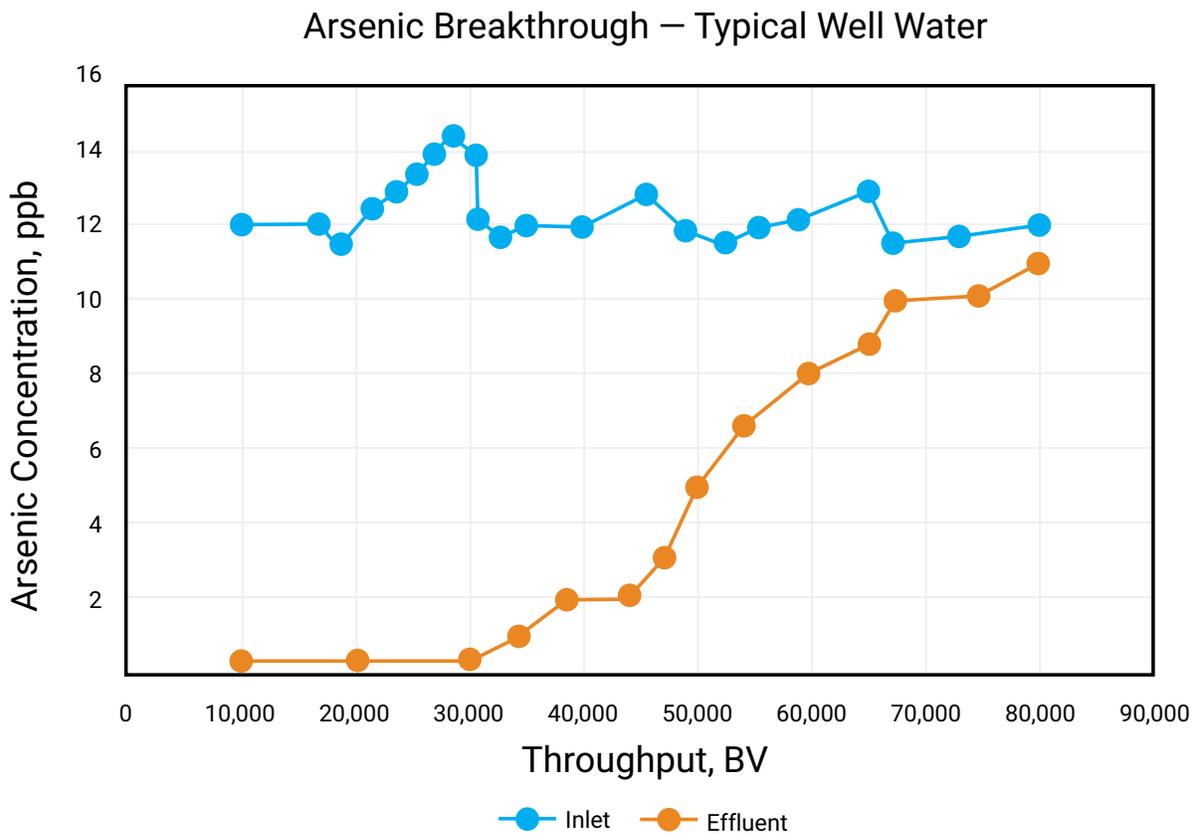


## Other Design Parameters

- 2–5 minutes contact time
- < 4 gpm/ft<sup>3</sup> flow rate (< 30 BV/h)
- Bed depth > 30" (760 mm)
- Distributor design for 16–50 mesh media (300–1,200 microns)
- Sample ports at the inlet/inter-stage/outlet positions
- Discount capacity for higher flow rate
- Pre-filter for suspended solids to maintain < 1 NTU turbidity influent to the resin vessels
- Consult with Purolite on further design details

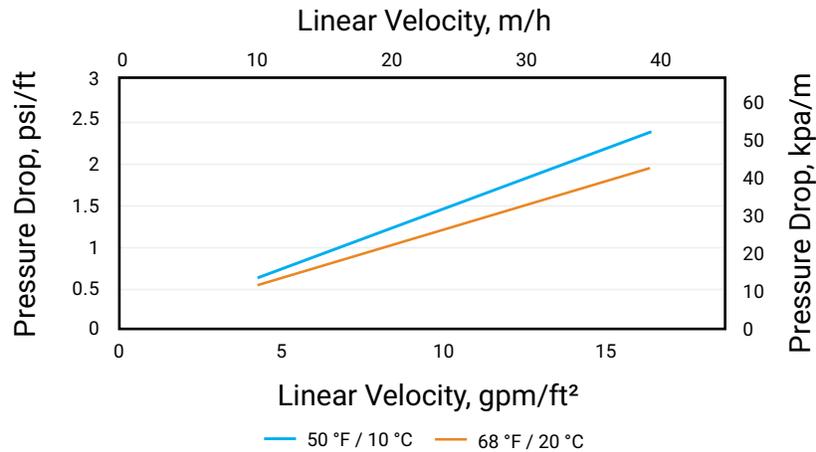
**FIGURE 2**

### Typical Breakthrough Profile



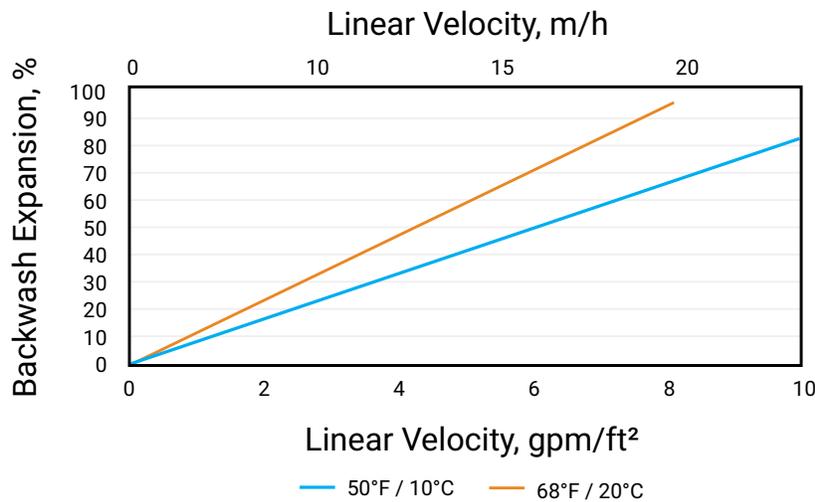
**FIGURE 3**

**Pressure Drop, Purolite FerrIX A33E**



**FIGURE 4**

**Backwash Expansion, Purolite FerrIX A33E**



Note: Once the resin is put into service, backwashing is not permitted as this will lead to shortened bed life.

**References**

United States Environmental Protection Agency. (2015, November 9). Chemical Contaminant Rules. Retrieved December 16, 2015, from <http://www.epa.gov/dwreginfo/chemical-contaminant-rules>

United States Environmental Protection Agency. Retrieved January 18, 2022 from <https://www.epa.gov/dwreginfo/drinking-water-arsenic-rule-history>

Federal-Provincial Territorial Committee on Drinking Water. (2006). It's your health: Arsenic in drinking water (ISBN # 0- 662-36233-0). Retrieved from Health Canada website: [https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/hl-vs/alt\\_formats/pacrb-dgapcr/pdf/iyh-vsv/enviro/arsenic-eng.pdf](https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/hl-vs/alt_formats/pacrb-dgapcr/pdf/iyh-vsv/enviro/arsenic-eng.pdf)

# Purolite FerrIX A33E Application Questionnaire

## General Information (To be completed by sales office)

Date: \_\_\_\_\_ Customer Address: \_\_\_\_\_

Sales Office: \_\_\_\_\_

Sales Person: \_\_\_\_\_

Customer: \_\_\_\_\_ Customer Email: \_\_\_\_\_

Customer Phone: \_\_\_\_\_

### Essential Water Inlet Requirements:

Total hardness  
(ppm as CaCO<sub>3</sub>)

Alkalinity  
(ppm as CaCO<sub>3</sub>)

T.S.S. (ppm)

T.D.S. (ppm)

pH

Nitrate (ppm)

Arsenic V (ppb)\*

Arsenic III (ppb)\*

Vanadium (ppb)\*

Phosphate (ppb)\*

Silica (ppb)\*

Molybdate (ppb)

Antimony (ppb)

Selenium (ppb)

Uranium (ppb)

\*Critical data input

### Application Details

Target arsenic leakage (ppb)

Daily water requirements (m<sup>3</sup> or USG)

Flow rate (m<sup>3</sup>/h or US gpm)

Vessel diameter

Number of vessels

Resin bed depth

Pre-Oxidation/Chlorination Yes  No

Pre-treatment Yes  No

### System Limitations

Total arsenic < 2,000 ppb, vanadium < 100 ppb, phosphate < 1,000 ppb, silica < 90 ppm

pH < 9.0 and pH > 6.0

< 50 ppm of other oxyanions (Sb, Se, Mo, Ur)

< 5 ppm of nitrate

### Design Requirements

Minimum bed depth = 76 cm (30"). 91 cm (36") is highly recommended

Two-vessel lead-lag design yields maximum capacity

Flow rate = 2.5 – 4 US gpm/ft<sup>3</sup> of resin

Flow rate = 12 to 30 BV/h (1.5 to 4 gpm/ft<sup>3</sup>) of resin

Contact your Purolite Representative for assistance if you exceed any of these parameters.

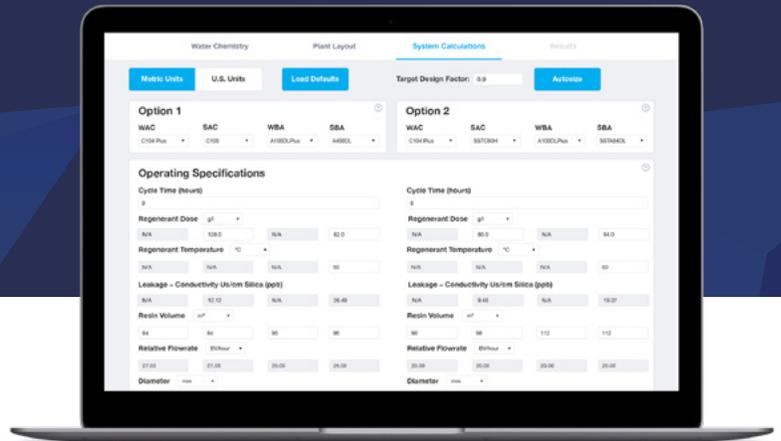


# Customized Resin Simulation at Your Fingertips



**PRSM™**  
Purolite Resin System Modeling

PRSM is a free program that models all aspects of plant design associated with ion exchange resin performance and operation.



Plan your next ion exchange resin project with better accuracy and less effort through Purolite's Resin System Modeling platform (PRSM™). This powerful web application for resin plant simulation contains seven specific system modules that instantly consider hundreds of variables. Whether you are designing a new plant or modeling an existing plant, Purolite's expert engineers are giving you the access you need to get the results you can trust.

## Key Insight Every Step of the Way



### Predict

Calculate the effect of your site's unique variables



### Compare

Side-by-side product and plant configuration performance evaluation



### Optimize

Add operation and product cost analysis to better understand the value of product options

PRSM includes modules for water softening, demineralization, WAC softening, brine purification, mixed beds and modules for removal of nitrate, arsenic and boron. Features include:

**Technical Help** – Reach out directly to Purolite engineers for advice

**Cloud Backup** – Easy and secure retrieval of projects

**Reporting** – Print/save a pdf of the entire design including all engineering details

**ROI Payback Calculations** – Contrast performance vs. standard resins

**Efficiency Evaluation** – Compare operating costs of existing ion exchange plant vs. new design

**Schedules** – Obtain detailed regenerant schedules for cation and anion resins

**Page, Topic and Calculation Help** – View detailed notes and suggestions for the optimal design

Register today and get started at [www.purolite.com/PRSM](http://www.purolite.com/PRSM)







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



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