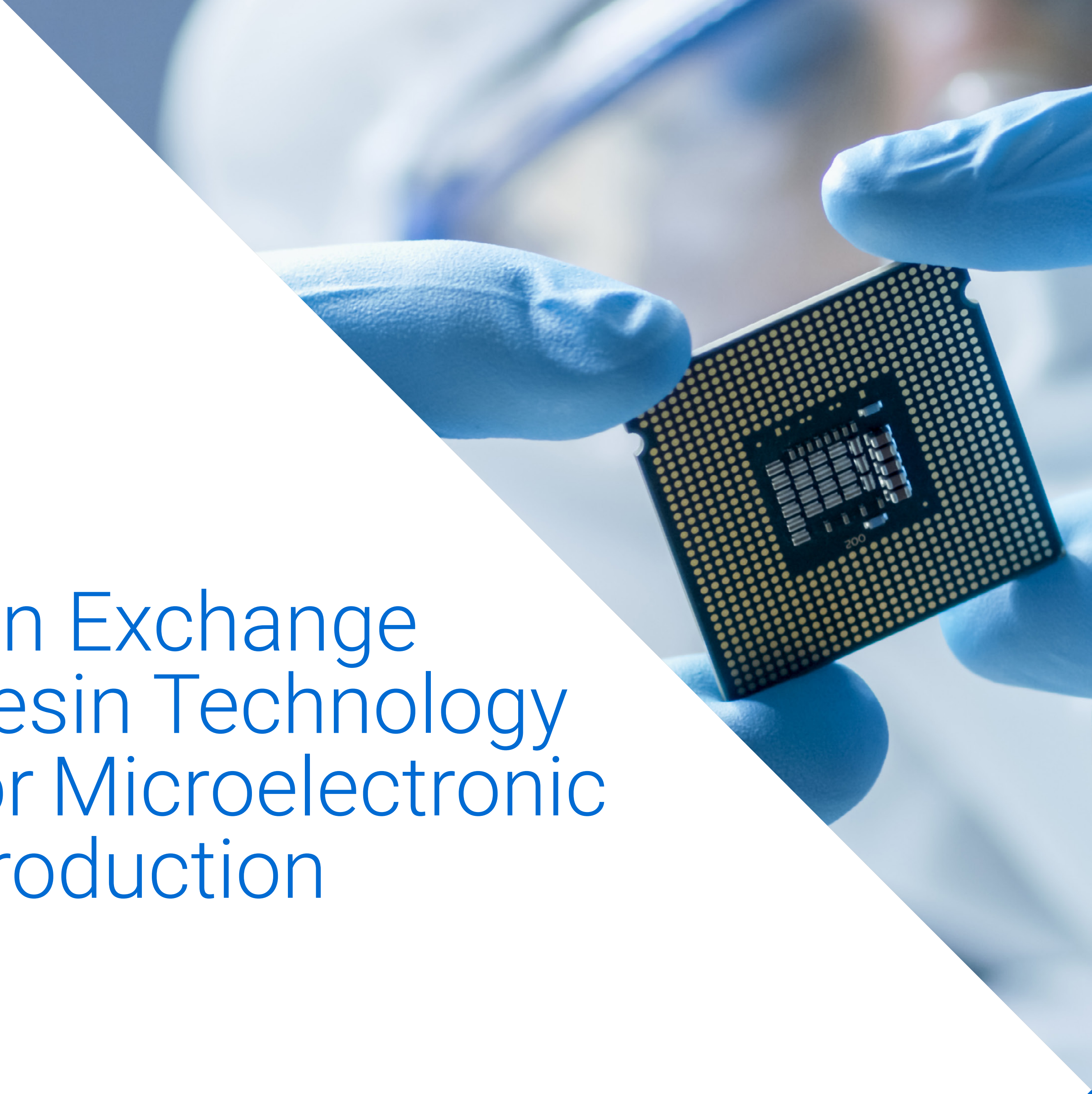

Ion Exchange Resin Technology for Microelectronic Production

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Ecolab has a range of Purolite™ Resins to optimize the most critical processes across a fabrication plant. From pretreatment and primary water treatment solutions to high and ultrapure needs such as polishing loops, chemical purification steps, and waste and reclaim streams — all helping to provide unparalleled purity.

Contents

Introduction

Ion Exchange Resins for Microelectronic Industries

Ecolab has been working to support the microelectronic industry for decades. We offer highly effective resin solutions from pretreatment to primary and polishing loops through waste and reclaim streams.

Ecolab supplies a robust selection of ion exchange resins manufactured to ensure microelectronic fabrication plants operate at peak performance. Choosing suitable resin throughout the multiple processes is critical for maintaining high manufacturing yields and attaining sustainability goals.

Ecolab Solutions

UltraClean™ Advantage

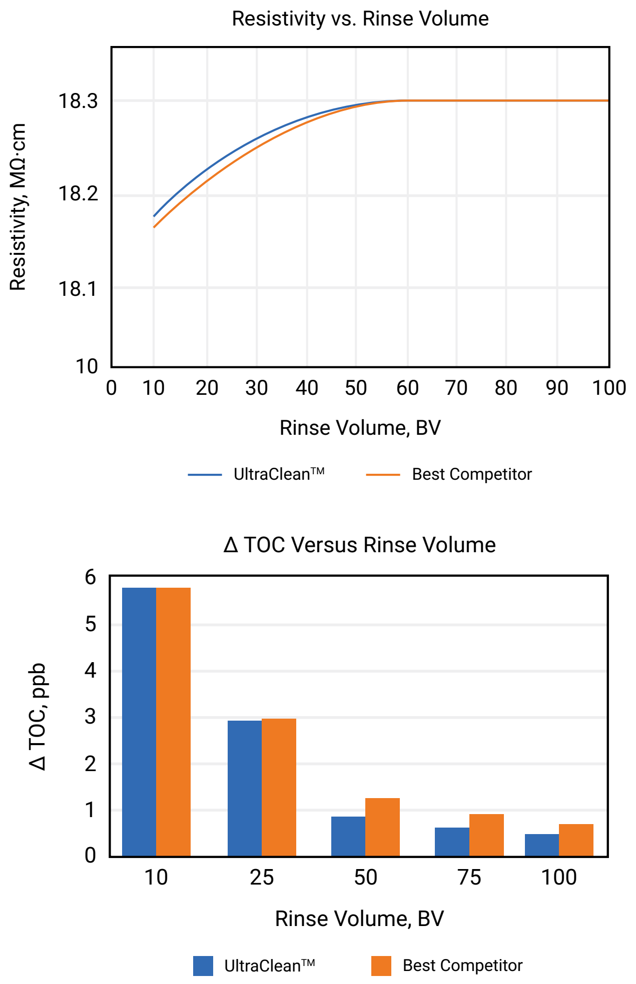
Purolite UltraClean ion exchange resins for ultrapure water are specially manufactured to meet the precise needs of the electronics industry for wafer and microchip production. These needs require the highest possible water quality, < 1 ppb Total Organic Carbon (TOC) and up to 18.2 MΩ·cm resistivity while working to eliminate contamination of the high-purity circuits when ion exchange resin is first installed.

TABLE 1 **UltraClean Product Specifications**

Product	Type	Matrix	Form	Description
UCW1080	Anion	Macroporous	Free Base	Targeted Boron (B) Removal
UCW3600	Mixed Bed	Gel	Separable	Higher Anion (-) Ratio
UCW3700	Mixed Bed	Gel	Separable	Balanced UPW
UCW3900	Mixed Bed	Gel	Separable	Higher Cation (+) Ratio
UCW5072	SBA	Gel	OH^-	Regenerable, Uniform Particle Size
UCW9126	SAC	Gel	H^+	Single Use, Uniform Particle Size
UCW9964	Mixed Bed	Gel	Separable	UPW Low TOC Extractables
UCW9966	Mixed Bed	Gel	Non-Separable	UPW Low TOC Extractables

FIGURE 1

Typical UltraClean UCW9964 and UltraClean UCW9966 Mixed Bed Resistivity and Δ TOC Versus Rinse Volumes (BV)



While all our resins maintain exceptional quality standards, our UltraClean product family incorporates rigorous additional quality measures into manufacturing to meet purity levels and optimize capacity. These extra steps are instrumental in minimizing the presence of leachable substances, such as TOC, resulting in reduced rinsing time and water consumption. UltraClean Resins are supplied in a fully regenerated (H or OH) form, allowing for ease of start-up with little to no regeneration required.

Ecolab provides multiple ion exchange resin types, enabling fabrication plants to achieve optimal performance through targeted ionic removal. Access to multiple resin types allows for a solution catered to your specific challenge.

Separable vs. Non-Separable Mixed Bed Ion Exchange Resin

Separable ion exchange resins typically provide the advantage of being less susceptible to fouling and provide a more efficient regeneration process. Separable resins are best used in polishing loops where they are more efficient at ion removal in low-concentration feed sources where they will remain in operation for extended periods between exchange or regeneration cycles.

Non-separable resin is typically a lower-cost option, commonly used to produce demineralized water in the primary loop process.

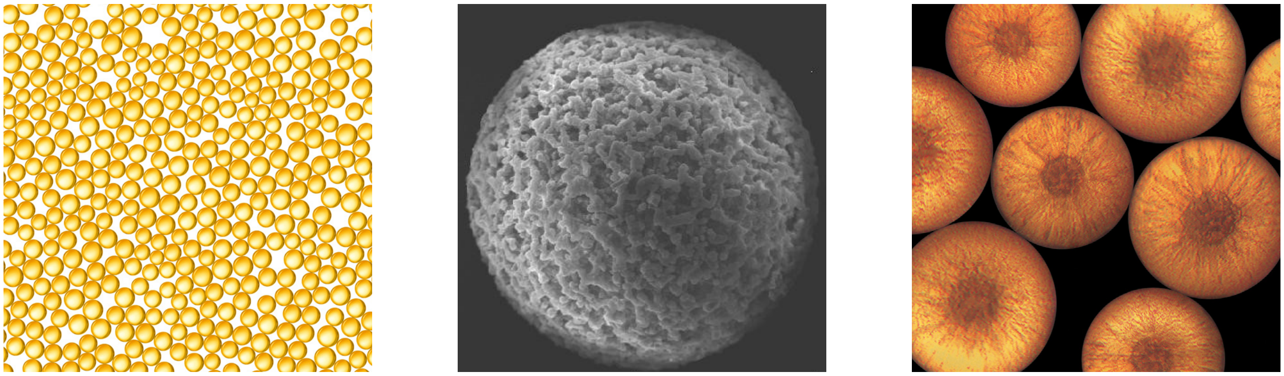
Macroporous, Gel, and Chelating Resin Types

Macroporous resins have open pores, making them more effective for organic contaminants. Gel resins provide smaller closed pores ideal for industrial processes to remove inorganic contaminates. Chelating resin is a unique structure with multiple functional groups providing high efficiency and stability. These resin types are ideal for heavy metal (Cu Pt, Pd, Zn, Cr, Pb) recovery from waste streams.

Purolite Shallow Shell™ Technology (SST)

Our exclusive resin bead design optimizes resin performance with its inactive core, leaving a 60% shell of active sites. This unique inactive core forces all ion exchange to take place at the bead's shell, allowing for quicker exchange and producing higher-purity water. The SST bead is easier to regenerate and less vulnerable to fouling than traditional ion exchange resin beads, as the ions and foulants do not exchange with the inactive core. The SST technology allows up to 15% reduction of regeneration chemicals and up to 50% reduction in water required for chemical dilution and fast rinsing, resulting in reduced operating expenses.

FIGURE 2



Cation Resin

Macroporous Resin

Shallow Shell Technology

Fabrication Applications

Primary Loop

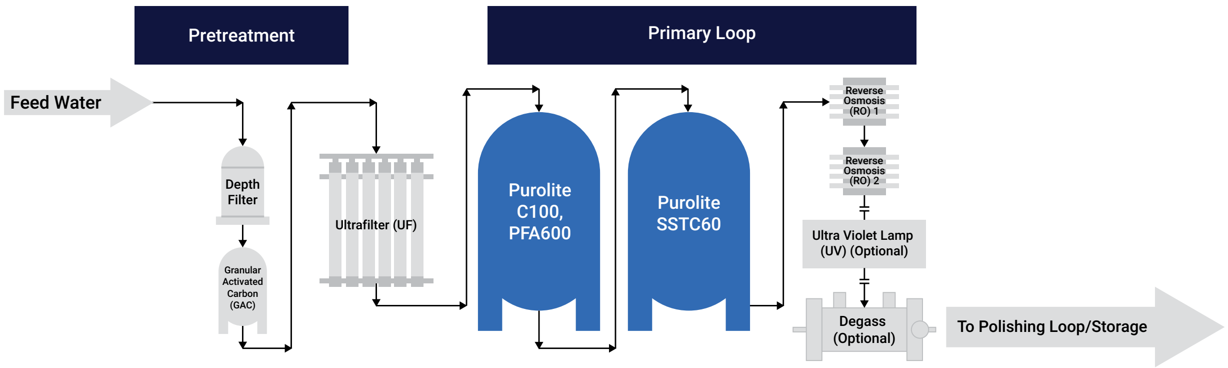
Multiple filtration technologies are deployed to treat incoming water that will interact in transforming raw materials into semiconductor devices, such as providing pure water to rinse applications and heat transfer processes.

These processes rely on ion exchange resin to remove impurities in water and ensure water is high quality, but also act as a pretreatment to the ultrapure water (UPW) polishing loop for critical applications.

Applications and Benefits

- Optimize and Protect Membrane Technologies Upstream: Remove hardness (calcium, magnesium, iron, etc.) and other foulants to reduce scale potential on reverse osmosis (RO) and Ultrafilters (UF) to optimize performance and maximize life.
- Chemical Reduction: Utilize resin to replace traditional anti-scalant chemical injection processes.
- Initial Demineralization: Anion, cation and mixed bed ion exchange resins attract and exchange harmful impurities with hydrogen or hydroxide, which do not interfere with the manufacturing process for bulk deionization of contaminants to optimize FAB efficiency, typically achieving up to 17 megohm-cm resistivity.

FIGURE 3



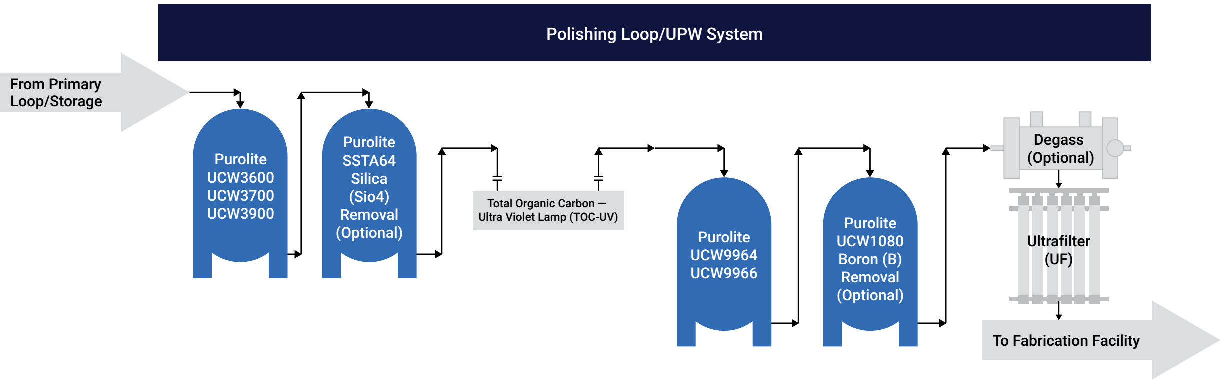
Polishing Loop/Point of Use

High-performance Ion Exchange resins are utilized in the polishing loop step to remove trace ions to produce UPW (up to 18.2 megohm-cm) for the most critical processes in semiconductor manufacturing. As microprocessors advance, so does the need for stricter water quality down to the parts per trillion (ppt) detection levels. UPW water is used in wafer products and display panel manufacturing.

Applications and Benefits

- Wafer Surface Rinsing: Impurities in water can affect the wafer in many ways, including creating a short circuit or landing on the resist layer, causing projection error on the wafer. Maintaining consistent quality is vital to optimizing yield and reducing waste.
- Chemical Dilution: Chemicals, such as abrasives, buffers and surfactants, are used to achieve surface finish. Typically, these are diluted, and a high level of pure water is required to make sure no impurities are introduced to the process.
- Targeted Ionic Removal: Traditional mixed bed deionization beds, like those found in the primary loop, will remove the most highly ionized impurities. Utilizing specific Anion, Cation and mixed bed resins formulated to target the removal of "killer particles" such as Silica, Boron, TOC, and other trace metals.

FIGURE 4



Wastewater Treatment and Reclaim, Chemical Purification

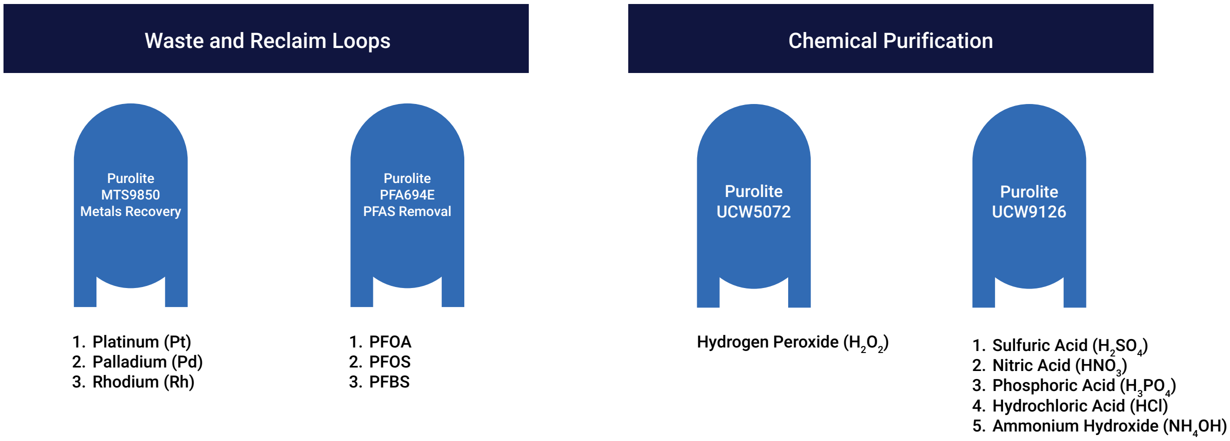
Water is a vital raw material in producing semiconductor and display technologies, which results in large quantities of once-clean water to be treated before discharge or reclaimed for reuse either back to the high-purity process or for use in non-high purity applications elsewhere in the fab.

Applications and Benefits

- Removal of High pH Corrosive Materials: Reduce these from being released to the environment or back to the process.
- Chemical Recovery: Remove ions from process chemicals.
- Metal Recovery: Recover precious metals, such as copper (Cu), to reduce waste.
- Membrane Protection: Remove foulants to increase the efficiency of the membrane technologies.
- Reduction of PFAS Compounds: Remove these harmful compounds from entering the waste stream or being introduced back into the process.

Chemicals also play a vital role in the cleaning process for wafer surface preparation and etching of metal, silicon, and other materials. It is crucial these chemicals also be free of organic, oxidants, and trace metal compounds.

FIGURE 5



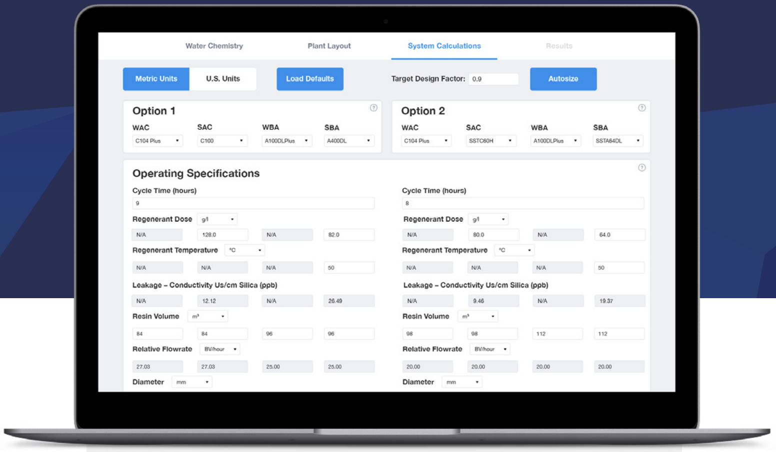
Learn More

Visit www.puroliteresins.com/microelectronics to discover how Ecolab can support your fabrication needs.

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.



Target Design Factor: 0.9

Option 1

WAC	SAC	WBA	SBA
C104 Plus	C100	A100DLPlus	A400DL

Option 2

WAC	SAC	WBA	SBA
C104 Plus	SSTC60H	A100DLPlus	SSTA64DL

Operating Specifications

	Option 1				Option 2			
Cycle Time (hours)	9				8			
Regenerant Dose (g/l)	N/A	128.0	N/A	82.0	N/A	80.0	N/A	64.0
Regenerant Temperature (°C)	N/A	N/A	N/A	50	N/A	N/A	N/A	50
Leakage – Conductivity Us/cm Silica (ppb)	N/A	12.12	N/A	26.49	N/A	9.46	N/A	19.37
Resin Volume (m³)	84	84	96	96	98	98	112	112
Relative Flowrate (BV/hour)	27.03	27.03	25.00	25.00	20.00	20.00	20.00	20.00
Diameter (mm)								

Plan your next ion exchange resin project with better accuracy and less effort using the Purolite Resin System Modeling (PRSM™) platform. 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, our 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 our 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

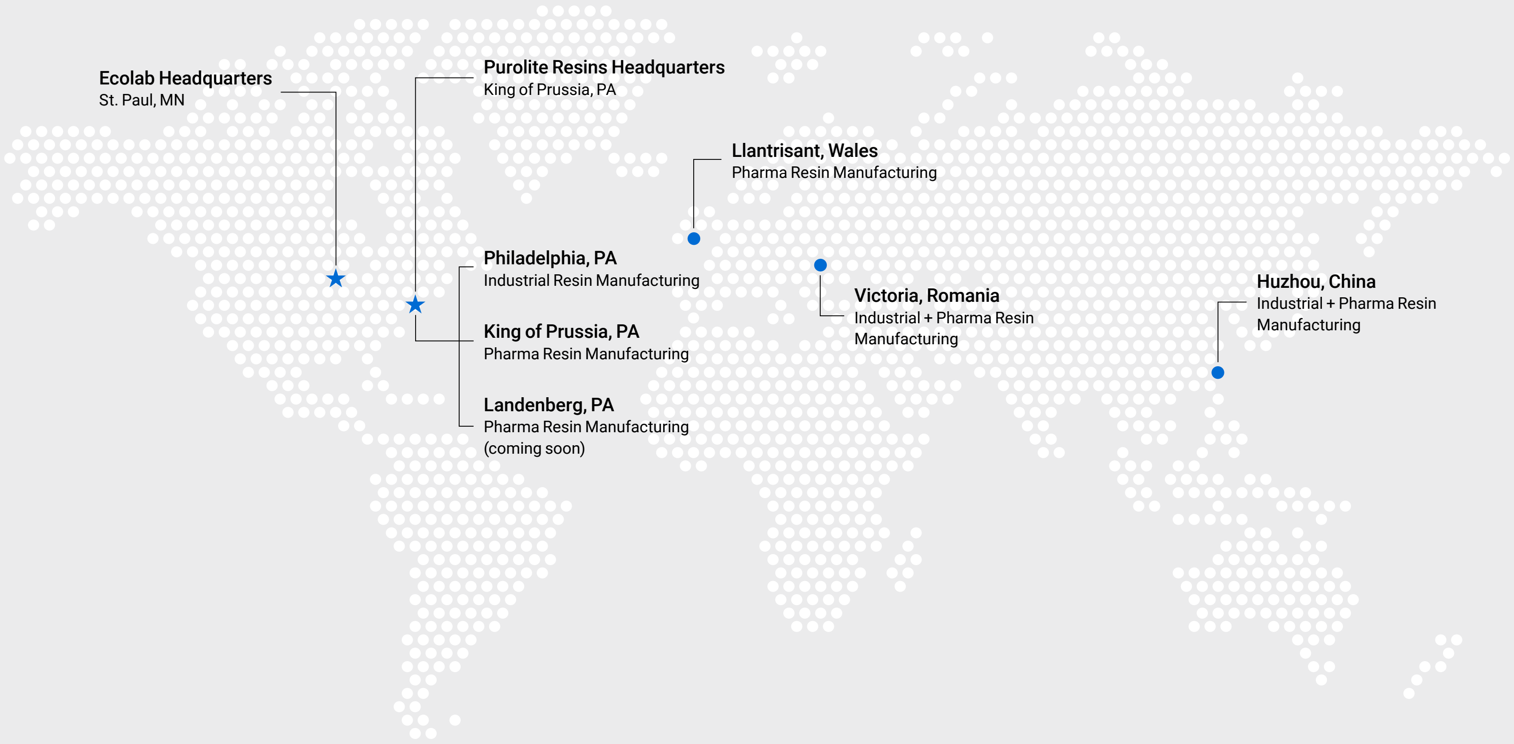
Page, Topic and Calculation Help – View detailed notes and suggestions for the optimal design

ECOLAB®

Register today and get started at **www.puroliteresins.com/PRSM**

Ecolab is a global developer, manufacturer, and supplier of Purolite™ Resins including ion exchange, catalyst adsorbent and advanced polymers that make the world cleaner and healthier.

www.puroliteresins.com



We're ready to solve your process challenges.

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