Ion Exchange

DuPont™ AmberLite™ P2X110 Ion Exchange Resin

Recommended Usage Guidelines in Mixed Bed Units

Solutions for Green Hydrogen Production

Introduction

Hydrogen can be produced by several methods from different feedstocks, but one that emits minimal to zero greenhouse gases is termed Green Hydrogen, in which Hydrogen is produced from water by renewable energy powered electrolysis. Electrolysis is the process of electrically splitting the water molecules into hydrogen and oxygen gas.

There are various types of electrolyzers, with Alkaline Water Electrolyzers (AWE) and Proton Exchange Membrane (PEM) electrolyzers among the most widely utilized. Both types require high-purity water as the feedstock to produce hydrogen, which is obtained through a water treatment system, usually called make-up water treatment system. The treatment scheme typically includes ultrafiltration, resin softening, double pass reverse osmosis, and electrodeionization and/or mixed bed polishing resin. Additionally, PEM electrolyzers require a polishing system, also called refinement loop, to maintain water purity in the recirculation streams.

AmberLite™ P2X110 ion exchange resin, is a mixed bed formulation designed for the unique water composition and operating needs that are present in water electrolyzers feed water and specially the recirculation loop of PEM electrolyzers. This document applies to high performance grade refinement loop ion exchange resins in mixed bed form supplied by DuPont, intended for operation in a non-regenerable mixed bed column, in once-through and closed-loop configurations.

Design & Operating conditions

Mixed Bed (MB) ion exchange units are designed to produce high purity water during the treatment process by removing small traces of soluble salts and contaminants that can disrupt reliable operation of the electrolyzer.

For optimum performance, ion exchange resins should be used within a defined range of operating conditions, although operating outside the suggested range is possible. Contact DuPont technical service for assistance when operating outside the suggested ranges to ensure high performance operation.

	Make-up water treatment polisher	PEM Recirculation loop water polisher
Bed Depth	0.8-1.5 m (32-59 inches)	1.2-1.5 m (47-59 inches)
Specific Flowrate*	20 – 50 BV/h	20 – 40 BV/h
Linear Flowrate**	≥ 24 m/h (10 gpm/ft^2)	≥ 24 m/h (10 gpm/ft^2)
Pressure drop	ΔP < 150 kPa (22 psi)	ΔP < 150 kPa (22 psi)

* Also called Spatial Velocity.

** Also called Linear Velocity. Lower flowrate limit is 24 m/h (10 gpm/ft2); upper flowrate limit is determined by pressure drop, not to exceed 150 kPa (22 psi).

Additional notes:

- The bed depth data apply to MB units with a diameter of 300 mm (1 ft) or more. In case of smaller vessel

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diameter, please contact DuPont.

- About bed depth and linear flowrate: the important parameter is pressure drop, which should not exceed 150 kPa (22 psi) as a design value, but preferably closer to 100 kPa (15 psi). Pressure drop typically increases during service.
- Operating below the recommended minimum flowrate can cause serious water quality problems, particularly when the salinity is relatively high.
- Operating above the recommended liner velocity may cause operational difficulties, such as excessive differential pressure.

Resin handling

1. This document applies to both makeup water treatment polishing, and refinement loop polishing resins supplied by DuPont™ as once-through and closed loop mixed bed products, intended for operation in a non-regenerable mixed bed column.
2. Use high purity water for all steps where water will contact the resin. In the present instructions, all mentions of the use of "water" mean high purity water, which should have a resistivity of at least 17 MΩ· cm. (< 0.06µS/cm).
3. Avoid the use of any mechanical pumps to transfer the resin to the vessel. Many types of pumps can physically damage the resin beads, creating fine particles or adding other contamination.
4. The resins are shipped with the cation resin >99% in the H form, and the anion resin >95% in the OH form. If properly loaded and operated these resins should produce water with more than 18 MΩ· cm (<0.056µS/cm) and less than 5 µg/L Delta TOC (ΔTOC) after a few hours of operation. [1].
5. All ion exchange resins will develop some amount of leachable organic material upon storage and shipment. Careful loading is required to ensure that the best performance can be obtained during the first operating cycle. Any contamination with ionic or organic material during the loading process can result in contamination of the resin and a reduction of performance or lifetime. For that reason, all equipment used in the loading operation must be well cleaned, contain no foreign material and is rinsed with high purity water.
6. Further, proper sanitization of equipment used for the loading process is recommended to prevent bacterial growth.
7. During the resin loading process, do not open more than two bags or drums of resin at any one time. This is to minimize the contact of resin with air and the risk of any extraneous material entering the resin containers.
8. Although AmberLite™ P2X110 resin supplied by DuPont is a high purity resin, it is essential for the user to perform sufficient rinsing until the final effluent water purity satisfies the specific requirements for the intended application. Closed loop recirculation rinsing of polishing mixed beds is not generally recommended unless specific devices (such as UV lamps) require TOC to be removed from the loop.

Vessel loading

1. To prepare for resin loading, take the above resin handling guidelines carefully into consideration.
2. Ensure the vessel is clean and inspected.
3. Ensure the nozzles are in good condition without damage.
4. For smaller vessels (diameter < ~1 m) resins can be loaded without the presence of water. For those cases, continue at step #7.
5. Prepare for resin loading for larger vessels by adding about 200 mm of water into the resin vessel. This is required to cover the vessel underdrain system or nozzle plate and should be sufficient to protect the underdrain from being hit directly by the resin that will be added.
6. AmberLite™ P2X110 mixed bed components may tend to separate during filling. It is therefore important to maintain the water level in the bed as low as possible above the resin during loading to avoid separation.
7. Add the resin to the MB vessel.
8. Depending on the storage time and conditions, when opening the package, the resin can release some odor which is caused by the anion resin. Proper ventilation during loading is recommended.
9. When loading with water, check the water level above the resin bed on a regular basis. If the water level is close to the resin surface, add additional water from the top, to cover the resin bed to maintain about 100 mm water coverage.
10. Continue the filling operation until the required resin volume is in the vessel.
11. After the resin is loaded, the resin bed should be fully covered with water filled from the top. When loading the resin as a slurry, even if the filling operation has been correctly conducted, a partial un-mixing of both

[1] Delta TOC means the difference between inlet and outlet value

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components may occur, and a re-mix is always recommended. The following procedure to re-mix can be undertaken:

- bring the water level to less than 50 mm above the resin bed,
- re-mix by agitation with bottom-fed clean nitrogen for 10 - 30 minutes.

12. After mixing, do not attempt to backwash or separate the resin again before performing initial pre-service rinse and normal operation.

Startup procedure

1. Prior to startup of the system carefully consider the guidelines for resin handling and resin loading contained herein.
2. Visually inspect the water surface after resin loading for the presence of any (floating) foreign materials and remove them if present.
3. Close the vessel and fill the vessel from the top with water. Make sure no flow in upwards direction is applied as this may lead to resin separation.
4. Carefully de-aerate the vessel during the vessel filling. The presence of air in the vessel can cause in-vessel turbulence and inaccurate conductivity measurements.
5. Rinse the resin bed at a flow rate of 20 – 30 bed volumes per hour (BV/h) [2] for a minimum of 60 bed volumes (BV) [3] to waste and observe the outlet conductivity and TOC quality during this period.
6. To achieve the maximum resin performance, it is not recommended to circulate the mixed bed rinse water back to the inlet side of the vessel during this step.
7. Once quality is within the expected range, the mixed bed is ready to be put in operation for refinement loop water treatment.

Resin storage

AmberLite™ P2X110 resin is a high-purity and high-performance resin. When properly stored, the resins can be kept for up to 3 years minimizing effects on purity and/or performance. Precautions must be taken during storage of AmberLite™ P2X110 resin in their original unopened packaging in a cool, dry area to prevent resin dehydration and/or microbial contamination.

AmberLite™ P2X110 mixed bed ion exchange resin is supplied as water-wetted beads. It is important to maintain the water content since resin beads which have dried out may crack or fracture when re-wetted. Additional considerations include:

- Do not expose resin bags to direct sunlight for long periods of time.
- Keep resin containers at a temperature below about 40°C.
- When the packaging has been opened or damaged, check that the resin remains moist. Spray with clean water if necessary.
- Renew damaged bags. Seal and label them properly.

Resins should be stored in their original unopened packaging in a cool dry area. An indoor storage facility with climate control between 2–40°C (36–105° F) is recommended for best results.

Temperatures as low as – 40 °C have no measurable effect on the resin properties. The moisture inside the resin beads does not freeze at these temperatures because of the high ionic strength inside the resin. However, the surface water on the beads and excess moisture in the containers will freeze below 0 °C, giving the impression that the resin mass is completely frozen.

- Frozen resin bags should be handled gently to avoid mechanical shocks and structural damage of the resin beads.
- Frozen resin packages should be thawed gradually, avoiding thermal shock.

The shelf life of unused AmberLite™ P2X110 mixed bed ion exchange resins is 3 years from date of manufacture.

[2] BV/h = flow rate (m3/h)/installed resin volume (m^3)

[3] BV = installed resin volume (m^3)

Resin regeneration

AmberLite™ P2X110 resin is designed and optimized for the challenges of the refinement loop, as a single use non-regenerable mixed bed. The combination of temperature and oxidative environment entails a risk of damaging the resin, which may impact the ability of the resin to recover its initial performance. Given these considerations, chemical regeneration is not technically useful neither suitable.

Sample analysis

Sustaining the high-performance is a challenge that requires awareness of the performance of all the components of your system, including the resin. The impacts of a damaged or poorly operating system can include operational downtime and additional costs for:

- Repairs
- Replacing system components
- Cleaning a fouled system
- Increased energy use
- Inefficient resin utilization
- System down-times and reduced electrolyzer capacity

DuPont system optimization services (SOS) puts our global team of highly skilled, experienced scientists and technicians at your disposal. For a nominal fee, we can conduct an assessment using state-of-the-art equipment and methods to identify critical issues or happenings in the refinement loop, affecting your AmberLite™ P2X110 mixed bed ion exchange resin. These services can lighten the burden of system startup and staff training, as well as assist with troubleshooting, ongoing operation, and maintenance.

It is recommended to provide resin samples on an as needed basis to DuPont SOS group for a full resin analysis. A well labeled two-liter core sample from end of life should be taken and stored in a sealed plastic container when end of life analysis will be pursued. For detailed sample collection guidelines, please contact your local technical representative.

More information about DuPont SOS can be found at:

www.dupont.com/water/resources/system-optimization-services.html

End of life

Ion exchange resins should be buried in a licensed landfill or burned in an approved incinerator according to local, state, and country regulations. For resin contaminated with hazardous material, dispose of the mixture as hazardous material according to all local, state and country regulations. Refer to the Material Safety Data Sheets for additional information SDS Finder.

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Have a question? Contact us at:
www.dupont.com/water/contact-us

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