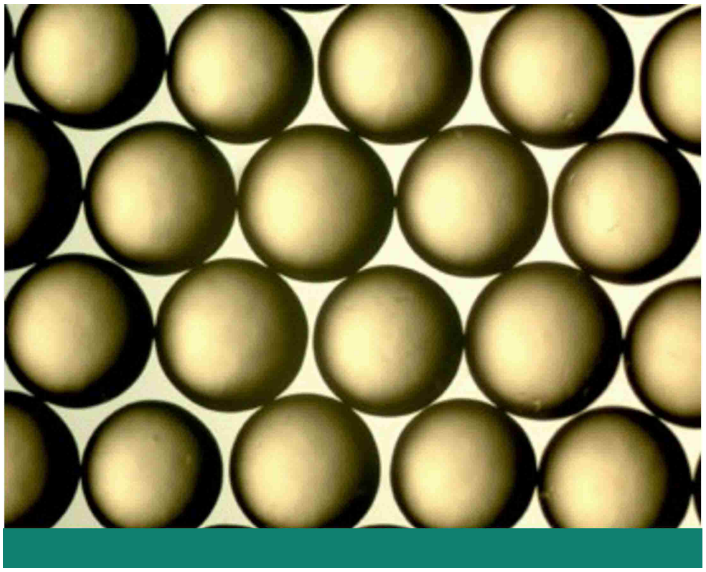
Water Treatment for Industrial and Power Markets

Packed Bed Ion Exchange Systems



For over 30 years, packed bed systems have been recognized as the leading process for employing ion exchange resins at maximum efficiency for demineralization, enabling lower chemical costs and waste volumes and higher product quality. For feedwater containing typically <10 meq/l (approximately <1,000uS/cm) ion exchange is the most cost effective technology to deionize water with packed bed technology. DuPont is the original inventor of both upflow and downflow operated packed bed systems and has led the way in packed bed innovation through its Upcore™ and AmberPack™ design systems. The high water recovery of our packed bed technology helps address the increasing water scarcity challenges and increasing cost of water and waste discharge.

DuPont Water Solutions' packed bed systems are characterized by:

1. Compact vessels
2. Single, double and triple resin compartment vessel technology
3. Counterflow regeneration technology
4. Cost effective operation
5. Low waste / very high water recovery
6. Reliable and high operational availability
7. Track record of experience and knowledge

Our packed bed systems come with a complete engineering package including a design manual, design software (WAVE), resin analysis service and a variety of AmberLite™ HPR resins for any water treatment need. AmberLite™ HPR Ion Exchange Resins are high- quality resins with a particle size specifically designed for use in packed bed system designs in industrial demineralization and softening applications when high operating performance, long resin life, simplified and cost-effective operation is required. When the system is equipped with the AmberLite™ HPR resins, the system's chemical performance can be maximized and the ultimate treated water quality can be delivered. Packed bed systems are supported by our outstanding global expertise on ion exchange resin technology. Our technical service and development engineers are available to support with your new system designs, system performance optimization or upgrades.

DuPont Packed Bed Solutions

Upcore™ Packed Bed Systems: a downflow service and upflow regenerated technology where the resin is packed between two nozzle plates with specific free space. Benefits include: • Variable production flowrate and even start/stop situations if water demand fluctuates over time • Maximize system availability and enhance efficiency with self-cleaning ability for solids – the only packed bed system with this capability – and integrated cleaning system, which is further improved by using our special designed floating inert AmberLite™ 62i • Layered bed resin configuration available See figures 1 and 2.	**AmberPack™ System:** an upflow service and downflow regenerated system technology where the resin is packed between two nozzle plates with minimized free space. Benefits include: • Maximum flexibility to adjust the regeneration contact time and effectiveness, especially required for low TDS water or water with relatively high level of TOC • Optimized system performance and water recovery achieved when the feedwater is free of suspended solids • Design includes an external backwash tank for cleaning as needed • Maximize available vessel volume with our HPR grade resins, avoiding the use of a floating inert resin See figure 3.	**Hybrid Packed Bed System (New):** a combination of the ultimate strengths of both AmberPack™ and Upcore™ Packed Bed Systems: • The Upcore downflow operation on the cation vessel allows variability in production flowrate if water demand fluctuates over time and its self-cleaning property is enabling the ability to deal with suspended solids passing the pre-treatment • The AmberPack™ downflow regeneration for the anion vessel allows maximum flexibility to adjust the regeneration contact time and effectiveness • The use of the specially designed floating inert AmberLite™ 62i is crucial to utilize full potential of self-cleaning ability in the cation vessel • Patented system design See figure 4.

Figure 1. Upcore™

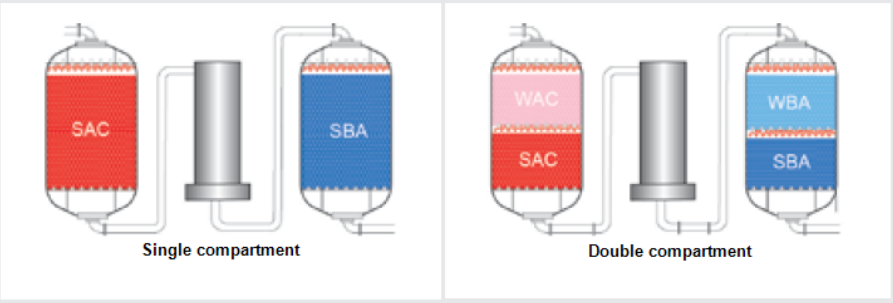


Figure 2. Upcore™ Anion Layered Bed

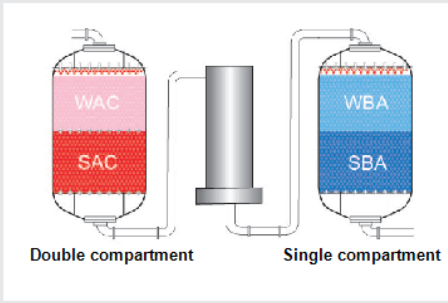


Figure 3. AmberPack™

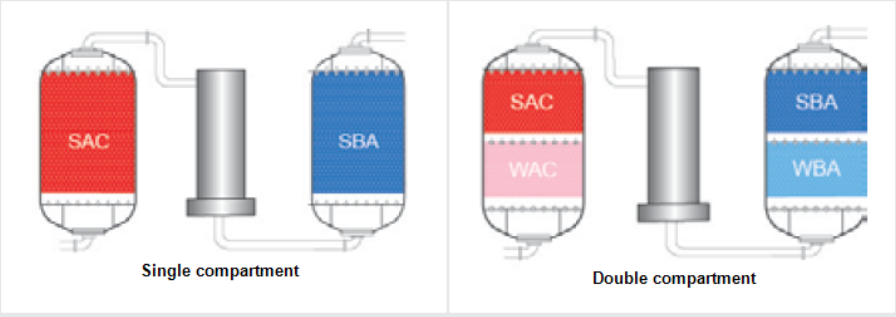
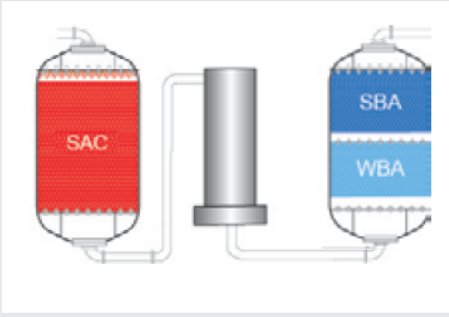


Figure 4. Hybrid



Simplified Packed Bed Selection Guide

Technical Element	Recommended Systems
Conventional pretreament / presence of solids in the feed	Upcore™ or Hybrid
Ultrafiltration as pre-treatment	AmberPack™
The need to run process over variable or intermittent flow rates	Upcore™ or Hybrid
Low TDS water and/or high organics	AmberPack™ or Hybrid
Most suitable to retrofit existing co-flow system	Upcore™
Conventional pre-treatment, low TDS and/or high organics, variable flowrate	Hybrid

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Recommended AmberLite™ Ion Exchange Resins for Packed Bed Systems in Industrial Water Treatment

Product	Type	Morphology	Matrix	Recommended Uses
HPR1100 Na	SAC	G	S	Softening resin with excellent physical stability and low rinse profile.
HPR1200 H & HPR1200 Na	SAC	G	S	Designed to be the go-to, high-quality SAC resin.
HPR1300 H & HPR1300 Na	SAC	G	S	High strength resin. Good for layered beds and mixed beds for polishing and pure water applications when very low sodium leakage and conductivity is a chief concern.
HPR4200 Cl & HPR4200 OH	SBA	G	S	Designed to be the go-to, high-quality SBA resin. Good balance of capacity, strength and silica leakage.
HPR4700 Cl & HPR4700 OH	SBA	G	S	High-capacity, high solids SBA resin with rapid kinetics. Excellent selectivity for silica makes it an ideal choice for post-RO mixed bed.
HPR4580 Cl	SBA*	G	A	High operating capacity, good physical stability and organic fouling-resistant acrylic SBA.
HPR4780 Cl	SBA*	G	A	Dual Functional (WBA+SBA) resin with extremely high operating capacity, efficiency and organic fouling resistance.
HPR4800 Cl & HPR4800 OH	SBA	G	S	High-quality SBA resin with excellent capacity and rinse characteristics.
HPR4811 Cl	SBA	G	S	High capacity porous gel SBA resin for use with high organic waters without the temperature limitations of acrylic resins.
HPR4100 Cl	SBA II	G	S	The go-to uniform Type II SBA resin.
HPR6700	WBA*	G	A	Very high-capacity WBA with exceptional physical stability and organic fouling resistance.
HPR7000	WBA*	G	A	High-capacity WBA with exceptional physical stability, organic fouling resistance, and good rinse down characteristics.
HPR2900 H & HPR2900 Na	SAC	M	S	High physical stability for harsh applications such as appreciable oxidative potential or high temperatures.
HPR8300 H	WAC*	M	A	High-capacity dealkalization and softening resin with demonstrated improved operating capacity versus other WACs available in both H and Na form operation.
HPR8400 H	WAC*	M	A	High-capacity dealkalization and softening resin allowing low pressure drop in high velocity operations.
HPR9200 Cl	SBA	M	S	Exceptional physical stability, resistance to osmotic shock, and well-suited for use in demineralization of high organic waters.
HPR9100 Cl	SBA II	M	S	High resistance to organic fouling and physical stresses with improved operating capacity compared to Type I macro SBA and increased resin lifetime in operation compared to a gel Type II resin.
HPR9500	WBA	M	S	Displays excellent thermal stability, good organic fouling resistance, and high kinetics yielding good operating capacity even in low-temperature operations. Offers a quick start- up in a single bed or when paired with an OH form strong base anion in layered bed systems.
HPR9600	WBA	M	S	Combines excellent physical and thermal stability, good organic fouling resistance, and high kinetics yielding good operating capacity even in low-temperature operations.
HPR9700	WBA*	M	S	Combines excellent physical and thermal stability, good organic fouling resistance, and allows low pressure drop in high velocity operations.
HPR2800 H	SAC	M	S	High physical stability for harsh applications such as demineralization systems involving appreciable oxidative potential or high temperatures. Allows low pressure drop in high velocity operations and optimized for separability in mixed beds.
HPR9000 OH	SBA	M	S	Specifically designed for use in regenerable mixed beds when highest resin purity and water quality are required. Exceptional resistance to surface fouling as well as physical, osmotic, and oxidative stresses, which allows increased resin lifetime in operation.
14i	Inert	PP	PP	Floating inert resin specifically designed for use as an upper layer in down-flow regenerated ion exchange systems, such as floating beds.
62i	Inert	PE	PE	Floating inert resin with properties specifically designed for use as an upper layer in up-flow regenerated ion exchange systems, such as Upcore™ Packed Bed Systems.

Abbreviations: **G** = Gel resins **M** =Macro resins **PE** = Polyethylene **PP** = Polypropylene **S** = Styrenic **A** = Acrylic

Where:

- All resins listed are uniform particle size except those marked with*. These are specially graded resins optimized for use in packed beds.
- For anion resins listed in both Cl and OH form, OH-form offers a quick start-up in a single bed and mixed bed systems.
- For cation resins listed in both H and Na form, Na is mainly intended for softening applications whilst it is available for demineralization when sodium-form is preferred by the user. However, Na- form resins are never recommended in mixed bed operations.

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