Ion Exchange and Adsorbent Solutions for the Nutrition Market

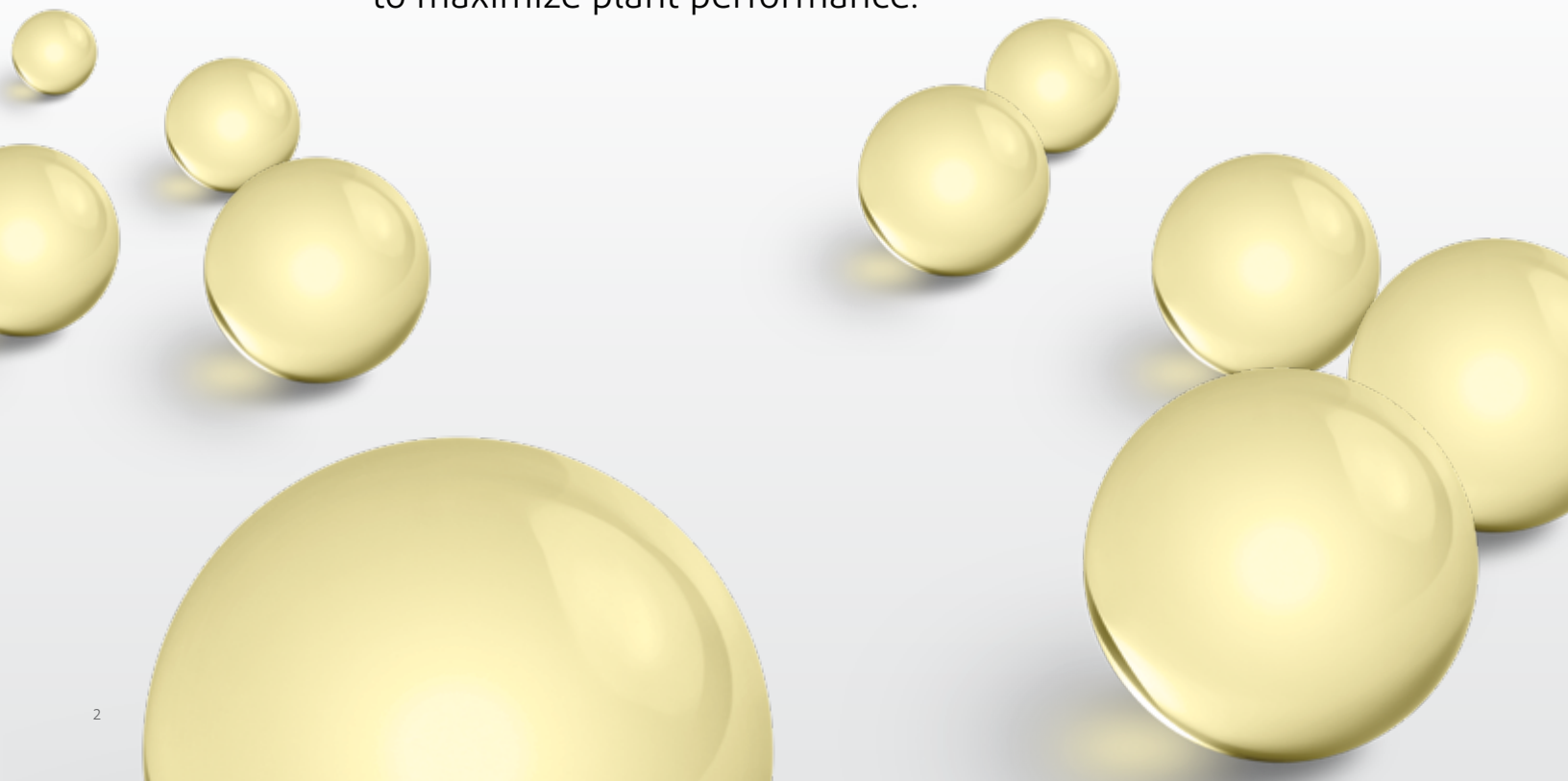
Food matters. DuPont makes it better.

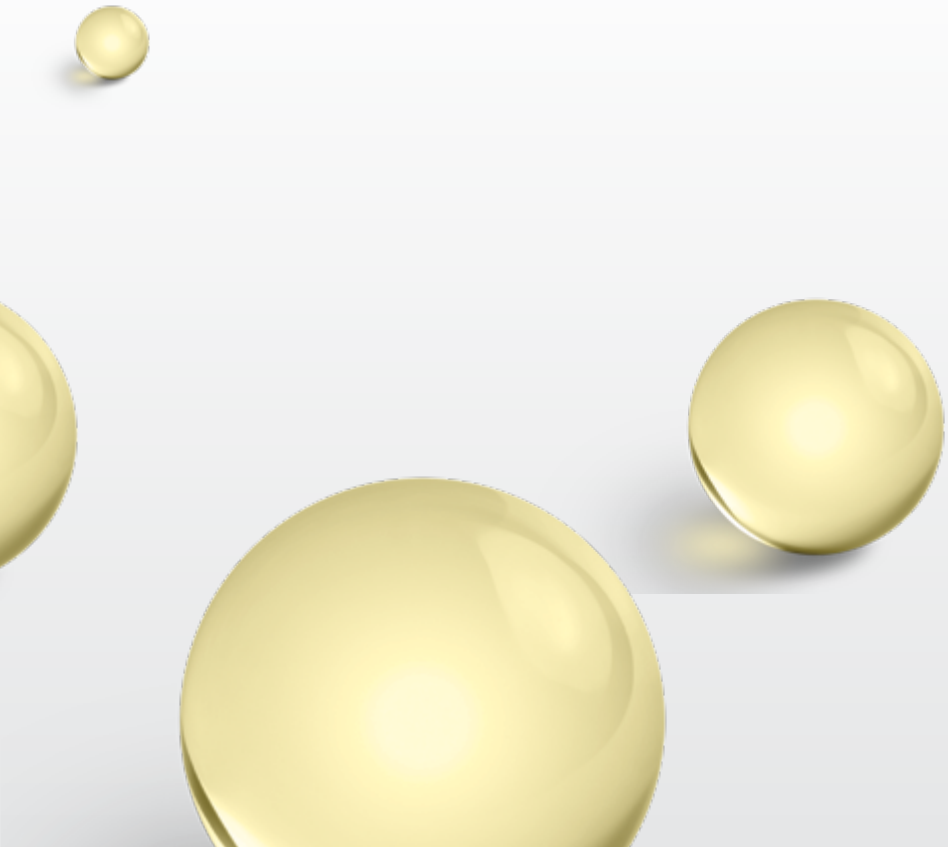
Reliability, Value, and Innovation

DuPont is the largest manufacturer of ion exchange resins worldwide. Our comprehensive product line, technical expertise, and global reach allow for optimized performance of even the most complex manufacturing processes. With continuous investment in product innovation and manufacturing excellence, we have global expertise in serving the food processing industry.

DuPont consistently offers:

- **Reliability** – capital investment in worldwide production facilities to supply increasing global demand and offer leading quality, global service, and support.
- **Value** – products designed for applications that help lower operating costs and increase throughput, yield, and product quality.
- **Innovation** – R&D focused on delivering innovative products to maximize plant performance.





Sweeteners
Corn & Starch Processing

The Value of Uninterrupted Production

With DuPont as your partner, you realize reliable production and benefit from our expertise.

You see DuPont's value in consistent plant uptime and lower-than-typical operating costs. From standard resins with Gaussian particle size distribution to premium resins benefitting from uniform particle size technology, DuPont products and solutions have served plants worldwide reliably for decades.

DuPont's value also comes in our expertise. Our deep history in the industry helps us understand your needs. We help you balance resin selection, system design, and plant operations to achieve optimal results. Altogether, DuPont helps you operate your plants with the highest return for your resin investment.

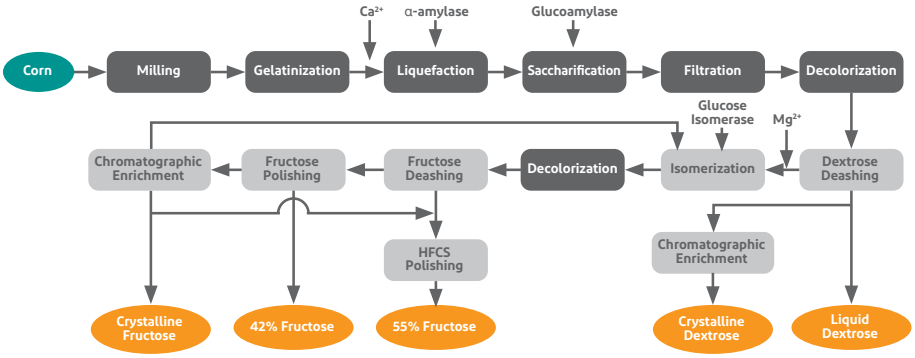


Diagram 1: ***Typical High Fructose Corn Syrup Plant***

Deashing and Mixed Bed Polishing

DuPont™ AmberLite™ FP Ion Exchange Resins: An Excellent Choice for Corn and Starch Sweetener Deashing and Polishing

AmberLite™ FP Ion Exchange Resins lead the corn and starch sweetener industry in deashing and mixed bed polishing, removing unwanted ions and other contaminants from the syrup stream. DuPont offers a full line of cation and anion deashing products ranging from standard to premium offerings.

AmberLite™ FPC88 Strong Acid Cation (SAC) Resin and AmberLite™ FPA66 Weak Base Anion (WBA) Resin are an industry standard for deashing dextrose and fructose. AmberLite™ FPC88 UPS SAC Resin and AmberLite™ FPA77 UPS WBA Resin are premium products offering the ultimate in process performance.

AmberLite™ FP UPS Ion Exchange Resins Help Reduce OPEX and Increase Plant Capacity

AmberLite™ FPC88 UPS SAC and AmberLite™ FPA77 UPS WBA Uniform Particle Size Resins – offering one of the most uniform-size beads in the industry – are premium products designed to deliver high ion exchange efficiencies and physical strength. Resin uniformity facilitates high throughput, economical regeneration, long life, and low operating costs.

AmberLite™ FP UPS resins are viewed as an industry standard as they help to achieve:

- Increased plant syrup capacity
- Less frequent regeneration, reducing chemical costs up to 25%
- Reduced sweetwater generation, reducing evaporation costs
- Reduced rinse requirements
- Reduced waste generation
- Packed bed and up-flow operations

AmberLite™ FPC88 UPS

DuPont™ AmberLite™ FP Mixed Bed Resins Help Improve Syrup Stability

Specifically designed for mixed bed polishing, AmberLite™ FPA22 Strong Base Anion (SBA) and AmberLite™ FPC88MB (Mixed Bed) Strong Acid Cation (SAC) Resins – are used near the end of the 55 High Fructose Corn Syrup process. Using a mixed bed avoids the large pH swings seen when separate columns are used. This minimizes impurities from degradation reactions that reduce syrup shelf life.

To provide a good balance between cationic and anionic sites, a typical mixed bed polisher consists of 60% (by volume) AmberLite™ FPA22 SBA resin and 40% AmberLite™ FPC88MB SAC resin. The AmberLite™ FPA22 SBA is paired to pick up both the acids produced by the cation, and weak acids in the product stream. AmberLite™ FPC88MB SAC is specially designed to distinctly separate from the anion resin during the regeneration procedure.

This resin pairing provides an easy-to-regenerate process and a clean finished product stream.

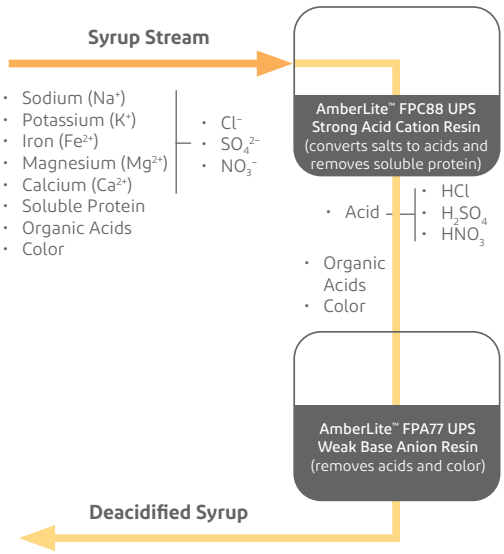


Diagram 2: ***Syrup Deashing***

Deashing and Polishing Product Pairs for Extended Syrup Run Times

Although performance-grade AmberLite™ FP Ion Exchange Resins will deliver high product quality, premium-grade AmberLite™ FP UPS Ion Exchange Resins help decrease operating costs and improve plant capacity. Premium resins extend syrup run times up to 25%, reducing downtime and the chemicals spent on regeneration. A simple change to premium AmberLite™ FP UPS resins can postpone or eliminate the need for capital expansion.

Syrup Run Time	Strong Acid Cation (SAC) Resins	Anion Resins
DEASHING Base Performance	AmberLite™ FPC88	AmberLite™ FPA66
Enhanced ~10% Increase	AmberLite™ FPC88 UPS	AmberLite™ FPA66 UPS
Premium ~25% Increase	AmberLite™ FPC88 UPS	AmberLite™ FPA77 UPS
POLISHING Base Performance	AmberLite™ FPC88MB	AmberLite™ FPA22
Enhanced ~10% Increase	AmberLite™ FPC88 UPS	AmberLite™ FPA22 UPS

Corn and Starch Sweetener Deashing Product Guide

Process and Resin Type	Resins	Best For
Deashing Cation (SAC)	AmberLite™ FPC88 Na	Sodium-form – Produces low-conductivity syrup products; most stable resin form for resin inventory safety stock
	AmberLite™ FPC88 H	Hydrogen-form – Produces low-conductivity syrup products
	AmberLite™ FPC88 UPS Na	Sodium-form – Offers reduced sweetwater and rinse requirements; most stable resin form for resin inventory safety stock
	AmberLite™ FPC88 UPS H	Hydrogen-form – Offers reduced sweetwater and rinse requirements
Deashing Anion (WBA)	AmberLite™ FPA66	Produces low-conductivity syrup products
	AmberLite™ FPA66 UPS	Increased syrup throughput using a uniform size product
	AmberLite™ FPA77 UPS	Lowest processing cost using highest capacity, uniform size product

Corn and Starch Sweetener Polishing Product Guide

Process	Resins	Best For
Polishing Mixed Beds	AmberLite™ FPC88MB H SAC paired with AmberLite™ FPA22 OH SBA	Syrup products with maximum shelf stability; both resins in their regenerated ionic form
	AmberLite™ FPC88MB Na paired with AmberLite™ FPA22 Cl	Syrup products with maximum shelf stability; most stable resin forms for resin inventory safety stock (Na- and Cl-forms, respectively)
	AmberLite™ FPC88 UPS H paired with AmberLite™ FPA22 UPS OH	Syrup products with maximum shelf stability; uniform particle size enables more efficient mixed bed utilization; both resins in their regenerated ionic form
	AmberLite™ FPC88 UPS Na paired with AmberLite™ FPA22 UPS Cl	Syrup products with maximum shelf stability; uniform particle size enables more efficient mixed bed utilization; most stable resin forms for resin inventory safety stock (Na- and Cl-forms, respectively)

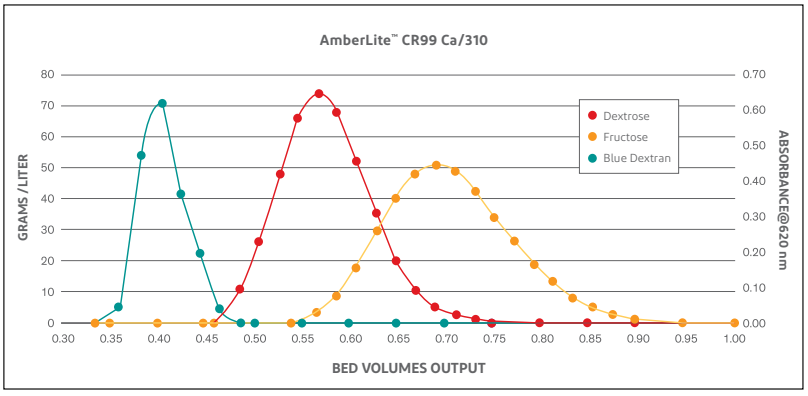
Sweeteners
Corn & Starch Processing

Chromatography
DuPont™ AmberLite™ CR99 Chromatographic Separation Resins help deliver fast, sharp, and economical chromatographic separations.

One of the most critical factors in chromatographic separation is the uniformity of the separation beads. Bead uniformity affects both the degree of sweetener separation achieved and the pressure on the chromatography columns. Resins with a wide particle size distribution demonstrate a high system pressure drop, which lowers productivity. Additionally, the wide particle size distribution beads produce more dilute product streams due to poor separation (wide and less distinct separation bands). Wide particle size beds require additional elution water and, as all of this water must ultimately be removed, places a higher demand and expense on the already expensive evaporation process.

AmberLite™ CR99 resins help eliminate these problems. The resin beads' uniform size and structure, as well as their smooth surface, more effectively produce enriched sweeteners.

Calcium-form CR99 resins (e.g. AmberLite™ CR99 Ca/310) are used for affinity-based processing of starch feeds, and work by selectively interacting with and slowing down the movement of a sweetener through the resin bed. Examples of affinity chromatographic separations include fructose/glucose, sorbitol/mannitol, and allulose/glucose where in each of these pairs the first molecule is selectively retained by the resin over the second.



The graph illustrates the sharp affinity-based chromatographic separation achieved with AmberLite™ CR99 in a small-scale laboratory column.

Sodium- or potassium-form CR99 resins are used for molecular size-based separations of starch degradation products. Commonly called "size-exclusion" chromatography, these separations are ideal for fractionating sugars of differing numbers of saccharide units. In size-exclusion chromatography, smaller sugars like monosaccharides enter the resin bed polymer matrix and are slowed up by diffusion within the resin beads, while larger oligosaccharides cannot diffuse into the resin bead and instead are flushed out of the resin bed much quicker with the bulk liquid. Examples of size-exclusion separations include dextrose enrichment (removal of dimers and trimers), raffinose separation from sucrose, and oligosaccharide purifications (DP1/2/3/4).

Sodium- or potassium-form CR99 resins can also perform ion-exclusion chromatographic separations, where the resin retains sugars and repulses ionic salts. Examples of these types of separations include beet molasses desugarization and removal of salts from amino acids at their isoelectric point.

AmberLite™ CR99 Chromatographic Separation Resins are available with uniform bead size ranging from 220 – 350 µm to suit your specific operational goals for an extensive variety of applications, as summarized in the related tables.

Application	Chromatographic Separation Resin
Dextrose	AmberLite™ CR99 K/320, Na/320, K/310, Na/310 or K/280
HFCS	AmberLite™ CR99 Ca/320, Ca/310, or Ca/280
High-purity fructose	AmberLite™ CR99 Ca/310 or Ca/280
Polyols/Sugar alcohols	AmberLite™ CR99 K/310, Na/310, K/280, or K220
Difficult to separate and high-value sweeteners	AmberLite™ CR99 Ca/220 or K/220

Chromatographic Separation Resin Size (µm)	Ionic Forms Available	Chromatographic Separation Resin
350	K	Low pressure drop
320	Ca, Na, K	Standard performance
310	Ca, Na, K	Enhanced Performance, Reduced Operating Costs
280	Ca, K	Difficult Separations, Reduced Separator Water Usage
220	Ca, K	Exceptional Performance in Shallow-Bed Separators, Operating Costs and Footprint Reduction

Decolorization

DuPont Adsorbent Resins Facilitate Syrup Quality by Removing Impurities

DuPont™ AmberLite™ SD-2 Adsorbent Resin helps deliver decolorization and extend product shelf life by removing unwanted flavors and aromas, as well as color precursors, such as 5-(Hydroxymethyl)furfural (HMF). AmberLite™ SD-2 is typically used in the downstream polishing position alone or in combination with activated carbon. This adsorbent can help correct color spikes in the syrup stream, such as those caused by a process upset or shutdown.

AmberLite™ XAD™761 resin is used where there are syrup heat or storage stability issues. This resin can adsorb and remove the underlying impurities that cause these issues.

Sweetener Decolorization

Process	Adsorbent	Best For
Decolorization	AmberLite™ SD-2	Color and HMF removal in the polishing position
	AmberLite™ XAD™761	Syrup storage stability, heat color issues

Protein Removal and Haze Stabilization with AmberLite™ FPX62

Haze can form in some starch solutions with high nitrogen counts and in beverages like beers, wines, and fruit juices after packaging. These problems can have a negative impact on consumer preference. Beverage haze is typically formed by the interaction of proteins and polyphenols, while color in starch can come from protein color precursors. Removing soluble proteins can reduce nitrogen-based color in starch feeds and improve the haze stability of beverages.

AmberLite™ FPX62 can bind and remove the underlying cause of haze and nitrogen-base color – the soluble proteins. AmberLite™ FPX62 is a cation exchange resin with a special large pore structure to bind and capture protein. After exhaustion, a quick regeneration with caustic is all that is needed to regenerate and reuse the resin again and again.

Sweeteners
Healthy Carbohydrates

With consumer trends towards healthier and more sustainable food ingredients, many sweeteners refineries are making new molecules from their existing feedstocks. New sugars like allulose can offer consumers lower calories while maintaining sweetness. Oligosaccharides can be fractionated from starch processes and used as bulking agents in food formulations. Still other processes convert sugars into monomers for bio-based, renewable polymers. By combining novel chemical and enzymatic conversions with existing feedstocks, refineries are achieving the next generation of sweeteners and molecules to add value to their operations. Diagram 3 below highlights the major application areas and molecules emerging from the trend towards healthier and more sustainable molecules.

Healthy Carbohydrates

New Sugars	Oligosaccharides	Polysaccharides	Sugar Alcohols
Allulose	Fructooligosaccharide (FOS)	Polydextrose	Erythritol
Mannose	Gluctooligosaccharide (GOS)	Resistant Dextrans	Maltitol
Tagatose	Isomaltooligosaccharide (IMO)	Soluble Dietary Fiber	Mannitol
Trehalose			Sorbitol
Xylose			Xylitol

Diagram 3: ***Novel sugars, saccharides, and sugar alcohols.***

Oligosaccharides

Oligosaccharides like isomaltooligosaccharide (IMO) have favorable digestion properties and are versatile and healthy molecules for bulking and sweetening foods. Maintaining the correct size distribution of saccharides in IMO is critical to achieving the correct physical and digestive properties that make it attractive as a food ingredient.

DuPont can help you purify oligosaccharides with DuPont™ AmberLite™ CR1360 chromatography resin. This resin is ideal for fractionating oligosaccharide mixtures with one, two, three, four, and greater than four saccharides, allowing you to control the saccharide composition of your product. For example, you could selectively remove mono- and di-saccharides from your oligosaccharide product. CR1360 is particarly adept at separations between di- and trisaccharides (DP2/DP3) and tri- and tetrasaccharides (DP3/DP4). CR1360 is available in the sodium-form for size-based separations or the calcium form for an added affinity component to the chromatographic separation.

Application	Chromatographic Separation Resin
Oligosaccharide fractionation by size	AmberLite™ CR1360 Na
Oligosaccharide fractionation by size and affinity	AmberLite™ CR1360 Ca

Sugar Alcohols

Sugar alcohols are typically made by hydration of starch feedstocks and add sweetness and bulk to foods at lower caloric values. Because they digest more slowly, they are also diabetic-friendly sweeteners. Additionally, sugar alcohols do not promote dental caries and see use in sugar-free candies and gums.

Often the conversion of a starch feedstock to a sugar alcohol produces other carbohydrate byproducts or is incomplete, requiring purification by chromatography. Because these mixtures contain molecules of similar size and chemical composition, a high degree of separative power is required relative to other chromatographic processes in the industry. DuPont offers premium chromatography resins with the power and efficiency to achieve economical separations in challenging sugar alcohol purifications.

Application	Chromatographic Separation Resin
Sorbitol / Mannitol	AmberLite™ CR1360 Ca, CR99 Ca/310
Sorbitol / Dextrose	AmberLite™ CR1360 Ca, CR99 Ca/310, CR99 Ca/280
High Purity Maltitol	AmberLite™ CR1360 Ca, CR99 Ca/310, CR99 Ca/280

Other Novel Separations

There are many separation challenges in the industry and DuPont is here with you ready to tackle them. For a more extensive look at other chromatographic-based purifications, consult the DuPont Separability Advisor™.

Sweeteners
Cane Sugar Decolorization

DuPont Ion Exchange Resins Help Maximize Cane Sugar Decolorization DuPont™ AmberLite™

Ion Exchange Resins have proven to be an excellent choice for cane sugar decolorization. Unlike with beet sugar, the sucrose in sugar cane cannot be extracted by diffusion alone. The cell walls of sugar cane must be broken, which is accomplished by crushing the sugar cane in large mechanical rollers. This processing introduces color impurities into the raw sugar. Cane-based color has a tendency to be incorporated into sugar crystals during crystallization. Therefore, as shown in Diagram 4, additional decolorization is required before cane sugar crystallization.

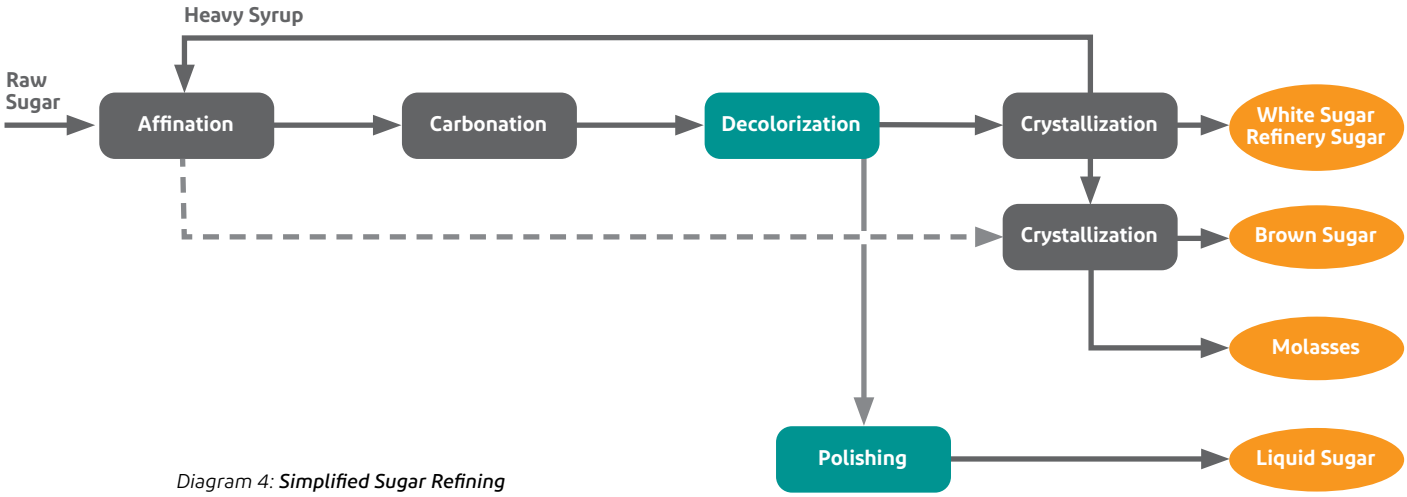


Diagram 4: ***Simplified Sugar Refining***

Cane Sugar Decolorization

Resin Type	Strong Base Anion Resins	Best For
Acrylic Matrix	AmberLite™ FPA98 Cl	High-color syrups and regeneration efficiency
Styrenic Matrix	AmberLite™ FPA900UPS Cl	Uniform size for increased efficiency
	AmberLite™ FPA90RF Cl	Size-graded for packed beds
	AmberLite™ FPA90 Cl	Highest degree of decolorization

Liquid Sugar Purification

Resin Type	Resin	Best For
Strong Base Anion	AmberLite™ FPA900UPS Cl	High color removal capacity for high throughput
Weak Acid Cation	AmberLite™ MAC-3 H	Paired with AmberLite™ FPA42 Cl – adds deashing to color removal

Polishing

Resin Type	Resin	Best For
Adsorbent	AmberLite™ SD-2	Downstream polishing to make final product quality

Liquid Sugar Production

Caloric soft drinks are generally formulated with fructose syrups or sucrose crystals. The sucrose cost can be reduced if it is supplied as a liquid from the refiner versus more expensive white crystals. However, additional processing of sucrose syrups is required to reach the high purity and low color required. Typically syrups that have already been through the cane sugar decolorization process still need further processing through a mixed bed and a polishing step to meet final color and organoleptic properties.

A mixed bed of DuPont™ AmberLite™ FP900UPS Strong Base Anion (SBA) with AmberLite™ MAC-3 Weak Acid Cation (WAC) can address these product quality challenges by removing minerals, color and impurities. Mixed bed processing avoids large pH swings seen when separate columns are used, which minimizes sucrose hydrolysis and avoids impurities from degradation reactions that would reduce syrup shelf life. To provide a good balance between cationic and anionic sites, a typical mixed bed polisher consists of 75% (by volume) AmberLite™ FPA900 UPS SBA resin and 25% AmberLite™ MAC-3 WAC resin. After service the resins are separated by backwashing, AmberLite™ MAC-3 is regenerated with hydrochloric acid and AmberLite™ FPA900 UPS is regenerated with sodium hydroxide. The regenerated resins are remixed in place, usually by turbulent air sparging.

Typically after the mixed bed, activated carbon and fine filtration are used to polish the quality of the liquid sugar product and ensure it consistently meets specifications. In certain cases, AmberLite™ SD-2 adsorbent resin can also help with final syrup quality by capturing problematic trace impurities and removing residual color. AmberLite™ SD-2 was designed with a very high surface area and a slight anionic functionality that can provide additional adsorptive chemistries to augment downstream

Recycling of Regenerant Salt

Regeneration of cane sugar resins involves a salt solution, usually 10% NaCl. Approximately 85% of the salt can be recovered using nanofiltration. Products are HTNF 8040/34 and 4040/34, these products are suitable for continuous use up to 70°C within pH limits. Consult the DuPont™ Membranes for Nutrition Applications brochure for more information.

Sweeteners
Beet Sugar Softening, Chromatography, and Betaine Recovery

Increase White Sugar Production and Recover Betaine with DuPont Ion Exchange Softening and Chromatography Resins

Sugar beets are an important source of sucrose (saccharose). Diagram 5 illustrates the key steps involved in refining beets to recover sugar. Critical unit operations using ion exchange resins include softening (decalcification) and chromatography.

The sugar syrup stream contains salts and color. These contaminants are molassogenic, which causes valuable sugar to remain in the remaining liquor (molasses) after crystallization. To extract more of the high-value sugar, the molasses is fed to desugarization chromatographic beds. DuPont™ AmberLite™ CR99 K Chromatographic Separation Resins, in potassium-form, help separate sugar from salts and color. A purified sugar stream is recovered and recycled back to crystallization, facilitating an increased overall sugar yield. In some plants, valuable betaine is also recovered by chromatography. The salts and color are routed to other byproducts, such as animal feed products.

Decalcification upstream of the chromatography step helps AmberLite™ CR99 K resins remain in the potassium-form. If calcium is not removed, the chromatography resin would convert to calcium-form, which would significantly reduce separation performance. Decalcification of the process stream with a cation resin listed in the table below helps reduce evaporation scaling, which helps increase efficiency and helps reduce downtime.

Processors rely on DuPont ion exchange technologies for critical decalcification processes and chromatographic recovery of sugar and betaine from beet molasses.

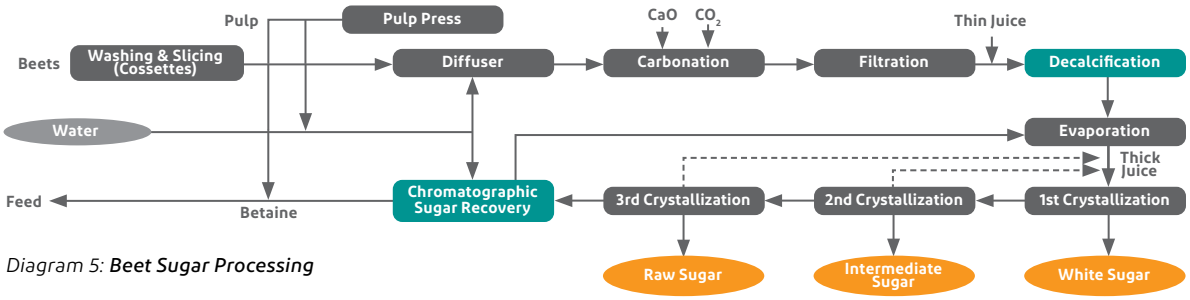


Diagram 5: ***Beet Sugar Processing***

Beet Sugar Decalcification

Processes	Strong Acid Cation Resins
Thin Juice,	AmberLite™ FPC14 Na
NRS Process,	AmberLite™ FPC14 Na
Gryllus,	AmberLite™ FPC22 Na or AmberLite™ FPC88
Quentin Process,	AmberLite™ FPC22 Na or AmberLite™ FPC88
and Decalcification	AmberLite™ MAC-3 Weak Acid Cation

Beet Molasses Desugarization/Chromatography

Process	Chromatographic Separation Resin	Best For
Beet Desugarization/Chromatography	AmberLite™ CR99 K/310	Low water consumption reduces evaporator cost
	AmberLite™ CR99 K/320	Low-pressure design for deep beds
	AmberLite™ CR99 K/350	Low-pressure design for deep beds and high viscosity
Betaine Recovery from Beet Molasses	AmberLite™ CR99 K/310	High performance for enhanced betaine recovery

Organic Acids

Organic Acid Deashing and Chromatography with DuPont™ AmberLite™ Resins

Organic acids like citric and lactic acids are large-volume, commercially important organic acids used primarily in the food and beverage industry as acidulents and preservatives. Citric acid is well-known as the source of the tart flavor in fruit juices. Lactic acid is used in many food applications including bakery, meat and dairy products, beverages, salads, and dressings, as well as a monomer for the renewable biopolymer polylactic acid (PLA). Succinic acid also is used in renewable biopolymers.

DuPont provides a full range of ion exchange products for manufacturing organic acids. Typical ion exchange processes include a strong acid cation exchange resin and a weak base anion exchange resin. Organic acids cause ion exchange resins to experience extreme swings in volume (swelling). For this reason, only the most physically stable ion exchange resins, such as those available from DuPont, can be used to recover and purify organic acids.

One acid-refining technique, shown in Diagram 7 for citric and lactic acid, uses a precipitation process with lime to produce calcium citrate and calcium lactate/citrate solids. This is then contacted with sulfuric acid to produce a partially purified soluble organic acid and a large mass of calcium sulfate (gypsum) byproduct. These processes produce streams that require demineralization using DuPont ion exchange products.

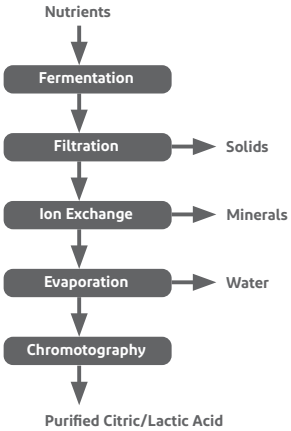


Diagram 6: ***Organic Acid Purification – Chromatographic Purification Process***

An alternative acid production process that does not produce gypsum as a byproduct utilizes an anion chromatography resin like AmberLite™ CR5550 to do the purification instead of precipitation (Diagram 6). Simulated moving beds with AmberLite™ CR5550 can chromatographically enrich organic acids, separating out contaminating salts and residual dextrose from the fermentation without producing gypsum. AmberLite™ CR5550 works by retaining anionic compounds like organic acids, slowing their progression through the resin bed. Di- and tri-carboxylic acids will be retained more strongly and have a longer elution time than mono-carboxylic acids, while salts and non-anionic compounds elute out quickly.

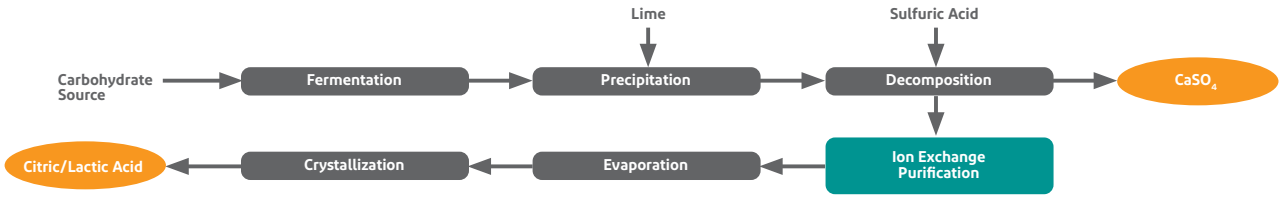


Diagram 7: ***Acid-refining Technique***

Organic Acid Purification

Application	Resin	Best For
Citric and Lactic Acid Deashing	AmberLite™ FPC23 UPS H	Lower processing cost using highest capacity, uniform size product
	AmberLite™ FPC88 UPS H	Offers reduced sourwater and rinse requirements
	AmberLite™ FPC88 H	Reliable performance
	AmberLite™ FPA53	Durable in citric or lactic acid feeds and paired with a SAC resin
	AmberLite™ FPA55	
Chromatographic Separation	AmberLite™ CR5550	Excellent chromatographic resolution, eliminating the citric acid precipitation step

Other Applications

Ion exchange is widely practiced in a variety of other purification processes shown in the table below. Two examples are enzymatic immobilization and polyphenols.

For enzyme immobilization in the starch industry, the two primary applications are converting starch to glucose (also known as dextrose) with alpha- and beta-amylase and converting glucose to fructose with glucose isomerase. The enzymes can be immobilized on phenolic-based resin media like Duolite™ A568 and packed into vessels for continuous, heterogeneous catalysis. Immobilizing the enzyme provides simpler operation and downstream processing, increased enzyme stability and lower enzyme dosing, higher and more consistent activity, and lower overall costs for raw materials and operation.

A second example of another application in the nutrition industry is polyphenol purification. Polyphenols are compounds found in natural foods that provide color and flavor and are highly valued for their antioxidant and health properties. These can be derived from many different sources including cane molasses, plants (cocoa, green tea, pine bark), fruits (red berries, pineapple, orange juice, grapes skins, and seeds), molasses, and oils.

Many food companies use DuPont™ AmberLite™ FPX66 or AmberLite™ XAD™7HP polymeric adsorbents to help remove, recover, and purify a variety of polyphenols for commercial use.

DuPont is constantly innovating to discover new applications and new ways to apply resins and membranes to solve problems, increase process efficiency, and lower your costs. Consult the table below for recommendations to a variety of applications or contact DuPont to discuss your process needs.

Application	Resin	Key industry
Amino acids	AmberLite™ FPC11 Na, AmberLite™ FPC16 UPS Na	Lysine recovery
Deashing	AmberLite™ FPC88 UPS and AmberLite™ FPA66 or AmberLite™ FPA 53	Gelatin, Cheese Whey, Glycerin, Fruit juices
Deacidification	AmberLite™ FPA66	Citrus and other juices
Debittering	AmberLite™ FPX66	Citrus and other juices
Decolorization	AmberLite™ FPX66, AmberLite™ SD-2	Juices, Grape, Beer
Enzyme immobilization	Duolite™ A568	Starch Glucose isomerase and other enzymes
Polyphenols recovery	AmberLite™ FPX66	Cane molasses, Grape, Tea and others
Protein removal	AmberLite™ FPC23 UPS H, AmberLite™ FPX62	Starch syrups, Fruit juices, Beverages

Innovation to Meet Future Customer Needs

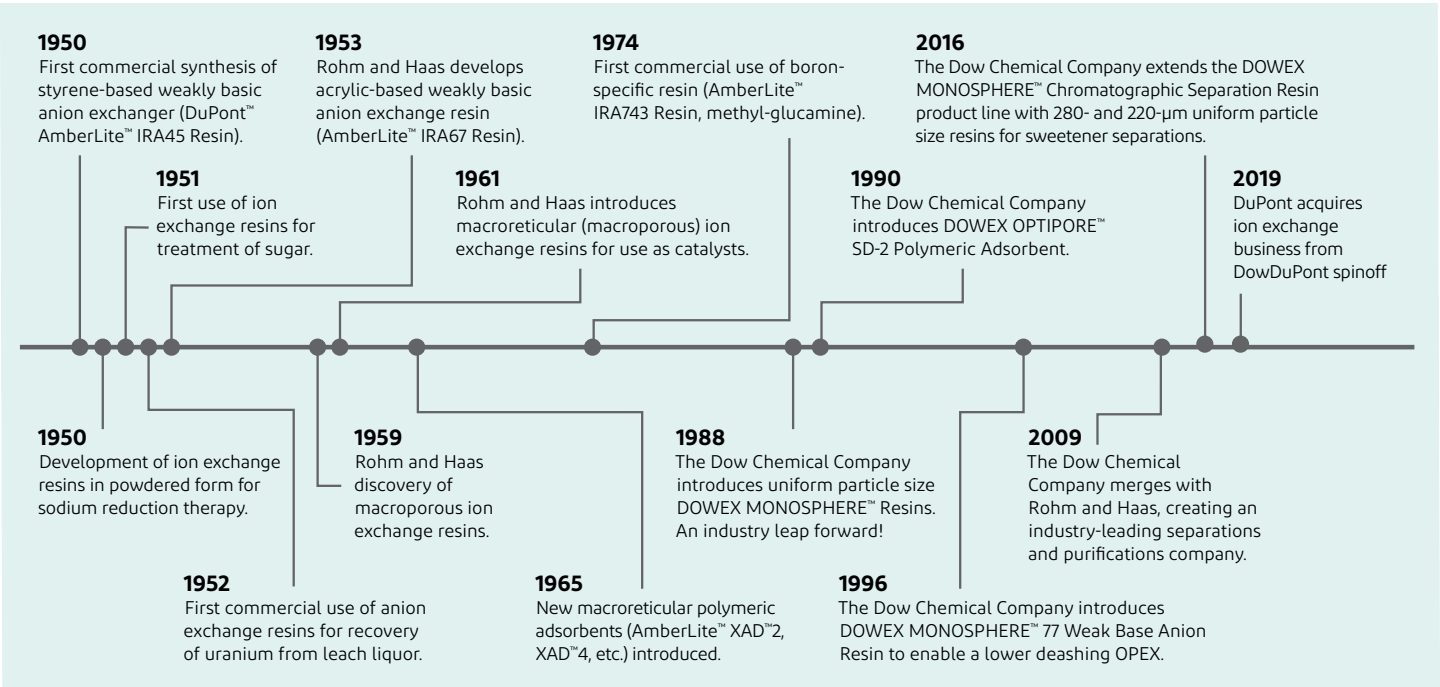
The DuPont research and development process starts with you. By proactively communicating with our customers and listening to your unmet needs, we are able to work to develop products that lower your cost of production and deliver the most economical approach to new and/or difficult separations.

DuPont's commitment to the food and beverage industries is demonstrated through our multiple research and product development centers around the world. These technology centers have delivered innovative new technologies. See below for a timeline of some of our most significant breakthroughs over the past 60+ years.

Some promising areas of development are:

- *Starch Decolorization:* DuPont offers a new XUR resin decolorization resin for removing color from starch streams. This resin is specially designed for bulk decolorization and can either supplement or partially replace activated carbon decolorization allowing a reduction of operating costs.
- *Anion and Organic Acid Chromatography:* we have created a ~300 micron, uniform particle size chromatographic-grade anion resin for separation and purification of organic acids and other anionic compounds in the food and fermentation industries.

Please reach out to DuPont to discuss your needs and to see if these innovations can solve your process challenges.



Regulatory Compliance

The resins here may be subject to food contact application restrictions in some countries. For country-specific food contact compliance statements, regulatory data sheets, and information on dietary rules, please contact the DuPont Contact Center.

DuPont has a fundamental concern for all who make, distribute, and use our products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with DuPont products – from initial concept and research to manufacturing, selling, using, disposing, and recycling each product.

DuPont Expertise
A Key Ingredient in Food and Beverage Processing

DuPont™ System Optimization Services℠ (SOS)

Working with DuPont is easy and convenient. Whenever you choose DuPont resins, you get expert support from DuPont ion exchange technical service and development teams.

For more involved issues, DuPont offers a full range of System Optimization Services℠ (SOS) to help you achieve optimal performance from your resin, system, and plant operations. SOS Services℠ place our extensive knowledge and experience at your disposal. These services can complement your R&D innovation team, lighten the burden of your system start-up and staff training, and support the ongoing operation and maintenance of your system.

Contact DuPont SOS Services℠

Request a Sample of DuPont Ion Exchange Products
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