

FilmTec™ Elements for Food & Beverage Applications

Food matters. DuPont makes it better.



Reliability, Value, and Innovation

Food processing is a broad industry requiring a wide range of process technologies to transform agricultural products into food. Membrane technology permits the pre-concentration and separations of food, sugars, sweeteners and beverages reducing the need for high temperature thermal evaporation while lowering water consumption and wastes.

DuPont provides multi-tech solutions for the food processing industry spanning membrane filtration, ion exchange resins and polymeric adsorbents. Our comprehensive product line, technical expertise, manufacturing excellence, continuous investment in product innovation, and global reach provide you with optimized performance for even the most complex manufacturing processes. We are here to help you realize the potential of your application and process.

This brochure covers the solutions offered by DuPont in membrane-based separation for Food & Beverage including our high-quality brands, such as FilmTec™ Hypershell™ elements.

DuPont Nanofiltration and Reverse Osmosis Membrane Portfolio for Nutrition

Starch sweeteners and sugar:

- Concentration:

- Concentration of Thin Cane / Beet Sugar
- Concentration with desalting
- Dilute sweetener concentration
- FilmTec™ Hypershell™ NF245N-8038/48-FF
- FilmTec™ Hypershell™ NF245N-8038/48-FF
- FilmTec™ Hypershell™ HTRO-8038/48

- Separation:

- Mono-/Di- saccharides purification
- Purification of Organic acids fermentations
- Waste Brine recycling from sugar decolorization
- FilmTec™ Hypershell™ NF245N-8038/48-FF
- FilmTec™ Hypershell™ NF245N-8038/48-FF
- FilmTec™ HTNF-8040/34

Beverages and other Food:

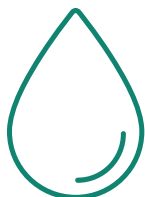
- Concentration:

- Juice concentration
- Tea concentration
- Grape Juice/Must concentrations
- FilmTec™ Hypershell™ HTRO-8038/48
- FilmTec™ Hypershell™ HTRO-8038/48
- FilmTec™ Hypershell™ HTRO-8038/48

- Other Separations:

- Dealcoholizing/alcohol adjustment
- Tartaric acid removal from wine
- Reduction of volatile acids
- FilmTec™ Hypershell™ NF245N-8038/48-FF/HTRO-8038/48
- FilmTec™ HTNF-8040/34
- FilmTec™ Hypershell™ NF245N-8038/48-FF/HTRO-8038/48

Food and Nutrition plant challenges-solving needs



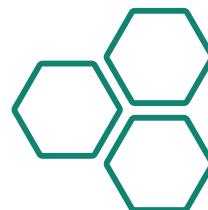
Water

- Waste water and process water recovery & reuse
- Improved water quality for process use



Energy

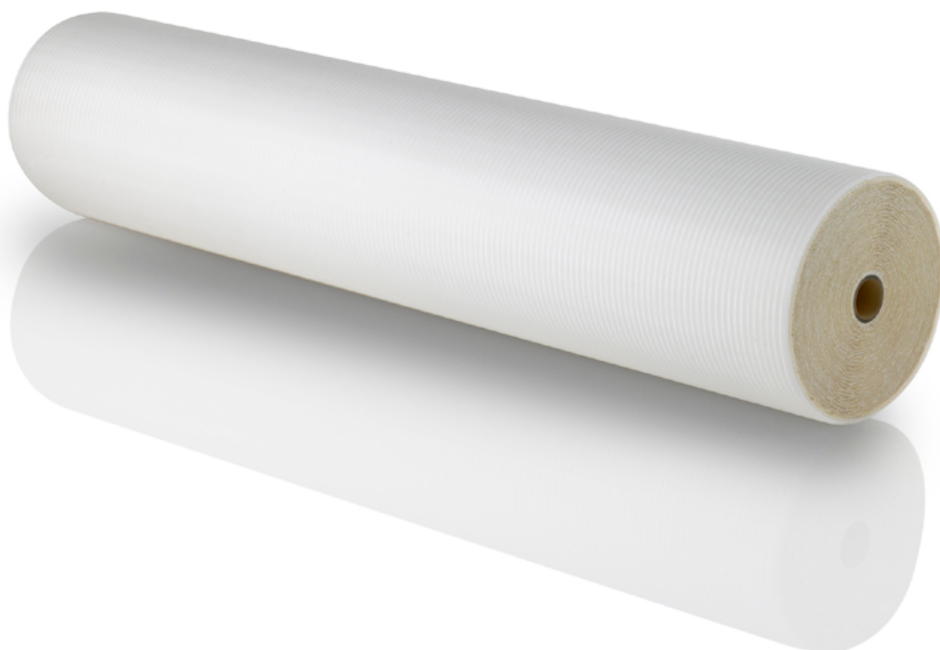
- Concentration of process streams with RO & NF reduces need for evaporation
- Decrease energy OPEX and evaporator CAPEX



Separations

- Sugars and sugar alcohols
- Organic acids and fermentation
- Waste brine recycling

Today, DuPont offers a **NEW** family of reverse osmosis (RO) and nanofiltration (NF) products with **broader specifications** to address food and nutrition plant challenges.

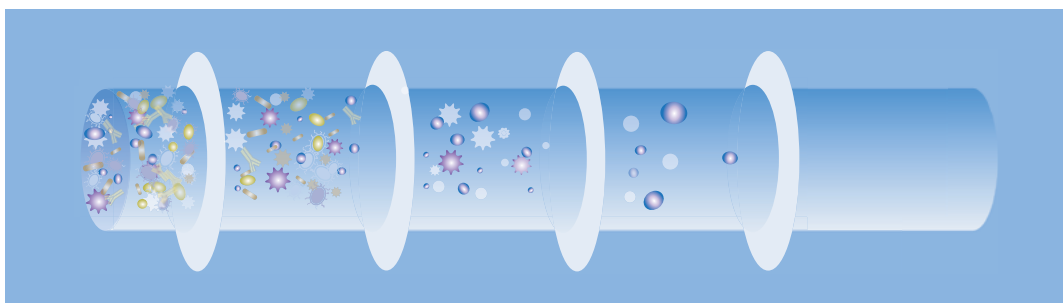


What do Membranes Separate in Food Processing?

Membrane technology can separate and concentrate desired components from a feed stream based on applied feed pressure and target molecular weight. While **Reverse Osmosis (RO)** retains salts and process application sugars, TOC and organics, **Nanofiltration (NF)** retains larger molecules, disaccharides and color bodies while passing smaller molecules, monosaccharides, smaller organic acids and monovalent ions. In Reverse Osmosis pressure is used to drive water and lower molecular weight through a semi permeable membrane while molecular weight cut off and charges primarily control what is retained and what pass through a Nanofiltration membrane.

Nanofiltration
Filters small molecules and nearly all inorganic contaminants and can soften hard water

Reverse Osmosis
Removes dissolved materials, including metals, minerals, and salts



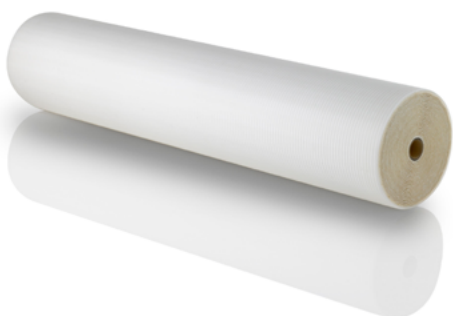
FilmTec™ Specialty Membranes for Sugars, Sweeteners, Food and Beverages

Short name	Name	Sanitary	Rating Max	Applications
HYRO-48	High Temperature Reverse Osmosis FilmTec™ Hypershell™ : • HTRO-8038/48 (8 inch) • HTRO-3838/48 (4 inch)	Yes	80°C/30bar	Concentrations. Sugar, Sweeteners and other food Condensate polishing
HYNF-48	High Temperature Nanofiltration FilmTec™ Hypershell™: • NF245N-8038/48-FF (8 inch) • NF245N-3838/48-FF (4 inch)	Yes	70°C/28bar	Separation. Based on molecular weight and charge
HTNF-34	High Temperature Nanofiltration FilmTec™ Hypershell™ • HTNF-8040/34 (8 inch) • HTNF-4040/34 (4 inch)	No	70°C/28bar	Brine recycle. High Temperature capability

FilmTec™ Hypershell™ Elements for Food Processing Applications

The FilmTec™ Hypershell™ elements are featured with a distinct membrane construction designed for unique industrial application needs. FilmTec™ Hypershell™ elements (sanitary grade) and FilmTec™ elements with Fiberglass outer wrap can be selected depending on process needs. The sanitary design with Full-Fit configuration is required for most Food Applications, the design helps minimize stagnant areas and has leaf edges trimmed off. The sanitary elements design is compliant with U.S. Food and Drug Administration regulations for indirect contact with food. The outer wrap of FilmTec™ Hypershell™ elements due to its rigidity and resistance to deformation enables the outer diameter to be designed with a closer tolerance to vessel walls than mesh wrap designs for enhanced performances.

Sanitary FilmTec™ Hypershell™ Element Design



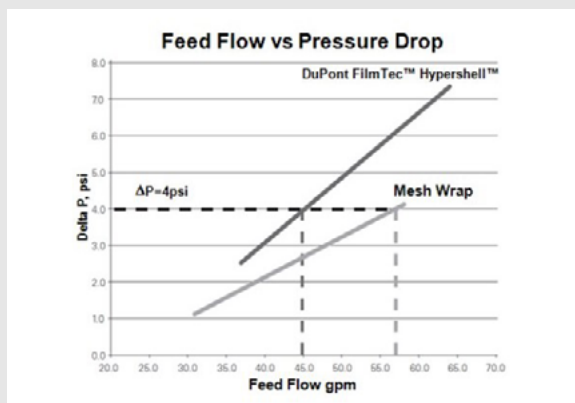
Fiberglass Design



FilmTec™ Hypershell™ offers up to 30% Energy Savings and up to 10% Greater Productivity than outer mesh-wrap.

Polypropylene outer shell – FilmTec™ Hypershell™ sanitary spiral wound design is the state-of-the-art design of spiral wound membrane configurations that differentiates from mesh wrap configuration as following:

- Safety – Easy installation and removal
- Low energy due to lower bypass
- Smaller recirculation flow pump size
- Maximize online time and productivity
- Higher COD rejection
- No channeling
- Less product retention on concentrate side



Starch sweeteners and sugar applications

Starch sweeteners are an important part of the global food and beverage industry requiring a wide range of process technologies to manufacture. Nanofiltration (NF) technology can be used to treat unrefined glucose for production of purified and crystalline glucose. Reverse Osmosis can be employed to concentrate and recover waste streams such as effluents coming from chromatographic enrichment process or used for condensate water polishing.

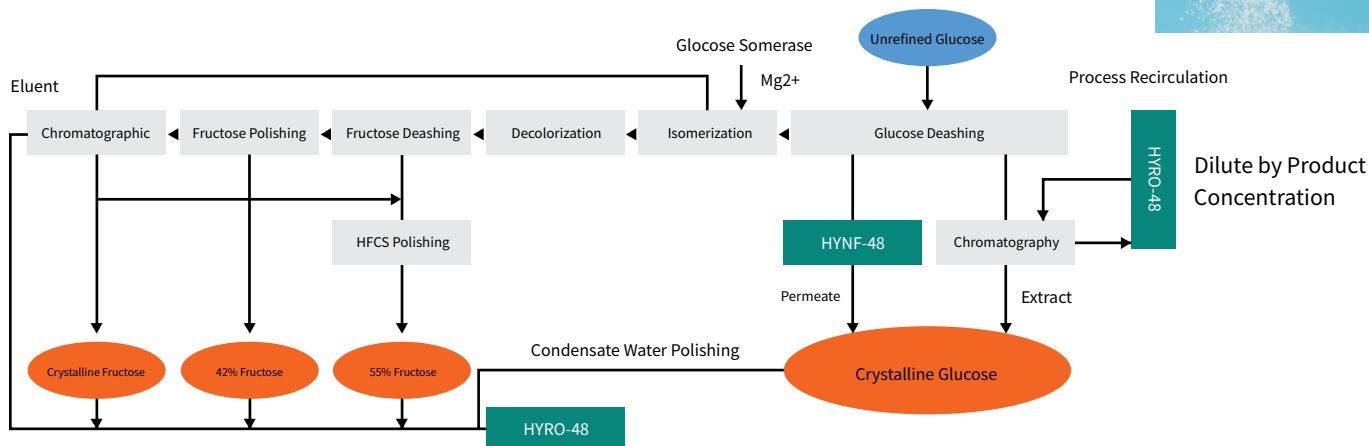


Figure 1 – Starch Sweeteners processing

Sugar processing is one of the most energy intensive processes in the food and chemical industries, Reverse Osmosis and Nanofiltration can be used at different stages of the sweetener production. Reverse Osmosis is ideal for pre-concentrating filtered sugar thin juice upfront of evaporation, either to de-bottleneck existing installations or reduce overall CAPEX and OPEX for new systems. Reverse Osmosis can also be used to treat condensates for water reuse. Nanofiltration technology can separate complex sugar streams with different molecular weights. Reverse Osmosis and Nanofiltration membranes can help to reduce waste water. Nanofiltration can also purify organic acids from fermentation processes and also enable waste brine recycling from sugar decolorization processes.

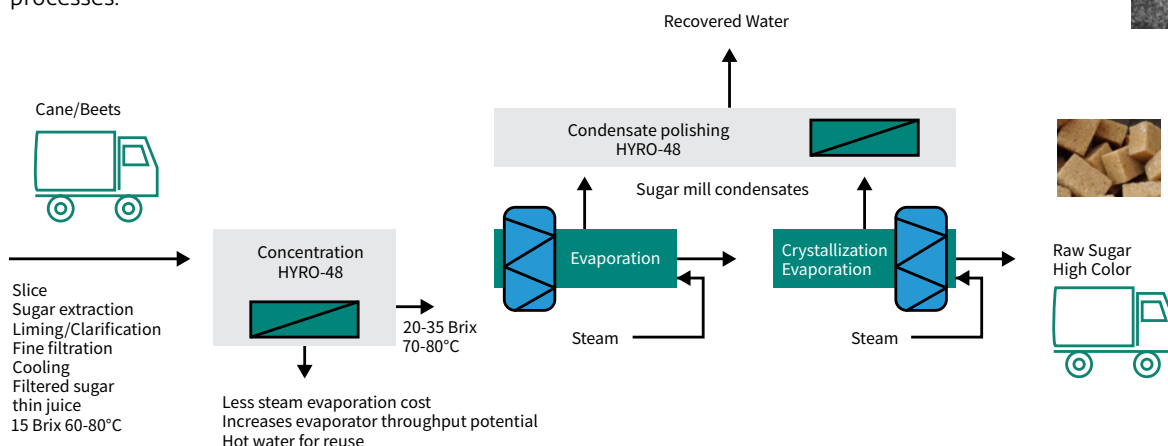


Figure 2 – Sweetener Concentration with Reverse Osmosis

Starch sweeteners and sugar concentration

Dilute sweetener Concentration

Evaporations involving water vaporization are energy intensive and the energy source is usually from coal or wood, which is costly and causes pollution. Processing in the sugar and starch industries generates dilute streams. Reverse Osmosis reduces the total energy and thermal evaporation needs.

- Concentrate a dilute maltose stream from a simulated moving bed chromatography system (DuPont™ AmberLite™ CR99 K/310 ion exchange resin + reverse osmosis technologies).
- FilmTec™ Hypershell™ HYRO-8038/48 elements (HYRO-48) concentrates sugars and reduces evaporator demand, saving OPEX with lower energy costs and CAPEX by avoiding evaporator capital expansion.

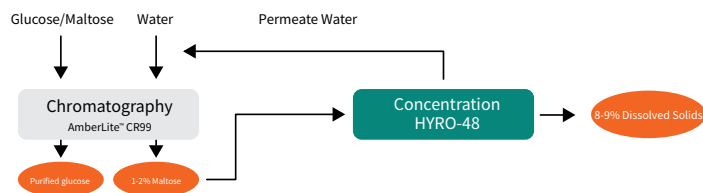


Figure 3 - Example of case study for dilute sweetener concentration

Concentration of Thin Cane / Beet Sugar Juice

HYRO-48 can be used to pre-concentrate cane sugar juice from 15 Brix to 30 Brix at high temperature (up to 80°C). HYRO-48 can reduce evaporator loads >50%.

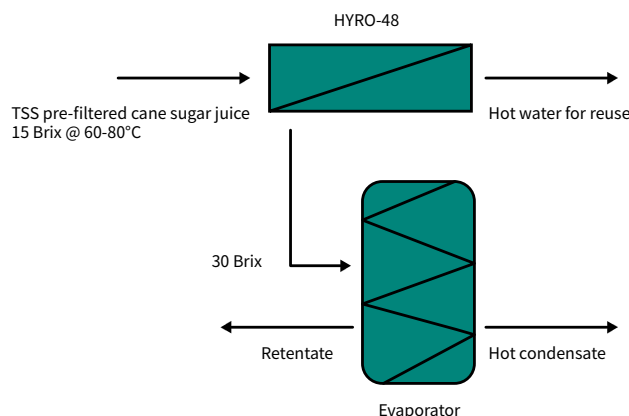


Figure 4 - Concentration of thin cane sugar by HYRO-48 and evaporator

Key Benefits:

- Reduce energy needed for evaporation > 50%
- Debottlenecking of existing installations
- Reduce impurities, odor & volatiles of operation versus thermal evaporation

Concentrating with Desalting

Various salts are sometimes part of the composition of sugar and sweetener process streams. FilmTec™ Hypershell™ NF245N 8038/48-FF elements (HYNF-48) contains an improved nanofiltration sheet that allows the concentration of sugars while simultaneously removing some salts to the permeate stream. Removing salts such as calcium and magnesium can also benefit evaporator capacity by removing potential salts that can precipitate as scale.

Short name	Product Name	Sanitary	Rating Max
HYRO-48	High Temperature Reverse Osmosis FilmTec™ Hypershell™ Elements: • HTRO-8038/48 (8 inch) • HTRO-3838/48 (4 inch)	Yes	80°C / 30 bar
HYNF-48	High Temperature Nanofiltration FilmTec™ Hypershell™ Elements: • NF245N-8038/48-FF (8 inch) • NF245N-3838/48-FF (4 inch)	Yes	70°C / 28 bar

Starch Sweeteners and Sugar Separation

Mono-/Di- saccharides purification

Sugar streams can be mixture complex containing mono- di- and/or oligosaccharides. The mixtures need to be separated to recover and often crystallize the desired products. Nanofiltration technology with different molecular weight cut-off (MWCO) capabilities is able of separate sugars and sweeteners with different molecular weights.

FilmTec™ Hypershell™ NF245N-8038/48-FF elements (HYNF-48) allow smaller monosaccharides (DP1) to pass through while rejecting larger disaccharides (DP2) and oligosaccharides.

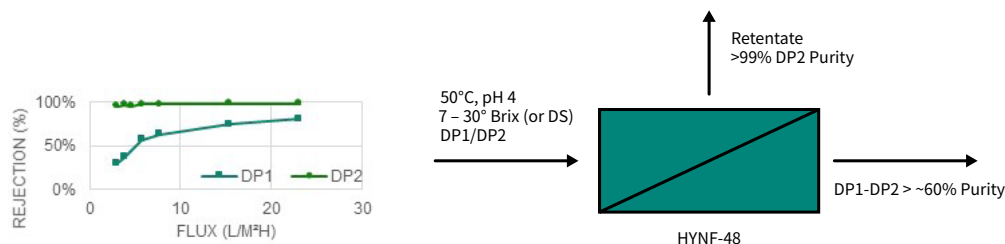


Figure 5 - Example of mono- / disaccharides separation



Waste Brine Recycling from Sugar Decolorization (BRS)

Decolorization of cane sugar juice is primarily accomplished using anion exchange resins. These resin removes high molecular colorants like melanin, caramels, polyphenols from sugar liquors. The anion exchange resins are regenerated with 10% sodium chloride. Spent cane decolorization anion exchanger regenerant is loaded with COD, color and sodium chloride, creating a disposal challenge.

Nanofiltration membranes can recover the regenerant salt while blocking the (500 – 20,000 Dalton) colorants. The recovered sodium chloride can be recycled back to the process for the anion exchange resin regeneration, significantly reducing waste disposal and salt costs for the plant.

Ion exchange regeneration also produces dilute, hot salt water (typically < 3wt%). FilmTec™ Hypershell™ HTRO-8038/48 elements can treat these streams up to 80°C and 30 bar.

Solution

FilmTec™ HTNF-8040/34-FF elements (HTNF-34) separates color and COD (in the retentate) from sodium chloride (in the permeate), allowing recycling of the sodium chloride regenerant and reducing the volume of waste water.

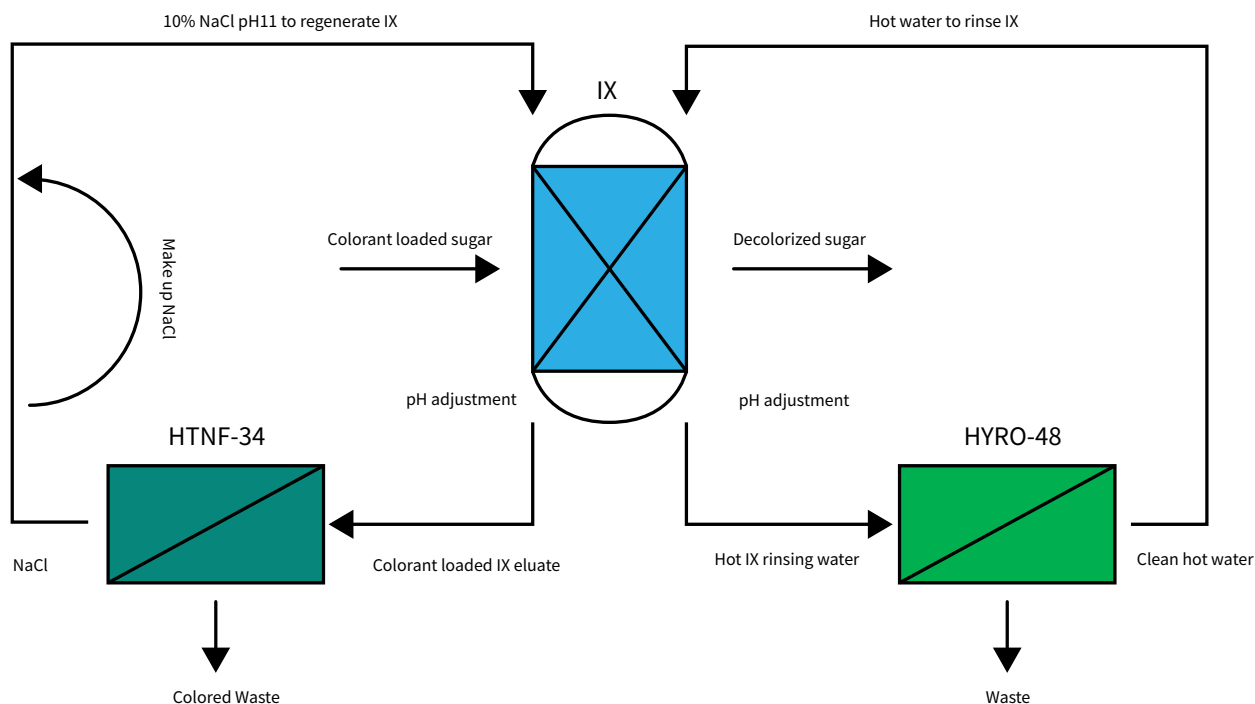


Figure 6 - Waste brine recycling from sugar decoloriza-

Short Name	Product Name	Sanitary	Rating Max.
HTNF-34	High Temperature Nanofiltration FilmTec™ Elements: • HTNF-8040/34 (8 inch) • HTNF-4040/34 (4 inch)	No	70°C / 28 bar
HYRO-48	High Temperature Reverse Osmosis FilmTec™ Hypershell™ Elements: • HTRO-8038/48 (8 Inch) • HTRO-3838/48 (4 Inch)	Yes	80°C / 30 bar

Evaporator Condensate Recovery

Evaporators separate a feed stream into two streams: the concentrated product and a condensate. The hot condensate water can have dissolved solids that can make it unsuitable for direct reuse. Example condensates include those from powdered milk production, sugar mills or paper mills. These condensates can contain dissolved sugar, proteins, lactose, carbonic acid, alcohols, glycols, salts, and other impurities carried over from the evaporator feed. In these facilities, condensate typically must be treated prior to reuse.

Solution

- High Temperature RO removes organic and inorganic impurities from evaporator condensate at up to 80°C, reducing the need to cool the condensate
- The permeate may be reused as rinse, CIP, boiler feed, or diafiltration water
- Recycling water avoids new water supply and treatment needs

Key Benefits

- High rejection of organics, for example from 100 ppm glucose to < 1 ppm glucose in permeate.
- Water is recovered and reused, reducing plant operating costs.

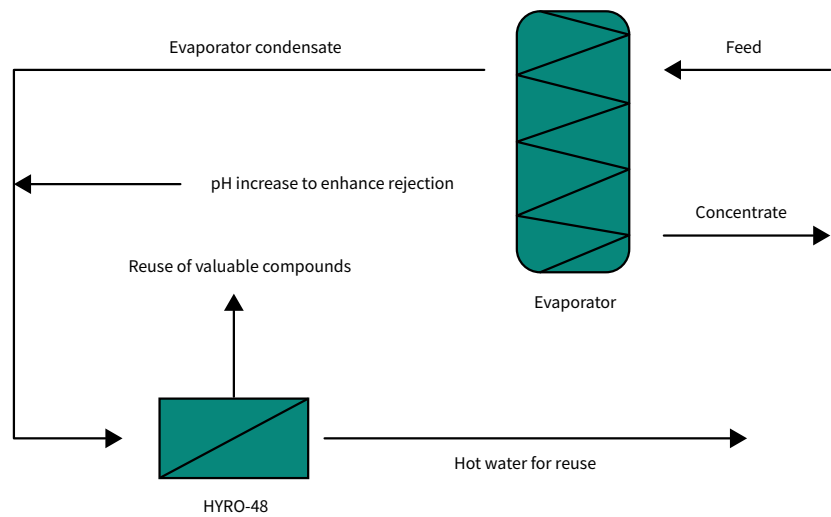


Figure 7 - Evaporator condensate recovery

Short name	Product Name	Sanitary	Rating Max
HYRO-48	High Temperature Reverse Osmosis FilmTec™ Hypershell™ Elements: <ul style="list-style-type: none">• HTRO-8038/48 (8 Inch)• HTRO-3838/48 (4 Inch)	Yes	80°C / 30 bar

Food and Beverage

Use of Reverse Osmosis and Nanofiltration membranes is increasing for processing of Beverages such as concentration of Juice and Must, Wine and Beer dealcoholization or the removal of undesired organics from Wine. Evaporation is used as a concentration technique. However, thermal separation techniques can affect the quality of food and beverages because of prolonged exposure at temperature greater than 70°C. Moreover, the concentration step by evaporation is the one with highest energy consumption. Membrane concentrations are operated at lower temperatures, protecting quality and use considerably less energy.

Juice Concentration

Case studies show that DuPont Ultra-High Pressure Reverse Osmosis (UHPRO) can pre-concentrate grape juice from 18°Brix to >30°Brix followed by evaporation for further concentration to 65°Brix. Energy savings of up to 55% can be achieved compared to evaporation alone.

Key Benefits

- Volume reduction of > 60%
- Permeate water that may be used in boilers for steam production
- Energy and OPEX savings
- Reduction of greenhouse gases as CO₂

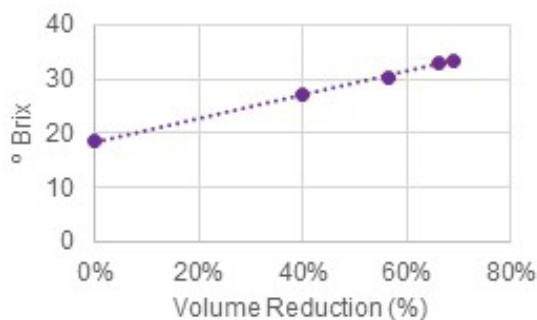
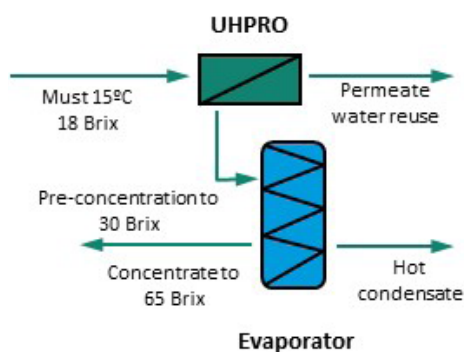


Figure 8 - Concentration of grape juice prior evaporator

Short Name	Product Name	Sanitary	Rating Max
HYRO-48	Temperature Reverse Osmosis FilmTec™ Hypershell™ Elements: <ul style="list-style-type: none"> • HTRO-8038/48 (8 Inch) • HTRO-3838/48 (4 Inch) 	Yes	80°C / 30 bar

Concentration of Tea with Reverse Osmosis

Reverse Osmosis technology has been successfully employed for tea concentration to reduce volume and shipment costs. It is later diluted for tea beverage consumption. Membrane technology allows tea concentration without altering its flavor. FilmTec™ Hypershell™ HTR0-8038/48 elements (HYRO-48), working at 25 – 35 bar can successfully concentrate tea 80-90%.

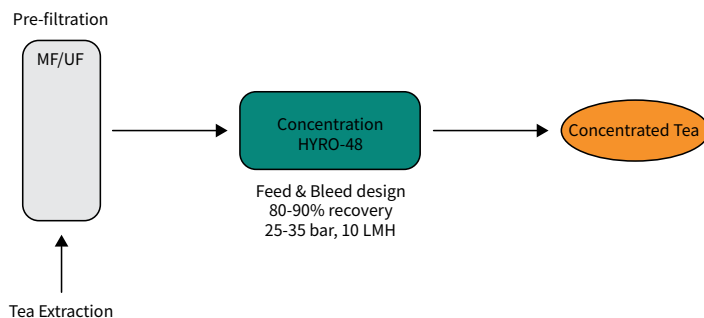


Figure 9 - Pre-filtration

Dealcoholization of Wine and Beer

In the last years, there has been an increasing trend for reduced or 0% alcohol beverages. Reverse Osmosis membranes HYRO-48 can be used in wine and beer processing for separating alcohol from the rest of the beverage. Alcohol passes through membranes whereas the main components of beer, wine or other beverages are retained. Nanofiltration FilmTec™ Hypershell™ NF245N-8038/48-FF elements (HYNF-48) can be as well used for obtaining reduced-alcohol wines and beers, providing higher alcohol passage together with higher permeability. The permeates from reverse osmosis or nanofiltration may contain other impurities such as excess acids, volatile acids or off flavors which can be removed by ion exchange or adsorption resins. The improved permeate can then be combined with the membrane concentrate stream to make the final product.

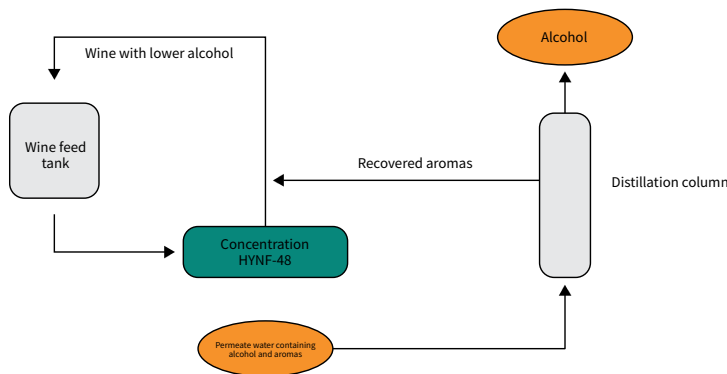


Figure 10 - Dealcoholization

Reduction of Volatile acids from Wine

The presence of higher concentrations of volatile acids in wine may lead to incomplete fermentation and mask desirable flavors and aromas in wine. Moreover, volatile acid compounds need to be below targeted limits. HYRO-48 can remove volatile acids from wine by enabling passage to the permeate. Permeate can be treated with ion exchange for volatile acid removal and then recirculated back to the feed.

Application Development Capabilities

Testing Key Applications

Test based approach for separations feasibility and early full-scale process design estimation

Element Supply

Sales and technical service. Sampling support for piloting – Flat sheet and 2.5, 4 and 8 inch elements

MultiTech Approach

Combine Ion exchange / Chromatography and Membranes for higher purity lower energy and other advantages

Flat Cells



Elements



A Key Ingredient in Food and Beverage Processing



DuPont System Optimization Services™ (SOS)

Working with DuPont is easy and convenient. Whenever you choose DuPont membranes, you get expert support from DuPont 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 membranes, 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.



Powering performance worldwide.

With a large global manufacturing footprint, strong R&D expertise and technical support services and systems, we supply high market volumes with high quality. DuPont partners with you, our customer, to understand unmet needs and develop tailored solutions.

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Form No. 45-D02568-en CDP, Rev. 5
May 2024