



A more sustainable journey for your beer and beverages

Concentration: Better for operations, better for the planet



March 2022



Curbing carbon emissions

How can breweries and beverage manufacturing facilities reduce their carbon footprints while making operations more efficient?

Reducing direct and indirect emissions plays an important role – from the purchase of raw material, electricity and manufacturing to packaging, materials and distribution.

This white paper will focus on reverse osmosis (RO) membrane filtration for beer and beverage concentration as a cost-effective way for manufacturers to reduce the carbon footprint of their supply chains.

Improve logistics efficiency and shrink your carbon footprint

Concentrating beer and beverages can raise production volumes, reduce emissions and cut costs across your logistics and distribution chains. This guide provides what you need to know about removing water from and rehydrating beer and cider at the point of consumption. Choosing the right beer and beverage concentration system helps cut costs, saves water and energy, reduces emissions and enhances your company's sustainability profile.

- Beer and beverage concentration – a better journey for your beer
- Methods for concentrating beer and beverages
- Why choose a low-temperature, high-pressure RO system
- The ultimate low-temperature, high-pressure RO system

Reduce your logistics costs and improve your sustainability profile with high-quality beer and beverage concentrates.



Beer and beverage concentration – a better journey for your beer and shrink your carbon footprint

Increasingly, beer and beverage manufacturers are adopting strategies to achieve carbon neutrality across the value chain – from sourcing and production to logistics and distribution. Take beer production, for instance. Production represents about 10% of a brewery's total carbon footprint while logistics and distribution, at 11%, is a slightly higher portion of a brewery's carbon footprint. To make beer and beverage production more carbon neutral, beer and beverage concentration is gaining ground as a sustainable business strategy among breweries and beverage manufacturers.

Beer and beverage concentration provides significant savings in terms of reduced energy consumption and carbon-cutting initiatives from transporting beverages to the point of consumption. Moreover, higher operational efficiency and enhanced sustainability credentials provide manufacturers a competitive advantage.



Methods for concentrating beer and beverages

There are two broad categories of methods for beer and beverage separation – thermal separation, and physical separation.

Thermal separation

Thermal separation methods include evaporation and freeze concentration, which cools the beverage, crystallizes the water as ice, and removes the ice crystals.

Evaporative methods for concentration involve changes in taste due to heating the product and aroma loss due to evaporation. This can be acceptable in certain beverage applications, such as juice. However, maintaining good flavour and aroma profiles for beer and more complex beverages calls for the use of other concentration methods.

Freeze concentration ensures the beverage is not heated nor is the water evaporated, retaining the taste profile of the original beverage. However, freeze concentration systems require significant cooling requirements to achieve a phase change from water to ice and back again. The cooling requirements make freeze concentration systems expensive from a capital and operating cost standpoint.

Physical separation

Physical separation methods include various membrane separation technologies. Membrane filtration technology has been in use since the 1960s in multiple industries to remove water from various products. In the most basic terms, membrane filtration, also known as crossflow filtration, involves passing a single feed stream through a membrane system that separates it into two individual streams, known as the permeate and the retentate.

Choosing the right membrane filtration technology

There are four types of membrane filtration technologies commonly used in food and beverage applications: microfiltration, ultrafiltration, nanofiltration and reverse osmosis – listed in the order of largest pore size to smallest effective pore size.

In concentrating beer and other alcoholic beverages, it is critical to allow water to pass through the membrane selectively, while retaining all other compounds. Critically, the membranes must be capable of retaining very small molecules – as small as ethanol, which is the smallest molecule in beer apart from water.

Selecting the appropriate type of membrane filtration technology for the application is fundamental to process efficiency.

Advantages of membrane filtration

Recent advances in membrane technology have increased its use within the food and beverage industry, especially with breweries and beverage manufacturers. These advances make membrane filtration more cost-effective than before due to reduced capital and operating expenditures and sustainability advantages such as energy savings. Furthermore, because membrane technology involves physical separation, it does not change the beverage's flavour profile provided that the membranes can retain all critical flavour compounds.

What is reverse osmosis

Reverse osmosis (RO) uses the tightest possible membrane in liquid separation. Materials, such as bacteria, spores, fats, proteins, gums, salts, sugars, and minerals, are unable to pass through.

Read more about our [RO flat sheet membranes](#) and [RO spiral wound membranes](#)

What is nanofiltration

Nanofiltration (NF) allows small ions (e.g., minerals) to pass through while excluding larger ions and most organic components (e.g., bacteria, spores, fats, proteins, gums and sugars).

Nanofiltration is not as fine a separation process as reverse osmosis and uses membranes that are slightly more open.

Read about our [NF flat sheet membranes](#) and [NF spiral wound membranes](#)

What is ultrafiltration

Ultrafiltration (UF) involves using membranes in which the pores are larger and the pressure is relatively low. Salts, sugars, organic acids and smaller peptides are allowed to pass, while proteins, fats and polysaccharides are not.

Read about our [UF flat sheet membranes](#) and [UF spiral wound membranes](#)

What is microfiltration

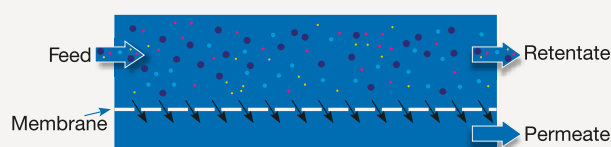
In microfiltration (MF), suspended solids, bacteria and fat globules are normally the only substances not allowed to pass through.

Read about our [MF flat sheet membranes](#) and [MF spiral wound membranes](#)

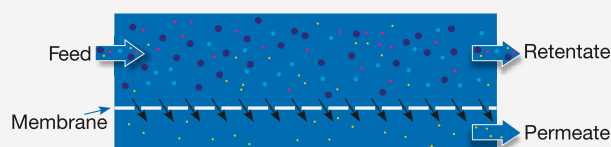
Types of membrane filtration

There are four commonly accepted types of membrane filtration. These are defined on the basis of the size of material they are required to separate from the feed liquid. The four types of membrane filtration are known as reverse osmosis, nanofiltration, ultrafiltration and microfiltration, in order of increasing pore size.

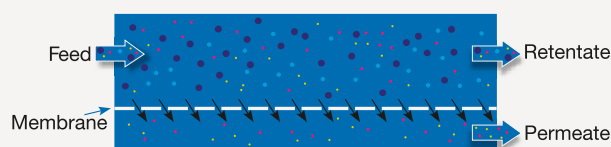
Reverse osmosis



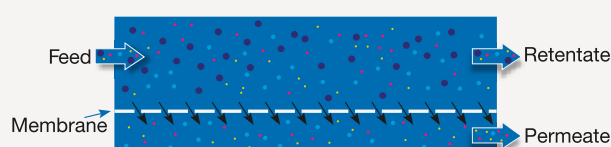
Nanofiltration



Ultrafiltration



Microfiltration



Why choose Revos for beer and beverage concentration?

Using traditional RO systems alone to concentrate beer or other alcoholic beverages proves inadequate in retaining the original flavour profile. The RO system must be able to retain tiny molecules, including ethanol, to preserve the original flavour profile. Moreover, the osmotic pressure of beverages like beer is high, and the pressure at which traditional reverse osmosis systems operate would be insufficient to achieve meaningful concentration factors.

The Alfa Laval Revos™ concentration system is a patented pre-engineered reverse osmosis process module that uses low-temperature, high-pressure membrane filtration technology to concentrate beer and beverages. The Revos system uses a series of proprietary RO membranes to remove water from the alcohols, proteins, and esters in the feed solution and concentrate the original beverage to up to 22% alcohol by volume (ABV). Unlike most RO membrane filtration systems, the Revos system prevents aromatics and alcohols from passing through the membrane filter.

The combination of low temperature, high pressure, tight pore size, and alcohol and aroma recovery enable Revos to deliver concentrates without impacting a beverage's flavour profile.

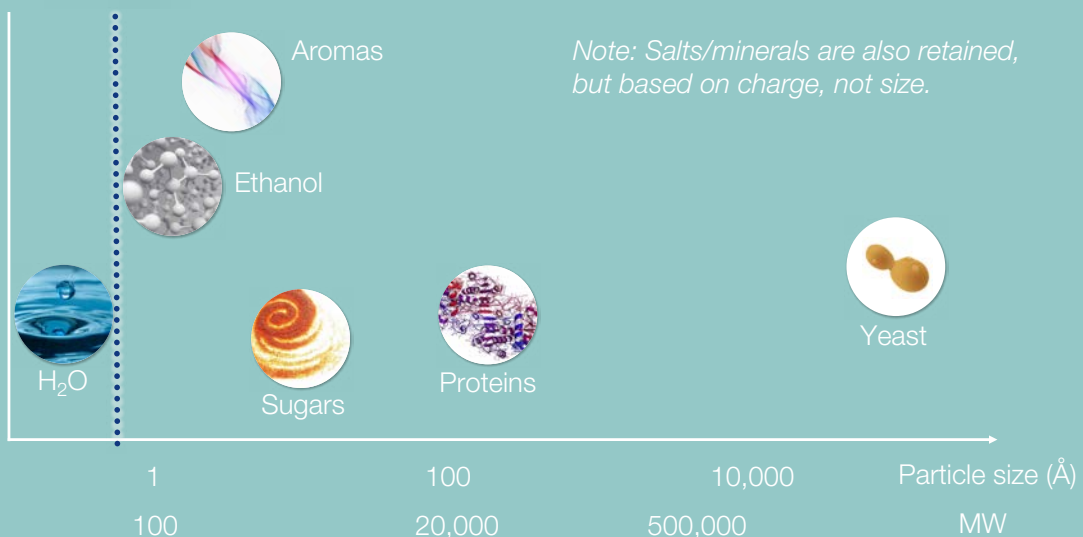
Low temperature – Ensures a beverage's unaltered taste and aroma profile when concentrated.

High pressure – Operating pressures up to 120 bar (1740 psi) enable the production of highly concentrated beverages – up to 22% ABV.

Tight pore size – Specially developed RO membranes with pore sizes allowing effective separation of water from molecules as small as alcohols and aromas.

Patented alcohol and aroma recovery process – Multiple passes through the membranes ensure the recovery of any alcohol or aroma compounds that may have escaped during the first filtration pass. A second pass produces clean water (known as final permeate) and a stream of recovered alcohol and aroma, which is recirculated back to the feed stream.

Revos cutoff at ~2°C



Alfa Laval Revos technology

The ultimate low-temperature, high-pressure RO system

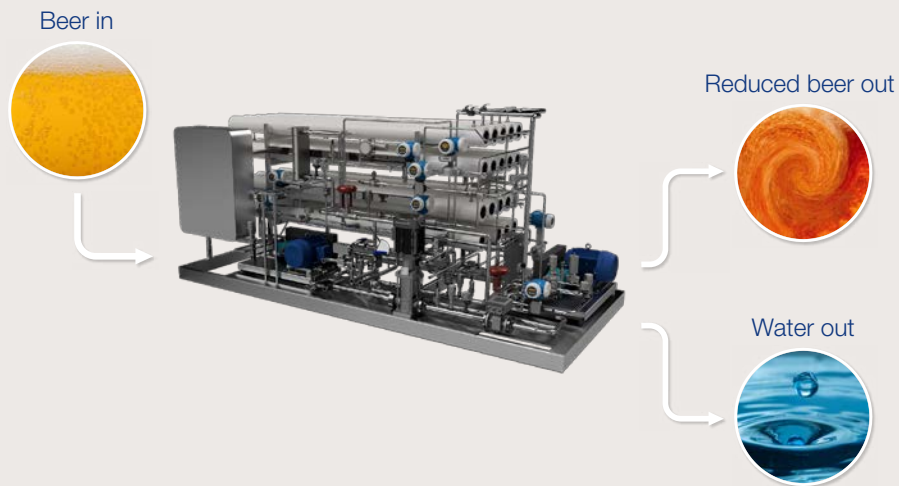
The Alfa Laval Revos concentration system is a low-temperature, high-pressure RO membrane filtration system capable of concentrating alcoholic beverages, including beer and cider. It removes water from beer while leaving alcohol, flavours and aromas in the remaining concentrate. High operating pressures (120 bar/1740 psi) produce highly concentrated beverages with up to 22% ABV.

Why rely on Revos technology

The Revos concentration system outperforms other RO systems due to patented technology, including:

- Core membrane design, with the smallest pore size, withstands high-pressures and eliminates flow dead zones during Cleaning-in-Place (CIP), enabling highly effective separation of water from alcohol and aroma compounds and complete membrane cleanability.
- Concentration control enables high recovery of alcohol, aroma and volatiles in a high-pressure multi-pass RO process.
- Flow control allows optimal flow patterns during production and CIP sequences, significantly reducing membrane cleaning times.
- Loss reduction during startup, changeover and run-out phases.
- Pressure vessel design with insulated housings to optimize process efficiency.
- Alcohol and aroma recovery system enables a perfect taste match between the original and the reconstituted beverages.

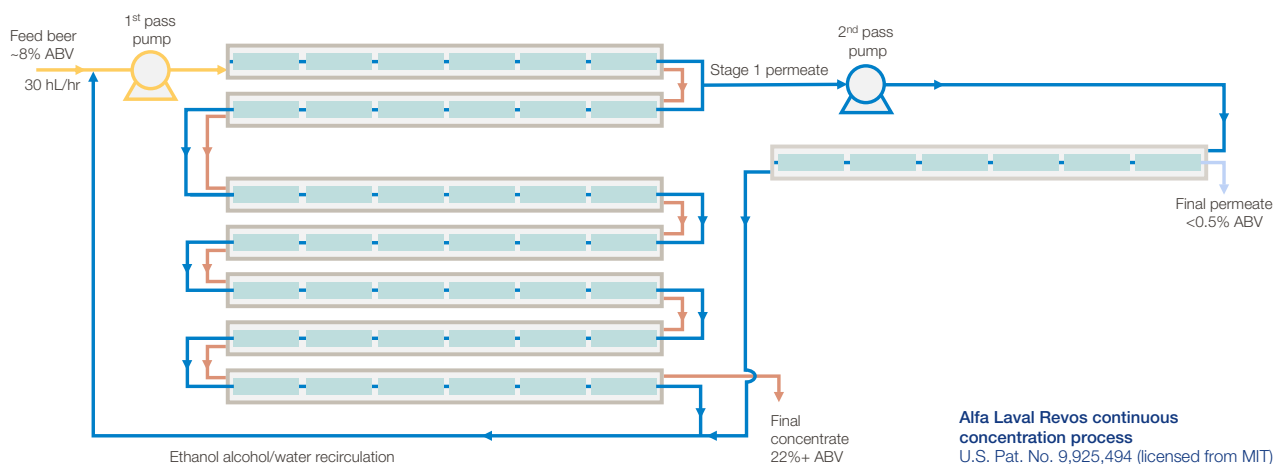




How it works

The Revos concentration system has a continuous two-pass filtration system.

- In the first pass, a pump continuously transfers the beer or beverage into the Revos concentration system through seven membrane housings with 42 spiral-wound membranes.
- At high pressure, water permeates the membranes, concentrating the product up to 22% ABV.
- Proteins, sugars, aromas are retained in the beer and beverage concentrate due to the tight pore structure of the membranes.
- When the beer reaches the end of the first pass, the final concentrate continuously flows from the system at about 22% ABV.
- Water removed in the first filtration pass (stage 1 permeate) is directed to a second filtration pass (below, right).
- The second pass recovers any alcohol or aroma compounds that may have escaped during the first pass of concentration.
- The second pass produces clean water or final permeate and a stream of recovered alcohol/aroma.
- The clean water, known as final permeate, can be used throughout the brewery.



Schematic diagram of the continuous two-pass filtration process of Revos concentration system.

A more sustainable journey for your beer

Beer and beverage concentration makes it possible for manufacturers to choose a better journey for their beer – one with a significantly lower carbon footprint.

On the one hand, concentrating beer and beverages reduces shipping costs for breweries and beverage manufacturers (see Bulk transport use case, left). On the other hand, it makes it easier and more convenient for bars, restaurants and cafés to simplify delivery logistics and reduce the environmental impact of the beverage distribution system (see Draft dispense use case, bottom left).

Shrinking your supply chain carbon footprint

Take bulk transport. Transporting beer concentrate instead of standard high-gravity beer, for instance, reduces the number of tanker journeys required by approximately 80%. Transporting concentrate saves about between 5 and 15 euro per hectolitre of beer or beverage delivered. The savings that accrue to the brewery, in terms of reduced labour and fuel costs, largely depend on the cost of beer on a particular route.

Implementing bulk transport with concentrates increases the blending ratio used in de-brewing the beer for the receiving brewery or packaging site. All other processes, such as brewing and fermentation, remain the same.



Bulk transport use case

- Reduces the number of tanker journeys by 80%
- Saves 5 to 15 euros per hl on tanker transport
- Shrinks supply chain carbon footprint



Re-draft use case

- Saves more than 20 euros per hl on keg transport
- Enables bars to rehydrate beer and beverages from concentrate and serve them on tap
- Shrinks supply chain carbon footprint






Capacities and operating parameters

The Alfa Laval Revos concentration system is available for throughputs of high-gravity feed beer or similar beverages at 30 hl/h. To increase capacity, when required, the systems may be operated in parallel.

Revos

Throughput (feed)	hl/h	6	30
Footprint	m	4.6 x 1.9 x 1.7	9.6 x 2.4 x 2.3
Electrical power	kWh/hl	0.8	0.7
Water use (deaerated water)	hl/hl	0.2	0.2
Water use (Cleaning-in-Place)	hl/hl	< 0.1	< 0.1
Permeate recovery	hl/hl	~0.7	~0.7

Alfa Laval Re-draft monitoring

 <p>Ratio control/tracking</p> <ul style="list-style-type: none"> • Responds dynamically to changes to ensure a consistent pour • Accounts for flow variability at the start of the pour and when water flow rate or pressure changes 	 <p>Quality</p> <ul style="list-style-type: none"> • Keeps beer and beverages cold at all times • UV sterilization prevents microbial growth after chlorine removal 	 <p>Touchscreen display</p> <ul style="list-style-type: none"> • Makes data about each pour and keg and CO₂ volumes available to bar staff • Provides data about cleaning, calibration and maintenance available to service professionals 	 <p>Alarms</p> <ul style="list-style-type: none"> • Alerts staff to change kegs, replace CO₂ or call for service • Recognizes issues with the machine or inputs • Helps prevent off-spec pouring 	 <p>Connectivity as a service</p> <p>Remote monitoring and logging ensures:</p> <ul style="list-style-type: none"> • Each pour is in spec • Cleaning on track • Usage analytics available to the brewer or manufacturer
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Rehydrating concentrates

Concentrates must be rehydrated upon reaching their final destinations. To do so, there's Alfa Laval's draft dispense system, Alfa Laval Re-draft. This compact, post-mix dispensing system reconstitutes beer and beverage concentrates at the point of consumption. It adds filtered water and recarbonates the beverage to match the flavour of the original, moments before serving cold draft beer and beverages at pubs and restaurants.

Serving alcoholic and non-alcoholic concentrates directly from the tap with the Alfa Laval Re-draft:

- Can save more than 20 euros per hl on keg transport.
- Ensures pour quality using the built-in monitoring system.
- Reduces the CO₂ footprint of breweries, beverage manufacturing facilities and serving establishments while contributing to meeting sustainability goals.

Benefits

- For the brewer and distributor: Transport costs are reduced by four to six times, enabling cost savings and/or price point increases.
- For the brewer: Real-time data is available from the dispense machine on pour quality (temperature, carbonation, ABV, flow rate).
- For the bar: Reduced deliveries and storage space requirements.
- For the customer: Improved product consistency due to the remote monitoring system that comes with the Revos draft dispense system.

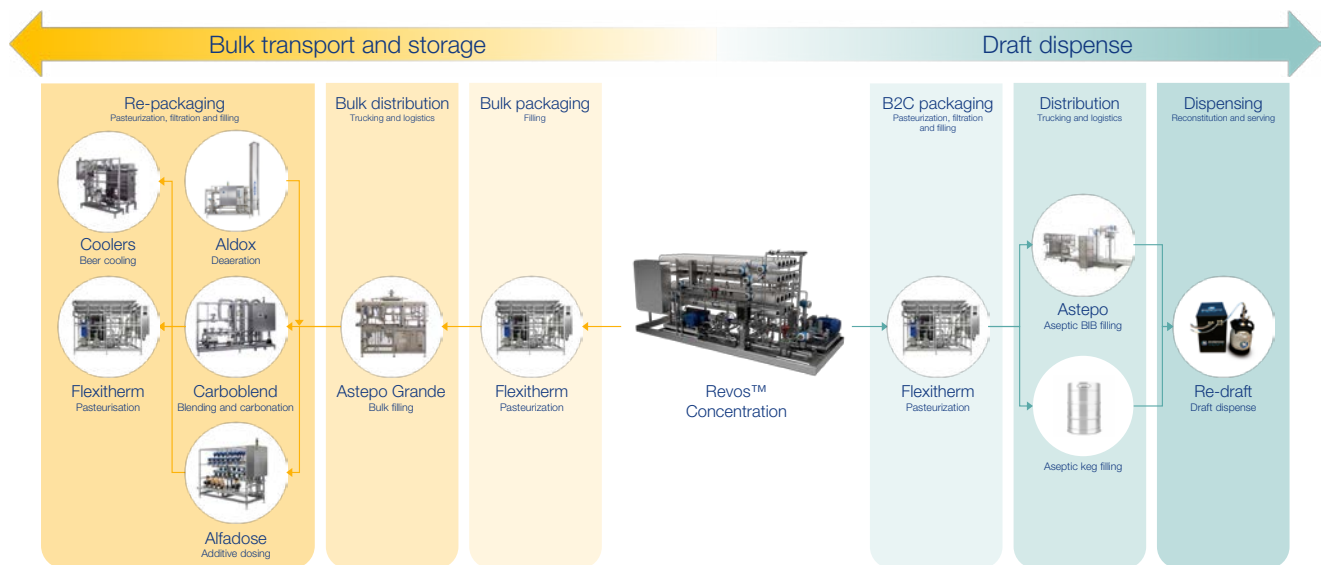


Alfa Laval Revos beer and beverage concentration

The Alfa Laval beer and beverage concentration portfolio consists of the Revos concentration system and the Re-draft system.

Complete end-to-end solutions

Alfa Laval can tailor an end-to-end solution for beer and beverage concentration and supply most process equipment, including aseptic bulk fillers, required upstream and downstream.



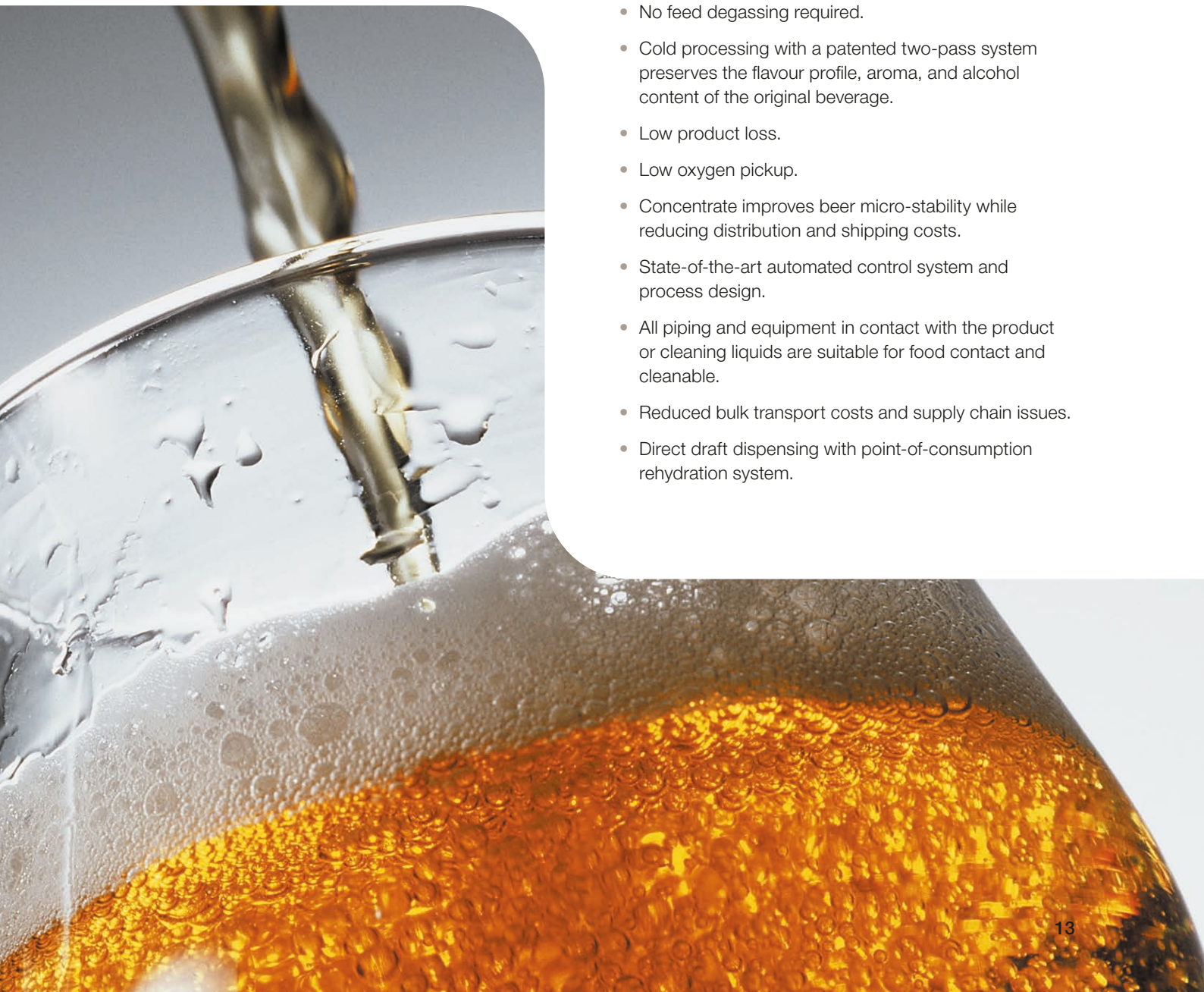
Alfa Laval Revos end-to-end solutions – Solution ecosystem: bulk re-packaging vs. pack-to-dispense.

Towards more carbon-neutral supply chains

The Alfa Laval Revos concentration system and Alfa Laval Re-draft provide breweries with a better journey for their beer and cider – one that is significantly more carbon-neutral and operationally efficient.

Key takeaways

- Compact, economical, and energy-efficient technology to remove pure water from beer or beverages while retaining flavour and aromas; only pure water is required to rehydrate the concentrate.
- High operating pressures allow for concentration up to 22% ABV.
- No feed degassing required.
- Cold processing with a patented two-pass system preserves the flavour profile, aroma, and alcohol content of the original beverage.
- Low product loss.
- Low oxygen pickup.
- Concentrate improves beer micro-stability while reducing distribution and shipping costs.
- State-of-the-art automated control system and process design.
- All piping and equipment in contact with the product or cleaning liquids are suitable for food contact and cleanable.
- Reduced bulk transport costs and supply chain issues.
- Direct draft dispensing with point-of-consumption rehydration system.



Get in touch

Want to talk to an expert who understands how to concentrate beer and cider? We'll put you in touch with someone who understands the challenges you face and can tailor a solution that meets your needs.

Alfa Laval's extensive know-how in the field of membrane technology means that you can rely on our beer and beverage solutions portfolio to shrink your carbon footprint and save money.

Contact Alfa Laval

Questions or comments? Reach out to Alfa Laval at [alfalaval.com/contact-us](https://www.alfalaval.com/contact-us). We look forward to hearing from you!





This is Alfa Laval

Alfa Laval is active in the areas of Energy, Marine, and Food & Water, offering its expertise, products, and service to a wide range of industries in some 100 countries. The company is committed to optimizing processes, creating responsible growth, and driving progress – always going the extra mile to support customers in achieving their business goals and sustainability targets.

Alfa Laval's innovative technologies are dedicated to purifying, refining, and reusing materials, promoting more responsible use of natural resources. They contribute to improved energy efficiency and heat recovery, better water treatment, and reduced emissions. Thereby, Alfa Laval is not only accelerating success for its customers, but also for people and the planet. Making the world better, every day. It's all about *Advancing better™*.

How to contact Alfa Laval

Contact details for all countries are continually updated on our web site. Please visit www.alfalaval.com to access the information.