

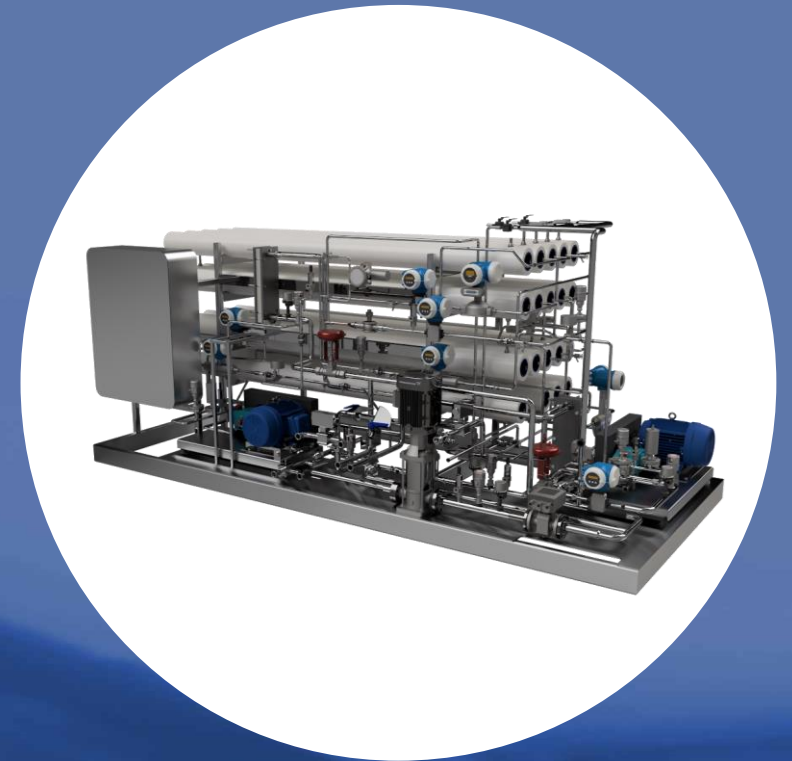
# Alfa Laval Revos™ concentration system

- The future of alcoholic beverage distribution

Ronan McGovern

# Agenda

- Beer concentration
- Dealcoholization and dearomatization
- Draft dispense
- Trial offerings for new customers
- Early Adopter Programme
- Q&As

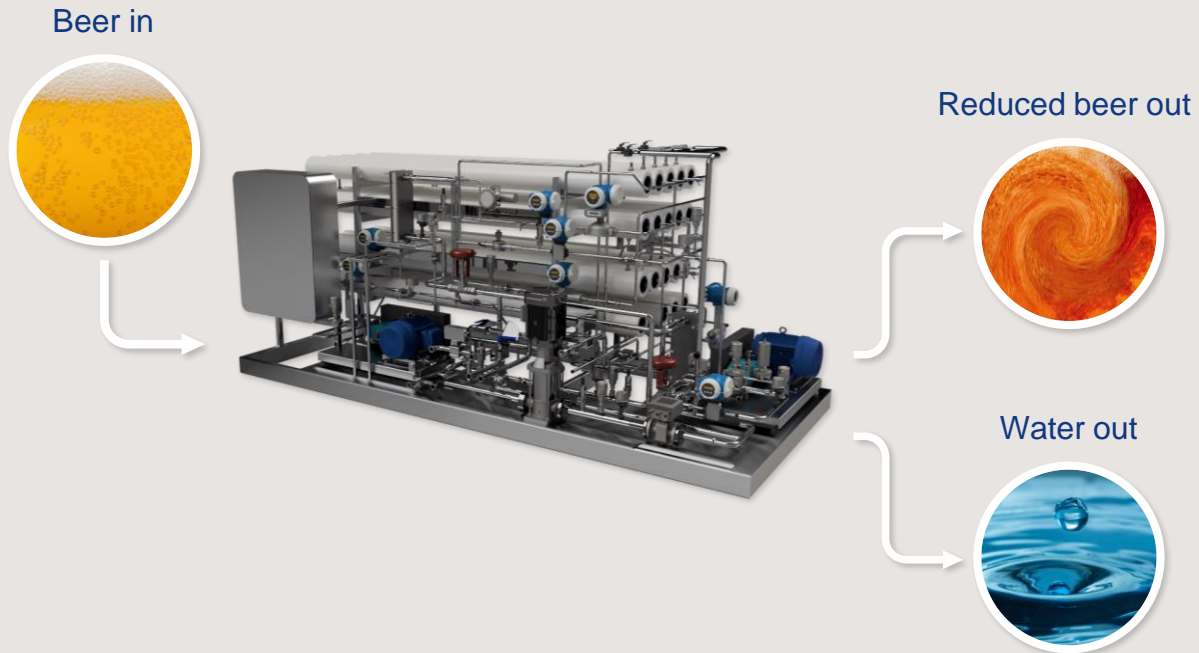


# Beer concentration with Alfa Laval Revos concentration system

– The future of beer production and distribution

# Alfa Laval Revos technology

– Alcoholic beverage concentration system

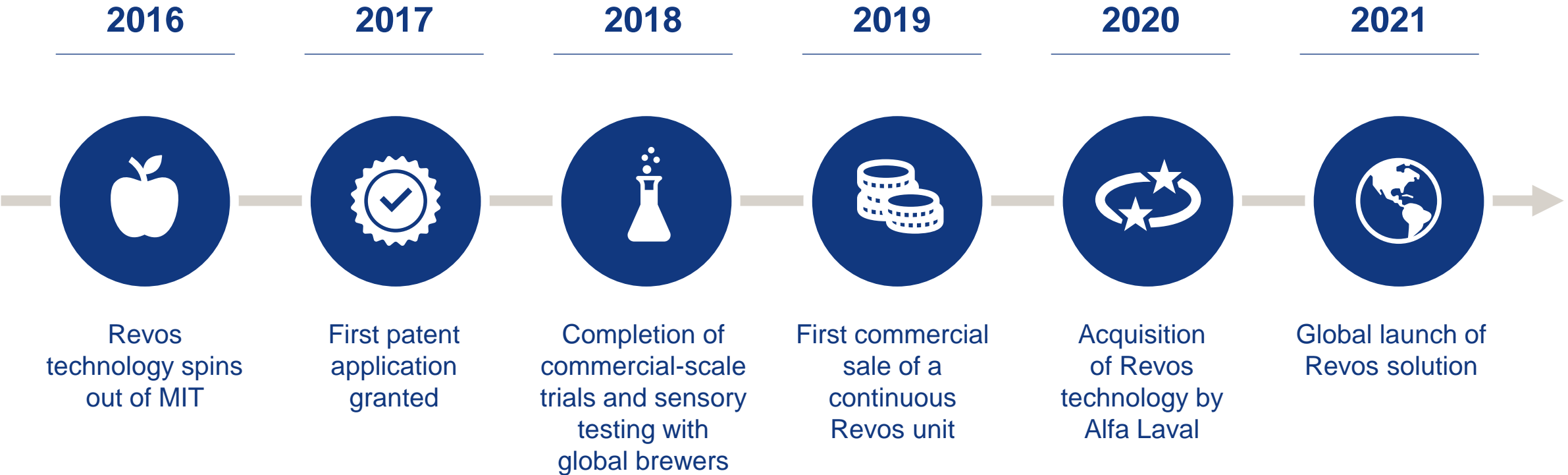


## High-pressure, low-temperature reverse osmosis system

- Taste match between original product and reconstituted beer or beverage
- Compact, energy efficient and low OPEX
- Optional add-on for dealcoholization and hard seltzer

# Commercialization status

– Revos through the years



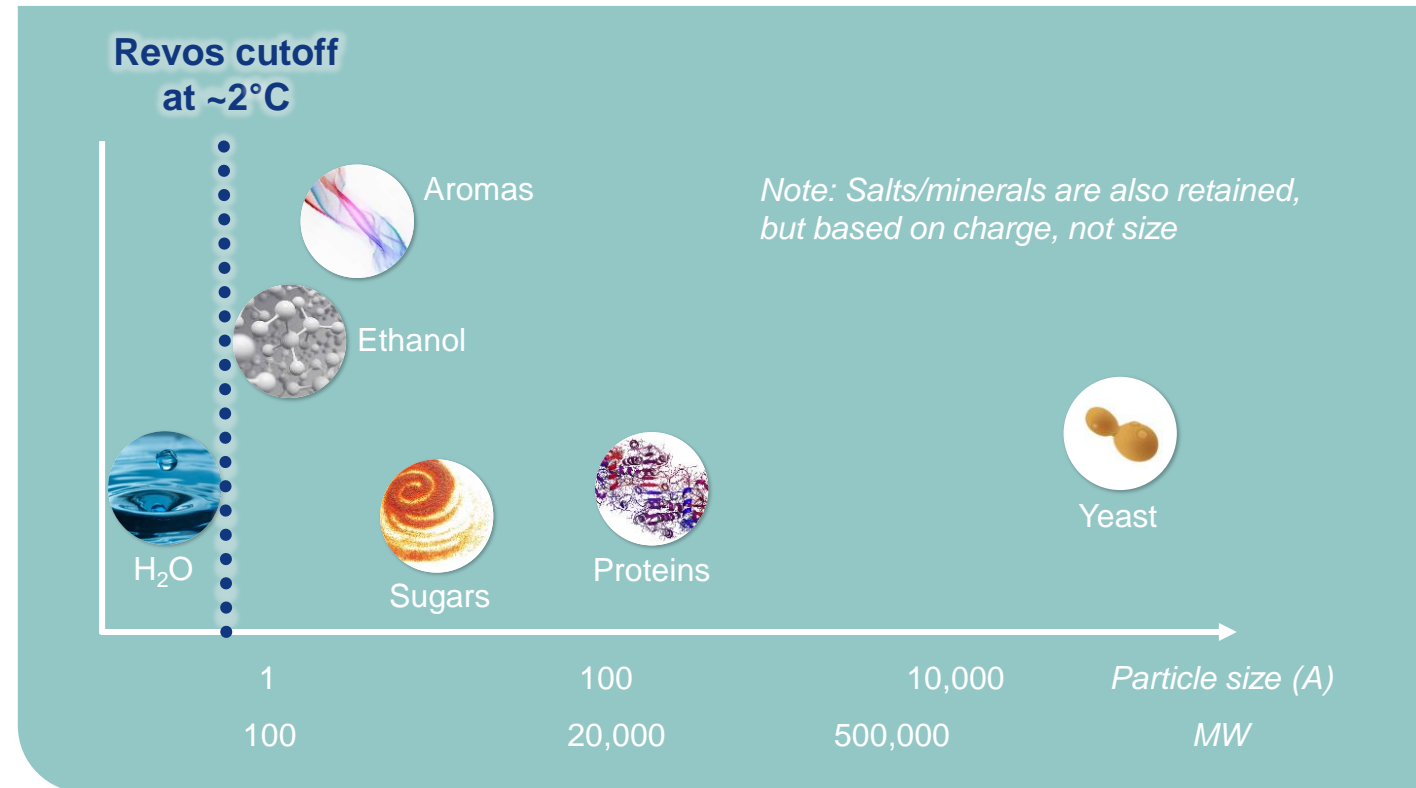
# Revos technology differentiation for concentration



– Precision in separation

## Revos for concentration is differentiated by:

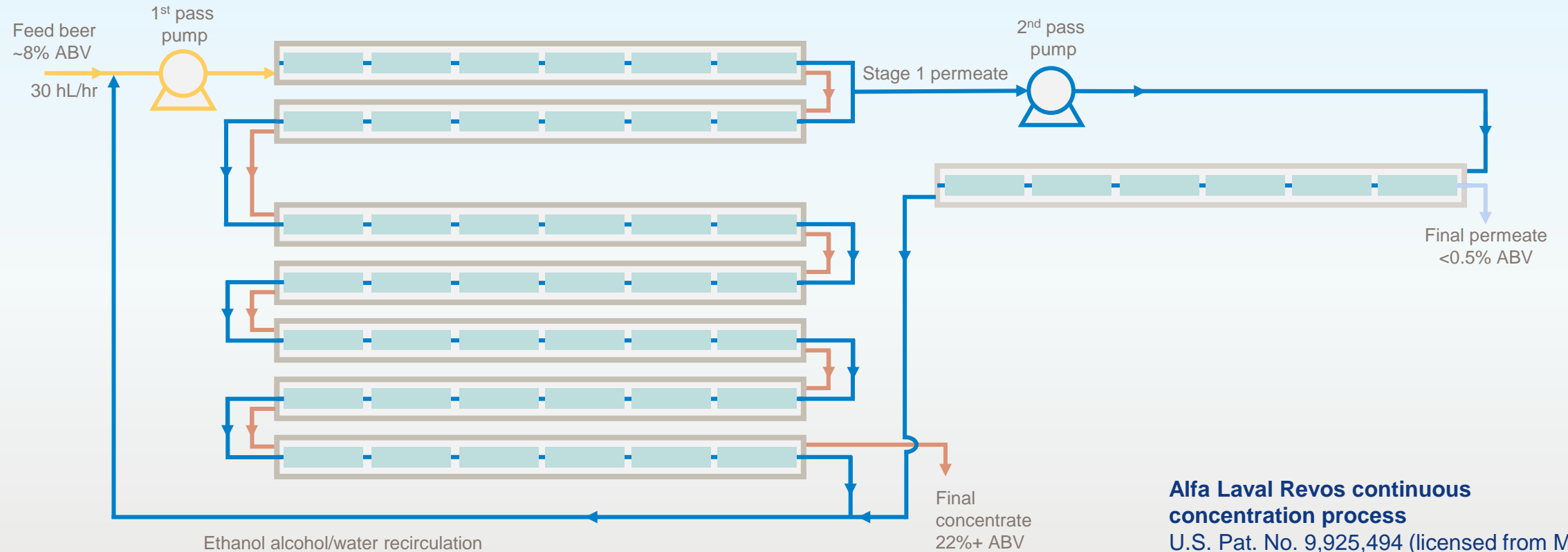
- 120 bar (1740 psi) process pressure
  - Allowing concentrates of 22%+ ABV
- Tight membrane pore structure
  - Passing water but retaining alcohol, aromas, proteins and sugars
- Patented alcohol and aroma recovery design
  - Allows a perfect taste match between original and reconstituted beverages



# Patented alcohol/aroma recovery process design



– Alfa Laval Revos continuous concentration process



**Alfa Laval Revos continuous concentration process**  
U.S. Pat. No. 9,925,494 (licensed from MIT)

# Intellectual property rights

– Alfa Laval Revos for alcoholic beverage concentration



## Core membrane design

Application no. 62/582,116 & 16/625,150

Withstands high-pressures and eliminates flow dead zones during CIP, allowing full membrane cleanability

## Flow control of reverse osmosis system

Application no. 62/582,131 & no. 18873923.9

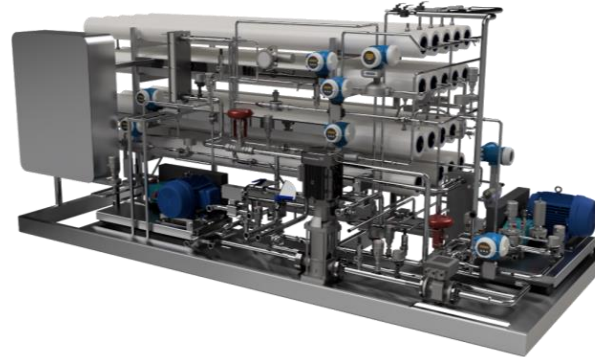
Optimal flow patterns during production and CIP sequences, significantly reducing membrane cleaning times

## Concentration control

U.S. Pat. No. 9,925,494 (licensed from MIT)

Enables high recovery of alcohol, aroma and volatiles in a high-pressure multi-pass RO process

Alfa Laval Revos concentration system



## Loss reduction loading/unloading

Application no. 62/596,435 & 16/770,765

Significant liquid-loss reductions during the startup, changeover and run-out phases

## System and method to control haze

Application no. 62/522,562 & 16/625,150

Improves shelf-life stability of concentrated beer

## Pressure vessel design

Application no. 62/597,078 & PCT/US18/59471

Temperature-controlled housing optimizing the effectiveness of the RO process



# Performance evaluation

– Revos: validated across a wide range of products, including at scale

## Pilot-scale trials

### 20+ products tested with 10+ clients

- Filtered lagers and ales
- Unfiltered ales
- Wine – red, white, rosé
- Neutral malt base

### *Analysis performed*

- Informal sensory performed
- Basic analysis – ABV and RE
- Headspace analysis – esters and alcohols

## Commercial-scale trials

### 16 products tested with four clients

- Filtered lagers and ales
- Unfiltered ales
- Cider

### *Analysis performed*

- Sensory Panel performed – fresh and aged
- Basic analysis – ABV and RE
- Headspace analysis – esters and alcohols
- Physical stability (haze and foam retention) – fresh and aged

# Sensory example: freshly reconstituted

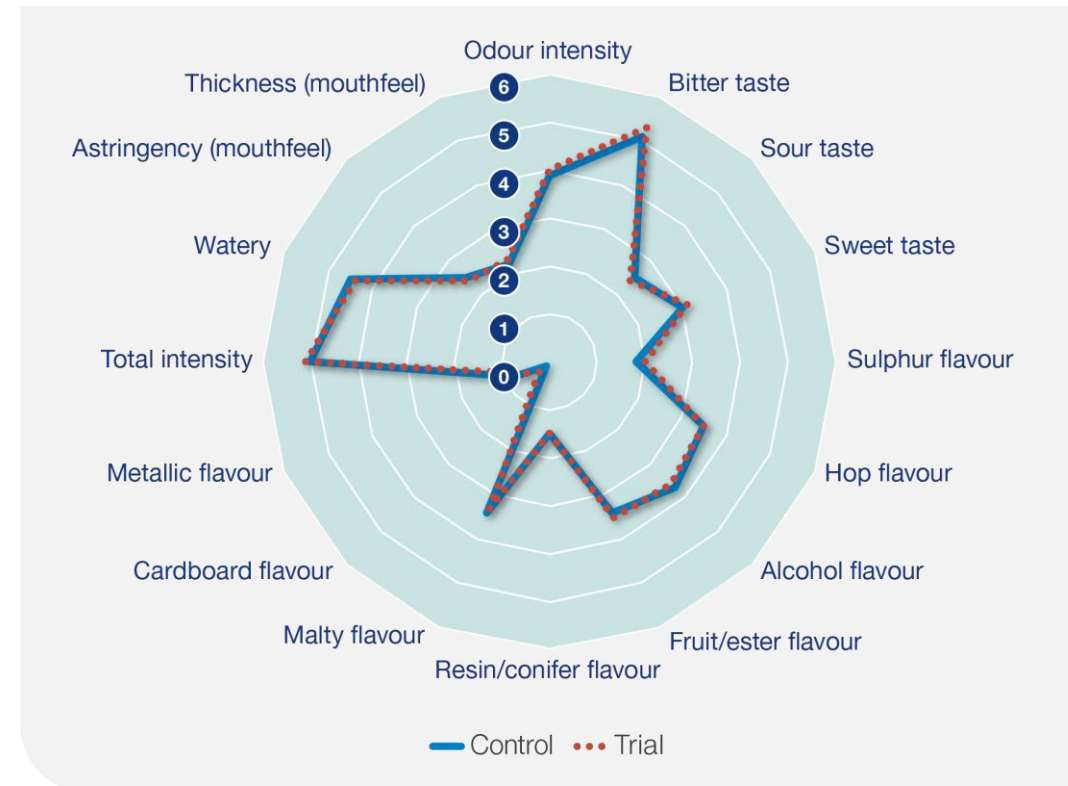
– Comparison of fresh beer and reconstituted Revos concentrate

## Procedure

- Fresh reconstituted lager was subjected to detailed descriptive sensory panel testing
- Scores were averaged over a large group of panelists

## Results

Sensory panel tests reveal minimal to no differences between the control (fresh beer) and the trial (reconstituted beer)



# Sensory example: aged and reconstituted



– Comparison of European lager, Revos concentrate and Revos reconstituted product

## Procedure

1. The European lager was concentrated using Revos
2. Reference and concentrate samples were prepared according to the table (3M = 3 months)
3. Samples were subjected to blind corporate tasting panels. Overall scores were reported. A score of 6.0 was considered acceptable for market release of this brand.

	Reference	Revos concentrate	Revos reconstitute
Conditions	European lager, finished product	Concentrate subjected to conditions at left, then reconstituted and tasted	Concentrate reconstituted then subjected to conditions at left and tasted
Fresh	6.7	6.7	–
3M 0°C	N/A	6.5	6.3
3M 30°C	6.0	5.7	6.0

# Alfa Laval Revos applications

– Core use cases



## **BULK TRANSPORT**

Saves €5–15 per hl  
on tanker transport



## **DRAFT DISPENSE**

Revos draft cellar:  
Allows bars to serve beer or other  
beverages from kegs of concentrate

Revos draft mobile:  
Provides a compact serving solution  
for seasonal venues

# Alfa Laval Revos for bulk transport

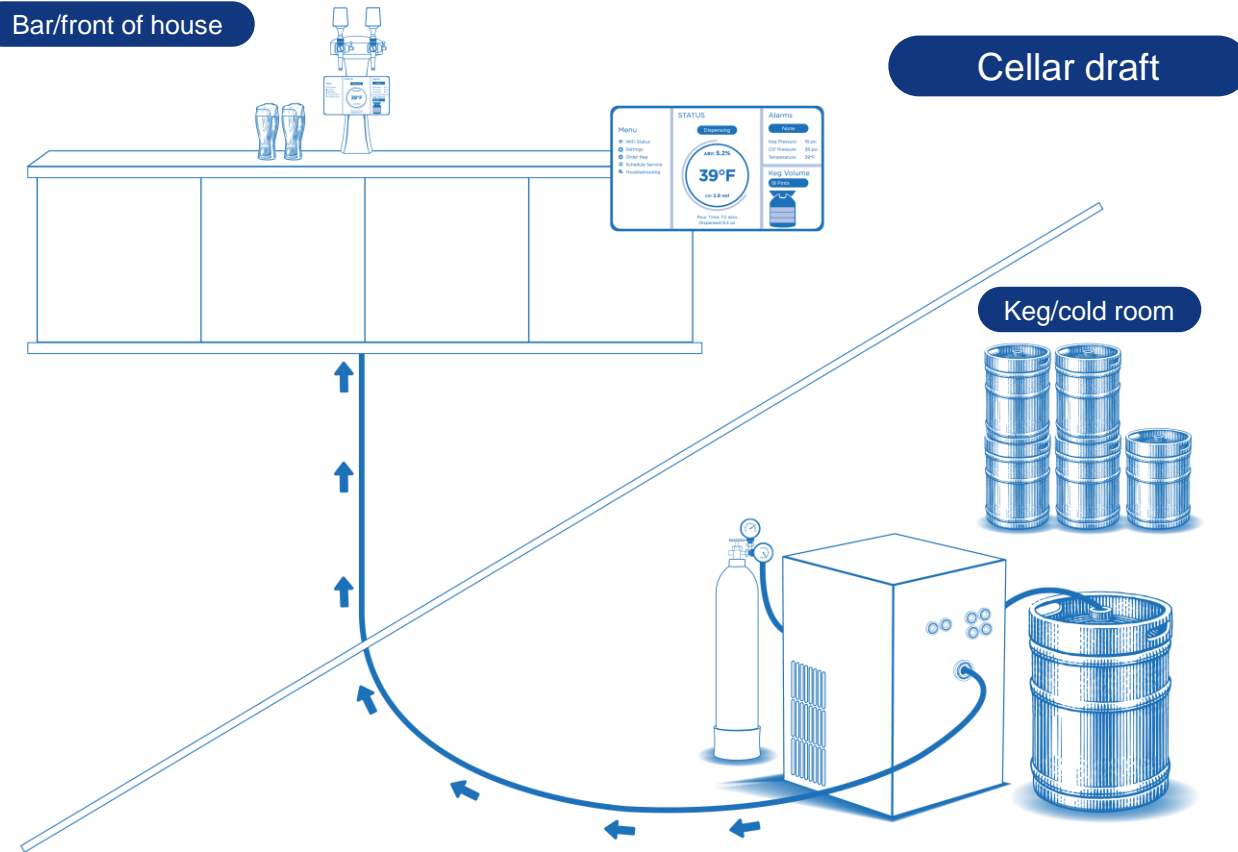
– Hitting environmental and cost-saving goals



- Reduce tanker journeys by about 65%
- Save €5–15 per hl on bulk transport
- Push towards corporate sustainability goals to reduce the CO<sub>2</sub> footprint

# Alfa Laval Revos draft dispense

– Go digital while reaching sustainability goals

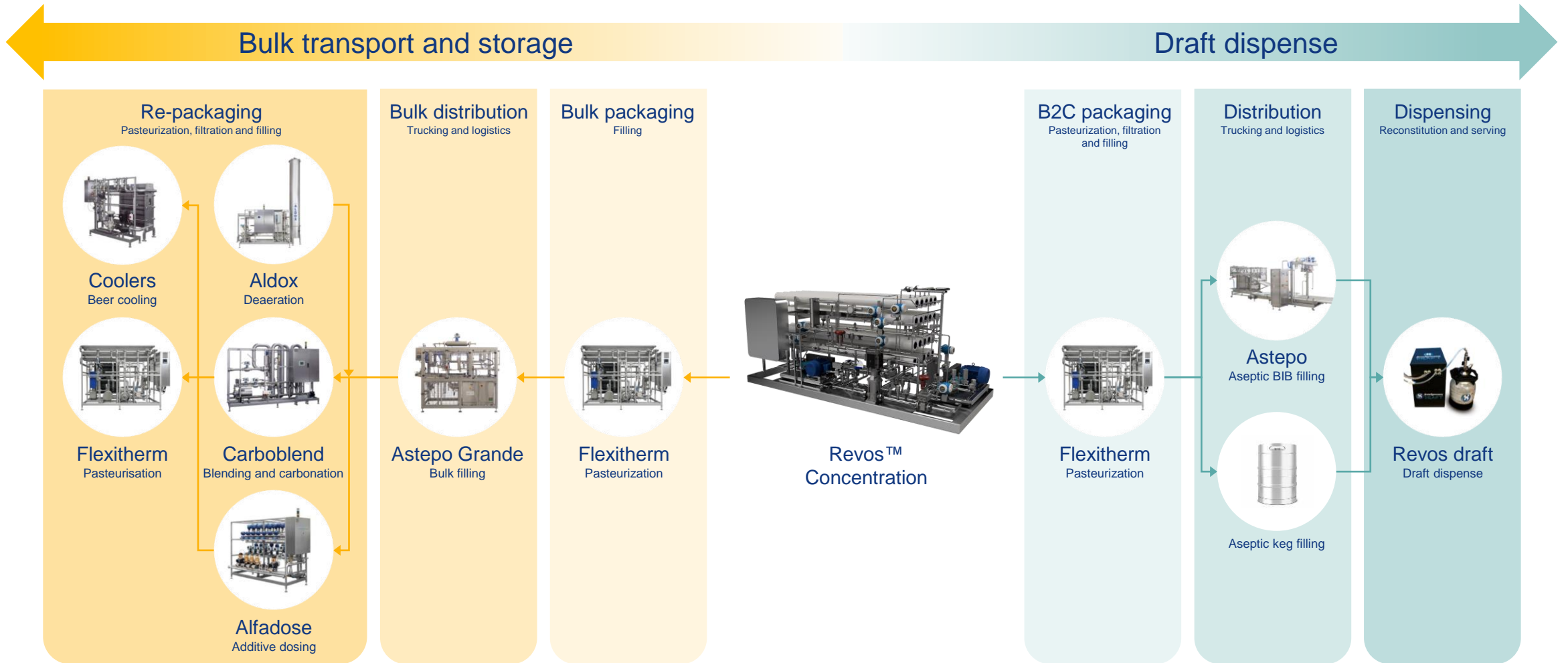


- Save €20+ per hl on keg transport
- Push towards corporate sustainability goals to reduce CO<sub>2</sub> footprint
- Improved analytics and quality control with Alfa Laval Revos draft digital platform

# Alfa Laval Revos end-to-end solutions



- Solution ecosystem: bulk re-packaging vs. pack-to-dispense



# Frequently asked questions



## **Q: How does reconstitution water affect taste?**

A: Revos removes pure water from beer or other beverages while retaining the minerals. This means that the water used to reconstitute the concentrate ideally should be pure water.

## **Q: What are the benefits of Revos over freeze concentration?**

A: Revos technology is more compact, has lower capital costs and lower energy requirements, and does not require degassing of the feed (which contributes to flavour loss) – all while delivering a taste match between the original beer and reconstituted samples.

## **Q: What are the benefits of Revos over forward osmosis concentration technology?**

A: Revos' multi-pass process achieves higher aroma retention than forward osmosis' single barrier layer. It does not require a draw solution recovery step, which requires high capital expenditure and increased operating expenses. Lastly, Revos does not require special cooling with temperatures below  $-2^{\circ}\text{C}$  typically required of brewery glycol systems.

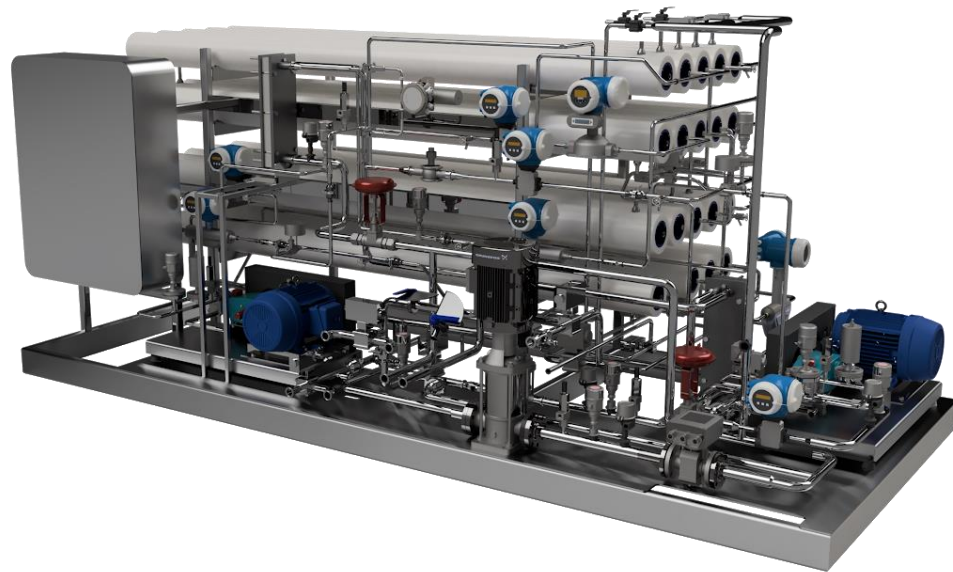


# Alfa Laval Revos concentration system for dealcoholization and dearomatization

- Leading aroma retention and removal technology

# Application overview

– Revos concentration system for dealcoholization



**The core Revos technology can be delivered with the following add-ons:**

- Beverage dealcoholization  
– to 0.5% or 0.05% ABV
- Beverage dearomatization  
– hard seltzer neutral base

Each add-on offered as a software upgrade

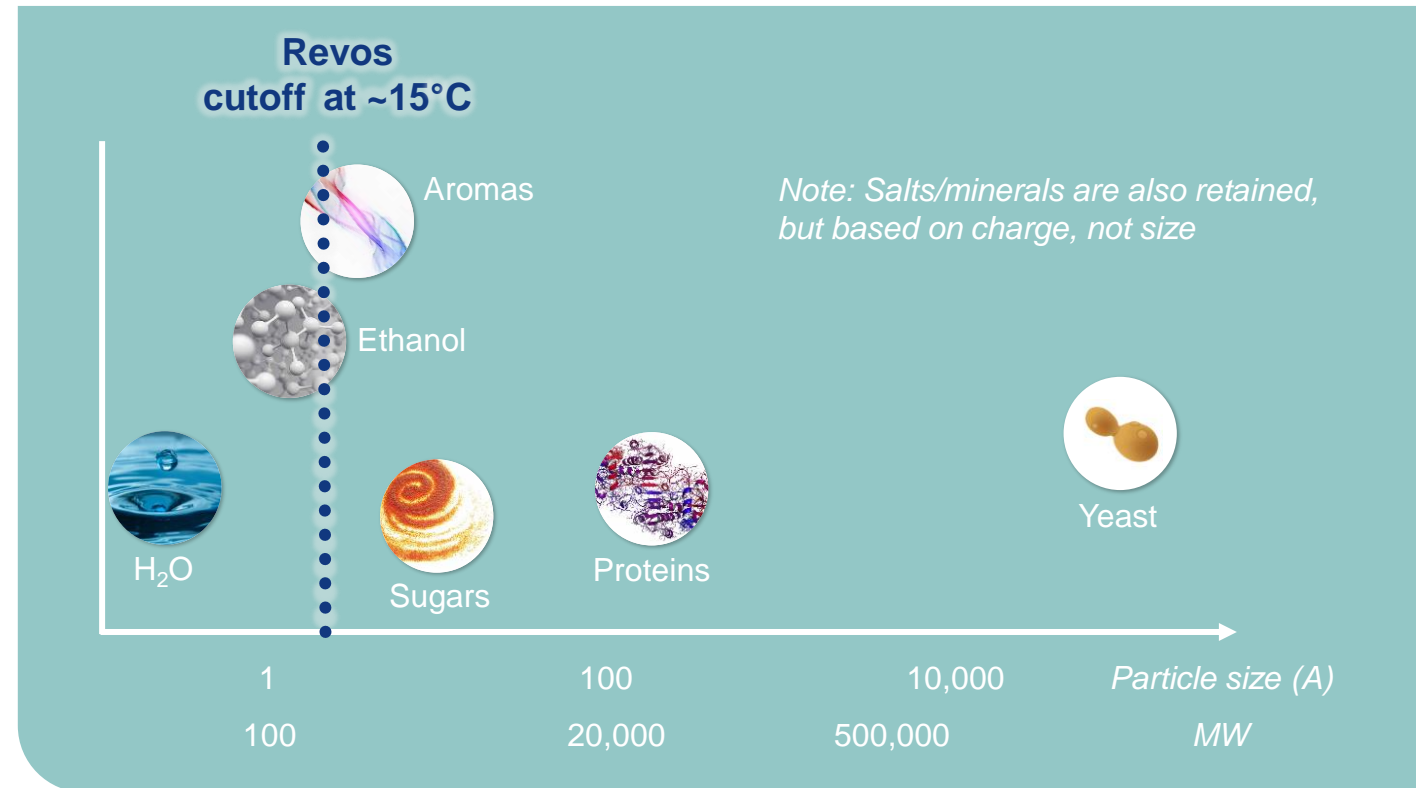
# Revos technology differentiation for dealcoholization



– Precision in separation

## Revos membranes' tight membrane pore structure separates ethanol from aromas

- Dealcoholization – superior aroma retention in dealcoholized beers
- Dearomatization – high purity ethanol-water base for hard seltzers



# Revos technology differentiation

– Minimal dilution



Revos 120 bar process reduces the need for dilution during processing, uniquely enabling...

**0.0%**

**Beers**

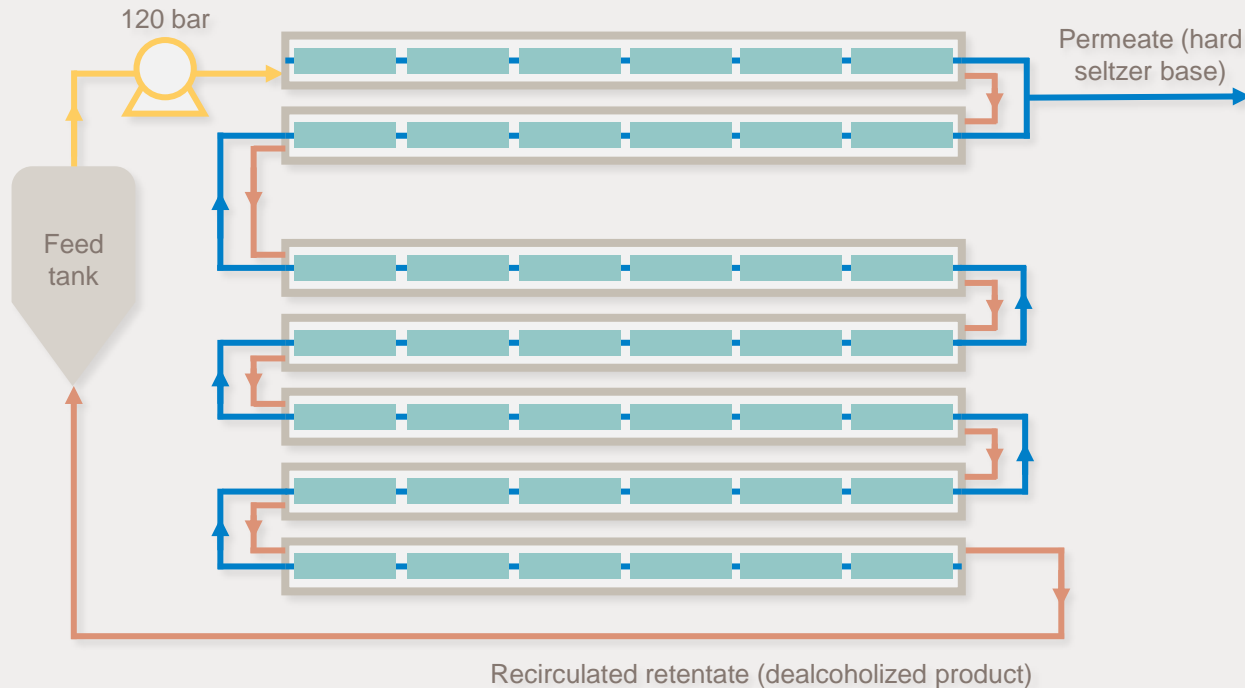
with minimal addition of water

**20%+**

**Ethanol bases**

with minimal dilution of product

# Revos concentration system for dealcoholization



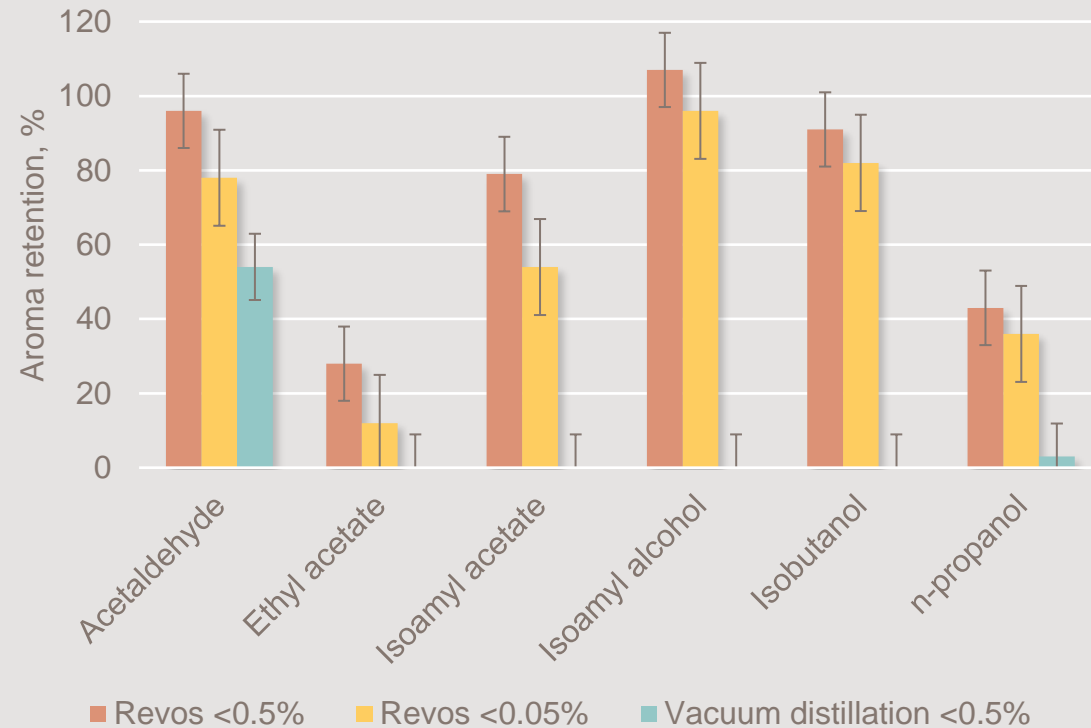
**Can dealcoholize, produce a hard seltzer base, or do both simultaneously:**

- Feed ABV: 4–20%
- Permeate ABV: 4–20%
- Dealcoholized product ABV: 0.05–0.5% after final dilution

Revos process, patent pending

# Dealcoholization performance

– Revos for non-alcoholic and alcohol-free beers and beverages



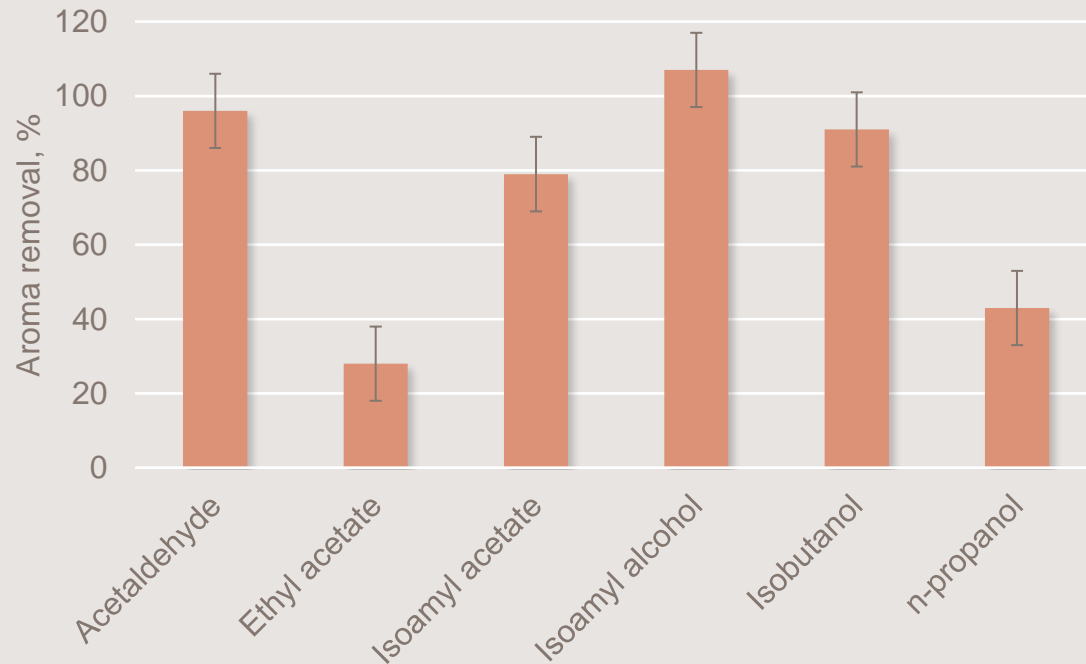
Revos delivers **far superior aroma retention** compared to thermal methods, notably:

- Exceptional retention of higher alcohols in < 0.5% and < 0.05% products
- Improved retention of esters at the 0.5% and 0.05% level

Aroma retention within dealcoholized beer and beverages

# Dearomatization performance

– Revos for hard seltzers



Revos allows for **high levels of aroma removal** from fermented base liquids, notably:

- High removal of acetaldehyde, isoamyl acetate, isoamyl and isobutyl alcohol
- Improved removal of ethyl acetate and n-propanol

Aroma removal for a hard seltzer base

# Commercial offerings



– Revos for alcoholic beverage concentration, dealcoholization and/or dearomatization

Revos		Batch			Continuous	
Alcohol retention	%	70%+			98%+	
Throughput (feed)	hl/h	2	6	12	6	30
Footprint	m	4.9 x 1.9 x 1.8			4.6 x 1.9 x 1.7	
Electrical power	kWh/hl	14	4.7	2.4	0.8	0.7
Water use (deaerated water)	hl/hl	1.3	0.4	0.3	0.2	0.2
Water use (Cleaning-in-Place)	hl/hl	5.2	1.7	0.9	< 0.1	< 0.1
Permeate recovery	hl/hl	N/A			~0.7	

## Notes

- Membrane costs ≈ €0.5–1/hl based on nine-month membrane life
- All “/hl” are per hl of final product at sales gravity
- Chemical costs ≈ €0.05/hl (standard caustic and peracetic acid). *Operating 24/7, with two Cleaning-in-Place/Sterilization-in-Place (CIP/SIP) cycles per week*
- Permeate recovered is low total dissolve solids content, low dissolved oxygen water suitable for reuse

**Stay tuned for details on the NEW Revos Early Adopter Programme – at the end of this presentation!**



# Utilities and operating expenses - Revos 6 (6 hl/h)

– Revos concentration system for dealcoholization



Utilities		Dealcoholization		Dearomatization	Concentration
		0.5% ABV	0.05% ABV	Hard seltzer	22% ABV
Throughput (feed)	hl/h	6.3	3.0	9.5	6
Operating mode		Batch	Batch	Batch	Continuous
Footprint	m	4.6 x 1.9 x 1.7			
Electrical power	kWh/hl	1.3	2.7	1.2	0.8
Water (deaerated water)	hl/hl	1.0	1.7	0	0.2
Water (Cleaning-in-Place)	hl/hl	0.5	0.5	0.5	< 0.1

## Notes

- Membrane costs: ≈ €0.5/hl
- Chemical costs: ≈ €0.05/hl (standard caustic and peracetic acid)
- All “/hl” are per hl of final product

# Alfa Laval Revos draft dispense

– The future of alcoholic beverage distribution

# Alfa Laval Revos draft dispense

– The most compact draft dispense solution



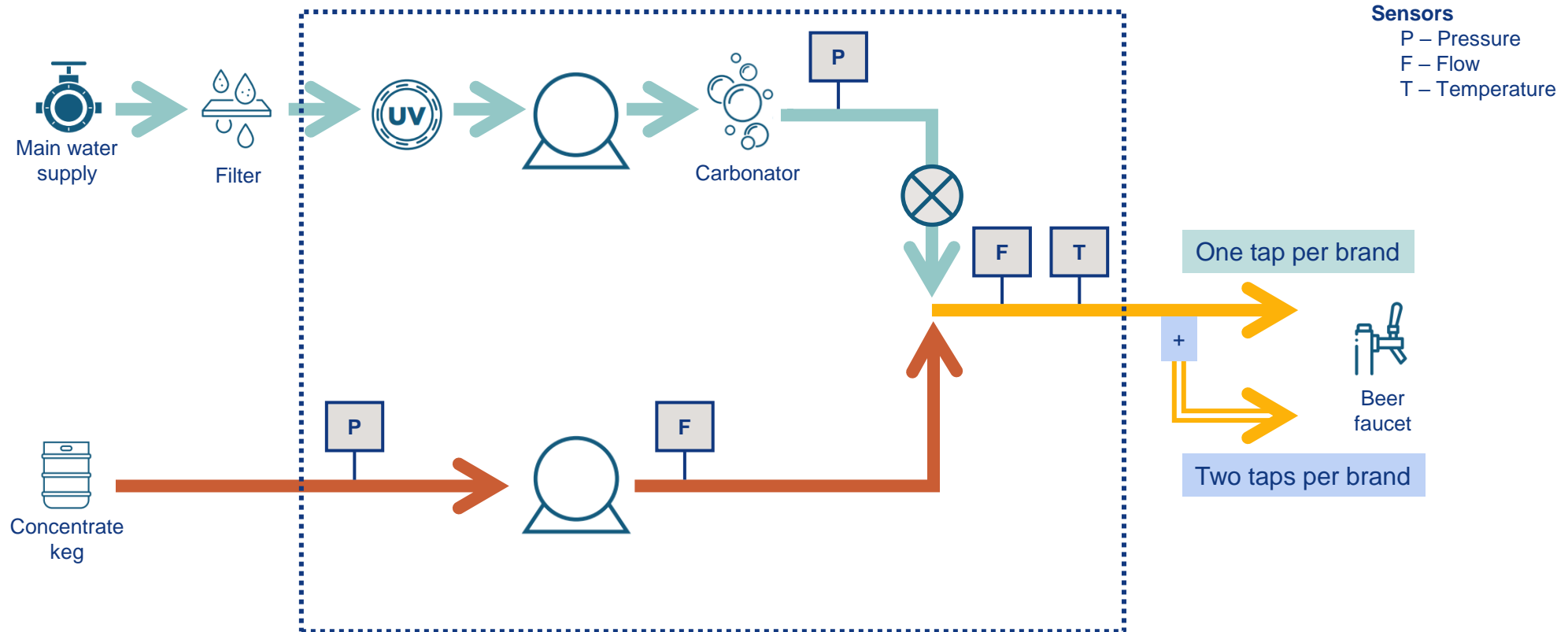
## Solutions

- Alfa Laval Revos draft dispense cellar
- Alfa Laval Revos draft dispense mobile



# Alfa Laval Revos draft dispense flow path options

– Serve up to two brands with mobile draft and four brands with cellar draft



# Alfa Laval Revos draft dispense monitoring

– For cellar and mobile draft solutions



## Ratio control/tracking

- Responds dynamically to changes to ensure a consistent pour
- Accounts for flow variability at the start of a pour and when water flow rate or pressure changes



## Quality

- Keeps beer and beverages cold at all points
- UV sterilization prevents microbial growth after chlorine removal



## Touchscreen display

- Makes data about each pour and keg and CO<sub>2</sub> volumes available to bar staff
- Provides data about cleaning, calibration and maintenance available to service professionals



## Alarms

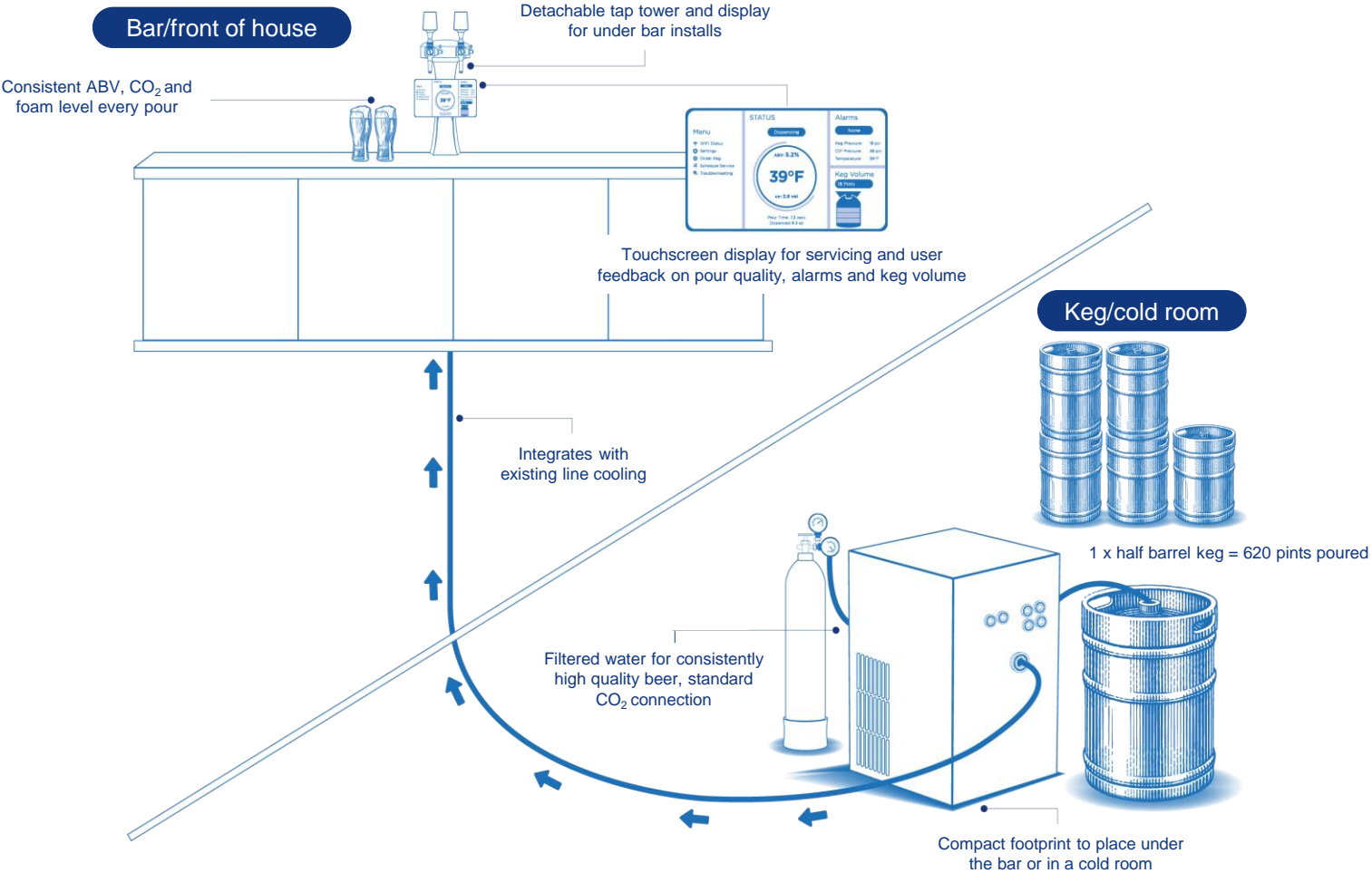
- Alerts staff to change kegs, replace CO<sub>2</sub> or call for service
- Recognizes issues with the machine or inputs
- Helps prevent off-spec pouring



## Connectivity-as-a-Service

- Remote monitoring and logging ensures:
- Each pour is in spec
  - Cleaning on track
  - Usage analytics available to the brewer or manufacturer

# Alfa Laval Revos draft dispense cellar



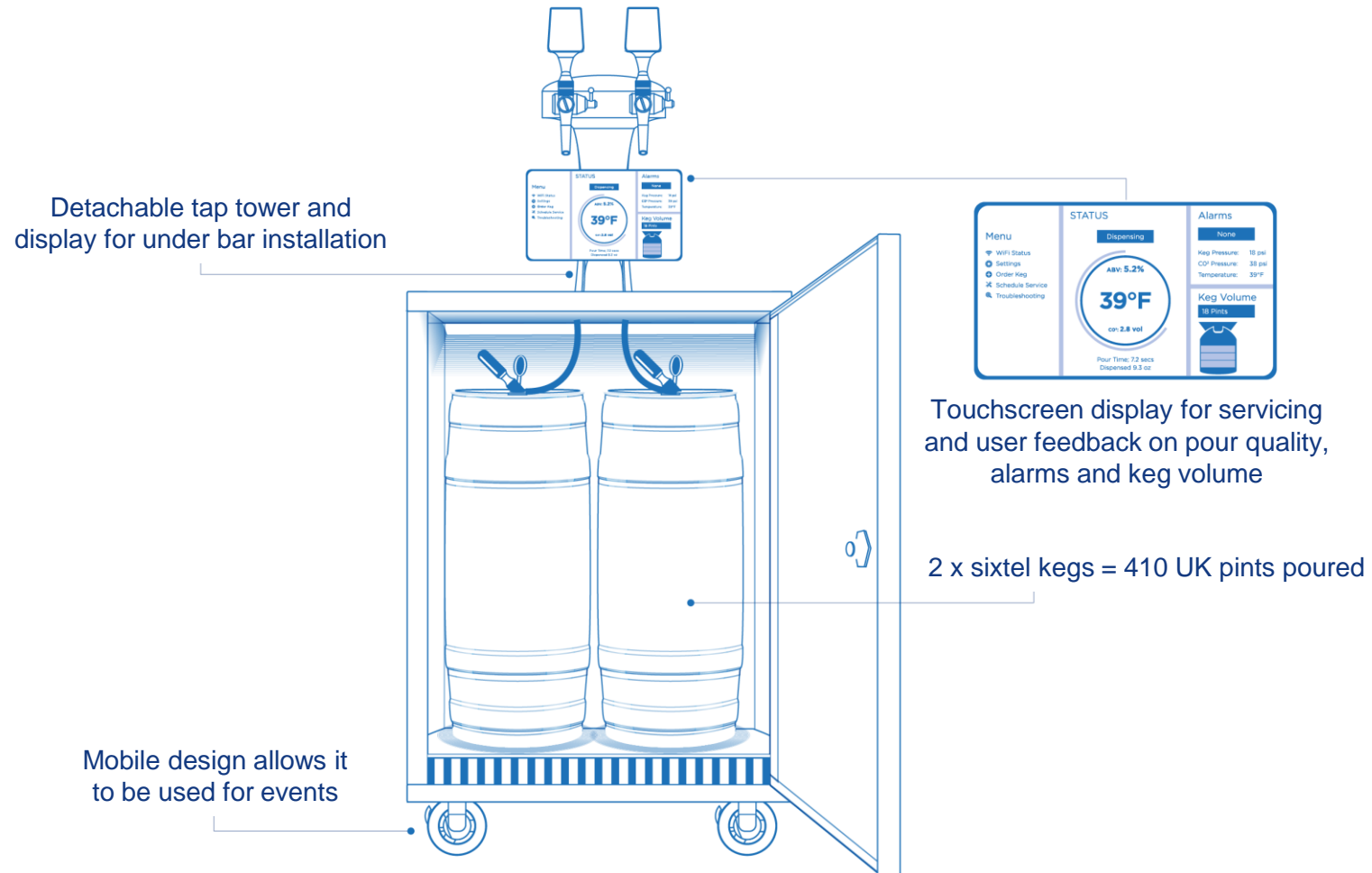
# Alfa Laval Revos draft dispense cellar

– For large volume applications



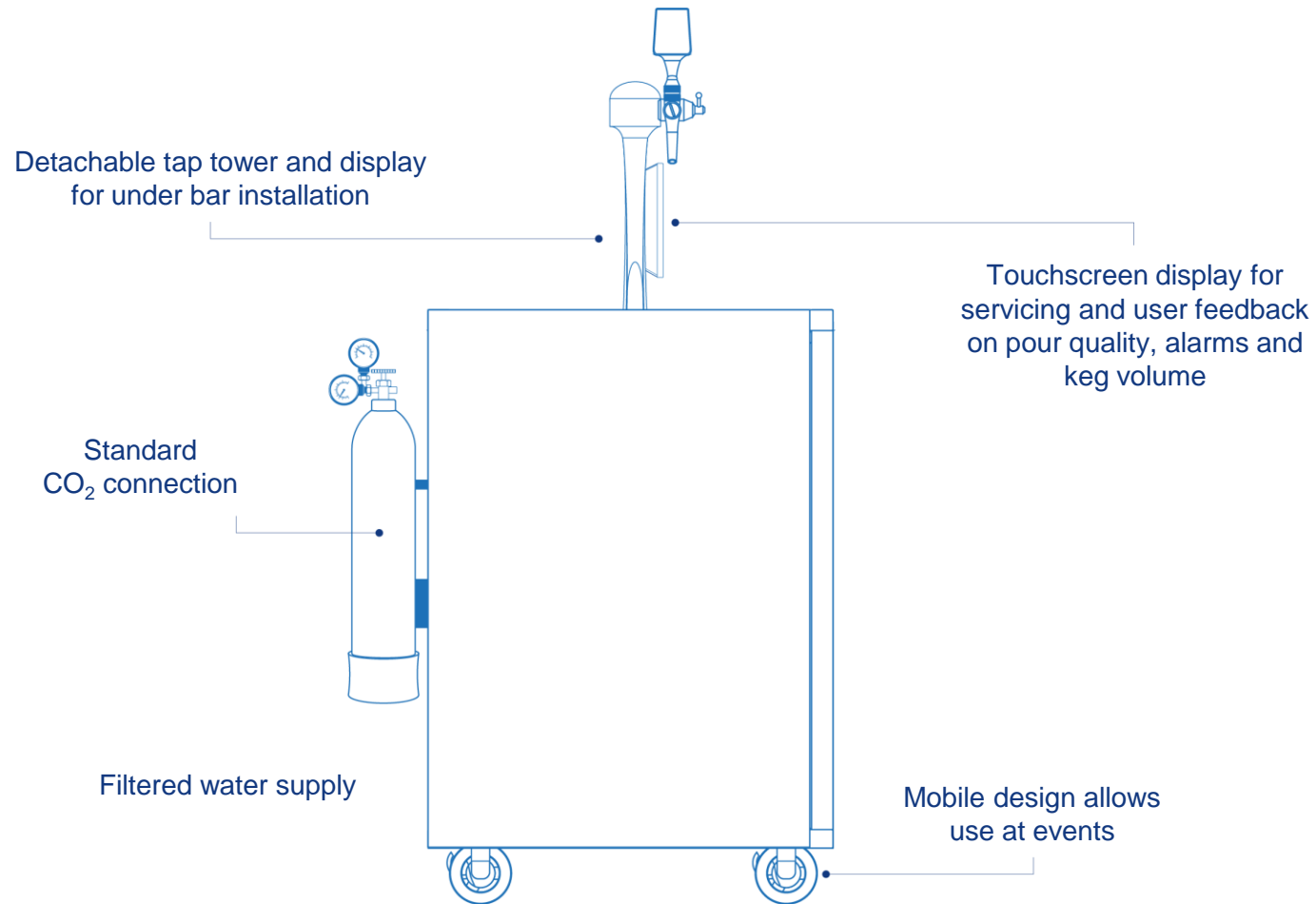
Specification		Notes
Number of brands/taps	4 brands/6 taps	
Python length served	30 metres (98.4 feet)	Without additional pump
Installation location	In cellar or adjacent to cellar	<12°C (<53.6°F) environment
Additional cooling	Trace cooling of concentrate and draft link	No cooling for main draft line
In spec pour capacity (per hr)	300 UK pints/360 US pints	20°C (68°F) feedwater, <6°C (42.8°F) pour
Flow rate per tap	Single tap 2.15 lpm (1.25 oz/s) Double tap 3.40 lpm (2.0 oz/s)	
Blend ratio precision	± 2%	
CO <sub>2</sub> precision	± 0.15 v/v	
Water treatment	External: Carbon filtration (5 µm) Internal: Ultraviolet (UV) sterilization	5 µm carbon filter not included
Gas type	Food grade CO <sub>2</sub>	
User interface	7" touchscreen display	User/technician interface
Alarms	Feedback and shut off valve	Prevent out of spec pours

# Alfa Laval Revos draft dispense mobile





# Alfa Laval Revos draft dispense mobile



# Alfa Laval Revos draft dispense mobile

– For lower volume mobile applications



Specification		Notes
Number of brands/taps	1 to 2 brands/2 taps	
Maximum draw length	N/A	Integrated tap
Installation location	Mobile	Integrated wheels
Additional cooling capability	Full cooling of concentrate and beer	Refrigerated air cooling
In spec pour capacity (per hr)	100 UK pints/120 US pints	20°C (68°F) feedwater, <6°C (42.8°F) pour
Tap flow rate	Single tap: 2.1 to 3.5 lpm (1.2 to 2.0 oz/s) Double tap: 2.1 to 3.5 lpm (1.2 to 2.0 oz/s) → 2.1 lpm (1.2 oz/s) simultaneous	Adjustable to brand/regional preference
Blend ratio precision	± 2%	
CO <sub>2</sub> precision	± 0.15 v/v	
Water treatment	External: Carbon filtration Internal: UV sterilization	5 µm carbon filter (not included)
Concentrate supply	Up to three 1/6-barrel keg or one 1/2-barrel keg	Internal cooled storage
Gas type	Food grade CO <sub>2</sub>	
User interface	7" touchscreen display	User/technician interface
Alarms	Feedback and shut off valve	Prevent out of spec pours

# Trial offerings for new customers

# Alfa Laval Revos concentration system

– Trial offerings for new customers



## Pilot-scale testing



- Send eight kegs to one of our two sites:
  - Woburn, Massachusetts, US – Operational
  - Copenhagen, Denmark – Opens February 2022
- Visit our sites for a tasting and performance review
- Best for initial sensory and throughput indication
- Ability to concentrate or dealcoholize
- Limitations – higher dissolved oxygen pickup and lower aroma retention than at scale

## Commercial-scale testing



- Revos short-term rental and installation at your site
- Ability to process 6 hl/h
- Best for aging, shelf life and initial market studies

*Quotations available upon request*

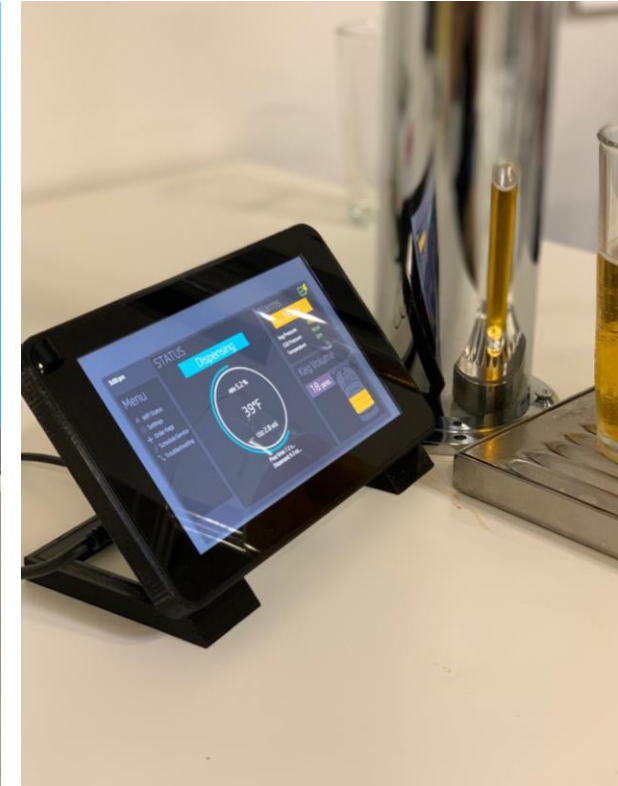
# Alfa Laval Revos draft dispense

– Trial offerings for new customers



## Trial offerings

- *Small 55-lph test unit:*  
Available for rental or testing during Revos trials
- *Commercial prototypes:*  
Available now for pre-order and built to customer requirements



# Early Adopter Programme

# Revos Early Adopter Programme



## Who is an early adopter?

Brewers considering deploying a first commercial Revos system

## Participants receive:

A discount of up to 50% on the purchase of a Revos 30 (30 hl/h) concentration system

## Be first!

Limited to a maximum of three brewers



# Q&As



Please feel free to contact:



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+353 722 7428



Visit our web page for more information

# Appendices

# Alfa Laval Revos draft dispense test unit

– Functional design



Specification		Notes
Number of brands/taps	1 brand/1 to 2 taps	
Maximum draw length	10 metres (32.8 feet)	Without additional pump
Installation location	In cold room/cellar	<12°C (<53.6°F) environment
Additional cooling capability	Link from keg, main draft line or link to main draft line	Water cooling, up to 5 m (16.4 ft) draw
In spec pour capacity (per hr)	100 UK pints/120 US pints	15°C (59°F) feedwater, < 6°C (42.8°F) pour
Tap flow rate	Single tap: 2.1 to 3.5 lpm (1.2 to 2.0 oz/s) Double tap: 2.1 to 3.5 lpm (1.2 to 2.0 oz/s) → 2.1 lpm (1.2 oz/s) simultaneous	Adjustable to brand/regional preference
Blend ratio precision	± 2%	
CO <sub>2</sub> precision	± 0.15 v/v	
Water treatment	External: Carbon filtration Internal: UV sterilization	5 µm carbon filter (not included)
Gas type	Food grade CO <sub>2</sub>	
User interface	7" touchscreen display	User/technician interface
Alarms	Feedback and shut off valve	Prevent out of spec pours

# Alfa Laval Revos draft dispense test unit

– Available for customer trials!



Connections	Notes
Water	3/8" push to connect
Concentrate (via a foam on beer detector)	3/8" push to connect
Beer	3/8" push to connect Max. keg pressure or 30 psi (2 bar)
CO <sub>2</sub> via a gauge at 2.6 bar (00 psi)	3/8" push to connect
Electrical power for dispense unit	60 Hz, 110 V, US plug
Electrical power for display	USB-C cable
Connectivity	Wi-Fi

מחנה  
המנוחה