

Craft Beer and Beyond

Moving from Craft Beer to
Craft Beverage Production



- About GEA
- Hard Seltzer Production – Gregg Norris
 - The Seltzer Market
 - GEA Technologies in Hard Seltzer Production
 - GEA Liquid Jet Mixing
 - GEA Membrane filtration
- Beer Dealcoholization and Blending – Eric Wickler
 - The Alcohol-free Beer Market
 - Dealcoholization Process – GEA Aroma Plus
 - Mix-Blend – GEA DICON
 - GEA ECO-FLASH
- All In One Packaging line – Pierpaolo Mattana
 - Market Need
 - Technology
 - Benefits

Strong local presence around the globe

North America

 1,821

Latin America

 518

North and Central Europe

 3,056

DACH & Eastern Europe


 6,765

Asia Pacific

 3,049

Western Europe, Middle East & Africa

 3,434

 GEA locations worldwide
(sales offices, service branch,
workshops, or other GEA sites)

 18,000 Employees

 Revenue 5 Billion in 2019

Our applications – in touch with GEA every day

Dairy Farming and Processing



Approx. one
quarter of
processed milk
comes from
GEA production
systems

Food



Every third
chicken
nugget is
produced
using GEA
technology



Approx. every
third process
line for instant
coffee was
installed by
GEA

Brewery & Beverages



Approx. every
second liter
of beer is
brewed with the
aid of systems
and process
solutions from
GEA

Pharma



Every fourth
liter of human
blood for
making
plasma-derived
products is
processed
using GEA
equipment

Chemical



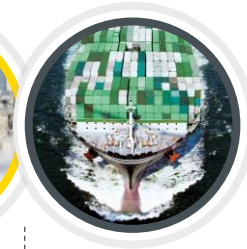
More than one
third of all
polymer
producers
are using
GEA drying
technology

Utilities



Each industry
we serve
utilizes
industrial
refrigeration
technology
from GEA

Marine



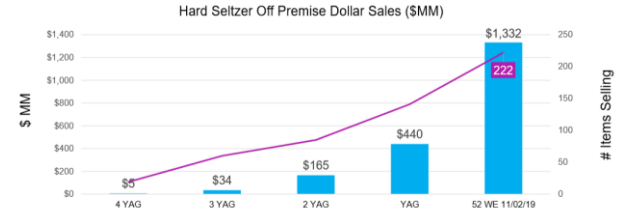
Every second
container ship
in the world
sails with
GEA marine
equipment on
board

Hard Seltzer

- Seltzer beer market drivers
 - Health conscious consumers – low calorie content
 - Regular “Water” market boom
 - Unlimited flavor options – todays consumer loves choices
 - Fashionable trade up from light beer
 - Tax relief from ethanol based products, ie canned cocktails
 - High profit potential for brewer

- Seltzer beer market trend
 - Outperforming total beer
 - Estimated that the US consumer market was shorted by tens of millions of CE’s in 2019
 - **Alcoholic seltzer held 2.6% volume share of the US alcohol beverage market in 2019 up from 0.85% in 2018**
 - Source: IWSR

HARD SELTZERS TO REACH \$1.5 BILLION THIS YEAR



Hard Seltzers generated \$1 billion with only 200 items on shelf!!

Source: Nielsen Off Premise All Outlet Scan; 52 weeks ending 11/02/19

HOW DOES THAT COMPARE?



Source: Nielsen Off Premise Scan All Outlet; 52 weeks ending 11/02/19

Why Craft Brewers?

Craft brewers have made a living distinguishing their products from the brewing giants... is this possible with hard seltzer? We are talking water here.

The short answer is yes!

- **Creativity**

- Flavors such as exotic fruits and botanicals have only been slightly explored. Add blends and the possibilities are endless
- Marketing – The opportunity for clever names, logos, and collaborations is infinite
- Draught options, expand your tap room variety
- Wide ABV range is possible

- **Ease of entry into the market**

- Relatively straightforward transition for a traditional craft brewer to produce craft seltzer.
- Cost is manageable while return is high
- Same distribution channels as traditional beer

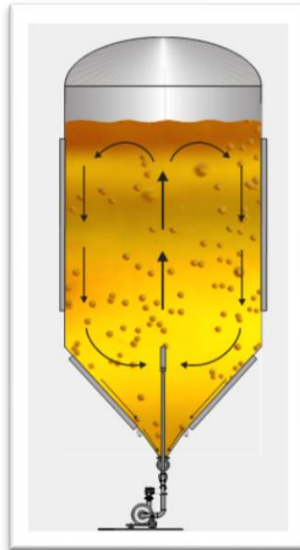
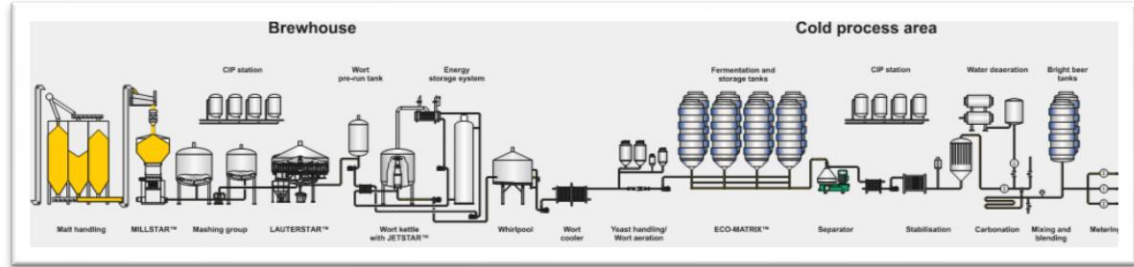


It's not that hard!

Brewing Hard Seltzer – the GEA way

Complete Process Coverage:

- Wort/Base Production
- Wort Aeration
- Yeast Handling
- Fermentation Optimization
- Centrifugation
- Membrane Filtration
- Flavor Blending Solutions
- Carbonation
- Flash Pasteurization
- Filling and packaging



Liquid Jet Mixing

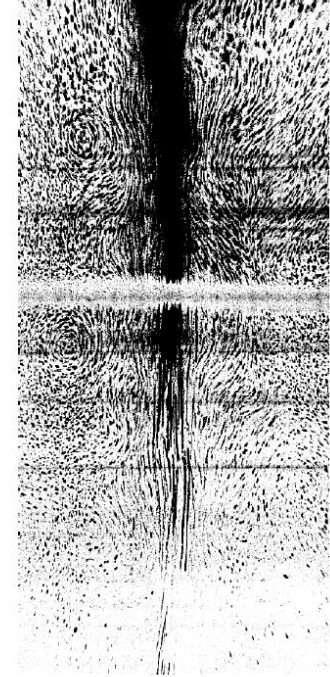
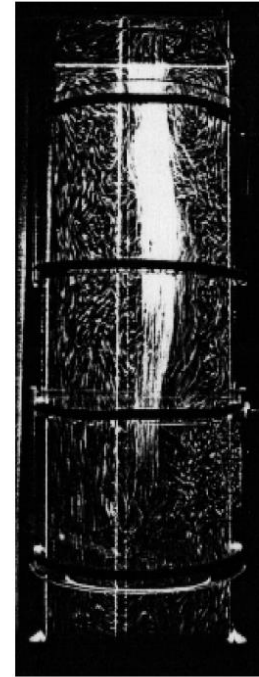
Benefits of GEA jet mixing technology

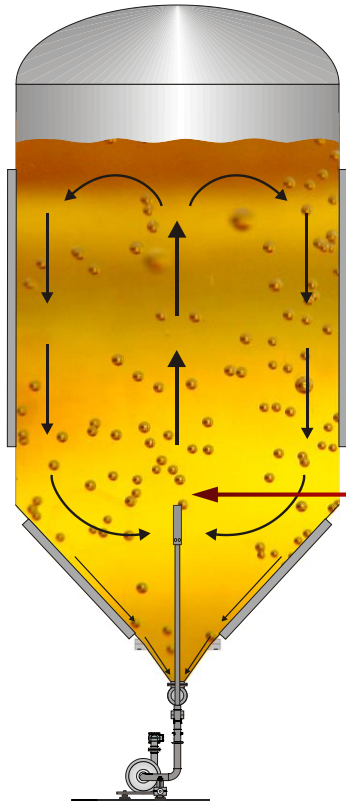
- Increase ABV potential
- Better attenuations
- Improve consistency and control of fermentation
- Reduce time of fermentation, maturation, and cooling
- Homogenization of the batch for easier downstream processing
- Potential for additions
- Real time monitoring possible



Movements due to formation of CO₂

- Denk and Stern visualized and measured the flow in a cylindroconical fermenter caused by rising CO₂ bubbles already in 1979.
- The model of the bubble column was confirmed by Schuch in 1996.
- **How do we optimize this natural phenomenon?**

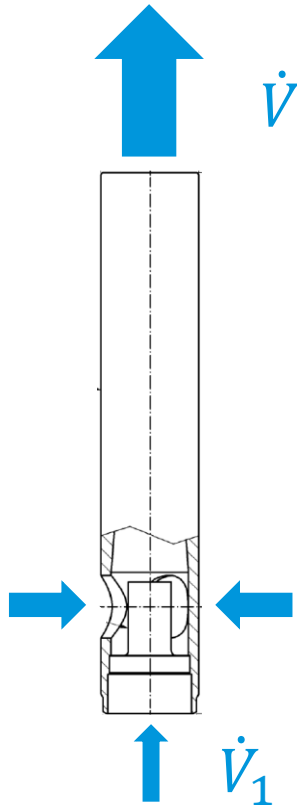




- **Jet mixing** in the tank using a GEA jet mixer driven by a liquid flow
- Jet mixer flow is supplied by a centrifugal pump fed from the tank bottom
- The flow is oriented in the center of the vessel and directed upward; similar to that caused by the formation of CO₂ and natural convection currents
- Inside the tank, the bulk of the mixed liquid is drawn into the jet mixer through its side openings, thus driving flow upward inside the tank
- Due to the special design, only ¼ of the total mixing flow created in the tank has to be supplied via the pump



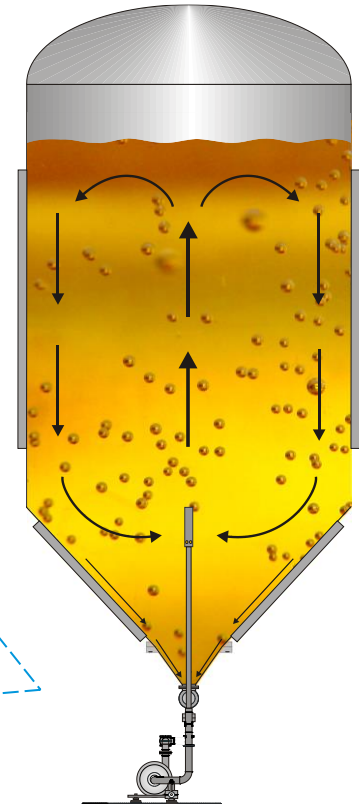
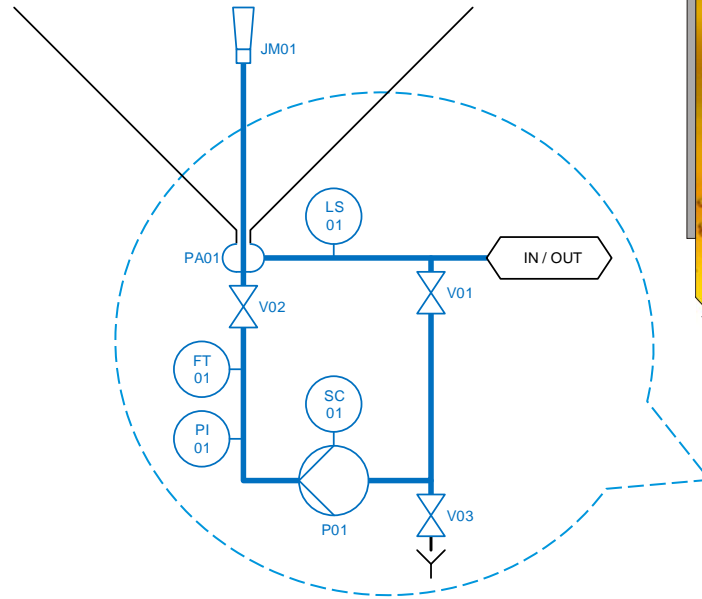
Energy input (example of fermentation application)



- Tank with 2,660 hl net content
- Liquid jet $\dot{V}_F = 80$ hl/h
- Liquid mixture $\dot{V} = 325$ hl/h
- Mixing time $T = 2,660 \text{ hl} / 325 \text{ hl/h} = 8.2 \text{ h}$
- Power consumption of pump: 1.7 kW
- Power consumption: 40.8 kWh per day

At 13.2 cents per kWh, total cost would be \$5.39 per day!

- Jet mixer with lance, vertically installed in tank bottom cone
- Control unit including
 - Speed-controlled circulation pump fed from the tank bottom
 - Protection against dry running
 - Flow measurement
 - Pressure measurement
 - Isolation valves
 - Drain valve
- Special process adapter for lance between tank and control unit



Installation example



Product inlet/outlet

Flow meter

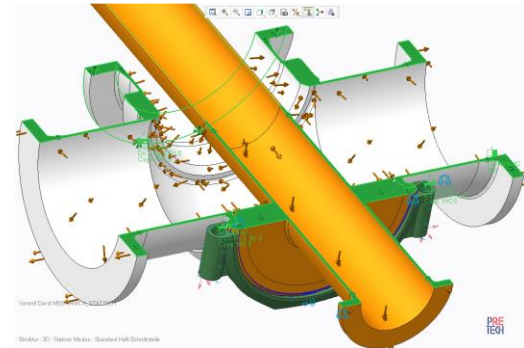
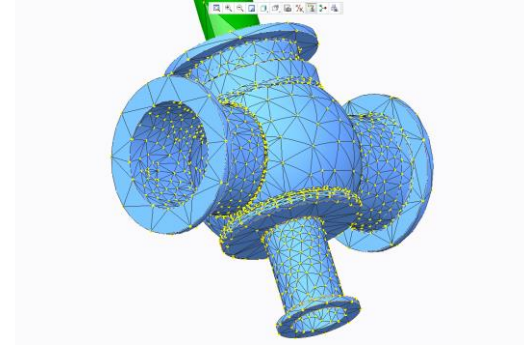
Variable speed pump

Return to Jet mixer

Tank bottom to
recirculation pump

Stress analysis of process adapter

- Insertion length 5,000 mm, extension tube DN 65, jet mixer type 6 – 80
- Static and dynamic loads (finite element analysis)
- Weld between lance pipe and cover plate considered critical
- Assumption of realistic operating conditions
 - Weld R = 2 mm (weld root depth = 1.4 mm)
 - Vertical misalignment of lance pipe (e.g. installation error) $\leq 5^\circ$
 - Pulsation caused by gas bubbles in fluid ($\leq 10\%$)
- Conclusions:
 - System withstands all static loads
 - Fatigue strength assured



- Consistent total turnaround time of fermenters allows for optimized production scheduling
- Shorter fermentation, maturation and cooling times achievable; total occupation time of tanks have been reduced in many installations
- Increased fermenting capacity possible with the same number of tanks
- Maintain same high beer quality and flavor profile
- Higher degrees of final attenuation achievable
- Considerably lower operating costs compared to other concepts due to less energy consumption

Membrane Filtration

GEA is a world-leader in membrane filtration technology for the beverage, brewery, food, vegetable/fruit juice and dairy industries.

- 1,000+ systems sold over 30+ years
- Process and process waste streams
 - GEA's membrane filtration technology began in the dairy industry but has grown dramatically as membrane technologies and new applications were developed.
 - Brewery now has most activity in North America!



Neutral Base (NB)

- Neutral Base (NB) is an alcohol – water mix derived from beer / fermented sugar solution
- NB is used to produce Flavored Alcoholic Beverages (FAB) by adding flavors, sweeteners, color etc.
- In many countries NB is a favored raw material for making FABs compared to grain alcohol due to its very low taxation level.
- Fermented products can have a strong influence on a beverage's flavor and can make FAB formulation a challenge.
- The key is to produce a base beer within the legal definition, but with virtually no flavor, aroma and color.
- GEA Membrane Filtration offers a simple economic process to produce NB.



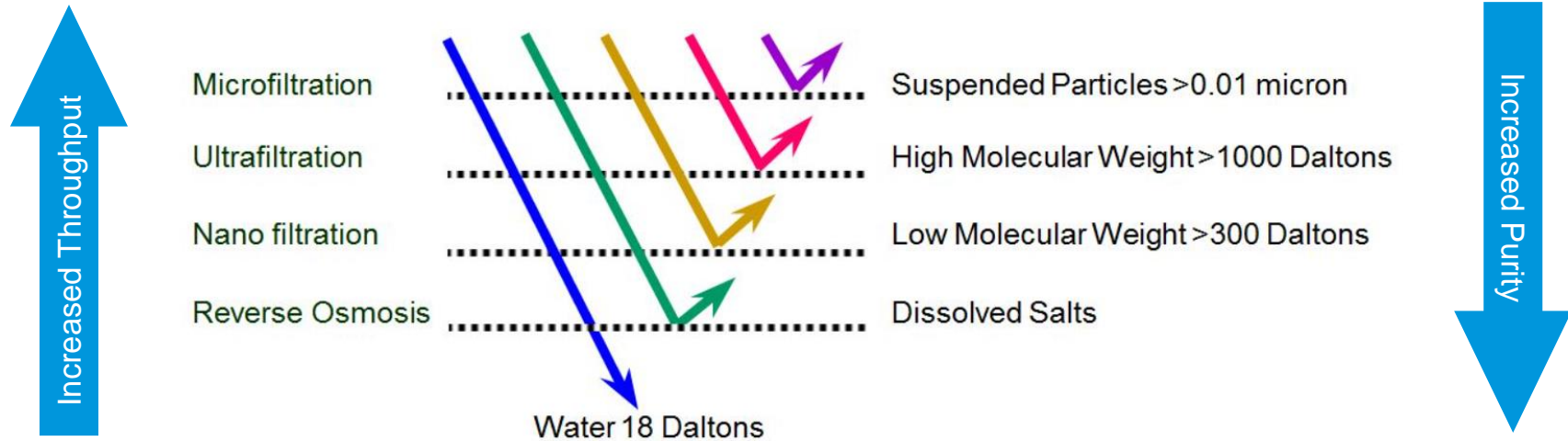
Membrane definition:

- A **membrane** is a barrier to mass movement that allows restricted or regulated passage of one or more elements through it.

Goals in NB / Seltzer for brewers

- Produce a high alcohol, no color, low to no flavor base
- Produce a base efficiently and consistently
- Maintain brewery level hygiene
- Control operating and maintenance costs
- Make operation seamless and reliable
- Integrate process into existing brewery operation
- Find the right, product specific, solution for each customer

- Membrane filtration types can differ based on requirements.
- The appropriate level of separation is chosen based on a balance of factors such as feed quality, desired cleanliness of base, and overall production capacity needs.



MF

Categories of Separations

- Removal of Bacteria & Spores with MF
- Fermentation Broth Clarification with MF
- Fractionation of Proteins with MF
- Concentration of Suspended Material with MF and UF
- Clarification of Liquids with UF
- Purification and Concentration of Proteins with UF
- Removal / Concentration of Color Components with UF and NF

UF

NF

RO

- Separation of Components with NF (ex. Salts and Sugars)
- Purification of Low MW organics (alcohols, etc.) with NF and RO
- Concentration of Low MW Components with NF and RO

NB and seltzer

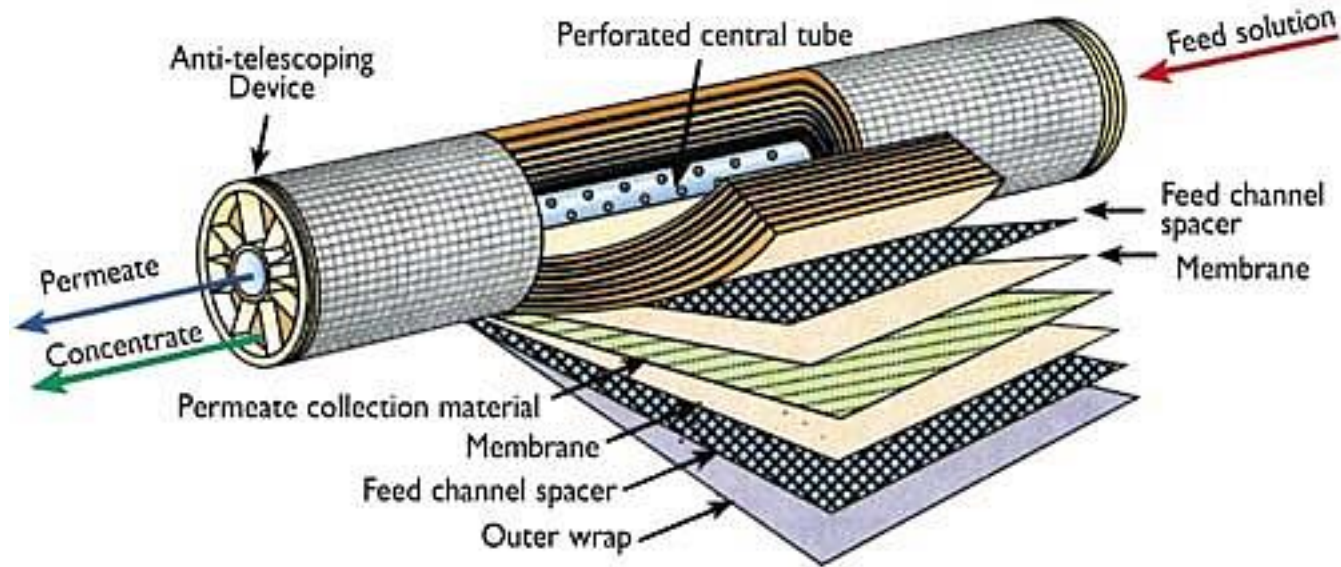
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graph TD; A([NB and seltzer]) --- B[ ]; B --> C[ ]; C --- D[ ]; style C fill:none,stroke:none; style D fill:none,stroke:none;
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Short List of Membrane Materials

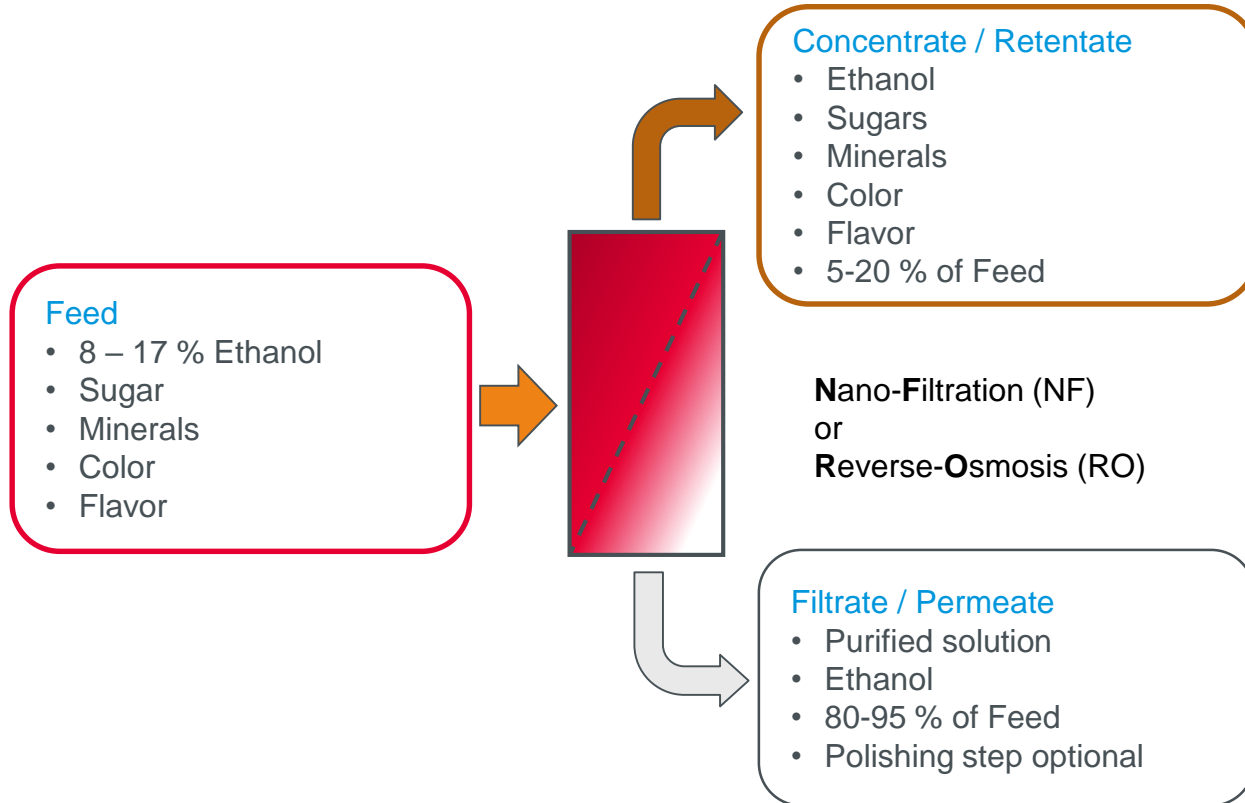
- Inorganic
 - Ceramics MF, UF
 - Stainless Steel MF, UF
- Polymeric
 - Polysulfone (PS) MF, UF
 - Polyethersulfone (PES) MF, UF
 - Polyvinylidene fluoride (PVDF) MF, UF
 - PTFE Fluorocarbon MF
 - PES / PVP Blend MF, UF
 - Cellulose Acetate Blend (CA) RO
 - Sulfonated PES UF, NF
 - Thin Film Composite (TFC) UF, NF, RO
- **More than 150 materials have been used to make membranes**



Anatomy of a Spiral-Wound Membrane Element



Principle Function of NF and/or RO



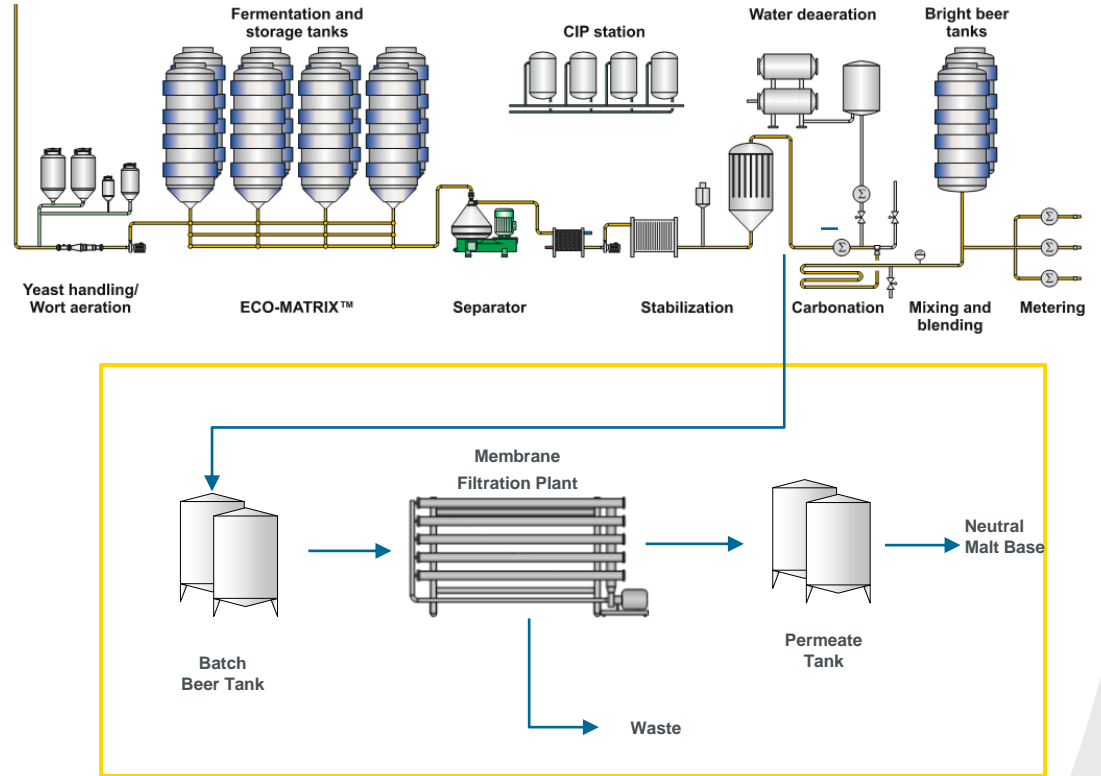
Neutral Base Process



↑
Feed beer

↑
NB

↑
Concentrate



- GEA is recognized as one of the world's leaders in this technology
- Installed first systems in 2005
- Over 30 commercial systems operational for NB production



Typical Plant Design



Model R Pilot Plant

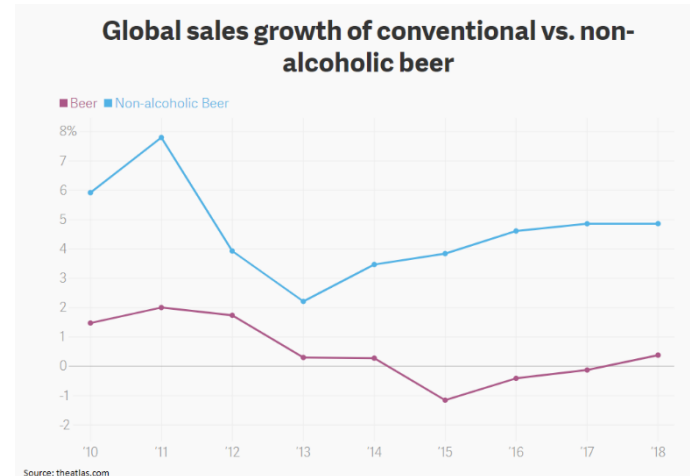
- Proof of concept
- Membrane comparisons
- Process optimization

GEA engineers have vast experience to assist our new and returning customers through the process of making hard seltzer base.



Beer De-alcoholization

- De-alcoholized beer market drivers
 - Health conscious consumers
 - Lower calorie
 - Little/No alcohol
 - Non Alcoholic beverage alternative (i.e. soft drinks)
 - Pregnant woman and nursing mothers
 - People who abstain for other reasons
 - New technologies create opportunities for Better Beer!
- De-alcoholized beer market trend
 - Consistently outperforming total beer
 - Year after year growth
 - Europe has majority of market share
 - Compound Annual Growth Rate ~7.5%
 - Huge opportunity for North America Market



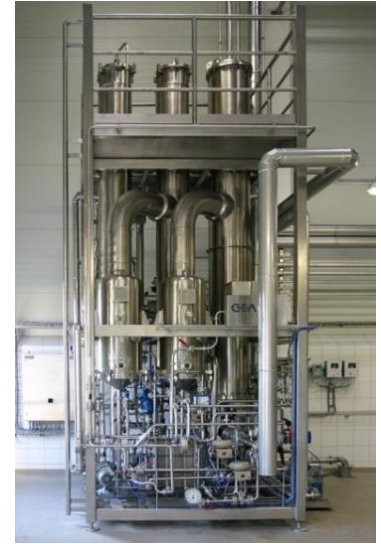
Biological Methods (stopped fermentation, specialized yeasts, ...)



Membrane Filtration (Crossflow Filtration)



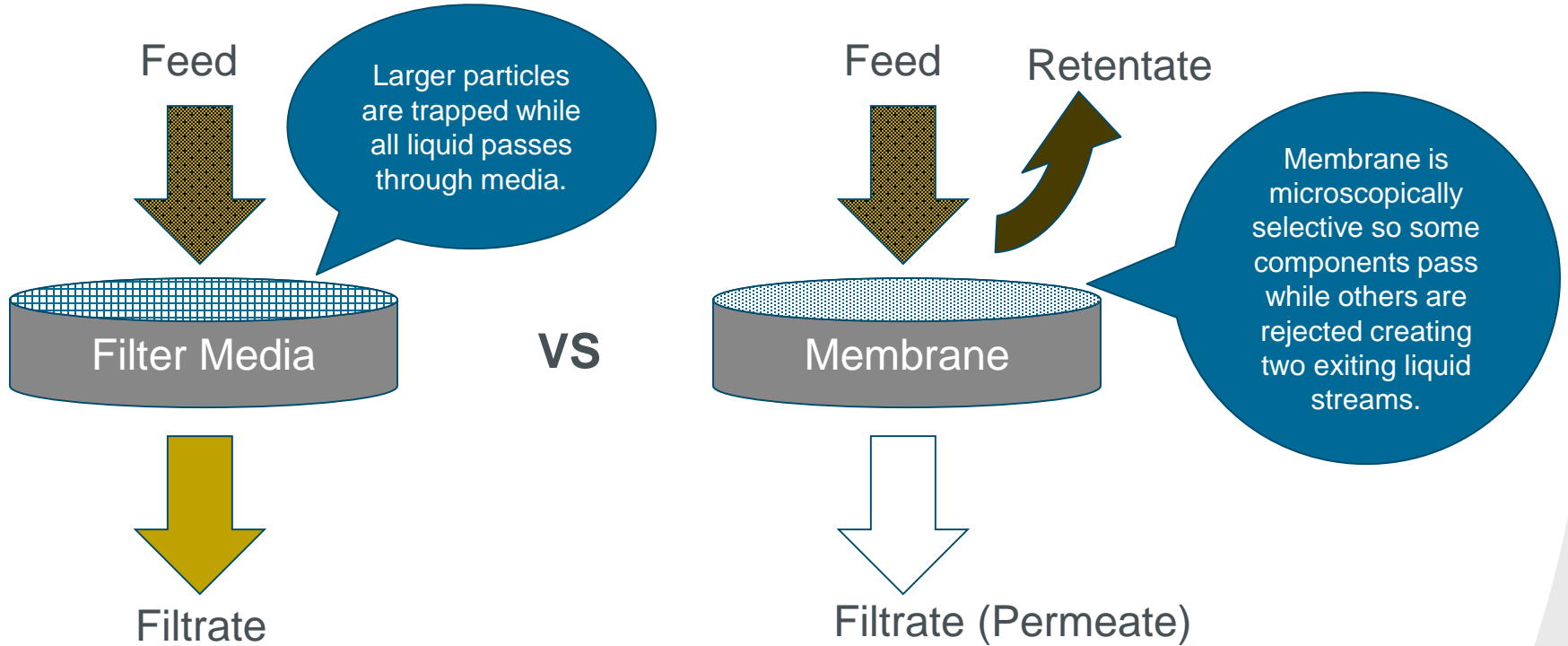
Thermal Processes (Vacuum Evaporation / Distillation)



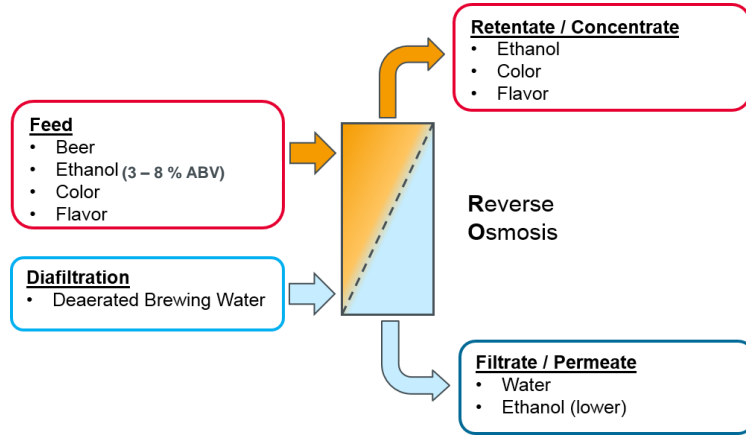
*All Technologies available from GEA

Cross Flow Filtration Principle

Traditional vs Cross-flow



Principle Membrane De-alcoholisation

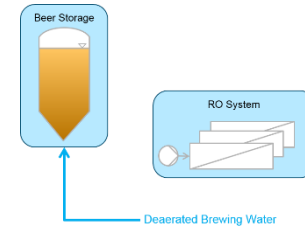
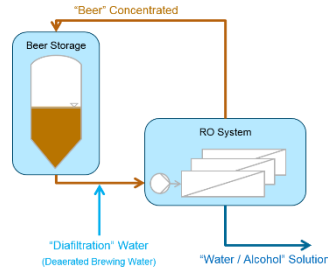
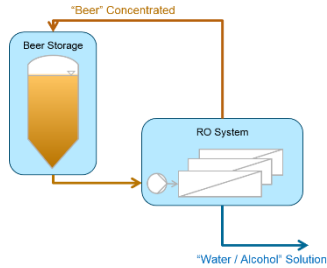
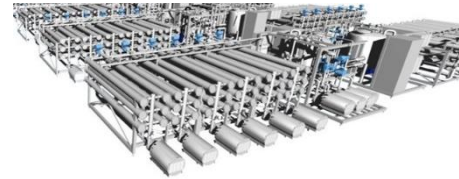


BATCH OPERATION

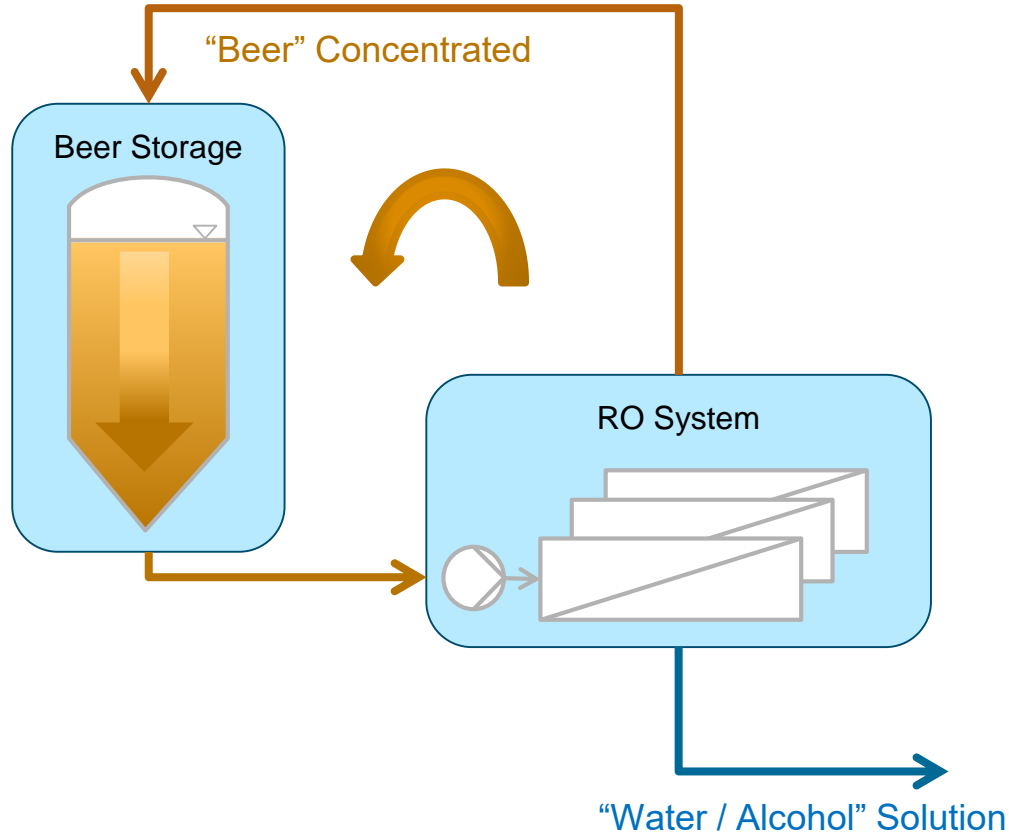
- Up to 650 hL/day. LOW-ALCOHOLIC 0.05% - 0.5% ABV

CONTINUOUS OPERATION

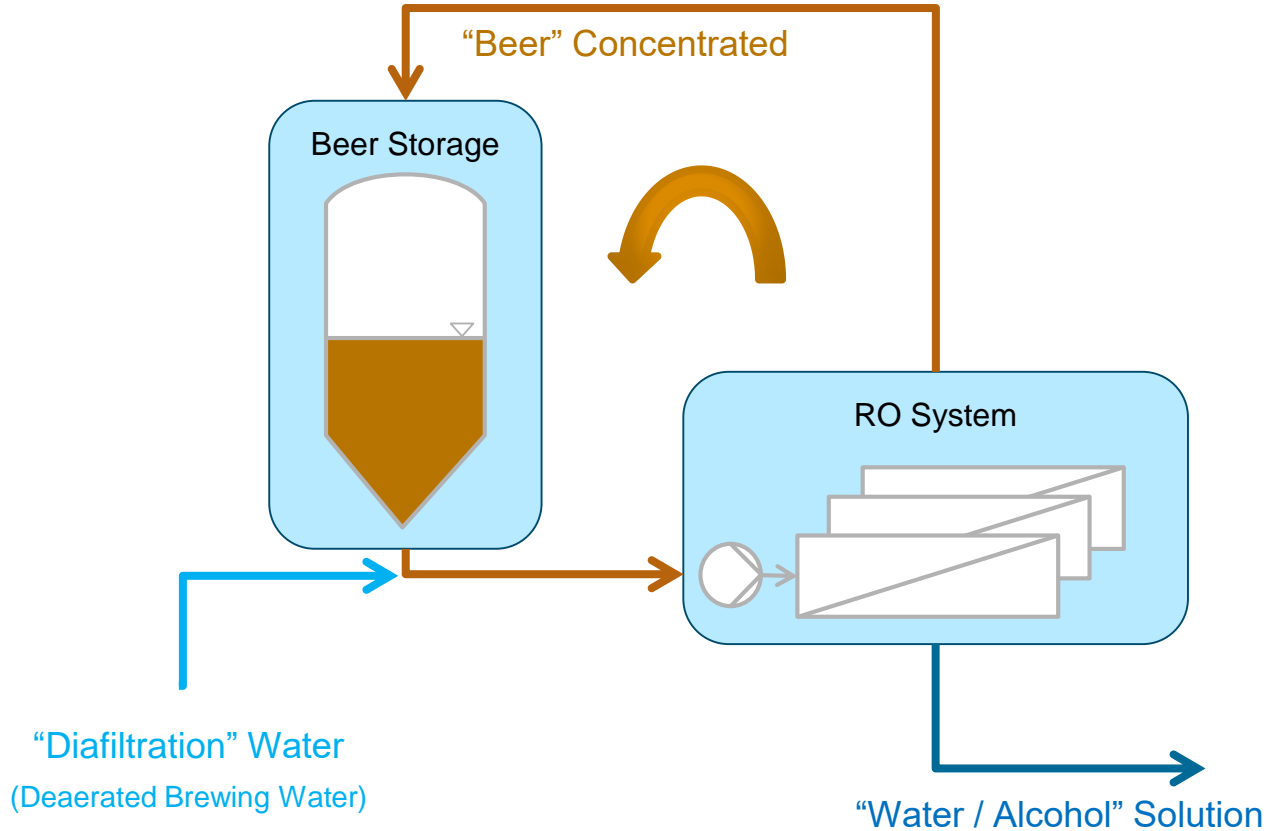
- 20-200 hl/hr, NON-ALCOHOLIC BEER 0.5% ABV



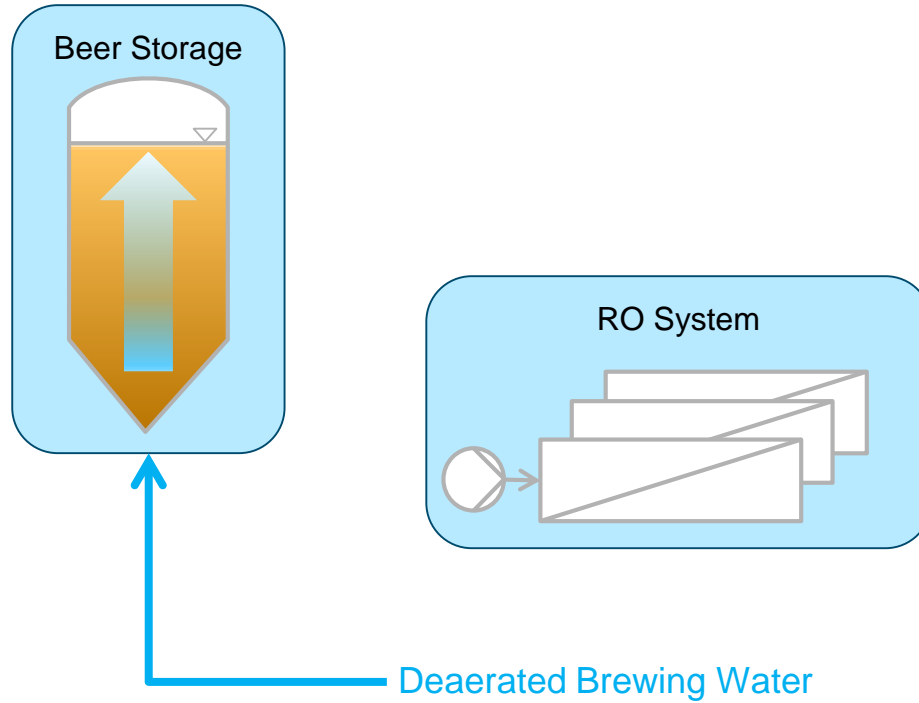
Operation Step 1 “Pre-Concentration”



Operation Step 2 “Diafiltration”



Operation Step 3 “Blending”

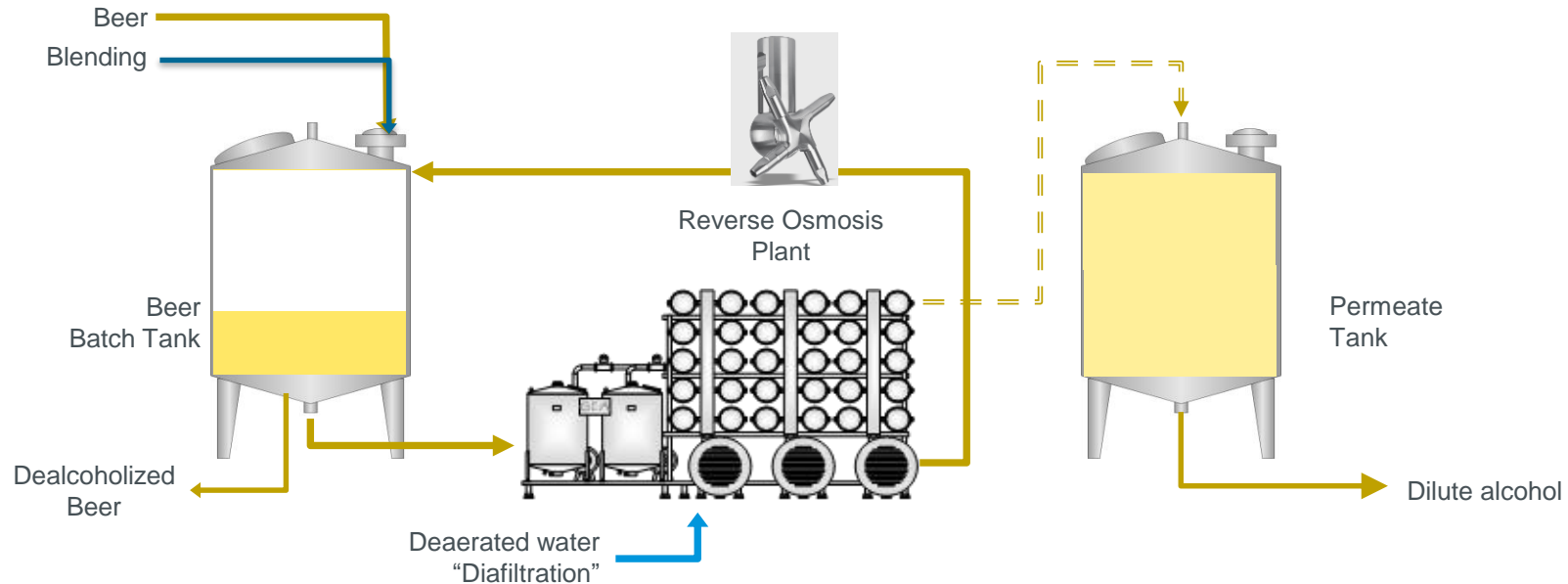


De-alcoholization of beer - Batch plant operation

1. Fill Batch tank
2. Start Process
3. Pre-Concentration
4. Diafiltration (washing out the alcohol)
5. Water Blending after batch end
6. Dealcoholized beer discharge to carbonization, pasteurization, filling

7. CIP cleaning of system (Tanks & Pipes with Brewery CIP)

- Special membrane cleaning program
- Sanitation: cold / chemical (<math>< 50^{\circ}\text{C}</math>)
- Membrane storage: ≥ 24 hrs down



Membrane Dealcoholization

Batch operation (50-500 hls per 24hrs with CIP)



Conveniently sized for Craft Brewers!



Cross Flow Filtration



Distillation



Processing temperature	Cold ($\leq 10^{\circ}\text{C}$) – Low/No thermal Impact	High ($\geq 38^{\circ}\text{C}$) – High thermal impact
Aroma losses	Reverse Osmosis - Very low (GEA “AromaPlus”)	Very high - Without “aroma-recovery” Moderate - With “aroma-recovery”
Design	<u>Hygienic design</u> / CIP’able Units modular, built in expansion slots	CIP’able (difficult cleaning with hazy beers) No expansion capability
Footprint	Small (height 4 meters)	Large (especially with respect to height)
Capex	Low	High
Opex	Similar	Similar
Explosion proofing requirements	No (alcohol % is max as high as in mother beer)	Yes (additional cost/administration)
Pre-treatment of beer	No (beer after maturation or filtration ok)	De-Carbonization, removal of yeast
Downstream processing	Blending, Carbonation, Pasteurization	Blending, Carbonation, Pasteurization

*Cross Flow Filtration with “Aroma Plus” technology is GEA’s preferred method for dealcoholizing flavorful and aromatic beers...
ie Craft brewed beers!*

Piloting at GEA - Hudson, WI (example)

Product: Imperial Stout 9.5% ABV

- Permeate (picture right) immediately came out clear, and free of noticeable taste or odor
- EtOH removed in Preconcentration step
- Diafiltration brought EtOH level well below needed level.
- Blended back to original beer gravity with resulting alcohol of 0.25%
- Beer body and character in alcohol free beer remarkably comparable to the original!



Advantages of Membrane Filtration

- High quality beer with retained aroma profile
 - Capable of 0.5% or 0.05% ABV
- Filtered or Unfiltered beers
- Modular design / expandable
- Food grade membranes - FDA approved
- Hygienic design
- Compact, skidded-system with full automation
- Integrated cleaning (CIP)



- Full flavor and aroma retention
 - Flavor, aroma, and color compounds stay in the beer
- Cold processing
 - Gentle on beer – No thermal impact
- Innovations
 - Reduced ABV Beer styles
 - “Session double IPA anyone?”
 - Ingredient additions post alcohol removal
 - Make multiple products from one
 - Purees, extracts, hop resins, botanicals, etc.
- Flexibility
 - Brew the beer you want
 - Decide what ABV you want later





“After we tasted de-alc beer produced with this membrane technology, we didn’t even consider alternatives.”

~ Gary Lohin, Brewmaster, Central City Brewers + Distillers, Vancouver, B.C.

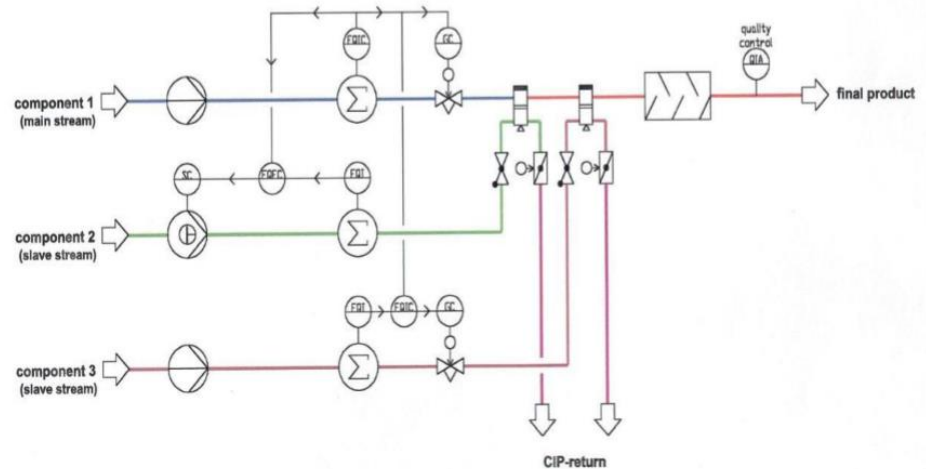
Mix Blend GEA DICON™

- **Technology adapted for many Applications utilizing Continuous In-Line Blending**
 - Soft Drinks
 - Fruit Juices
 - **Beer and beer-mix beverages**
 - Milk products
 - **Alcoholic Drinks**
 - Home and body
 - Chemical
 - Many more



- **Continuous In-Line Blending**

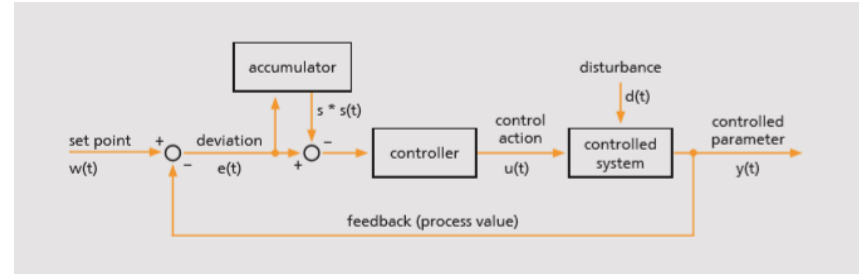
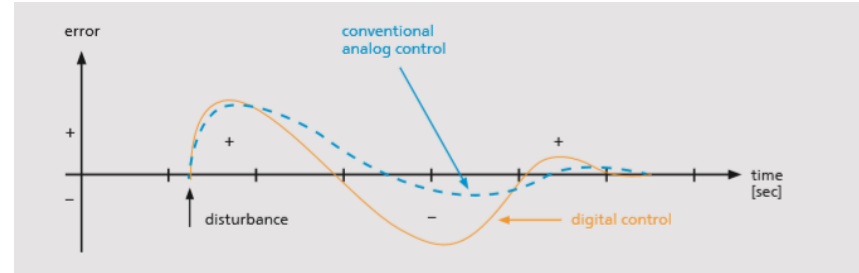
- Liquids are mixed in the pipeline
- Flow of all Components are simultaneous
- The ratio of all components are controlled at all times
- Product Leaving the system is homogenously mixed
- Inline quality analysis to verify ratio control
 - Mass flow meters can be used to control system to ensure more efficient mixing results
- Multiple Component Streams





- **Direct processing of raw products**, that means:
 - Prompt availability of the product
 - Small product stocks in the system
- **Big mixing tanks (and their CIP!) are not necessary**, that means:
 - Low space requirement, possible realization even in small rooms
 - Saving of investments for buildings (air con)
- **Fast reaction to changes in the production plan**
 - Just in time production possible
- **Special automatic start-up and shut-down sequences to avoid product losses**
- **Saving of time and (mixing) energy**
- **Savings in labor cost (process and lab)**
- **Quality control in real time**
- **25 years experience in in-line blending!**

- **Digitally Assured Reproducibility**
 - Digital controllers provide a constant and precise mixing ratio, even when process conditions vary
- **Totally Compensated Control Deviators**
 - Pulse-accurate dosing and digital signal processing ensure perfect mixing results
- **Flexibility**
 - Quick product changeovers
 - Tight tolerances
 - Varying flow ranges
 - Start/Stop functions



Application:

- Avoiding of air in pump housing
- Avoiding of air in the metering equipment caused by hose change-over, empty pipe parts or vortex in tank
- Trapped air effects flow meters negatively uncontrollable, also mass flow meters!
- Automatic flow meter check
 - Volume in lantern (a constant volume) is being compared with flow quantity measurement
 - No production stop during this sequence
- Automatic container change-over
 - No production stop



In-line blending unit for 8 components:

- Beverage water
- Liquid sugar
- 6 concentrates



Flash Pasteurization ECO-FLASH™

Experience

GEA has been successfully involved in hygienic plant design for more than 50 years:

- +300 references for beer pasteurizers worldwide
- +250 references for milk/food pasteurizers worldwide
- Global brewing groups use GEA as auditor for all installed pasteurizers
 - Insured Quality!

Why Pasteurize?

Flash pasteurization is crucial for stable product quality with original taste

- Thermal inactivation of microbiological properties in the product
 - Destruction of microorganisms without harming the product
- Sustained quality of the product is ensured
 - strict hygienic design criteria
 - all-time accurate temperature profile
 - Always keeping a positive pressure difference between pasteurized product and unpasteurized product
- Inactivation of foam-negative proteinases excreted by the yeast
- Increased shelf stability

ECO-FLASH Layout



Product Quality Factors

Precise temperature control ensures:

- Product safety
- Reliable pasteurization effect
- Consistent product quality

Minimized product losses & downtime

- Buffer tank level control integrated with filler speed
- During standby mode: water is recirculated instead of product
 - Maintains product quality and reduces product loss
- Use of on-board sterilization (circulation loop) for heating-up



The GEA solution ensures ideal interaction between the different control loops and can achieve PU accuracy of up to +/- 1!

GEA VIPOLL Filling and Packaging

How are you **filling** today?



About VIPOLL and GEA

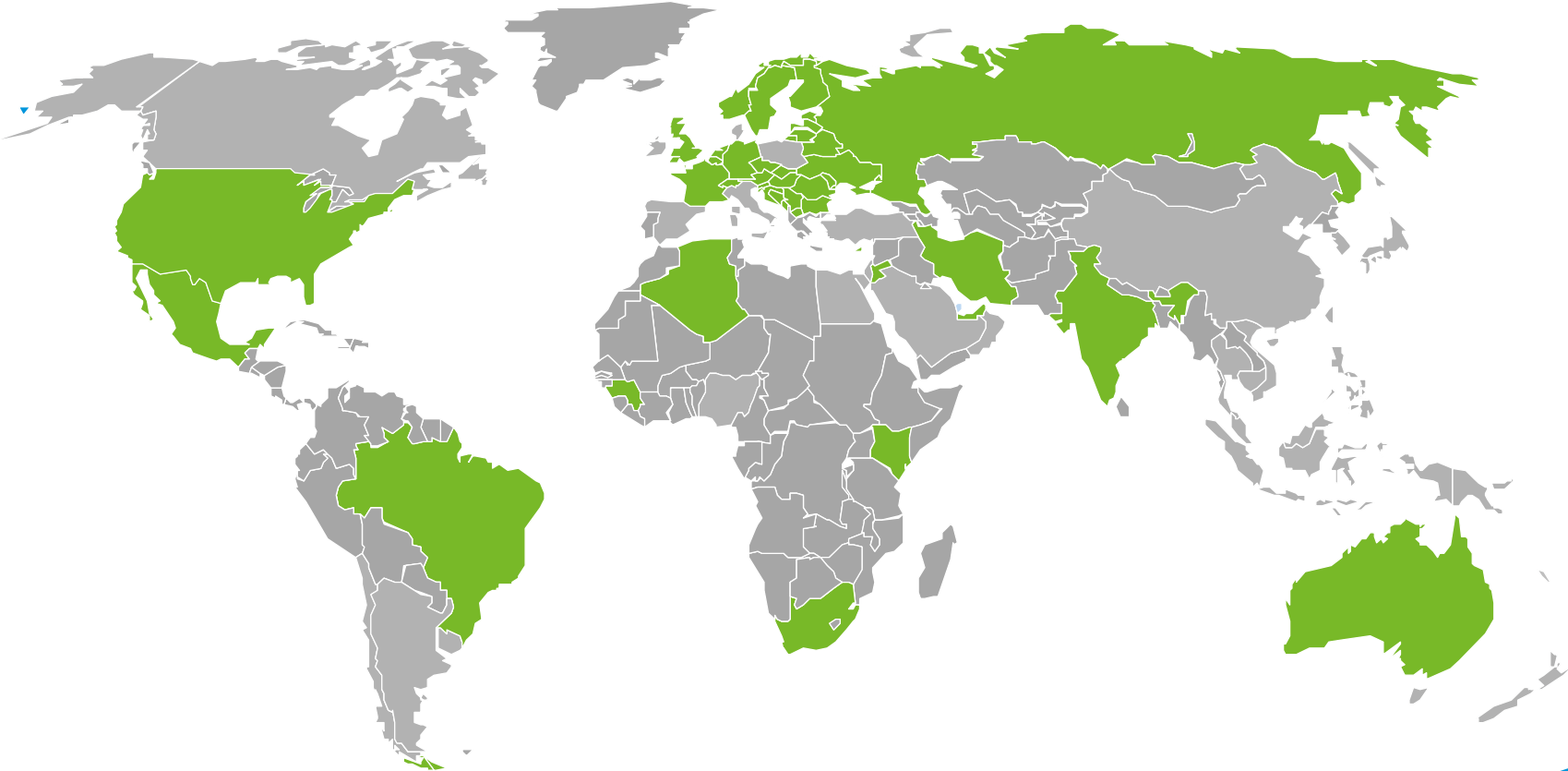
- VIPOLL is a Slovenian based company with expertise in packaging equipment/solutions world wide
 - Est. 1991
- Specialized in equipment for filling beer, non-carbonated and carbonated beverages (hot and cold) in:
 - Cans, Glass, Aluminum bottles, PET
- 2018 - VIPOLL joined GEA Group



Filling lines speed – range of min. / max. capacities:

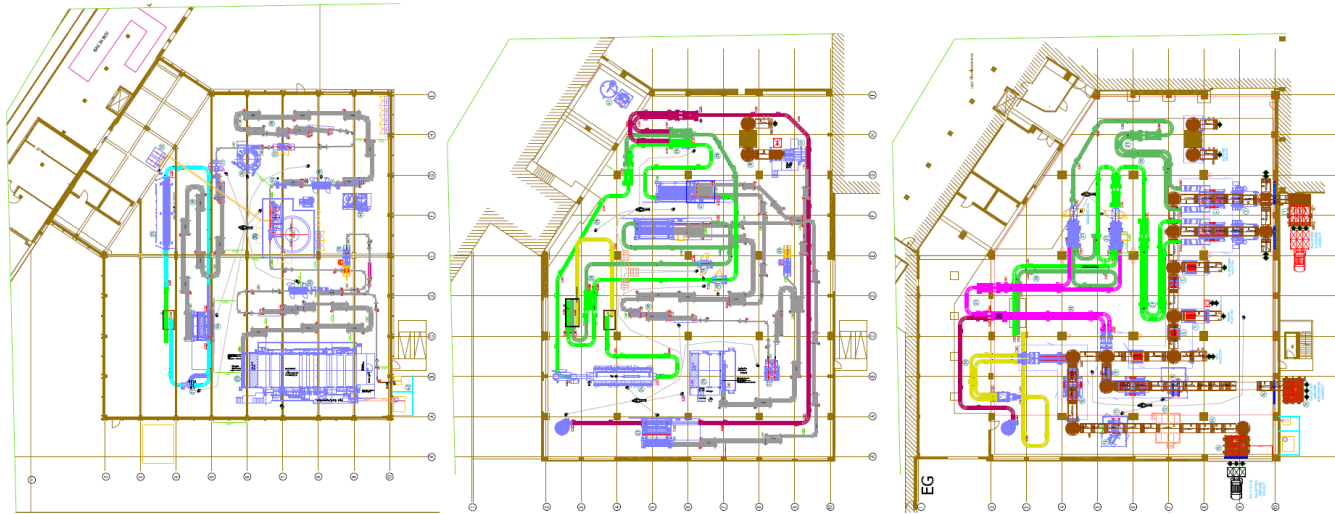
- **Glass line**
 - From 40 bpm up to 750 bpm
 - Starting with 16 filling valves – up to 130 filling valves
- **Can line**
 - From 50 cpm up to 1,000 cpm
 - Starting with 16 filling valves – up to 120 filling valves
- **PET line**
 - From 50 cpm – 500 bpm
 - Starting with 24 filling valves – up to 120 filling valves
- **ALL IN ONE**
 - From 50 cpm – 420 cpm
 - Starting with 16 filling valves – up to 70 filling valves

Installed Base

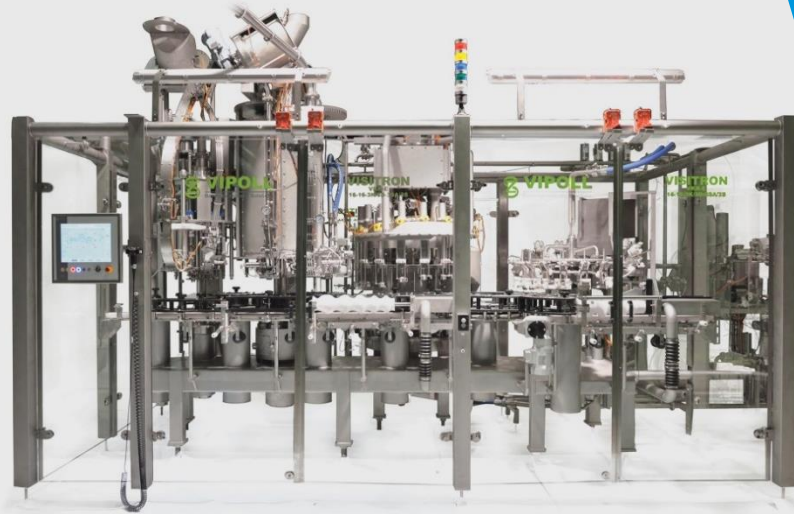


Turnkey Project Approach – Overview

- We pay attention to your needs, offer advice and create the best possible solution for the capacities and beverages of your choice.
- You can choose between machines from our production line or order a **complete turn-key filling line** (in partnership with other established companies).



All In One Filling



Visitron Filler ALL IN ONE

- A flexible and space saving solution for **cans, glass and PET bottles**
- **Speed range:** from 50 cpm up to 420 cpm
- **Can / bottle range:** from 150 ml (5 Oz) up to 3,000 ml (100 Oz)
- Suitable for
 - still and carbonated drinks
 - hot and cold filling
 - beer / CSD / juice / syrup / wine / sparkling wine / spirits
- Excellent choice for **small and medium sized plants or pilot plants**
- Revolutionary fast format change



PET



Glass



Can



Beer



Alcoholic bev.

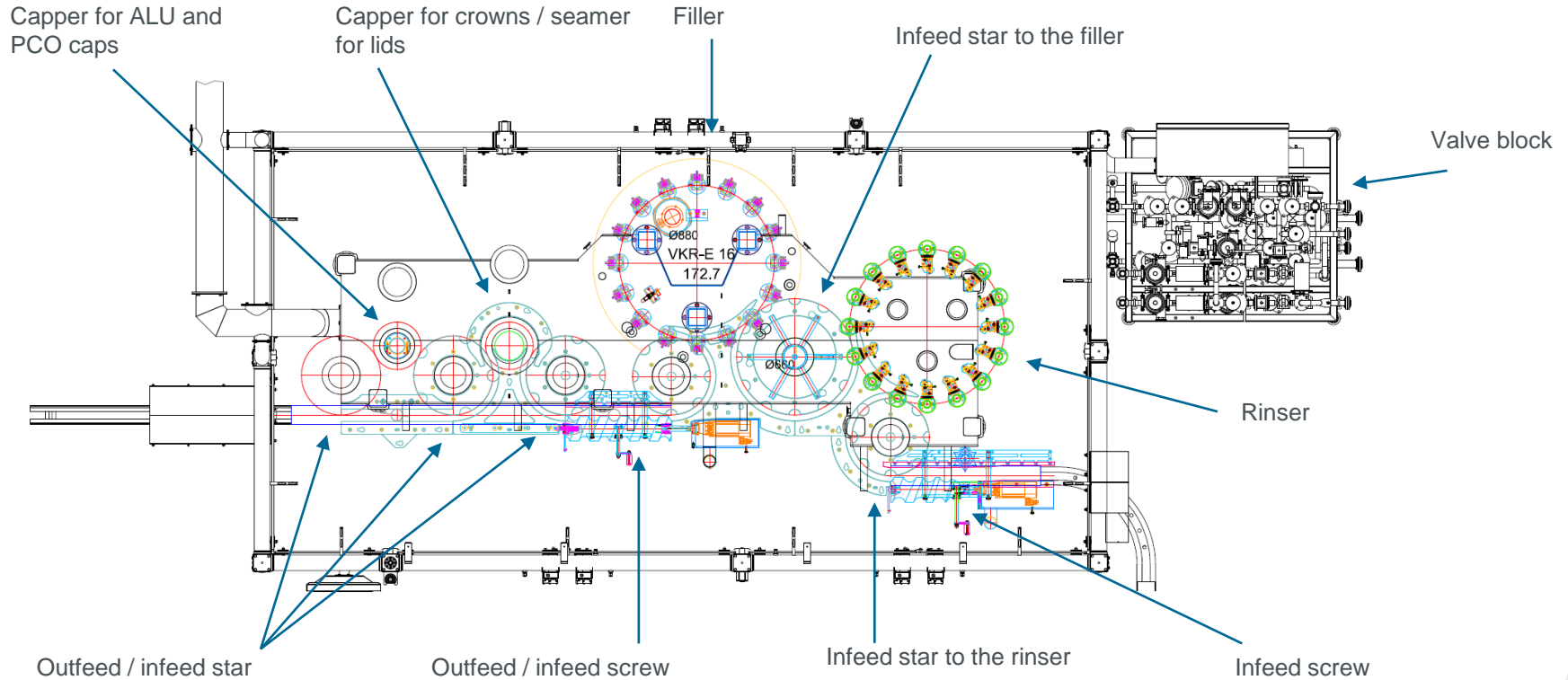


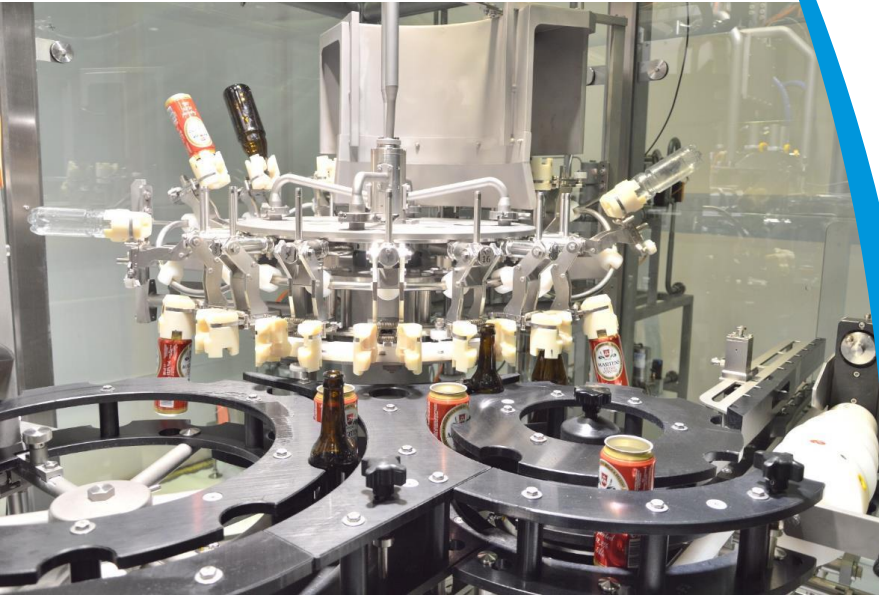
Juice



CSD

Visitron Filler ALL IN ONE layout





INFEED & RINSER

- Low (app. 4 feet) infeed into the rinser/filler/seamer/capper block – the same depalletizer for glass bottles and cans can be used
- **Universal rinser grippers** for glass, cans and PET (no change necessary) with automatic height adjustment
- Designed with **one or two** separate channels allowing the usage of different rinsing media



PET



Glass



Can



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Alcoholic bev.



Juice



CSD



FILLER

- **Volumetrical** filling system or **short** filling tubes
- Filling Valve electro-pneumatically controlled
- Single or double air evacuation for **all containers** (low O₂ pick-up)



PET



Glass



Can



Beer



Alcoholic bev.



Juice



CSD

Filler: designed for extremely fast changeovers

Filler



Changeover parts

- For bottles



- For cans





CAPPING / SEAMING

- Unique capper / seamer combination on a single turret
- Seaming: including **undercover gassing**
- Capping: including **hot water injection**



PET



Glass



Can



Beer



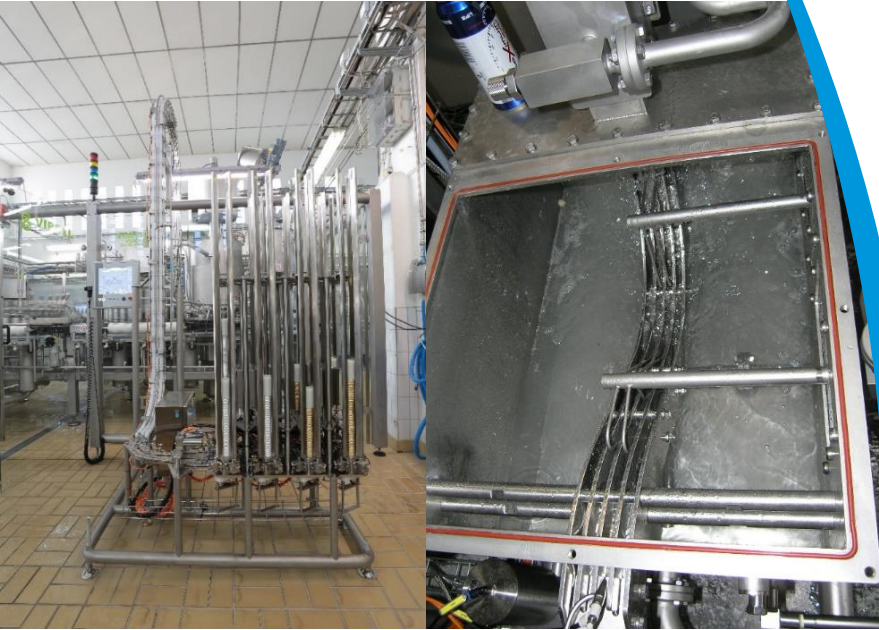
Alcoholic bev.



Juice



CSD



LID SUPPLY SYSTEM

- Automated lid feeding system to the seamer (app. 20 minutes of buffer)
- Possibility of handling different lid types (standard and slim), without adjustment
- Possibility of **lid disinfection!**



PET



Glass



Can



Beer



Alcoholic bev.



Juice



CSD



Alternative seamer execution



- Combination of seaming stations for 2 or 3 different type of lids (eg. slim & standard & king size can)



can



Beer



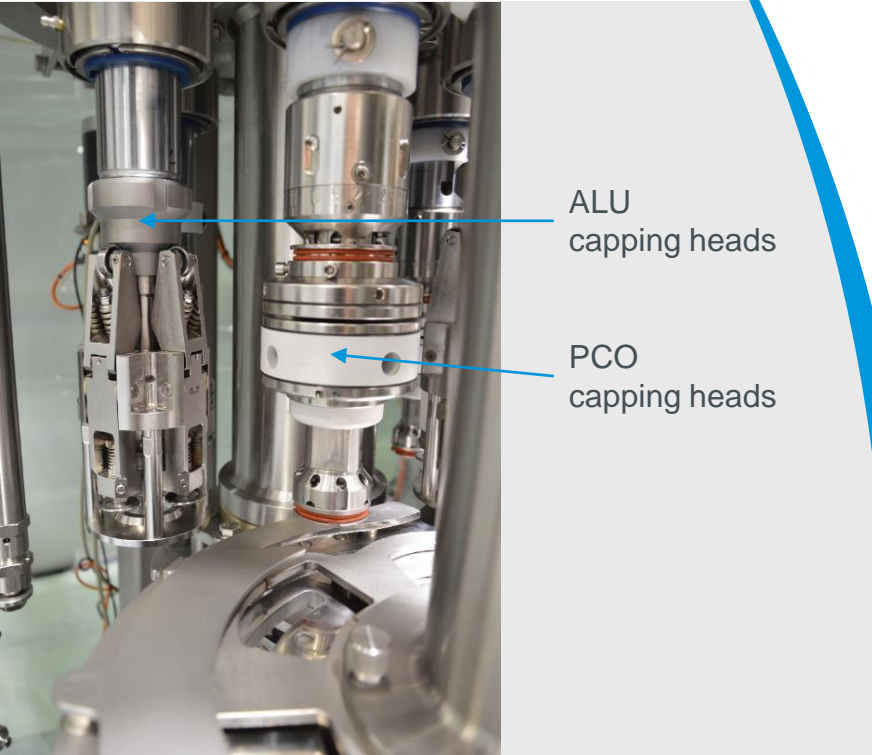
Alcoholic bev.



Juice



CSD



ALU
capping heads

PCO
capping heads

Option: Second capping turret

- Optional second capping turret for:
 - ALU-Screw caps
 - PCO caps



PET



Glass



Can



Beer



Alcoholic bev.



Juice



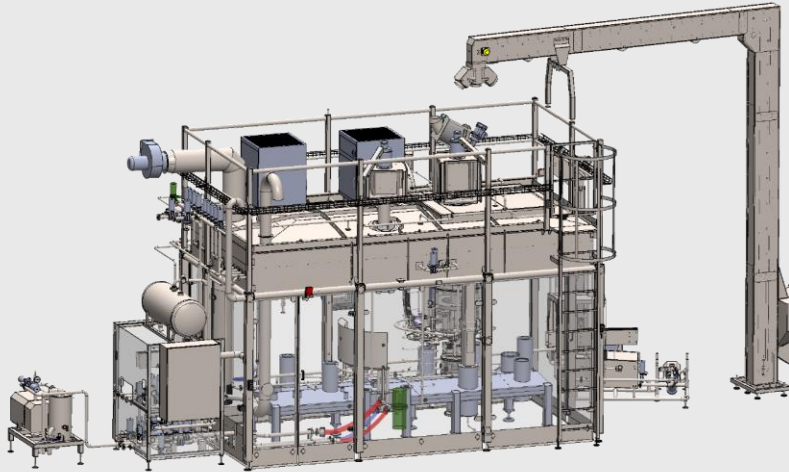
CSD

Possible upgrades

- Ultra clean application with air laminar flow
- LID disinfection



- **Reducing the need for a tunnel pasteurizer**



PET



Glass



Can



Beer



Alcoholic bev.



Juice



CSD

FORMAT CHANGE



20 – 40 min

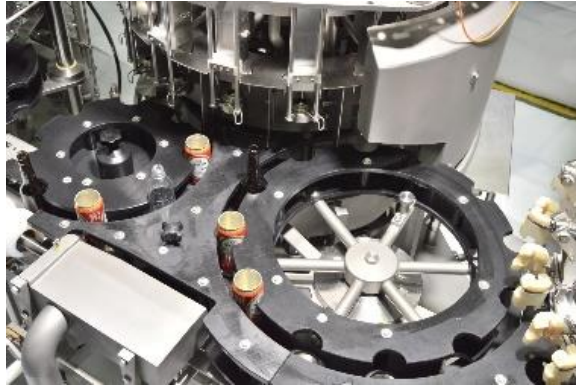
(depending on the machine size
and configuration)

1 operator / tool free



Format change: Can → Glass (part 1)

Change-over
parts



10 - 15 min
(tool-free)

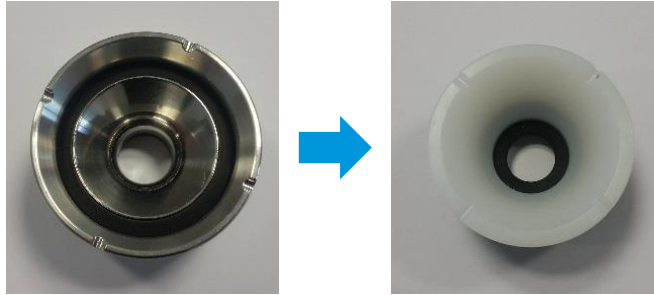
Rinser



Touch panel

Format change: Can → Glass (part 2)

Filler



10 - 25 min

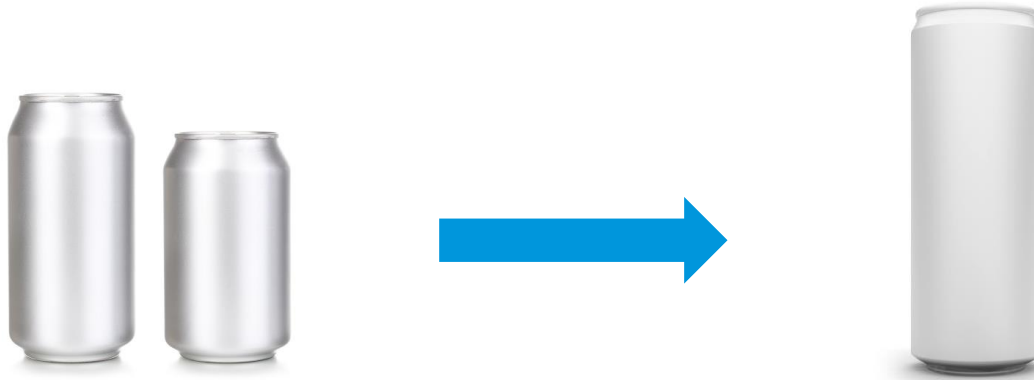
Seamer /
Capper



Touch panel

Alternative seamer execution

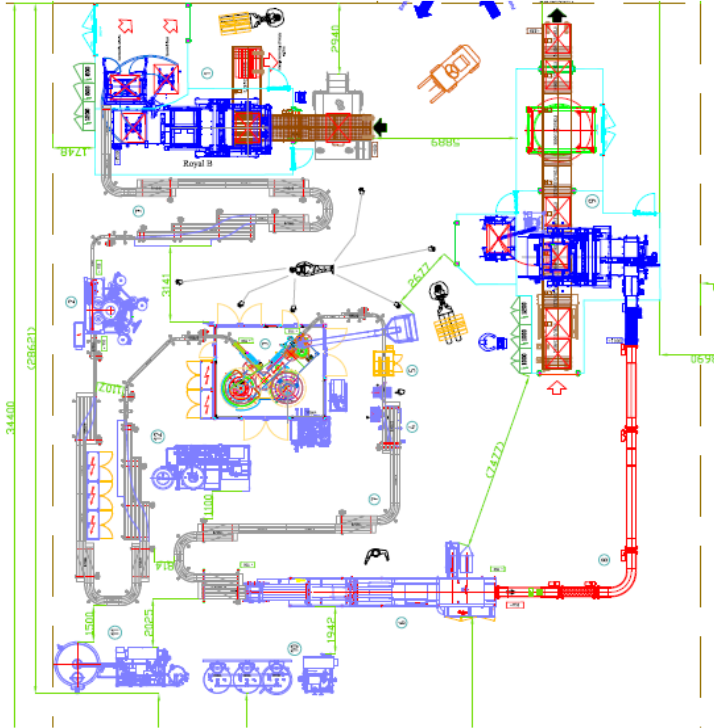
Format change: standard → slim



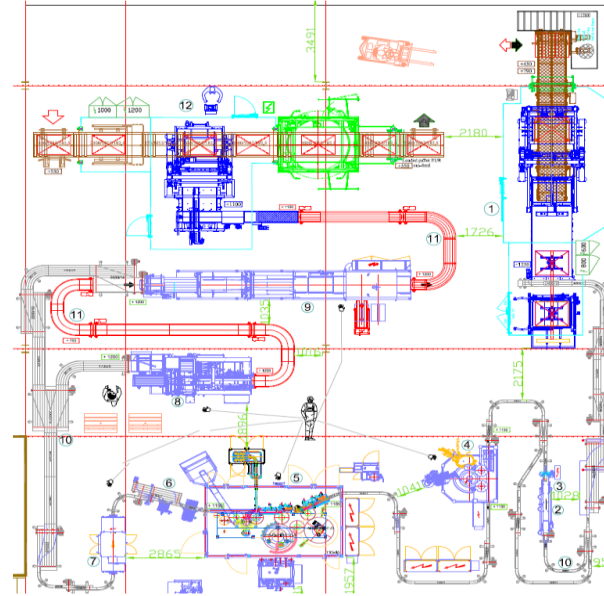
- **ALL IN ONE SYSTEM**
(with alternative combined execution)
- **10 - 40 minutes, 1 operator**
(depending on the machine size and configuration)

Floor requirement: comparison

Glass line



ALL IN ONE line



By processing cans, glass and PET bottles, hot and cold filling, there is **significant savings potential** compared to conventional filling systems with only one type of container:

- Combined can / glass filling line take about **60% less floor space**
 - Lower investment in buildings, lighting, ventilation and energy
- A combined can / glass filling line require a **reduced amount of equipment in the plant**
 - Less time and material for maintenance
 - Reduced stock of spare parts
 - Single line offers higher rate of utilization than multiple lines
- In a few words... **Lower OPEX and CAPEX**



- Since the first presentation at the Drinktec in September 2017, GEA VIPOLL's "ALL-IN-ONE", has been greeted with great success. As one of **the most flexible filling blocks in the market** for cans, glass and PET bottles, GEA Vipoll lines have been delivered all around the globe. The most common application is the can - glass combination.
- March 2019: The ALL-IN-ONE receives two awards from the APPMA Awards of Excellence in Melbourne / AUS: "**Best New Product**" and the "**Imported Equipment Award**".
- Going forward bottlers are expected to focus on **beverage innovations and more flexible production**, making better use of marketing potential through the use of different types of containers.

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a better world