Updated Production of Low-Alcohol Beverages using RO/NF Technology – Smart Solution for Craft Brewers

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11th June 2024

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Presentation Overview

HYDRANAUTICS

1. Why De-alcoholization?
2. What is De-alcoholization?
3. Distillation Vs. Membrane Driven De-alcoholization
4. Membrane De-alcoholization Steps
5. Hydranautics' Solution
6. Smart Solution (not only) for Craft Brewers
7. Summary

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Why dealcoholization

HYDRANAUTICS

Lifestyle

Low alcohol/No Alcohol drink options have also gained popularity among young consumers trying to make positive lifestyle choices and manage their alcohol intake.
Other reasons: Health, Sport, Safety (driving, machine operation), Religion

Sustainability

Some processes to make Low Alcohol/No Alcohol Beverages from alcoholic originals are energy-intensive. Moving away from heat Intensive processes is a Must Have requirement for breweries.

Quality

Maintaining flavor and aroma of the final product to ensure wider audience acceptability is a hurdle that most Low/No alcohol drinks manufacturers are facing today. Conventional technologies produce poor taste (not fully fermented) or are expensive. Fermentation process produces valuable substances including vitamins, so the de-alcoholized drinks are healthier options to soft drinks.

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What is De-Alcoholization?

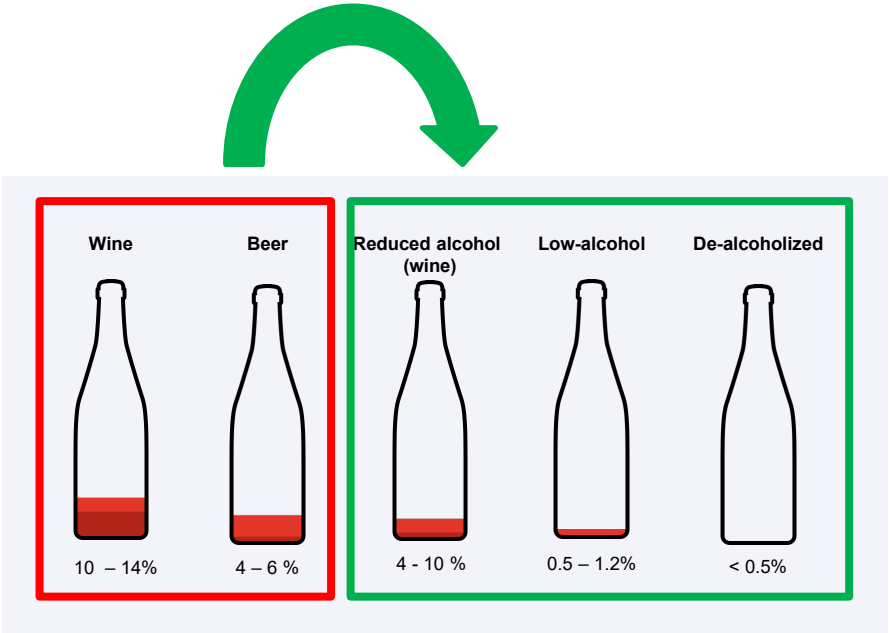
HYDRANAUTICS

The removal of alcohol from an alcoholic beverage: Beer, Wine, Cider etc.

Objective of Membrane Driven De-Alcoholization: Reduce or *Remove Alcohol, but preserve Flavor, Taste and Aroma using RO or NF Membranes.*

The typical targets:

- ***Adjustment of alcohol level in Wine or Beer Alcohol reduction by just few %***
- ***Alcohol reduction to obtain low alcoholic drink***
- ***Full De-Alcoholization to achieve ABV* ≤ 0.5%***



*Alcohol By Volume

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What is De-Alcoholization?

HYDRANAUTICS

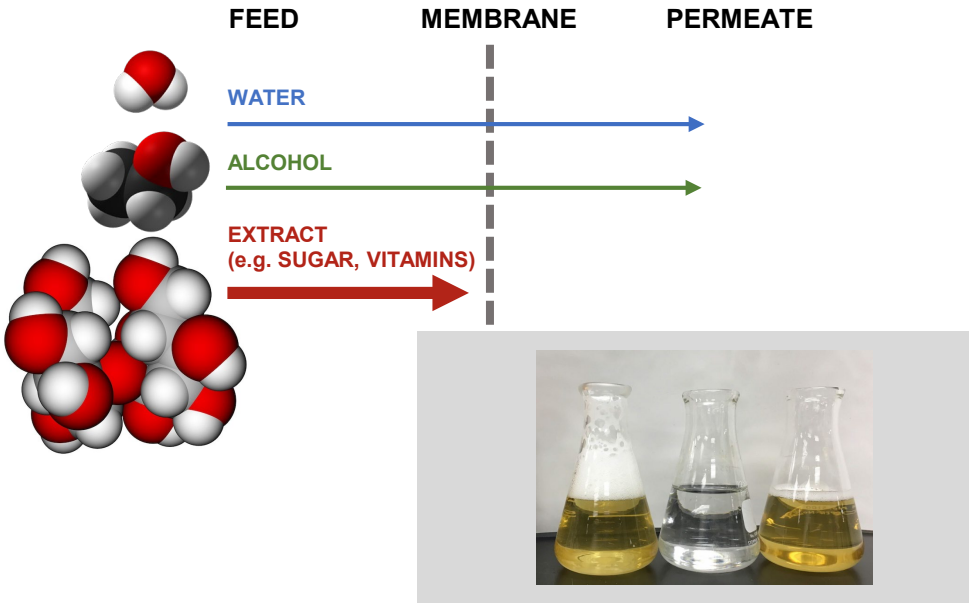
The removal of alcohol from an alcoholic beverage; Beer, Cider, Wine

Objective of Membrane Driven De-Alcoholization: *Remove Alcohol but preserve Flavor, Taste and Aroma using RO or NF Membranes.*

Typical Target in Beer dealcoholization is ≤ 0.5% ABV

Selected beer compounds:

Water	MW = 18 g/mol
Alcohol	MW = 46 g/mol
Niacin	MW =123 g/mol
Vitamin B6	MW = 169 g/mol
Maltose	MW = 342 g/mol
Vitamin B2	MW = 376 g/mol



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Distillation Vs Membrane Driven De-Alcoholization

HYDRANAUTICS

Thermal Distillation

- Core Technology is Thermal Distillation which is a temperature driven separation process based on volatility of the compounds
- Process runs warm – High Thermal Impact
- High CAPEX and OPEX
- High aroma losses – Need for recovery (Membranes?)
- Suitable also for final Alcohol content of 0.01% vol.

Membrane Driven Process

- Core Technology is pressure driven separation process which is based on passage of compounds through a semipermeable membrane
- Process runs cold – No Thermal Impact
- Low CAPEX and OPEX
- Very low aroma losses
- Suitable for final alcohol content greater or equal to 0.5% vol.
- Flexible Production Planning and Final Alcohol Content Adjustment

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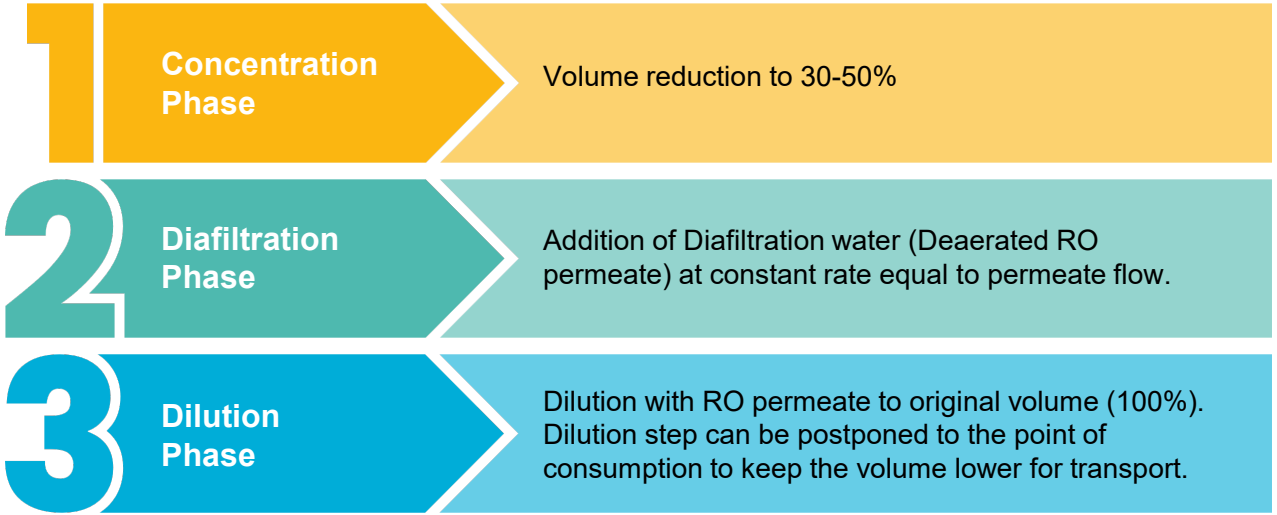
De-Alcoholization Steps

HYDRANAUTICS

Membrane De-Alcoholization Process

Both Continuous and Batch processes are possible



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Step 1: Concentration Phase

HYDRANAUTICS

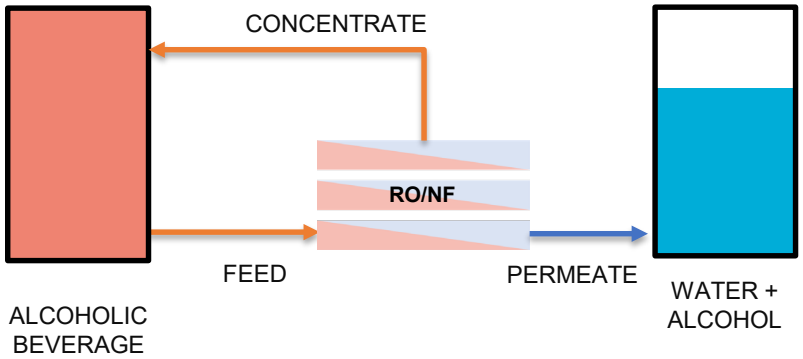
1

Volume of the feed beverage is reduced **30 - 50%**

Permeate produced during this step contains alcohol and small amount of some low molecular substances from the beverage. This water and alcohol mixture could be used for production of Hard Seltzer

Higher concentration factor during the initial concentration step reduces significantly the consumption of diafiltration water.

OBJECTIVE:
Concentrate the feed beverage



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Step 2: Diafiltration Phase

HYDRANAUTICS

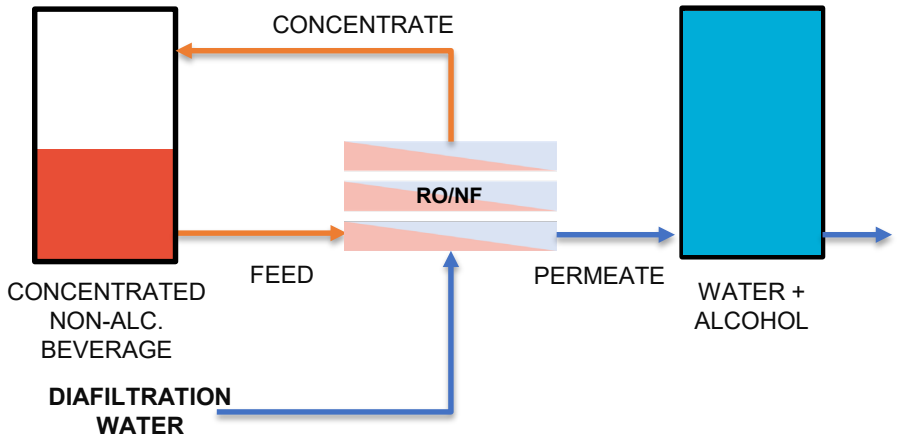
2

Addition of RO permeate (CO_2 saturated for Beer or deaerated for wine) at constant rate equal to permeate flow.

Once the volume of beverage reached **30-50%** of the original volume, the **diafiltration water is turned on**.
Match the flow of diafiltration water with permeate flow (This ensure that the volume of the batch stays constant in the process)

Amount of diafiltration water used in this step depends on beverage type and required final alcohol content.

OBJECTIVE:
Washing out alcohol using diafiltration



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Step 3: Dilution Phase

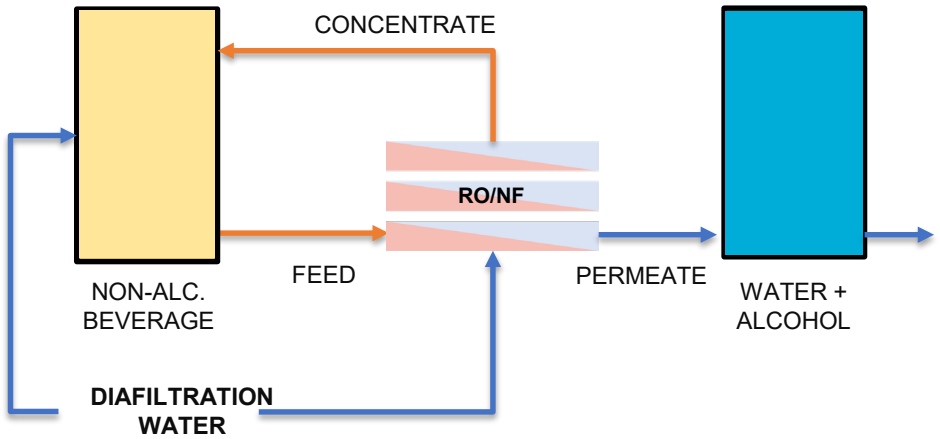
HYDRANAUTICS

3 Dilution with RO permeate to original volume (100 %).

Dilution step can be postponed to the point of consumption to keep the volume lower for transport.

Additionally, beer can be enriched with more CO2 and some additives could be added per customer requirements.

OBJECTIVE:
Achieve the desired final alcohol and extract content for either a low-alcohol or non-alcoholic beer and to fine-tune the flavor



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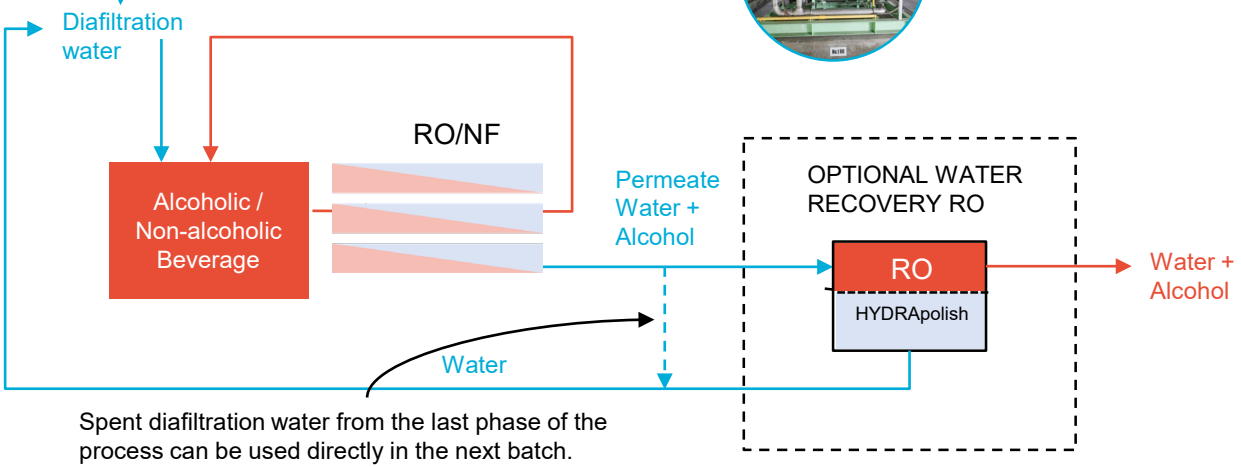
Proposed Hydranautics Solution (Batch Process)



Spent diafiltration water from the last phase of the process can be used directly in the next batch.

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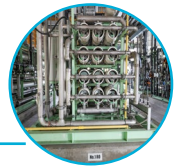
Proposed Hydranautics Solution (Continuous Process)

HYDRANAUTICS



Diafiltration water production

Diafiltration water

LOOP 1 | LOOP 2 | LOOP 3

Alcohol Beverage

RO/NF | RO/NF | RO/NF

Low Alcohol Beverage

Permeate Water + Alcohol

Permeate Water + Alcohol

Permeate Water + Alcohol

Spent diafiltration water from the last loop can be used directly in the first loop.

HYDRApolish

Water + Alcohol (3-10 ABV%)

OPTIONAL: WATER RECOVERY RO

Opportunity to Reduce Water Consumption by 30-70%

Number of loops depends on beverage type and required final alcohol content.

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High Quality Diafiltration Water *(A must)*

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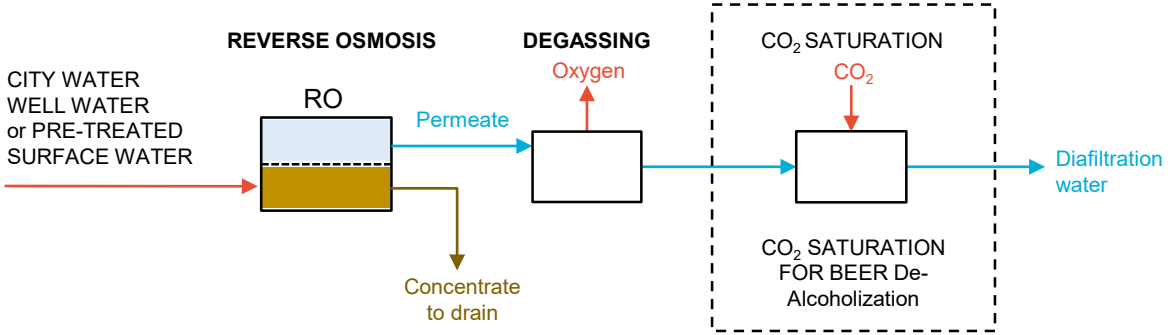

Diafiltration water should be **produced by RO. Degassing** is needed for extended shelf life of the final product.
For most types of feed waters **Energy Saving membranes (ESPA) and CPA** are sufficient to provide high quality diafiltration water.

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De-alcoholization Membrane Requirements

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1 SELECTIVITY

High selectivity between alcohol and other components of the beverages provides short run time and low Diafiltration Water consumption.

2 ROBUSTNES

Robust construction of the elements and **chemical stability** of the membrane.
Operating pressure up to 55 bar and cleaning pH 11.5

3 CERTIFICATES

FDA regulation **CFR Title 21 Part 177, USDA 3-A sanitary standard 45-03, EC Reg. No. 1935/2004**, and **EU Reg. No. 10/2011**
Kosher Certified and **Halal** Certified
ISO 9001

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Smart Solution for Brewers

HYDRANAUTICS

DEALCONOX M

Smart de-alcoholization solution for Craft Brewers

Plug and Play solution with sophisticated process control

Unit developed by BUCHER DENWEL company in cooperation with HYDRANAUTICS

BUCHER DENWEL is well established supplier of various process technologies for brewery Cold Block

Easy scale-up of the technology for larger breweries

BUCHER
denwel

Gusmer
Enterprises, Inc.®

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MAIN FEATURES OF TRIAL UNIT

- Continuous measurement of Alcohol content, Extract, CO2 and other quality parameters
- Standard connection points for beer and water kegs
- Air-tight system - no risk of Oxygen contamination
- Optional CIP unit for hot and cold CIP
- Hot sanitation process without membrane elements
- Chemical sanitation with membrane elements
- Feed pump with VFD
- Pressure and Flow Transmitters
- Beer and Diafiltration Water level monitoring
- Hygienic sampling valves
- Touch screen HMI
- Data logging in PLC
- Possible remote control and integration to existing SCADA system of the Brewery

BEER DEALC. UNIT IN OPERATION

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SAMPLES: FEED PRODUCT

FEED PERMEATE

FACTORY TESTING - RESULTS

- Process tested with NF and RO membranes
- Czech Lager Beer with 4.2 %vol. and 5.1 %vol.
- Optimization of hydraulic conditions in the membrane element

SUMMARY

	ALCOHOL		DIAFILTRATION Water	AVG. FEED P	AVG. FLUX	TEMP.
	[% vol.]	REDUCTION	[%]	[bar]	[lmh]	[C]
FEED BEER	4.2					
NF (RUN1)	0.45	89%	140%	25	7.4	< 10
NF (RUN2)	0.20	95%	160%	30	10.6	< 10
RO	0.25	94%	260%	15	7.4	< 10

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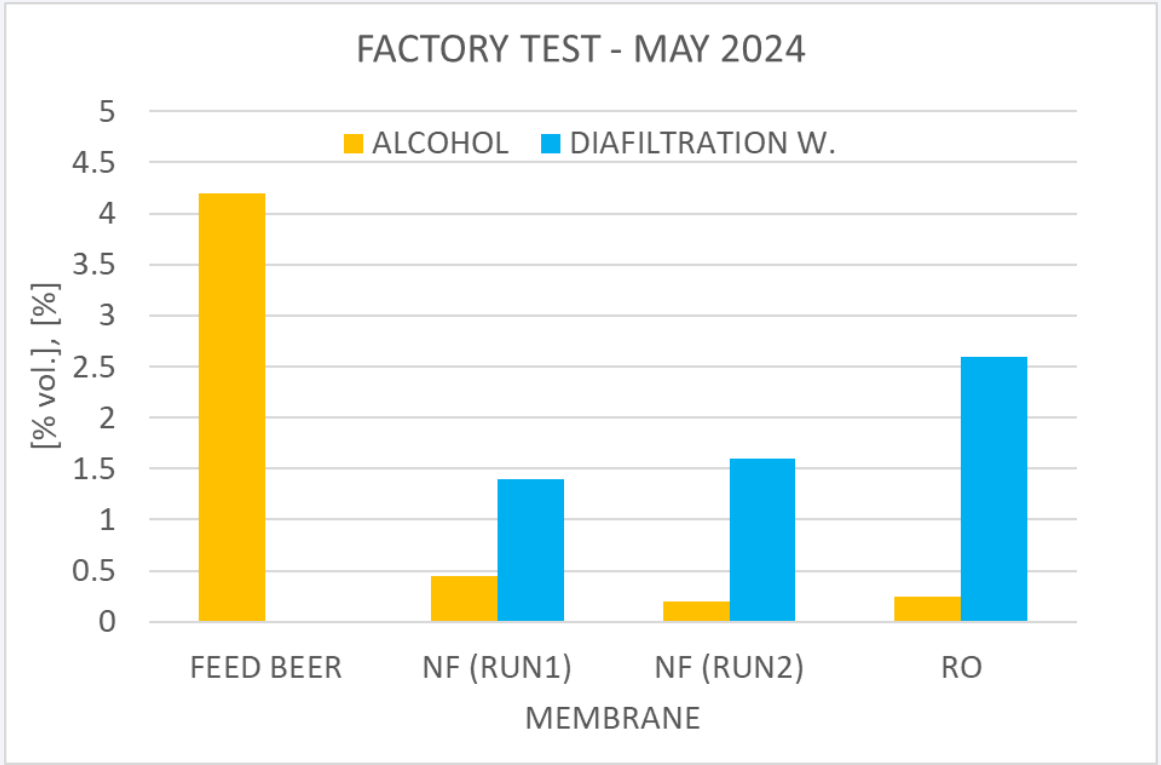
FACTORY TESTING RESULTS

- NF provides lowest consumption of diafiltration water
- Reduction of alcohol content is equivalent to diafiltration water consumption



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KEY COMPONENT

- Real time measurement of Alcohol, CO2, Conductivity and Temperature
- Optimizing process parameters in real time

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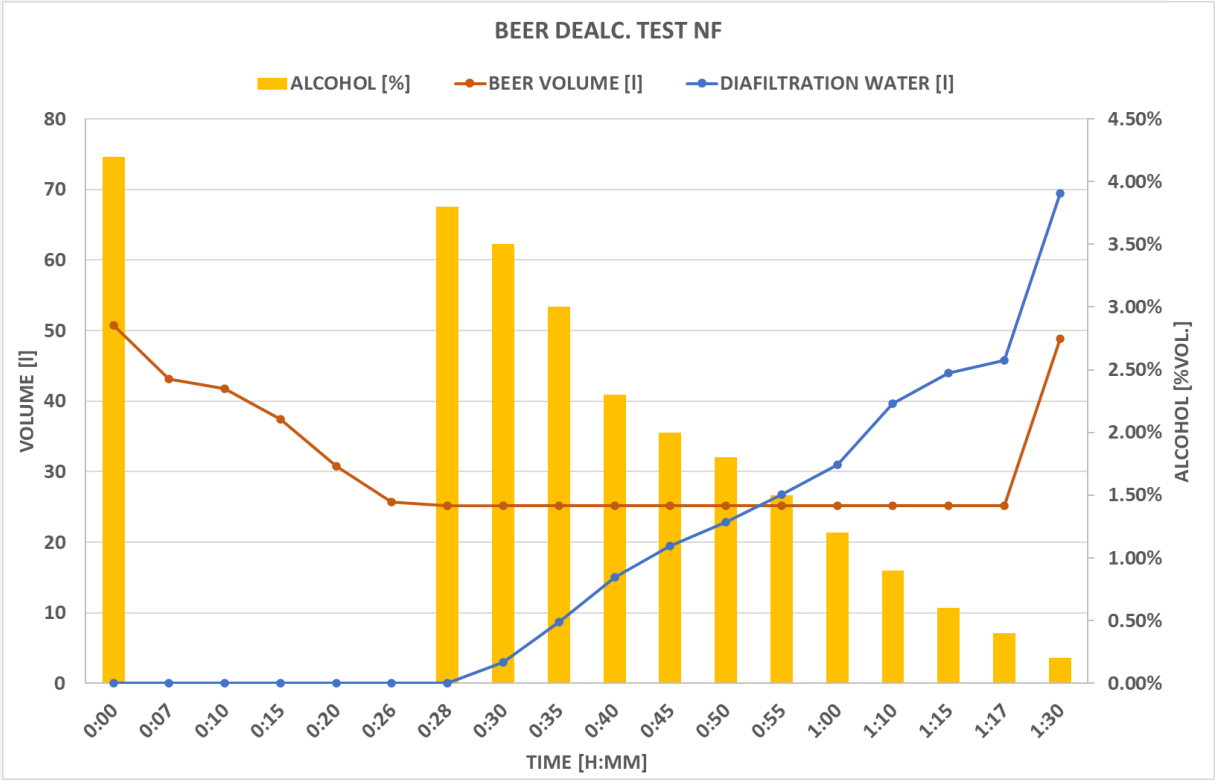
EXAMPLE OF OPERATING DATA - NF

- Realtime control of alcohol content
- Alcohol content is constant during the concentration phase
- Alcohol reduction is constant during the whole diafiltration process
- Low consumption of diafiltration w.
- Very short runtime
- Light beer aroma in permeate



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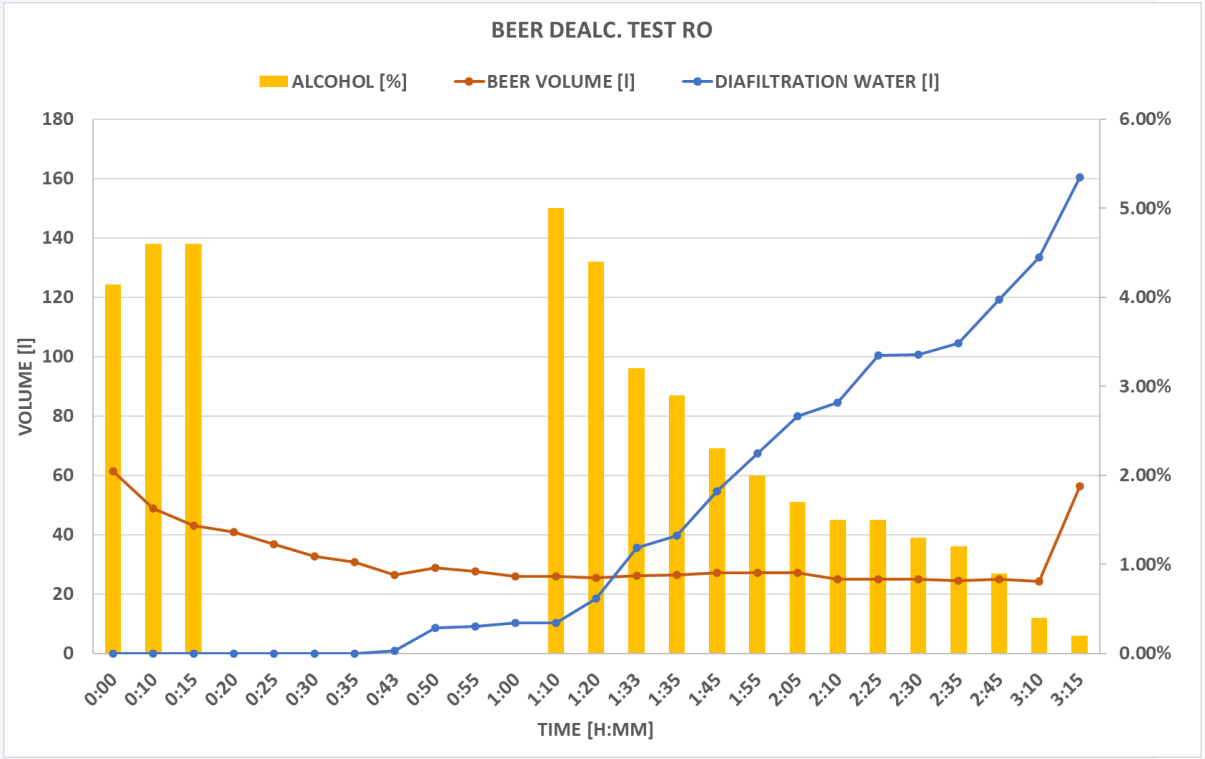
EXAMPLE OF OPERATING DATA - RO

- Realtime control of alcohol content
- Alcohol content slightly increases during the concentration phase
- Alcohol reduction is fastest in the beginning of diafiltration process
- Longer runtime compared to NF
- Higher consumption of diafiltration w.
- No aroma in permeate



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Summary

HYDRANAUTICS

Energy, Water and Cost Savings

- Low Operating Temperature
- Low Operating Pressure
- Low CAPEX
- Solution for Diafiltration Water recovery
- Valuable by-product Hard Selzer

Consistent Flavor and Taste Profile

- Use of Fully Fermented feed beverage
- Operate at low temperature. Volatile substances stay in the product
- Hygienic design
- No Oxygen pickup
- CO2 pressurization possible

Great Flexibility

- High energy efficient membranes and short cycle time process provides greater flexibility in terms of production capacity
- Easy scale-up
- Realtime alcohol monitoring
- Solutions for Craft Brewers
- Full Automatization

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