

# DALUM

Beverage Equipment

## DALUM CO<sub>2</sub> Recovery Plant

*CO2 recovery solutions tailored for your specific brewery.*

*Designed by process engineers and veteran brewers.*





## It began in Denmark, 2019

Kim, engineer and beverage industry expert, approached several craft brewers and was encouraged to invent an affordable craft-scale CO2 recovery solution.

He partnered with Ørbæk Bryggeri and had the first plant up and running in March of 2020.

# The Result: Serious Technology for Sustainable Brewing

Proven Industrial Technology  
Scaled & Priced for  
Craft Breweries

**DALUM**  
Beverage Equipment



**DALUM CO<sub>2</sub> UNIT**

# *Svaneke*

**DALUM**  
Beverage Equipment

First commercial customer installed a plant in November 2020 and has been self-sufficient ever since. They sell their excess CO2 to local businesses on the island of Bornholm.

Svaneke Bryghus and Jan Paul, brewmaster, were a big part of the R&D process from the beginning.





## DALUM CO<sub>2</sub> RECOVERY PLANT OVERVIEW

Our CO<sub>2</sub> Recovery Plant promotes a circular utilization of the brewery's own CO<sub>2</sub>, by recovering the CO<sub>2</sub> from the fermentation.

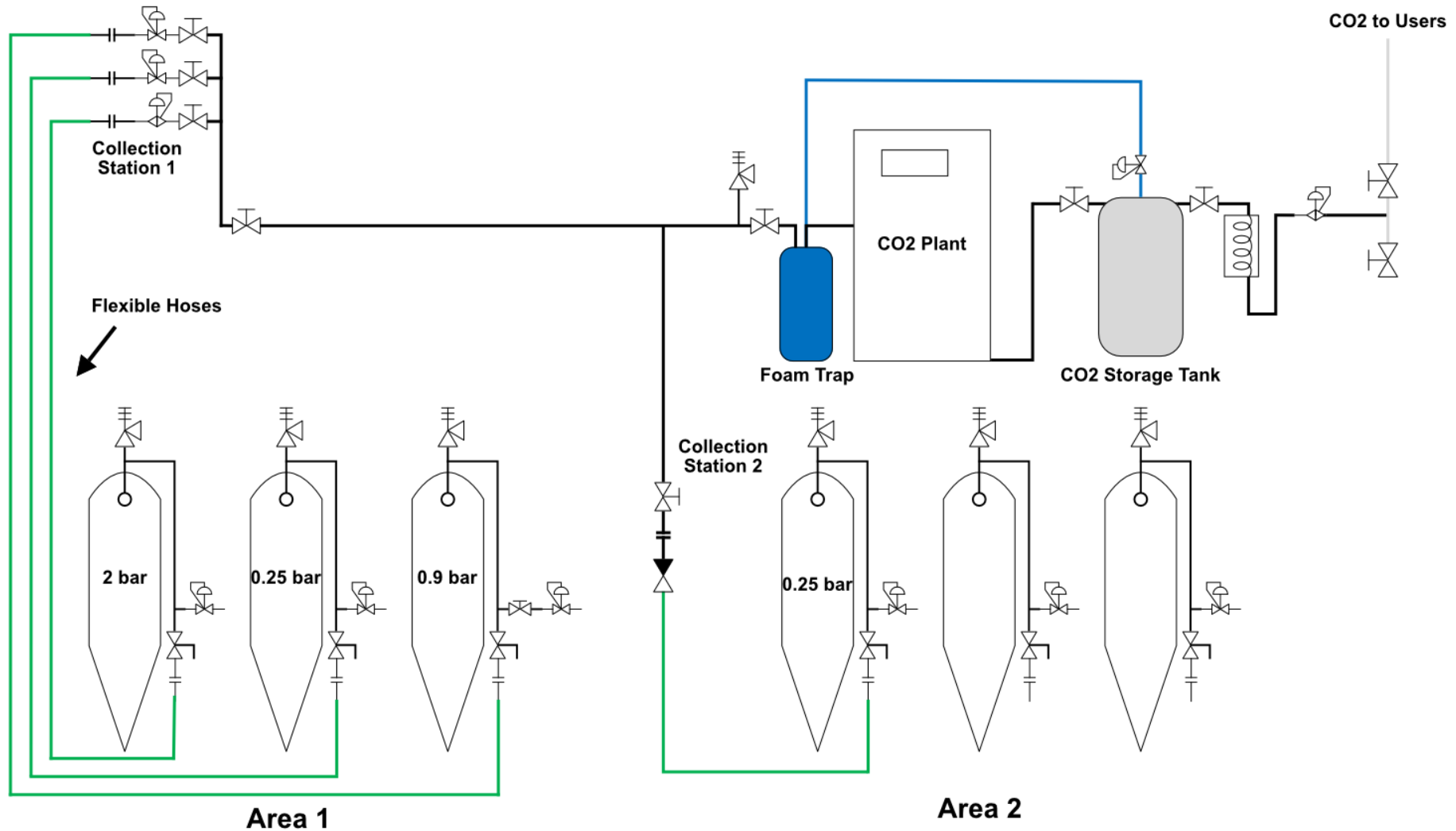
Secures own high-quality supply of CO<sub>2</sub>

80% of DALUM customers are CO<sub>2</sub> self-sufficient

Saves costs from the day it is installed and for the rest of the lifetime of your brewery

Appropriately sized unit & proper operation will recapture approx. 70-80% of CO<sub>2</sub>.

# System Overview



## HIGH QUALITY CO<sub>2</sub>

- Own control of CO<sub>2</sub> source and secure supply.
- No oil, chemical filters, or refrigerants in CO<sub>2</sub> Plant.
- Stainless steel and 3-stage variable speed oil-free DALUM Compressor.
- Only food safe materials in contact with CO<sub>2</sub>.
- ISBT standard - 99.98% purity and no detectable odor in product.
- Oxygen traces in ppb.

## PLUG-AND-PLAY PLANT

- Fully assembled and tested plant ready to plug in.
- Water, electricity, coolant, and drain to be connected.
- No vendor installation and commissioning hours needed.
- No PED or ASME needed for plant.\*

\*Storage tanks for liquid CO<sub>2</sub> need approvals and may need inspections.



## EASY TO USE AND MAINTAIN

- Simple and fully automatic operation with self-diagnosing software.
- Adapts automatically capacity to fermentation cycles.
- No consumables to be replaced regularly.
- Dashboard on smartphone and remote access.

## FINANCIALLY FEASIBLE

- Low capex and short ROI
- Protected from CO2 shortages and price increases.
- Reduces cost of CO2 considerably and secures supply.
- increases surplus CO2 value by cylinder filling for beer dispensers for draft beer.





## EASY TO FIT

- Small footprint of plant (1 m<sup>2</sup> or 10 sq. ft.)
- Low noise level (65 dB) and can be placed anywhere in the brewery.
- No balloon due to 100% variable speed DALUM Compressor.
- No hazardous ammonia or CFC refrigerants as external cooling source is used.

## ENVIRONMENTALLY FRIENDLY

- Low consumption of power and water.
- Better working environment.
- Eliminates breweries largest CO<sub>2</sub> emission source (2 tons less emissions per ton recovered).
- Eliminates breweries need for purchase and transport of CO<sub>2</sub>.



# DALUM Customers

Creating  
collaborative  
partnerships  
globally.



"There's no reason every brewery shouldn't have one, it's performing as promised which is kind of unheard of."

**Paul Graham, President of Central Waters, WI, USA**



"The whole system is extremely reliable and very efficient. Incredibly well-thought-out condenser. First class quality CO2."

**Eddie Gadd, President of Ramsgate Brewery, UK**



"If you're a craft beer brewery looking to get into it and save any money and help save the environment by letting less CO2 get out of the atmosphere, I couldn't recommend it enough."

**Ross Terlick, Head Brewer at Rocky Ridge Brewing, Australia**

# CO<sub>2</sub> Self-Sufficiency



CO<sub>2</sub> self-sufficient on day one since commissioning two Craft models in February 2023, and are selling excess CO<sub>2</sub> in cylinders to local businesses

CO<sub>2</sub> self-sufficient on day one since commissioning the first Micro model in October 2023

CO<sub>2</sub> self-sufficient on day one since commissioning a Mini model in April 2023

# Cost Reduction and Increased Profits



2024  
Vanuatu

Brewery located on island with volatile CO2 prices and unpredictable disruptions



Thisted  
BRYGHUS  
*since* 1902

2023  
Denmark

Saving approx. 150 tons of CO2 annually with two Craft models



GOTLANDS+  
BRYGERI  
VISBY  
S:T HANSG  
1995

2024  
Sweden

Newly built brewery with built-in piping for CO2 recovery

# Simple and Easy Installs by Brewing & Engineering Experts



2023  
WI, USA

First US install running after two days and recovering approx. 67,200 lbs. annually



BLACK ISLE  
BREWING CO.

2023  
Scotland

Plant was running and producing CO2 after two days



2024  
Maine, USA

Running and producing CO2 on day one

# Financially Feasible for Craft Breweries



Beer Output in hL	Plant Model	Theoretical Compressor Displacement Size	Plant Price
1,000 - 5,000 hL/yr	Micro	5 kg/hr	€ 32,200
5,000 - 15,000 hL/yr	Mini	10 kg/hr	€ 47,700
15,000 - 25,000 hL/yr	Craft	15 kg/hr	€ 64,000
25,000 - 50,000 hL/yr	Senior	30 kg/hr	€ 99,750

\*Storage tanks for liquid CO2 need approvals and inspections  
Pricing subject to change

# Financially Feasible for Craft Breweries



Beer Output in BBL	Plant Model	Theoretical Compressor Displacement Size	Plant Price
800 – 4,300 bbl/yr	Micro	10 lbs/hr	\$ 44,000
4,300 – 12,800 bbl/yr	Mini	20 lbs/hr	\$ 62,000
12,800 – 21,300 bbl/yr	Craft	30 lbs/hr	\$ 79,000
21,300 – 42,600 bbl/yr	Senior	60 lbs/hr	\$ 115,000
42,600+	Multiple units		

\*Storage tanks for liquid CO2 need approvals and inspections.

CRN not included.

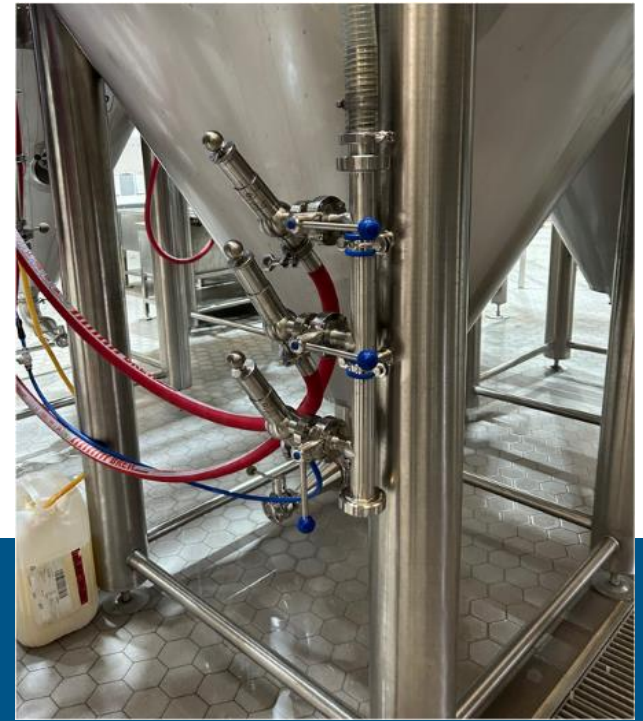
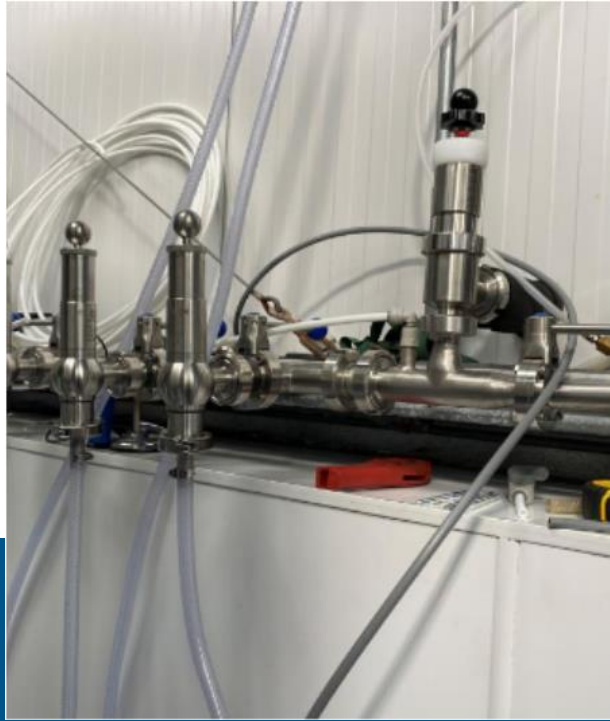
Pricing subject to change

# Total Solution Packages: Storage Tanks, Cylinder Filling Stations, Vaporizers etc.





# Customized Collection Stations




# Emission Reduction is 2:1 Relationship

Two tons of emission reduction from each ton of CO2 recovered.

Producing and transporting one ton of CO2 to a brewery emits 2 tons of CO2.\*

\*University of Winnipeg.

Beer Output 5% alc. Hl	Compressor Displacement Size	CO2 Recovery (Tons CO2)	Emission Reduction (Tons CO2)
7,000	5 kg/hr	22 	44
15,000	10 kg/hr	66	132
25,000	15 kg/hr	99	198
50,000	30 kg/hr	198	396

# Calculate How Much CO<sub>2</sub> is Recovered

Experiment performed at a brewery, with a flowtransmitter

Result => 3.4 kg CO<sub>2</sub> per hL beer

- 15,600 L fermenter with 128 hL wort, expected 4.8% v/v alcohol, 120 hL beer.
- 4.8% v/v is approx. 3.84% w/w or 3.8 kg/hL beer, meaning 460 kg CO<sub>2</sub> is expected.
- 0.4% or 36 kg remain in beer, which means 420 kg leaves the tank. Measured 442 kg.
- First 20 kg is lost with too high oxygen content. Approx. 400 kg goes to plant. Measured 420 kg.
- 420 kg go to plant, but 410 kg are measured in CO<sub>2</sub> tank.

## Calculations

Very little loss due to high oxygen	4	%
Yield of the theoretical total CO <sub>2</sub> produced	89	%
Yield of CO <sub>2</sub> out of the fermenter	93	%
Yield of CO <sub>2</sub> sent to the CO <sub>2</sub> Plant	97	%

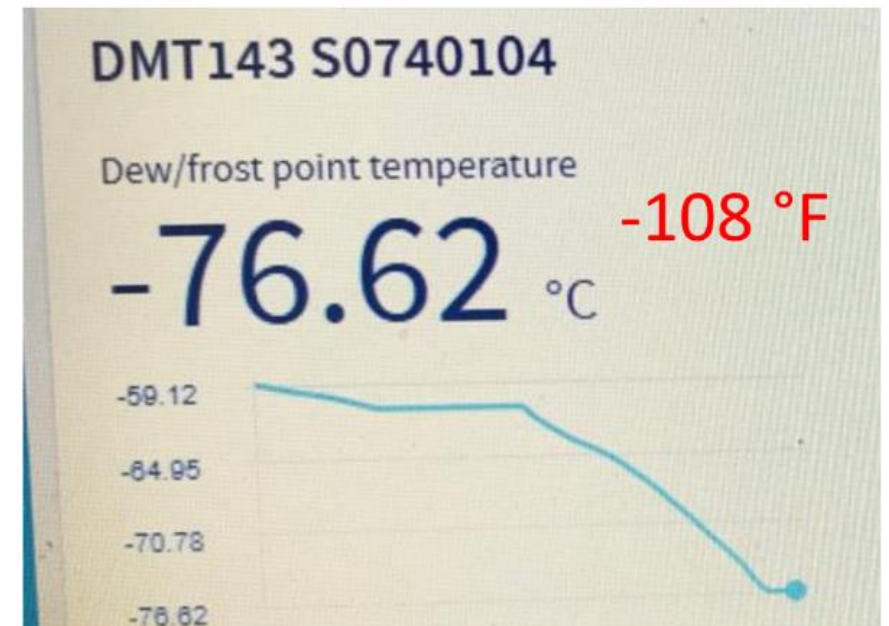
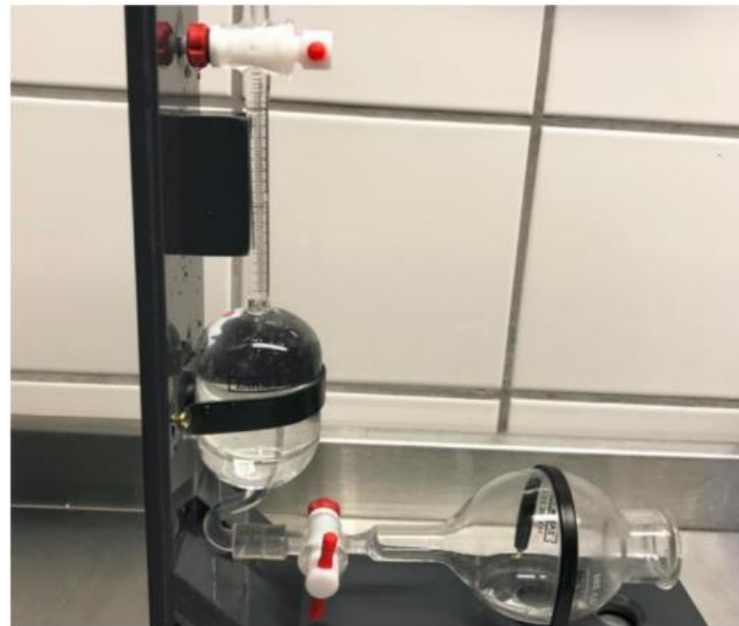
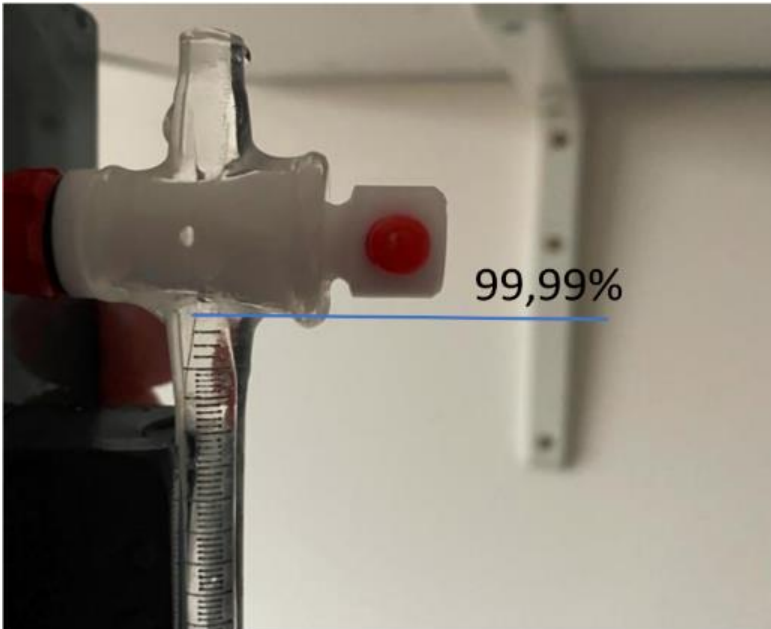


$C_6H_{12}O_6 = >2C_2H_5OH+2CO_2+heat$  or approx.:  
2 grams of extract = 1 g alcohol + 1 g CO<sub>2</sub>

# High Purity and Low Oxygen Content

**Eddie Gadd, Managing Director, Ramsgate Brewery:**

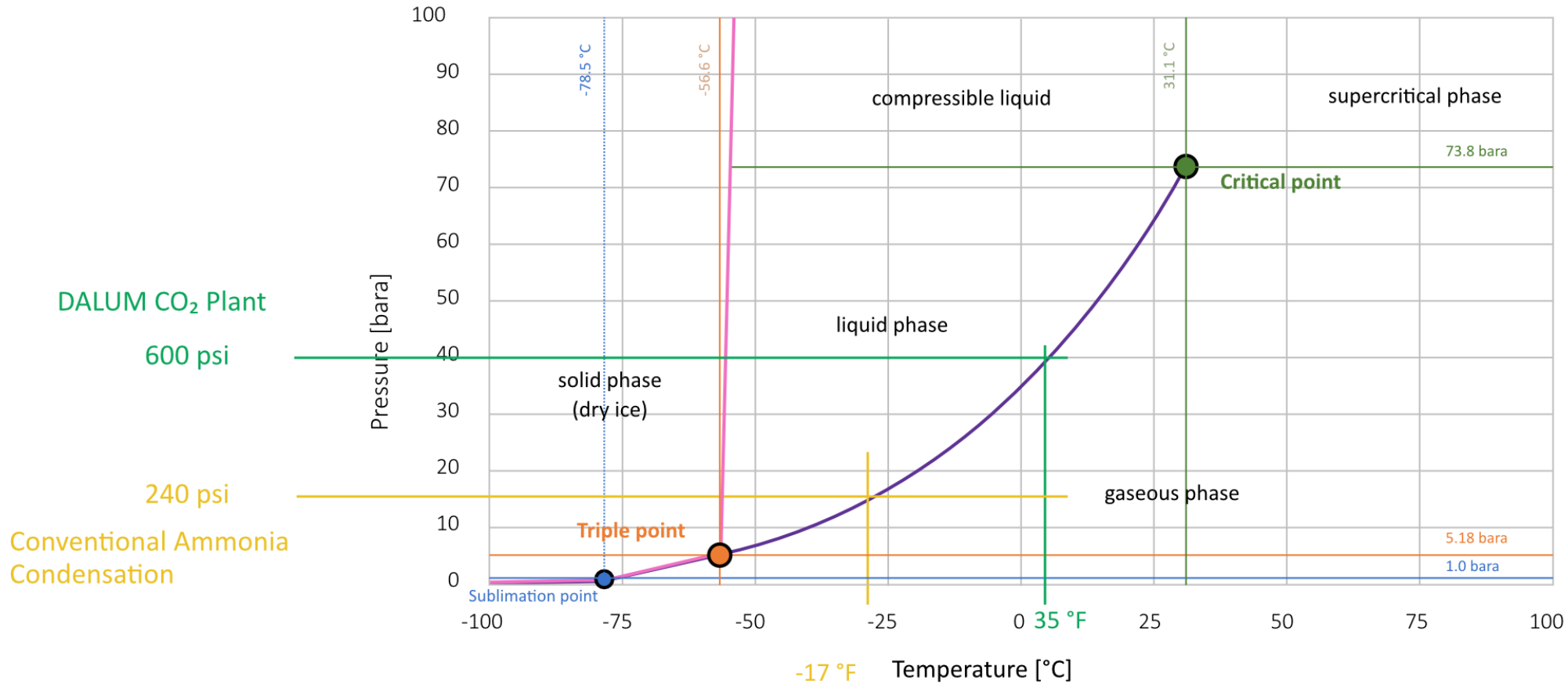
Collection system (generally 16 hours from yeast pitching). Some CO<sub>2</sub> is lost through the initial stage of fermentation, due to high O<sub>2</sub> content, and some remains in the beer at the end. With good management, **75% yields** can be achieved, with an oxygen **content of <6 ppb**, measured with an Orbisphere (wholesale liquid CO<sub>2</sub> at the bottling site measures 16 ppb O<sub>2</sub>). A burette is used to demonstrate **purity >99.99%**.



# Typical Chemical Profile in CO<sub>2</sub> Output

Typical chemical profile in DALUM CO <sub>2</sub> Recovery					
Component	Presence in feed, ppm	After water scrubber, ppm	After compressor, ppm	After dehydrator and condenser, ppm	ISBT ppm
Acetaldehyde	20	0	0	<b>0.02</b>	0.2
Ethyl acetate	200	10	8	<b>0.0</b>	
Mercaptans	5	1	0.7	<b>0.0</b>	0.1
Dimethyl sulfide	35	3	2	<b>0.05*</b>	0.1
Ethanol	2500	5	0	<b>0.0</b>	
Carbon disulfide, CS <sub>2</sub>	0	0	0	<b>&lt;0.05</b>	0.1
Hydrogen sulfide, H <sub>2</sub> S	0	0	0	<b>&lt;0.01</b>	0.1
Carbonyl sulfide COS	0	0	0	<b>&lt;0.05</b>	0.1
Oxygen O <sub>2</sub>	1000	1000	1000	<b>0.005-0.1*</b>	30
Moist H <sub>2</sub> O	>10000	>10000	1000	<b>1</b>	20
<b>Carbon dioxide %</b>	<b>96</b>	<b>97</b>	<b>99</b>	<b>99.985-99.995</b>	<b>99.900</b>
Nitrogen	4000	4000	4000	<b>0.1</b>	na
Ammonia	na	na	na	<b>&lt;1</b>	2.5
Oil & grease	na	na	na	<b>&lt;1</b>	5
Hydrocarbon	na	na	na	<b>1.5</b>	50
Benzene	na	na	na	<b>&lt;0.01</b>	2.5
Methanol	na	na	na	<b>0.06</b>	10

ISBT: International Society of Beverage Technologists



# No Refrigerants

Three stage compressor produces 45 bars/650 psi bars condensation pressure. Unnecessary to use separate CFC or ammonia cooling systems. A glycol, ice-water, or alcohol coolant system can be used – even the existing coolant system in the brewery can be utilized.

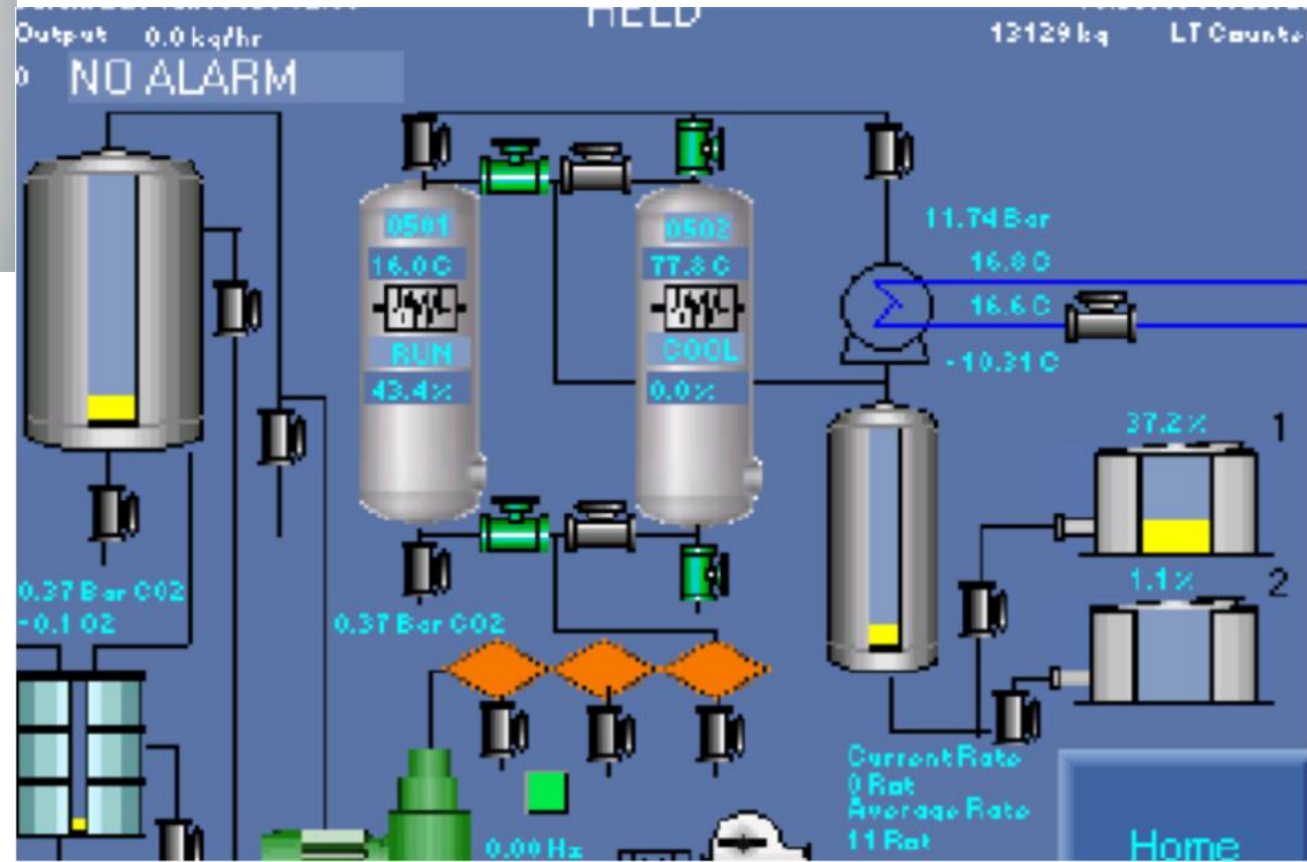
# Control System With Vision Combi PLC Remote Operator

Simple and fully automatic operation with  
self-diagnosing software



## User Interface

Easy to monitor and control



# Remote Operator and Smartphone Dashboard



**Dalum Beverage Equipment**

1,738  
Production Counter

Running

No Alarm

No Alarm

No Alarm

No Alarm

ON  
At present there is no Asset selected.

OFF

58%  
Storage Tank Level

Inlet CO2  
%

Inlet CO2  
Bar

Average Rot.  
Rotations

Coolant Inlet  
Deg C

Coolant Exit  
Deg C

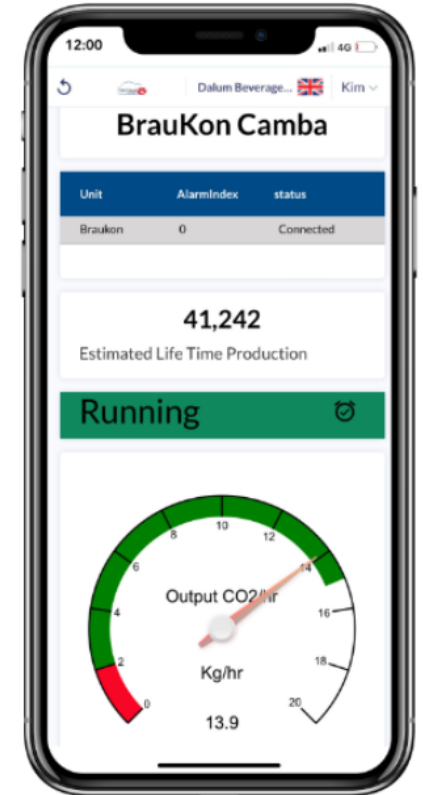
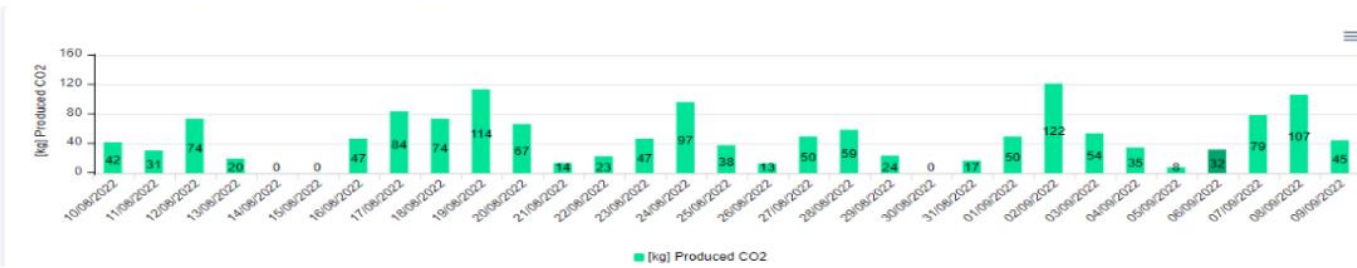
Compressor Temp  
Deg C

VFD Max Current  
A

VFD Current Hz  
Hz

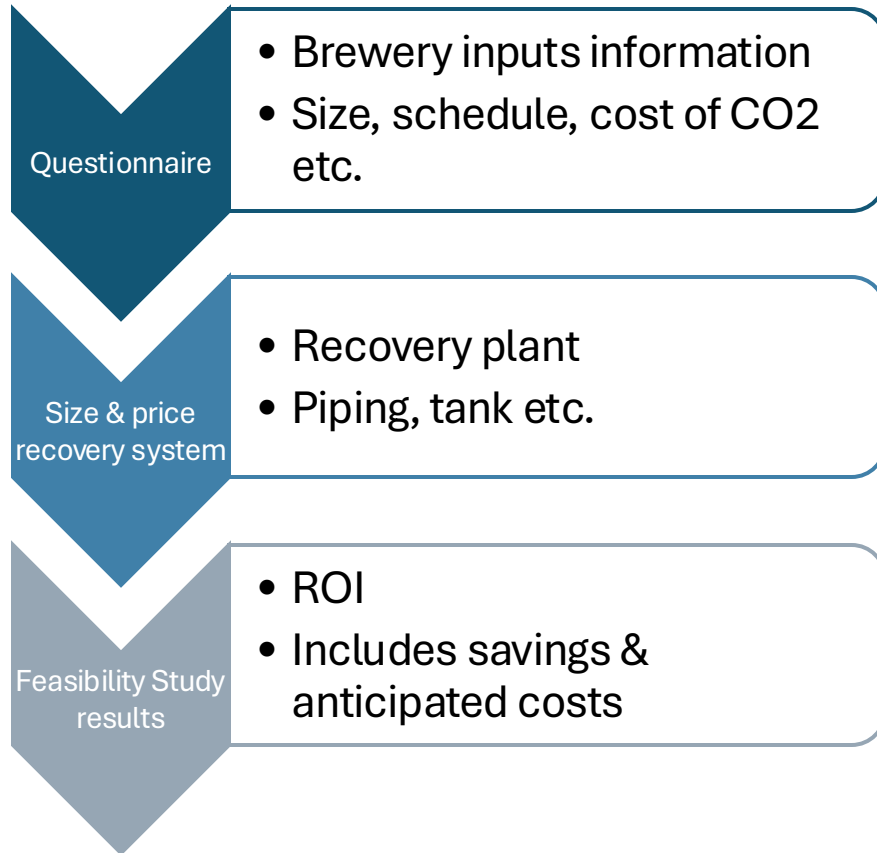
Condenser P  
Bar

Deepoint  
Deg C





# Partner with Brewery on Feasibility



Year	2022	2023	2024
Production HI Beer	10.000,00	11.500,00	12.650,00
CO2 Usage Brewery, Kg	33.000,00	37.950,00	41.745,00
Recovery, Kg	34.900,00	40.135,00	44.148,50
Saving	159.011,02	182.171,47	199.927,81
kg/h, 47 weeks/y	4,42	5,08	5,59
No inflation			
Cash Flow of operations		182.171,47	199.927,81
Working Capital		0,00	0,00
Increase in working capital		0,00	0,00
Capital investment		<b>81.700,00</b>	
Sale of plant			
Net cash flow	0,00	100.471,47	199.927,81
PV 2018 at 2,5%	0,00	98.020,94	190.294,17
Cost of capital rate	1,0250		
NPV(at 2,5%)	<b>2.265.510,71</b>		
PV 2021 at IIR%	11.370,00	91.337,70	165.229,60
IRR =10%	<b>1,10</b>		
NPV(IRR= 10.0%)	1.477.386,03		

EXAMPLE

Continues (10 yr analysis)

# Resources

- Quotes, feasibility study, info on government grants
  - Denmark office (All countries outside of North America) [Frederik@dalumequipment.com](mailto:Frederik@dalumequipment.com)
  - Wisconsin, USA office (USA, Canada, Caribbean) [Eric@dalumequipment.com](mailto:Eric@dalumequipment.com)
- How much CO2 does my fermenter produce? Article [here](#)
- Brauwelt article [here](#)
- Brewer's Journal article [here](#)
- Brewery case studies [here](#)
- CO2 systems and importance of quality - MBAA podcast [here](#)
- Dalum Newsletter [HERE](#)