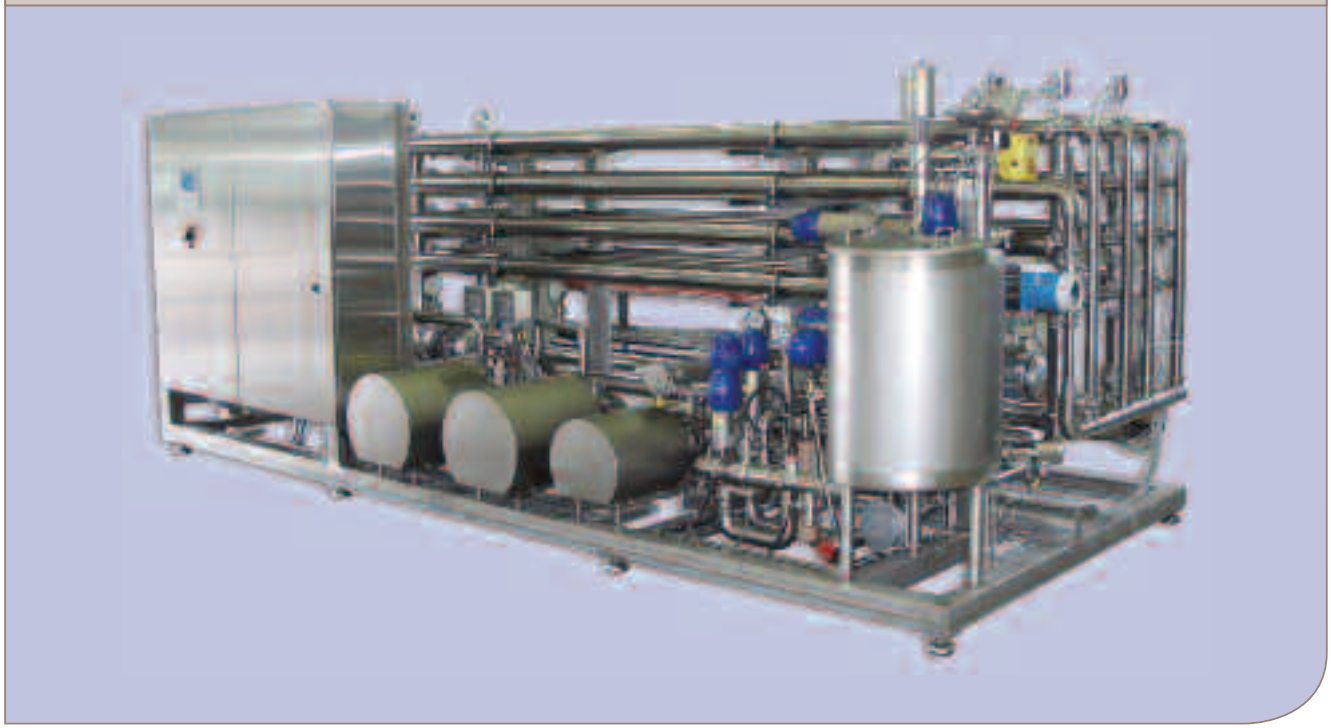
Alfa Laval beer dealcoholization system

A solution for beer dealcoholization at ambient temperature



Beer DeAL 300

The design and operation of the Alfa Laval Beer dealcoholization system are based on more than 20 years of experience with the beer dealcoholization process.

Our many reference installations are located throughout the world, and we provide you with practical, cost-effective standardized solutions for making low-alcohol beer or other similar low-alcohol products.

Dealcoholization by reverse osmosis
The system uses reverse osmosis spiral membranes in a high-hygiene set-up and consists of four individual operations:

- Pre-concentration
- Diafiltration
- Alcohol adjustment
- Post-treatment

Each of these steps takes place at temperatures of 7–8ºC (44.6 - 46.4 ºF) or less, resulting in a high-quality beer whose flavour is unaffected by heating.

Special features and key benefits
Any process temperature in the range 1–30°C (33.8-86 °F) can be chosen. However, the temperature normally used is 7–8°C (44.6 - 46.4 °F) in order to minimize any unfavourable effects on the dealcoholized beer. Higher temperatures increase processing throughput but have a negative influence on the aromas of the beer, while lower temperatures have the opposite effect.

With this solution, the beer is not heated to remove the alcohol and there is no evaporation involved. This means there is no need for steam, and the beer is not exposed to the effects of heat.

The same plant can handle all types of beer, including wheat beers, and dark beers. The process is the same for all these types, although the throughput may vary. The same process can also be used to produce beers with different levels of alcohol content in the same plant.
Because the beer is treated at pressures of 30–35 bar (435.1 - 507.6 psi) , there is no oxygen pick-up in the beer.

Control and automation

Alfa Laval beer dealcoholization units feature the MemProc control system, making them fully automated. The volume of the charge, the alcohol content of the original beer and the desired alcohol content in the dealcoholized beer are simply entered into the programme. The unit then works automatically, including the necessary CIP and disinfection procedures after treatment.

Operating principles

The membranes separate the feed beer into two streams. The permeate stream (consisting of water and alcohol) passes through the membranes whereas the retentate stream, consisting of concentrated proteins, colours and flavours, does not, and can therefore be led back to the beer tank.

The original beer from the beer tank is pumped to the dealcoholization unit. Two feed pumps then bring the pressure of the beer up to 30 bar (435.1 psi). At this point, the beer is introduced into the first loop where the beer is circulated over the membranes in loop 1 by a pump. The retentate from the first loop continues to the second loop and is recirculated over the membranes in loop 2.

The retentate from loop 2 is returned to the beer tank via a pressure release valve. The permeate (i.e. the water + alcohol that have passed through the membranes) from all the loops is collected and led to a drain or stored in tanks with a view to recovering the alcohol.

The beer is made to flow parallel to the membrane surface, which keeps the membranes clean (cross-flow). Due to the static pressure of 30–35 bar (435.1 - 507.6 psi) on the membranes, the small molecules, such as water and alcohol, are pressed through the membranes, whereas the larger molecules, such as flavours, colours and protein, are unable to pass. These compounds therefore remain in the retentate.

Pre-concentration – step 1

This step reduces the volume of the feed beer. After passing through the membrane modules, the feed beer is recycled over the batch tank. The permeate is removed, while the retentate goes back into the beer tank until the desired reduction in volume has been achieved.

Diafiltration – step 2

This step involves washing out the alcohol using diafiltration. It is similar in principle to the pre-concentration step, but diafiltration water is now added. The volume used is the same as that of the permeate leaving the installation, thus keeping the level in the beer tank constant.

The diafiltration step reduces the alcohol content to the desired value for the final low-alcohol beer.

Alcohol adjustment – step 3

After diafiltration, the beer can be adjusted still further by adding water into the batch tank in order to achieve the desired final alcohol content and to fine-tune the taste. The amount of water added is normally the same as the amount of permeate in step 1.

Post treatment – step 4

The dealcoholized beer can be given its special characteristics by adjusting CO_2 levels or by using hop extract or other flavour enhancers.

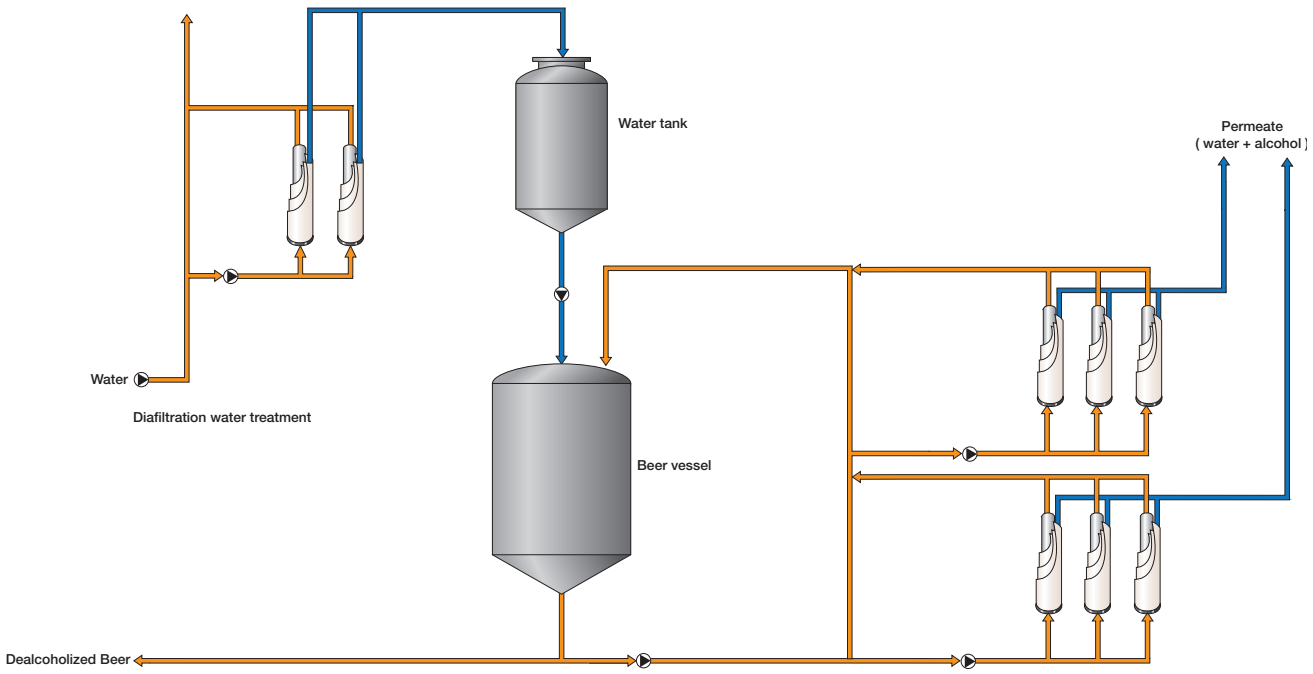


Fig. 1 Flow chart of the beer dealcoholization system

A standard system

This standardized spiral membrane filtration system is a plug-in unit that is ideal for batch operation. It is designed as a self-contained modular system mounted on frames equipped with a Cleaning-in-Place (CIP) tank and easily exchangeable spiral membranes.

The permanent fixtures, such as piping, pumps, strainers, valves and fittings, as well as the control panel, are all manufactured by Alfa Laval. This is a significant advantage in terms of service and spare parts inventory.

All piping and equipment in contact with the product and/or CIP liquids are of high-hygiene design, and steel parts are made of AISI 316L stainless steel or an equivalent acid-proof stainless steel material. The spiral membranes are designed for excellent hygiene and comply with the relevant food and dairy hygiene standards.

Control system

The system is controlled and monitored by an operator via a local PLC panel featuring the Motor Control Centre. The system is based on 3 x 400 VAC/50 Hz, enclosures for motors and a combined control/MCC mounted in an IP54 unit.

Major operating sequence:

- Water recirculation
- Production including water displacement and product displacement
- CIP procedures, including heating, adding of agents, contact time and flushing

Key control parameters:

- Tank level
- Pressure control
- Temperature control
- Alcohol reduction
- Volumetric control factor
- CIP and sanitation conditions

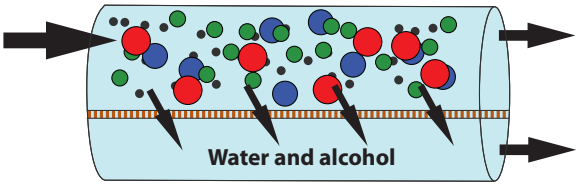


Fig. 3 Dealcoholization process.

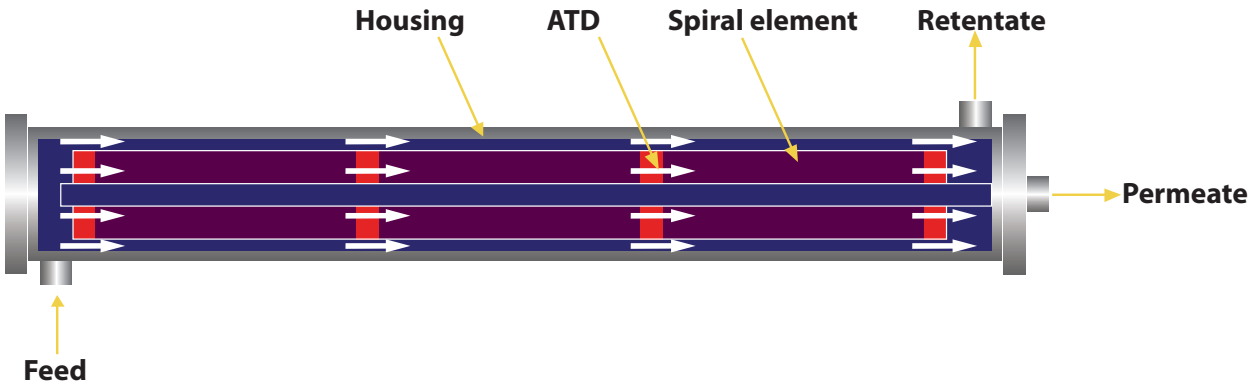


Fig. 2 The installation is based on a spiral module as shown.

Technical specifications

Plant type	Beer DeAL 300	Beer DeAL 400	Beer DeAL 600	Beer DeAL 1000
Capacity (hl/day (GPD))	300 (6,811)	400 (10,570)	600 (15,850)	1000 (26,420)
Diafiltration water (hl/day (GPD))	900 (23,780)	1200 (31,700)	1800 (47,550)	3000 (79,250)
Nominal capacity (hl/h (GAL/hour))	15 (396.3)	20 (528.3)	30 (792,5)	50 (1,321)
Operation time (h/day)	20	20	20	20
CIP (h/day)	4	4	4	4
Operation temperature (ºC (ºF))	7-8 (44.6 - 46.4)	7-8 (44.6 - 46.4)	7-8 (44.6 - 46.4)	7-8 (44.6 - 46.4)
Operation mode	Batch	Batch	Batch	Batch
Number of loops	1	2	2	3
Number of modules (housings)	12	16	24	42
Type of modules (housings)	M4-4040	M4-4040	M4-4040	M4-4040
Type of spiral	4040/30	4040/30	4040/30	4040/30
Number of spirals	48	64	96	168
Type of membrane	CA995-PE	CA995-PE	CA995-PE	CA995-PE
Installed power (kW)	50	60	105	140
Power consumption, prod. (kW)	40	50	70	105
Diafiltration (m^3/h (GAL/hour))	4 (1,057)	6 (1,585)	8 (2,113)	14 (3,698)
CIP (m^3/sequence (GAL/sequence))	5 (1,321)	7 (1,849)	10 (2,642)	18 (4,755)
Plant dimension	6.0 x 2.5 x 2.5	6.0 x 3.5 x 2.5	6.0 x 3.5 x 2.5	6.0 x 4.5 x 2.5
Space required, L x B x H (m)	8.5 x 4.5 x 3.0	8.5 x 5.5 x 3.0	8.5 x 5.5 x 3.0	8.5 x 6.5 x 3.0
Weight (kg)	3,600	4,200	4,700	6,400
Noise level	< 80 dB (A)	< 80 dB (A)	< 80 dB (A)	< 80 dB (A)
Batch tank (hl (GPD))	300 (6,811)	400 (10,570)	600 (15,850)	1,100 (26,420)

Note: This table of data is based on clarified malt beer of the pilsner type with an alcohol reduction factor from 5% to 0.5%

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How to contact Alfa Laval
Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com