Alfa Laval De-alcoholization Module

Cost-efficient solution for chilled non-alcohol beer below 0.05%

The Alfa Laval De-alcoholization Module enables breweries to produce non-alcohol or very low alcohol beer without facing the heavy capital investments typically required for such applications. The cost- and energy-efficient de-alcoholization concept provides chilled low-alcohol beer below 0.05% alcohol by volume.

This is achieved by an innovative combination of diverse technologies, from beer degassing and culinary steam generation to vacuum stripping and alcohol condensing, which work in tandem as an integrated system.

The system also produces a condensate stream composed of water, stripped alcohol and other volatiles that can be reused for ethanol production and concentration of aroma volatiles.

Applications
The de-alcoholization module is ideal for removal of alcohol from full-strength beer for the production of low-alcohol (LAB) and non-alcohol (NAB) beer.

Features and benefits
The module combines processes for effective single-pass removal of alcohol from beer at low temperature and pressure. The de-alcoholization principle uses stripping without the need for recirculation. The process is especially designed with focus on a high degree of energy recovery, minimizing thermal energy and the risk of freezing the de-alcoholized beer.

The de-alcoholization module is fully automated and includes steam-based sterilization-in-place (SIP) plus a built-in cleaning-in-place (CIP) program.

- Single-pass removal of alcohol (to <0.05% ABV) with degassing step
- Minimal thermal impact (stripping at <45 °C)
- Low energy consumption
- Sanitary design prepared for CIP and SIP
- Exceptional reliability and low maintenance
- Options: Pre-treatment with separator, final product carbonation and blending, seal water recirculation
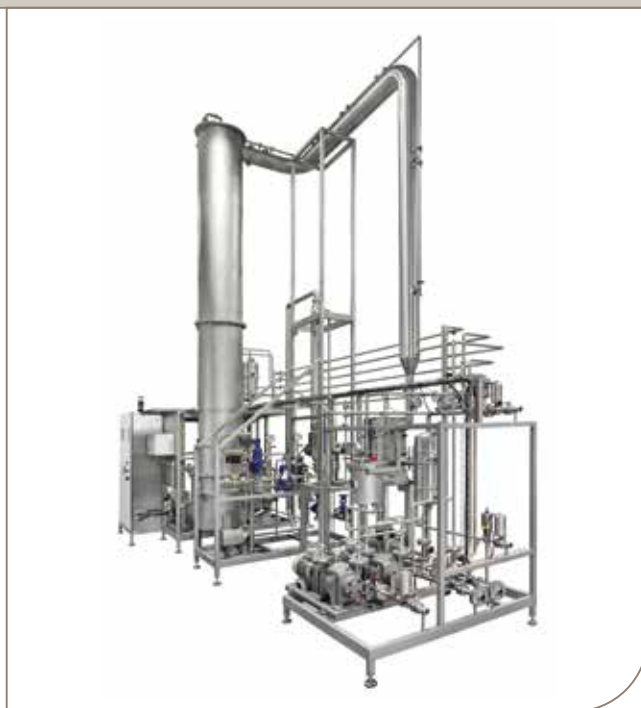
The full arrangement of the Alfa Laval De-alcoholization Module

How it works – alcohol removal and condensate cooling
The alcohol present in the feed beer is removed in a special vertical stripping column. This column makes it possible to achieve high desorption by flowing a stripping gas (culinary steam) up a tower of densely packed material under conditions that are close to a vacuum.

The production capacity is set by regulating the incoming beer flow prior to routing to the liquid distributor at the top of column. This distributor then disperses beer into the column, where it trickles downwards against the flow of the stripping gas injected at the base of the column and rising up through it.

The vapour stripped out of the beer consists of steam, alcohol and other volatiles. This vapour vents from the top of the column and a plate heat exchanger is then used to cool the vapour into an alcohol condensate stream. A final vacuum phase removes any remaining non-condensable volatiles. A glycol-side recirculation pump minimizes any risk of the stripped vapour stream freezing during condensing.

The process sections of Alfa Laval De-alcoholization Module – deassing (right), alcohol removal & culinary steam generation (middle) and condensate cooling (left).

One key benefit of this stripping principle is its exceptionally effective alcohol removal at low temperature and pressure. This does away with any need for recirculation to achieve the required specifications for the final de-alcoholized beer.

If any additional stripping is required, for whatever reason, the system includes a recirculation loop for sending stripped beer back to the column. Stripping efficiency can also be boosted by regulating the temperature of the beer before it is passed into the column, or by altering the pressure in the system.

How it works – the specifics
The overall efficiency of the Alfa Laval De-alcoholization module stems from the effective integration of multiple Alfa Laval technologies.

Gentle heating with high recovery
Final heating to the temperature required during alcohol stripping takes place in a dedicated heating section. To minimize product degradation from exposure to high temperature, the heating section re-circulates water through a brazed plate heat exchanger that is fed with steam.

To ensure a high degree of energy recovery and keep the need for costly thermal inputs to a minimum, the warm outgoing flow of de-alcoholized beer is used to heat the feed beer, using an energy-efficient Alfa Laval plate heat exchanger.

Beer degassing
The carbonation level of the feed beer is reduced by degassing in a low-pressure chamber installed upstream of the stripping column. The degassing prevents formation of foam when distributing the beer at the top of the column.

A chilled separator vessel returns condensable flavour vapours removed during degassing to the feed beer stream.

Culinary steam generation
The module includes a culinary-quality steam generator based on the heating of deaerated water in a shell-and-tube or plate heat exchanger supplied with steam.

The steam that is produced serves as the stripping gas that enters the base of the column during the stripping process.

Chilling
The dealcoholized beer is cooled to the required outlet temperature in a glycol-fed cooling section integrated into the module's plate heat exchanger that is part of the de-alcoholization module.

The cooling system is designed to minimize any risk of the de-alcoholized beer freezing during the chilling phase.

Control and automation
The module is fully automated, with all operations controlled via a local PLC Siemens system (with remote connection to SCADA).

Specific functions and operating procedures can be selected via an easy-to-use colour touch panel, which displays a comprehensive array of process data (including current status, actual and set point temperatures, alarm conditions and controller settings).

The de-alcoholization module's condensate cooling section

Cleaning-in-place

The module is designed to ensure effective cleaning-in-place (CIP) of all contact surfaces and is equipped with a built-in CIP programme.

The module also features steam-based sterilization-in-place (SIP) of both the stripping column and the vapour lines leading to the vapour condenser.

The cleaning frequency required depends on a combination of beer quality and specifications, and the type of impurities to be removed. However, a typical recommended routine would involve CIP with caustic acid twice per week and SIP once per week, followed by acid cleaning twice a month. If exceptional fouling is encountered, flooding the entire stripping column with lye overnight is recommended.

Hygiene

To ensure full compliance with international food industry regulations and hygiene requirements, all components that come into contact with process liquids are made of stainless steel, with heat resistant seals.

Flowchart for the de-alcoholization module, featuring the four process sections: alcohol removal, degassing, culinary steam generation and condensate cooling.
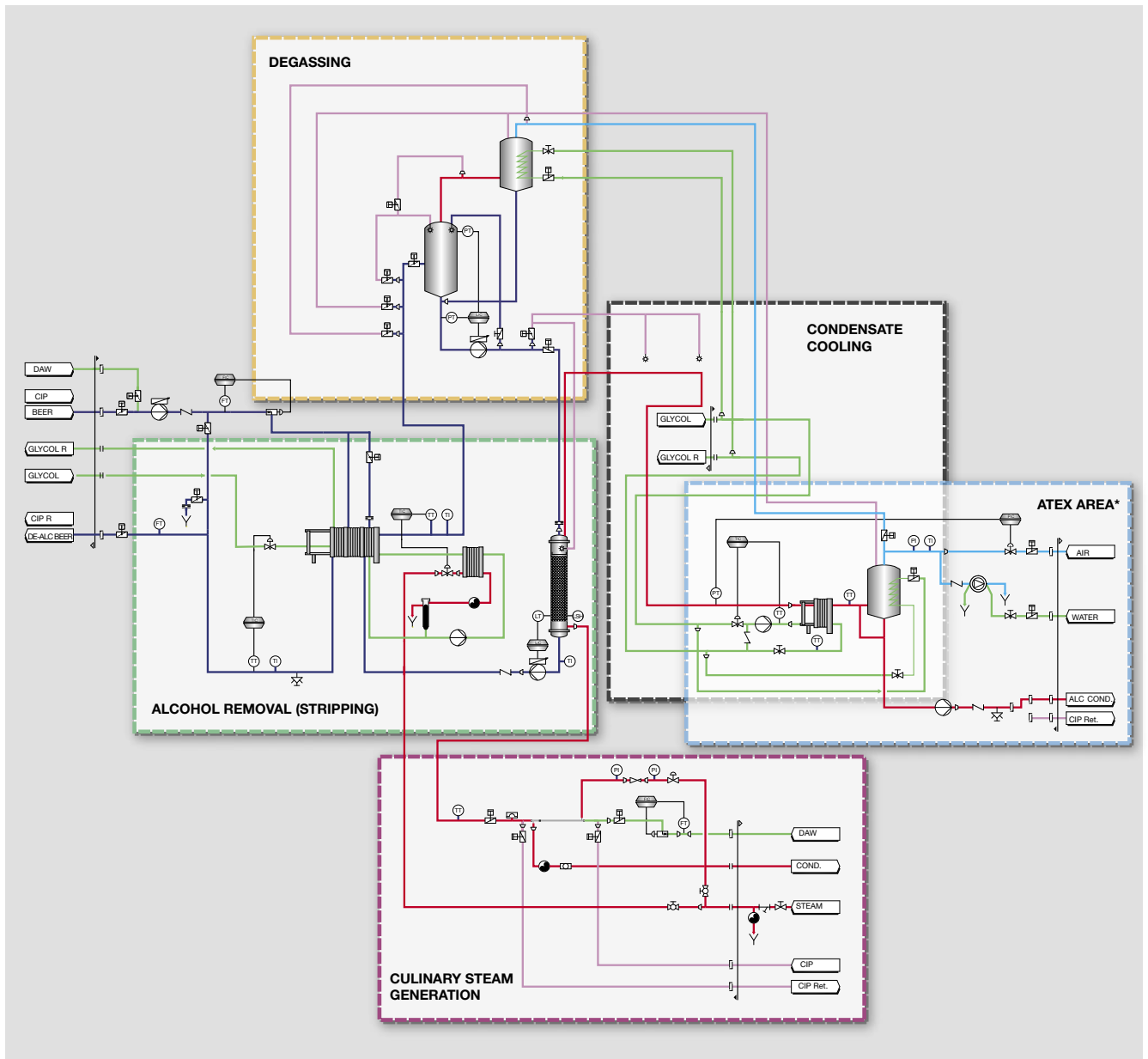
*Components located in the ATEX area comply with hazardous area requirements (ATEX Class II 2G).

Technical specifications

Energy consumption depends on the particular specifications of the de-alcoholization process. The following figures apply to a fixed feed beer flow with an inlet/outlet temperature of 2 to 4°C, which has the following specifications:

Feed beer (alcohol by volume)	4.5 to 8.0% ABV*
Exit beer	<0.05% ABV
Capacity range	5 to 100 hl/h* (6 to 117 bbl/h)
Deaerated water	2 to 20 hl/h (1 to 10 gpm)
Heating	200 to 2500 kg/h (600 lb/h 7500 lb/h)
Cooling (of product & condensing)	241 to 1800 kW (822,300 to 2500 BTU/h)
Seal water for vacuum system	~10 to 20 hl/h (4.4 to 9 gpm) **
Electricity installed/operating	18/11 kW to 35/21 (24/15 to 47/28 HP)
Instrument air	~ 1 m³/h (2,120 cfm)

* Final alcohol by volume (ABV) and NAB/LAB capacity will depend on feed beer alcohol, CO_2 content.

** Can be decreased if re-circulated.

Nominal capacity

The standard capacities can range from 5 to 100 hl/h and will depend on the target alcohol by volume in the feed beer and the final beer, as well as the stripping pressure and operating temperature. The throughput can be increased by lowering the stripping pressure, increasing the operating temperature and/or tuning the final target alcohol reduction target.

Nominal stripping pressure	10 to 12 kPa (1.5 to 1.7 psi)
Operating temperature	44 to 48°C (111 to 118°F)

Approximate dimensions (W x L x H)

The Alfa Laval de-alcoholization module has two parts, the degassing/stripping/steam generation section (which includes the control panel) and the condensing section, as dimensioned below, as example, for 15 hl/h case.

Section	Width in mm (inches)		Length in mm (inches)		Height in mm (inches)	
Degassing, alcohol removal (stripping) and culinary steam generation (A)	2,210	(87.0)	3,810	(150.0)	6,310	(248.4)
Condensate cooling incl. vacuum phase (B)	1,500	(59.1)	2,430	(95.6)	3,750	(147.6)

A   B

A   B
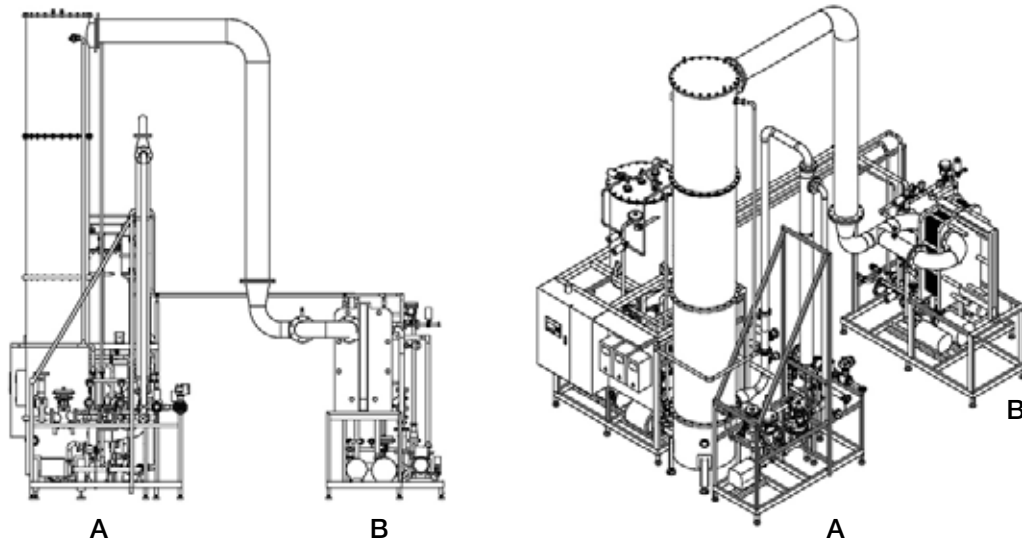
Alfa Laval reserves the right to change specifications without prior notification.

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