

Alfa Laval De-alcoholisation module

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

Introduction

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 a 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.

Application

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.

Benefits

- Single-pass removal of alcohol (to <0.05% ABV) with degassing step
- Minimal thermal impact (stripping at low temperature)
- Low energy consumption
- Sanitary design prepared for CIP and SIP
- Exceptional reliability and low maintenance.

Design

The De-alcoholization 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.

Options

- Pre-treatment with separator
- Final product carbonation and blending
- Seal water recirculation.

Working principle

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 the 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. 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.



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

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 recirculates 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 and aroma recovery: 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 aroma 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 soft 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 de-alcoholized 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).

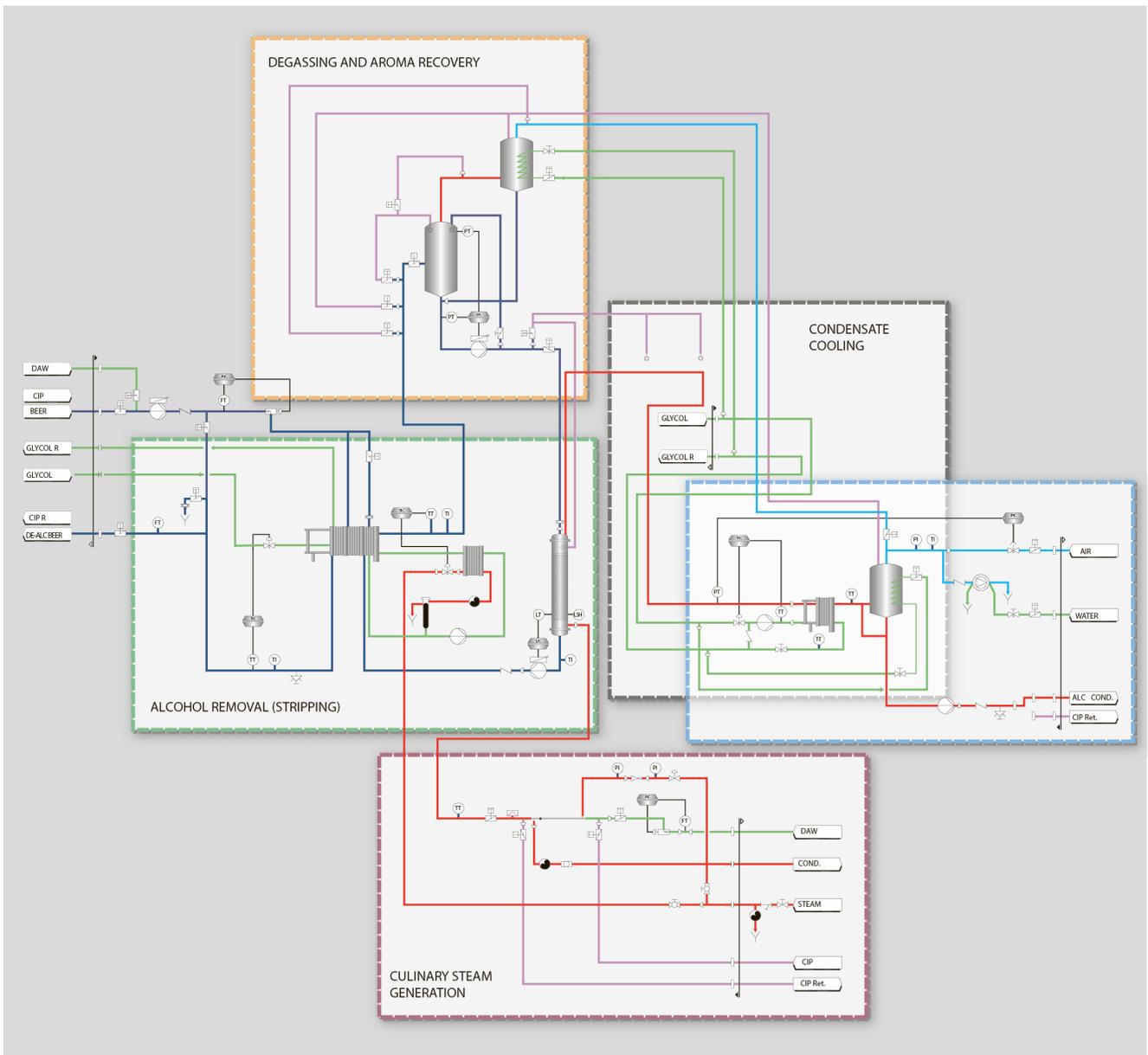
Specific functions and operating procedures can be selected via an easy-to-use colour touch panel, which displays a comprehensive array of process data (including current status, actual and set point temperatures, alarm conditions and controller settings).

Cleaning-in-place: The De-alcoholization module is equipped with a built-in cleaning-in-place (CIP) programme and 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.



The De-alcoholization module's condensate cooling section.



Flowchart for the De-alcoholization module, featuring the major process sections: alcohol removal, degassing and aroma recovery, culinary steam generation and condensate cooling.

Technical data

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 ¹
Exit beer	<0.05% ABV
Capacity range	5 to 100 hl/h ¹ (6 to 117 bbl/h)
Soft water	2 to 16 hl/h (1 to 8 gpm)
Heating ²	100 to 1950 kg/h (300 lb/h 5850 lb/h)
Cooling (of product & condensing) ²	70 to 1170 kW (240 to 4000 mBTU/h)
Seal water for vacuum system	~ 10 to 20 hl/h (4.4 to 9 gpm) ³
Electricity installed/operating	13/8 to 48/30 kW (17/11 to 64/40 HP)
Instrument air	~ 1 m ³ /h (2,120 cfm)

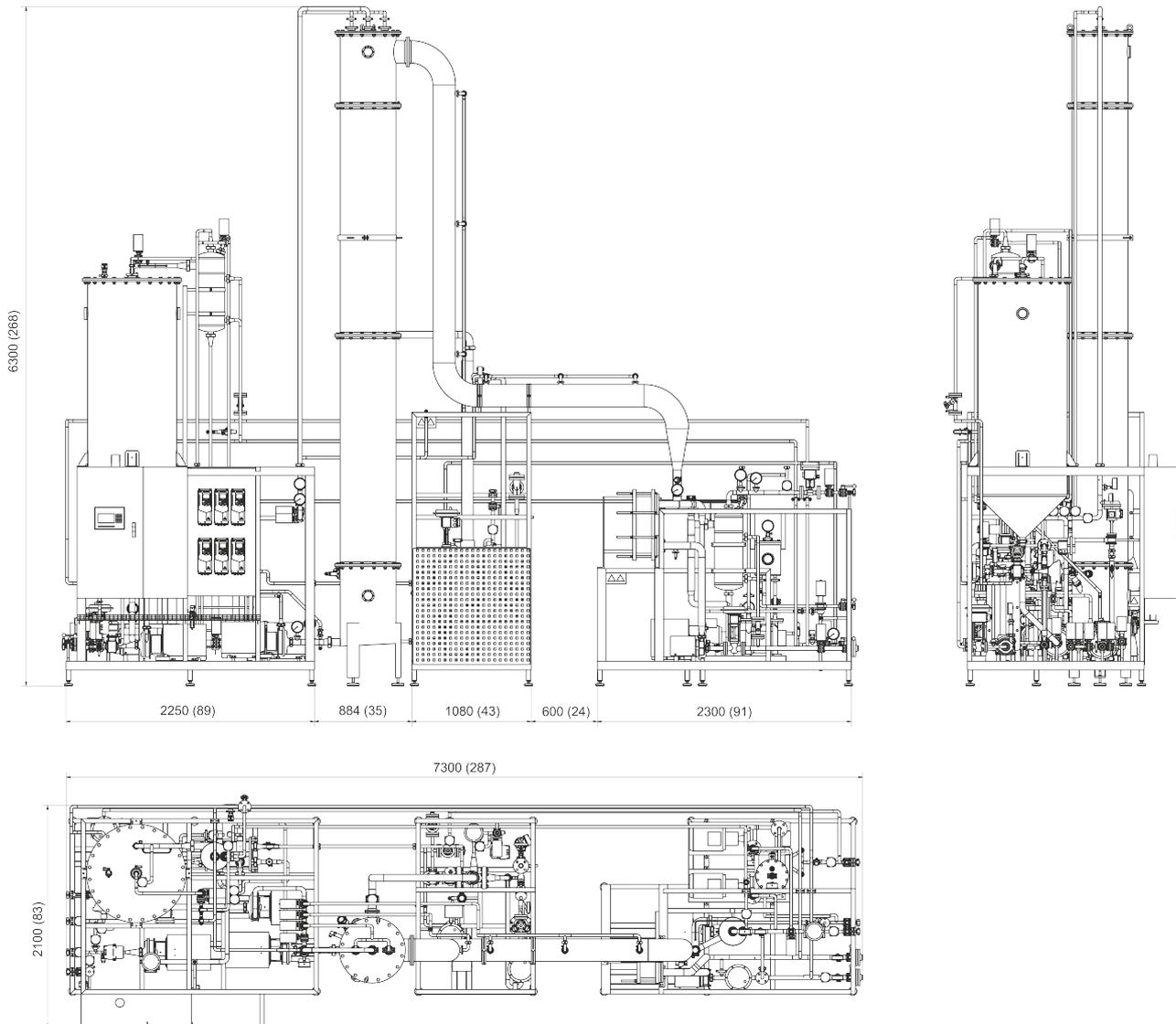
¹ Final alcohol by volume (ABV) and NAB/LAB capacity will depend on feed beer alcohol and CO₂ content.

² Steady state operation.

³ 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 alcohol reduction target.

Nominal stripping pressure	10 to 11 kPa (1.5 to 1.6 psi)
Operating temperature	~ 40 °C (104°F)



The Alfa Laval De-alcoholization module is fully assembled and dimensioned as shown above, as example, for the 10 hl/h case. Dimensions are indicative in mm (inches).

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