Aroma-Preserving Dealcoholization for Wellbeing Brewery

BREW WELL TO BE WELL | For many, beer is that must-have drink for the weekend and that small antidote after a stressful day. However, for Jeff Stevens, the relationship between himself and alcohol would never find common ground. In January 2017, Jeff left the world of alcoholic beverages and founded the Wellbeing Brewing Company in Maryland Heights, USA.

ALONG WITH HIS WIFE, Genevieve, the couple is excited to present the world's first brewing company "solely dedicated to brewing beers and tonics with no alcohol to meet the growing demand of healthy adult drinking alternatives and lower alcohol consumption worldwide" [1].

Jeff works alongside Jim Gorczyca, CEO of O'Fallon Brewery since May 2011 [2], and uses the latest technology for his non-alcoholic (NA) craft beer. Wellbeing speaks of their process as "high vacuum culling" to describe gently floating out the alcohol, after the beer has been fully brewed [3]. This feat is accomplished using a state of the art DeAlcoTec system designed and manufactured by Centec.

For more than 40 years, Centec has been standing for fully automatic, skid-mounted process systems and high precision measurement technology from a single source. Our systems and sensors are designed to perfectly meet the most demanding requirements of breweries and food and beverage manufacturers.

Jeff is proud that Wellbeing is one of the first craft breweries in the US that use a vacuum distillation machine. Heather Riske, digital editor for Feast Magazine, shares a few reasons why Jeff chose this unique form of technology: Many NA beers taste sweet, as if they contain a teaspoon of sugar. Jeff thinks this is due in part to the way most breweries process the beer, by limiting the fermentation, and/or stopping the fermentation. When this is complete, the sugars cannot ferment, leaving no alcohol in the beer. While a NA drink is the outcome, this usually creates a 'worty taste' and the flavor of the beer is ruined. The technology that Jeff uses allows the beer to boil at approximately room temperature, completely avoiding the risk of ruining the beer [4].

System Design

The "DeAlcoTec 5" system commissioned at Wellbeing Brewing Company produces up to 5 hl/h of non-alcoholic beer and consists of the following components: Product de-aeration, dealcoholization, aroma recovery, carbonation, instrumentation, automation and product de-aeration.

As the solubility of gases in liquids decreases with increasing temperature, the alcoholic beer is first heated. For this purpose, it flows before degassing through a regenerative plate heat exchanger in counter current to the warm, dealcoholized product. The removal of carbon dioxide from the beer is required to avoid the formation of foam in the dealcoholization column. It is based on the principle of vacuum degassing. The beer is sprayed via a spray ball into a

Fig 1
Optical oxygen sensor (OXYTRANS)
Photo: Centec LLC

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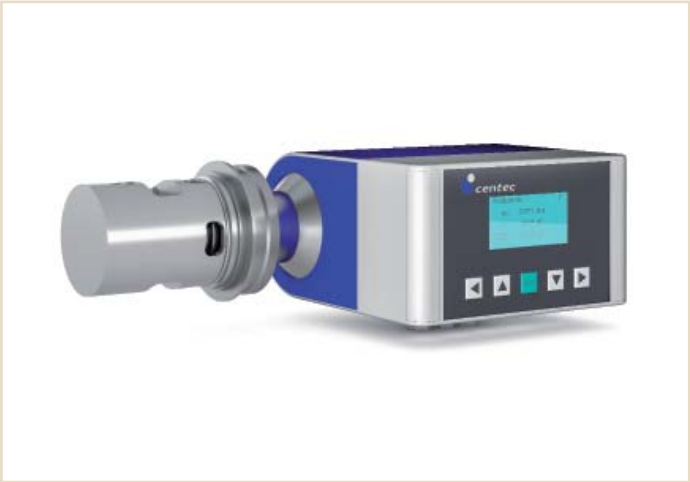

Fig. 2 High precision CO_2 sensor (CARBOTEC) *Photo: Centec LLC*

Fig. 3 This high precision sensor measures alcohol, extract and original gravity (BEER MONITOR) *Photo: Centec LLC*

vacuum container, the "degasser". According to "Henry's Law", the carbon dioxide is expelled.

Dealcoholization

After degassing, the product is dispersed at the top of a specially designed evaporation column. Exhaust vapors are fed into the bottom of the column. They rise upwards inside the column in counter current to the falling warm liquid. Thereby, they remove the volatile alcohol from the product. The less volatile components fall to the column base and flow into the falling film evaporator that generates the exhaust vapor. Densely packed, thin stainless steel sheets in the column maximize the transfer surface and the contact time between product and exhaust vapors. The complete process takes place under vacuum. The particular benefit of this technology is the gentle processing at low temperature with a short retention time, which optimizes the product's characteristic flavor and taste profile. The remaining completely alcohol-free beer is cooled in counter current to the regeneration zone and regulated by means of glycol to the final temperature. After the taste has been optimized by adding flavor or original beer, the carbonation of the final product takes place. The exhaust vapor is produced directly from warm, alcohol-free beer. Therefore, hot steam available in the brewery is used. When leaving the column, the exhaust vapor has an alcohol content of about 30 - 35 vol%. In addition, it contains taste-relevant aroma components that have been removed from the beer.

Aroma Recovery

The alcohol and aroma containing exhaust vapor is introduced into a water-cooled reflux condenser, which is operated in a closed circuit with the dealcoholization column. The aroma components are volatile and therefore can be separated from the alcohol. In the glycol-cooled aroma recovery unit, the aroma components are absorbed in degassed water. The degassed water flows in the circuit until it contains a certain concentration of aroma components. This resulting "aroma water" is then added to the dealcoholized beer for flavor optimization. For further taste optimization, the non-alcoholic product can also be mixed with original beer (mother beer dosage).

Carbonation

The Centec carbonator is a fully automated system that increases the CO_2 content of dealcoholized beer to a set point. The plant has a high precision in-line CO_2 analyzer (CARBOTEC) to determine the CO_2 concentration in the product after carbonation. The CO_2 sensors continuously measure carbon dioxide levels in carbonated liquids. A digital controller compares the measured CO_2 values with the set point and adapts the added amount of CO_2 instantaneously. The carbon dioxide is introduced into the product via Centec's special CO_2 injectors, known as vortex venturi nozzles. The CO_2 is injected from up to ten different directions in tiny bubbles into the fast streaming beer. As a result, the carbon dioxide dissolves quickly and completely in the product and the carbonization is free of losses.

Instrumentation

For measuring carbon dioxide, the carbonated liquid flows through the head (measurement chamber) of the CO_2 sensor. Several times per minute the chamber is closed and its volume rapidly increases. This expansion generates a gas phase in the chamber. The large partial pressure difference of CO_2 forces the carbon dioxide out of the sample (liquid in the chamber) into the gas phase. This fundamental principle is described by "Henry's Law". Within seconds pressure equilibrium in the measurement

Fig. 4 From the left: Devon Verhoff, Trey Chatman, Luke Backer, Brian Owens of O'Fallon Brewery and Manuel Kullick of Centec *Photo: Wellbeing Brewing Company*

Fig. 5 From the left: Philippe Knall of Centec LLC and Jeff Stevens of Wellbeing Brewing Company *Photo: Wellbeing Brewing Company*

chamber is reached. The equilibrium pressure corresponds to the content of CO_2 in the sample. The CO_2 content is determined by pressure and temperature measurement in the chamber. Any temperature drifts of the measured signal are automatically compensated for. After each measurement the sample is completely returned to the product without any loss. The sensors cover a measuring range of 0 to 10 g/l with a measuring accuracy of ± 0.05 g/l.

A high precision beer monitor from Centec allows measuring alcohol and extract simultaneously. The original gravity is automatically calculated and displayed by the sensor. The instrument combines density and sound velocity measurement. The density measurement is based on the oscillating U-tube principle. For sound velocity measurement a sound pulse is created by a sonic transmitter and detected by a sonic receiver. As a specific property of each liquid, the correlation between concentration and density resp. sound velocity can be described by a mathematical polynomial. The BEER MONITOR measures the alcohol content in the range of 0 to 12.5 vol. % (± 0.02 vol. %) and the original gravity from 0 to 25 °Plato (± 0.03 °Plato).

An optical oxygen sensor from Centec (OXYTRANS) permanently monitors the oxygen content in the beer before it leaves the system. In the measurement range from 1 ppb to 2 ppm, this sensor can detect oxygen in the liquid product with an accuracy of ± 1 ppb. The measurement technology is based on the radiationless redistribution of excitation energy via molecular interaction. In the measuring head a small glass component with a thin layer of indicator molecules is installed, the optical window. The indicator molecules are illuminated with blue-green light produced by an LED in the sensor. They absorb the incident light and are promoted to a higher energy state. After a certain time the molecules convert back to their ground state, during which red light is emitted. The red light is detected inside in the sensor. If O_2 molecules are present the energy is transferred from the excited indicator molecules to the oxygen. The detected signal decreases with increasing concentration of O_2 molecules in the product. Other gases don't absorb this energy, so they have no impact on the measurement result.

The entire dealcoholization system is CIP-cleanable and equipped with a Siemens SIMATIC S7 controller.

Summary

Like every brewery, Wellbeing is active in distribution and marketing, using the ability to ship directly to its customers, giving them a distribution boost [5]. With 13 states ready to purchase the NA craft beer, Wellbeing is looking to have additional states on their customer and consumer list.

Jeff is confident of his product, and seeks to "take advantage of our first mover position, build a NA community, and develop retailer and wholesaler relationships" [6]. Centec is excited to be a part of this endeavor, wishing all the best to Wellbeing Brewing Company – "Brew well to be well" [7]. ■

Technical Data "DeAlcoTec 5"
Output: 5 hl/h (non-alcoholic beer)
Initial alcohol content: 3.5 - 6.0 vol. %
Residual alcohol content: up to 0.05 vol. %
CO_2 content: max. 6 g/l

Sources

1. Stevens, J.: Our Story, accessed January 16, 2018, URL: https://wellbeingbrewing.com/#our-story.
2. Gorczyca, J.: Know Us, About Us, O'Fallon Brewery, accessed January 16, 2018, URL: http://ofallonbrewery.com/know-us/.
3. Wellbeing BrewingCompany, "Wellbeing Brewing Company Introductory Deck.pdf" accessed January 16, 2018, p. 9, URL: https://wellbeingbrewing.com.
4. Riske. H.: "How Jeff Stevens Built Wellbeing Brewing Co., the Country's First Nonalcoholic Craft Brewery", December 28, 2018, URL: http://www.feastmagazine.com/drink/drink_st_louis/artical_a10bb27e-0a1e-11e9-aba0-e760381efcd6.html.
5. Wellbeing Brewing Company, "Wellbeing Brewing Company Introductory Deck.pdf" accessed January 16, 2018, p 8, URL: https://wellbeingbrewing.com.
6. Wellbeing Brewing Company, "One Pager.pdf", accessed January 16, 2018, p. 1.
7. Wellbeing Brewing Company, "Wellbeing Brewing Company Introductory Deck.pdf" accessed January 16, 2018, p. 20, https://wellbeingbrewing.com.

Fig. 6 Alcohol-free Golden Wheat and Dark Amber *Photo: Wellbeing Brewing Company*