Installing a MultiMixer system at Distell Springs

LARGE-SCALE PROJECT | For years now, a diverse range of beverage products containing alcohol has fueled continuous growth in the segment. "Ready-to-drink" products (RTDs) include beer and cider as well as other beverages containing alcohol mixed with sodas, fruit juices or other non-alcoholic drinks. In South Africa, RTDs are in high demand. The Distell Group is one of Africa's leading producers of spirits, premium wines, ciders and other RTDs. This case study describes the conversion of the production at the Distell Springs facility from a batch process to an in-line process which is controlled by measurement of the concentration in degrees Brix.

FOR MORE THAN 40 YEARS, Centec has been a trusted supplier of fully automatic, skid-mounted process equipment and high precision measurement technology – all from a single source. Their systems and sensors are designed to perfectly meet the most demanding requirements of breweries and food and beverage manufacturers.

The company was contracted to deliver the following equipment as part of the Distell Springs project:

- 150 hl/h column water deaeration unit with UV disinfection and storage tank;
- 400 hl/h mixing unit for fruit juice;
- 400 hl/h aeration unit for fruit juice;
- 430 hl/h mixing system incorporating up to 13 different liquid product streams.

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Centec incorporated sensors from its own manufacturing line in the processing equipment. The oxygen sensor can detect concentrations from 1 ppb to 2 ppm with an accuracy of ± 1 ppb. Alcohol can be measured over a range of 0 to 100 % by volume with an accuracy of ± 0.02 %. The sensor for determining °Brix has a measuring range of 0 to 80 °Brix with an accuracy of ± 0.02 °Brix.

Column water deaeration unit

In order to produce high quality beverages with long shelf life, the oxygen content of the water must be reduced to a very low concentration. The water deaeration process takes place at ambient temperatures. To begin, the water is distributed throughout the upper portion of the column. The column contains densely packed, thin stainless steel sheets arranged in such a pattern that the water is forced to take many routes as it flows downwards through the column (fig. 1). This maximizes the surface area for gas transfer and the contact time between the water and the stripping gas (CO_2). The stripping gas is fed into the base of the column and rises upwards through the column, countercurrent to the flow of the water. The significant difference in partial pressure drives the oxygen from the water and into the gas phase. At the top of the column, the oxygen removed from the water exits the system in the gaseous state along with the residual stripping gas. The water reaching the base of the column has an oxygen content of less than 30 ppb. From there, it passes through a UV system for disinfection and flows to a 350 hl storage tank. The entire production facility is supplied with deaerated process water from this storage tank. The water is transported under a pressure of three bars to various extraction points throughout the facility.

The oxygen concentration in the degassed water is constantly monitored using Oxytrans, an optical oxygen sensor from Centec (fig. 2). The sensor can detect and measure concentrations of oxygen in water between 1 ppb and 2 ppm with an accuracy

Fig. 1 Column water deaeration unit

Fig. 2
Optical oxygen sensor developed by Centec (OXYTRANS)

of ± 1 ppb. The optical technology is based on the energy released through a phase change, which is redistributed through molecular interaction without radiation. A small glass component with a thin layer of indicator molecules, an "optical window" of sorts, is installed in the measuring head of the device. The indicator molecules are exposed to a blue-green light source which is generated by an LED in the sensor. The molecules absorb the incident light. The resultant excitation elevates the molecules to a higher energy state. After a defined period of time has elapsed, the molecules revert to their ground state, causing the emission of red light that is then detected by the sensor.

If O_2 molecules are present, the energy from the excited indicator molecules is transferred to the oxygen. The detection signal from the sensor weakens as the concentration of O_2 molecules increases in the product. Other gases do not absorb this energy, and therefore, they do not affect the measurement results.

Mixing unit for fruit juice

Each recipe is based on a specific ratio of various ingredients. If a specific recipe is selected while the system is in operation, the entire mixing procedure is carried out automatically. Coriolis mass flow meters are employed for high precision process control.

Flow meters, which operate based on the Coriolis principle, contain measuring tubes which vibrate when acted upon by a force. When a medium flows through a vibrating tube, Coriolis forces are generated which bend the tube. Sensors detect the change in the vibrational frequency of the tube. The phase shift of the sensor signals is directly proportional to the mass flow. The density of the medium can be determined using the vibrational frequency of the measuring tubes. Mass flow meters can also measure the temperature of the medium. A microprocessor converts the digital signals to document the mass flow, density and temperature of a medium. After a recipe is selected, the flow of input streams is accurately controlled at all times, while automatically compensating for any effects due to any differences in temperature which may occur. To avoid dead spaces, the process system is equipped with mix-proof double-seated valve technology.

A Combitec in-line sensor developed by Centec is employed to ensure that the final product always contains the exact sucrose content specified for fermentation. The Combitec sensor is perfectly suited for three-stream systems and is capable of determining density, concentration and the speed of sound simultaneously.

The density measurement is based on the oscillating U-tube principle. To measure the sound velocity, a sonic pulse is generated by an ultrasonic transmitter and detected by an ultrasonic receiver. The relationship between concentration and density or speed of sound is a property specific to each fluid and can be described by a mathematical polynomial.

In an aqueous solution, sucrose splits into glucose and fructose. This reversible process is known as "hydrolysis". With the Combitec device, it is possible to measure the individual components and to determine the sucrose content with an accuracy of ± 0.02 °Brix. After mixing, the product is pasteurized and then aerated.

Aeration unit for fruit juice

Fruit juice is aerated to increase the activity of the yeast and start the fermentation process. The unit is equipped with a specially dimensioned Vortex-Venturi injector to aerate the product (fig. 3). A very large number of tiny oxygen bubbles are injected directly into the product stream with this unit. The oxygen dissolves completely in the medium due to high pressure and turbulent

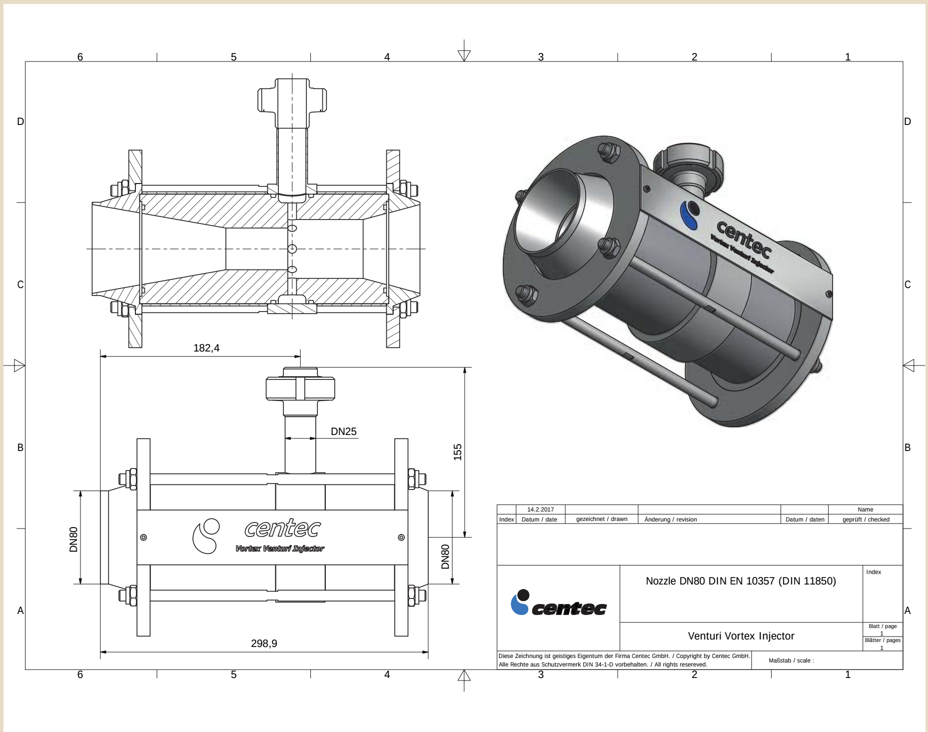

Fig. 3 Vortex-Venturi injector for aerating fruit juice

Fig. 4
Centec's high precision sensor for measuring alcohol and concentration in °Brix (COMBITEC)

Fig. 5
Mixing system capable of incorporating thirteen liquid product streams

flow conditions. A control valve is installed at the end of the segment where the oxygen goes into solution. This valve maintains a constant pressure within the system, above the saturation pressure. In order to precisely control the target flow of both fruit juice and oxygen, the air runs through a Coriolis mass flowmeter with an accuracy of ± 0.5 % v. M., while the fruit juice flows through a magnetic-inductive flowmeter which has an accuracy of ± 0.2 v. M. The aerated juice destined for cider production has an oxygen content of 20 mg/l. The juice passes through the yeast dosing station on its way to the fermentation tanks.

Mixing up to 13 different product streams

The mixing system for Distell Springs is one of the largest process systems that Centec has ever manufactured and commissioned. In the first phase of the project, a system was designed and constructed to enable a fermented product to be mixed with up to eight different streams of liquid ingredients. Today, after undergoing expansion, this system is now capable of mixing a total of thirteen different streams with a fermented product (fig. 4).

The individual streams feeding into the system are equipped with Coriolis mass flow meters, which are accurate to ± 0.1 % by mass. vol. M. For every recipe formulation, the proportions are specified for each stream, allowing the target ratios to be reliably achieved with automatic compensation for any fluctuations in temperature. Here, mix-proof, double-seated valve technology is utilized as well.

The concentration of alcohol and °Brix are measured in the finished products using an in-line Combitec sensor integrated into the mixing system (fig. 5). Centec's own measuring device is used for process control. Measurements of the finished products are accurate to ± 0.025 % by volume for alcohol and to ± 0.03 °Brix.

All systems can be cleaned by means of CIP and are equipped with a Siemens Simatic S7 controller. Prior to their shipment to South Africa, they were subjected to a Factory Acceptance Test at our manufacturing facility. A VPN router allows remote access to the system via the internet at any time.

Summary

Two packaging lines with a capacity of 30 million litres per year were installed and commissioned at Distell Springs in Gauteng back in 1995. Since that time, it has undergone constant expansion. Currently, it is Distells' largest RTD facility, featuring seven packaging lines as well as a fully automated RTD and cider processing plant.

The system was built and commissioned in 2014/2015. This phase of expansion revolutionized the production of RTD beverages. Along with the 13-stream beverage mixing system, Centec also installed a column water deaeration unit as well as equipment for mixing and aerating fruit juice. The project was carried out by Centec in close partnership with High-Tech Processing, a South African supplier of systems for the brewing and beverage industry who offers a wide range of technical solutions for customers on the African continent, in Eastern Europe and the Middle East. These include the engineering and design of processing plants, consulting, project management and complete turnkey installations.

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