



White Paper: On-Line Fermentation Monitoring of Extract and Ethanol for Automatic Fermentation Control

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Summary: *This study demonstrates that the sensor technology from BevSense LLC can be used for on-line measurement of real extract and ethanol during beer fermentation.*

The implementation of this technology, in combination with the Iso-Mix Rotary Jet Mixing System from Alfa Laval, allows for the automatic adjustment of flow rate and start/stop of the Rotary Jet Mixer (RJM). Therefore, the RJM can be operated automatically providing the lowest possible fermentation time. The sensor technology also enables automatic calculation of the time for cropping, and consequently the possibility of an automated cropping procedure.

The sensor probe can be installed directly in the fermentation tank wall or integrated into a Scandi Brew® Centralised Sampling System, thereby allowing a single sensor to be used for automatic measurement on multiple tanks.

Installation and Methodology

A BevSense LLC VS-3000BM•SS sensor for measurement of real extract and ethanol using the Attenuated Total Reflection Mid-Infrared (MIR) technique was installed into the tank wall of a cylindroconical fermentation tank with a working volume of ~ 5000 hL. The sensor was connected to a VS-300 Sensor Management Station. The station displays the output of the concentrations of real extract and ethanol, as well as of original extract (OE), specific gravity (SG), and real degree of fermentation (RDF) that are inferred from the measurements of real extract and ethanol. Furthermore, the signals can be transmitted to the brewery control system through 4-20 mA output or Profibus DP. It is also possible to communicate with the station through Ethernet/IP.

The sensor was trialled in a brewery operating with markedly different wort compositions. The sensor was calibrated to laboratory data by taking samples regularly and measuring these on a laboratory Near-Infrared (NIR) / density meter to quantify ethanol and real extract.

Results

It was found that the sensor measurements required individual sensor calibrations for fermentations having markedly different wort compositions, but measurements of fermentations of relatively similar wort compositions could be performed using a single, common calibration.

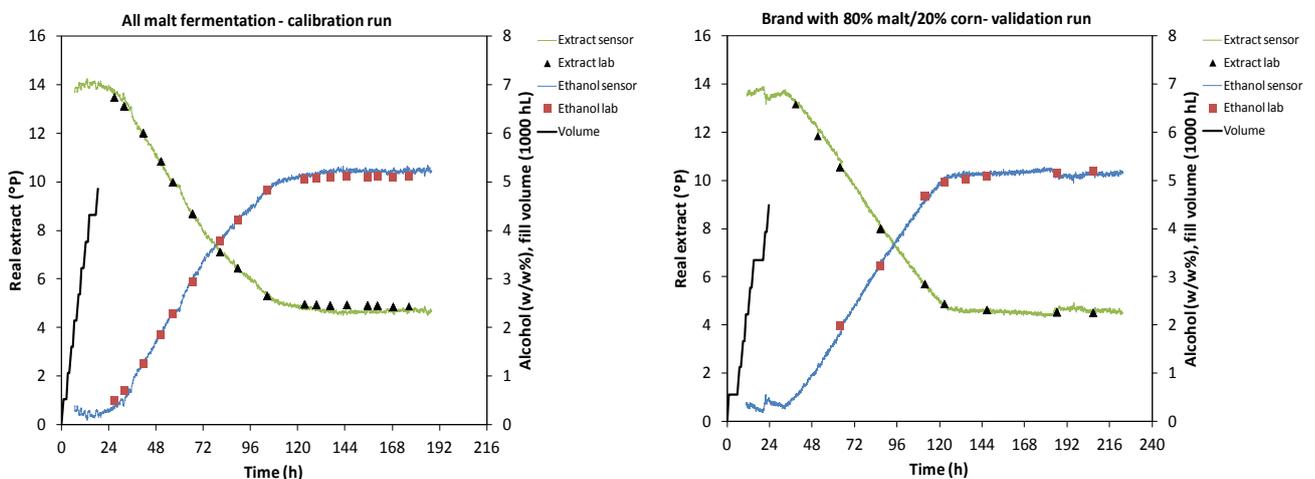


Figure 1. Sensor measurements and laboratory measurements of ethanol and real extract for one of the three fermentations utilized to calibrate the sensor to two 14.5°P brands (left). Sensor measurements and laboratory measurements for a fermentation that was not included in the set of fermentations used to calibrate the sensor (right).



For example it was found that an all-malt brand with an OE of 14.5°P could 'share' a single calibration with a wort composition containing 80 percent malt and 20 percent corn grits, also with an OE of 14.5°P. A total of three fermentations were used to produce a common calibration of the sensor for these brands. The results of one of these calibration runs are depicted in Figure 1 (left). The figure shows that there was good correspondence between laboratory data and sensor measurements. The same also applied for fermentations following the calibration runs, illustrated in Figure 1 (right).

Conclusion and Benefits

The results illustrate that the sensor from BevSense LLC can be used for on-line measurement of real extract and ethanol during fermentation. This technology provides the following new opportunities:

- **Automatic control of the Iso-Mix system from Alfa Laval**

The on-line measurements can be used to control the flow rate and start/stop of the Iso-Mix system. In combination with an optimisation scheme, this configuration allows automatic operation in the mode giving the shortest possible cycle time.

- **Automatic cropping and fermentation profile tracking**

The time for cropping can be automatically calculated and initiated using this system. Furthermore, the sensor installation enables the implementation of a scheme in which temperature is adjusted within an allowed band, with the objective of the fermentation profile following a preset pattern.

- **Single sensor for multiple tanks when build into a Scandi Brew[®] Centralised Sampling System.**

The sensor technology can be integrated into a Scandi Brew[®] Centralised Sampling System, thereby allowing a single sensor to be used for automatic measurement on multiple tanks.

- **Less manpower needed for fermenter sampling**

The development in real and/or apparent extract and ethanol can be followed from the control room.

For more information please contact

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About Alfa Laval

Alfa Laval is a leading global provider of specialized products and engineering solutions based on its key technologies of heat transfer, separation and fluid handling.

The company's equipment, systems and services are dedicated to assisting customers in optimizing the performance of their processes. The solutions help them to heat, cool, separate and transport products in industries that produce food and beverages, chemicals and petrochemicals, pharmaceuticals, starch, sugar and ethanol.

Alfa Laval's products are also used in power plants, aboard ships, in the mechanical engineering industry, in the mining industry and for wastewater treatment, as well as for comfort climate and refrigeration applications. Alfa Laval's worldwide organization works closely with customers in nearly 100 countries to help them stay ahead in the global arena.

Alfa Laval is listed on Nasdaq OMX, and, in 2012, posted annual sales of about SEK 29.8 billion (approx. 3.5 billion Euros). The company has today about 16,400 employees.

For more information about Alfa Laval's process solutions, products and services, please visit www.alfalaval.com.

About BevSense LLC

BevSense LLC is an applications-specific spectroscopy company headquartered in Newton, Massachusetts USA. Founded in 2018, BevSense is dedicated to the development and production of maintenance-free Inline Infrared Sensors using proprietary mid Infrared technology.

BevSense' target markets are industries which require accurate and reliable process control measurements in real-time. BevSense products are currently used by industry leaders in beverage, food, energy and pharmaceutical production on five continents.

For more information about BevSense' solutions, products and services, please visit www.beveragesensors.com.