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Optical In-line Alcohol Measurement

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Introduction

The alcohol content of beverages is a key quality parameter of beer production. Governments qualify beers either by alcohol content or original gravity content and taxes are paid accordingly. When alcohol content is too high breweries lose money, whereas with content that is too low they violate the law.

Accurate alcohol measurement from fermentation on to filling is a critical element of the brewing process

The well-established optical alcohol measurement used in laboratory environment is transformed to an in-line application, bringing the advantages of optical alcohol measurement to the process line.

Conventional Method of In-line Alcohol Measurement

Conventional in-line methods to determine the alcohol and extract concentration in beer are based on the measurement of two independent parameters that can come :
- Density
- Ultrasonic sound speed
- Refractive index

Using a calculation model, based on the beer's properties, the alcohol and extract value is determined from two of these parameters and the original gravity is calculated.

Novel Optical Method of In-line Alcohol Measurement

For about 10 years optical technologies for measuring alcohol content has been well established in the laboratory environment, using NIR-spectroscopy.

New to brewing industry is the approach to measure alcohol optically in an in-line application using NIR-spectroscopy.

How Optical Alcohol Measurement Works
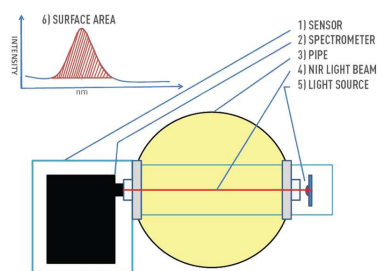
The measuring principle of the optical alcohol measurement works as follows:
- A NIR-light beam (4) that is selective for alcohol is transmitted through the beer that is running in a process line.
- The NIR-light beam is received in the spectrometer (2) and the light intensity and adsorption in the wavelength band for alcohol (6) is measured.
- The surface area within the wavelength band for alcohol is determine, which is a direct measure for the alcohol concentration.

Applications

Products
- Alcoholic and alcohol-free beers and beer-mix drinks

Process
- At critical locations in the production line where the determination of alcohol in beverages is required
- Typically after filtration, dealcoholization, carbonation, blending/mixing and in front of the filler

Calibration and Results

The in-line optical alcohol measurement is calibrated with water alcohol solutions of different alcohol concentrations.

Compared to traditional in-line measurements the direct optical measurement of alcohol is performed independent of:
- Product composition - reducing product specific calibrations or adjustments
- Dissolved gas contents like CO_2 and other gasses in beverages
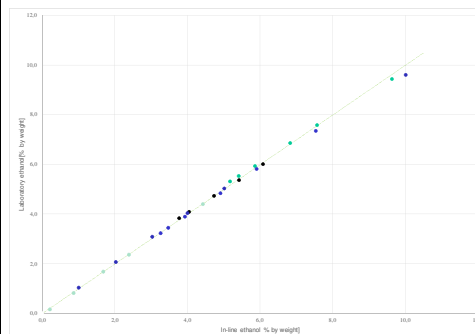
The above chart shows the measurement results of various kinds of beer and a water solution, enriched with alcohol.

In-line measurement is proven to be suited for filtered beer with turbidities below 1 EBC / 69 ASBC; beer with higher turbidity is under investigation.

Conclusion

Testing proved the optical alcohol measurement, based on NIR light, works when used as an in-line application.

As it is a direct alcohol measurement independent of product composition and dissolved gasses, the in-line optical alcohol measurement will be beneficial to the brewing and beverage industries, reducing:
- Product specific calibrations
- Operating time/expense
- Investments in CO_2 measurements for compensation purposes

This novel technology is applicable for clear beverages with an alcohol content up to 20 % w/w, incl. beers, alcohol-free beers, beer-mix drinks and other beverages.

Future R&D
- Alcohol measurements of beers with higher turbidity
- Investigation of a parameter that allows extract measurement and calculation of original gravity

Haffmans
In-line Alcohol sensor

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