



NIR Solutions for the brewing and distilling industry

Safeguard quality and yield through all the manufacturing process

NIRS to provide detailed information on raw materials, ingredients, intermediates and finished products

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Abstract

In the modern digital world, consumer product experiences are rapidly communicated to a global audience. More than ever before, the value of a brand is reflected in the quality and consistency of every single product realized into the marketplace, despite variation in raw material quality or production process.



The production of brewed and distilled beverages with consistent taste and quality requires experience and control at all stages of production, from raw material inspection to final product analysis.

Successful implementation of Near Infrared Spectroscopy (NIRS) relies on the knowledgeable application of NIR into the user value chain. Since more than 50 years BUCHI has understood the importance of forming partnerships with its customers and how to assist them meeting their goals. Hardware, software, support pre-calibrations and support underpin the NIRSolutions concept.

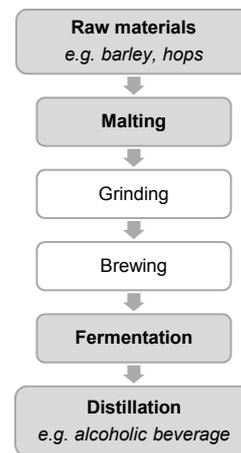
BUCHI NIRSolutions can support you to detect and minimize variations by providing analysis of key quality parameters in a matter of seconds either in the laboratory, at the point of production or providing continuous process measurement using in-line sensors.

1. Introduction

Last year the Scottish Whisky industry accounted for over £4.3 billion in global export sales. This valuable industry is currently estimated to have over 20 million casks of whisky maturing in Scotland. The value associated with this product and the considerable time related to the maturation process, means that it is hugely important that each of these casks contains well characterised whisky of the highest quality, with any variation due to raw ingredients or process well controlled and understood by the whisky manufacturer. NIRSolutions can assist with the control of these parameters by providing rapid measurement. For example, typical applications of NIR would include the analysis of moisture levels of barley or maltings

prior to storage (preventing mould growth) and measurement of nitrogen levels (which correlates to protein) in barley to ensure only raw material with high starch content is used for the fermentation process.

2. The production process



Excluding maturation and any subsequent blending processes, the distilled beverage manufacturing process is summarized in the diagram beside.

The grey tiles in the diagram show where BUCHI NIRSolutions can provide measurements.

3. Applications and parameters for rapid implementation of NIR technology

With NIR technology, the parameters of interest are calculated from signals called 'spectra' using mathematical algorithms. Commonly these algorithms are called "calibrations".

Usually calibrations have to be developed by an end-user by feeding a number of calibration samples to the spectrometer. BUCHI NIRSolutions allows the possibility to shortcut this process, using BUCHI pre-calibrations. These are based on databases which consist of thousands of spectra, taken from different geographical areas over different harvest years to included seasonal variations. The table below shows a selection of available pre-calibrations related to the distilled and brewed beverage industries.

Production step	Product	Parameters
Raw material intake	Barley	Moisture, protein and nitrogen
	Hops	Alpha and beta bitter acid, moisture and hop storage index
Malting	Malt	Total nitrogen, soluble nitrogen, moisture
Fermentation	Fermented grains	Moisture, acid, alcohol and starch
Distillation	Alcoholic beverages	Alcohol (ABV)*

*Alcohol by Volume

Table 1: NIRS tested applications for the brewery industry



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4. Laboratory and at-line analysis

BUCHI NIR Solutions for the laboratory and for the production line are based on the use of either the versatile N-500 or the robust NIRMaste spectrometers. Both are based on proven polarisation FT-NIR technology with the N-500 optimized for laboratory use and the NIRMaste designed for production environments. Polarisation spectrometers are insensitive to mechanical disturbance and do not require periodic standardization: the wavelength accuracy is assured by permanent laser aided monitoring. No controlled environments or special user conditions are required.



Figure 1: The N-500 and NIRMaste FT-NIR spectrometers

The modern clean design of both spectrometers allows simple operation reducing sample preparation time to an absolute minimum. Samples of hops, barley or other grains are simply poured into a petri dish and placed onto the top of the spectrometer. The operator simply presses a button, the sample rotates and the measurement results are presented within few seconds. If required, operation can be even faster by using a barcode reader to input the sample's information.

The flexibility of the N-500 spectrometer is demonstrated by its ability to perform the analysis of liquid samples in transmission mode, using the liquids module. This module allows the sequential analysis of up to 6 samples presented to the spectrometer using cuvettes or monouse vials.



Figure 2: NIRFlex N-500 Liquid Cell for measurement of alcohol content in transmission mode

The ability to rapidly change to liquids measurement allows the end-user to use NIRS for measurement of final product parameters such as the alcohol content. Unlike traditional alcohol determination, the measurement accuracy is independent, whoever is the operator. The sample is simply pipetted into a cuvette or a monouse glass vial and placed into the spectrometer. The NIRFlex N-500 sequentially analyzes each sample providing ABV results, with each sample taking just few seconds.

5. In-line analysis

Close monitoring of key parameters is critical to detect and correct any deviations in the manufacturing process. In contrast to laboratory based measurement, the BUCHI NIR-Online® sensors provide real-time control through continuous in-line measurement.

The NIR-Online instrument can be incorporated into the production process with a wide range of product presentation platforms. This would allow, for example, measurements in chutes and pipes. The sensor could be used even in conjunction with the truck probe during initial raw material inspection.

Calibration of BUCHI NIR-Online can be performed either by transfer of data from BUCHI N-500 and NIRMaste spectrometers or by the use of the autocal function of its SX software suite. Using autocal the NIR-Online instrument is calibrated by simply pressing a small button in the same moment when a calibration sample is collected from the production line. Once the reference analysis values have been entered, the unit automatically updates the calibration. For those users wanting to delve deeper, it is possible to use the proprietary SX-Plus chemometric software suite.

In addition to NIR analysis, the NIR-Online instrument offers additional options of visible color measurement coupled with video imaging processing opening up further possibilities of real-time control.



Figure 3: NIR-Online X-Square configuration for in-line measurement of seeds



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6. Conclusions

BUCHI NIR Solutions represents the leading edge of NIR provision to the brewed and distilled beverage industries with competencies in laboratory based, at-line or in-line instrumentation. This perfectly complements BUCHI range of primary analysis laboratory solutions including distillation, Dumas and Kjeldahl analysis.

7. Additional resources

- Application Note No. 72/2012 interlaboratory test for the determination of total SO₂ in wine by distillation and titration
(<http://www.BUCHI.com/en/content/sulfur-dioxidedetermination-wine>)
- NIR Spectroscopy and Wine - Class-modeling for the characterization of Italian red wine
(<http://www.buchi.com/en/content/nir-spectroscopy-and-wine>)