Analytical Instrumentation – Views into the nano-world

IMPRINT

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CO_2 determinatio

Fast help with TOC

Quality assurance is only one of the attributes for brand name products such as beer. And quality is dependent on the quality of the starting materials, strict production processes as well as specialists whose keen eyes oversee the entire production. Finally, millions of consumers are testing their favorite brand of beer every day.

An important player in the production process and a condition for quality is invisible: carbon dioxide, formed during the fermenting process. After filling the beer into barrels and bottles, carbon dioxide ensures that the necessary pressure is maintained. This is an important factor for guaranteeing shelf life and fresh taste of the beer. A constant concentration of carbon dioxide also ensures a steady taste and consistent quality of the beer. The concentration of carbon dioxide also plays an important role in other soft drinks. Beer contains 4 – 6 g/L CO_2; soft drinks contain 4 – 10 g/L CO_2.

Quality control during beverage production therefore requires a routine method for fast and accurate determination of CO_2. Traditional procedures such as titration and manometric methods are usually time-consuming, not very selective and difficult to automate. In collaboration with the König brewery in Duisburg, Germany, a new procedure was developed for the determination of CO_2 content using a TOC analyzing system (Figure 1).

Analytical system and measuring method

For this application, a Shimadzu TOC-V_{CPH} with autosampler (ASI-V) was used. A typical method for TOC determination is the differential method where, initially, the total carbon content (TC) is determined and subsequently the inorganic carbon content (IC). The difference between both parameters represents the organic carbon content.

Stock solution	Dilution factor	Calibration points	Area units
1,000 mg/L C	20	50	205.9
	10	100	407.5
	5	200	803
	2	500	2120

Table 1: IC calibration curve with automatic dilution function

n in beer

The IC method was used for CO_2 determination. The sample was injected into a vessel containing a phosphoric acid solution. The phosphoric acid converts all carbonates and hydrogen carbonates to CO_2. Carrier gas is used to transfer the CO_2 from the sample solution to the NDIR detector where it is selectively detected. The peak area of the NDIR analog output signal is then integrated. For evaluation of the correlation between peak area and IC concentration, the TOC system is calibrated using an IC standard solution.

Figure 1: TOC-V_{CPH} with autosampler

Sample preparation for CO_2 determination

In a vessel containing 180 mL beer, 5 mL of a 32 % sodium hydroxide solution was added in order to convert dissolved carbonic acid into carbonates. After mixing, the solution was transferred to the autosampler. As the CO_2 concentration is relatively high, the TOC-V_{CPH} automatically dilutes the sample by a factor of 5 respectively 10. This also minimizes the influence of the aggressive, alkaline matrix.

Calibration and measurement results

For the IC determination, the TOC-V_{CPH} was calibrated with a carbonate/hydrogen carbonate solution. The automatic dilution function again simplifies the calibration procedure. Only one standard solution is prepared manually and the instrument subsequently carries out the entire dilution sequence (see Table 1 and Figure 2).

The calibration curve expresses area units in terms of carbon concentration. The values obtained are multiplied by a factor of 0.00038 in order to obtain the CO_2 content in the original solution (beer).

Figure 3 shows an IC determination of a beer sample.

The CO_2 content of various types of beer was determined using this method. In order to check the plausibility of the data, the results were compared with a reference method (Corning method). Figure 4 shows the results. IC determination resulted in less varying

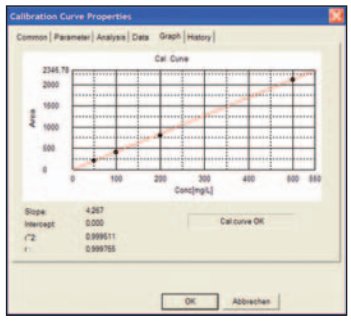

Figure 2: IC calibration curve 500 ppm

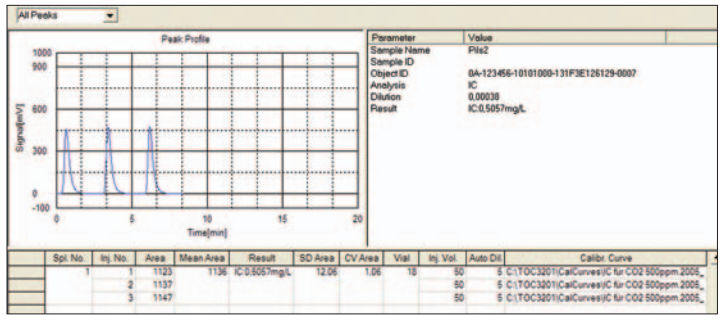

Figure 3: IC determination of a beer sample

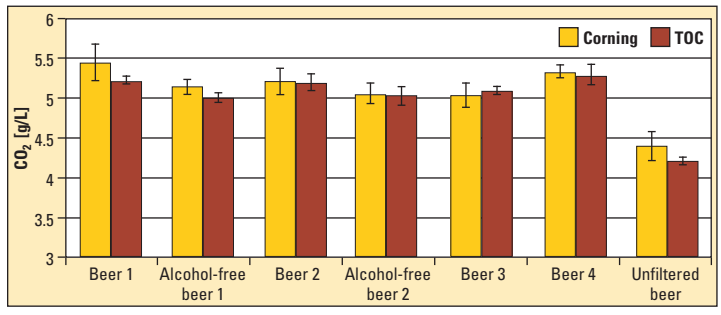

Figure 4: Bar graph

of the data compared to the reference method. In absolute terms, these values were always within the data deviation zone of the reference method.

Summary

IC determination using the TOC analyzer has established itself as a suitable alternative to the classical methods for CO_2 determination. In comparison with the traditional methods, this new method is much more selective, easier to handle and to automate. The excellent reproducibility, the wide measuring range and the fully automatic dilution function of the TOC-V_{CPH} enable its use in routine analyses in an industrial brewery. Furthermore, the TOC system can be used in additional applications in the brewery (for instance for testing of process- and wastewater).

Cheers!

Shimadzu thanks the König brewery in Duisburg for providing their measuring data.