If it ain't broke...

What is important in measuring CO_2 content?

In virtually every field, the practical usefulness of a measurement is often more important than its absolute accuracy. End-users need to be quite realistic and selective about their equipment choices and aware that suppliers are often prone to present their measurements at irrelevant levels of accuracy.

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The CPA (Compact Package Analyzer) is a modular combination of different instruments important in the quality control on beverages – a kind of robust multifunctional mini lab for QC directly at the filling line. It can measure: CO2, torque, fill height, Brix/density.

For example, it is near-useless while driving to be told by Traffic Information that the jam at our motorway exit junction is 7½ miles long. We want to make little Johnny's school play and what we really need to know is what the time delay is? Is it better to stick it out or get off early and maybe sit in a longer jam in side roads with everybody else that came off too? The units of measurement presented are not well suited to the objective.

The classic hotel claim of 'just two minutes from the beach' expresses distance in time units, and could technically be correct whilst leaving out that the time was actually rounded from 2.49 minutes set by an Olympic gold medalist in the middle of the night so he could sprint across the intervening expressway without being knocked down. The units of measurement suit the measurer, but are ill-defined and ill-suited to the objectives of the end-user.

A platinum-iridium bar was established as the standard meter for comparative length but since 1983 it has been defined as the distance that light takes to pass through a vacuum in 299,792,458th of a second – this is because the speed of light is the only thing assumed to be absolutely constant and measurable. The practical applicability of this knowledge is rather low. A person's height is usually rounded off to half an inch. It would be pointless, nit-picking and absurd to include an influence of less than 100,000th of a millimeter – caused by relative speed – in a height measurement. Despite that, people can still tend to aim at what seems the most precise method of measurement possible, when far simpler and less demanding solutions are more appropriate.

In the real world, it is possible to record time precisely to 15 decimal places, but the accuracy of a wristwatch with a mechanical movement is fully adequate to avoid missing the bus. There is no benefit in lugging an atomic clock around in a suitcase, and even a modern clock with quartz movement and millisecond accuracy offers little practical advantage over a mechanical watch 10,000 less precise. The objective of not missing the bus can be achieved using the simple wristwatch.

An optimum measuring system is thus not necessarily the one with the highest measuring accuracy, but a system that is simple to use and gives the best and most useful results!

Benchmark

The CO_2 content of a drink cannot be measured directly. CO_2 content serves as the benchmark for the impression and sensation of taste in the mouth and on the palate, ranging from tingling to small pinpricks. CO_2 content is controlled in order to repeat this taste experience precisely.

The manometric shaking method is the oldest way of ascertaining the CO_2 content in a filled container. The principle is to shake the bottle or can until equilibrium is established. The CO_2 content is calculated based on physical law of Henry-Dalton by measuring pressure and temperature and comparing CO_2 content with a reference liquid in a reference container at the same pressure and temperature. The method is just as ordinary as measuring density with a hydrometer. The calculated CO_2 correlates very well with the sensory test.

Designers of drink products established years ago that different compositions of a mineral water for example can create different impressions of taste even though CO_2 contents are identical. The dependence in this case is not on the content of mineral substances, but because water containing phosphate actually binds the CO_2 differently than plain water for example. This fact does not surprise the specialist because a drink's saturated vapour pressure of CO_2 is significantly dependent on its composition.

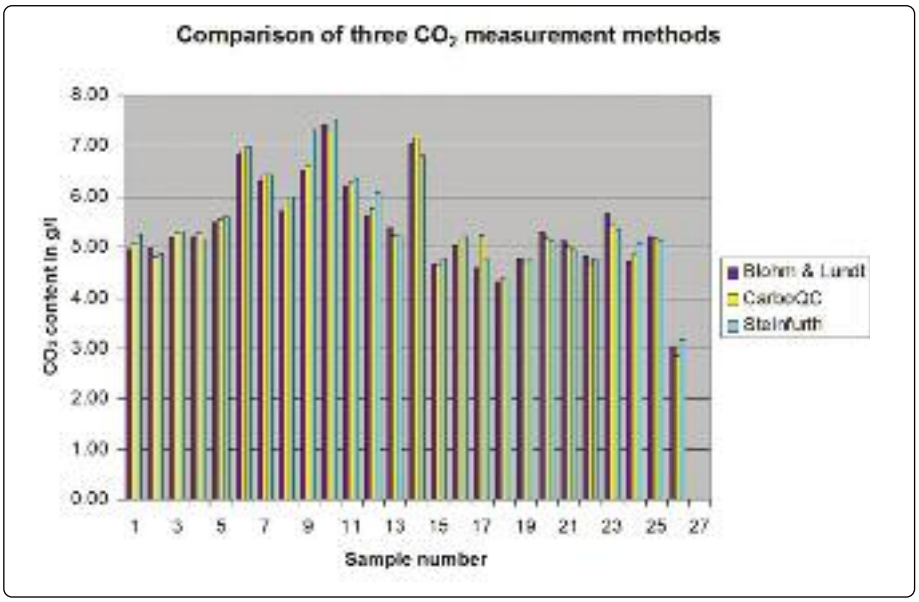
As well as constituents like sugar, salt, and alcohol, the saturation vapour pressure of CO_2 is also influenced by other gases. These could be nitrogen or air. For example, a drink may be carbonated very weakly, say primarily to reduce the pH value for improved shelf life and then have nitrogen added to stabilise the container. In this case, the only measurement of saturated vapour pressure without proper sample preparation is not a suitable method of ascertaining the CO_2 content because it is a sum of the partial pressures of each gas. Knowledge of the saturation vapour pressure in an unknown liquid is likewise unsuitable for ascertaining the CO_2 content. These 'foreign' gases present in the drink are generally known and are relatively constant for specific bottling plants and beverages.

Modern, automatic CO_2 shakers eliminate foreign gases by an automatically controlled

snift and optimal sample preparation. Excessive outlay to attempt to compensate for foreign gases in beer, non-alcoholic soft drinks or mineral water does not resolve anybody's problems. Any theoretical advantage that might appear to accrue from 'correctly' measuring a beer that is saturated with air will not stand up to serious scrutiny. When the objective is a measurement, one should not choose a way of achieving it that is unnecessarily costly, difficult, or risky.

Results achieved with the automatic CO_2 shaker are noticeably more precise than the divergence in CO_2 content created by differences in the volumes of head space of pre-filled containers. The saturation vapour pressure in the bottle settles within a certain time after filling. This pressure is generated by dissolved CO_2 coming out of solution and filling the head space. Different quantities are released because the head space in the bottles and cans is naturally subject to variation.

A pressure balance develops in the head space until the measurement is taken. It is dependent on filling temperature, CO_2 content, time between filling and measuring, etc. Measurement with the automatic shaking CO_2 instrument takes this head space pressure fully into account. However, it is the responsibility of the measurer to consider the head space pressure when taking measurements from the liquid phase.



Comparison of Blohm & Lund's method with the Steinfurth tumbling method and Carbo QC.

The measured results for CO_2 (taken by a recognised independent beverages laboratory) have been compared using the analytical Blohm & Lund's method and the method used by Steinfurth's fully automatic CO_2 shaker (see chart). Taking into account the different head space volumes, divergences between the two different measuring principles are very low and lie very well within statistical margins of error.

Besides the fundamental suitability of a method, other factors are very important for an equipment purchase. Reliability, easy operation, combination of sample preparation with piercing device and accurate CO_2 measuring head are frequently decisive; as shown clearly with automatic CO_2 shaker. Manual shaking devices are losing more and more of their significance in the market – because this measuring method is rightly rejected for poor ergonomics and operator influences.

Steinfurth currently offers four different automatic CO_2 shakers. All have an identical measuring principle with overhead shaking - they differ in the degree of automation. The overwhelming proportion of customers chooses the fully automatic CO_2 shaker because the optimum ergonomics practically exclude any faulty operation, even by unqualified personnel. The system has been perfected by continuous further development based on over 5,000 CO_2 shakers supplied. It is currently the only automatic system which is used directly in the bottling plant at the filling line – outside the laboratory – and delivers reliable results every time.

Newly designed implementation of the CO_2 measurement into a modular 'mini-lab' for the filling line combined with automatic measurement of removal torque on bottle closures, fill height control via balance, Brix measurement via refractometer and sample scanning via laser offers the optimum in measuring performance.

The CO_2 shaker's technique is simple, easy to understand, extremely reliable, highly accurate and free of operating errors. Permanently stored algorithms ensure that the correct CO_2 content, or the reference method for the specific operation, is displayed directly. The saturation vapour pressure without compensation for sugar and alcohol actually corresponds with the subjectively felt taste, rather than the true CO_2 content..

There is no other system on the market which delivers comparably good results with optimum ergonomics. It is absolutely unmatched if one considers the ease of use, long-term stability and it seldom needs to be serviced.

Steinfurth's CO_2 shaker system provides the information to the operator which he actually needs, and which he can apply to his product directly: rather like the driver hearing on his radio what actual delay he can expect in the upcoming jam. Additional information is often unhelpful, and can easily obscure true benefits and increase risks. ■