Reliable CO_2 monitoring in the beverage industry

Carbon dioxide (CO_2) is an indispensable additive in beverage production today. However, under certain circumstances it can prove extremely hazardous for employees. This risk can be controlled by the continuous monitoring of the production process.

CO_2 – a key ingredient in beverage production

Carbon dioxide (CO_2) is one of the most important substances in the production of soft drinks, wine, sparkling wine or beer to a standard quality. It is used in various forms:

Perhaps the best-known application is the addition of carbon dioxide gas as a flavour stabiliser. It is governed primarily by country-specific consumer habits and flavour preferences. Another common use-case of CO_2 is in the rinsing of component parts or filling units. It is used to displace oxygen, reduce foam formation and thus preserve the flavour of the drink. At the same time, CO_2 is released as part of the maturation or manufacturing process. In modern plants, it is recycled for economic and ecological reasons.

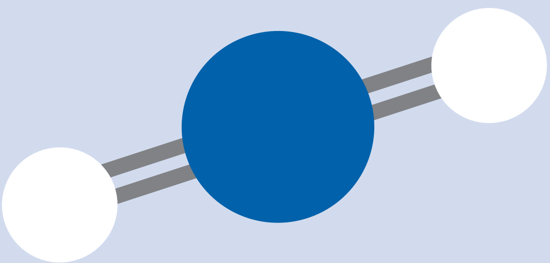
Toxic hazard at ground level

In manufacturing, carbon dioxide is usually used in gaseous form. The gas is 1.5 times heavier than air and therefore has the specific characteristic to accumulate at ground level. This results in a key problem when dealing with the substance: Any leaks or overflow scenarios can lead to the build-up of so-called lakes with dangerously high concentrations. They are not visible to the human eye, which makes them particularly treacherous.

MAIN PROPERTIES OF CO_2

Properties	Colourless, odourless, non-flammable gas; only liquid at high pressure; can react with water to form carbonic acid; displaces oxygen (inert gas)
CAS No.	124-38-9
Molecular weight	44.01 g/mol
Boiling point	No boiling point at normal pressure
Physical state under normal conditions	Gaseous at 1,013 mbar and 20°C
Reaction behaviour	Risk of explosion, e.g. on contact with metal dust under heat; dangerous reactions incl. with ammonia and sodium
Perception threshold	None, as it is odourless and colourless
Poisoning symptoms	> 2 Vol% : increased pulse, circulatory problems within the brain, dizziness, nausea, sickness
Lethal concentrations	8 to 10 Vol%
Handling	Secure gas bottles against accidents; fill and decant them where possible in sealed areas with flue

Sources: Dräger VOICE® / GESTIS



Carbon dioxide

Chemical formula: CO_2

Risk: wrong measurement strategy

Rising CO_2 concentrations displace the percentage of oxygen in breathable air, posing the threat of suffocation in extreme cases. This fact has given rise to a misconception widely held throughout the industry that can lead to the wrong monitoring measurements being used. The percentage of CO_2 in the ambient air cannot, as is often assumed, be controlled by monitoring the percentage of oxygen (O_2). CO_2 is not only dangerous as a result of displacing oxygen, but also through its own toxic or even lethal effect on humans. Any measurement strategy must therefore always focus on the CO_2 content of the ambient air.

SELECTED NATIONAL/INTERNATIONAL WORKPLACE EXPOSURE LIMITS FOR CO_2

Country/Region/ Organisation	Value (in ppm)	Reference value
International	5,000	WEL
OSHA (PEL), USA	5,000	TWA
NIOSH (REL), USA	5,000 30,000	TWA STEL
Australia	30,000	STEL
Germany	5,000	WEL
Great Britain	5,000 15,000	LTE STEL
Mexico	5,000 15,000	TWA STEL
New Zealand	5,000 30,000	TWA STEL
South Africa	5,000 30,000	TWA STEL

Key: WEL – Workplace exposure limit; TWA – Time weighted average; STEL – Short-term exposure limit; LTE – Long-term exposure limit

Typical CO_2 processes in the beverage industry

Carbon dioxide fulfils many different functions in the drinks industry: As carbonic acid dissolved in water, it provides refreshment. It helps preserve the sensory quality over a prolonged period of time and prevent tipping during storage. It also reduces any unwanted foam formation. Typical areas of application include:

Carbonation

The carbonation of soft drinks requires CO_2, made gaseous under high pressure. The aim is to release as little CO_2 as possible and achieve an optimal mixing ratio.

Fermentation

Consumer preference with regard to the residual CO_2 content of still wines varies from country to country and from wine type to wine type. The so-called fermentation process is practiced in many markets and involving the addition of CO_2 to still wines (wines without sparkling effect; < 2g/l CO_2 at a temperature of 20°C). It is a common way of suppressing the oxygen in the drink and preserving its

well-balanced flavour over a long period of time. Any oxidation of the wine often has a negative impact on the colour and the bouquet. The targeted application of CO_2 also makes it possible to eliminate unwanted aromas from the wine.

Carbon dioxide is also an essential element in the beer industry. It is released in large quantities during the fermentation process. For beer connoisseurs, the correct CO_2 content is an extremely important factor in the flavour. At the same time, carbon dioxide ensures that the beer does not oxidise when stored, allowing for a longer shelf life.

Pressurisation and rinsing

In the beer and wine industries alike, the so-called pressurisation and rinsing of containers or pipes play a part in preserving the quality of the flavour. The introduction of CO_2 into the filling container creates internal pressure. It prevents excessive amounts of foam from being generated during filling. Rinsing the container with CO_2 during the cleaning process also removes any residues from filter devices and equipment.

Inerting

In the production of fruit juice, CO_2 reduces the reaction of the juice contents with the oxygen present in the containers – thus avoiding any later unwanted fermentation during the shelf life of the product. This ensures prolonged sensory quality.

Assessing and reducing risks

When producing drinks with the aid of carbon dioxide, it is important to make a meticulous risk assessment of the critical work areas. This is particularly crucial in closed rooms and containers as well as in ground-level or lower areas such as shafts or cellars.

An overview of possible safety risks

- Storage areas: Leakages in supply lines; leaky gas bottles
- Production halls: Overflow from maturation vessels
- Filling plants: uncontrolled release of CO_2
- Recovery systems: Faults in the adsorption system

Measurement methods for different work areas

Monitoring CO_2 concentrations in work areas in the beverage industry requires different measurement strategies: These include labelling confined spaces, a clearance measurement of spaces before work is carried out; monitoring the ambient air with a portable gas measuring device while working in containers; continuous area monitoring with fixed gas detection systems in extensive work areas, or temporary area monitoring with a portable gas measurement system during maintenance work.

Monitoring CO_2 when working in confined spaces

In daily work, time and again fatal accidents occur during work in confined spaces. Even experienced employees sometimes underestimate the risk of CO_2 accumulating within a tank requiring cleaning or maintenance, and suffocate as they lean in. The important thing is to identify any confined space in the plant as part of the risk assessment.

The appropriate safety measures can then be applied. These include the clearance measurement (checking of CO_2 levels and other potential hazardous substances) of the space before starting work each time, using a portable gas measuring device and the correct pump hose. Furthermore, employees should always carry a portable CO_2 gas measuring device with them while carrying out any work inside such spaces.

Area monitoring of CO_2 in production plants

To ensure a safe working environment in drinks production plants, the atmosphere in critical areas must be monitored continuously. Since CO_2 accumulates at ground level in the event of an uncontrolled escape, it is advisable to install gas measuring heads at a low height. The choice of measuring technology should also take into account the risk assessment – in areas exposed to explosion hazards for example, an ATEX-certified device is required. In areas with high temperature variations, technology should be used that is not affected by the ambient temperature.

It is essential to position the gas measuring heads and sensors correctly, ideally close to ground and the potential hazards. They should therefore be planned by experienced engineers. Once installed and connected to the alarm management system, the gas detectors trigger an alert every time the alarm thresholds (A1, A2) are exceeded. In each case, they must be calibrated and maintained at regular intervals.

Integration in the process automation and alarm management

All production areas can be monitored seamlessly in real time by linking the individual fixed gas measuring heads with an analysis unit, which in turn is connected to the plant's alarm management system. Bundling the information in a control software makes it easier for safety officers to maintain an overview of all measurement results and respond quickly to any changes.

Choice of measurement technology

The most appropriate device for monitoring CO_2 areas is an infrared (IR) detector. These are based on the principle of the absorption of infrared rays in a certain wavelength range when they hit a CO_2 molecule. IR detectors are noted for their rapid response times (t90) in both low and high gas concentrations. In the event of a pre-alarm or even a main alarm, countermeasures can be taken immediately, up to and including the evacuation of the work area.

IR detectors are also less susceptible to dust or dirt deposits and due to their high measuring accuracy trigger fewer false alarms. Major changes in temperature (minus to plus values) and high humidity have very little impact on measurement accuracy.

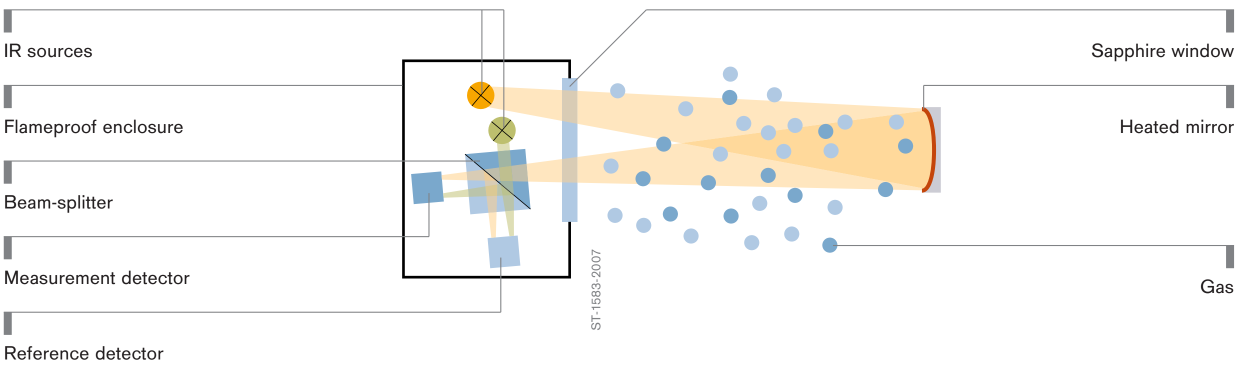
Measurement based on the IR technology has a long service life since the measuring elements themselves do not come into contact with the measuring gas and thus are subject to very little wear. That saves the budget.

Dräger stationary gas detection systems

The primary concern for plant and occupational safety is to ensure reliable warnings against unnoticed, hazardous gas concentrations. It is the only way to prevent incidents that lead to uneconomical, dangerous or even fatal consequences.

An accurate and plant-specific CO_2 gas measurement system custom-built for the respective measurement task is therefore an essential and worthwhile investment in the safety of personnel and the plant. This is why the task should be handled by experts – find out more at **www.draeger.com**

This is how a infrared sensor works:



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