HONEYWELL BW™ SOLO CO2 SERVICEABLE SINGLE-GAS DETECTOR

INTRODUCTION

Carbon dioxide is a commonly encountered but often misunderstood gas, and as such, the potential hazard it poses to human health can often be disregarded. As the applications involving the use or possible exposure to CO2 are on the increase, the need for dedicated personal carbon dioxide monitoring has never been greater.

WHAT IS CO2?

At standard temperature and pressure, carbon dioxide is a colorless, odorless, heavier than air gas. CO2 is produced by all aerobic organisms during respiration, during the processes of decay of organic materials and during the fermentation of sugars in bread, beer and wine making. It is produced by the combustion of wood and other organic materials and fossil fuels such as coal, peat, petroleum and natural gas.

Its high solubility in water, forming carbonic acid, gives it a sour "soda water" like taste at high concentrations, which may also cause irritation to the body's mucous membranes such as eyes, nose and lungs. It is naturally present in air at just over 400ppm and is completely harmless at these concentrations. At higher concentrations, as well as being a simple asphyxiant gas, it has a pronounced toxic effect upon the human body. These effects, such as increased breathing rate, tiredness, confusion and eventually unconsciousness, occur at concentrations much lower than those required for suffocation. This toxic effect has led most regions to impose Occupational Exposure Levels (OELs) for carbon dioxide of around 5000ppm TWA and 15,000ppm STEL[1].

1. Consult local regulatory bodies for specific relevant OELs

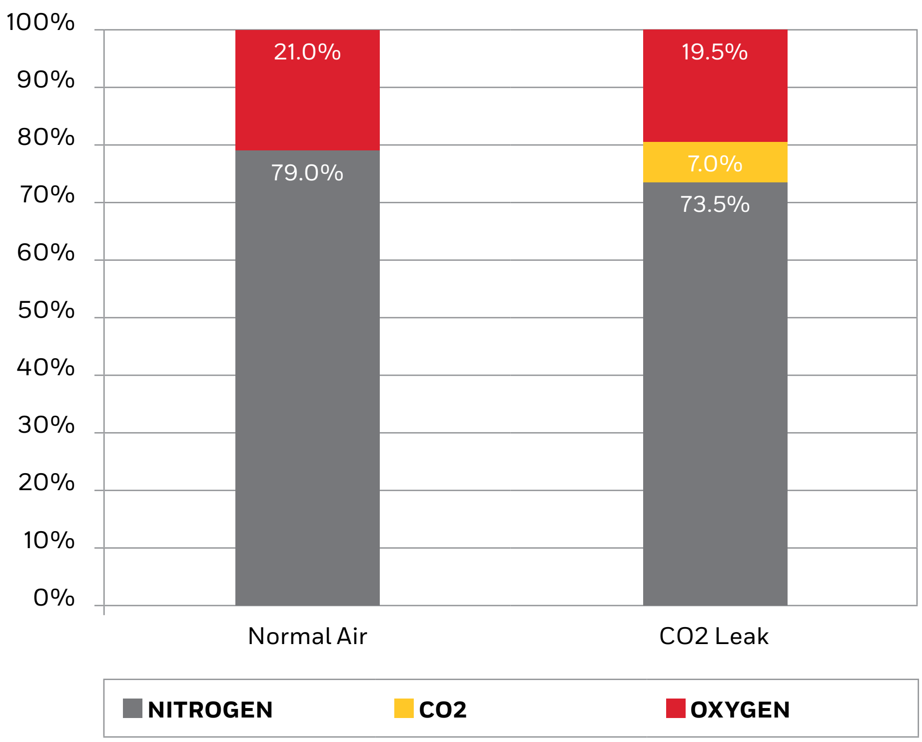
WHY ARE DEDICATED CO2 SENSORS VITAL?

The ever-increasing number of applications and processes involving potential human contact with dangerous levels of CO2 means that dedicated gas detection can make the difference between life and death. We are often asked the question;

“but surely, I’m safe to use a simple oxygen sensor to warn me of dangerous levels of carbon dioxide like I would for any other displacing gas such as nitrogen?”

Should CO2 only be an asphyxiant gas, then the above statement may well be true but, unfortunately, it also has a significant debilitating toxic effect on the human body at far lower concentrations than are safely detectable using a simple oxygen sensor alone.

To displace enough oxygen from normal air to trigger a low alarm on a standard oxygen gas detector, the CO2 concentration would need to be in the region of 7%vv or 70,000ppm. This value is 14 times higher than the standard EU Occupational Exposure Limit (TWA) of 5000ppm, meaning employing an oxygen detector alone would be a wholly insufficient method of protection against this gas.



Using a dedicated CO2 sensor also gives us the ability to offer both Instantaneous Alarm Thresholds as well as the Time Weighted Average (TWA & STEL) alarms usually required by local national legislation.

Above 5% (50,000ppm), the effects on the human body quickly become very serious, leading to tiredness, confusion, hyperventilation and, eventually, to unconsciousness and potentially death. Typical 8-hour time weighted average Occupational Exposure Limits sit at around one tenth of this value, and represent the average allowable exposure over an 8-hour standard work shift period and would apply to all workplaces.

TYPICAL APPLICATIONS EXPLAINED

THE DRINKS INDUSTRY

This industry has numerous processes dependent on the use of CO2 or which themselves produce this gas as a byproduct. On top of this, a global upturn in the emergence of the smaller craft or microbrewery segments is reaffirming the need for better CO2 safety practices in the work place.

We can identify three major subcategories within this industry, each with its own unique set of circumstances and potential risks: beer & wine production, distilleries, and the wider hospitality industry such as pubs, bars and restaurants.

BEER BREWING AND WINEMAKING

It's widely understood that the conversion, by yeast, of certain sugars during the anaerobic fermentation process produces alcohol and, as a byproduct, releases substantial volumes of carbon dioxide. A proportion of this CO2 may be allowed to remain in solution giving the characteristic "fizz" in beers and sparkling wines but much is released as a by-product. Traditionally with smaller breweries and winemakers, this excess CO2 is simply vented to the immediate environment, which can lead to considerable fluctuations in the local environmental CO2 levels, potentially exceed ingthe local Occupational Exposure Limits. Due to its heavier than air property, there is also potential for this gas to collect in low-lying spaces such as pits and drains, leading to serious oxygen depletion. In modern high-volume brewing facilities, this excess CO2 from the fermentation process may be captured and stored for later use in the carbonation process. This introduces the risks associated with the storage and management of large volumes of compressed CO2. Cleaning of the fermentation vessels, which may still contain the CO2 byproduct, is often a very manual process involving the brewer/winemaker fully entering these confined spaces, usually without proper ventilation or SCBA.

DISTILLING

The process of distilling begins with a very similar fermentation process to create an alcoholic "wash" and so distilling liquor such as whiskey, gin, and rum introduces the same risks of CO_2 exposure as beer and wine making. The exception with this application is that the process of distillation also includes further gas hazards that the user should be fully aware of. Distillation requires a strong heat source which is more commonly now powered by natural gas. As well as this, the product of the distillation process is a strong alcoholic liquor of up to 65-70% ABV. With alcohol being itself a potentially flammable Volatile Organic Compound (VOC), this gives the distiller two further potential gas hazards to monitor for. Portable multi-gas detection, which includes both CO_2 and flammable gasses as a minimum, would be the preferential choice in this application.

THE HOSPITALITY INDUSTRY

The modern hospitality industry incorporates a multitude of applications, but the use of compressed CO_2 to carbonate drinks, or as a propellant to dispense them, is widespread, and so too are the risks. The market for carbonated and draught drinks includes not only bars, restaurants and pubs but hotels, cinemas and fast-food restaurants. This also means that the area at risk has diversified away from the classic pub/restaurant cellar to a wide variety of purpose-built storage areas acting as confined spaces. All these spaces should be risk assessed with the same rigor as the traditional pub cellar commonly is, ensuring the most appropriate personal CO_2 protection is employed where necessary.

CONTROLLED OR MODIFIED ATMOSPHERE STORAGE

Grains, seed and legumes are commonly treated in specially constructed Controlled Atmosphere Storage buildings, which control not only the humidity and temperature, but also the atmospheric gas concentrations. Elevated concentrations of 35%vv and above carbon dioxide are often employed over several weeks to control insect pests and limit molds and bacterial growth.

In a similar way, fruit and vegetables such as bananas, apples and potatoes may be stored for far longer periods in atmospheres of decreased oxygen concentration and increased carbon dioxide levels. This modified atmosphere will slow down the natural ripening process as well as inhibiting mold and bacterial growth, which could damage the products. The optimum storage concentrations do vary from product to product.

This technology may also be employed in the packaging process to ensure the best storage conditions are achieved during the often long international transportation period from grower to supermarket.

The large modified atmosphere storage locations themselves obviously create numerous potential CO2 exposure hazards throughout the process. Large volumes of compressed CO2 will be present on site leading to the potential of accidental releases of CO2 into confined spaces or general work areas. Due to CO2's heavier than air property, any large release will act like a liquid and flow away from the leak source, engulfing everything in its path.

The storage chambers will need to be cleaned and maintained, and it is vital to monitor the occupational exposure levels of anyone entering these confined spaces.

CARBON CAPTURE

Carbon capture and storage (CCS) is the process of capturing waste carbon dioxide from bulk industrial processes such as power generation, steel and cement and sequestering it away, so it never re-enters the atmosphere and doesn't contribute to further climate change. These vast quantities of CO2 are injected deep into the earth, often in oil and gas fields or unmineable coal seams, where the rock formations are stable enough to safely absorb and contain the waste carbon dioxide.

CCS will result in CO2 being handled in quantities many orders of magnitude greater than it is today. For example, a coal-fired power station consuming 8000 te a day of coal (in the region of one GW power generation) will produce up to 30 000 te/day of CO2 to be captured and transported to long-term storage facilities. Whereas in existing CO2 handling facilities an inadvertent release of CO2 may have created a small-scale hazard, potentially only affecting those in the local vicinity, a very large release of CO2 from a CCS scale operation has the potential to produce a harmful effect over a significantly greater area and as such it would be likely to affect a significant number of people. CCS scale of CO2 operation, therefore, has the potential to introduce a major accident hazard (MAH) where currently one does not exist[2].

2. http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/
   https://www.hse.gov.uk/carboncapture/assets/docs/major-hazard-potential-carbon-dioxide.pdf

SEWERS AND WASTEWATER TREATMENT FACILITIES

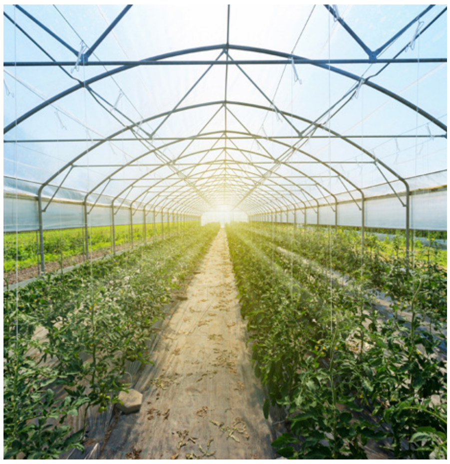
The aerobic digestion of sewage sludge is known to produce up to 30%vv carbon dioxide as well as other waste gasses such as methane. This aerobic digestion may be harnessed as part of the wastewater treatment process, and the risk of exposure to this CO2 to a degree may be limited to the waste treatment sites themselves.

However, as aerobic digestion is a naturally occurring process, CO2 is commonly formed throughout the sewer system. Unlike other waste gasses from this process, such as methane, CO2 is a heavier than air gas and can potentially remain trapped within the subterranean sewage network leading to toxic atmospheres.

WIDER APPLICATIONS

We have covered only a small number of the potential applications which involve possible exposure to CO2 at toxic levels but there are, of course, a multitude of other environments that are known to contain similar potential hazards.

- Landfill
- Biogas
- Mining
- Horticulture
- Refrigeration
- Food production



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