WHITE PAPER

Distilleries: The dangers of ethanol (C_2H_5OH) and carbon dioxide (CO_2)

Distilleries and breweries manufacture alcohol via a fermentation process that produces liquid ethanol. Fermentation also produces ethanol vapours, which means that ethanol gas leaks are a risk in most breweries and distilleries. During the fermenting process, yeasts convert sugars into alcohol, which also creates carbon dioxide and other metabolic byproducts.

Monitoring ethanol and CO_2 levels with a reliable gas detection solution is crucial to maintaining the well-being of employees and customers in distilleries and breweries. Gas detection is also necessary during the transportation of carbonated drinks. The current regulations, ATEX and IECEx, are designed to set a minimum standard for the health and safety of workers related to risks of explosions in areas with a hazardous atmosphere.

This paper will explore the best ways to meet these standards and delve a little deeper into why working in spaces that produce ethanol holds many potential dangers. It will look at all the risks of CO_2, and discuss the need for gas detection devices.

CROWCON
Detecting Gas Saving Lives

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A volatile, flammable liquid. It is a psychoactive substance, as well as a recreational drug and a component in alcoholic drinks.

Ethanol is a volatile, flammable liquid. It is colourless with a wine-like smell and a strong flavour. It is a psychoactive substance, as well as a recreational drug and a component in alcoholic drinks.

The majority of ethanol is made from starch-based crops. A cooking procedure converts the starch or cellulose into sugar. Ethanol is then produced by microbes such as yeast and bacteria that feed on the sugar in a process known as fermentation. Ethanol is one of the most widely used organic compounds in both industrial and consumer goods, and ethanol is commonly found in lacquers, fragrances, mouthwash, polishes, cosmetics, drugs, and plastics. In medicine, ethanol is used as a topical antiseptic and an antidote for methanol poisoning.

Ethanol is also used as a renewable fuel in a mixture with petrol to make fuel cleaner. Mixing ethanol in fuel has the benefit of lowering carbon monoxide and other smog-causing pollutants. From September 2021, all petrol and diesel sold in the UK must include a set amount of biofuel (10% bio ethanol in petrol (E10) and 7% biodiesel in diesel). Ethanol is being used to help reach broader emissions objectives.

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What are the dangers of ethanol?

Ethanol produces explosive vapour concentrations in the range of 3.3–19.0% (v/v) in air. At 350 parts per million, the chemical is detectable by nose, while higher levels of 5000–10000 parts per million can irritate the eyes and upper respiratory mucous membranes. Concentrations above this threshold become unbearable, resulting in severe coughing and laceration. Vapours may irritate and even harm your lungs if inhaled, and can result in long-term breathing issues. Drying and cracking of the skin, as well as peeling and redness, can occur as a result of exposure.

Ethanol exposure can also result in headaches, sleepiness, nausea, vomiting, as well as unconsciousness. Workers might be incapacitated by a substantial accumulation of ethanol that goes unnoticed, although the quantities necessary to cause actual injury are quite high. The hazard of a fire or explosion from ethanol in the air is a much greater threat.

A single spark in an area with an excessive amount of ethanol might result in a catastrophic explosion. The gases and vapours created by ethanol are the most common flammable dangers identified in distilleries and breweries.

Ethanol vapour, which may be discharged via leaks in tanks, casks, transfer pumps, pipelines, and flexible hoses, is a very serious fire and explosion threat for distillery workers. Once the gas and vapour have been discharged into the atmosphere, they can quickly build up and represent a threat to employees' health. This fact emphasises the need for gas detection technology to quickly detect and repair any leaks in order to avert devastating results.

Moonshine, helps to give an indication of how explosive ethanol vapours can be without proper regulation. Moonshine, often called "hooch" or "homebrew," is manufactured by fermenting a sugar source to produce ethanol and has become a popular kind of distillation. Alcohol vapours are produced during the distillation process, which are extremely flammable. The flammable vapours are one of the main reasons why moonshine stills are nearly always found outside, despite the fact that this makes them more visible to law enforcement authorities. If they are located inside, the risk of vapour explosions is too great.

In all types of distilleries and breweries, there is a risk of explosion from ethanol gases should a sufficient buildup become present in the atmosphere. Potential ignition sources include:

- Open flames
- Welding and torch cutting
- Electrical, mechanical, and static sparks
- Hot surfaces
- Heat generated by friction
- Radiant heat

Cowcon has developed various products to help detect leaks in distilleries and breweries. For example, T4 is Crowcon's personal protection solution for detecting the four most common gas hazards, including Carbon Monoxide (CO), Hydrogen Sulphide (H_2S), Flammable Gases (including ethanol), and Oxygen Depletion (O_2).

For distilleries, microdistilleries, and breweries, it's important to meet these standards to mitigate a potentially explosive safety hazard

Regulations

ATEX and IECEx provide the basis for the minimum requirements for improving the health and safety protection of workers potentially at risk from explosive atmospheres.

ATEX

ATEX sets out rules for controlling explosive atmospheres. If a product or a piece of equipment has official ATEX certification, it has been fully tested and approved to be safe to use in hazardous and explosive atmospheres. ATEX regulations are mandatory in Europe.

IECEx

IECEx is the International Electrotechnical Commission Scheme for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres.

Unlike ATEX this is an international certification accepted in several countries to promote safety in equipment used in explosive atmospheres. It employs an evaluation based on International Electrotechnical Commission (IEC) Standards.

Some companies choose to attain certification for both sets of regulations. For distilleries, microdistilleries, and breweries, it's important to meet these standards to mitigate a potentially explosive safety hazard. A gas detection system should continuously monitor for ethanol buildup and leaks in processing equipment such as stills, tanks, and fermenters.

Reasons to follow the guidelines and install gas detection equipment include:

- Both nitrogen and carbon dioxide are colourless and odourless. This makes them potentially silent and deadly gases.
- Anyone entering a tank or other enclosed space must be outfitted with a proper gas detector, otherwise, they risk being exposed to dangerous gases in excessive concentrations.
- The ability to detect a leak early on can be the difference between life and death.

Ethanol is a toxic chemical and should be handled and treated as such, whether at work or at home.

The health impact of ethanol

Ethanol can produce inebriation at high concentrations. Ethanol use might result in mood swings, slurred speech, clumsy movements, and nausea. Blurred vision, confusion and disorientation, mobility issues, vomiting, and sweating are all possible side effects of higher doses.

While ethanol is included in alcoholic beverages, taking ethanol on its own can result in more serious health consequences. Ethanol may possibly be carcinogenic, but further research is needed to confirm this. Ethanol is a toxic chemical and should be handled and treated as such, whether at work or at home. If you are exposed to ethanol vapours, relocate to a well-ventilated place and get some fresh air. For more help, contact emergency medical professionals.

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Dangers of Carbon Dioxide and Nitrogen

Carbon dioxide has been used in brewing and distilling for many years. Several producers have recently shifted from CO_2 to nitrogen, or employ both CO_2 and nitrogen (N_2). CO_2 is colourless, odourless, and has a higher density than air, therefore pockets of CO_2 form low on the ground and grow in size over time.

CO_2 concentrations already exist in the atmosphere at a relatively low level – approximately 400 parts per million (ppm) – and this is harmless to humans. Extra caution is required in brewery and basement environments, where the possibility of gas canisters or associated equipment leaking might result in increased levels of CO_2 in enclosed spaces.

CO_2 has an effect on concentration even at low concentrations of 1000 ppm. CO_2 levels as low as 0.5 percent volume (5000 ppm) are harmful to human health. CO_2 is produced in large quantities in distilleries as yeast consumes the carbohydrates in the grains and gases are released into the atmosphere during fermentation. This can pose a threat in confined spaces such as vats, cellars, or cylinder storage areas. Because CO_2 can be fatal to workers in the surrounding environment, health and safety managers must ensure that the proper equipment and detectors are in place.

Nitrogen, on the other hand, has the ability to displace oxygen, which can lead to inert gas asphyxiation if undetected. That's why it is so important to have proper ventilation, and gas detection systems in place in breweries and distilleries. You wouldn't be able to identify a gas leak until it was too late if you didn't have the necessary equipment. Detection is also required for delivery drivers who are transporting carbonated beverages containing gases like CO_2 and nitrogen, for example when transporting beer from a brewery to a pub.

To carbonate beer and give it a frothy texture, CO_2 may be poured into kegs and held at pressure.

What processes use CO_2 and N_2?

CO_2 is used by beverage companies to eliminate air and preserve their products from oxidation during brewing and distillation. This guarantees that the product has a decent flavour, texture, quality, and shelf life. To carbonate beer and give it a frothy texture, CO_2 may be poured into kegs and held at pressure.

Brewers may also utilise nitrogen at several stages of the brewing and dispensing process to add bubbles to beer, especially stouts, pale ales, and porters. It also prevents the beer from oxidising and polluting the following batch with unpleasant flavours. Nitrogen aids in the transfer of liquid from one tank to another and can be pumped into kegs or barrels to pressurise them for storage and shipping. This gas is not harmful, but it can deplete oxygen in the environment, which may be dangerous if a leak occurs, which is why effective gas detection is so important.

What are the risks of CO_2 and N_2 in breweries?

Carbon dioxide, oxygen, and nitrogen are the most widely used gases in the brewing process. Because CO_2 is a moderate asphyxiant, it can be hazardous to anybody working near the process machinery. Without the necessary training and safety standards in place, working with CO_2 or nitrogen in any capacity may be harmful. Hazards might arise when gas collects at the bottom of tanks and leaks out. Gas detection devices should be installed in production facilities to warn employees of potential hazards or to automatically activate ventilation systems.

Rapid breathing, headaches, hearing loss, and an elevated heart rate can all occur when CO_2 levels rise. Carbon dioxide exposure can cause loss of consciousness, asphyxiation, and even death at higher levels. Distilleries and breweries of all sizes should be aware of the hazards of CO_2 and should implement a permanent gas leak detection system.

Responsibilities for distillery owners

Distillery owners should take a proactive approach to safety, especially when it comes to reducing the risk of ingestion of harmful and toxic gases produced in day-to-day operations, and the threat of a gas buildup that could pose an explosive threat to workers and equipment. During the purchase and maintenance stages, distillery owners must verify that their equipment and production processes are in compliance with requirements (meet ATEX or IECEx standards), and that continuous monitoring and gas detection are in place. These actions are critical for the company's health and safety officer to safeguard the safety of personnel in distilleries making alcohol who may be exposed to harmful gases.

This involves keeping track of the nitrogen levels used in canning and bottling. Distillery owners should also be aware of the associated gases and chemicals involved in all manufacturing processes, including ethanol and CO_2 gases from fermentation; disinfectants such as chlorine dioxide and sulphur dioxide used for cleaning equipment; argon and nitrogen used as blanketing gases to create inert atmospheres; ammonia from refrigeration equipment; and oxygen monitoring in confined spaces such as tanks.

Lack of understanding, training, or knowledge can contribute to distilleries and breweries not being fully compliant. This is also the case for microdistilleries and small businesses. For example, micro gin producers have proliferated in recent years, and many smaller operators may not be fully aware of the health and safety requirements.

Gas detection is available in both permanent and portable configurations. A stationary gas detector installed in a bigger area, such as a plant room, can provide continuous area and employee protection 24 hours a day. A portable detector, on the other hand, may be more suited for worker safety in and near cylinder storage facilities and locations designated as restricted spaces.

Portable detectors are also useful for the safety of other employees who are unfamiliar with the surroundings, such as delivery drivers, sales teams, or equipment technicians; this is especially true in pubs and beverage dispensing outlets. The portable gadget may be readily fastened to belts and detects CO_2 pockets via alarms and visual indications, suggesting that the user should leave the area immediately.

At Crowcon, we're dedicated to creating a safer, cleaner, healthier future for everyone, every day by providing best-in-class gas safety solutions. It's vital that once gas detectors are deployed, employees should not get complacent and should make the necessary checks an essential part of each working day, as early detection can be the difference between life and death. Monitoring the surroundings helps to prevent health issues and potential explosions.

Using the correct equipment to protect your employees whilst they are working around C_2H_5OH, CO_2 and N_2 gas is vital.

Correct equipment

Using the correct equipment to protect your employees whilst they are working around C_2H_5OH, CO_2 and nitrogen gas is vital. Before entry, rigorous training should be implemented so that your workforce not only understands the risks associated with the space they will be working in but also knows how to accurately and efficiently undertake thorough gas detection protocol within the space, as well as how to quickly depart in the event of an emergency.

Portable solutions including the T4, Gas-pro, Gasman, and Clip SGD provide peace of mind for organisations with workers operating within environments that produce ethanol and CO_2. Fixed detection products include the Xgard and Xgard Bright, while the Vortex control panel and our range of addressable controllers also help to protect employees from hazardous gases in an efficient manner. For deliveries of carbonated beverages, Crowcon Connect is a cloud-based solution that quickly and automatically collects comprehensive data from Crowcon gas detectors and presents it in a user-friendly format that is ideal for audit while at the same time keeping drivers safe.

For more information about gas detection solutions for distilleries, breweries and related industries, or to ask further questions about best practice on monitoring gases in confined spaces, get in touch today.