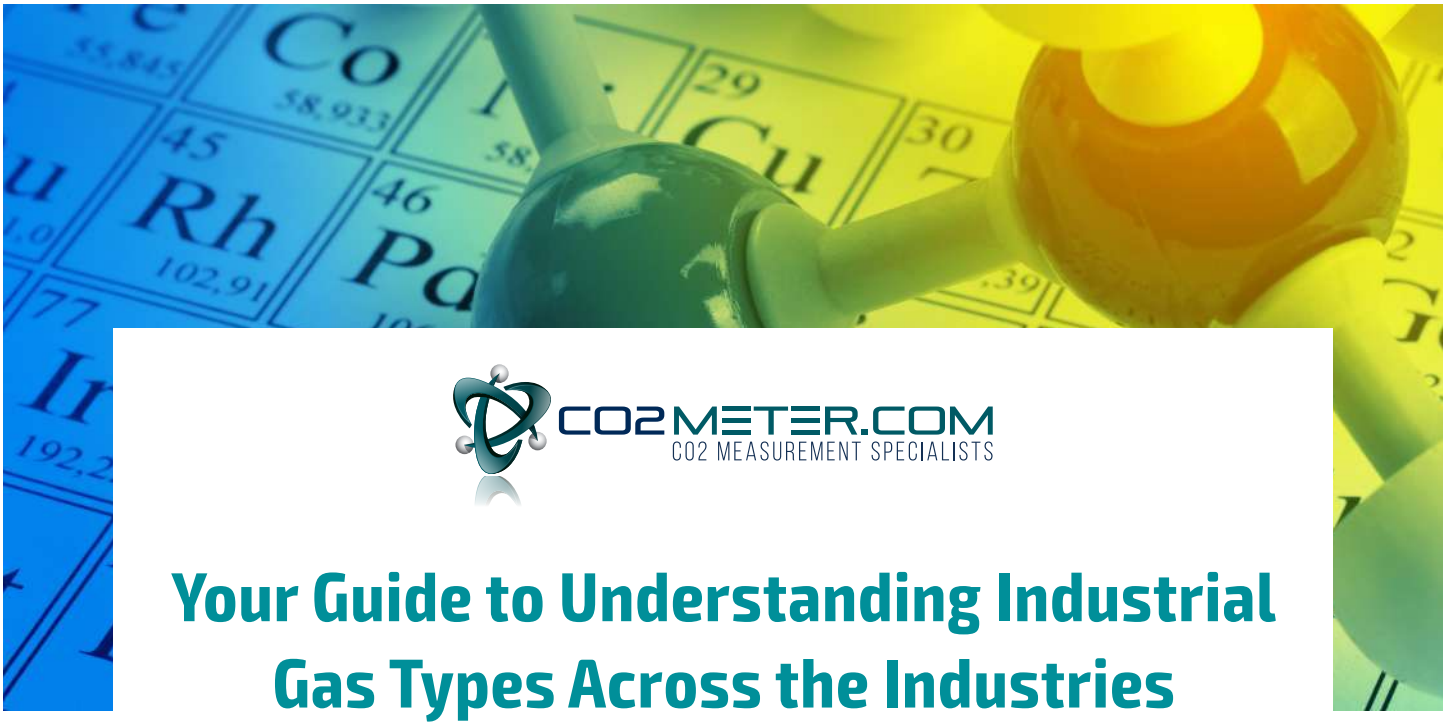


CO2METER.COM
CO2 MEASUREMENT SPECIALISTS

Your Guide to Understanding Industrial Gas Types Across the Industries

Introduction

As a leader in gas detection and analytical devices, the CO2Meter team has expanded well beyond CO2, becoming experts in several gases across the industry in order to provide our customers with the best possible solutions. This valuable "gas education" is also invaluable when assisting new customers with understanding the gas(es) they are working with, how best to approach their application, and what devices will provide them ease of use, accuracy, and longevity.

CO2Meter is known for designing and manufacturing great devices. Just as important is our reputation around the world for providing the education and support to assist customers (and non-customers too) accelerate their goals and business.

Core Values:

- Subject Matter Experts
- Advanced Technology
- Human-Centered Support
- Continued Research & Development
- Trusted Solutions
- Customer Commitment

Our Gas Detection Solutions Are Found In:

- Restaurants & Food
- Breweries & Wineries
- Agriculture
- Scientific & Medical
- Indoor Air Quality (IAQ)
- Safety
- Fire Suppression
- Sensors & OEM

What is a Gas?

When it comes to understanding and identifying gas types, the first step is to understand what defines specific "gas" itself. Gas is defined as a matter, of whose molecules are bound by weak forces of attraction, such that they are widely separated from each other. Due to this, the gases are invisible and without a specific shape. In addition, they are often categorized in sets: reactive vs. non-reactive. The difference between non-reactive vs. reactive is that when a gas is "non-reactive" it means that it is incapable of reacting with other elements under the right conditions. A non-reactive gas is best described as a gas that does not react with any other element. Opposite, of non-reactive gases are highly "reactive" gases, which are created unnaturally, at rates that are dependent solely on atmospheric resistances. These gases are often selected when one is looking for a gas that will join forces and react with each other. For example, some metals are so reactive that when they join forces, they are capable of replacing Hydrogen in water.

Gases are invisible and without a specific shape.

The most common non-reactive gases consist of:

- Argon (Ar)
- Carbon Dioxide (CO_2)
- Carbon Monoxide (CO)
- Helium (He)
- Neon (N)
- Nitrogen (N_2)
- Methane (CH_4)
- Refrigerants (many)

The most common reactive gases consist of:

- Ammonia (NH_3)
- Hydrogen Sulfide (H_2S)
- Nitric Oxide (NO)
- Oxygen (O_2)

In addition to reactive and non-reactive gases, many gases are also classified by the terms: artificial, elemental, compound, explosive, and synthetic. Now let's get into understanding a few of the most common inert gases, their structure, their importance in application, and their hazards across the industry.

Understanding Gas Types and Gas Detection Solutions

Ammonia (NH_3)

Ammonia is a colorless gas with a distinct odor and is a critical element used throughout many products that individuals use day to day. This gas type occurs naturally throughout the environment in the air, soil, water,

plants, animals, and even humans. The human body makes ammonia when the body breaks down foods containing protein into amino acids and ammonia, then converts the ammonia into urea. Ammonium hydroxide is also a common household ammonia and is used in many cleaning products.

Dangers and Monitoring

Ammonia can be dangerous to humans as lower levels of the gas type can cause irritation to nose and throat. An increase can even cause severe burns to skin, eyes, throat, and lungs. This is because the gas type ammonia reacts with water in the human body to produce a very corrosive chemical called ammonium hydroxide. In addition, for those working near and arround Ammonia, the Occupational Safety and Health Administration (OSHA) has also set a permissible exposure limit of 50ppm averaged over an eight-hour day. By using gas monitoring solutions like the Ammonia (NH_3) Handheld Gas Detector individuals can measure azane gas concentrations in a variety of industries and environments, ensuring protection and proper indication by visual and audible alarm settings.

Applications That Use NH_3


LIVESTOCK/FARMING


AGRICULTURE


INDUSTRIAL


SAFETY

Argon (Ar)

Argon is a chemical element with the symbol Ar and atomic number 18, it is the third-most abundant gas in the earth's atmosphere and is more than twice as abundant as water vapor. The gas is typically produced

Fun Fact – About 90% of ammonia produced is used in fertilizer to help sustain food production for billions of people around the world.

through industrial processes by the fractional distillation of liquid air. It is most used as an inert shielding gas in welding, a preservation in packaged foods, a carrier gas for chromatography and in graphite electric furnaces to prevent burning. The gas is chemically inert

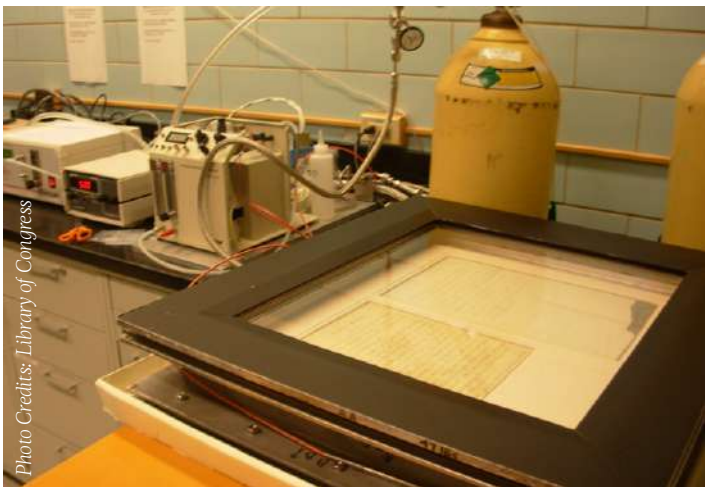


Photo Credits: Library of Congress

under most conditions and forms no confirmed stable compounds at room temperature. It is colorless, odorless, nonflammable, and nontoxic as a solid, liquid, or gas.

Dangers and Monitoring

Argon although not extremely dangerous or toxic, can displace oxygen in the atmosphere causing asphyxiation in closed areas. It is 38% more dense that air which makes it a hazard specifically in closed spaces. It is also very difficult to detect because it is colorless, odorless, and tasteless. Furthermore, making gas detection solutions such as the TS-300 Oxygen Gas Analyzer a vital tool to detect low oxygen concentrations. In addition, oxygen safety monitors such as the Remote Oxygen Depletion Alarm can be installed to trigger individuals should the concentrations of oxygen that are present be lower than standard.

As a rule of thumb, the OSHA guidelines set the standard that the minimum level of oxygen in the atmosphere be 19.5% oxygen.

Applications that Use Ar

WELDING

INDUSTRIAL

3D PRINTING

HEAT TREATING

Fun Fact – Another use for Argon is the preservation of historical documents. In fact, the gas is used to preserve documents such as the 'Declaration of Independence' in the Library of Congress!

Carbon Dioxide (CO_2)

Carbon Dioxide is a gas consisting of one-part carbon and two parts oxygen. This gas type is one of the most important gases on the earth because plants use it during photosynthesis, and humans and animals depend on plants for food. Essentially, carbon dioxide is vital for life here on earth. CO_2 is a colorless, odorless, and tasteless gas with a density of about 53% higher than that of air. Common natural sources of carbon dioxide include volcanoes, hot springs, geysers, and carbonate rocks.

*Fun Fact – While many individuals often mistake CO_2 and CO. An easy differentiator is paying close attention to CO2's subscript 2. As carbon dioxide has **one** carbon atom and **two** oxygen atoms, CO only has **one** of each.*

Dangers and Monitoring

Carbon Dioxide is a greenhouse gas that is natural and harmless in small quantities, but as levels rise it can directly affect individuals in many ways. Many industries such as restaurants and breweries utilize carbon dioxide to create the sensational "fizz" in our favorite

OSHA has set exposure limits for CO2 in the workplace to ensure that individuals are not exposed to higher-than-normal concentrations.

beverages; however, when entering a space with too much carbon dioxide an individual can have severe health issues such as asphyxiation. Exposure to CO_2 can produce a variety of health effects including headaches, dizziness, restlessness, asphyxiation, fatigue, elevated blood pressure, and fatality. The standard level for carbon dioxide in the outside air is typically around 400ppm (parts per million). For further reference you can print and use our Carbon Dioxide (CO_2) Recommended Levels Guide per industry.

As a reference, it is important to note that OSHA has set exposure limits for CO_2 in the workplace to ensure that individuals are not exposed to higher-than-normal concentrations. The potential negative health effects of carbon dioxide are vast, and the main route of exposure is almost always, inhalation. To ensure and prevent CO_2 exposure from occurring in your establishment, a carbon dioxide safety monitor should always be installed in areas which produce or use carbon dioxide. These devices, such as the CO_2 Multi Sensor System or Remote CO_2 Storage Safety 3 Alarm can further indicate to individuals in the space should levels exceed the threshold and exposure limits, providing audible and visual indication to evacuate or ventilate the space.

Applications That Use CO_2


RESTAURANTS


BEVERAGE


AGRICULTURE


SAFETY

Carbon Monoxide (CO)

Carbon Monoxide is often confused with the gas Carbon Dioxide, and it is important to understand the differences between the gases. Carbon Monoxide is man-made and is a colorless, odorless, and tasteless flammable gas. Carbon Monoxide (CO) consists of one carbon atom and just one oxygen atom, connected by a triple bond. A key differentiator between the gases is that carbon monoxide is the result of incomplete combustion, which happens when there is a limited supply of air, so only half as much oxygen is added to the carbon, forming carbon monoxide.

Dangers and Monitoring

Carbon Monoxide can be very dangerous and can be produced by any fuel-burning appliance, including gas furnaces, gas stoves, gas dryers, gas water heaters, fireplaces, and above all – automobiles. As a colorless and odorless gas, you cannot identify it without the use of proper gas detection devices. Severe hazards typically occur when homeowners are unaware of the gas and a lack of sufficient oxygen is present during operations. In these circumstances, areas or appliances producing carbon monoxide in poorly ventilated areas can cause unsafe and life-threatening dangers.

By using a gas detector such as the Carbon Monoxide (CO) Handheld Gas Detector, or any CO detector from your local hardware store, individuals can measure carbon monoxide concentrations and gain indication by visual and audible alarm settings, should the gas exceed normal thresholds.

It is always vital to recognize that carbon monoxide poisoning is all too common – especially during the winter season and can take a heavy toll on individuals with poor gas detection knowledge. By understanding the dangers of carbon monoxide (CO) and other inert gases you can share with others and ensure protection and prevention from gas hazards and overall exposure.

Applications that Use CO


INDOOR AIR QUALITY


AUTOMOTIVE


INDUSTRIAL

Nitrogen (N)

Nitrogen is the chemical element with the symbol N and the atomic number 7. This gas happens to be one of the lightest members of the periodic table, often called the pnictogens. Just like Carbon, Nitrogen is another substance that is vital for life on planet Earth. Nitrogen is also a very common element in the earth's universe and many industrial important compounds like ammonia, nitric acid, organic nitrates, and cyanides, contain nitrogen. Aside from its prevalent use in fertilizers and energy plants, nitrogen is often used in prolonging

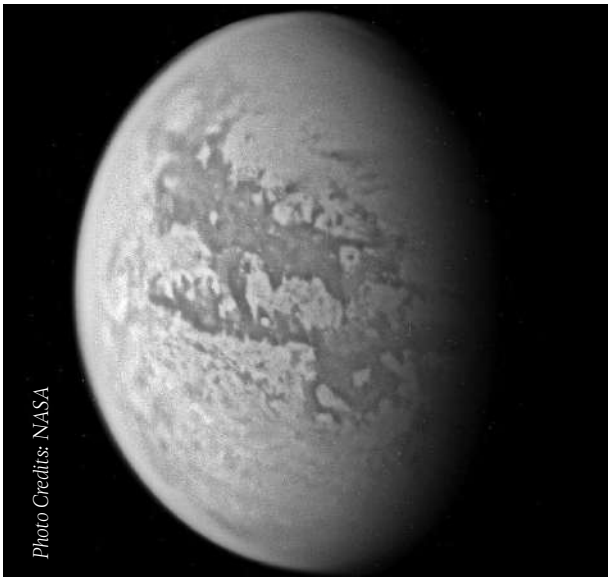


Photo Credits: NASA

the shelf life of produce, as well as blanketing, purging, and packaging in the chemical industry. Another use of nitrogen is in medical and pharmaceutical industries, by assisting in preserving body tissues and samples, as well as sterilizing and maintaining cleanliness of processes.

Dangers and Monitoring

Much like other inert gases, Nitrogen can be very deadly. The gas can act as an asphyxiate and push out O2 in the atmosphere – in less than 40 seconds. For example, the US Chemical Safety and Hazard Investigation Board started researching incidents involving the gas. The board discovered and populated 85 nitrogen asphyxiation incidents, all occurring in the workplace between 1992-2008. This is because Nitrogen tends to displace oxygen from the air, whenever it encounters it. A

Fun Fact – Nitrogen is the 7th most abundant element in the universe and on Titan (Saturn's largest moon) 95% of the atmosphere is made of Nitrogen!

worker who may be carrying out a vessel inspection at a petrochemical plant or a doctor working near nitrogen at a hospital can be at extreme risk without equipped with proper gas detection devices.

As a reference, the only way to detect low oxygen concentrations levels is with a real-time, advanced, gas detector. These devices, such as the Remote Oxygen Depletion Safety Alarm can further indicate to those near hazardous spaces should levels exceed the threshold and exposure limits, providing audible and visual indication to evacuate or ventilate the space.

Applications That Use N


FOOD & BEVERAGE


PHARMACEUTICAL


MODIFIED ATMOSPHERIC PACKAGING (MAP)


METALLURGY

Oxygen (O_2)

Oxygen is a critical element with the symbol O and atomic number 8. It is a member of the chalcogen group on the periodic table and is a highly reactive nonmetal, as well as an oxidizing agent that readily forms with most elements and compounds. The gas is also colorless, odorless, and tasteless – however is essential to living organisms which convert it to carbon dioxide, utilizing CO_2 as their source of carbon and returning the O_2 to the atmosphere. At 46 percent of mass, oxygen is the most plentiful element in Earth's crust and its most important compound is water. Additionally, of the main components of air, oxygen has the highest boiling point and is less aggressive than nitrogen or argon gases. Typical uses of oxygen include cryogenics, modified atmosphere packaging, and welding where fuel gases are used in gas cutting, oxygen scarfing, flame hardening and flame straightening. Particularly in gas cutting, the oxygen must be of highest quality to ensure a high cutting speed and clean weld.


Photo Credits: Eielson Air Force Base

Dangers and Monitoring

Contrary to popular belief, oxygen itself is not flammable. Instead, an oxygen enriched environment can be extremely flammable and can create an explosion. Oxygen also can even make some materials burn that are not typically flammable. Due to the gas also being colorless, odorless, and tasteless; it is often very difficult to detect an increase unless you have an oxygen

Fun Fact – Liquid and solid oxygen is pale blue. At lower temperatures and higher pressures however, oxygen changes its appearance from blue monoclinic crystals to orange, red, black, and even a metallic appearance!

enrichment gas detector to alert if oxygen levels are at an increased level.

As a reference, devices such as the Remote Oxygen Enrichment Safety Alarm can further indicate to those near hazardous spaces should levels exceed the threshold and exposure limits, providing audible and visual indication to evacuate or ventilate the space. If oxygen depletion is also an area where monitoring is needed, the Remote Oxygen Depletion Safety Alarm or Personal O_2 Safety Monitor can be used to protect customers and workers near stored oxygen. As a reminder, high oxygen alarms are critical in cryogenics, cryotherapy, food production, process cooling and many other environments.

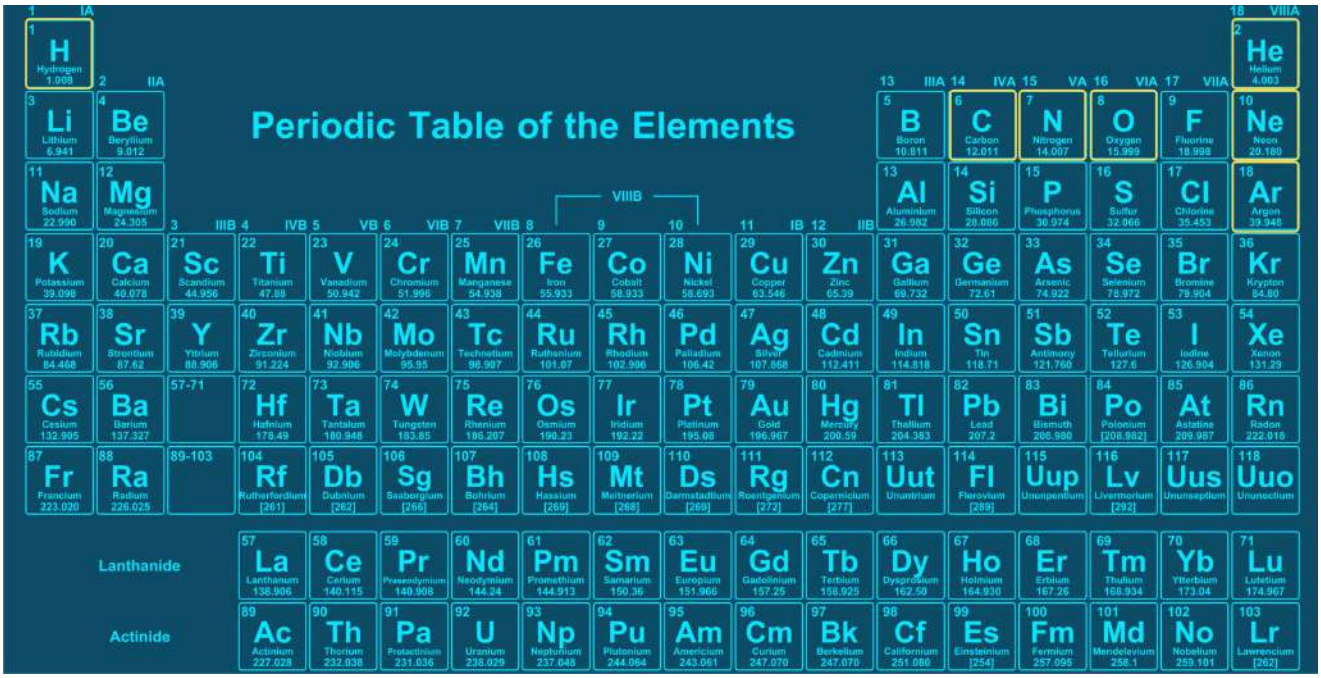
Applications That Use O_2

CRYOGENICS

INDUSTRIAL

SCUBA

WELDING



Pictured Above: Reference Periodic Table

Common Worldwide Legislation and Requirements around Inert Gases

In creating this *Guide to Understanding Industrial Gas Types Across the Industry*, CO2Meter would first like to mention that although there are a variety of nationwide, statewide, and jurisdictional requirements around gas detection we have compiled the most common requirements set around inert gases. Please be advised, that should you have any additional questions pertaining to requirements or regulations in your specific region - we always recommend speaking with your local compliance officer, first, then contacting CO2Meter for further assistance.

United States (U.S.)

Regulations: National Fire Protection Association (NFPA), Occupational Standards Hazards Association (OSHA), National Board Inspection Code (NBIC), International Fire Code (IFC).

Carbon Dioxide monitoring is very similar to food trucks, in that requirements to monitor have only appeared in the last few cycles. The National Board Inspection Code (NBIC) for example, was the first to codify requirements for CO_2 monitoring in their 2012 edition in response to localized incidents such as the CO_2 incident in Phoenix. The Boiler and Pressure Vessel inspectors started with what was under their purview, cylinders, and bulk storage vessels. The early codes from the NBIC discuss the need for specified alarm setpoints based on OSHA requirements and that a warning device must be located outside any hazard room that stored or produces CO_2 — to pre-warn occupants of an issue.

Unlike the NBIC, OSHA's expectations cover more than just the CO_2 storage vessels. OSHA is uniquely interested in the health and safety of all employees in commercial, industrial, and confined spaces. For CO_2 OSHA and the National Institute of Occupational Safety and Health (NIOSH) created guidelines for CO_2 exposure that clearly state that no lower than 5,000ppm TWA (time weighted average) should be set for the first alarm, 15,000ppm as the half STEL (short-term exposure limit) 30,000ppm as the STEL, and 40,000ppm as the IDLH (immediately dangerous to life/health exposure). These standards are fixed by OSHA and do not change.

The next organization to include regulations around stored CO_2, safety and gas detection monitoring is the National Fire Protection Association (NFPA). However, the NFPA did not have a specific place to put CO_2 monitoring requirements so it is placed into the NFPA 55 Compressed Gases and Cryogenic Fluids. The NFPA 55 is the most "vanilla" of the codes as it relates to CO_2 because it mandates almost no specifics about devices, locations, or performance. The last update was released in 2020.

The last organization that has mandated CO_2 monitoring is the International Fire Code (IFC). The IFC is part of the International Code Council (ICC) that also creates building, electrical, plumbing, and additional codes. The IFC has traditionally been the code that is more

Devices that meet U.S. Codes & Regulations

CM-7000 | CO_2 Multi Sensor System

RAD-01026 | Remote CO_2 Storage Safety 3 Alarm

Devices that meet EU/ IT Codes & Regulations

CM-7000 | CO_2 Multi Sensor System

RAD-01026 | Remote CO_2 Storage Safety 3 Alarm

RAD-0002 | Remote O_2 Depletion Safety Alarm

Devices that meet UK Codes & Regulations

RAD-01026 | Remote CO_2 Storage Safety 3 Alarm

RAD-0002 | Remote O_2 Depletion Safety Alarm

prescriptive about devices, locations, and alarm setpoints. Some of the common recommendations in the IFC include a 12 inch from the floor-mounted height for monitors, the first alarm at 5,000ppm, and that a monitor or ventilation be required whenever 100+ lbs. of carbon dioxide (CO_2) is stored or produced. The latest edition of the IFC was published in 2018 and will be updated in 2021.

Europe (EU) / Italy (IT)

Regulations: EH40 Workplace Exposure Limits, Guidelines for storage of Nitrogen (N) Italy

Much like the United States (US), Europe has a set of defined workplace exposure limits set by the 4th indicative occupational exposure limit values (IOELV) directive. These limits are set for a variety of hazardous gases and substances that can cause injury if not properly monitored, including carbon dioxide (CO_2) and oxygen (O_2).

The EH40, most recently updated in 2020, states specific long term exposure limits for Carbon Dioxide at 5000ppm for an 8-hour period. The short-term limit is set for 15,000ppm at a 15-minute period. In terms of oxygen in specific applications, the EH40 additionally states that there are severe hazards around oxygen concentrations at 20.9% and the minimum accepted concentrations are 19.5%.

One set of guidelines in Europe is specific to the country of Italy (IT) and is formed regarding the storage of nitrogen (both liquid and gas from) in scientific and medical applications. These guidelines are approved by the Italian National Transplant Centre which is a technical body of the Ministry of Health, chaired by the President of the Italian National Institute of Health. These requirements address the risk and hazards associated with the use and storage of liquid nitrogen and dry ice, and then apply to all laboratories. Furthermore, the standard specifies that monitors must be in place for areas that store nitrogen, and that gas detectors require two alarms at 19% and 18% which have a central display located outside of the room holding the gas(es).

United Kingdom (UK)

Regulations: Health and Safety Work Act (HSWA) and Control of Substances Hazardous to Health Regulations (COSHH)

The United Kingdom created further provision for securing the health, safety, and welfare of individuals at work for protecting others against risk to health or safety, in connection with the environment and atmosphere. The Health and Safety at Work Act (HSWA) was created in 1974 as a legislation which holds occupational health and safety. The legislation with local authorities sets the standards for

Devices that meet AU Codes & Regulations

RAD-01026 | Remote CO_2 Storage Safety 3 Alarm

RAD-0002 | Remote O_2 Depletion Safety Alarm

statutory instrumentation relevant to individuals and their specific workplace environment. This specific act mentioned BS EN 50073 (1999) which includes proper selecting and installation of gas detection and measurement devices for both oxygen and combustible gases.

In addition, the United Kingdom has also created the Control Substances Hazardous to Health Regulations (COSHH) which is a set of rules that protect employees and prevent damage to individual's health and wellbeing. The set of rules gives important information and education on how to use monitoring devices and reduce health risks.

Australia (AU)

Regulations: AS5034: Installation and use of inert gases for beverage dispensing

Australia specifically has a standard known as AS5034, which was created in 2005 and developed by a group including the Australian Chamber of Commerce and Industry, Victorian and New South Wales Work-Cover Authorities, gas suppliers, insurers, and breweries. These standards place an outline on measures that must be taken by all areas where gases such as carbon dioxide, nitrogen, argon, and other inert gases are used to deliver beverages. This standard also outlines the requirements for safety in storage, delivery, and maintenance of beverage delivery systems by compressed gases (CO_2, N_2).

Specifically, the act mentioned that fixed or wall-mounted gas detectors must be hard-wired and provide audio/visual indication should oxygen or carbon dioxide levels reach a certain hazard level. Specific warning signage should also be present and clearly shown outside the display unit.

Devices that meet SG Codes & Regulations

RAD-01026 | Remote CO_2 Storage Safety 3 Alarm

RAD-0002 | Remote O_2 Depletion Safety Alarm

Singapore (SG)

Regulations: Workplace Safety and Health Act (WSH)

The Workplace Safety and Health Act (WSH) is an act issued by the republic of Singapore which addresses requirements for safety and health in workplace environments. This specific act replaced the Factories Act in March 2006. What this act entails is that individuals cannot work around confined spaces or hazardous environments which pertain gases without a permit. Maximum penalties are given for failure to comply with the WSH act.

The act additionally mentioned that the permit will not be granted if the concentrations of oxygen (O_2), carbon dioxide (CO_2), or carbon monoxide (CO) exceed the standard permissible exposure limits. For confined spaces, the act states that the oxygen level should be more than 23.5% and less than 19.5%.

Conclusion

One of the keys to understanding the gases in your industry or application is gaining education on how the gas is formed, the dangers of the gases, and the regulations that are in place to ensure safety and protection in your establishment. CO2Meter has continued to provide education and guidelines to our customers to inform them on specific gas incidents that have occurred in the past in order to mitigate potential injuries from occurring in the future. We often hear that "it could not happen to me" or "I should have done something sooner."

With accurate gas detection monitoring and technologies to indicate that a hazardous gas is present, you can confidently improve your corporate environment and provide peace of mind for your employees on their overall health and well-being while working around inert gases. Even if you have the perfect gas monitor installed that adheres to the regulations as mentioned above, it is important to continue to educate your team members so that they are aware of what to do should an incident or gas leak occur.

If you are looking for further resources on safety monitoring guidelines or specific gas detection solutions, our team is happy to help provide you with more information and training resources. Contact us at Sales@CO2Meter.com for more information.

Continued safety training is the best way to ensure that your employees know what to do should an incedent or gas leak occur.

Get More Information

For further information on inert gas safety devices for your specific application please call 877-678-4259, or email us at sales@co2meter.com.

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