Gas Detection.

.MSR ELECTRONIC

The principles of gas measuring technology

NH_3
Ammonia

CO
Carbon monoxide

CH_4
Methane

O_2
Oxygen

H_2
Hydrogen

NO_2
Nitrogen dioxide

C_3H_8
Propane

CO_2
Carbon dioxide

Protecting lives and plants
through reliable gas detection.

Gas molecule

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How has gas detection developed over the years?

In mining, hazardous levels of gas concentration can build up all the time, causing powerful explosions and accidents. The search for methods for the early detection of hazardous gases, such as methane and carbon monoxide, was therefore already of crucial importance in the 19th and 20th centuries to ensure the safety of miners.

The first method of gas detection involved the use of canaries. For this, a canary was kept in a small cage and monitored regularly. If the bird displayed any signs of stress or illness, this was taken as a clear warning signal for the presence of hazardous gases. To protect the animal's health, flame lamps would then be used to determine hazardous levels of gas concentration.

For this, the miners lit the flames in a fresh air environment. If the flame shrank in size or began to go out, this indicated a low level of oxygen in the air. If, on the other hand, the flame increased in size, this was a sign that methane - as well as oxygen - was present in the mine.

Gas warning technology has continued to develop to this day. Today, precise, compact and robust gas detectors are used to monitor dangerous gas concentrations and combustible vapours.

Various technologies such as catalytic, electrochemical, infrared, ultrasonic or MPS™ technologies offer the best possible options for monitoring and analysing the ambient air. These allow safe and reliable gas detection in a wide range of applications and ensure maximum protection for lives and plants.

The gas detectors must monitor various gases and vapours safely and continuously in changing conditions. This requires maximum reliability, flexibility and stability in order to protect the safety of people and plants in the best possible way.

In addition, not every gas detector may be used in every working environment. It is therefore necessary to check whether the required device specifications are met before use. These device requirements are explained in the relevant standards and regulations.

What are gases?

Matter above its boiling point is generally referred to as a gas. In this physical state, the molecules or atoms move far away from each other and completely occupy the available space. In contrast to matter in solid and liquid states, gases have no solid form and no solid volume.

Gases consist of a swarm of molecules moving randomly and chaotically, constantly colliding with each other and with everything around them. They fill every available space and, because of the high speed at which they are moving, mix rapidly with any atmosphere into which they are released.

Gases can be lighter or heavier than air or have approximately the same density. Gases can have an odour or be odourless. There are coloured and colourless gases. Even if you cannot see, smell or touch them, this does not mean that they are not present. Gases in principle are not harmful. They are, after all, part of the earth's atmosphere. It is only when their concentration exceeds critical levels that there is a risk of poisoning and explosion and, if it falls below these levels, danger of suffocation from lack of oxygen.

Methane, for example, is colourless and odourless and difficult to detect when present. However, as this natural gas is used in many homes for heating and cooking, it is present in people's everyday lives. Vehicle engines burn fuel and oxygen and produce emissions/waste gases containing nitrogen oxides, carbon monoxide and carbon dioxide and are a hazard to life and plants. Oxygen and hydrogen must also be detected continuously to keep the ambient air clean and prevent oxyhydrogen explosions.

What are the different gas hazards?

Choosing the correct measuring principle is of central importance in the detection of gas hazards. Each measuring principle is suitable for different danger zones and is optimised for either toxic and/or combustible gases and oxygen. In principle, the following gas hazards can be distinguished:

1. Explosion hazard due to combustible gases

Wherever combustible gases such as methane, butane and propane are present, there is an increased risk of explosion, for example in petrochemicals, industry and refineries. Sensors with a catalytic sensor element for combustible gases are used here.

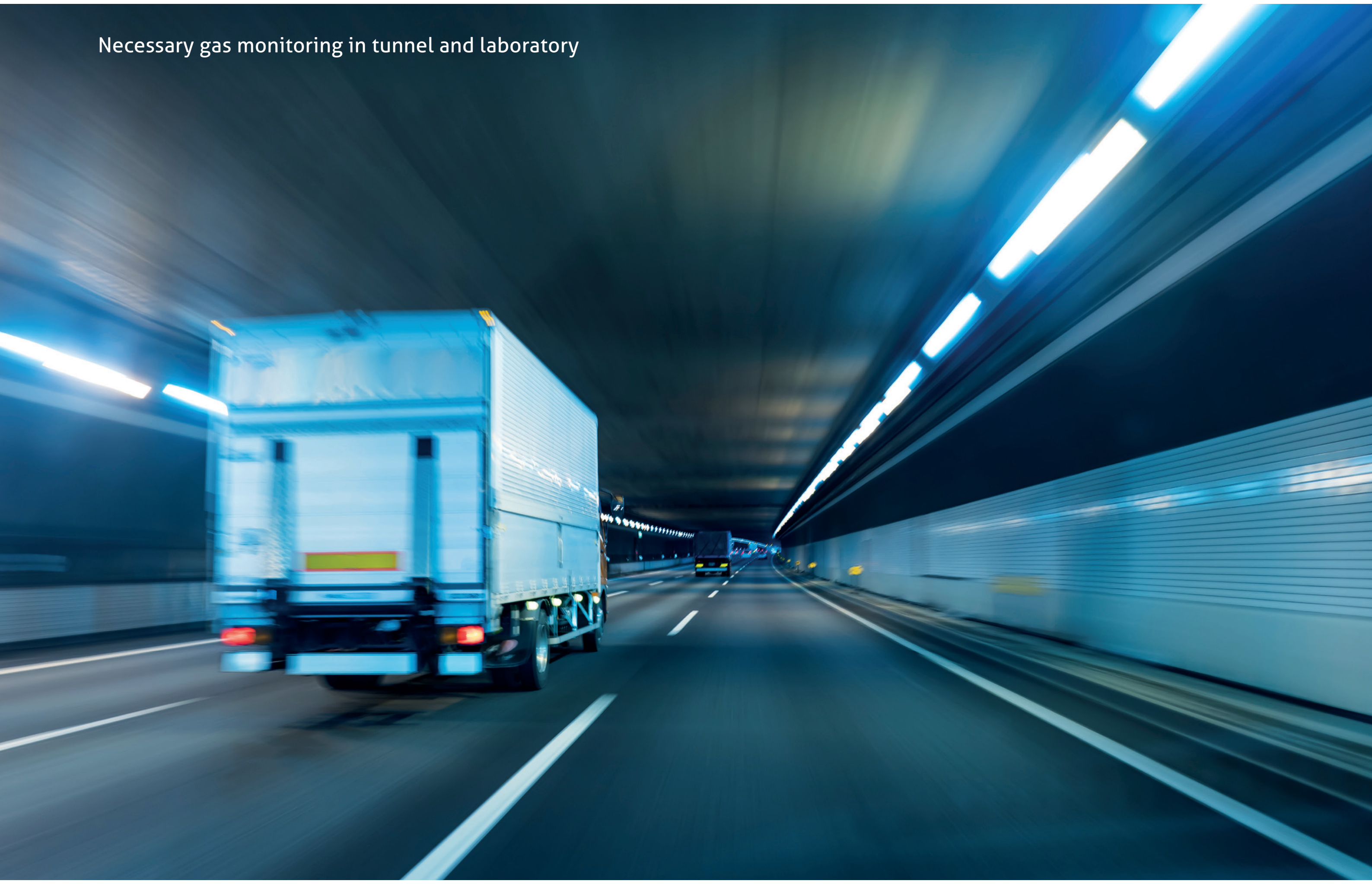
2. Excess oxygen and lack of oxygen

While excess oxygen makes materials more flammable, a lack of oxygen is life-threatening. Oxygen can be consumed or displaced by another gas. Sensors with an electrochemical sensor element are generally used for monitoring oxygen levels.

3. Toxicity

Hazards from toxic gases can arise in a wide variety of areas, such as in industrial production processes or during transport, but also in natural processes, such as putrefaction processes during the degradation of biomass. Sensors with an electrochemical sensor element for toxic gases are used here.

In addition to the different gas groups, selecting the suitable measurement method depends on many other factors, such as checking whether other hazardous substances are present in the environment (cross-sensitivity), whether continuous measurement or long-term or short-term measurement is required and whether there needs to be an alarm and warning notification if limit values are exceeded.



Necessary gas monitoring in tunnel and laboratory

What are the sensors and measuring principles used in gas detection?

The sensors use certain properties of the gas to convert them into an electrical signal. The following measuring principles are used in gas detection technology: the electrochemical measuring principle, the catalytic measuring principle, the infrared measuring principle, the semiconductor measuring principle and the MPS measuring principle.

The electrochemical measuring principle

Electrochemical sensors are often used because of their precision, sensitivity and fast reaction times. They are used in areas such as environmental monitoring, medical diagnostics, food control and industry.

Electrochemical gas sensors work in a similar way to batteries and are used to measure carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO_2), ammonia (NH_3) and oxygen (O_2). The ambient air to be monitored diffuses through the filter membrane into the liquid electrolyte of the sensor.

The chemical process of the measurement is an oxidation, whereby one molecule of the target gas is exchanged for one molecule of oxygen. The reaction drives the oxygen molecule into the counter electrode, resulting in a current signal (nA) between the measuring and reference electrodes. As a rule, gas sensors are specific, so there is little - if any - cross-sensitivity to other substances.

Advantages

- Linear measurement signal
- Highly sensitive
- Low cost

Gas sensors by MSR-Electronic
(c) MSR-Electronic

Catalytic measuring principle

The catalytic measuring method involves measurement using pellistor and catalytic bead sensors and is suitable for measuring explosive gases and vapours. In this measuring method, two platinum coils are embedded in a ceramic layer and connected electrically via a bridge circuit (a Wheatstone measuring bridge).

The surface of one platinum coil is activated with an oxidation-promoting catalyst, while the surface of the other platinum coil is not activated. Current flows through the coils, heating them to approx 500 °C. The oxygen in the air reacts with the combustible gas on the surface of the active coil. This increases the temperature and resistance in the active platinum coil, causing the bridge to become unbalanced. This process can be measured.

Advantages

- Total measurement of many combustible gases
- Linear signal
- High measurement accuracy
- Poisoning from silicones etc.

Infrared measuring principle

The infrared measuring principle involves the measurement of CO_2, methane etc. using infrared sensors. The IR principle uses the individual absorption spectrum of the gas to be measured as a base and determines the exact concentration by analysing it precisely and quantitatively. Since all measured gases absorb in different spectral ranges, this results in a kind of „fingerprint" that allows selective characterisation with almost no cross-sensitivities.

Advantages

- Low cross-sensitivity
- High measurement accuracy
- Wide measuring range
- High selectivity
- Dust & dew point sensitive
- Long lifetime
- Low maintenance costs

Semiconductor measuring principle

Semiconductor sensors are used for some toxic and explosive gases. A metal oxide-based semiconductor (tin oxide) is applied to a substrate. The substrate contains electrodes that measure the resistance of the semiconductor and a heater that heats the semiconductor to 200 to 400 °C.

The sensor reacts to changes in the composition of the surrounding atmosphere by changing the resistance of the semiconductor. Reducing gases such as carbon monoxide or hydrogen lower the resistance of the semiconductor. The sensitivity of the semiconductor to a specific gas can be changed through the temperature of the semiconductor.

Advantages

- Low budget
- Versatile in use
- Non-selective
- Robust

MPS™ measuring principle

MPS™ sensor technology is used to detect combustible gases such as hydrogen, methane, propane and acetylene as well as refrigerants. This highly flexible sensor solution is attractive for a wide range of applications. MPS™ sensors are particularly suitable for areas that are difficult to access, as they can operate for long periods without requiring calibration or maintenance. The integrated environmental sensor measures the change in thermodynamic properties.

Advantages

- Lifetime 15+ years
- Maintenance free
- Low power consumption
- High linearity
- High stability
- Non-selective
- Environmental compensation

Gas monitoring of a hydrogen-powered container ship


Gas monitoring of an oil platform

What do explosion protection and explosion limits mean?

Explosion protection

Many combustible substances come into play in industrial processes. This releases combustible gases and vapours through valves or other openings. For prevention purposes, these danger zones are called Ex-areas in which only equipment of a safe ignition protection category may be used.

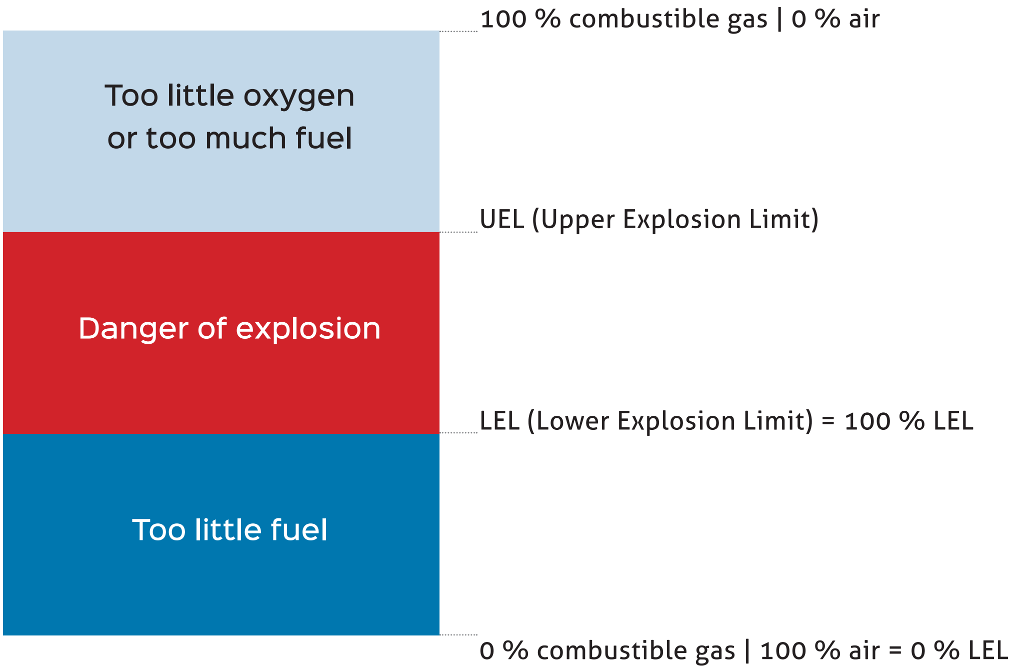
Explosion protection is standardised worldwide and based on the 3-zone concept. Ex zones are areas in which a hazardous explosive atmosphere exists. The zones can be distinguished as follows:

EX-Zone	Type of hazard	Areas in which a haz-ar-dous explosive at-mosphere exists	Permitted devices/ Protective measures
Zone 0	Permanent danger of explosive atmosphere	e.g. inside containers	Ex-protected devices required
Zone 1	Occasional danger of explosive atmosphere	The immediate vicinity of Zone 0, e.g. filling openings	Ex-protected devices recommended, non-ex-protected devices with special protective measures
Zone 2	Low risk of explosive atmosphere	The area surrounding Zones 0 and 1	Non-ex-protected devices, provided the probability of an explosive atmosphere is low

Explosion limits

The explosion range is defined by a Lower Explosion Limit (LEL) and an Upper Explosion Limit (UEL). The Lower Explosion Limit describes the lowest concentration of a combustible substance in the air at which a flame can ignite and spread.

The Upper Explosion Limit describes the highest concentration at which a flame can only just ignite and spread independently. However, it should be noted here that the situation can change rapidly, for example through dispersal of the mixture caused by a gust of wind, and the concentration can then again fall below the Upper Explosion Limit.



Which requirements and guidelines apply to gas detectors?

Safe Integrity Level – SIL

The Safety Integrity Level, also known as the safety requirement level (SIL for short), is an internationally-recognised measured variable in the field of functional safety. The Safety Integrity Level is used to assess electrical/electronic/programmable electronic (E/E/PE) systems and refers to the reliability of safety functions.

4 SIL levels are used to determine the potential risk to persons, systems, plants and processes. These are realised using safety functions with the aid of a safety instrumented system (SIS), which may consist of different equipment such as sensors, actuators and control elements.

A distinction is made between SIL1 up to SIL4, which requires the strictest measures for the greatest risk. These are requirement measures for the probability of dangerous random failures.

Functional safety is part of the overall safety of a device, a plant, a train, a car or any other complex automated system. The aim of functional safety is always to protect people, plants and the environment from malfunctions. Without functional safety, trains would not be accident-free, chemical plants would not be able to be operated safely, or airbags would be triggered at the wrong moment.

Which certificates and standards are required for gas detectors?

Many applications require special certificates that prove that the gas detectors meet environmental requirements, such as ATEX, ISO, Marine, IEC, EN, SIL, etc. Gas detectors also differ significantly in respect of their technical features. In particular, there are sometimes considerable differences in terms of functionality, calibration, lifetime and suitability for installation as well as user-friendliness. MSR-Electronic offers a wide range of gas detectors for the detection of toxic and combustible gases.

MSR-Electronic is a manufacturer of fixed gas warning systems with decades of experience in the area of building automation and gas measuring technology. The international company with headquarters in Germany offers a wide range of methods for the detection of toxic and combustible gases. On this basis, MSR-Electronic develops individual gas sensors, controllers and warning devices for many applications, such as parking garages, tunnels, the petrochemical industry and shipping. The products meet and surpass general standards and regulations and can thus guarantee the safety of the plant.

Further information on MSR products can be found in the current online catalogue or in the webshop www.msr-24.com.

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Version 10/24