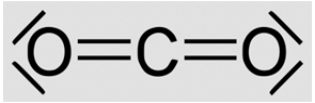
Application note: N° F023 February 2013

CO2 and Indoor Air Quality (IAQ)

Facts & figures:

- CO2 is a naturally occurring molecule consisting of two oxygen atoms and a single carbon atom.
- At standard temperature and pressure CO2 is a gas, invisible without any smell and taste.
- CO2 is 50% heavier than air and has no liquid state under atmospheric pressure.
- In the earth's atmosphere CO2 has a concentration of 390 ppm by volume.
- The worldwide industry produces approximately 36´000 million tons of CO2 per year.
- Industrial activities are responsible for an increase of atmospheric CO2 concentration and thus for an increase of global warming (greenhouse effect).



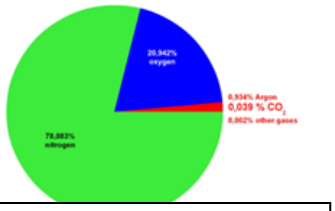
CO2 structural formula

Discussed in this edition:

Indoor Air Quality in general

The quality of the air in rooms which are occupied by humans extremely contributes to their health, productivity and well-being. Up to now temperature and humidity of the indoor air were considered as the most important parameters describing their quality, but there are some more to be examined.

Indoor Air Quality (IAQ) problems are very often caused by gases or particles released by pollution sources that emit them into the air. This can be avoided by a careful selection of the materials which are deployed in the interior of dwellings, offices, classrooms, gymnasiums, hotels, shopping malls, hospitals and in all enclosed spaces where people stay. But there is another source of air pollution, which cannot be avoided, as it is represented by the people themselves, which produce carbon dioxide (CO2) with every breath of air. Inadequate ventilation may increase CO2-concentration to an unhealthy or even life-threatening level by not bringing in enough outdoor air.

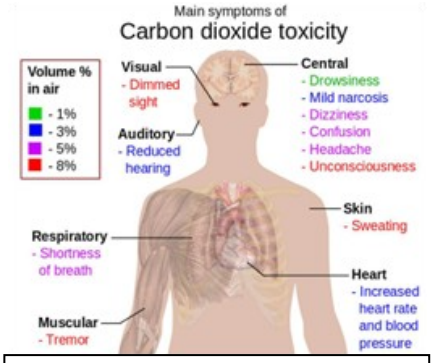


Only 390 ppm of the atmosphere is gaseous CO2, thus called a trace gas.

So the most important control parameters for a good Indoor Air Quality are temperature, relative humidity **and** CO2-concentration. If these are input to an intelligent air conditioning system, an energy efficient supply with high-grade quality atmosphere is possible.

Influence of CO2 on humans

Only a trace of the atmosphere consists of CO2, the prevailing components are nitrogen and oxygen. The natural outdoor atmosphere CO2 level is appr. 390 ppm. Increasing this concentration in the breathing air of a human, causes symptoms of poisoning, ranging from drowsiness beginning at 1´000ppm over unconsciousness to death ending at more than 10´000 ppm. Even if a certain rise of CO2 concentration has not yet an influence on the health of people, it may reduce their productivity, efficiency and well-being.

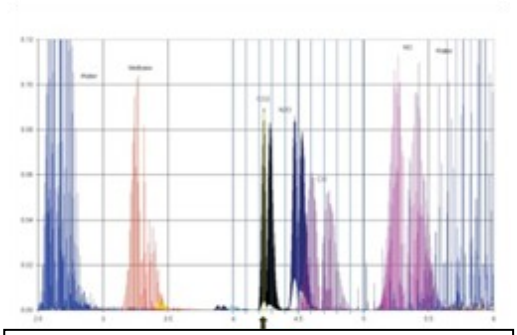


The poisoning influence of CO2 in higher concentration in the breathing air.

How to measure CO2?

The most common measuring method for CO2 concentration nowadays is based on a spectroscopic principle. Sending infrared light (IR) with a wavelength of 4.23 µm through a CO2 containing gas sample a resonance with the CO2 molecules occurs which absorbs energy from the light. Thus having passed the sample gas the light is attenuated proportional to the CO2 concentration in the sample.

The sensitivity of a CO2 sen-



At a wavelength of 4.23 µm IR light brings CO2 molecules to oscillation thus leaving energy.

sor increases with the length of the light path through the sample gas. Thus the sensor used in Rotronic CO2 measuring devices makes use of multiple reflections of the IR beam at the walls of the probe chamber. So the CO2 sensor with small dimensions of 2.5 cm x 5 cm has a measuring path length of 12.5 cm and is accordingly sensitive. The applied sensor is a so called NDIR type (Non Dispersive Infra Red), which means, that a broadband IR light source is used and the filtering of the measuring wavelength takes place at the end of the beam in front of the IR detector.

A „folded“ path of the IR beam through the sample gas increases the sensor´s sensitivity.

Drift compensation

Every IR CO2 sensor is subject to a certain drift in the course of time and needs an occasional readjustment. On Rotronic CO2 measuring devices this can be done very easily, as the sensor has a hole for input of a CO2-free reference atmosphere, which allows to readjust the zero point. Rotronic offers a calibration set which produces the zero CO2 atmosphere by a chemical reaction.

In rooms, where a total exchange of the indoor air against outdoor air in a couple of days is ensured, Rotronic sensors can readjust themselves automatically by the embedded ABC method (Automatic Baseline Correction).

The Rotronic CO2 calibrator produces CO2 free air as a reference for readjusting the sensor.

Why the need to measure humidity?

New demands on energy efficiency lead to more airtight buildings and ventilation being completely turned off at nights. Intelligent HVAC systems must be able to adapt themselves to situations with changing occupancies of rooms. An important answer is Demand Controlled Ventilation (DCV) with CO2 sensors. By doing this, huge amounts of energy can be saved without any drawback for the occupants. According to a study of the UN Climate Panel 40-50% of world energy is used in buildings. Only the adoption of the EU Directive on Energy Efficient Buildings would result in saving 30-45 MT of CO2/year. As HVAC causes 40-65% of energy usage in commercial and public buildings, a balance between comfort and energy saving under all conditions must be targeted.

In wine cellars, breweries and the beverage industry CO2 measurement is prescribed by law.

A little calculation example demonstrates the evidence of CO2-controlled room ventilation. The exhaled air of a human contains up to 40´000 ppm CO2. In one hour a person breathes out 15 litres of CO2. Thus in a classroom with a volume of 200 m³ occupied by 25 pupils the CO2 concentration increases in one hour by 1´875 ppm!

Especially in wine cellars, breweries, the beverage industry and everywhere where CO2 may be produced or processed the constant measuring of CO2 concentration is absolutely necessary to prevent deadly threats for the employees. This is not only a rational procedure but also prescribed by official regulations in nearly every developed country.

What solution can Rotronic offer?

For applications in building automation, ventilation of underground garages, vehicle depots, tunnels, food transportation/storage, green houses and climate chambers

Rotronic offers a wide range of fix-mounted CO2-only and CO2-temperature transmitters. All of them are based on the principle of NDIR technology. They are pre-calibrated and have a lifetime of more than 15 years under normal conditions. Multiple analog outputs like current loop, voltage and relay contact allow for the easy adaptation to every HVAC system.

CF-3-W-EU-DISP: Installed in the environment to be monitored and fits directly on standard EU surface mounted boxes.

CF-5D-DISP: For ventilation control in residential rooms, offices, classrooms, cinemas, etc.

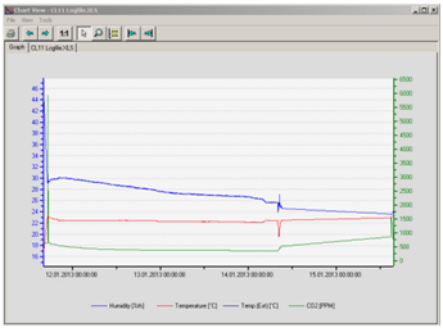
CF8-D-DISP-IN: Model IN (Incubator) is suitable for measurements in incubators or climate chambers.

For mobile applications

The CP11, Rotronic´s latest development of an inexpensive multimeter handheld instrument is the ideal mobile measuring solution. It simultaneously measures and records CO2, humidity and temperature and also calculates dew point and wet bulb temperature. Equipped with the field-tested ROTRONIC HYGROMER® IN-1 humidity sensor, this instrument offers unbeatable value for money. Using the ROTRONIC HW4-Light software that comes with the device, it can be set as required and data can be saved and analyzed. An audible alarm function warns against inappropriate CO2 concentrations.

CP11: For mobile fast and reliable measurement of the relevant IAQ

CL11: Benchtop display for all IAQ parameters at a glance, including time stamped data logging.



A picture tells more than a thousand words: Graphical presentation of logged measuring values by the included software.

For benchtop purposes

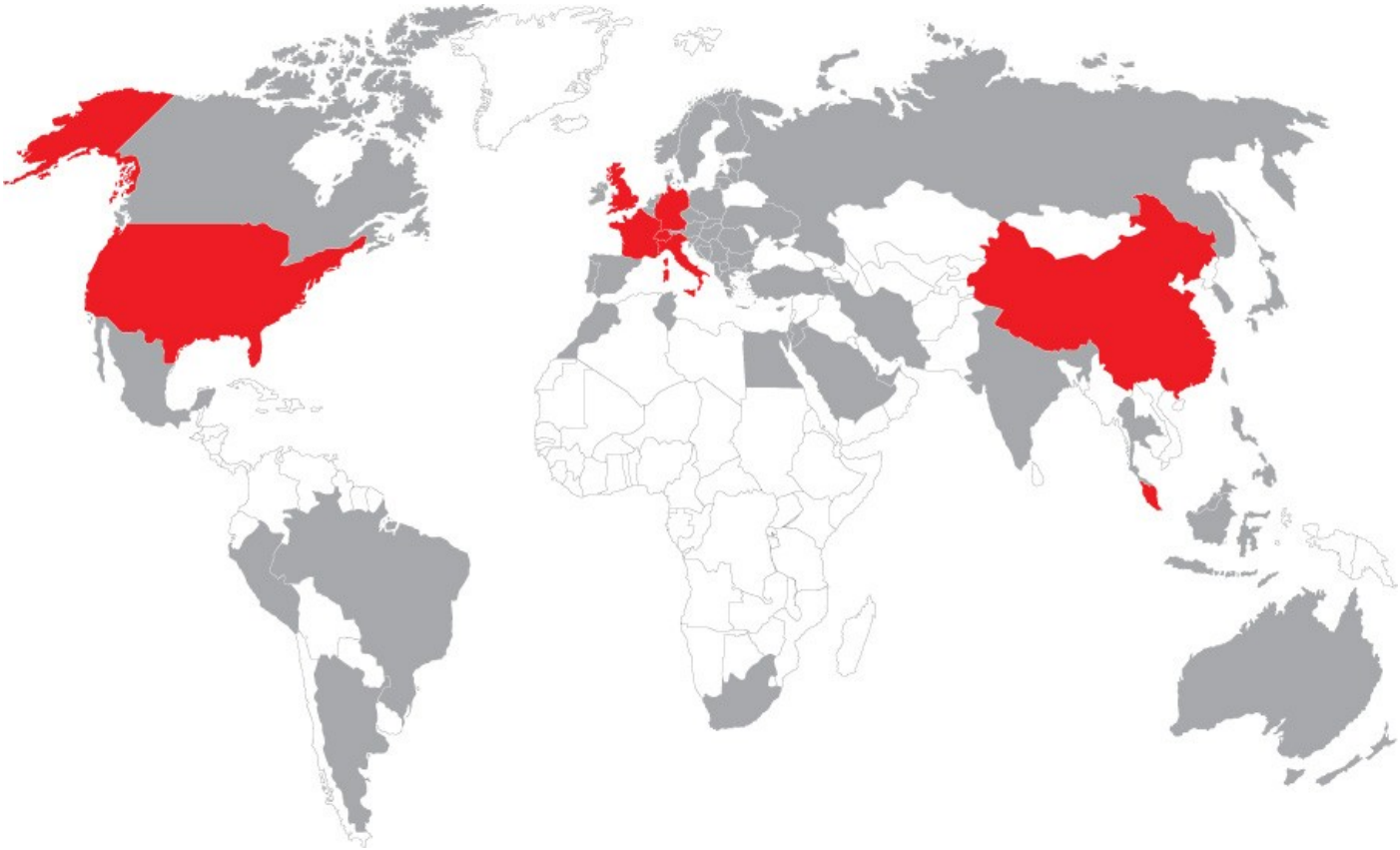
CL11 measures and logs CO2, relative humidity and temperature. The features comprise: 40´000 data point memory for CO2, humidity and temperature values including analyzing software , maximum, minimum and average values displayed, adjustable audible and visual CO2 alarm, real time clock and optional external temperature probe.

Customer benefits:

Accuracy, long term stability and calibration. Rotronic products give you the best accuracy and long term stability in the market. The Rotronic CO2 sensors can easily be calibrated, to guarantee highest possible precision of the measured concentration. The ABC function autonomously avoids baseline drift.

Contact us:

Rotronic is represented in more than 40 countries around the world. An up to date list of all our partners is available at www.rotronic.com



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