

# Vaisala's Barometers Used to Track Leakage from Nuclear Enclosures

Vaisala's PTB101C analogue barometers are being used by the French Electricity Company in their program to track leakage from nuclear power plant enclosures.

**T**hanks to fruitful co-operation between Gianelli Mesures and Vaisala SA, some sixty of Vaisala's PTB101C analogue barometers have been delivered to the French Electricity Company (Electricité de France, or EDF).

The PTB101C has been installed in an instrument cabinet with a 220V power supply by Gianelli Mesures, a company located close to Valence, France.

The resulting unit is being used in EDF's SEXTEN program, designed to track leakage from nuclear power plant enclosures.

The PTB100 series of analogue barometers is designed both for accurate barometric measurements at room temperature and for general environmental pressure monitoring over a wide temperature range. The excellent long-term stability of the barometers minimizes or even removes the need for field adjustment in many applications.

The SEXTEN system measures the atmospheric pressure inside nuclear enclosures with high precision and stability. These enclosures are maintained at a slightly higher pressure than the atmospheric pressure, in the range 900 to 1100 hPa. The value of the outside atmospheric pressure is also measured by the Vaisala barometer and compared with the inside pressure. The allowed rate of leakage from each enclosure, proportional to the difference between the inside and outside pressures, is calculated from these two sources of information.

All of the French nuclear power plants in the 900, 1300 and 1450 megawatt range have been equipped with this system. ■

Biotechnologie-Kempe incorporates

# Dissolved CO<sub>2</sub> Measurements

**F**or over 15 years Biotechnologie Kempe GmbH has been situated in Berlin and has been active mainly in the field of measuring and regulating technology for biotechnology and environmental protection at the international level, where our export share is about 90 per cent. Our workshops produce measuring technology, electrical components, scientific instruments and machines, and, in order to control fermentation procedures, we have a self-owned programming technology department at our disposal.

A major field of achievement for Biotechnologie Kempe GmbH is our development of measuring probes (EU and US patent), as well as systems for the registration of measurements. This results in the opportunity to develop customer-oriented, personalized automating concepts, thus achieving highly economical production.

Biotechnologie Kempe's new probe incorporates Vaisala's GMM220 series carbon dioxide sensor. The GMM220 series sensors are based in CARBOCAP® technology, enabling trouble-free control of CO<sub>2</sub> levels in demanding environments.

## Carbon dioxide in biotechnology

Carbon dioxide is a product of the respiratory and fermentative metabolism of micro-organisms. During fermentation the carbon dioxide emission correlates with the biomass concentration and substrate consumption.

Depending on the concentration, carbon dioxide may influence the growth and metabo-

lism of micro-organisms. For example, a high concentration of carbon dioxide leads to a delay in budding of *Saccaromyces cerevisiae*, so the reproduction of yeast is influenced negatively.

Further, the negative effect of a very low carbon dioxide concentration on the metabolism during aerobic substrate-limited yeast fermentation is well known and results in a yield loss. Also, the formation of products and by-products in the fermentation processes frequently depends on the content of carbon dioxide in the medium.

## On-line monitoring of dissolved carbon dioxide

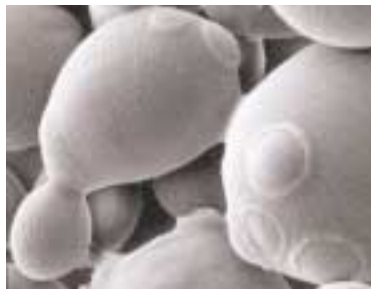
Continuous detection of carbon dioxide by the presented measuring system is realized by the combination of a silicone tubing probe and a Vaisala GMM220 carbon dioxide probe. Vaisala's GMM220 series modules incorporate enhanced CARBOCAP® technology. Many advanced features enable trouble-free control of carbon dioxide levels in extreme environments.

The CO<sub>2</sub> measurement is carried out as follows:

- directly in the fermentation broth, where carbon dioxide is formed and where the micro-organisms are affected by CO<sub>2</sub>.
- in the gas stream
- both above and below the carbon dioxide saturation achieved under atmospheric pressure
- without any preparation of the exit gas
- with high stability
- with a short response time

## Vaisala's GMM220 series sensor

Biotechnologie Kempe's new probe is equipped with Vaisala's modular carbon dioxide GMM220 series sensor. The GMM220 series CO<sub>2</sub> modules incorporate the CARBOCAP® technology. The sensor's operation is based on the NDIR Single-Beam Dual-Wavelength principle. Its main advantages are long-term stability and a long life.



Yeast cells



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*Biotechnologie Kempe's silicone tubing probe for dissolved carbon dioxide.*



Vaisala's CO<sub>2</sub> probe GMM220

Double membrane  
(Silicone + Teflon)

Protecting tube

### Silicon tubing probe

The silicone tubing probe was developed by Biotechnologie Kempe GmbH (EU and US patent) and is steam sterilizable.

The probe, which is inserted into the broth, consists of a silicone coated channel through which is passed a carrier gas. Carbon dioxide permeates through the silicone membrane and is carried to the CO<sub>2</sub> sensor.

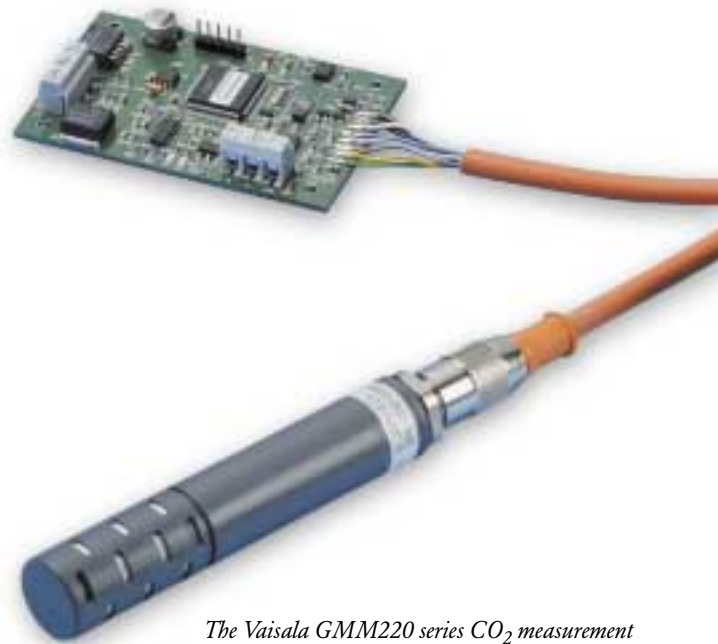
The measuring principle of the system is based on the linear relationship between the partial pressure of carbon dioxide inside the broth and the amount of carbon dioxide permeating through the membrane. The concentration of CO<sub>2</sub> in the carrier gas is

far from the equilibrium concentration, so permeation back into the broth is negligible.

The carrier gas control and the signal converter are located inside a separate box.

### Signal processing

The gas is measured by absorption of infrared radiation inside the CO<sub>2</sub> sensor located in the housing of the ST probe. The infrared radiation emitted by a lamp passes through a filter working at the selective wavelength which is characteristic for absorption by carbon dioxide. If there is carbon dioxide inside the measuring cell, the intensity of light decreases in



The Vaisala GMM220 series CO<sub>2</sub> measurement modules based on CARBOCAP® technology.

relation to the actual CO<sub>2</sub> concentration.

The ST probe described here is equipped with Vaisala's modular CO<sub>2</sub> sensor. The CARBOCAP® sensor is silicone based and operates on the NDIR Single-Beam Dual-Wavelength principle. Based on this new measuring principle, its main advantages are long-term stability and a long life – the main reasons why we chose Vaisala's product for our carbon dioxide application.

The output of the sensor (Signal Converter Module) is 0 (4) – 20mA and a serial interface RS-232 is available.

Additional signal processing is realized by connecting the CO<sub>2</sub> probe to a measuring computer FMC-MINI LCD. This is a modification of an existing measuring computer which is successfully used in biotechnology to detect volatile organic compounds. The system for measuring carbon dioxide is a new development by Biotechnologie Kempe.

The carbon dioxide concentration in the carrier gas is shown as % Vol. after processing by the computer.

Based on the detected concentration in the carrier gas, the computer calculates the partial pressure of CO<sub>2</sub> in the fermentation broth. The next step is the calculation of the dissolved CO<sub>2</sub> by means of the additionally measured temperature. The influence of other compounds on the solubility of CO<sub>2</sub> can be compensated for with the computer program. The measuring computer realizes the collection of values, processing, calibrations and graphs.

### Measuring range

Several CO<sub>2</sub> probes are offered for measuring the dissolved carbon dioxide concentration by the described principle, in accordance with the measuring range.

The measuring range is fixed by the carrier gas flow rate, which, in turn, depends on the nozzle being used. Depending on the chosen nozzle, a measuring range of 0–50 % or 0–100 % of saturation can be realized. These probes are offered for using during no-pressure fer-

mentation; a probe which covers a range of 0–500 % saturation, for use during pressurized fermentations, is also available.

### Carbon dioxide applications

Carbon dioxide is a product of the cellular metabolism of micro-organisms used in biotechnology. During fermentation the carbon dioxide content is the result of carbon dioxide formation by the micro-organisms and its transport by aeration. By means of the CO<sub>2</sub> probe it is possible:

- to detect the carbon dioxide concentrations which inhibit the metabolism and growth of micro-organisms, so the user is able to start compensating measures – for example, aeration.
- to obtain information about the growth and activity of micro-organisms during fermentation.
- to realize the control of anaerobic fermentations.

Carbon dioxide also plays an important role as a quality parameter in the beverage and brewery industry and can be detected by the measuring system in order to ensure the quality of the final product. ■

## GMM220 Series Carbon Dioxide Measurement Module

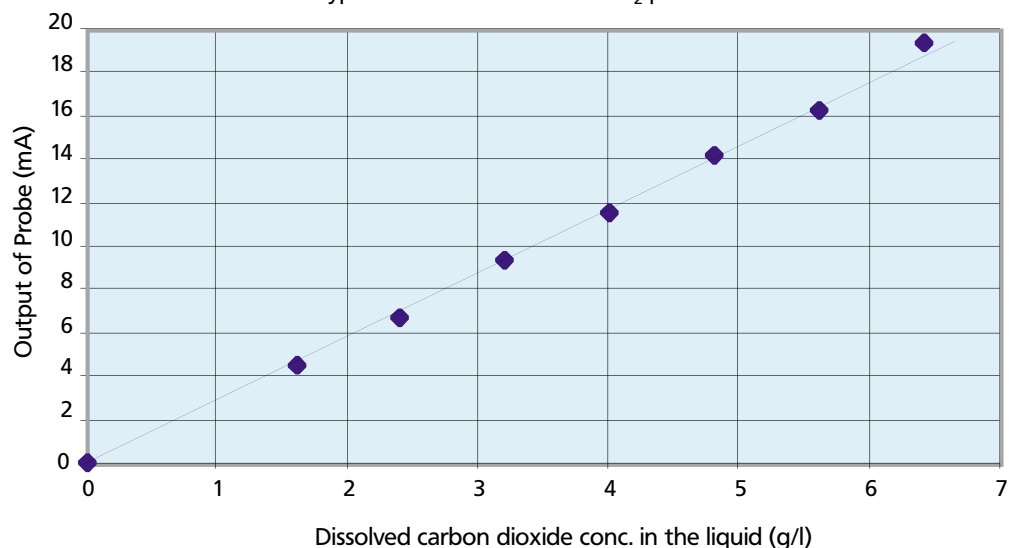
The Vaisala GMM220 series CO<sub>2</sub> measurement modules incorporate the enhanced CARBOCAP® technology. The transmitters have been optimized for integration into equipment for greenhouse control, incubators, fermentors, safety alarms and integrated systems.

Many advanced features enable trouble-free control of CO<sub>2</sub> levels, even in demanding applications and harsh environments.

The GMM220 series transmitters provide both time and temperature stability thanks to the CARBOCAP® sensor's constant reference measurement.

Fully interchangeable probes make the GMM220 series transmitters very versatile. The probes do not only simplify calibration and field service, but they also make it easy to alter the measurement range. Different power supply voltages and output options as well as different probe attachments are also available. ■

Typical calibration curve for CO<sub>2</sub> probe



Calibration curve (related to a beverage industry application).