PENTAIR

HAFFMANS
ALWAYS OPTICAL

FOOD & BEVERAGE | OXYGEN MEASUREMENT

MODERN OXYGEN MANAGEMENT IN BREWERIES

OPTICAL OXYGEN MEASUREMENT

Optical oxygen (O_2) measurement for brewing technology was first used in 2004. Today, you can cover the entire process, from the brewing room to bottled product including all relevant gases and liquids, with static and/or portable optical measurement systems. This minimizes losses in both product and quality much more effectively than with traditional methods for determining O_2, which raises a brewery's overall performance. The credo for up-to-date O_2 management is therefore, 'always optical'.

In optical measurement, sensors determine the O_2 content according to the quenching of luminescence (fluorescence and phosphorescence) principle. The luminescence of dye molecules in an exited state changes depending on the quantity of O_2. Oxygen from the medium (gas or liquid) diffuses in the O_2 sensor until equilibrium is reached, whereas the medium has no effect on the O_2 measurement.

To carry out the analysis, the layer of the sensor that is sensitive to O_2 is illuminated with a blue light. This brings the O_2-sensitive molecules in the O_2 sensor to an excited state. When these molecules lose the excited state they will emit red light.

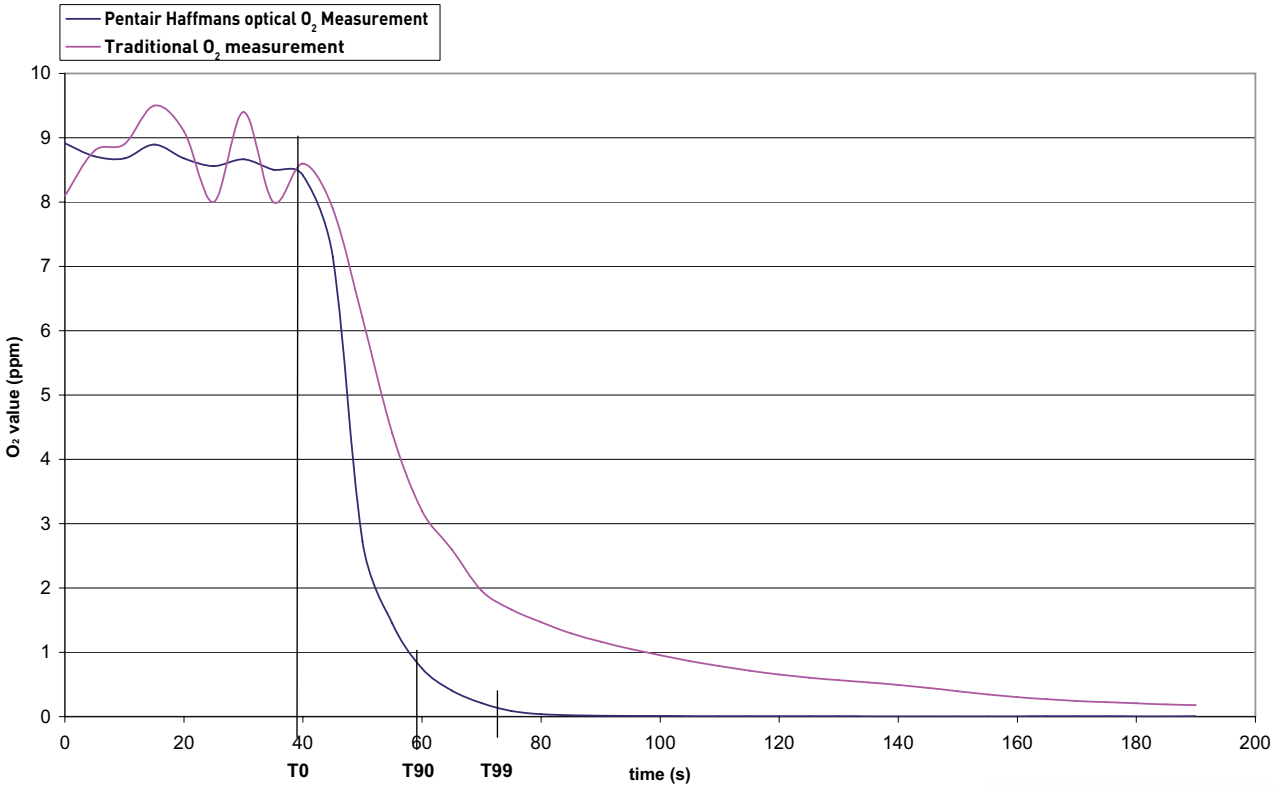
The O_2 in the sensor collides with O_2-sensitive molecules. This affects luminescence intensity and time. The luminescence behavior enables determination of the O_2 concentration, while considering the medium's temperature.

BENEFITS

The optical O_2 measurement offers many benefits to the brewing and beverage industries and outperforms the traditional Clark cell O_2 measurement. In addition, optical measurement requires no maintenance and much less frequent calibration and its measurement stability and response time is better.

- **Rapid response times**
  The very quick response time results in fewer product losses. For example, every minute that an analysis is faster adds 250 liters of beer to a150 hl/h filler. With the traditional Clark cell, the O_2 must first diffuse through a membrane, go into a solution in the electrolyte, and establish equilibrium. An electrode is placed in the electrolyte to measure the O_2 concentration based on an electrical current through the electrolyte. This analysis is a rather slow process, compared to the optical O_2 measurement.
- **Low operational costs**
  The optical O_2 requires no maintenance and minimal calibration. It is empirically guaranteed that after one million illuminations, deviation from the zero point is only five ppb and at higher O_2 values, no significant deviation is recorded. Assuming 500 illuminations per day, seven days per week, 52 weeks per year, the sensor would, from a purely technical perspective, only need to be calibrated or replaced once every five years.

RESPONSE TIME



SEAMLESS O_2 MANAGEMENT FOR WHERE IT MATTERS THE MOST

With the traditional Clark cell, electrolytes have to be replaced, new membranes installed and the system re-calibrated at least every one to three months. After calibration, the measurement cell needs to polarize, which often means that the system is only ready to use again after waiting eight additional hours.

When optical O_2 measurement is compared to the traditional method, operating cost savings of up to 50 percent can be realized.

All of Pentair Haffmans' O_2 measurement instruments use identical optical systems that can be used on all relevant gases – carbon dioxide (CO_2) and nitrogen (N_2) – and liquids (water, wort, yeast, deaerated water, beer and beverages). This applies to:

- Portable O_2 equipment
- In-line O_2 equipment
- Portable and in-line combined CO_2/O_2 equipment
- Lab equipment for CO_2/O_2 measurement of filled packages

This continuity provides the brewery or beverage plant with absolute comparability of measurement values. Furthermore, the operating method and menu structure for all optical O_2 measurement equipment are easy to operate and very similar, which minimizes the risk of operator error.

Currently, the most important areas for seamless O_2 management are the brew house, cold block and packaging.

BREW HOUSE

In the brew house, the degassed water is used for sparging at the lauter tun is monitored. A high O_2 value can lead to undesirable wort coloration.

For measuring high quantities of O_2 dissolved in wort the optical O_2 instrument is positioned after the aeration to monitor switching the aeration on and off, which assures the right conditions for optimal fermentation.

In addition, yeast propagation can be controlled with an in-line solution or monitored with a portable O_2 meter.

COLD BLOCK

Applications in the cold block include measuring the O_2 content in the fermentation, storage and bright beer tanks. Here, combined O_2 and CO_2 meters detect both parameters by taking a single sample, which reduces product loss and saves working time.

Oxygen pick-up is monitored on the inlet and outlets of centrifuges and filters. A rapid and reliable result allows you to react

sooner to reduce production losses and increase efficiency.

In high gravity brewing an additional check in the cold block monitors whether any additional O_2 pick-up occurred when the deaerated blending water and CO_2 were added during carbonation. A separate measurement of dissolved oxygen (DO) after water deaeration assures that the deaerated water meets the quality requirements.

An optical O_2 instrument installed at the filler inlet provides a quick O_2 measurement, which means a shorter changeover time. Furthermore, it prevents inadequate product quality ending up in the package.

In-line O_2 meters for gas are installed to monitor removing CO_2 from a tank before it is cleaned-in-place with caustics, to minimize the risk tank implosion.

Considered as a whole, O_2 measurement in the cold block increases the productivity and reduces beer losses.

PACKAGING

Differentiated O_2 measurement in the packaged beverages

Even if all measures are taken during processing and the O_2 quantity in the beer or beverage is within specifications before packaging, the filling process can affect the Total Package Oxygen (TPO) quantity. Oxygen enclosed in a package has a major influence on the beverage's shelf life and flavor stability, and can only be measured in the packaged beverage.

Using the traditional Z-method, the TPO value is obtained by measuring DO in a package that is shaken to equilibrium.

Pentair Haffmans provides a novel method that enables measuring TPO from a single package, which includes the O_2 in the headspace and the DO. This makes it possible to directly pinpoint the source of the O_2 and identify filler inefficiencies in:

- Package preparation
- Liquid handling
- Headspace air retention

With this novel method of TPO measurement and use of the optical O_2 measurement, breweries and beverage companies are able to improve the efficiency of the filler and reduce product losses.

UTILITIES

The optical O_2 measurement can be applied in the utilities to monitor, for example, the O_2 content of CO_2 gas from fermentation, compressed and/or ultra pure gases to provide key parameters in an efficient and economical operation of a CO_2 recovery system or a N_2 generation plant.

Optical O_2 measurement is suitable for many other areas including monitoring the O_2 content of water for the steam boiler.

CONCLUSION

The innovative optical O_2 measurement technology provides a fast and accurate picture of the entire brewing or beverage production process. This results in quicker response times, immediately lower production losses and reduced OPEX. Pentair Haffmans' Total O_2 Management solutions, based on the innovative optical O_2 technology, using laboratory, portable at-line and in-line equipment make seamless management possible.

Please feel free to contact us if you have any question about the described applications and challenge us to come up with more applications for the optical O_2 measurement!

OPTICAL OXYGEN MEASUREMENT — RANGE OF PRODUCTS

LABORATORY EQUIPMENT

Inpack TPO Meter, type TPO

The Inpack TPO Meter, type TPO automatically determines the total O_2 content by measuring the dissolved O_2 and the headspace O_2 content of the packaged product in a single measurement.

Inpack TPO/CO_2 Meter, type c-TPO

Determines the dissolved O_2, headspace O_2 and total O_2 content of the packaged product. In addition, the c-TPO measures CO_2.

Automator

Pentair Haffmans' Automator automatically measures all relevant quality parameters directly in the filled package in a single measurement cycle. In addition to the basic parameters O_2 and CO_2, the system can be extended for further analysis to meet customer requirements.

PORTABLE EQUIPMENT

O_2 Gehaltemeter, type o-DGM

The portable O_2 Gehaltemeter combines high accuracy with excellent measurement stability. The instrument is equipped with an advanced operator and location identification system, which provides traceability of measuring data.

The o-DGM is available in two measuring ranges for DO and O_2 in gases:

- Low measuring range (LHO) for accurate DO measurement of beverages < 2,000 ppb (e.g. beer and deaerated water) and of the O_2 content of CO_2 gas up to 4.18 percent (e.g. CO_2 gas from fermentation)
- Wide measuring range (WLO) for accurate DO measurement of beverages < 45 mg/l (e.g. wort, soft drinks and non-deaerated water) and of the O_2 content of air and mixed gases up to 100 percent.

CO_2/O_2 Gehaltemeter, type c-DGM

The CO_2/O_2 Gehaltemeter combines the internationally standardized determination of the dissolved CO_2 content based on Henry's Law with a highly accurate DO measurement. The design allows for higher product pressure, making it suitable for the soft drink industry. Equipped with an advanced operator and location identification system, it provides traceability of measuring data. Up to 10 different product types can be programmed into the instrument.

IN-LINE EQUIPMENT

In-line O_2 Gehaltemeter, type OGM

The in-line O_2 Gehaltemeter, type OGM, combines high accuracy with excellent measurement stability.

The instrument is available in three measuring ranges for DO and O_2 in gases:

- Low measuring range (LHO) for accurate DO measurement of beverages < 2,000 ppb (e.g. beer and deaerated water) and of the O_2 content of CO_2 gas up to 4.18 percent (e.g. CO_2 gas from fermentation)
- Wide measuring range (WLO) for accurate DO measurement of beverages < 45.0 mg/l (e.g. wort, soft drinks and non-deaerated water) and of the O_2 content of air and mixed gases up to 100 percent
- Ultra pure range (LHG) for measuring the O_2 content of treated CO_2 gas from fermentation up to 200 ppm v/v and/or generated N_2

In-line CO_2/O_2 Meter, type AuCoMet-i

The in-line CO_2 Meter combines the internationally standardized determination of the dissolved CO_2 content based on Henry's Law with a highly accurate DO measurement.

o-DGM

c-DGM

c-TPO

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