

# EXACT, STABLE AND FAST

## Optical measurement of dissolved oxygen for the beverage industry

*The required quality for an acceptable taste and flavour stability is continuously under discussion in the beverage industry. A parameter that plays a very important roll in it is oxygen, as it causes a rapid decline of the taste and flavour stability. Brewers and beverage manufacturers control and measure the quantities of gasses continuously during the production steps of their beer and beverages in order to prevent even low oxygen pick-ups. As a result, beer and beverages are produced with very low dissolved oxygen (DO) levels, consistent quality and high flavour stability during their complete shelf life.*

The traditional measurement method for DO can be very time consuming and often proves to be inaccurate. With a new and unique optical DO measurement, however, very accurate and stable measurement results can be achieved with comparatively quick response times, even at very low oxygen levels.

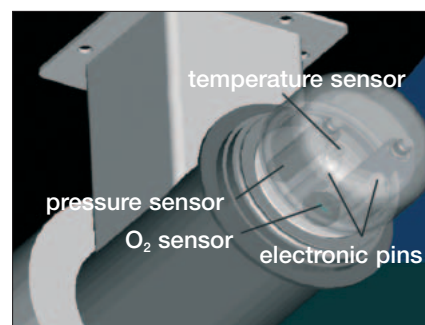
### Traditional DO measurements

Traditional DO measurements used in the beverage industry are electrochemical analysis systems using a Clark or similar kind of sensor. The measuring principle of electrochemical O<sub>2</sub> measurements is amperometric and based on the measurement of a current

generated by an oxidation-reduction reaction. Generally, this type of measurement is known to be time consuming in operation with slow response times and maintenance and calibration intensive. Furthermore, O<sub>2</sub> is consumed, causing an erratic decline of DO in case of no product flow.

### New optical DO measurement

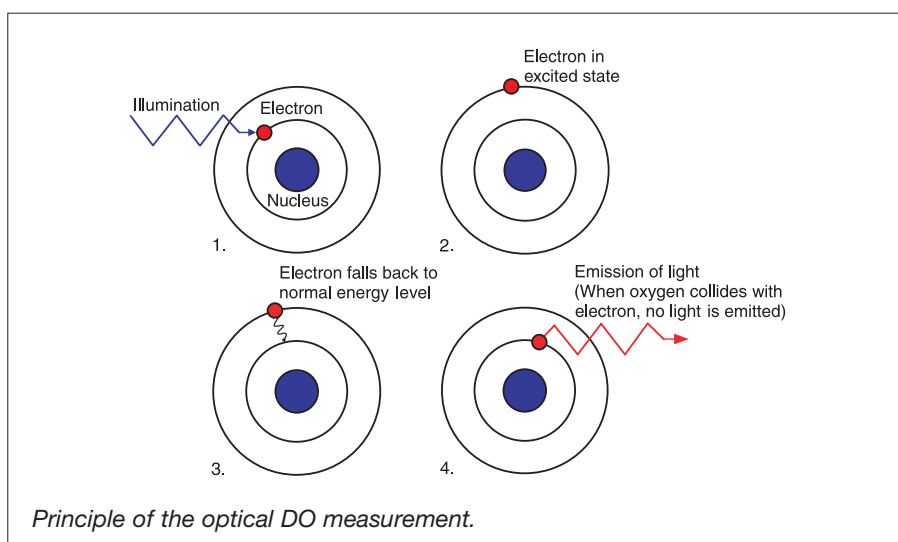
Recently, Haffmans developed an innovative new optical O<sub>2</sub> measuring technology for the beverage industry. Together with the globally accepted and preferred CO<sub>2</sub> measurement, which is based on Henry's law, the new O<sub>2</sub> measuring technology is combined in their CO<sub>2</sub>/O<sub>2</sub>meter.



*The optical measurement of DO is independent of pressure, colour and flow rate of the liquid and also independent of the age of the light source.*

### Measuring principle:

The oxygen sensor optically determines the O<sub>2</sub>-content of a liquid based on the effect of dynamic luminescence quenching by molecular oxygen. In the process, an oxygen-sensible sensor layer is illuminated with a light source, causing the molecules in this particular layer to reach an excited energy level. As soon as the energy of the molecules decreases, they will emit luminescence. Oxygen accelerates the process of falling back to a normal energy level, during which



*Principle of the optical DO measurement.*

### Frank Verkoelen

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light is emitted. The degree of the decay is depending on the quantity of  $O_2$ .

Based on the time difference between illumination and emission and the product temperature, the oxygen content is determined. The optical measurement of DO is independent of the pressure, color and flow of the beverage and the aging of the light source.

In order to meet the industry's requirements, the following three parameters need to be met:

### 1. High accuracy at very low oxygen levels

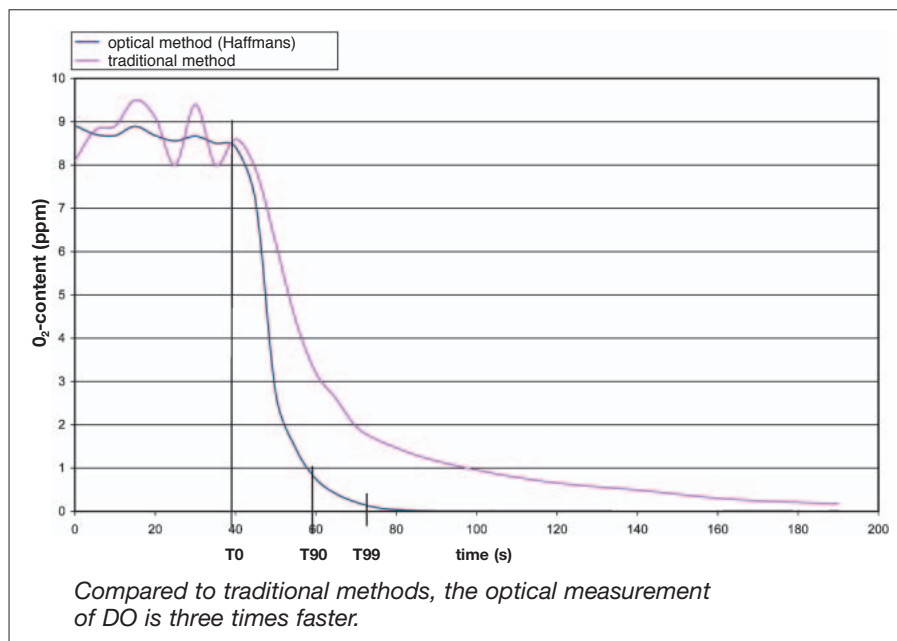
Breweries are capable to control the oxygen level in such a way, that the DO level in the finished products is almost negligible. Particularly at extremely low oxygen levels, the traditional  $O_2$  measurement tends to be quite inaccurate. Special measures are necessary to avoid that a zero current, caused by the use of dissimilar electrode materials with a different standard potential that is exposed to an electrically conducting solution and the polarization voltage, affects the  $O_2$  result.

The optical  $O_2$  measurement, however, excels in measuring low oxygen levels with a high accuracy. The measuring range spans from 0 – 2000 ppb with an accuracy of  $\pm 1$  ppb + 2 % of the measured value.

### 2. Quick response

Compared to traditional  $O_2$  measurements that take minimal 3 minutes to reach a stable  $O_2$  content, the optical measurement responses are approximately 3 times quicker. This enables breweries to reduce not only costs of labour but product loss as well. An average response time of the optical  $O_2$  measurement is  $T_{90} < 10$  sec and  $T_{99.9} < 60$  sec respectively.

For the portable (type c-DGM) and in-line (type c-AGM) execution of the  $CO_2/O_2$  analyser, the measurement of the DO content takes place during the sampling for the  $CO_2$  measurement. For the portable execution, at the recommended beer flow of 10 l/h, one minute is sufficient to reach an  $O_2$  value that differs less than 0.1% from its end value.



For the in-line execution, at a recommended min. beer velocity of 0.5 m/s, the measurements taking place within one minute are sufficient to reach an  $O_2$  value that deviates less than 1% from its end value.

### 3. Long-term stability

Typically, traditional DO measurement devices need to be calibrated every three months. With the optical  $O_2$  measurement, calibration is only recommended after 1.000.000 measurements. At 0 ppb the maximum deviation is  $< 5$  ppb and at higher DO concentrations no change of signal is observed. For the portable execution, 1.000.000 measurements mean that no calibration would be required for 5 years, assuming 100 measurements/day.

The inline execution does not require calibration for 2 years, assuming an operating time of 12 h/day and 2 measurements/min. The  $O_2$  sensor can either be replaced by a new one, which is supplied with a certificate, or calibrated. After a successful calibration the measurement counter is reset to zero and the  $O_2$  measurement is ready for a next round of 1.000.000 measurements. As the DO measurement is one of the most important measurements in the brewing industry, it is vital for a quality assurance system, such as ISO, to prescribe a regular check on it. Both, zero point and high  $O_2$  value can be easily checked or calibrated without having to dismount the sensor. This reduces the maintenance effort substantially.



The analysers have low operational costs and are easy to calibrate.

## Conclusion

The new optical oxygen measurement provides the brewing and beverage industry with a reliable DO measurement, which enables you to improve your product quality and flavor stability.

This measurement technology is not only more accurate but, because of its quick response times, more efficient than traditional DO measurement. Taking into consideration that the optical DO measurement devices feature very low maintenance and calibration efforts, changing-over to the new method is even more attractive. □