MEM3 Application Note Oxygen Sensor Background Gas Compatibility

Contents

1) High Concentrations of CO_2

General

MEMBRAPOR`s Oxygen-Sensor has an acidic electrolyte which makes it resistant to high concentrations of carbon dioxide. In opposite to O_2-sensors with a basic electrolyte (solution of KOH) the presence of CO_2 has no impact on the sensor life.

MEMBRAPOR`s Oxygen-Sensor shows no cross-sensitivity to CO_2 and is best suitable to measure oxygen even at high concentrations of carbon dioxide.

Performance with CO_2 as Background Gas

If the sensor is installed or exposed to a gas matrix with a high amount of CO_2, like 80% for instance, then the sensor needs at most 1 hour to fully establish to the new condition. The inside of the sensor equilibrates with the new gas matrix. After conditioning the sensor behaves the same as at ambient air, response time and resolution are as reported in the data sheet. Bellow is shown a typical measurement of low O_2-concentrations in a CO_2/N_2-atmosphere, containing 80% CO_2.

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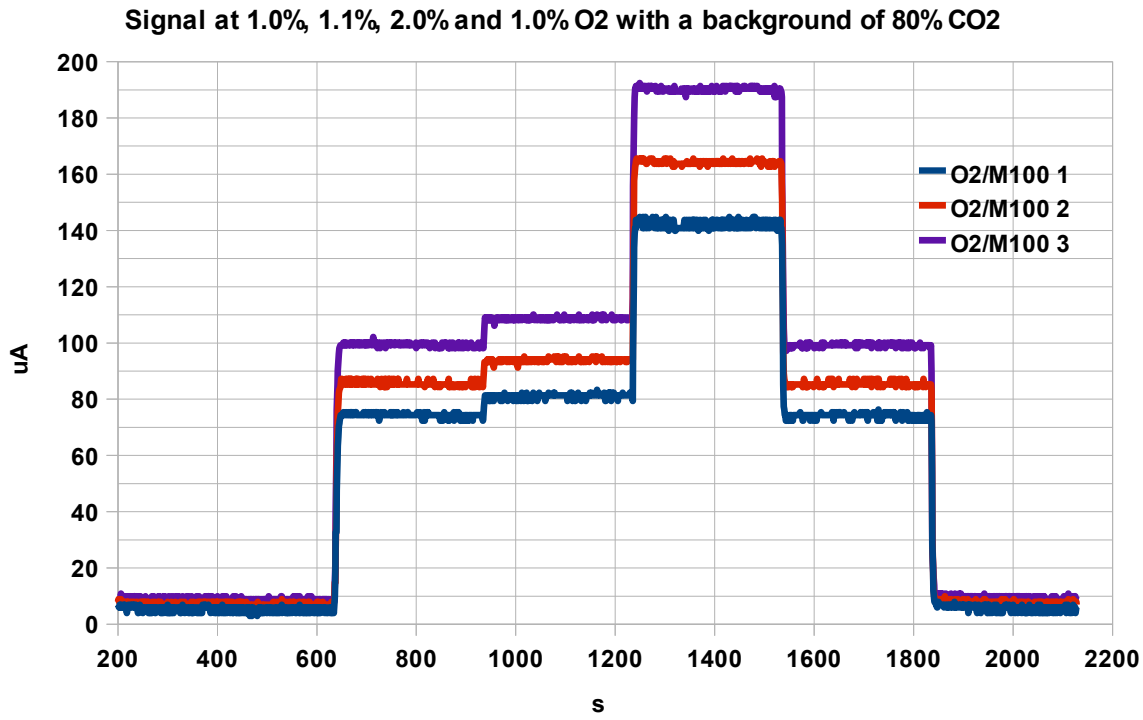

Figure 1 Performance of three O2/M-100 sensors in a atmosphere with 80% CO_2, measuring 1% - 2% oxygen.

Background Gas Correction Factor

If the background gas has a higher molecular size and weight than nitrogen the oxygen-sensor will give a slightly lower signal compared to an atmosphere with N2, like ambient air. This effect occurs because it is more difficult for the oxygen molecules to diffuse through a high molecular weight gas than through nitrogen. This situation is typical in biogas applications, where the concentration of the heavy molecule CO_2 is high and replacing nitrogen in the gas mixture.

The figure below shows the influence of the CO2 concentration on the output signal of the oxygen sensor. The result is shown in the graph as a mean for several batches of sensors, along with confidence intervals corresponding to ±3 times the standard deviation. The sensitivity dependence is expressed as a percentage of the signal at 99% nitrogen. The output signal of the sensor corresponds to 1% oxygen which was hold constant.

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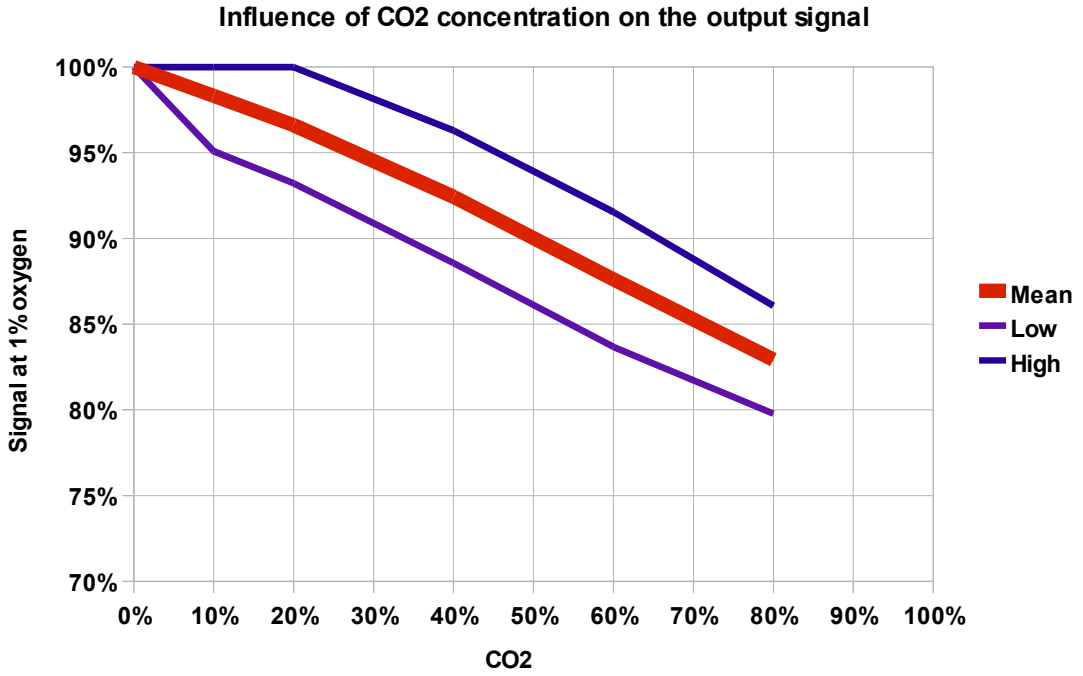

Figure 2 Dependence of the sensor signal on the background concentration of CO_2, obtained with 1% O_2 concentration.

Membrapor has investigated gas mixtures, containing oxygen, carbon dioxide and nitrogen, to allow a correction of this effect. The background gas correction factor (BGCF) allows to correct the oxygen signal for this background gas effect. The corrected sensor signal is:

$$S_{corr} = S_{raw} \times BGCF$$

S_{raw}: Raw sensor signal (without baseline correction)

BGCF: Background gas correction factor

The BGCF of a CO2/N2 gas matrix can be obtained from the figure below.

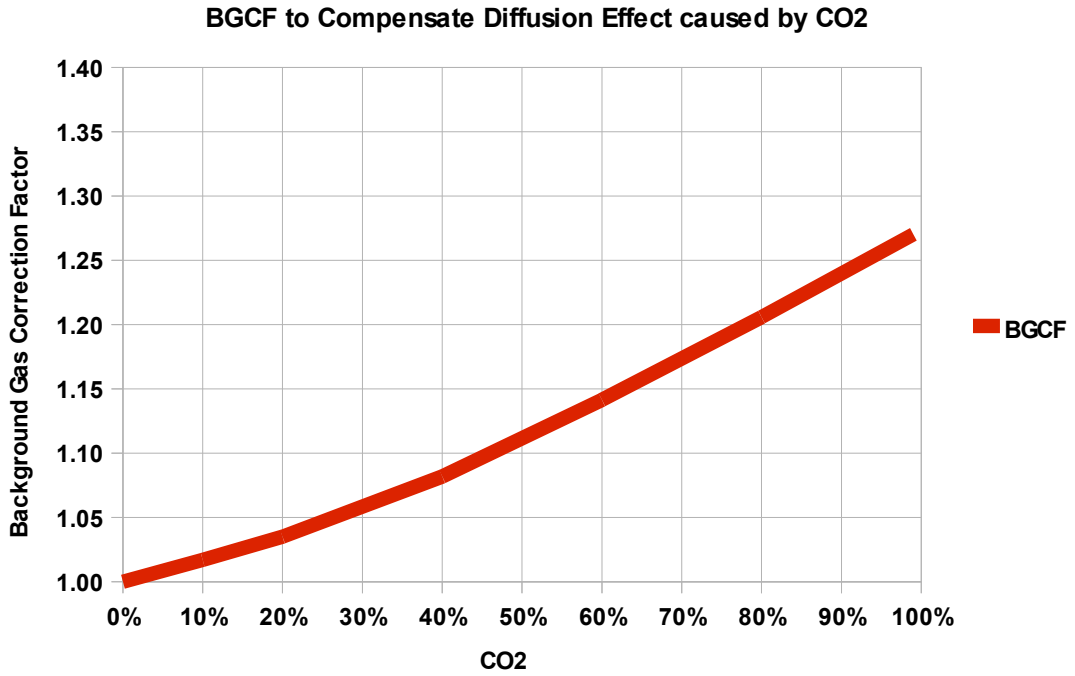

Figure 3 The Background Gas Correction Factor for CO_2/N_2-Gas Mixtures

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The BGCF data are valid for the O2/M-100 and the O2/M-1. With this method an analyser with such a sensor can be calibrated at ambient air and used afterwards to measure low levels of oxygen in a CO_2-atmosphere.

The correction of the sensor signal with the equation and data above implies an uncertainty of ± 4%.

2) Background Gas Compatibility

Membrapor`s oxygen-Sensor will work in inert gas backgrounds. These can be mixtures of following gases:

- Nitrogen
- Hydrogen
- Alkanes like methane, ethane
- Noble gases like helium, argon

For a multicomponent gas mixture it is recommended to calibrate with an oxygen standard that has a similar background as the sample gas.

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