Real-time Oxygen Monitoring for Modified Atmosphere Processing using the OxySentry System

Written By: Dr. Devinder Saini
dsaini@oxysense.com
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OxySense, Inc.
www.oxysense.com

Introduction

The food industry continues to change in response to marketplace and consumer demands, as well as economic realities.
The industry is increasing its emphasis on:

a. Food safety
b. Quality
c. Shelf life

The use of Modified Atmosphere Packaging (MAP) is one important way the food industry has responded to increased scrutiny of packaging. In fact, MAP is one the fastest growing segments of packaging industry. Exposure of food products to the atmosphere causes the oxidation of the product resulting in major issues for the food industry such as a decrease in shelf live, loss of flavor and discoloration. MAP works by reducing the amount of oxygen the product is exposed to. This is accomplished by flushing the package with nitrogen or CO_2 just prior to sealing – resulting in an internal package environment of less than 0.5% oxygen.

For an MAP package to meet this stringent low oxygen requirement, three things are required:

1. Good packaging materials with oxygen barriers
2. A good flush of the package before sealing
3. A good seal (package integrity)

In 2001 OxySense introduced a system that was a notable advancement in the evolution of packaging material and superior testing methodology. Using this new system, labs were able – for the first time - to monitor what was happening inside a package without having to destroy the package.

The new OxySentry System brings the same breakthrough technology to the MAP packaging floor. The OxySentry System integrates the proven OxySense 4000B non-invasive monitoring system technology and the revolutionary OxyDot.

For the first time, a packaging line operator can now have real time, non invasive, non intrusive monitoring, control and documentation of the flush cycle (the second of the three MAP success criteria).

Optical Sensing

Typically, the oxygen is monitored by extracting a sample of the atmosphere from the package or flush chamber which is then taken to an instrument that makes the measurement. The sample is extracted automatically using a vacuum system with long hoses/tubes. However, this type of system is intrusive and does not provide real time information or documentation of the flush cycle.

The vacuum system can easily breakdown or the sampling tube can easily be clogged leading to unreliable readings resulting in stoppages of the packaging line. Frequent stoppages lead to loss of productivity and hence revenue.

The OxySentry System provides non-invasive, real time, passive, in-situ monitoring of the flush chamber/packages. It is a system that has two major and separate components:

1. The Master Controller (the box)
2. OxySentry Sensor

With this system there is no sample extraction, no vacuums or hoses. Its lack of any moving parts results in very limited maintenance requirements. The oxygen is measured directly in the chamber or package using a separate solid state optical sensor the revolutionary OxySentry sensor.

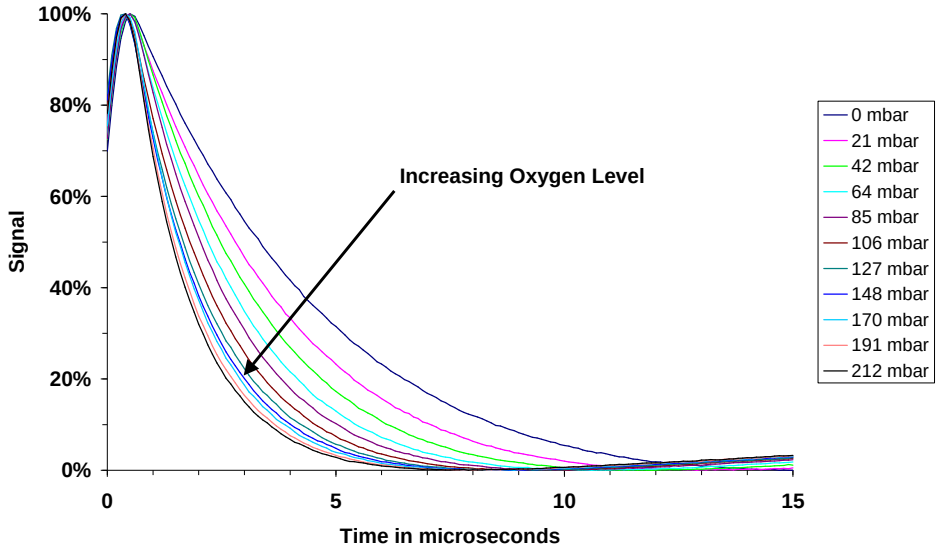
The use of optical sensing allows measurements to be made without disturbing the environment in which they are being made. The act of sensing does not consume the oxygen, which is very different from the conventional sensors as they consume the oxygen during measurement and alter the environment in which they are being used.

The optical oxygen sensing method used in the OxySentry System is based on the fluorescence quenching of a dye immobilized in a gas permeable hydrophobic polymer (patented formulation which can stand high temperatures, oils and other harsh environments). The dye absorbs light in the blue region of the spectrum and fluoresces in the red region of the spectrum. The presence of oxygen quenches the fluorescent light from the dye, resulting in a change in the emitted intensity as well as its lifetime as function of oxygen concentration. This

change in the lifetime can be calibrated to provide very accurate oxygen measurements.

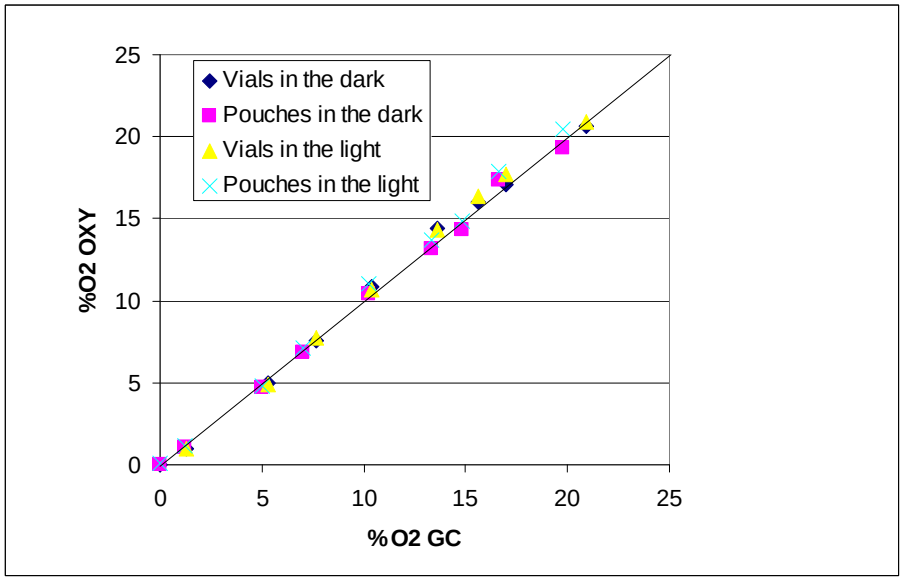
While calibrating the oxygen concentration to achieve very accurate oxygen measurements, the sensor is completely passive and does not consume oxygen to make the measurement.

Fluorescence decay curves for differing concentrations of oxygen



The accuracy of measurements made by this optical sensing method has been compared with measurements made by a Gas Chromatograph and show a very high degree of correlation. Independently conducted, these tests show a better than 99% correlation with GC in light and dark conditions (see graph below).

Optical Sensor Performance compared to a G.C.



OxySentry System

As previously stated, the OxySentry System is composed of two parts: the instrument (box) and the sensor. The instrument box contains all the electronics and serves as the controller. The OxySentry is a separate optical sensor which can be configured and customized to the individual production lines such as machines with flush chambers, form fill and seal machines, etc.

The OxySentry System

This instrument is designed to have specifications that make it ideal for use in the food, beverage and pharmaceutical industries.

- Operating Range: 0- 30% O_2
- Detection Limits: 0.03 % O_2
- Accuracy: 5% of the reading
- Minimum Response Time: < 0.2 seconds
- Operating Temperature: 32-140°F (0-60°C)

Making measurements using the OxySentry System are simple and reliable. The sensor is attached to the inside wall of the flush chamber, a fiber optic bundle is aligned with the sensor through the wall of the chamber and the other end of the bundle is attached to the OxySentry instrument (which can be placed at a convenient location).

Once the instrument is activated, measurements are made automatically and displayed on a screen. The instrument is operated via the touch screen which displays the oxygen concentration. It also has other features such as automatic

logging, user settable alarm levels, a digital or analogue output signal, and a port to be used to connect to the local Ethernet.

Some of the key features and benefits are listed below:

- Totally passive sensor – Does not alter the monitoring environment.
- Measurement within the chamber – No need for sample extractions.
- Real time, continuous, rapid measurements – For the first time, allows the monitoring of every flush fill cycle.
- Easily integrated with line controller – Enables adjustable alarms and shut-down points.
- Automatic data logging – Allows the tracking of oxygen concentration in every package.
- Factory calibrated – Eliminates field calibration requirements.

The real-time measuring capability of this instrument makes it possible to monitor the oxygen concentration on every flush and fill cycle of the packaging machine for the first time. Coupling that with the automatic logging facility allows the user to track the oxygen concentration in every package and hence improve the efficiency of the packaging process.

Summary

OxySense has been developing advanced, non-invasive oxygen measurement systems for labs since 2001.The OxySentry System is an innovative, on-line oxygen monitoring/control system for use with vacuum/gas flushed MAP systems that can substantially improve the packaging line efficiency. It uses proven technology from the OxySense 4000B which has been used in food industry research and test labs for the past several years.

The system is completely passive and is capable of rapidly and accurately providing measurements of oxygen concentration within the fill chamber. The OxySentry System provides real time measurements of residual oxygen concentration. The near-instantaneous response time (< .2 second) means quick response and reduced loss from substandard fill atmospheres.

Due to the fact that the OxySentry system is a direct and passive measurement system (as opposed to a system that draws a gas sample from the chamber prior to measurement), it provides information that has not been obtainable using conventional instruments. This is a key instrument that will allow food manufacturers and packers to improve the quality of their products leading to better customer satisfaction.

The optical technology developed by OxySense has produced instruments that address the testing needs for two of the three criteria for a good MAP package. The OxySense 4000B addresses the testing needs for the first criteria for an MAP package (good packaging materials). The OxySentry System addresses the second criteria for a good flush of the package before sealing by real time monitoring of the flush cycle. An instrument for the third criteria (package integrity) is under development that will allow the monitoring of every single package on the production line and along the distribution chain.

For additional information about OxySense products, please contact:

John Ryan
Jryan@oxysense.com