WHITE PAPER

Using CO_2 Sensors in MAP Applications

Gas Sensing Solutions Ltd.

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Modified Atmosphere Packaging (MAP) Introduction

Modified Atmosphere Packaging, or MAP as it is commonly referred to within the industry is a technique used to extend and prolong the shelf life of fresh products, including fruit, vegetables, and meat.

Modified Atmosphere Packaging has been around for over one hundred years. The first record dates back to 1821 in Montpellier, France. Professor Etinne Berard of the School of Pharmacy reported successfully extending the shelf life of fruit by delaying the ripening process. This was achieved by storing the fruit in low oxygen conditions. Whilst there are a variety of packaging techniques, they all aim to serve the same purpose – to extend the shelf life of food.

MAP Methods

There are two types of Modified Atmosphere Packaging. Active and Passive. The US Federal Drug Administration (FDA) defines active MAP as “the displacement of gases in the package, which is then replaced by a desired mixture of gases.” This differs from passive modified atmosphere packaging where “the product is packaged using a selective film type, and the desired atmosphere develops naturally because of the products’ respiration and the diffusion of gases through the film.

The mixture of gases that are used in Modified Atmosphere Packaging vary depending on the product itself, refer to Figure 1. The main gases used are Nitrogen, Oxygen and Carbon Dioxide.

Nitrogen (N_2)

Nitrogen is used in Modified Atmosphere Packaging in a process called gas flushing. It is used because it is inert, has no smell or taste. It is also easy to obtain and takes a long period of time to escape through the plastic film commonly used on food packaging. Gas flushing describes the process of reducing the amount of oxygen that surrounds the product in the package. Nitrogen, or another gas which is denser than oxygen is used to push out the oxygen within the packaging. This is important as oxygen can speed up the decaying process of foods.

Oxygen (O_2)

Oxygen is usually removed from food packaging to extend the shelf life of a product. However, there are a few circumstances where oxygen levels are increased to preserve the product. Due to being odourless and tasteless, it is used with red meat to maintain the bright red colour. Otherwise, the meat would become pale and unappetising to the consumer. Heightened levels of oxygen also prevent the growth of anaerobic organisms.

Carbon Dioxide (CO_2)
Carbon Dioxide is a colourless, odourless, and tasteless gas that makes it perfect for Modified Atmosphere Packaging applications. As a rule, the higher the concentration of CO_2 used in the packaging, the longer the shelf life of the product. However, too much Carbon Dioxide gas can alter the flavour of the food, giving a sour taste. Additionally, as the gas is absorbed by the product, and escapes from the packaging over time, the packaging can collapse. As a result, CO_2 is commonly used with other supporting gases to reduce the issues previously mentioned. Overall, a minimum level of 20% CO_2 is recommended as this keeps bacteria and mould growth to a minimum.

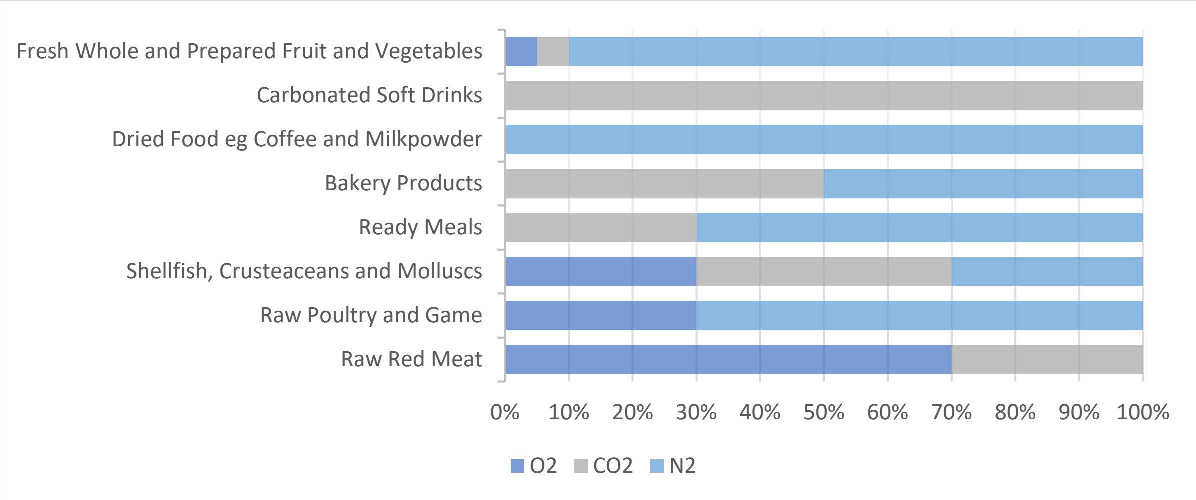

Figure 1. Table showing MPA gas composition for various foods

Modified Atmospheric Packaging Safety

The general opinion is that Modified Atmosphere Packaging is safe. It is a technique that contains no chemicals – only gases, most of which are typically found in the atmosphere. However, MAP is not a fail-safe process. The technique merely delays the decaying process of foods, but it does not stop it. For this reason, it is critical that testing is conducted on the packaging to ensure the correct gas levels are present.

The altered levels of gas minimise the activities of spoilage organisms that would typically give off warning signs that food had begun to decompose. As a result, bacteria such as clostridia can cause food poisoning before spoilage begins to occur. Additionally, reduction in oxygen levels within the packaging may lead to the growth of pathogens since food is stored for a longer period.

Advantages of Modified Atmosphere Packaging
MAP has several advantages, both to the consumer, as well as to others in the supply chain. It is believed that food products that are packaged using MAP have a shelf life which is 50-500% longer

than if they had not been packed with this technology. This is done without the need for chemical preservatives.

The extended shelf benefits the supplier of the product also, as there is a reduction in economic losses. As food takes longer to spoil, it is more likely to be sold. This has a knock-on effect, reducing waste, which is a positive for the environment.

The distribution chain also benefits from Modified Atmosphere Packaging, as longer shelf life of products means more products can be shipped at a time, and can be transported longer distances, resulting in fewer deliveries required.

Disadvantages of Modified Atmosphere Packaging

MAP is a highly technical technique and therefore, specialised equipment is required, as well as training for the staff on the production line. Additionally, there is the cost for gases and packaging materials to consider. As highlighted in table 1, different food types require different gas formulations and MAP is not a one type fits all process.   This means that production lines must spend time changing the configuration of the gases before a new product can be packaged.

Furthermore, some experts believe that MAP poses risks to the consumer of the product due to the lack of indicators that food has spoiled as mentioned previously in this paper.

Testing Gas Levels

Testing gas levels within Modified Atmosphere Packaging is important to ensure quality and safety is maintained. This is done in two ways, production line monitoring and batch testing.

Production line monitoring is a process where the composition of gas is checked before the packaging is sealed. This is non-destructive to the packaging, and should an error be highlighted, the machine can be programmed to alert the operator and the line can be stopped immediately. Many of these machines can supply the gas and measure at almost the same time. This is beneficial as it gives a true picture of the gas composition.

Batch testing is another method for checking MAP, which should be used in conjunction with production line monitoring to ensure the best quality is achieved. Batch testing involves selecting a small number of sealed packages, usually around 5-10 consecutive in the product line. These are selected on a regular basis, commonly every 20-30 minutes. A gas analyser, containing a hollow needle is then inserted through the film of the Modified Atmosphere Packaging using a septum to protect the packaging. A small sample of the gas is then extracted, and the composition of the gases are then checked.

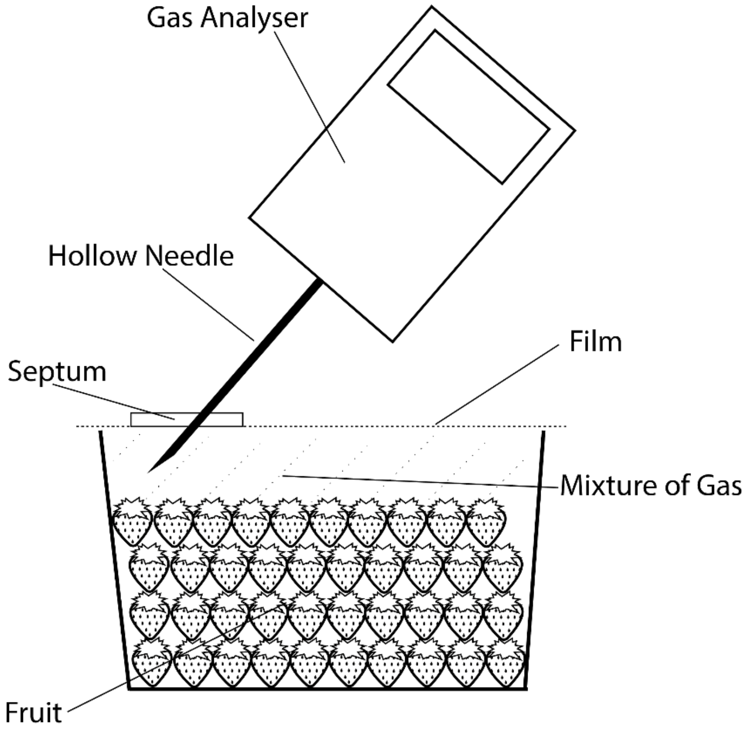

Figure 2. Diagram of MAP Testing

MAP Requirements

When monitoring the levels of CO_2 (or any other gas) used in Modified Atmosphere Packaging, it is crucial to obtain a reading as quickly as possible. Delays in acquiring a reading mean either an increased number of product packages with incorrect gas levels, or the production line is run slower to match the measurement rate capability.

Advantages of GSS Sensors

Many Modified Atmosphere Packaging applications require a CO_2 sensor that is capable of high-speed Carbon Dioxide readings.

The SprintIR range of CO_2 Sensors are built on unique, patented LED technology and optical designs that enable best-in-class speed, power consumption and durability.
The SprintIR-R CO_2 sensor can capture 50 readings per second, with a 70ppm typical accuracy, making it one of the fastest CO_2 sensors on the market. As with all sensors in the SprintIR range, the SprintIR-R is ideally suited for MAP applications where CO_2 levels are likely to change rapidly.

The SprintIR-R also comes with a flow adapter as standard. Flow rate is critical to the response time of a sensor, including the SprintIR-R. To obtain a good measurement, the old gas needs to be flushed out, and the new gas processed by the sensor. The graph below shows how the speed of the response time in relation to the flow rate.

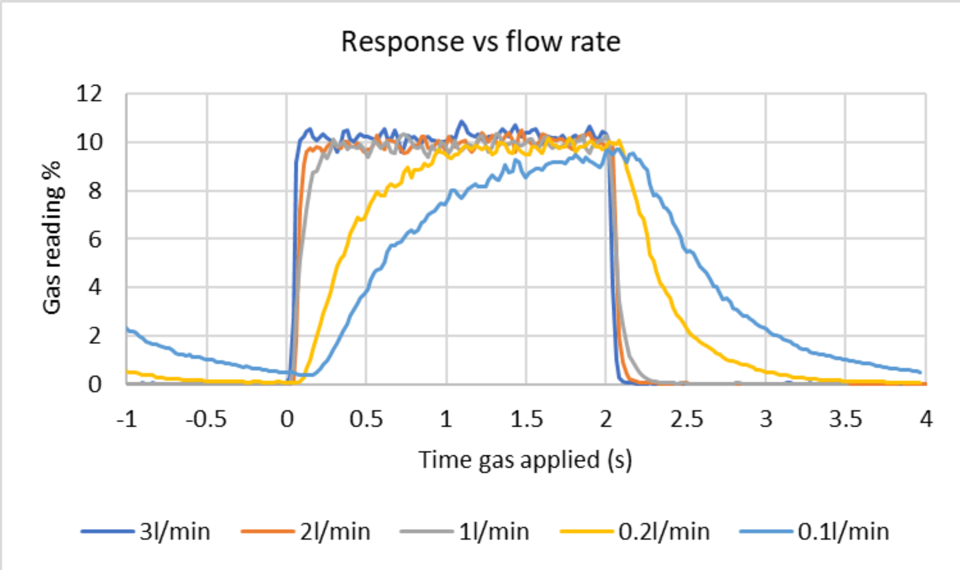

Figure 3: Response Time Graph (2 second gas pulse)

Conclusion

Modified Atmosphere Packaging is a complex technique used to extend the shelf life of fresh products such as fruit, vegetables, meat, and baked goods. For MAP to be both effective and safe, it is imperative that levels of CO_2 and other gases are monitored correctly.

One of the key issues found when measuring gas levels is the response time of the sensor being used. Long response times can mean errors are not identified quickly enough, resulting in financial losses and damage to the reputation of the supplier.

Gas Sensing Solutions offer a range of high-speed CO_2 sensors in the SprintIR range that can take up to 50 readings per second, well matched to MAP applications.

For more information about Gas Sensing Solutions and the SprintIR- range of CO_2 sensors, please visit https://www.gassensing.co.uk/products/products/SprintIR---R--CO2-Sensor

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ADDRESS

Gas Sensing Solutions Ltd.
60-62 Grayshill Road
Westfield Industrial Estate
Cumbernauld
G68 9HQ
United Kingdom