→ Whitepaper

BOC
A Linde company

How to pick the best gas mixture for your food packaging application

Consumers want fresh. So how do you improve shelf-life, maximise food safety and exceed consumer expectations?

From the very moment fruit is picked, corn is harvested, or fish is caught, the race against time begins.

The way that a product is handled during the processing and packing stages plays an important role in prolonging shelf life and guaranteeing food safety.

Consumers want to purchase and prepare fresh foodstuffs and ready-made dishes. Therefore, it is becoming increasingly important that food manufacturers meet these expectations and ensure food products are delivered as fresh as possible. Failure to do so can result in reduced profit and reputational damage.

Modified Atmosphere Packaging (MAP) is being widely adopted by businesses who are either new to the food sector or those who are seeking to expand their production and improve shelf life. In this paper, we will provide an overview of MAP and how you can choose the best gas mixtures to meet your specific production needs.

What is MAP?

Modified Atmosphere Packaging (MAP) uses food-grade gases and special packaging materials to assist in extending shelf life and maintaining food quality. MAP helps reduce spoilage which means fewer returns by customers. MAP technology has the potential to open up new markets for fresh and chilled food while simplifying distribution logistics.

For example, if a Queensland producer of par-baked bread with an approximate 5 day shelf life is approached by a customer in Victoria, without MAP they can only provide a limited shelf-life considering that it will take 2 days to get there. MAP technology can provide up to 20 days additional shelf life, allowing the producer to successfully deliver to Victoria and to consider other cities like Perth as well.

By packaging foodstuffs in a modified atmosphere, it is possible to maintain high quality and extend shelf-life by days or even weeks, depending on the product. Products that previously could not be stored fresh throughout the distribution chain can now be offered in shops without sacrificing quality. There are clear economic advantages for companies who use MAP.

Factors affecting freshness

Original freshness and shelf-life are affected by the inherent properties of the product just as much as by external factors.

Internal factors	External factors
• The type and quantity of micro-organisms	• Temperature
• Water content	• Hygiene
• pH	• Gas atmosphere
• Cell respiration	• Processing methods
• Food composition	

How long will MAP extend my shelf life?

Extension of shelf life depends on many factors such as food product, temperature, hygiene, package and gas mixture. Generally, shelf-life can be increased by a period ranging from days to several weeks, but this largely depends on the product (See table to the right).

MAP aids in high quality, extended shelf life while retaining the original taste, texture and appearance of the food. MAP gas mixtures usually consist of the gases that make up the air we breathe: carbon dioxide (CO_2), nitrogen (N_2) and oxygen (O_2).

For example, cultured products such as cottage cheese and yogurt were not packaged in modified atmospheres until recently but the demand for longer shelf life has led to their use. The shelf-life of cottage cheese packed under carbon dioxide can be extended by a week.

In contrast, red meat has a special consideration from a pack presentation perspective with regard to colour changes caused by the oxidation of the red pigment. Therefore, the atmosphere for fresh meat normally contains high concentrations of oxygen (60–80%) in order to retain the red colour by ensuring high oxygen levels in the meat's myoglobin. Highly pigmented meat such as beef thus requires higher oxygen concentrations than low pigmented meat such as pork. With the right mixtures, the practical shelf-life of consumer-packed meat can be extended from 2–4 days to 5–8 days at 4°C.

Typical shelf life in air and using MAPAX®

Food	In air	With MAPAX®
Raw red meat	2 – 4 days	5 – 8 days
Raw light poultry	4 – 7 days	16 – 21 days
Raw dark poultry	3 – 5 days	7 – 14 days
Sausages	2 – 4 days	2 – 5 weeks
Sliced cooked meat	2 – 4 days	2 – 5 weeks
Raw fish	2 – 3 days	5 – 9 days
Cooked fish	2 – 4 days	3 – 4 weeks
Hard cheese	2 – 3 weeks	4 – 10 weeks
Soft cheese	4 – 14 days	1 – 3 weeks
Cakes	Several weeks	Up to one year
Bread	Some days	2 weeks
Pre-baked bread	5 days	20 days
Fresh cut salad mix	2 – 5 days	5 – 10 days
Fresh pasta	1 – 2 weeks	3 – 4 weeks
Pizza	7 – 10 days	2 – 4 weeks
Pies	3 – 5 days	2 – 3 weeks
Sandwiches	2 – 3 days	7 – 10 days
Ready meals	2 – 5 days	7 – 20 days
Dried foods	4 – 8 months	1 – 2 years

How do I choose the right gas mixture?

Recommended gas mixtures for fruits and vegetables

Product	Gas mixture	Gas volume/Product volume	Typical shelf-life		Storage temp.
			Air	MAP	
Lettuce	5% O_2 + 5–20% CO_2 + 75–90% N_2	100–200 ml/100 g prod.	2–5 days	5–8 days	3–5°C
Fresh cut salad mix	5% O_2 + 5–0% CO_2 + 75–90% N_2	100–200 ml/100 g prod.	2–5 days	5–8 days	3–5°C
Pre-peeled potatoes	40–60% CO_2 + 40–60% N_2	100–200 ml/100 g prod.	0.5 hours	10 days	3–5°C

Recommended gas mixtures for meat and meat products

Product	Gas mixture	Gas volume/Product volume	Typical shelf-life		Storage temp.
			Air	MAP	
Raw red meat	60–80% O_2 + 20–40% CO_2	100–200 ml/100 g meat	2–4 days	5–8 days	2–3°C
Raw light poultry	40–100% CO_2 + 0–60% N_2	100–200 ml/100 g meat	4–7 days	16–21 days	2–3°C
Raw dark poultry	70% O_2 + 30% CO_2	100–200 ml/100 g meat	3–5 days	7–14 days	2–3°C
Sausages	20–30% CO_2 + 70–80% N_2	50–100 ml/100 g prod.	2–4 days	2–5 weeks	4–6°C
Sliced cooked meat	30% CO_2 + 70% N_2	50–100 ml/100 g prod.	2–4 days	2–5 weeks	4–6°C

In order to choose the right gas mixture, an assessment will need to be carried out with a gas supplier to evaluate the product and any problems that are occurring. Key considerations before choosing a mixture are:

Spoilage mechanism

It is important to understand what is causing your limitation in shelf life. Microbial and chemical/biochemical action are the main reasons for food degradation and start immediately after harvest or slaughter.

Micro-organisms are found everywhere in our surroundings and so good hygiene is a key factor in any process. The exact ways in which micro-organisms induce spoilage varies, and depends on the type of organism and the foodstuff itself.

For example, microbial growth and rancidity are the primary causes of the quality deterioration in dairy products. Hard cheeses with relatively low water activity are normally affected by the growth of moulds, whereas products with high water activity, such as cream and soft cheeses, are more susceptible to fermentation and rancidity.

Shelf life

Shelf life varies from product to product and largely depends on the type of food being processed. For example, dry foods, such as roasted peanuts, can last up to 12 weeks whereas red meat can typically only last 2–4 days. Shelf life can be determined by multiple factors so it is always advisable to conduct trials to determine what the best fit for the product is.

Understanding what you are trying to achieve and why

When shelf life and spoilage are taken into consideration, food manufacturers then need to understand what exactly is trying to be achieved. MAP does not act as a bandaid for bad manufacturing processes. Rather, it help extends product life in good manufacturing processes. Understanding exactly what needs to be achieved, whether it's extending shelf life or changing the packaging, will determine what gas mixture is used.

The right gas mixture for your product will depend on the type of food product, desired shelf life, the manufacturing process, and the target market. Your gas supplier will be able to assist in finding the right gas mixture for your specific application.

What are the functions of different gases?

The most important gas is carbon dioixide as it delays the growth of microorganisms by dissolving into the food. Nitrogen is used to replace oxygen and decrease deterioration. It is also used as a buffer or filler gas. Oxygen is used to keep the red colour of meat and for the respiration of fruits and vegetables. The gases are normally used in mixtures to suit the needs of the specific product.

BOC has a range of gases created to meet the special quality requirements of the food industry and facilitates customers in complying with legislated Food Standards during packaging, storage and distribution.

Nitrogen

Nitrogen (N_2) is an inert gas and is used to exclude air – in particular oxygen. It can be engaged as a balance or filler gas to make up the required volume in a gas mixture, helping to prevent the collapse of packs with high moisture or fat-containing foods (the latter absorbs carbon dioxide from the modified atmosphere).

Carbon dioxide

Carbon dioxide (CO_2) inhibits the growth of most aerobic bacteria and moulds, so the higher the level of CO_2 the longer the achievable shelf life. However, CO_2 is readily absorbed by fats and water so most foods will absorb it. In the wrong concentrations, it can also cause the film on product packs to collapse. Getting concentrations right is key.

Oxygen

Oxygen (O_2) can cause food deterioration and is often an undesirable. However, it will maintain the fresh colour of red meats and also inhibits the growth of anaerobic organisms in some types of fish.

What are my gas-supply options?

Cylinders or onsite supply

Selecting the right gas supply option will depend on on the volume of production and the type of production.

If production is relatively limited pre-mixed cylinders can be supplied.

Alternatively, if production volume is large or if the plant produces different products with different gas requirements, it may be more convenient and economical to switch over to mixing gases on site. In this instance, a mixer is used and the gases are supplied from cylinders, tanks or PSA/membrane systems. A gas supplier such as BOC can provide training on any equipment supplied.

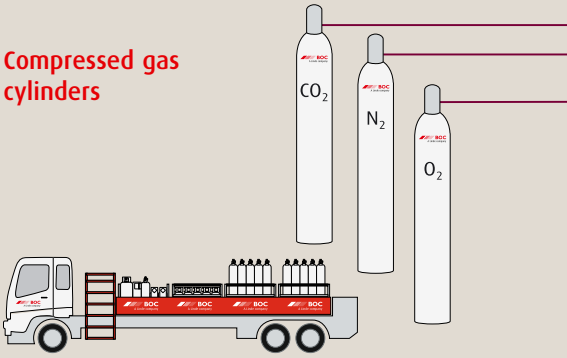
Each application must be evaluated separately before decisions can be made regarding the supply options. For quality assurance, regularly checking the gas mixture in the ready packages after sealing is recommended.

BOC services customers across all supply options.

Compressed gas

BOC Food Fresh cylinders and Manifolded Cylinder Packs (MCP) have been developed for food businesses using Modified Atmosphere Packaging (MAP). Food Fresh cylinders can be supplied as single gases or as mixtures.

Compressed gas cylinders



CRYOSPEED®

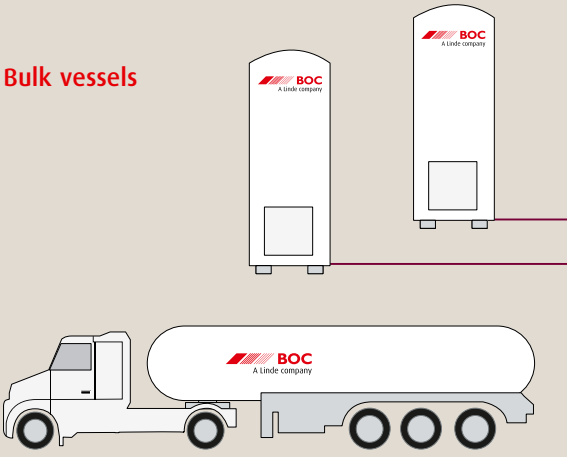
BOC's CRYOSPEED® service is an intermediate offer between compressed and bulk gas. Oxygen, nitrogen and carbon dioxide in cyrogenic liquid form, are stored in compact stainless steel vacuum-insulated vessels on your site and are filled by our CRYOSPEED® vehicles. With up to 2000 l capacity, our storage vessels are set up for the pressures, flow rates and sizes to accommodate your business. Mix Onsite units have an integrated mixing panel to blend gas components to the required gas composition. Vessels are monitored remotely by BOC to give you peace of mind.

CRYOSPEED® Cryotank/GASMATIC® vessels and Mix Onsite units

Bulk

High gas volumes can be stored in BOC bulk cryogenic vessels (>2000 l capacity). These are installed on your site, providing a continuous and secure supply of oxygen, nitrogen or carbon dioxide. A mixing panel is used to blend gas components to the required gas composition.

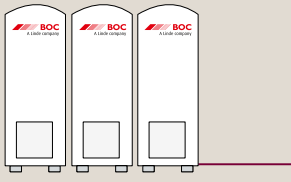
Bulk vessels

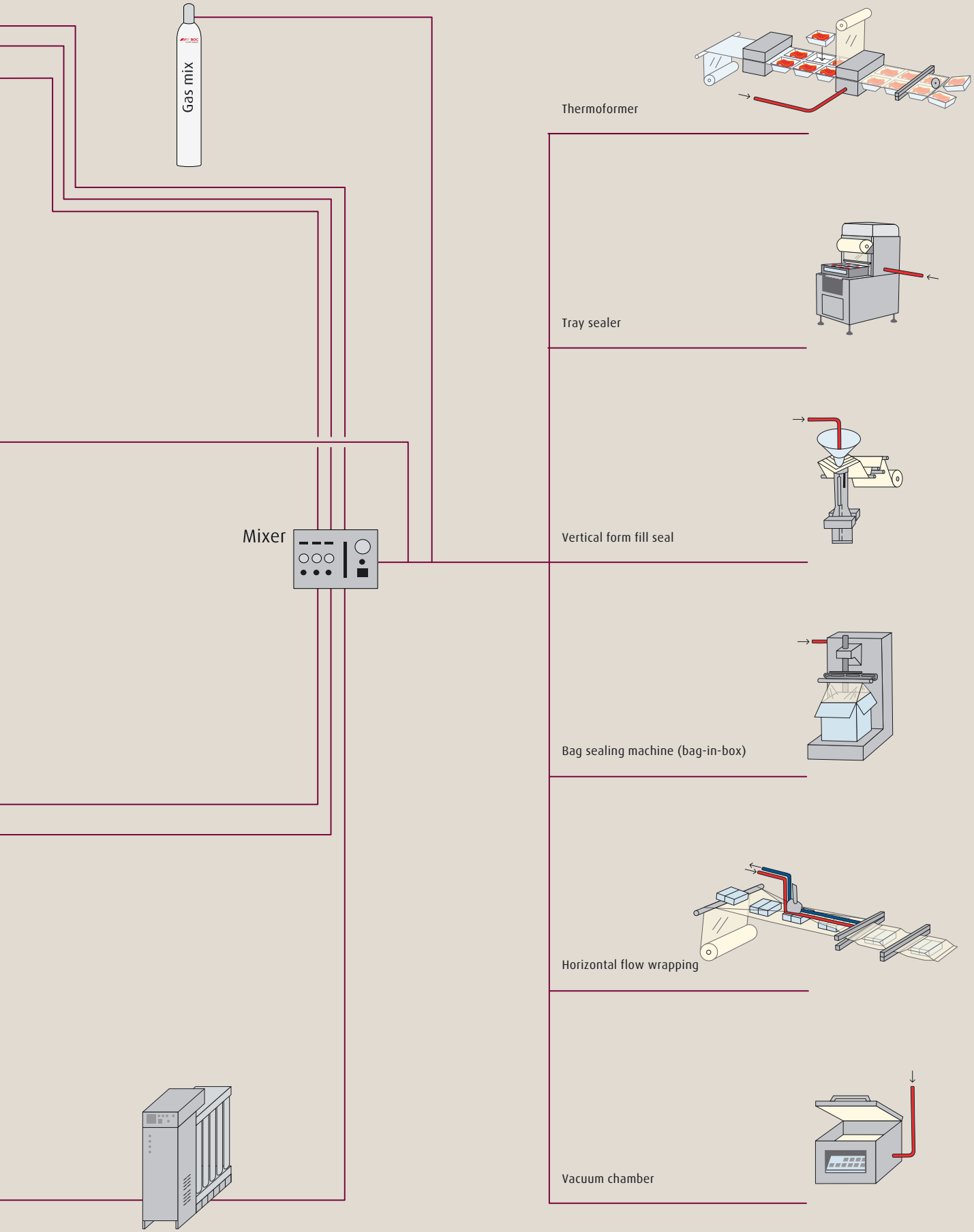


On-site generation

For those needing generated nitrogen, the BOC ECOVAR® mini range provides an on-site generation solution at a range of pressures, flow rates and purities. On-site generation requirements are assessed on a site-specific basis to ensure the resulting set-up will cater for your needs now and in the future.

On-site generation




Gas mix
Mixer
Thermoformer
Tray sealer
Vertical form fill seal
Bag sealing machine (bag-in-box)
Horizontal flow wrapping
Vacuum chamber

What type of packaging machine should I use?

There are five main groups of packaging machines used with MAP technology for different kinds of products. The basic mode of operation is the same for all of them. First, a pack (either produced on site or prefabricated) is filled with the product. Then, the air in the package is replaced by a modified atmosphere. Finally the package is sealed. These steps can be carried out manually or automatically.

Gas flushing vs vacuum extraction

Atmosphere modification is achieved by gas flushing or vacuum extraction, followed by gas injection. The amount of gas needed depends on the type of machine. In gas flushing, the air in the pack is progressively replaced by a continuous gas stream that gradually replaces the air surrounding the food product before the package is sealed. Since this is a continuous process, the packaging rate can be high. In the vacuum process, air is extracted from the package and the resultant vacuum is broken by injection with the desired gas mixture. This two-step process is slower than the gas flushing method. However, because the air is almost totally removed, the control of residual oxygen levels is better than gas flushing.

First, determine how the product will be presented and then identify the best machine type and gas combination for that. For example, refrigerated fresh pasta can currently be packed in either a Thermoformer or a Vertical Form Fill Seal machine dependant on the producer's display preference.

What else do I need to be aware of?

Once the packaging machine and gas mixture is decided upon, it is highly advisable to trial the gas mixture. For multi-component products, such as prepared meals, it may take longer to trial to get the right potential mixture.

It is important to implement the right quality control checks to ensure ongoing production parameters. This means periodically checking the contents of the package with regards to the gas mixture as well as checking for any physical imperfections that may appear on the product. Businesses should build in regular quality checks to ensure they meet their own quality requirements and standards.

Conclusion.

MAP can help food manufacturers in the race against time to maintain the freshness of their product. Understanding the spoilage mechanism of a product and the desired shelf life is key to picking the most appropriate gas mixture.

Through the use of natural gases and appropriate packaging material and machines, food manufacturers can continue to meet growing consumer demands. This can also create opportunities for business expansions and transitions in to new markets.

For more information on how to pick the best gas mixture for your product, please talk to a BOC representative or visit our website at www.boc.com.au or www.boc.co.nz.

Getting ahead through innovation.

With its innovative concepts, Linde is playing a pioneering role in the global market. As a technology leader, it is our task to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

Linde offers more. We create added value, clearly discernible competitive advantages, and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardised as well as customised solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimisation, and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, joint activities form the core of commercial success.

Linde – ideas become solutions.

For more information on how to pick the best gas mixture for your product, please talk to a BOC representative or visit our website

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