

# MAP gases

(Modified Atmospheric Packaging)  
Foodfresh range





## FOODFRESH™

A range of quality gases and gas mixtures for modified and controlled atmosphere packaging.

## Introduction

All food is subject to deterioration. From the consumer viewpoint, this means loss of flavour, loss of colour and microbial spoilage. These effects can be retarded and the shelf-life extended, in some cases almost indefinitely, by the use of a gas packaging technique known as Modified Atmosphere Packaging or MAP. MAP can be utilised on its own or together with other preservation techniques such as the Cook-Chill process.

MAP can extend product shelf life easily and economically – and without the need for vacuum packaging, artificial preservatives or freezing.

To appreciate the importance of this process, we must first understand how food deteriorates and how we can prevent this from happening. Food spoilage is usually the result of bacterial action, oxidation, enzyme action, mould growth or the accumulation of metabolic by-products. MAP employs the properties of specific gases or gas mixtures to slow down those decay mechanisms that have the dominant effect on packaged food products.

MAP not only keeps packaged food looking good, it is also the most economical packaging method. Customers will naturally prefer products which have that quality look and where the juices and aromas have been sealed in. Add to that the benefits obtainable from extended shelf life such as longer production runs, fewer deliveries and reduced man-hours spent restocking the shelves, and you have a natural competitive advantage.



MAP has a major role to play in the food industry when used in conjunction with the highest standards of hygiene and temperature control throughout the production, delivery and storage processes. The benefits of MAP are applicable to most food products and include such food categories as

- Meat
- Poultry
- Fish
- Dairy products (in particular cheese)
- Confectionary products (including pasta)
- Dried products and snack foods; and
- Fresh fruit and vegetables.

# The food industry, Modified Atmosphere Packaging and Afrox Gases

The MAP gas range has been created to meet special quality requirements of the food industry. The range assists customers in complying with strict food standards legislation in packaging, storage and distribution. With the FoodFresh range, we can provide the traceability and safety guarantees required by law.

Whenever you see the FoodFresh name you can be assured that the product is of the highest quality demanded by food processors and consumers alike. The overall quality of FoodFresh gases and gas mixtures is achieved by carefully controlling both the preparation and filling procedures of each FoodFresh cylinder.

- FoodFresh gases and gas mixtures are supplied in dedicated high capacity, high-pressure steel cylinders providing longer cylinder life and fewer cylinder changeovers.
- The cylinders are also fitted with softseat handwheel valves to facilitate their opening and closing.
- The quality of FoodFresh gases and gas mixtures is rigorously monitored in our SABS ISO 9002- rated quality control laboratory.
- The external presentation of the cylinders and the distinctive FoodFresh label contain compliance information, to complement the high quality of gases contained within.

In these ways Afrox ensure that the cylinders are dedicated to one industry only – the Food Industry. FoodFresh gases and gas mixtures therefore are the ideal way for you to move into MAP.

Afrox offer a range of FoodFresh gases and gas mixtures which cover all current MAP processes. As new applications arise, Afrox will incorporate appropriate new products into the FoodFresh range. If required, tailor-made FoodFresh mixtures can be prepared to meet specific needs.

Each food category has its own needs and requirements. FoodFresh gases and gas mixtures can meet those needs and requirements no matter what the product involved. The recommended mixtures are guidelines and trials should be carried out before a final choice is made. The component gases in Afrox' FoodFresh range comprise Carbon Dioxide, Nitrogen and Oxygen which contribute the following preservation benefits:

## Modified atmospheres for all food

### Food grade gases

#### Carbon Dioxide

Carbon Dioxide is bacteriostatic and fungistatic, retarding the growth of mould and aerobic bacteria.

#### Nitrogen

Nitrogen is used to displace Oxygen where aerobic spoilage mechanisms dominate. It is also used as an inert filler gas to prevent pack collapse.

#### Oxygen

Oxygen is used in MAP mainly for colour retention in red meat. In small concentrations it is used for fruit and vegetable respiration and to avoid anaerobic conditions in white fish.





## Bakery & dried food

Health-conscious, convenience-seeking consumers are putting the bakery and snack industry under ever increasing pressure. The hunt for new products is relentless. Likewise the search for new and innovative technologies for a wide range of products including flour-based foods such as breads, cakes, biscuits, crackers, croissants, muffins, bagels, pancakes, waffles and pasta as well as crisps and peanuts. While every product presents its own challenges, manufacturers are always looking to strike the right balance between productivity improvement and product quality over extended shelf life.

The solution lies in new ways of working – in highly sophisticated, efficient production and packaging processes that guarantee taste, appearance, food safety and value for money.

### The challenges

Dry foods such as potato crisps, peanuts, coffee, spices and powdered products contain unsaturated fats. This makes them sensitive to oxidation and rancidity. Oxygen also impacts upon shelf life – even the smallest amount trapped in the packaging induces spoil. Powdered baby milk for example demands oxygen levels of less than 0.2% in order to preserve quality.

Bakery products are susceptible to spoil from mould growth and chemical breakdown. Filled bakery foods are prone to fermentation and iced cakes such as Danish pastries can suffer 'ice melt' as the fat content in the icing sugar slowly dissolves.

While the low water content of bakery products naturally inhibits the growth of micro-organisms, a hygienic processing environment will eliminate risk of spore contamination and mould.

### The solution

Strict hygiene, together with temperature and atmospheric control in processing and packaging, minimises the risk of mould growth and chemical breakdown, the two main causes of spoilage in flour-based bakery and dried foods.

Modified Atmosphere Packaging (MAP) offers a barrier to oxygen and moisture. It significantly extends shelf life. Replacing the oxygen in the pack with nitrogen, carbon dioxide or a mix of the two is an option. Reducing the oxygen level at the processing stage is another. Carbon dioxide also slows mould growth on bread. It controls the development of aerobic micro-organisms thereby significantly extending shelf life.

Modified Atmosphere Packaging (MAP) is especially well suited to the production and packaging of rye bread, sweet bakery products and pies. It eliminates the risk of excess carbon dioxide – the cause of 'ice melt' for example – and offers the ability to balance the carbon dioxide concentration with nitrogen. This helps to retain the fresh appearance and texture of bakery and dried foods over time.

The right packaging material will also prevent moisture loss or absorption in bakery products.

### Recommended gas mixtures for dry foods and bakery products

Product	Gas mixture	Gas volume Product volume	Typical shelf-life		Storage temp.	
			Air	MAP		
Pre-baked bread	FoodFresh 1	100% CO <sub>2</sub>	50 – 100 ml 100 g prod	5 days	20 days	20 – 25°C
Cakes	FoodFresh 9	50% CO <sub>2</sub> + 50% N <sub>2</sub>	50 – 100 ml 100 g prod	15 days	60 days	20 – 25°C
Coffee (ground)	FoodFresh 1 or 2	N <sub>2</sub> or CO <sub>2</sub>	50 – 100 ml 100 g prod	4 weeks	24 weeks	20 – 25°C
Milk powder	FoodFresh 2	100% N <sub>2</sub>	50 – 100 ml 100 g prod	12 weeks	52 weeks	20 – 25°C
Peanuts	FoodFresh 2	100% N <sub>2</sub>	50 – 100 ml 100 g prod	12 weeks	52 weeks	20 – 25°C

# Dairy

The consumer is putting the dairy industry under ever-increasing pressure. On the one hand they demand high quality dairy foods with long shelf life; on the other they expect value for money. For food processors this translates into a need for new production processes that satisfy strict food regulations and deliver on these needs.

It's a complex agenda. Microbial growth and rancidity are the primary causes of quality deterioration in dairy products, although the type of breakdown depends on the foodstuff. Hard cheese with its relatively low water content is predisposed to mould growth, whereas cream and soft cheeses with their high water content are susceptible to fermentation and rancidity.

The solution lies in an efficient production process that offers gentle handling and rapid processing. If dairy foods can be preserved before the onset of deterioration, then quality and longevity will be maintained.

## The challenge

Hard cheese is susceptible to microbial activity and mould growth. The packaging of value-added cheeses such as grated or sliced cheddar is prone to collapse. Overtime the carbon dioxide in the pack may also taint the cheese. Cultured products such as cottage cheese and yogurt are also at risk of spoil.

## The solution

Carbon dioxide is a priority when packaging hard cheese. It significantly reduces – even stops – microbial activity and helps to maintain texture. Concentrations of just 20% are required to inhibit mould growth. Used with nitrogen, it slows the spoil of soft cheese.

Carbon dioxide can also prevent package collapse. Bagging grated cheese in a modified atmosphere comprising 50% nitrogen and 50% carbon dioxide will eliminate this problem. In cases where carbon dioxide absorption is causing product to taint, a nitrogen atmosphere is recommended to eliminate this risk.

Modified atmospheres are also proven to preserve the freshness of cultured products such as cottage cheese and yoghurts.



## Recommended gas mixtures for dairy products

Product	Gas mixture	Gas volume Product volume	Typical shelf-life		Storage temp.
			Air	MAP	
Hard cheese	FoodFresh 9 50% CO <sub>2</sub> + 50% N <sub>2</sub>	50 – 100 ml 100 g cheese	2 – 3 weeks	4 – 10 weeks	4 – 6°C
Soft cheese	FoodFresh 5/7/9 20 – 50% CO <sub>2</sub> + 50 – 80% N <sub>2</sub>	50 – 100 ml 100 g cheese	8 days	21 days	4 – 6°C
Yogurt	FoodFresh 2/4/5 0 – 20% CO <sub>2</sub> + 80 – 100% N <sub>2</sub>		10 – 14 days	22 – 25 days	4 – 6°C



## Fish & seafood

The focus on healthy eating is accelerating demand for fish and seafood. The challenge facing the industry is to ensure that these delicate products maintain the highest quality from the hatchery to the plate. Food processors must ensure that the final product, whether frozen, chilled or packed in a modified atmosphere, retains its original freshness. This is complicated by a high water and fat content, a neutral pH and enzymes, all of which can rapidly spoil.

The solution to preserving product quality lies in new ways of working – in highly sophisticated, efficient production and packaging processes that guarantee taste, appearance, food safety and value for money.

### The challenge

Fresh fish deteriorates very quickly. Its high water content, neutral pH (at which micro-organisms thrive) combines with the presence of enzymes to encourage microbial growth and spoil. This makes for bad taste and smell. Naturally occurring micro-organisms also break down fish proteins compounding the problem. Herring and trout can turn rancid even before microbial deterioration is detectable while the oxidation of unsaturated fats in high-fat fish such as tuna, herring and mackerel is another risk.

### The solution

In order to maintain the high quality of fresh fish products, it is vital to keep temperatures as close to 0°C as possible.

With the right gas mixture, shelf life can be extended by a few days. For example, Modified Atmosphere Packaging (MAP) is proven to extend the shelf life of cod, flounder, plaice, haddock and whiting. At 0°C, it enables it to be stored for twice as long as in air. Depending on the storage temperature (0 – 2°C), MAP can prolong

shelf life by three to five days compared with that of raw fish in a covered tray.

Carbon dioxide is essential to quality. It inhibits the growth of common aerobic bacteria. A carbon dioxide level of at least 20% will reduce the pH value of the tissue surface and consequently, slow bacterial growth. In practice, however, it is not unusual to find carbon dioxide levels of 50%. But beware, excessive concentrations of carbon dioxide can produce undesirable side-effects such as loss of tissue liquid and, in the case of crabs, a sour taste.

Oxygen, as a component of a modified atmosphere, will stop colour change and fade. It also prevents the growth of anaerobic micro-organisms. Nitrogen is better suited to preserving the quality of high-fat fish.



### Recommended gas mixtures for fish and seafood

Product	Gas mixture	Gas volume Product volume	Typical shelf-life		Storage temp.
			Air	MAP	
Raw fish	FoodFresh 9 50 % CO <sub>2</sub> + 50 % N <sub>2</sub>	200 – 300 ml 100 g fish	3 – 5 days	5 – 14 days	0 – 2°C
Smoked fish	FoodFresh 9 50% CO <sub>2</sub> + 50% N <sub>2</sub>	50 – 100 ml 100 g fish	15 days	30 days	0 – 3°C
Cooked fish	FoodFresh 7 30% CO <sub>2</sub> + 70% N <sub>2</sub>	50 – 100 ml 100 g fish	7 days	30 days	0 – 3°C

# Fruit & vegetables

Consumers demand high quality, fresh fruit and vegetables all year round. This is both an opportunity and a challenge to producers, processors and packers. Careful handling supports hygiene and product integrity through the supply chain and over distance – from harvesting, through storage, preparation, packaging and distribution. It promotes product quality and longer shelf life.

For growers and food producers, the solution lies in new ways of working – in highly sophisticated, efficient production and packaging processes that guarantee taste, appearance, food safety and value for money.

## The challenges

The right choice of modified atmosphere in the right packaging material is essential. Get this wrong and the product will quickly spoil. If fruit and veg are sealed with a film that has insufficient permeability, undesirable anaerobic conditions (less than 1% oxygen and more than 20% carbon dioxide) will lead to loss of quality. Conversely, if they are sealed in a film which has excessive permeability, little or no modified atmosphere will be retained.

Moisture loss is another risk as it can accelerate the deterioration process.

Getting the right balance between the transmission of oxygen and carbon dioxide through the packaging medium and a product's respiration rate is a crucial factor. An equilibrium modified atmosphere (EMA) is influenced by many things. As well as respiration rate, the variety, size, maturity and intensity of produce preparation, temperature, packaging film, pack volume, fill weight and light levels all come into play. Rigorous testing is required to ascertain the best EMA for each product.

## The solution

Atmospheric control combined with the right packaging is proven to extend the lifespan of fresh produce. Micro-porous film is a good example of fit-for-purpose Modified Atmosphere Packaging (MAP). It has the right level of permeability to retain freshness and lengthen the shelf life.

It also offers the correct intermediary permeability. It supports the establishment of a desirable EMA – when the rate of oxygen and carbon dioxide transmission through the pack equals the product's respiration rate. Typically, EMAs of 3 – 10% oxygen and 3 – 10% carbon dioxide significantly increase the shelf life of fruit and vegetables. Determining the optimum EMA for a particular fruit or vegetable is a complex issue that can only be solved with practical testing.



## Recommended gas mixtures for fruits and vegetables

Product	FoodFresh	Gas mixture	Gas volume Product volume	Typical shelf-life		Storage temp.
				Air	MAP	
Lettuce	24	5% O <sub>2</sub> + 15% CO <sub>2</sub> + 80% N <sub>2</sub>	100 – 200 ml 100 g prod	2 – 5 days	5 – 8 days	3 – 5°C
Fresh cut salad mix	24	5% O <sub>2</sub> + 15% CO <sub>2</sub> + 80% N <sub>2</sub>	100 – 200 ml 100 g prod	2 – 5 days	5 – 8 days	3 – 5°C
Pre-peeled potatoes	9	50% CO <sub>2</sub> + 50% N <sub>2</sub>	100 – 200 ml 100 g prod	0,5 hours	10 days	3 – 5°C





## Meat & poultry

Health-conscious, convenience-seeking consumers are putting the food industry under ever increasing pressure. On the one hand the public is concerned about product quality – the source, treatment and freshness of meat, meat products and poultry – on the other, they demand value for money. For food processors this translates into a need for production processes that deliver consistently high quality meats that satisfy strict food regulations, consumer expectation and the need for longer shelf life.

The solution lies in new ways of working – in highly sophisticated, efficient production and packaging processes that guarantee taste, appearance, food safety and value for money.

### Meat and meat products

#### The challenges

The naturally high water and nutrient content in meat and meat products makes them susceptible to bacterial contamination. Food handling and processing is another potential source of spoil.

The de-oxygenation of myoglobin within red meat can also lead to unwanted colour change.

#### The solution

Strict hygiene, temperature and atmospheric control in processing and pre-packaging minimises the growth of mould and chemical breakdown which causes rancidity and food poisoning.

Carbon dioxide can also inhibit the growth of harmful bacteria such as *Pseudomonas* while a high concentration of oxygen (60 – 80%)

in the fresh meat packaging room can help to retain meat's healthy red colouring over time. Indeed, with the right mix of oxygen in the atmosphere, the shelf life of meat in consumer packs can be doubled – it can be extended from 2 – 4 days to 5 – 8 days at 4°C.

### Poultry

#### The challenges

Poultry is susceptible to microbial growth, evaporation loss, off-odour, discolouration and biochemical deterioration. Unlike red meat, however, it does not undergo irreversible surface discolouration in the presence of oxygen.

#### The solution

Carbon dioxide is an effective inhibitor of aerobic spoilage bacteria in poultry. Levels of 20% and above can help to retain original taste, texture and significantly extend shelf life provided the headspace volume (almost) equates to the product volume. The right gas mix is proven to lengthen the shelf life of pre-packed poultry to between 16 and 21 days.



### 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	FoodFresh 22	80% O <sub>2</sub> + 20% CO <sub>2</sub>	100 – 200 ml 100 g meat	2 – 4 days	5 – 8 days	2 – 3°C
Raw light poultry	FoodFresh 1/9	40 – 100% CO <sub>2</sub> + 0 – 60% N <sub>2</sub>	100 – 200 ml 100 g meat	4 – 7 days	16 – 21 days	2 – 3°C
Raw dark poultry	FoodFresh 22	80% O <sub>2</sub> + 20% CO <sub>2</sub>	100 – 200 ml 100 g meat	3 – 5 days	7 – 14 days	2 – 3°C
Sausages	FoodFresh 5/7	20 – 30% CO <sub>2</sub> + 70 – 80% N <sub>2</sub>	50 – 100 ml 100 g prod	2 – 4 days	2 – 5 weeks	4 – 6°C
Sliced cooked meat	FoodFresh 7	30% CO <sub>2</sub> + 70% N <sub>2</sub>	50 – 100 ml 100 g prod	2 – 4 days	2 – 5 weeks	4 – 6°C



# Prepared & catered food

Convenience-seeking shoppers want high quality, attractive 'consumer ready' foods with a long shelf life. Receptive to exotic tastes and quick to try new lines, they are prepared to pay premium prices in exchange for minimal preparation. Pizzas, sandwiches and ready meals fall into this category.

In order to meet this demand, the catering industry must deliver fresh, fine foods of consistent high quality. Producing to order is often employed to satisfy these demands, which could result in a very expensive operation.

The solution lies in new ways of working – in highly sophisticated, efficient production and packaging processes that guarantee the taste, appearance and food safety of these multi-ingredient, added value foods.

## The challenge

Pre-prepared and catered foods present a complex challenge. Their multiple ingredients increase the potential for deterioration. Each bespoke mix carries its own particular risk. If meat is the main ingredient, as in ravioli or lasagne, it spoils in a different way and rate to pasta for example. The manufacturing process for prepared foods also carries risk of microbial contamination.

Spoil is caused by the growth of micro-organisms and by oxidation. It leads to rancidity, discolouration and loss of taste; food can become stale. A fresh pizza left in the open air at 4 – 6°C will be inedible within a week for example.

Getting the right carbon dioxide/nitrogen balance is another priority. Whilst it will vary according to the moisture content and composition of the different ingredients, the mix can significantly influence the speed of microbial growth, oxidation and enzyme activity.

## The solution

Stringent hygiene is critical throughout the production process. It reduces risk of contamination. Atmospheric control and temperature also supports the right environment for product quality and extended shelf life. Packaging a product in a modified atmosphere with a low oxygen concentration and high carbon dioxide level will promote longevity. In the case of pizza, an oxygen level of less than 1.5% will achieve this.

As a general rule, the higher the water content, the higher the required carbon dioxide concentration. Modified Atmosphere Packaging (MAP) can reduce the risks associated with multiple-ingredient foods. Food producers are advised to identify a trusted expert – a supplier with the proven expertise – to recommend the right gas mixtures to sustain freshness and so maintain product quality over time.

## Meeting the needs of the catering industry

### The challenge

Consumers have very high expectation of the catering industry. They demand fresh, appetising foods when and where they want them. Though an inefficient and expensive way to operate, production-to order is often the supplier's preferred means of meeting this need.

### The solution

Temperature and atmospheric control during the kitchen or factory production process supports a managed and planned production process. It enables caterers to plan ahead – to drive productivity improvement and better control supply chain costs. The ability to plan ahead also makes it easier to organise storage and distribution needs, all the time supporting product quality over longer shelf life.

In a hotel or restaurant kitchen, modified atmosphere packaging enables efficient production. Rather than slicing cheese or meats for the breakfast table on a daily basis, for example, this task can be reduced to once or twice a week. The number of slices stays the same, but you work more efficiently. The same applies when preparing fresh meat cuts for the grill.

Packing sandwiches and chilled food is a profitable option for many caterers. Here too atmospheric control and correct temperature selection are essential to product quality and shelf life.

## Recommended gas mixtures for prepared and catered food

Product	Gas mixture	Gas volume Product volume	Typical shelf-life		Storage temp.	
			Air	MAP		
Pizza	FoodFresh 7/9	30 – 50% CO <sub>2</sub> + 50 – 70% N <sub>2</sub>	50 – 100 ml 100 g prod	1 week	3 weeks	2 – 4°C
Pasta	FoodFresh 7/9	30 – 50% CO <sub>2</sub> + 50 – 70% N <sub>2</sub>	50 – 100 ml 100 g prod	1 week	3 weeks	2 – 4°C
Sandwiches	FoodFresh 7	30% CO <sub>2</sub> + 70% N <sub>2</sub>	50 – 100 ml 100 g prod	2 days	10 days	2 – 4°C
Ready meals	FoodFresh7/9	30 – 50% CO <sub>2</sub> + 50 – 70% N <sub>2</sub>	50 – 100 ml 100 g prod	4 days	21 days	2 – 4°C

# Supply options

If your usage of FoodFresh gases is relatively small then you may be best suited to pre-mixed cylinders of gas.

As your usage increases, the most suitable way to receive your FoodFresh gases could be in single gas cylinders that can be connected to an Afrox mixing panel to ensure that you receive the correct mix as and when required. As you continue to increase your usage you may wish to move away from compressed gases to portable cryogenic containers, a bulk liquid supply stored on site or on-site gas generation.

With over 80 outlets across the country and a comprehensive nationwide delivery service, Afrox has the supply option to best suit your needs.

## Regulators

For simple and safe delivery of FoodFresh gases and gas mixtures from cylinders to the process, Scientific regulators are recommended. The diaphragms of both the first and second stages of a Scientific regulators are made from 304 stainless steel which guarantees that the gas reaches your food packaging process uncontaminated and at the same quality as that contained in the cylinder.

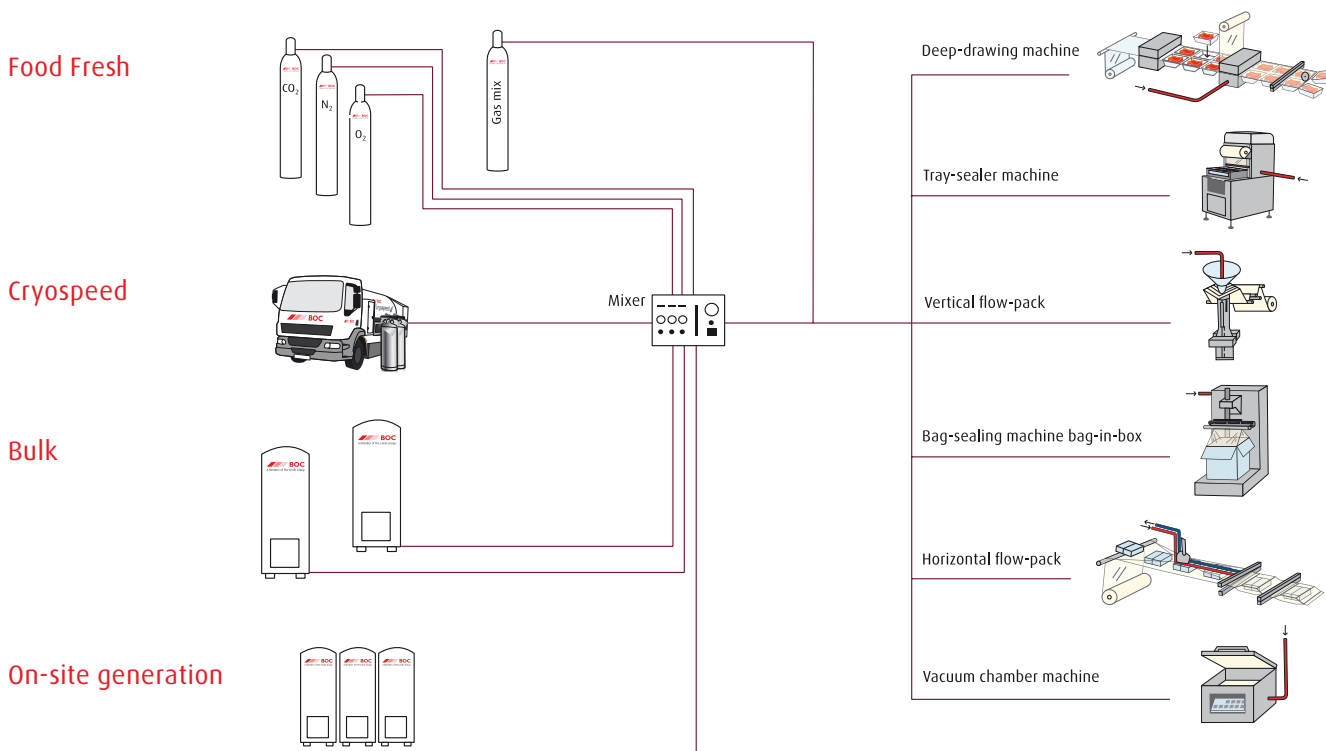
## Chilling

In addition to our range of FoodFresh products, Afrox provide additional cost-effective, flexible chilling technology to the food industry. Snowshooting® for example can be regarded as a useful addition to your option for ensuring that customers receive their perishable products in the freshest possible condition.



### Supply options

Food grade gases can be supplied in several ways: cylinders; Cryospeed; bulk; and through on-site generation.



### Cylinders

Afrox Food Fresh cylinders and Manifolder Cylinder Pallets (MCP) have been developed for food businesses using modified atmosphere packaging (MAP). Food Fresh cylinders can be supplied as single gases or as mixtures. Your Aprox sales and technical specialist will advise on the appropriate mixing equipment, or pre-mix cylinders. Where a pre-mix gas is chosen, Aprox will recommend a gas mixture for packing your product.

### Cryospeed

Afrox's Cryospeed service gives you access to larger volumes of oxygen, nitrogen and carbon dioxide in cryogenic liquid form. These are stored in fully maintained stainless steel vacuum-insulated vessels on your site and are filled by our Cryospeed operators. Our storage vessels are set up for the pressures, flow rates and sizes appropriate to each customer. All rented vessels are fully maintained under the supply agreement with Aprox.

### Bulk

High gas volumes can be stored in Aprox bulk cryogenic vessels. These are installed at the customer's site, providing a continuous and secure supply of oxygen, nitrogen or carbon-dioxide. Our Customer Engineering Service (CES) designs, installs and maintains the vessel in line with customer requirements and in compliance with all the relevant regulations (such as the Pressure Systems Safety Regulations 2000). Our On-Stream service can also cover customer-owned systems.

### On-site generation

For those needing generated nitrogen, the Aprox Ecovarmini range provides an on-site generation solution at a range of pressures, flow rate and purity. 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.



# Perfect food comes in perfect packaging

## Tailored solutions for all kinds of product

Packaging materials are crucially important for food quality and shelf life. Many sophisticated solutions have now been developed to prevent the rapid deterioration caused by oxygen, light and bacteria – or by foreign odours and tastes that may come into contact with the product. A manufacturer choosing suitable packaging designs and materials has many important decisions to make, as well as complying with the relevant regulations.

Before making a choice, consider:

- Manufactured to allow optimum gas transfer
- Able to withstand heat sealing
- Able to withstand normal handling and distribution without failing; to ensure the integrity of the gas mixture throughout the storage period.

## Packaging materials

Packaging films are selected according to the characteristics of the food product. Film permeability, water vapour transmission rates and sealing characteristics all need to be matched with MAP properties. The high barrier films, foils and other materials form the substrates for MAP packages when formed into trays, lids or bags.

Our research strives to incorporate environmentally friendly materials (in terms of both manufacture and disposal) and to ensure that the modified atmosphere will be retained during the lifetime of the product. Several different materials are often combined into a multi-layered structure, each layer having its own function.

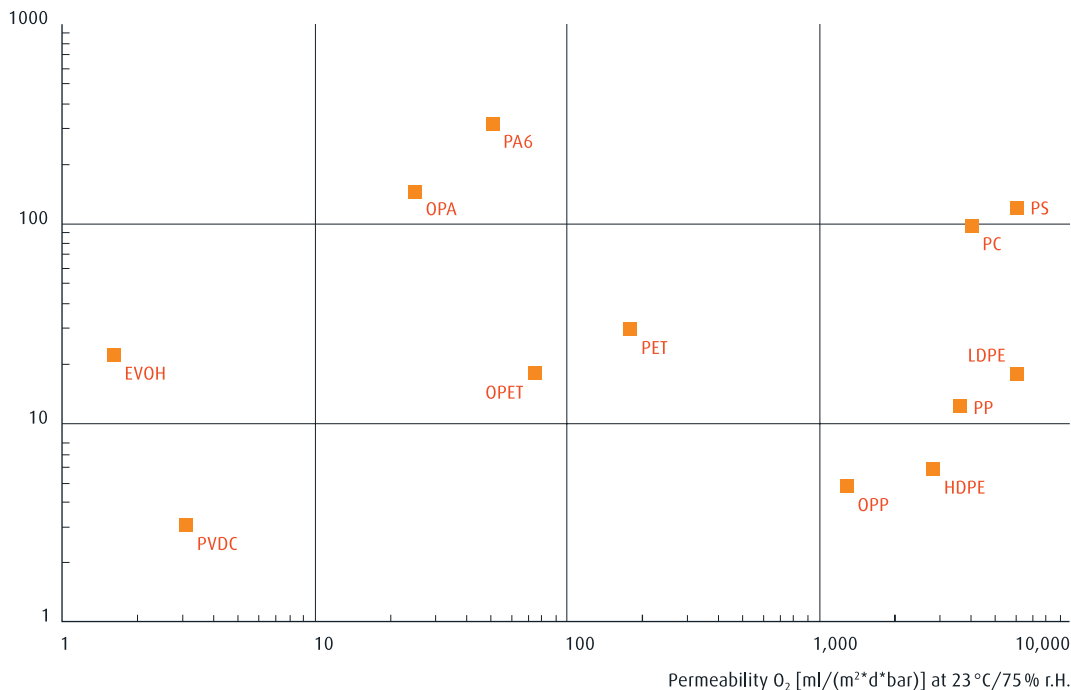


## Permeability of various basic materials

Permeability H<sub>2</sub>O

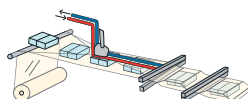
[g/(m<sup>2</sup>\*d)] at 40 °C/90 % r.H.

Permeability according to film thickness 25 µm



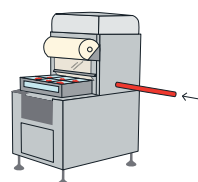
# Packaging machines

The machines used depend on whether the product is packed for retail display or in bulk. There are two processes commonly used to pack products individually. Products that require an atmosphere high in Carbon Dioxide are generally packed using a form, fill and seal machine. This machine employs a purge of gas into pre-formed cylinder of film, which is formed from a single web and is then sealed at each end. Products that require less Carbon Dioxide are generally packed using a vacuum-gas machine similar to the one illustrated on the right.



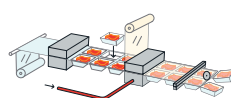
The method first evacuates the container and then replaces the atmosphere with the appropriate gas mixture before sealing with a top film.

Bulk pack machines are a more recent development and can be used when the product is in primal form – such as a meat carcass – or when the product is individually packed in permeable packs within a large container filled with a modified atmosphere. Essentially bulk pack machine is a larger version of the vacuum-gas machine in which a vacuum is formed and then filled with FoodFresh mixture.



There are five main groups of packaging machines used with MAP technology, for different kinds of product. 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.

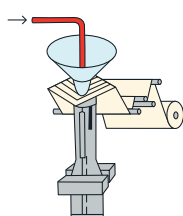
Finally, the package is sealed. These steps can be carried out manually or automatically. Atmosphere modification is achieved by gas flushing or vacuum extraction, followed by gas injection. The amount of gas needed depends on the type of machine. In gas flushing, the air in the pack is progressively 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.

## Vertical flow packing

A film is formed into a tube which is pinched together at one end, the other end being sealed over an injection pipe. Product is portioned out into the tube, which is then sealed at the other end and cut off. Gas is continually fed through the tube to purge the air. This type of machine is mostly used for powdered and bulk products such as coffee and peanuts as well as diced foodstuffs. Gas flushing may sometimes be necessary before packing.



— Gas flow  
— Gas analyser

## Horizontal flow packing

The foodstuffs are fed into a horizontal flowing tube that is constantly formed by a packaging machine. The tube is sealed and cut off along both sides of the product. Gas is flushed through the resulting bag, purging the air. This is quick and the machine uses less complex film materials than the deep-drawing machine. It is typically used with bakery products, sausages, cheese, pizza and green salads. One technique that can be used here is BDF (Barrier Display Film) which is employed to pack the food product on a tray in MAP. The trays then pass through a heating tunnel where the film shrinks around the packages, enclosing them in the modified atmosphere.

## Tray sealer

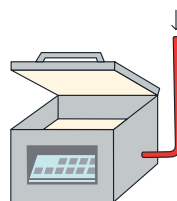
The tray sealer can be operated manually, semi-automatically (illustrated here) or continuously. This machine is similar to the deep-drawing machine but the bottom trays, into which the product is put, are ready-made rather than formed during the process. A wide range of trays can be used with the tray-sealer. This type of machine can be used for most food products, e.g. ready meals, salads, meat and fish.

## Deep-drawing machine

Film is heat-formed into a tray on a lower conveyor belt and the product is then added. Air is extracted, gas injected and the loaded package is sealed by welding on a film from an upper conveyor belt. This machine is suitable for meat, fish and prepared food.

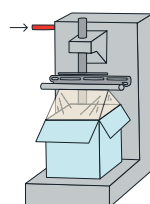
## Vacuum chamber

The product is inserted into prefabricated bags or trays. The packages are placed in a chamber from which the air is extracted and the pressure equalised with gas. The packages are then sealed by welding. This machine type is suitable for small production volumes at a relatively low cost.



## Bag-sealing machine (bag-in-box)

Prefabricated bags are filled with product. A snorkel probe is introduced into the bag and air extracted. Gas is then fed in, the snorkel is removed, and the bag is sealed. This type of equipment is used for large packages of meat, poultry and fish, for example.





## FAQ's

### Food

#### How long can a Modified Atmosphere Packaging (MAP) system extend shelf life?

That depends on many factors. Product type, temperature, hygiene, packaging and gas mixture all influence shelf life. With the right mix, it can be increased by days – even weeks. For more information, see the relevant section in this brochure.

#### Can I freeze a product which is packed in a modified atmosphere?

You can, but as it thaws, the product will lose liquid. This will cause it to look unappetising if it remains in the sealed package. You should also ensure that the packaging material is suitable for freezing.

#### There is there a white substance on the sausage that easily comes off. What is it?

This white substance is made up of calcium compounds or salt (not table salt). It comes from the product as a result of its high residual oxygen level. By controlling the residual oxygen, it can be reduced or eliminated.

#### There are some pale grey (almost white) spots on the smoked sausage. The sausage has been rinsed, cooled in a cryogenic freezer and then packed in MAP. How can I prevent this?

There may be a number of reasons for these spots. It could be down to a localised low temperature area arising during the cooling process prior to slicing. Cryogenic freezing can also cause bleaching. Contact your application engineer to check the freezer. Adjusting the process may stop this.

#### Which gas or gas mixture can I use to prevent a greenish tinge on the ham I produce?

This colouring is caused by bacteria which grow naturally during processing. No gas or gas mixture can change this.

#### The meat I pack under MAP loses its colour, but the colour reappears after I open the package. Am I using the right gas mixture?

The myoglobin molecule which is responsible for the colour of meat and meat products, turns different colours with different gas mixes. For recommendations on the right gas mixture for your product, please see the relevant section in this brochure.

#### The sliced meat we pack under MAP turns grey. Sometimes there are different-coloured spots on the meat. Could this be caused by a wrongly filled gas cylinder, or is it a common problem with any gas mixture?

The gases and mixtures in the Afrox Food Fresh cylinder range are controlled constantly and the wrong labelling or filling of a cylinder is almost impossible. The grey spots could be the result of a number of factors. For example, the packaging film's UV filter may have been changed and no longer match the light exposure; the additive mix could have changed or the production process altered. Even raw ingredients like water and meat can vary. It could be that the optimum gas mixture is not being used; there is an excessive residual oxygen level in the package; or condensation (water that has been released from the food product and condensed within the pack) has fallen from the lid. Consult your Afrox technical specialist for advice.

#### When I open the food pack, there is a smell. Why is this?

Each product generates its own odour which is made up of the many volatile compounds that collect in the headspace of the package. Wait for a minute after opening: if the smell has not gone away, check the quality.

#### Which gas or gas mixture should be used to ripen meat?

Meat can be ripened in mixtures of carbon dioxide (CO<sub>2</sub>) and nitrogen (N<sub>2</sub>). The exact mixture depends on the type of meat and how it is sliced.

### Gas

#### Which gas mixture should I use?

This depends on the type of food product, the shelf life you want and the target market. For specific information, refer to the MAPAX brochure and your local Afrox sales and technical representatives. Tests may be needed to decide the optimum mixture.

#### I am just starting out with MAP. What equipment do I need?

Most processes require a regulator, a flow meter and a selection of pipes and tubing at the very least. Start with Food Fresh premixed single cylinders. Your local Afrox sales and technical specialist can advise on the right selection and set-up for your MAP equipment.

#### Is it better to purchase pre-mixed cylinders or to buy individual gases and mix them on site?

This depends on the volume and the type of production. If the volumes are large or your plant produces different products with different gas requirements, it could be better to mix on site.

#### Where should I place the cylinders I am using?

Ideally you want them out of the processing area for quality and hygiene reasons. Please refer to your local regulations.

#### What gas pressure do I need?

This depends on the type of machine and the type of product. Consult your machine manufacturer as well as your local Afrox sales and technical representatives.

#### As I use more gas, will cylinders become a more expensive option?

Yes. As your business grows, so will your gas consumption. Your Afrox sales and technical specialist can help you determine when the time is right to switch from cylinders to a bulk tank operation.

#### What about employee safety?

We provide safety training courses and relevant safety data sheets. Each country has its own regulations for the safe use of gas. These must be followed and integrated into your quality assurance systems.

#### What precautions should be taken when using high-oxygen gas mixtures?

Please contact the machine supplier to check whether the machine is suitable for high-oxygen gas mixtures.

### What do the different gases do?

Carbon dioxide delays the growth of micro-organisms by dissolving into the food. Nitrogen is used to replace oxygen and thereby slow deterioration. It is also used as a buffer gas. Oxygen is used to maintain the red colour of meat and to allow respiration in fruit and vegetables. The gas mix is usually tailored to suit different product needs.

### Why should I use food grade gases?

Industrial gases do not satisfy legal requirements relating to the quality, labelling and handling of gases as additives. Food grade gases do.

### Packaging

#### Does the packaging have to be labelled with the words 'MAP packaged'?

The consumer act stipulates that if the durability of a food has been extended by being packaged in a permitted packaging gas, it must carry the words 'packed in a protective atmosphere'.

#### What head space (gas volume) is used in the package?

That depends on the food product and type of package. For example the gas volume/product volume ratio lies between 0.5 for sausages and 2.0 for fish.

#### I get condensation in my packs. What is wrong?

The most likely reason is the difference between the product temperature and the storage temperature. Packaged product visibility can be improved by using anti-fogging films. The product should always have the lowest possible temperature at the moment of packing and be kept at the same temperature or lower during storage. Condensation could also occur if the package is punctured. Also check the residual oxygen level.

#### The packages blow up over time. Is the product fermenting?

This is nearly always due to carbon dioxide generated by the product. It can be caused by the temperature being too high (>4°C) over a period

and cannot be reversed by cooling the product. Some foodstuffs, such as hard cheeses, develop carbon dioxide through natural fermentation. This process can continue after packing and cause 'blow-up'. Contamination can also lead to the development of unwanted gases and package expansion. Check immediately with your food lab.

#### Why do MAP packages collapse?

This is a normal occurrence with high water content products. Carbon dioxide in MAP mixtures dissolve easily in the water and fat phases of products kept at low temperatures. The amount of carbon dioxide in the headspace decreases and creates a small degree of 'under pressure' inside the package.

#### How do I know that I have the right gas volume and mixture in the package?

There are several types of gas analysers on the market. They are easy to use and give quite accurate answers on mixture and residual oxygen levels. It is important to establish best practice monitoring regimes in order to avoid large amounts of produce being packed incorrectly.

#### Why does the residual oxygen level in the package increase over time?

There are several reasons why this may happen. There could be a leak in the package or the oxygen barrier may not be high enough. Moreover, air (containing 21% oxygen) may have been trapped within the product during packaging (cakes and bread for example). That said, the most common reason is a leak in the seal.

#### How much residual oxygen is recommended in the package?

This depends very much on the product. Consult your Afrox sales and technical specialist.



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