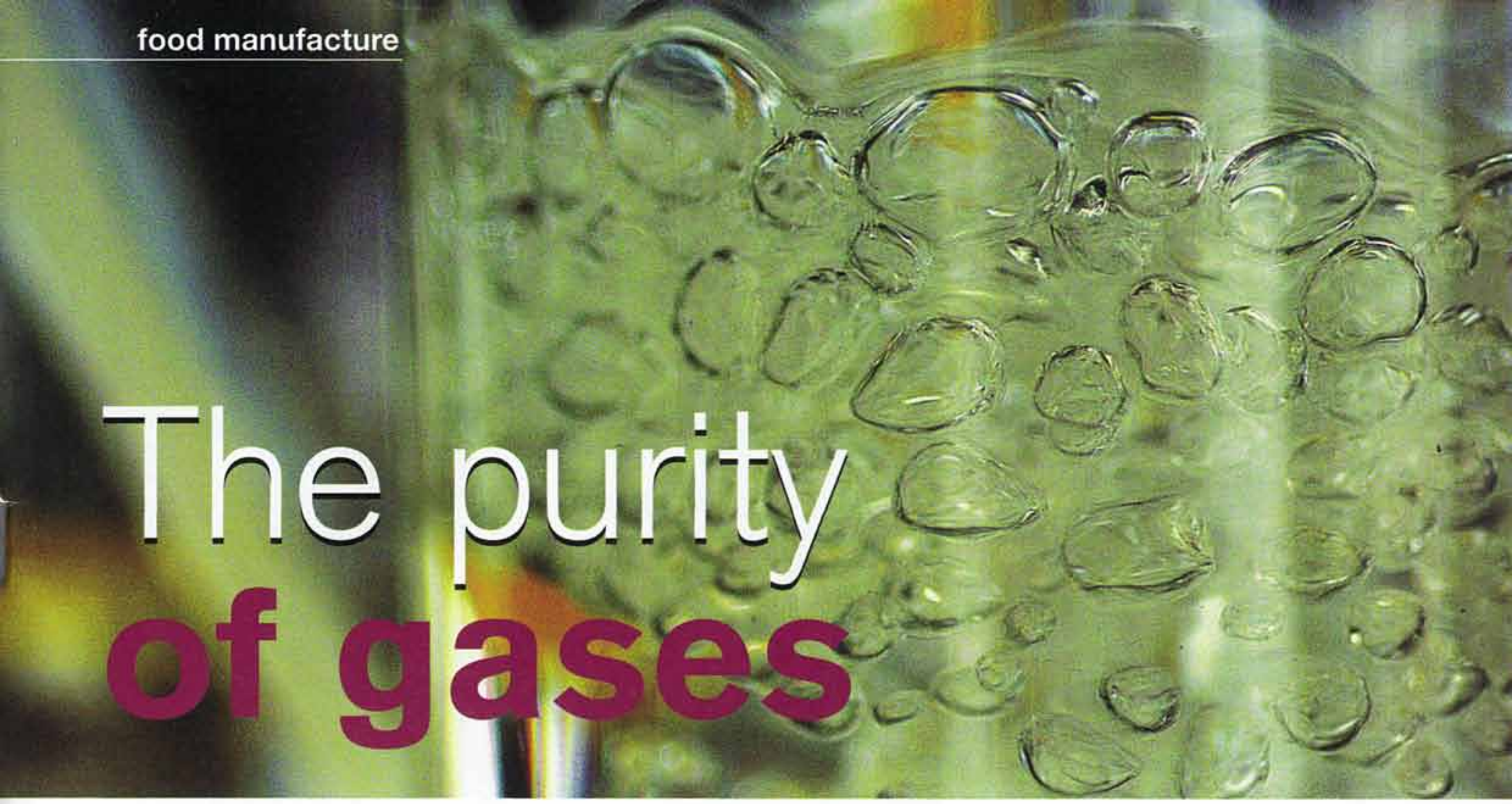

The purity of gases

Gases have become an essential part of the food production process. **Linde Gas** looks at the importance of gas purity and traceability in its use either as part of the product, for increasing pack shelf life, or for the equipment used in food analysis

Food production, transport and storage in the 21st century are guided by standards and regulations from the farm to the fork, with the onus on suppliers to demonstrate to retailers and consumers that their product safety, quality and legal obligations have been met in full.

As international legislation and country-specific regulations governing food production and handling continue to tighten, the specialist gases and gas equipment used in the food production arena have become increasingly sophisticated in response to these standards.

Food grade gases are those used as a processing aid or additive to ensure that manufacturers comply with the relevant standards. Any gases that come into contact with food must not add any toxic or dangerous contaminants. Gas applications in the food and beverage sector fall into one of three categories: food additives, food processing aids and food ingredients.

As the European Commission (EC) and Food Standards Australia and New Zealand (FSANZ) both define "food additives" as substances not normally consumed as food itself, but which are added to food intentionally for a specific purpose, such as food preservation, additives include gases.

Both the EC and FSANZ set minimum purity criteria for gases when used as food additives – including gases such as carbon dioxide (CO_2), nitrogen (N_2) and oxygen (O_2). Each must be approved under law and assigned a food additive number code – for example, E941 for nitrogen – indicating that it has been assessed for use within the EU (the "E" prefix stands for Europe). Also, JEFCFA (Joint FAO/WHO Expert Committee on Food Additives) publishes minimum specifications for food gases.

Gases are regarded as processing aids when used during the processing of a food, e.g. when liquid N_2 is used for freezing and CO_2 for freezing and chilling, and during the packaging of products such as bread and meat, during storage and for ripening fruit and vegetables in controlled atmospheres, but are not themselves consumed as part of the foodstuff. In this case, the European Industrial Gases Association (EIGA) says the only legal requirement is that the gas should not leave residues in the product that would present a health risk.

A gas is described as a food ingredient when used in the preparation of a food and is still present in the final product, even in an altered form, for instance, in the carbonation of beverages. No specific purity criteria are set under EU law for the use of gases as an ingredient, although any food additive criteria set for the gas could be relevant together with general food safety and hygiene legislation.

Gas quality control in the food sector is getting tighter

The International Society for Beverage Technologists (ISBT) also lays down guidelines for responsibilities of gas producers supplying the carbonated drinks industry. CO_2 producers must identify, measure and control all listed impurities at acceptable levels in their final CO_2 product.

"The critically important role played by gases in food production is very plainly indicated by the surprising and shocking fact that more than half the food grown in the ground is lost and wasted on its way through the food supply chain," says Linde Gases' Steve Harrison, head of Specialty Gases and Specialty Equipment.

Cutting spoilage

"Some of that wastage is through over-preparation, but much is a result of spoilage. The primary motivation for using gases is to increase the amount of food produced that is successfully consumed at the end of the supply chain. Gases are able to minimise food wastage significantly – during and after production, in transit and on the shelf.

"In the early stages of the supply chain, gases are used to control certain processes that make food spoil. Gases such as N_2 and ethylene are used to control the ripening of tomatoes and bananas. Food gases prevent the produce ripening in transit and then stimulate the ripening process once it gets to the retailer. This means less wastage in transit."

Preservation and temperature control are other essential applications for gas in the food industry. Notably, liquid N_2 and CO_2 are used to preserve food – frozen or chilled – to help keep it fresh over the period from production to consumption.

To prevent external factors – such as hygienic conditions while processing and temperature – giving rise to loss of natural freshness and quality, the gas industry developed the food preservation concept of Modified Atmosphere Packaging (MAP), preferably applied in cleanrooms. Through the use of natural gases and adequate packaging materials and machines, the quality of foodstuffs is maintained and their shelf life enhanced.

MAPAX from Linde Gas is a tailor-made MAP product offering based on the necessary data relating to foodstuffs, gases and packaging. It relies on close co-operation between the suppliers of the packaging material, the packaging machines and the gases. The purpose of this collaboration is to produce efficient and cost-effective packaging of foodstuffs, with consistent product quality throughout the entire distribution chain – from the packaging itself to attractive display.

The US FDA defines a modified atmosphere as one that is created by altering the normal composition of air (78% N_2, 21% O_2, 0.03% CO_2 and traces of noble gases) to provide an optimum atmosphere for increasing the storage length and quality of food. This can be achieved by using controlled atmosphere storage (CAS) and MAP. Under CAS the atmosphere is modified and these conditions are maintained throughout storage. MAP uses the same principles as CAS, but it is used on smaller quantities of produce and the atmosphere is only initially modified.

Gas is supplied to the food industry in a variety of ways. For high volume use of food chilling, gases such as liquid N_2 and liquid CO_2, bulk road tankers deliver large storage tanks to customers' premises. For lower volume requirements, gases are transported and supplied in cylinders, which are also used to supply gases with a much higher purity specification or pre-mixed gas blends. Liquid gases with a low vapour pressure can also be supplied in small cylinders, such as chemical type gases like sulphur dioxide (SO_2) for wine preservation and sterilisation or the refrigerant gases used to run food chilling and freezing systems.

One of the main differentiators between food grade gases and gases for industrial use is the traceability factor. Traceability refers to the recording, by means of barcodes and other tracking media, all movement of the gas from production to end user. This can be a critical factor in instances where an issue of contamination arises and a recall is required. Where traceability has been closely adhered to, it is possible to identify, by precise date/time and exact location, which goods must be recalled and which are safe.

Specialist gases used for food analysis in labs around the world have to be of high purity

Food safety requires scientific monitoring to ensure the safe handling, preparation and storage of food. Quality and consistency are also primary outcomes in food production that have driven the development of scientific food analysis methods and instrumentation to highly advanced levels.

Advanced analysis

Specialist gases are used for food analysis in labs around the world. Gases are also used with gas chromatography mass spectrometry (GC/MS) and liquid chromatography mass spectrometry (LC/MS) systems to verify ingredients such as sweeteners, colourings, aromas, the addition of glycerol, any undeclared additives, to identify isotopic profiles and to assess whether flavours are natural. They play an important role in the assessment of fat and protein content and assist with the complex testing of flavour and aroma compounds.

"Today, sophisticated technology protects food consumers from risk of illness from contaminated foods," says Harrison. "Laws and regulations have tightened up considerably and food analysis techniques are advancing rapidly to the point where profiling to determine the origin of ingredients is on the way.

"In the wake of the melamine-tainted milk incident in China, the FDA has instituted analytical methods to detect melamine levels as low as 0.25 parts per million (ppm). Analysis down to 0.25ppm is made using LC-MS/MS. The GC/MS method is used for screening the presence of melamine and analogues.

These sophisticated analytical techniques were developed by regulatory and compliance labs specifically to identify the presence of melamine and have now become a standard methodology. Inductively coupled plasma mass spectrometry, used for trace element analysis, is also coming to the fore. These techniques require high purity specialist gases with very low levels of impurities."

In addition to cylinder supplies of all high purity gases for analytical instrumentation, Linde supplies lab gas generators to create high purity gases for analysis, especially N_2 for LC-MS and hydrogen for gas chromatography and its associated detectors.

"It's critical to monitor food quality at a variety of different control points, from the supply of individual ingredients, through the manufacturing process and during distribution," says Linde's Katrin Åkerlindh, global product manager, Specialty Gases.

"For these purposes, Linde's HiQ lab nitrogen generators are ideal for use with mass spectrometers, while our combined hydrogen and air laboratory gas generator for gas chromatography is also ideally suited to food analysis."

Complementing the specialist gases, Linde's Redline gas supply system for high-purity gases and specialist gases is a modern, carefully designed range of regulators, panels, valves and gas control equipment.

"Distribution systems for high-purity specialist gases have to match up to increasing demands for high standards of performance, new analytical methods and production refinements," says Åkerlindh. "Impurities occurring in just a few ppm, or ppb within gas equipment, can have serious consequences. Components must also be capable of dealing with high and low pressures, large and small flows and must be suitable for high-purity inert gases as well as reactive, flammable, corrosive or toxic gases."

Production and handling of food grade gases must also adhere to regional and national regulations, such as those set by the US FDA, by the Australian Food Standards Code and by EU regulations and directives in Europe.

Generally Recognised as Safe (GRAS) is an FDA designation that a chemical or substance added to food is considered safe by experts. When use of a substance does not qualify for the GRAS exemption, the use of that substance is subject to the premarket approval mandated by the Federal Food, Drug and Cosmetic Act food additive tolerance requirements. GRAS is often used to specify equipment requirements for pharmaceutical applications, as well as food. Legislation affecting equipment that delivers gases to food will soon come into play in Europe and will have far-reaching implications for the industry.

Tighter controls

"This equipment needs to be demonstrated to be fit for purpose in terms of cleanliness and quality, to handle food gases," says Harrison. "In the past, nothing stopped users utilising other equipment to deliver food gases. So this is a new development for Europe which is similar to recommendations being made in the USA."

In addition to legislation, the gas industry also adheres to self-imposed standards and best practice guidelines. "The best way to explain how the gas industry approaches issues of purity is to describe it as a pyramid of quality control," says Harrison. "At the bottom are the gases used for basic technical applications such as welding. Moving up this quality control pyramid, the area governing food preparation and processing would be in the middle, with medical or semi-conductor gases right at the top since traceability and specification of gases is essential.

"The legislation that governs quality increases rigorously as you go up the pyramid. So with the general technical gases, we would rely on QA in our own processes to determine quality and purity. In the middle tier, we conduct batch analysis and batch traceability to ensure this, and further up the quality control pyramid, individual cylinders or every delivered batch is analysed, alongside an external audit of quality procedures."

Harrison adds that ever-tightening legislation has seen gases for the food industry being elevated into a realm previously reserved for pharmaceutical gas quality control.

"We feel it's timely that the quality guidance and regulations pertinent to food gases are coming closer to what has been in place for many years in pharmaceutical gases," he says. "This is also a trend taking place in regard to the equipment that delivers the gases from the supply sources to the food itself." **CT**

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