WHITE PAPER

Food and Beverages – The Hidden Dangers From Production To Table

Manufacturing any products on an industrial scale presents industry-specific hazards and risks. The food and beverage industry is no exception. Over the 2019/20 period, 2.8% of all non-fatal workplace injuries occurred in the food and beverage manufacturing industry.

The food and beverage (F&B) industry includes the production process of edible and drinkable consumables from start to finish. The process covers everything from sourcing and processing raw food materials through to packaging them and distributing them to retail outlets.

During each stage and in each production sub-group, there are hazards and risks present. One of the most substantial risks is that of accidental toxic gas exposure or flammable gas explosion. In the food and beverage industry, many toxic and flammable gases are used in a variety of industrial processes.

In this whitepaper, we will look at some of the specific risks posed by hazardous gases in the food and beverage industry and the steps you can take to mitigate those risks.

CROWCON
Detecting Gas Saving Lives

Minimising the risks posed by gas during the production, storage, and transportation of food and beverage items

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The food and beverage (F&B) industry includes the production process of edible and drinkable consumables from start to finish. The process covers everything from sourcing and processing raw food materials through to packaging them and distributing them to retail outlets.

Please note that the F&B industry does not include the farming of raw ingredients, as these are considered to be part of the agriculture sector.

The F&B industry includes many global companies which are household names such as Nestle, Kraft Heinz, Danone, Coca-Cola, PepsiCo, Budweiser, etc. Large global F&B brands often own dozens or hundreds of large manufacturing facilities around the world to serve local markets.

- **Primary food processing** – converting raw foodstuff into commodities or ingredients, such as milling wheat into flour or churning milk into cream or cheese.
- **Secondary food processing** – converting ingredients into readily consumable products, such as flour into bread.
- **Tertiary food processing** – commercial production of convenience or ready-to-eat foods such as instant meals, frozen pizza, etc.

Gas Applications in F&B Industry Processes

Food Processing

Food processing involves taking raw ingredients and turning them into consumable products that are fit for human consumption by applying various methods and techniques.

The food ingredients used are either slaughtered and butchered or harvested during the agricultural stage of food production. The ingredients are then cleaned, temporarily packaged, and distributed to food processing plants.

There are four main types of food processing:

- **One-off production** – single one-off food items to meet customer needs, e.g. making a wedding cake
- **Batch production** – a small to medium quantity of food items on a product line to order, e.g. baking several batches of cupcakes for a party
- **Mass production** – large scale production of identical items, e.g. cupcakes to be sold in a supermarket
- **Just-in-time** (JIT) production – food items made to order for immediate consumption, e.g. in a restaurant or cafeteria

The processing of food typically involves preparing and mixing ingredients, before cooking them which uses flammable or combustible gas to provide the required heat. Typically, the gas used for cooking is natural gas (methane) or liquefied petroleum gas (LPG).

The cooking stage of food processing presents the highest risk of fire and explosion in the event of a gas leak, which means that it is vitally important to put gas detection safeguards in place during this stage.

Chemical Disinfection

In order to meet national and international food hygiene standards during the production of food items.

The food industry in the UK is regulated by the Foods Standard Agency (FSA) which mandates that food processing businesses thoroughly clean and disinfect ingredients and products to meet BS EN 1276 or BS EN 13697.

Cleaning products through the use of oxygen or ozone has become increasingly popular as it is a cheap, quick, and convenient way to disinfect food. Applying ozone is an effective way to eliminate pathogens and reduce the bacterial load.

Ozone is most commonly used to disinfect meat and plant-based products, as well as improving surface hygiene during food processing.

Refrigeration Facilities

The storage of perishable goods in the F&B industry relies heavily on refrigeration and freezing. The types of gas used in industrial refrigeration units has changed considerably in recent years. Traditionally, refrigerants such as fluorocarbons or chlorofluorocarbons (CFCs) were used, but since a link between ozone destruction and CFCs was made, they have been phased out and banned across the globe.

A wide range of alternative refrigerant gases are now used in the F&B industry, such as ammonia, carbon dioxide, and non-halogenated hydrocarbons such as methane.

In some cases, liquid nitrogen is used to rapidly freeze food items in a process

Gas Applications in F&B Industry Processes

Brewing and Drinks Industry

The brewing industry commonly uses nitrogen, oxygen, and carbon dioxide during the brewing process.

For alcoholic drinks such as wine and beers, their core natural ingredients are left to ferment, which gives them their unique flavour and alcohol content. The fermentation process also creates CO_2 gas which must be carefully ventilated and can pose a hazard if equipment failure results in a gas leak.

CO_2 can also be replaced, giving beer or soft drinks their distinct bubbles and 'head' – a process known as 'forced carbonisation'. The process involves using a cylinder of compressed CO_2 gas that gives more control and ensures consistency across every product. Due to the complex hoses, connectors, regulators, and bottles, this process poses a risk of CO_2 leakage. This is especially true if it takes place in an unventilated cellar, as the gas will be unable to escape and won't be detected without specialist equipment.

Wine makers often apply a gas mixture of carbon dioxide and nitrogen to eliminate any oxygen in the liquid, helping to enhance and preserve the flavour and colour of the wine.

Packaging, Transport and Dispensing

Food packaging is used in the F&B industry to extend the lifespan of perishable items, allowing them to be transported and distributed over longer distances.

Nitrogen gas is often used to preserve food within packaging. Bags of potato crisps or crackers are often inflated with nitrogen before being sealed to stop the contents from going stale, soggy, or rotten.

Nitrogen is the most commonly used gas in food packaging as it quickly removes oxygen and moisture, without leaving any adverse taste or odour.

Gas Risks In The F&B Industry

In this section, we will identify the main gas risks in the production of goods in the F&B industry and how the risks are managed through health and safety legislation.

Carbon dioxide CO_2

Carbon dioxide is used frequently in the F&B industry, especially in the carbonation of beverages. At low concentrations (0.04%volume/ 400ppm), CO_2 is relatively harmless and non-hazardous to human health.

However, if the concentration of CO_2 rises it can cause unpleasant side effects such as headaches, confusion, dizziness, and unconsciousness. If the concentration of CO_2 reaches very high levels, it can even cause asphyxiation and death due to the complete displacement of oxygen from the air.

HSE guidance EH40/2005 Workplace Exposure Limits states that the safe workplace exposure limit for CO_2 over a long period of time (8 hours or more) is 5000 parts per million (ppm) and for shorter exposure (approximately 15 minutes) the limit is 15000 ppm.

For reference, background levels of CO_2 in the atmosphere are ~0.04%volume (400ppm), so a functioning CO_2 detector will read that in ambient conditions.

Nitrogen (N)

Nitrogen makes up ~78% of the air we breathe, so isn't normally dangerous in our daily lives. Nitrogen is commonly used in the F&B industry for a variety of purposes including preparation of beverages and food packaging.

Nitrogen is relatively harmless in ambient air, but causes oxygen depletion in enclosed spaces and can cause asphyxiation. This most commonly happens when there is equipment failure and a gas leak occurs.

Liquid nitrogen is a liquefied gas that can cause damage to uncovered skin, known as 'cold burns'.

Management and control of nitrogen and inert fluids such as liquid nitrogen is covered by HSE legislation: Control of Substances Hazardous to Health Regulations 2002 (SI 2002/2677), Regulations 6, 7 and 13 (COSHH)

Ammonia (NH_3)

Ammonia is commonly used to disinfect food products due to its microbial properties. It is also frequently used as a refrigerant in the F&B industry.

A solution of ammonia, known as ammonium hydroxide, is used when processing foodstuffs such as beef products, cheese, chocolate and some baked food items.

Exposure to ammonia can be hazardous to health, causing lung damage and airway burning and swelling. In high concentrations, ammonia can be fatal when inhaled. Above 14.8% volume concentration, ammonia also presents a fire and explosion risk.

EH40/2005 Workplace Exposure Limits states that the safe workplace exposure limit for anhydrous ammonia over a long period of time (8 hours or more) is 25 parts per million (ppm) and for shorter exposure (approximately 15 minutes) the limit is 35 ppm.

Carbon monoxide (CO)

Carbon monoxide is created as a byproduct of combustion and can be present in some food processing activities such as cooking. CO levels can reach poisonous levels in the air if left unchecked, especially in large industrial cookers and confined or poorly ventilated spaces.

If a high concentration of CO is inhaled by humans over a long period, it can cause loss of consciousness and death.

The HSE has released guidance to help prevent exposure to carbon monoxide in commercial kitchens. COSHH regulations state that CO gas risks need to be reduced to acceptable levels.

EH40/2005 Workplace Exposure Limits exposure limits for CO over the long-term (8 hour) exposure limit is 20 ppm and short-term (15 minutes) is 100 ppm.

Gas Risks In The F&B Industry

Hydrogen chloride (HCl)

Hydrogen chloride gas can cause mild to severe irritation to the skin, throat, nose, and eyes, even at a low concentration in the air. Hydrogen chloride is often mixed with calcium carbonate to create a common food additive called calcium chloride.

EH40/2005 Workplace Exposure Limits exposure limits for HCl over the long-term (8 hour) exposure limit is 1 ppm and short-term (15 minutes) is 5 ppm.

Hydrogen cyanide (HCN)

Hydrogen cyanide is a highly toxic gas that can harm the human brain, heart, lungs, and blood vessels. Exposure to HCN can prove fatal, especially in high concentrations. Even low concentrations in the atmosphere can cause harm and injury, especially in poorly ventilated or confined spaces.

EH40/2005 Workplace Exposure Limits exposure limits for HCN over the long-term (8 hour) exposure limit is 0.9 ppm and short-term (15 minutes) is 4.5 ppm.

Hydrogen sulphide (H_2S)

Hydrogen sulphide is commonly produced as a byproduct of many bacterial processes. During winemaking or brewing, as the yeast ferments the fruit or grain, H_2S is released and gives off a rotten egg or sewage type of odour. Exposure to H_2S may cause respiratory and eye irritation, and at high concentrations headaches, dizziness, nausea, and loss of consciousness.

EH40/2005 Workplace Exposure Limits exposure limits for H_2S over the long-term (8 hour) exposure limit is 5 ppm and short-term (15 minutes) is 10 ppm.

Nitrogen dioxide (NO_2)

NO_2 is frequently used in food processing. A highly dangerous and reactive gas, it is mostly used as a disinfectant due to its antimicrobial properties.

In raised concentrations, NO_2 may cause skin, eye, and respiratory irritation.

EH40/2005 Workplace Exposure Limits exposure limits for NO_2 over the long-term (8 hour) exposure limit is 0.5 ppm and short-term (15 minutes) is 1 ppm.

Phosphine (PH_3)

Phosphine is usually used in the agricultural stage of food production as an effective fumigant or pesticide. In dried food and cereals, it can survive the processing and packaging process, so it needs to be detected and controlled during industrial processes.

Phosphine is highly toxic to humans and can cause nausea, vomiting, diarrhoea, muscle cramps, and respiratory problems, even at relatively low levels.

EH40/2005 Workplace Exposure Limits exposure limits for PH3 over the long-term (8 hour) exposure limit is 0.1 ppm and short-term (15 minutes) is 0.2 ppm.

Combustible gases

Combustible gases (also known as flammable gases or fuel gases) are ones that can burn in the air. Examples of combustible gases include methane, butane, acetylene, ethylene, propane, propylene, etc.

Combustible gases are most commonly used during the cooking and preparation of food during the processing stage. These gases can present explosion and fire risks if they are not used or stored correctly. Control of Substances Hazardous to Health Regulations 2002 (COSHH) contains information on how to safely store, use, and monitor combustible gases.

EH40/2005 Workplace Exposure Limits exposure limits for NO_2 over the long-term (8 hour) exposure limit is 0.1 ppm and short-term (15 minutes) is 0.2 ppm.

Oxygen enrichment

Oxygen enrichment can be used to reduce oxygen deficiency in food and beverages and to accelerate certain processes, such as fermentation in the brewing and winemaking industries. The oxygen creates an ozone layer during the process.

The main hazard posed by oxygen enrichment and ozone is the increased risk of fire. Even a small spark can quickly escalate to a large-scale fire in an oxygen rich environment, especially in an enclosed space.

Ozone exposure can cause headaches and respiratory problems. Long-term exposure has been linked to the onset or worsening of asthma, which means that HSE set a zero limit for long-term exposure.

EH40/2005 Workplace Exposure Limits exposure limits for ozone over the short-term (15 minutes) is 0.2 ppm.

Gas Detection Devices

The HSE Control of Substances Hazardous to Health Regulations 2002 state that risks posed by toxic or flammable gases need to be managed carefully and consistently.

Gas detection equipment and products are a highly effective way to identify gas leaks and to monitor the concentration of potentially harmful gases in the atmosphere.

The following gas detection devices are ideal for managing gas hazards in the food and beverage industry
Portable solutions including the T4, Gas-pro, Gasman, and T3 provide peace of mind for organisations with workers operating within environments that produce HCN, HCL, H_2S, NO_2, PH_3, combustible gases and oxygen enriched environments. Fixed detection products include the Xgard and Xgard Bright, while the Vortex control panel and our range of addressable controllers also help to protect employees from hazardous gases in an efficient manner. For more information about gas detection solutions for the food and beverage industry and the steps you can take to mitigate those risks or to ask further questions get in touch today.