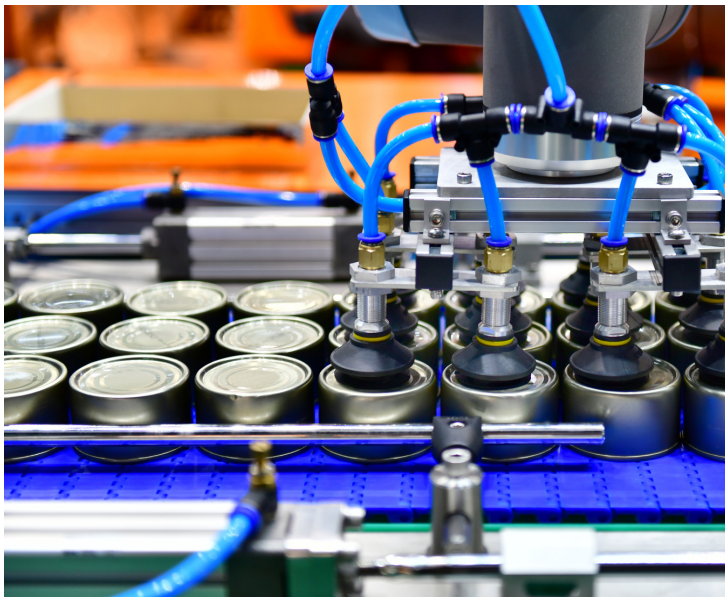
APPLICATION SERIES

PROCESS COOLING IN THE FOOD AND BEVERAGE INDUSTRY

Process cooling equipment is an essential component of many food and beverage production and packaging processes. The equipment is used to regulate temperatures during various stages of manufacture to ensure that food and beverages are safe, high-quality, and shelf stable.

In an aseptic process, cooling equipment is typically used to maintain the temperature of the product or the process equipment at a desired level. This is important because aseptic processing involves sterilizing the product and the equipment, and any deviation from the required temperature can compromise the sterility of the process. In addition to maintaining the required temperature, process cooling equipment can also help to prevent the growth of microorganisms, which is critical in aseptic processing. By keeping the temperature low, the growth of bacteria and other microorganisms is slowed down, reducing the risk of contamination.



In the food and beverage industry, process cooling equipment can range from small refrigerated units to large-scale industrial cooling systems. The specific type of equipment used will depend on the production requirements, such as the volume of product being produced, and the cooling capacity and temperatures needed.

Process cooling equipment can be used in a variety of applications, such as:

- ***Cooling of ingredients*:**
  - Process cooling equipment can be used to cool down ingredients used in food and beverage production, such as dairy products, fruits, and vegetables.
- ***Cooling during production*:**
  - During production, the equipment is used to cool down machines and equipment that generate heat, such as ovens, mixers, and grinders.
- ***Packaging*:**
  - Process cooling equipment can be used to cool down packaging materials, such as plastic bottles or cans, to prevent them from warping or deforming during the filling process.
- ***Preservation*:**
  - Cooling is used to preserve food and beverage products for longer shelf life and maintain freshness, such as in refrigeration and freezing.




The use of recirculating chillers in the food and beverage industry

One common application of recirculating chillers in the food and beverage industry is in the production of chocolate. Chocolate requires a specific temperature range during various stages of production, including melting, tempering, and moulding. During the tempering process, recirculating chillers are often used to maintain a consistent temperature, which is critical in producing chocolate with a smooth texture and glossy appearance. Throughout tempering, the chocolate is heated and cooled to specific temperatures in a controlled manner, and a recirculating chiller is used to remove excess heat during the cooling phase to prevent the chocolate from solidifying too quickly.

Another application of recirculating chillers in the food and beverage industry is in the production of beer and other alcoholic beverages. During the fermentation process, yeast produces heat as it metabolises sugar, and this heat must be removed to maintain the optimal temperature for fermentation. A recirculating chiller can be used to remove this heat and maintain a consistent temperature, which helps to ensure a consistent flavour and alcohol content in the finished product.

In the brewing industry, recirculating chillers are commonly used for a process called “cold crashing”. Cold crashing is a technique used to clarify beer by rapidly dropping the temperature of the beer to near-freezing temperatures. This causes any remaining yeast or other suspended particles to settle to the bottom of the fermentation vessel, making it easier to siphon off clear beer.

Recirculating chillers are also used in the production of dairy products, such as yogurt and cheese, to control the temperature during the heating and cooling stages. In addition, they are used in the production of sauces and dressings to maintain a consistent temperature during mixing and cooking.

The use of recirculating chillers can be essential in ensuring the consistent quality and safety of products produced. By controlling the temperature during various stages of production, manufacturers can produce products with a consistent taste, texture, and appearance that meet the high standards of the industry and consumers.

The use of airblast coolers in the food and beverage industry

Airblast coolers are commonly used in the food and beverage industry to cool down various products and ingredients quickly and efficiently. These coolers work by forcing air over heat transfer fluids which remove heat from the process, which is then blown away by the cooler's fans.

Some common applications of Airblast coolers in the food and beverage industry include:

Cooling baked goods

- Airblast coolers can be used to quickly cool freshly baked goods, such as bread and pastries, after they come out of the oven. This helps to prevent overcooking and maintains the product's quality.

Cooling cooked foods

- Airblast coolers are also used to cool cooked foods, such as soups and stews, before they are packaged or further processed. This helps to prevent spoilage and ensures that the food is safe to consume.

Airblast coolers offer several benefits in the food and beverage industry. They are highly efficient, allowing for rapid cooling of products and ingredients, which reduces the risk of spoilage and helps to maintain quality. They are also highly versatile and can be used for a wide range of applications. Additionally, they are relatively low maintenance.

Cooling ingredients

Process cooling equipment can cool ingredients in a number of ways, depending on the specific equipment and the requirements of the production process. Generally, process cooling equipment works by transferring heat from the ingredients to a cooling medium, such as air, water, or other heat transfer fluid.

These are some common methods used for cooling ingredients with process cooling equipment:

- ***Immersion cooling*:**
  - Products are immersed in a heat transfer fluid to maintain their temperature. This heat transfer fluid is then circulated through a chiller in order to remove heat and maintain a set temperature.
- ***Plate cooling*:**
  - Ingredients are spread out on a flat surface, such as a plate or tray, and chilled water or other heat transfer fluid is circulated underneath the surface. The chilled surface draws heat away from the ingredients and cools them down.
- ***Spray cooling*:**
  - A fine mist of chilled water is sprayed onto the ingredients, cooling them down through evaporation. This method is often used for products that are difficult to cool using other methods.
- ***Air cooling*:**
  - Ingredients are exposed to a flow of chilled air, which cools them down through convection. This method is often used for products that are dry or have a low moisture content.
- ***Vacuum cooling*:**
  - Ingredients are placed in a vacuum chamber and the air pressure is reduced, causing the water in the ingredients to evaporate and rapidly cool the product. This method is often used for leafy vegetables or delicate fruits.

The specific method used for cooling ingredients will depend on factors such as the type of product being produced, the volume of production, and the cooling capacity of the equipment.

Immersion cooling

Immersion cooling is a technique used in the food and beverage industry to maintain the quality and freshness of products by keeping them at a specific temperature during production and storage.
In immersion cooling, the product is immersed in a cooling medium to maintain its temperature. The cooling medium is then circulated through a chiller to remove the heat and maintain the desired temperature.

Process cooling equipment, such as a recirculating chiller, can be used to cool the cooling medium, such as water or glycol, which is then used to cool the product being immersed. The cooling medium, or heat transfer fluid, is circulated through a closed loop in the chiller to remove heat from the immersion cooling process.

The recirculating chiller helps to maintain the temperature of the cooling medium at a constant level, ensuring that the product being cooled remains at the desired temperature. This helps to ensure that the product quality is maintained, and spoilage is prevented, resulting in longer shelf life and reduced waste.

Cooling ingredients

Plate cooling

Plate cooling is a common method used in the food and beverage industry to rapidly lower the temperature of food and beverages, which helps to preserve quality and freshness.

In plate cooling, process cooling equipment, such as a recirculating chiller, is used to cool a flat plate or surface, which is then brought into contact with the food or beverage product to quickly lower its temperature.

The basic principle behind plate cooling is that the heat is transferred from a warmer object to a cooler object through direct contact. In plate cooling, the heat transfer fluid in the plate absorbs the heat from the product, causing the product to rapidly cool down. The heat transfer fluid is then circulated back to the chiller, where it is cooled down again before being circulated back through the plate.

The plate itself is typically made from a highly conductive material, such as copper or aluminium, which allows the heat to be quickly and efficiently transferred from the heat transfer fluid. The plate may also have a series of channels or grooves to increase the surface area and improve the heat transfer efficiency. Plate cooling is commonly used in the food and beverage industry to quickly cool down products such as sauces, soups, juices, and dairy products, among others. It is a highly effective and efficient cooling method that can help to preserve the quality and safety of these products.

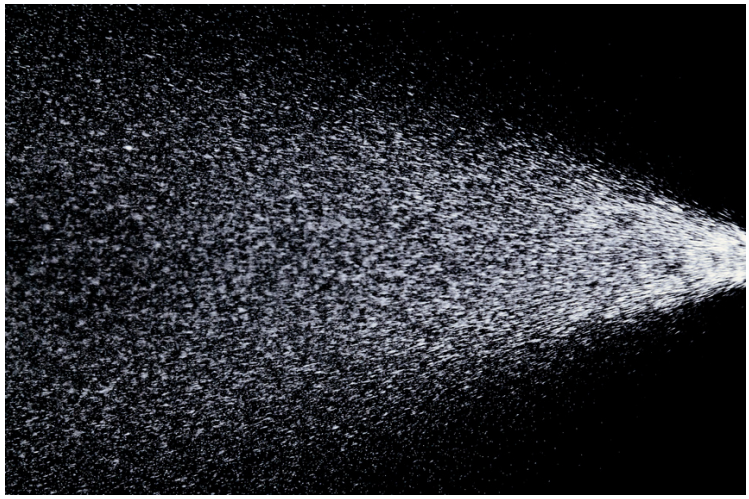
When making candies and sweets, the mixture of sugar, water, and other ingredients needs to be heated to a specific temperature to dissolve the sugar and create the desired consistency. Once the mixture reaches the desired temperature, it needs to be cooled rapidly to stop the cooking process and prevent the candy from becoming overcooked or burnt. Process cooling equipment can also be used to maintain the temperature of the candy mixture during the cooling and moulding process to ensure that the candy sets properly and has the desired texture.

Cooling ingredients

Spray Cooling

Spray cooling is a commonly used method in the food and beverage industry to rapidly cool down hot products or ingredients. This process involves spraying a chilled liquid onto the surface of the product, which effectively transfers heat from the product to the liquid and results in a rapid reduction in temperature.

Chillers are commonly used in spray cooling systems to provide the chilled liquid. This is done by circulating a heat transfer fluid through a closed loop system, which is cooled down by a compressor and heat exchanger. The chilled heat transfer fluid is then circulated through a heat exchanger in the spray cooling system, where it absorbs heat from the hot product and returns to the chiller to be cooled again.



The benefits to using spray cooling in the food and beverage industry are numerous. For example, it can help to preserve the quality and integrity of products by quickly cooling them down, which can reduce the risk of spoilage or contamination. It can also improve production efficiency by reducing the amount of time needed for products to cool down before further processing or packaging.

Some examples of where spray cooling might be used in the food and beverage industry include cooling down hot liquids such as soups or sauces, chilling hot ingredients such as chocolate or caramel, or rapidly cooling down cooked products such as meats or vegetables.

Cooling ingredients

Air Cooling

Air cooling is a common method of temperature control in the food and beverage industry. This technique involves using a chiller, which is essentially a closed-loop refrigeration system that circulates heat transfer fluid to a heat exchanger, which removes heat from the surrounding air. The chilled heat transfer fluid is then recirculated to maintain temperature.

In the food and beverage industry, air cooling is often used to control the temperature of products during processing and storage. For example, in the dairy industry, it may be used to cool milk or cream in bulk storage tanks, while in the baking industry, it may be used to cool hot baked goods as they exit an oven.

One of the advantages of air cooling with a recirculating chiller is that it provides precise temperature control, and can achieve sub-ambient temperatures, which is critical in many food and beverage applications. The chiller can be set to maintain a specific temperature range, and the cooling rate can be adjusted to meet the needs of the particular product being processed or stored.

Another advantage of using a recirculating chiller for air cooling is that it is an energy-efficient method of temperature control. The chiller unit can be designed to use a variety of heat transfer fluids, including water or glycol, depending on the needs of the application. These heat transfer fluids can be cooled using a variety of methods, including air-cooled or water-cooled condensers, which can help to reduce energy consumption and costs.

Cooling ingredients

Vacuum Cooling

Vacuum cooling is a process that rapidly cools food and beverage products by reducing the air pressure in a vacuum chamber, which causes water in the products to boil and evaporate, thus removing heat from the products. This process is commonly used in the food and beverage industry to preserve the quality, flavour, and texture of fresh produce such as fruits, vegetables, and herbs.

One of the key components of the vacuum cooling process is a recirculating chiller. A recirculating chiller is a refrigeration system that circulates a heat transfer fluid, such as water or glycol, through a closed loop to remove heat from a process. In the case of vacuum cooling, the recirculating chiller is used to cool the vacuum pump or vacuum chamber and the products inside it.

The food or beverage product is loaded into the vacuum chamber. The chamber is then sealed, and the air inside is removed to create a vacuum. The recirculating chiller is then activated, and the heat transfer fluid is circulated through the refrigeration system. The heat transfer fluid flows through a heat exchanger where it absorbs heat from the vacuum chamber and the food or beverage product inside it.

As the heat transfer fluid absorbs heat, it increases in temperature and is then passed through the chiller's refrigeration system to remove the heat. The cooled coolant is then recirculated back into the heat exchanger, where it absorbs more heat from the vacuum chamber and the food or beverage product. This process continues until the desired temperature is reached, and the product is sufficiently cooled.

The recirculating chiller is used to control the cooling rate, allowing for precise temperature control and rapid cooling. The vacuum cooling process using a recirculating chiller can reduce the temperature of products by up to 90% in just a few minutes, preserving the quality, flavour, and texture of products, while extending their shelf life.

Packaging

Chillers are commonly used in the food packaging industry to cool down packaging materials such as plastic bottles or cans, or hot products, prior to filling. This is important because hot filling and cooling can cause the packaging material to warp or deform, resulting in product leakage or spoilage. Cooling the packaging material before filling can prevent these issues and ensure that the product remains fresh and stable.

Chillers used in the food packaging industry are typically designed for high-volume production, with a large cooling capacity and high-speed operation. The chiller can be integrated with the packaging line to provide continuous cooling for the packaging material. The temperature of the chiller can be adjusted to suit the specific requirements of the product being packaged.

Vacuum Packaging

Vacuum packaging is a method of packaging food products in which air is removed from the packaging before it is sealed. This method is used to extend the shelf life of the product by reducing the amount of oxygen present, which can cause spoilage and degradation. Chillers can be used in conjunction with vacuum packaging to ensure that the product is properly cooled before packaging, which can help to maintain its quality and safety. Vacuum pumps are often water-cooled.

The process of vacuum packaging involved placing the food product in a bag or pouch, sealing it, and then removing the air using a vacuum sealer. The bag is then sealed, creating a vacuum-sealed package that is free of air. In order to ensure that the product is properly cooled before vacuum sealing, a chiller can be used to rapidly reduce the temperature of the food product.

Packaging

Vacuum Packaging

Chillers used for vacuum packaging are designed to provide cooling, typically using a refrigeration cycle. The chiller system can be integrated into the vacuum packaging process, allowing the product to be quickly and efficiently cooled before packaging. This helps to ensure that the product is properly chilled, which can prevent the growth of bacteria and other microorganisms that can cause spoilage.

In addition to cooling the product, chillers used in vacuum packaging can also help to maintain the quality and appearance of the product. For example, rapid cooling can help to preserve the colour, texture, and flavour of fruits and vegetables, while preventing the formation of ice crystals that can damage the product.

The process typically begins with the product being loaded onto a conveyor belt or other type of feeding mechanism, which moves the product into the vacuum packaging chamber. As the product moves into the chamber, it passes through a cooling zone, which is maintained at a specific temperature using the chiller system.

The chiller system typically consists of a refrigeration cycle that uses a heat transfer fluid to absorb heat from the product. This is circulated through a series of heat exchangers, which remove the heat and transfer it to a primary cooling circuit or surrounding environment. The cooled heat transfer fluid is then circulated back through the system to absorb more heat from the product.

As the product moves through the cooling zone, it is rapidly chilled by the cold heat transfer fluid circulating through the chiller system. Once the product has been properly chilled, it moves on to the vacuum sealing stage, where it is sealed in a vacuum bag or pouch.

What other machinery is supported by process cooling equipment in the food and beverage industry?

Process cooling equipment supports a wide range of machinery in the food and beverage industry. Some of the most common types of machinery that require process cooling include:

Mixing Equipment

- This includes mixers, blenders, and agitators that are used to combine ingredients in the food and beverage manufacturing process.
- Mixers are used in a wide range of food and beverage manufacturing processes, including blending, emulsification, and homogenisation. These processes generate heat due to friction and mechanical movement, which can negatively impact the quality of the final product if not properly managed.
- Cooling is typically accomplished using jacketed vessels, which allow heat transfer fluid such as water or glycol to flow around the outside of the vessel, cooling the contents inside. By maintaining a consistent temperature, the quality of the product can be preserved, and the mixing process can be carried out more efficiently.
- The use of process cooling equipment with mixers can also help to increase production rates and reduce downtime. By maintaining consistent temperatures, the mixer can operate more efficiently, reducing the need for downtime due to equipment failures or product quality issues.

Grinding equipment:

- This includes grinders, mills, and pulverisers that are used to process food and beverage ingredients.
- Grinding is an important process in food and beverage manufacturing, as it is often used to reduce the size of food particles, enhance flavour and texture, and increase the surface area of ingredients.
- Grinding also generates heat due to friction and mechanical movement. Process cooling equipment is used to cool grinding equipment and the product being ground, ensuring that a consistent temperature is maintained throughout the grinding process.
- Cooling is typically accomplished using chilled water or glycol that is circulated through the grinding equipment.
- There are a variety of grinders used in the food industry, and the type of process cooling equipment used will depend on the specific grinder and process.

What other machinery is supported by process cooling equipment in the food and beverage industry?

Cooking Equipment

- This includes ovens, kettles, and steamers that are used to cook food and beverage products.
- Cooking is a critical process in food and beverage manufacturing, as it is used to transform raw ingredients into finished products that are safe to consume.
- During the cooking process, heat is generated by direct or indirect heating, which can impact the quality of the final product if not properly managed. It may also be necessary to remove heat from the doors of ovens for safe handling.
- Cooling is typically accomplished using chilled water or glycol that is circulated through the cooling jacket of the cooking vessel. This cooling helps to reduce the temperature of the cooking equipment and the product, preventing overheating and maintaining product quality.

Sterilisation Equipment

- This includes pasteurisers and autoclaves that are used to sterilise food and beverage products.
- Sterilisation is used to remove or kill all microorganisms, including bacteria, viruses, and fungi, to ensure the safety and shelf life of the final product.
- During the sterilisation, process cooling equipment is used to cool the sterilisation equipment, and the product being sterilised, ensuring that a consistent temperature is maintained throughout the process.
- Regardless of the type of equipment being used, process cooling equipment plays a critical role in maintaining product quality and ensuring that the sterilisation process is carried out efficiently and effectively.

What other machinery is supported by process cooling equipment in the food and beverage industry?

Conveying Equipment

- This includes conveyors, elevators, and chutes that are used to transport food and beverage products throughout the production process.
- Conveying is used to move raw materials, intermediate products, and finished products through the production process.
- During the conveying process, heat can be generated by friction, compression, or exposure to ambient temperatures, which can impact the quality of the final product if not properly managed. Process cooling equipment is used to ensure a consistent temperature is maintained throughout the conveying process, allowing the process to be carried out efficiently and effectively.

Overall, process cooling equipment plays a critical role in supporting the machinery used in the food and beverage industry. By maintaining consistent temperatures, process cooling helps to ensure product quality and safety, reduce downtime, and optimises the production process.

Heat Transfer Fluids

Several types of heat transfer fluids are used in the food and beverage industry. The type of fluid used will depend on the specific requirements of the application, such as the desired operating temperature range and the compatibility with the materials used in the system.

Some common heat transfer fluids include:

Water

- Water is a commonly used heat transfer fluid in the food and beverage industry. It is inexpensive, readily available, and has a high heat capacity, However, water has a limited operating temperature range and can freeze at low temperatures.

Propylene Glycol (Hexid)

- Propylene glycol is a non-toxic alternative to ethylene glycol. It has a lower heat capacity than water but can operate at lower temperatures without freezing. Propylene glycol is food safe.

Ethylene Glycol

- Ethylene glycol is a common heat transfer fluid used in process cooling equipment to prevent freezing. It has a higher boiling point than water and can operate at lower temperatures. However, ethylene glycol is toxic and requires careful handling and disposal.

Silicone Oil

- Silicone oil is a commonly used heat transfer fluid for high-temperature applications. It has a high boiling point and good thermal stability, but is more expensive than water or glycols.

Food-grade heat transfer fluids

- Food-grade heat transfer fluids, such as those based on vegetable oils or polyalkylene glycols, may be used in process cooling equipment in the food and beverage industry to meet regulatory requirements for food contact. These fluids are designed to be non-toxic and non-reactive with food products.

The choice of heat transfer fluid will depend on the specific requirements of the application, including the operating temperature range, heat transfer properties, and compatibility with the process cooling equipment and food products. It is important to carefully consider these factors when selecting a heat transfer fluid for a process cooling equipment in the food and beverage industry.

Standard Options

There are several control methods that may be beneficial for process cooling equipment operating within the food and beverage industry which help to ensure efficient and effective operation. Some common options include:

Stainless steel enclosure

- Use of a stainless steel enclosure allows units to be cleaned effectively to meet sanitary requirements and reduce the risk of contamination.

Castors

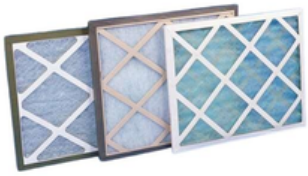
- It is likely that process cooling equipment used in the food and beverage industry will need to be cleaned regularly. By adding castors, the equipment can be easily rolled to the desired location for cleaning and maintenance, saving time and reducing the risk of injury when moving large and heavy equipment.

Mod for outdoor use

- Addition of a mod for outdoor use allows the unit to be sprayed with water for cleaning purposes.

Air Filters

- Environments within the food and beverage industry can be prone to dust and crumbs as a by-product of food production. Addition of air filters can help to protect process cooling equipment from airborne contaminants that may otherwise accumulate on the equipment, clogging components resulting in a reduction in efficiency and lifespan.



Particulate filters

- Particulate filters can be used to prevent solid particles within heat transfer fluid from entering process cooling equipment by trapping particles larger than the size of the filters. They can be installed at various points in the system to improve performance, prolong lifespan and improve process water quality.

Inline UV decontamination

- By passing process cooling water through a chamber that contains a UV lamp, it is possible to deactivate any microorganisms that are present. This provides a chemical-free way of ensuring that process water is safely decontaminated for use in the food and beverage industry.

Inline deioniser

- An inline deioniser is able to remove impurities such as minerals, salts and other dissolved solids, from the process water supply. Such impurities can negatively impact the performance of equipment and cause scaling and corrosion.

Standard Options

RS485 Comms

- Addition of RS485 communication protocol allows for continuous monitoring and logging of temperatures and alarms. This allows for remote temperature control, which is particularly useful in scenarios where process cooling equipment is located a distance from the application. RS485 communications can also send signals to trigger an alarm to send in the event of an error, allowing for the system to be shut off before any costly errors occur.
- When this option is installed, it is then possible to install a conductivity sensor, a pressure sensor, or a flow meter pack to communicate further information via RS485.

Standard Volt Free Connection (VFC) Set

- Volt free contacts operate like an ordinary switch. When required, the switch will close to allow current to flow through, triggering other systems to perform an action
- VFCs can be used to monitor alarms, allowing flow, temperature and all-OK VFCs to be communicated. In cases of high flow, temperature within a set range, or high levels, the circuit will close, causing a signal to be sent.
- It is possible to transmit other alarms via VFC, when specified and available.

Heater pack

- Addition of a heater pack provides temperature control above the norm – particularly beneficial in the production of many foods and beverages. The heater pack allows the unit to maintain a specific temperature range, which can be crucial in processes where temperature control is critical.

Low Temperature Pack

- Chillers are typically able to operate down to +4°C. The low temperature pack supplied by Applied Thermal Control is designed to maintain the temperature of the heat transfer fluid down to -15°C. When operating at these temperatures, selection of heat transfer fluid is an important consideration. Hexid is recommended for operating at these temperatures in the food and beverage industry.