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Thinking Outside the Liquid Nitrogen Freezing Box

Liquid nitrogen can improve your food manufacturing operation in ways you may have never even considered.

Brought to you by Air Products.
Over 75 years of cryogenic food freezing innovations.

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Liquid nitrogen can be used as an ultra cold gas at temperatures as low as –265° F.

Perfect for quick freezing or chilling.

Introduction

For more than a half-century, liquid nitrogen has been used to freeze and chill food products. In the food industry, liquid nitrogen is most commonly used to power tunnel or spiral freezers for the final preservation of food before it is packaged and shipped around the country. Capitalizing on liquid nitrogen's extraordinary refrigeration properties, food manufacturers use liquid nitrogen freezers to increase throughput and improve product quality. While final product freezing with liquid nitrogen remains a common process, liquid nitrogen is moving upstream in the production process, where its application is providing added benefits for food manufacturers.

Thinking outside of the "liquid nitrogen freezing" box has led to even more innovative ways of using nitrogen throughout the food production process. The following pages share unique ways food manufacturers are using nitrogen to improve both the quality of their products and the efficiency of their operations.

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Liquid nitrogen can improve your food manufacturing operation in ways you may have never even considered.

Overview

Today, liquid nitrogen is being used to remove troublesome heat from food processes up and down the production line, thereby increasing production throughput, reducing cycle times, and even helping to prevent microbial growth. In mixing applications, liquid nitrogen is used to instantly stop the cooking process in order to chill sauces and gravies, ultimately reducing cooling times. In coating applications, the low temperature of liquid nitrogen provides greater control of the enrobing process. And during grinding, liquid nitrogen can be used to eliminate frictional heat to help improve the throughput of mills and the consistency of the grind. This also helps to prevent the loss of flavor and aroma components in food additives, ingredients, and functional foods.

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Ultra cold liquid nitrogen cools very efficiently. Nitrogen injection systems can use the same or less amount of cryogen than comparable CO_2 systems thus representing a cost effective gas alternative.

Injection Cooling of Meat with Liquid Nitrogen

Direct food cooling targets liquid nitrogen at the food product. Almost all processed foods require cooling at some point in the process prior to packaging and shipment. For example, high capacity meat forming machines are used to deliver the great demand for burgers and other formed products. However, the heat generated by mixing and grinding can melt the fats, making subsequent forming of the meat product quite difficult.

Liquid nitrogen can be used to help maintain the cold temperature of the meat through a controlled injection directly into the product during mixing/grinding. The nitrogen injection is regulated to provide the cold that is required at all times, adjusting the liquid nitrogen consumption to the requirements of the process.

Injecting liquid nitrogen during processing improves the quality of the ground meat as the fat is not broken up, and the cuts are regular and even. Additionally, the mixes are more even, as the time taken to make them does not need to be shortened as the temperature increases; bacteria are inhibited by changing the contact atmosphere of the meat (eliminating oxygen); and the appearance of the meat is improved by avoiding the formation of metmyoglobin, which results from excessive exposure to the oxygen in air.

A producer of hamburger patties was having daily processing complications due to the highly variable mix of fresh and frozen beef cuts available for use in their patty forming operation. The hamburger patty producer had to be sure that the proper portions of fresh and frozen cuts were on hand in order to create their high-quality ground product. If no frozen cuts were available, or there was an insufficient amount, either the production run was cut short or the quality of the patties was diminished. However, by adding liquid nitrogen injection—with a special control system—to their mixer, the hamburger patty producer was able to create ground beef patties at consistently low temperatures.

Applying liquid nitrogen directly to a food product using a proper injection system ensures repeatable and consistent products for forming. This solution is also suitable for fish, chicken, pork and many other products.

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Applying liquid nitrogen directly to a food product using an injection-cooling system ensures repeatable and consistent products for forming or further processing. This solution is suitable for soups, sauces, mixed vegetables, fish and chicken.

Injection Cooling of Sauces with Liquid Nitrogen

Liquid nitrogen can be directly injected into flowing liquids for practically immediate cooling. Almost any product that is able to be pumped—such as sauces, gravies, marinades, custards and purees—can be chilled in-process. Typically, liquid food cooling is accomplished using relatively large scraped surface heat exchangers (continuous) or in-kettle cooling (batch). By using liquid nitrogen injection, liquid foods can be cooled from nearly boiling temperatures to packaging temperatures in just seconds.

One food manufacturer was experiencing a host of problems when trying to add a hot, cooked sauce to what would ultimately become a frozen meal. Problems included:

- Continued cooking of the sauce and other ingredients
- Moisture migration from the sauce to other ingredients in the meal
- A relatively time-consuming final freeze.

By installing a system that directly injects liquid nitrogen into the hot sauce, the food manufacturer was able to cool the sauce before adding it to the meal, with no delay in the process. The injection cooling system halted cooking and moisture migration, as well as shortened final freezing time, improving the quality of the product.

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Precision cooling can be a perfect solution for machine-component or food surface cooling applications. It directly targets cold nitrogen precisely where needed, whether it's knives/blades/fixtures or directly on food spots or surfaces.

Machine Component Cooling with Liquid Nitrogen

Machine component cooling targets extremely cold nitrogen gas at heat-generating parts in a food production process. Chilling knives, blades and other fixtures during operation decreases product build-up on these appliances, helping food processors avoid a bottleneck in their operations. In addition to increased throughput, this application also eases clean-up and can inhibit mold growth.

Targeting nitrogen at machine components can alleviate problems such as caramel sticking to cutting blades; ice cream sticking to forming molds; dough sticking to chopping knives; or product adhesion in a bowl, chopper, grinding mill, slicing machine or mixer.

For example, an ingredient producer mincing a very sticky product was having trouble with the product building up on the rotating blades and scrapers. This would require the producer to shutdown the operation every hour so the blades could be cleaned. To address this problem, a system was installed that targeted very cold nitrogen gas at the blades well inside the machinery. Cooling the blades prevented product build-up, enabling the ingredient producer to eliminate waste and unnecessary downtime.

Nozzles can be contorted, arranged and pointed at just about any internal or external machine fixture. Multiple nozzles can be incorporated to ensure that targeted cooling hits every blade in a fine mincing machine, or a single nozzle can be used to cool a particular hot spot.

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Precision cooling systems spray nitrogen with pin-point accuracy utilizing a wide range of flow rates and temperatures to alleviate tricky processing where heat may create an issue like sticking, clogging, or jamming.

Food-Surface Cooling with Liquid Nitrogen

Food-surface cooling targets extremely cold nitrogen gas at the specific spot, point or surface of food that requires heat removal. This type of cooling can alleviate tricky processing problems where heat may create an issue, such as sticking, clogging or jamming. Surface cooling can also add speed and ease to layering steps or prevent the mixing of two different food items.

Cooling food surfaces with nitrogen can help alleviate issues with taffy cooling, product layering, die jamming, fixture handling or sticking, and much more. When a decorative drizzle turns into a puddle or a seven layer cake looks like three, targeting very cold nitrogen gas at the problem area might be the solution.

Liquid nitrogen systems are relatively small due to the extraordinarily cold temperature of liquid nitrogen and the high energy that it carries, often enabling them to fit into locations where other solutions are impossible.

This worked particularly well for an ice cream producer that needed to solidify a topping on a manufactured cone product before packaging. With very limited space available, a system could be installed that targeted cold nitrogen gas at the topping, providing the cooling needed to harden the topping and ready the cone for packaging.

Conclusion

With a little innovation and ingenuity, and some out of the box thinking, the benefits of nitrogen cooling in food processing applications seem endless. An industrial gas supplier with strong technical know-how and solid industry experience can evaluate a food manufacturer's operation and help uncover areas where nitrogen cooling can be advantageous... perhaps in ways you may have never even thought!

About Air Products

For over 75 years Air Products team of food experts have worked with processors to show how our gas and equipment solutions can improve food production processes.

Air Products' Freshline offerings provide innovative freezing and preservation systems to the food industry that not only enhance product quality, but are also designed to help increase production rates and capacity plus improve yields with less waste. All this adds up to lower costs and a more efficient system.

Air Products supplies a full line of Freshline liquid nitrogen and CO_2 freezing systems that can be tailored to meet your specific needs. Our tunnel and immersion freezers can freeze a wide variety of foods, including raw, cooked, marinated, and breaded products. All of our freezing systems use our cryogenics, which provides the most efficient means of freezing and cooling available.

Air Products also provides engineering and services, including a state-of-the-art food lab for testing a customer's product on commercial-scale equipment to determine the feasibility of using cryogenic freezing or chilling for their specific process, as well as on-site testing capability and processing audits to reduce cryogen consumption.

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