Liquid nitrogen can improve food manufacturing operations in ways not previously considered.

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For more than a half century, liquid nitrogen has been used to freeze and chill food products. In the food industry, liquid nitrogen is used most often to power tunnel or spiral freezers for the final food preservation before it is packaged and shipped. 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, and its application is providing added benefits. It is being used to remove troublesome heat from food processes up and down the production line, thereby increasing production throughput, reducing cycle times and 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.
- During grinding operations, liquid nitrogen can be used to eliminate frictional heat to
help improve mill throughput and grind consistency. This also helps to prevent the loss of flavor and aroma components in food additives, ingredients and functional foods.

Thinking outside the “liquid nitrogen freezing” box has led to innovative uses of nitrogen throughout the food production process. Here are some unique ways food manufacturers are using nitrogen to improve both product quality and operation efficiency.

**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-grinding machines are used to satisfy the demand for burgers and other formed products. However, the heat generated by these machines during the grinding process can melt the fats, making subsequent forming of the meat product difficult.

Liquid nitrogen can be used to help maintain the meat at a cold temperature through a controlled injection directly into the product during grinding. The nitrogen injection is regulated to provide the cold that is required at all times, and the liquid nitrogen injection rate is controlled to meet process requirements. Injecting liquid nitrogen during grinding improves the quality of the ground meat in several ways:

- The fat is not broken up during grinding and the cuts are regular and even.
- The mixes are more even because the time taken to make them does not need to be minimized as the meat temperature increases.
- Bacteria are inhibited because the contact atmosphere of the meat is changed (eliminating oxygen).
- The appearance of the meat is improved by avoiding the formation of metmyoglobin, which results from excessive exposure to the oxygen in air.

For instance, 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 if 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 and its special control system to the grinder, the hamburger patty producer was able to create ground

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beef patties at consistently low temperatures.

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

**Injection Cooling of Sauces with Liquid Nitrogen**

Liquid nitrogen can be injected directly into flowing liquids for practically immediate cooling. Sauces, gravies, marinades, custards and purees — almost any product that can be pumped — can be chilled in-process. Typically, liquid food cooling is accomplished using relatively large, scraped-surface heat exchangers for continuous processes or in-kettle cooling for batch operations. By using liquid nitrogen injection, liquid foods can be cooled from nearly boiling temperatures to packaging temperatures in 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, shortened final freezing time and improved the product quality.

**Machine Component Cooling with Liquid Nitrogen**

Machine component cooling directs extremely cold nitrogen gas at heat-generating parts in a food production process. Chilling knives, blades and other fixtures during operation decreases product buildup on these appliances, helping food processors avoid bottlenecks in the operations. In addition to increased throughput, machine component cooling also eases cleanup and can help inhibit mold growth.

Directing 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 shut down the operation every hour so the blades could be cleaned. To address this problem, a system was installed that directed liquid nitrogen gas at the blades well inside the machinery. Cooling the blades prevented product buildup, enabling the ingredient producer to eliminate waste and cut 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.

**Food-Surface Cooling with Liquid Nitrogen**

Food-surface cooling aims nitrogen gas at a specific position or surface of food that requires heat removal. This type of cooling can alleviate tricky processing problems where heat may create issues such as sticking, clogging or jamming. Surface cooling also can 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. When a decorative drizzle turns into a puddle or a seven-layer cake looks like three, directing 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. These features help allow them to fit into locations where other solutions may be impossible. This worked particularly well for an ice cream producer that needed to solidify a topping on a manufactured cone product before packaging. Within the limited space available, liquid nitrogen cooling was directed at the topping to harden it before the cone reached packaging.

In conclusion, the benefits of nitrogen cooling in food processing applications seem endless. An industrial gas supplier with technical know-how and industry experience can evaluate a food manufacturer’s operation and help uncover areas where nitrogen cooling can be advantageous.

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