

→ Bottom injection chilling

ACCU-CHILL™

Bottom injection chilling systems
for accurate temperature control.



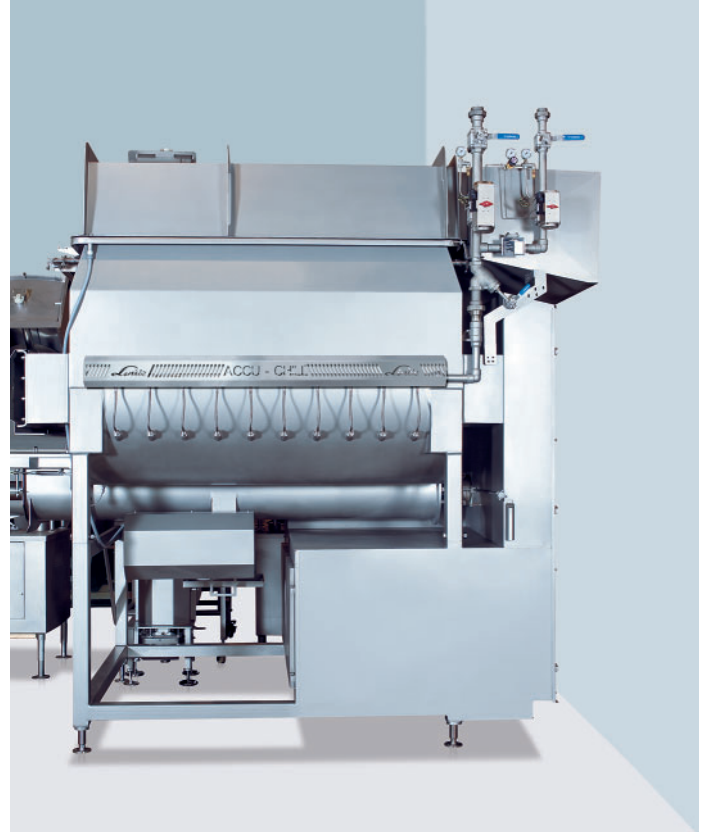
THE LINDE GROUP

Linde

Introduction.

Better quality, lower production cost, food safety, and control over your critical operational control points – these are just some of the demands placed on the food industry and your business. This highly competitive environment demands technology, experience, and skills to deliver profits essential for staying in business.

Food processors that require reducing batch food temperatures during mixing or blending can utilise Linde's ACCU-CHILL™ family of solutions. You may know this processing step as bottom injection chilling (or simply BI), a system to chill food products in blenders, tumblers, or other mixing vessels. If your purpose of lowering product temperature is to obtain product firmness or if it is just to reduce product temperature before packaging, then Linde ACCU-CHILL™ systems can provide you with total control over your changing variables.



Linde and the food industry – a history of success

As a world-leading supplier of industrial gases and corresponding hardware and services, Linde's ties to the food industry go back over 130 years. In fact, the first commercial refrigeration machines invented and built by our company's founder, Carl von Linde, were designed to meet the need for a reliable, year-round method of refrigeration for the fermentation and storage of beer.

Today, Linde virtually serves the entire food and beverage industry with a wide range of useful gases and cutting-edge application solutions, including such important sectors as dairy products, dry foods and bakery products, fish and seafood, fruit and vegetables, meat and edible oils and fats. In all of these business areas, ensuring the quality, wholesomeness and freshness of our customers' products and providing them with safe, efficient and eco-friendly processes are among our top priorities.

Whether you're chilling meat, seafood, poultry, vegetables or bakery dough, the ACCU-CHILL™ system helps you achieve excellent product quality by preserving the freshness, appearance and colour of your food products. With ACCU-CHILL™, you benefit from a broad range of ground-breaking technological innovations that characterise our advanced solutions:

High precision, targeted temperature control

With the ACCU-CHILL™ bottom injection chilling system, the temperature of food products in blenders, mixers or other food processing vessels can be controlled with minimal variations of ± 0.5 °C, enabling targeted temperature control and high-precision food design.

Consistent product quality, repeatable processes

The consistent product characteristics that can be achieved with the use of ACCU-CHILL™ mean that each process cycle is repeatable, thus retaining the high level of quality you require for your products. This leads to minimised rework and/or batch loss, which in turn means that your company can actively save money by using the ACCU-CHILL™ process. On the other hand, the precise control of product characteristics possible with ACCU-CHILL™ gives you the flexibility to swiftly change the product whenever necessary.

Reliable forming results

In order to achieve the optimal viscosity necessary for forming shapes, 25 % of the water in the food product must be crystallised. Precise, targeted chilling with ACCU-CHILL™ helps you obtain this crystallisation percentage exactly and rapidly, resulting in ideal product consistency for efficient food-forming operations. Moreover, the use of ACCU-CHILL™ lets you achieve consistent product temperature and meat firmness to achieve high forming production rates, minimises rework, and improves product yield for formed products such as beef patties and chicken nuggets.

Fast and cost-efficient food processing

Cryogenic cooling with liquid nitrogen or liquid CO₂ is by far the quickest way of obtaining the optimal temperature and/or product crystallisation level for a broad range of food types and food products (see the list below). Faster in-process chilling with ACCU-CHILL™ also means faster production speed, which can either be used to increase production capacity or for higher processing efficiency. The latter leads to a decrease in hours worked to meet the same production capacity, thus lowering overtime and increasing overall profits.

Areas of ACCU-CHILL™ application

Food types

- Vegetables
- Bakery dough
- Seafood
- Poultry
- Meat

Product examples

- Hamburger patties
- Vegetable patties
- Chicken nuggets
- Meatballs
- Meat loafs
- Sausages
- Baby food
- Soups
- Sauces

ACCU-CHILL™ can be retrofitted to most existing equipment, from meat grinders to food mixers or other food processing vessels, providing rapid temperature pull-down and precise temperature control in a wide variety of applications.

In comparison to competitive top injection CO₂ snow horn systems or other conventional chilling methods, Linde's USDA-approved and CE-marked liquid-nitrogen and liquid-CO₂ bottom injection chilling systems can improve the efficiency of your existing system by 20 to 30 %.

An innovative solution for an old challenge.

What is ACCU-CHILL™ bottom injection chilling?

There are two major customer needs segments for bottom injection chilling, the first is rapid removal of heat and the other is increasing product firmness, i.e. increasing product viscosity, for the purpose of improving downstream operational performance. Both of these needs require solutions that will neither damage the quality of the food nor increase the overall processing time. Many food products have a common step in manufacturing the end product that is a mixing of several ingredients. Linde, the inventor of bottom injection technology and now ACCU-CHILL™, understands the customer process and has engineered a solution that combines the mixing stage with the chilling process.

Over the years, a number of different solutions for these problems have been developed and applied. Five of today's most commonly used cooling methods for food blenders, mixers and other food processing vessels are:

- Manually added water ice*
- Manually added dry ice (solid CO₂)
- Top injection CO₂ snow horns
- Pre-frozen meat blocks
- Glycol-jacketed vessels

All of these methods, however, share a more or less poor temperature control, i.e. the product can be cooled, but reaching and retaining a certain desired temperature level often proves to be rather complicated and time-consuming. Top injection CO₂ snow horns, for example, require three times the amount of time and 20–35% more cryogen to achieve the same desired temperatures as bottom injection systems.

Because of the poor temperature control, all of these methods also share a high risk of batch-to-batch temperature variations and can create hot and cold spots within the batch, e.g. through CO₂ snowball or dry ice pockets. Some of the methods are also rather cost-intensive, such as the application of water ice or dry ice, which both not only need additional storage space, but also require more man-hours, as they have to be manually added to each batch.

Another serious disadvantage is that all five methods include the risk of batch contamination by microorganisms. This can be caused, for example, by the manual handling of water ice or dry ice (e.g. shovelling), or by accumulated moisture dripping into the mixture from top injection snow horns. The contamination risk is also rather high during the processing of pre-frozen meat blocks, because with this method, the processor first has to unwrap, chop and temper the product – which also adds extra time, labour and capital expense to the bottom line.

*) Often used when producing so-called "value-added" formed products, such as chicken nuggets (with breading) or meatballs (with breadcrumbs, minced onions, spices, eggs etc.). As a special disadvantage, this method implies the risk of hard-to-control water impact on the food product.

And what is so special about ACCU-CHILL™?

Linde's cutting-edge ACCU-CHILL™ bottom injection chilling systems are special for various reasons. First and foremost, they eliminate practically all of the aforementioned disadvantages of conventional cooling methods, such as poor temperature control, high contamination risk, batch-to-batch inconsistencies, high operating costs and expenditure of time. But that is not all, as the technical differences are also quite substantial:

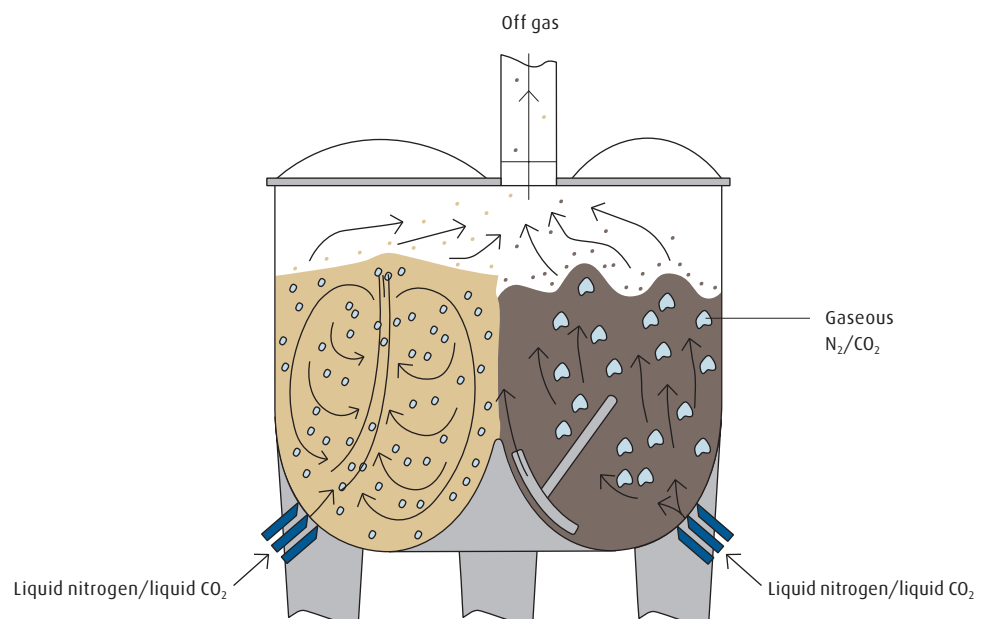
As the name implies, the ACCU-CHILL™ bottom injection system delivers the cryogenic coolant into the bottom of the mixer or blending vessel and directly into the food ingredients. The cryogenic coolant's direct contact with the food product provides the most rapid and efficient heat transfer of all technologies.

The mixing action within the mixer or blender spreads the heat transfer evenly throughout the entire batch, reducing hot and cold spots typically associated with other cooling alternatives. Linde's ACCU-CHILL™ system is engineered to not only measure product temperatures but

also the motor torque on the system. The operator can pre-set desired parameters (time, temperature, or torque) and have the ACCU-CHILL™ blender/mixer chilling system automatically regulate the cryogen flow to achieve precise and consistent temperatures.

The cold power of these so-called cryogenics (CO_2 is liquid at -78°C , N_2 at -195°C) brings about a rapid temperature drop: Upon contact with the food product, the cryogenic refrigerant immediately sublimates (i. e. turns to gas), rapidly cooling the batch. Subsequently, the cold gas provides additional cooling as it is pulled through the product mass in the blending or mixing process.

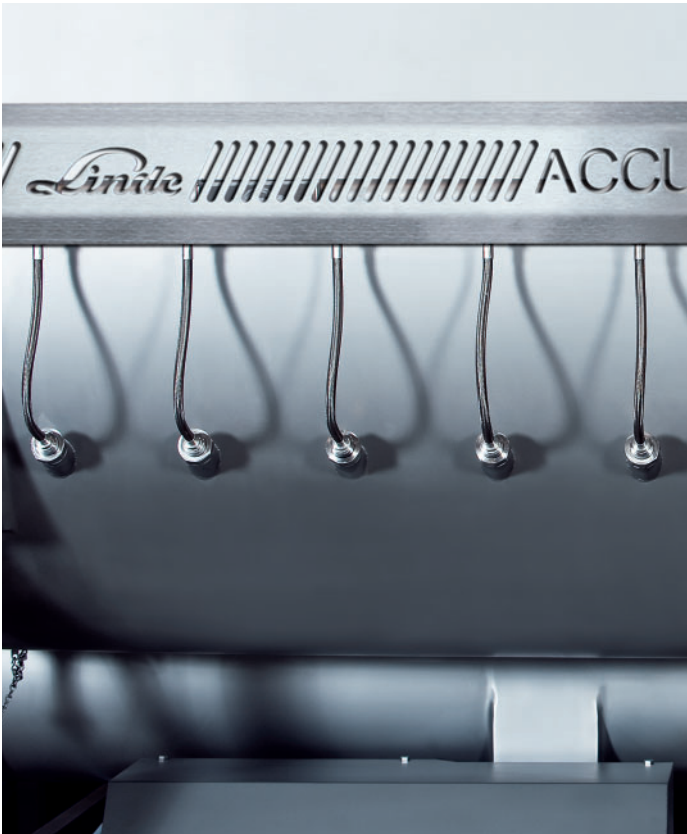
With this technology, the temperature can be controlled precisely, efficiently and rapidly in order to provide high-quality products as well as batch-to-batch process control in mixer/grinder applications. Moreover, ACCU-CHILL™ blender/mixer chilling from Linde reliably provides the consistent product temperature and viscosity necessary for repeatable food-forming operations.



Fast, reliable and highly efficient: ACCU-CHILL™ bottom injection chilling

Precise, innovative, hygienic and efficient.

The components of the ACCU-CHILL™ system.



Using Linde's patented ACCU-CHILL™ control panel or the standard bottom injection control panel provides extreme flexibility and efficiency with full control of the chilling impact, including consistent product viscosity, batch-to-batch portion control and appealing product appearance.

The advantages of the ACCU-CHILL™ control system

- Due to the possibility of highly accurate parameter settings, Linde's ACCU-CHILL™ control system automatically compensates incoming product variations, including temperature and batch size.
- Unlike the trial-and-error approach usually required with timer control, the ACCU-CHILL™ control system provides consistent product temperature, viscosity and weight from the very first batch.
- Consistent product weight eliminates the need to adjust the hydraulic plunger pressure in a mixer, which could result in variable product weight.
- Consistent product viscosity enables the processor to achieve optimal conditions for product forming, significantly improving forming machine operations.
- The system also reduces raised edges, flakes and "partial" patties typically caused by inconsistent product weight or temperature. This in turn reduces the need to "rework" products and the quantity of "lost" batches.
- Last but not least, the ACCU-CHILL™ control system eliminates the need to constantly monitor batches for temperature and other characteristics, thus largely removing the human element in chilling control and reducing potential errors.

Each ACCU-CHILL™ blender/mixer chilling system is custom-designed with precision-engineered components to suit your specific needs as a processor. The ACCU-CHILL™ system includes the following components:

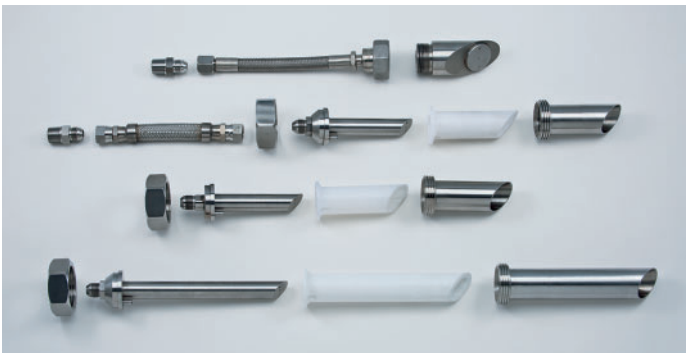
- Injection nozzles and flex hoses
- Control manifold
- Control panel
- Phase separator
- Header pipe
- Exhaust blower
- Exhaust duct
- Liquid nitrogen or liquid CO₂ storage tank

Manifold systems

Linde's ACCU-CHILL™ manifold (control valve piping with high torque, pneumatically actuated ball valves and pre and post-vapour purge cycles) controls the liquid and gaseous cryogen supply to the nozzles. ACCU-CHILL™ technology uses the high-pressure cryogenic gas to pre-purge and post-purge the nozzles. This keeps the nozzles clean and open for accurate liquid cryogen flow. Further advantages:

- The ACCU-CHILL™ system minimises maintenance labour because there are fewer valves and parts compared to competitive systems.
- The high-pressure cryogenic gas is isolated out of the way of workers and equipment.
- Unlike competitive systems, ACCU-CHILL™ doesn't require a separate gas vapour line or electricity to be supplied to a valve at every nozzle.
- The system eliminates any orifice plugging (snow blocks).
- It also eliminates valve freeze-ups, making it a safer and more reliable system.

An additional advantage of the Linde design is that it allows the processor more flexibility in feeding multiple mixer/grinders from the same in-feed system.



ACCU-CHILL™ nozzles

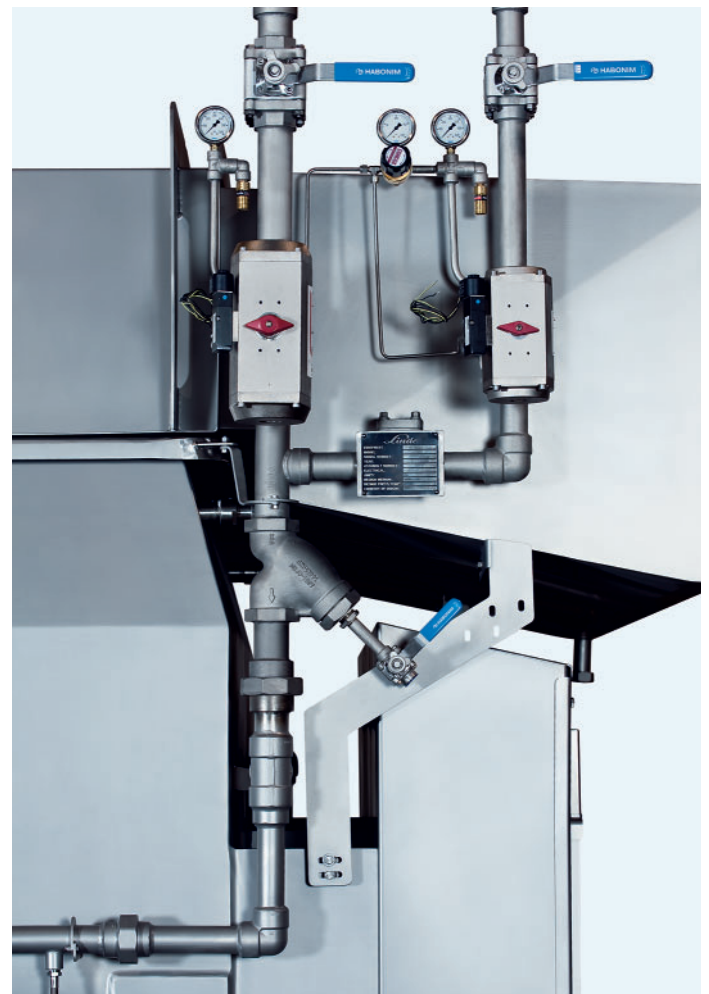


LIXSHOOTER® system

ACCU-CHILL™ bottom injection nozzles

The ACCU-CHILL™ system is a complete application of various interdependent components. However, the heart of the system is the nozzle. This is why Linde has designed many models tailored to fit your product requirements and operational needs. Nozzle designs include our patented single to triple-orifice injectors. This provides a more uniform cryogen spray pattern and a shorter overall chilling time. Chilling time is not only critical to maximise daily output, but also reduces the risk of damaging the product by overmixing.

All nozzles provided with or for ACCU-CHILL™ blender/mixer chilling systems can be easily disassembled and cleaned to ensure proper hygiene. After cleanup of the food processing vessel, CO₂ gas can be used to clear the nozzles of any residual product or moisture.



Manifold

Easy to install, even easier to use. The LIXSHOOTER®.

With the LIXSHOOTER®, Linde offers a special, highly advanced and very effective bottom injection nozzle system that works with liquid CO₂ or liquid nitrogen. Due to its compact dimensions and precision engineering, it can be easily installed either in new or existing equipment.

Each LIXSHOOTER® device comes with a self-sealing, single-orifice nozzle designed to meet maximum hygiene requirements. Once installed, the nozzle is flush and can be easily cleaned with the inner surface of the food processing vessel, thus saving the processor time and money. Smooth, inert, stainless-steel components and the avoidance of dead space further add to the very hygienic design of the system.

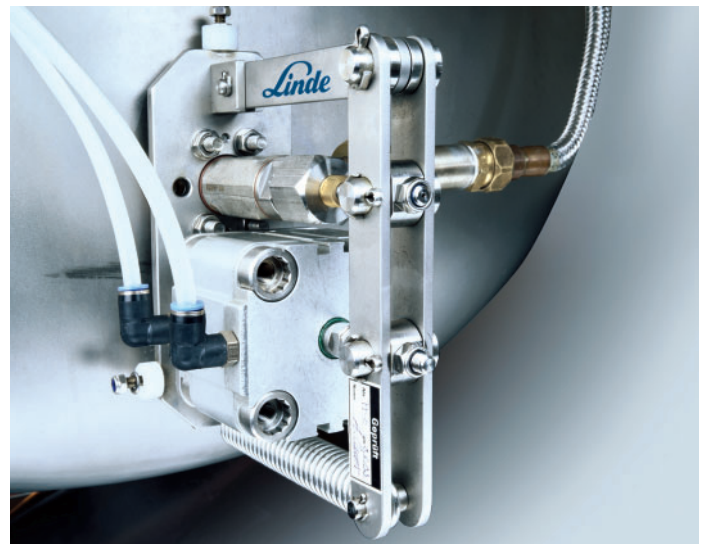
Moreover, the LIXSHOOTER® technology is also highly efficient: it works by injecting a discrete amount of coolant directly into the product mass. The coolant immediately evaporates upon contact with the product, absorbing the heat from it, and the cold gas then continues to cool the food batch before being safely evacuated at the end of the process cycle.

Special LIXSHOOTER® system advantages at a glance:

- Easy field installation
- Compact dimensions
- Very hygienic design
- Very easy to clean
- Designed for liquid products
- High capacity

Application example

Product	Minced meat in a mixer
Volume	1,400 kg
Temperature in	+4.5 °C
Temperature out	-1.5 to -2 °C
Cooling time	100 seconds
Exhaust gas temperature	-15 °C
Efficiency	90 %
Gas used	Carbon dioxide
Number of shooters	6





Service and support for ACCU-CHILL™ customers.

As a reliable, full-service partner for its customers, Linde has more than 40 years of experience with bottom injection of cryogenics during food grinding, mixing or forming operations. In order to consistently maximise the efficiency of our systems and to optimally protect the quality of food-stuffs, we work closely with all major manufacturers of food blenders, mixers and other processing vessels. Our highly flexible ACCU-CHILL™ systems for liquid nitrogen or liquid CO₂ application can be installed directly at the original equipment manufacturer (OEM) or retrofitted in the field.

To our ACCU-CHILL™ customers, we offer an extensive range of services – from initial consulting and planning to engineering and installation to gas supply, safety trainings and maintenance support.

Linde can provide the complete ACCU-CHILL™ solution, including:

- Cryogenic storage tanks and pipes
- Cryogen supply (liquid nitrogen or liquid CO₂)
- Engineering design
- Nozzle design
- Manifolds
- Exhaust systems
- Control panels
- Installation
- Maintenance

Safety precautions and trainings

Due to the extremely cold temperatures of liquid CO₂ (-78 °C) and liquid nitrogen (-195 °C), direct contact with these cryogenics can cause severe cold burns. Moreover, in their gaseous state, the inhalation of pure CO₂ or N₂ can lead to asphyxiation and, ultimately, death (especially in unventilated areas). As both gases are colourless, odourless and tasteless, asphyxia may occur without prior warning signs, i. e. the exposed person may faint before becoming aware of what is happening.

The application of carbon dioxide or nitrogen for chilling purposes therefore requires strict safety precautions. To its customers and their employees, Linde offers special safety trainings and clear guidelines to ensure that responsible handling of both liquid and gaseous CO₂ or N₂ by qualified personnel is always observed. For more information about our safety training offers, please contact your local Linde sales representative.

Precision-engineered for your success.

The advantages of using ACCU-CHILL™.



Chicken nuggets



Baby food

With ACCU-CHILL™ blender/mixer chilling systems, the product temperature is always perfectly under control. Each system is optimally engineered for liquid flow and exhaust flow to maximise process efficiency and the number of chill cycles. Food industry customers using our innovative technologies, reliable cryogenic gases supply and extensive services profit from a broad range of advantages:

Effective, efficient and economical systems:

- In-process chilling with ACCU-CHILL™ is highly effective and significantly faster than with conventional food cooling methods.
- Due to the optimal utilisation of the chilling power in the cold gaseous CO₂ or N₂, the system is 20 to 30% more efficient than conventional methods.
- ACCU-CHILL™ blender/mixer chilling systems can save between 10 and 15% of CO₂ or N₂.
- The high efficiency and process speed of the system can be transformed either into higher production capacities or less man-hours for the same capacity.
- Linde's specialised injection system can significantly reduce the number of injection nozzles required.
- Inexpensive technology means low capital investment costs for the equipment.
- Fast and easy cleaning of the ACCU-CHILL™ components saves time and money.

Easy installation and operation:

- ACCU-CHILL™ systems have compact dimensions and are easy to install on new or existing food processing equipment.
- ACCU-CHILL™ control systems are flexible, precise and user-friendly and save time in batch formulation.
- Customers using ACCU-CHILL™ systems can rely on Linde's global services and support.
- Linde offers complete solutions with liquid nitrogen/liquid CO₂ tanks, cryogen supply, safety trainings etc.
- Due to their hygienic design, all ACCU-CHILL™ components are easy to clean.

Hygienic design, safe application:

- Rapid temperature pull-down with the ACCU-CHILL™ system effectively prevents the growth of microorganisms in the food batch.
- Direct chilling of the food batches with injected liquid nitrogen or liquid CO₂ means no frozen residues can stick to the inner walls of the food processing vessels.
- Each unit is designed according to today's strict legal requirements for food hygiene.



Falafel (vegetable patties)

Get in touch with Linde

With its ACCU-CHILL™ systems for the food processing industry, Linde is the global technology leader. Our company has one of the broadest product line offerings on the market and the long experience in the industry to deliver customised, state-of-the-art solutions.

If you would like to learn more about our high-performance ACCU-CHILL™ technology and services (or about our other, highly developed gas application solutions for the food industry), please contact your local Linde representative or visit our website: www.linde-gas.com

Further publications about our complete range of applications and products can be obtained via our sales offices. Our experts are available for consultation and are looking forward to your call.

Accuracy and repeatability:

- Highly precise process control with the ACCU-CHILL™ control system ensures consistent product characteristics (e. g. temperature, viscosity, moisture etc.).
- Significantly less hot and cold spots or batch-to-batch variations than with top injection snow horns or manually added dry ice.
- The application of ACCU-CHILL™ improves the productivity of downstream processes, such as food-forming operations.
- Uniform product quality can be maintained, e. g. when manufacturing hamburger patties, chicken nuggets etc.

High-quality results:

- Blender/mixer chilling with ACCU-CHILL™ is a gentle cooling method that effectively prevents texture damage and microorganism growth.
- Inhibited microorganism growth means less spoilage risk and longer product shelf life.
- The rapid chilling process reduces aroma losses and retains the original good taste of foodstuffs.
- The low product stress preserves the attractive appearance of the end product.
- Due to lower overall costs and risks, and superior product quality and yield, food processors using ACCU-CHILL™ benefit from clear competitive advantages.

Getting ahead through innovation.

With its innovative concepts, Linde is playing a pioneering role in the global market. As a technology leader, it is our task to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

Linde offers more. We create added value, clearly discernible competitive advantages, and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardised as well as customised solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimisation, and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, joint activities form the core of commercial success.

Linde – ideas become solutions.