The benefits and applications of a tunnel freezer

It's all about Cryogenius.

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What is a *tunnel freezer*, and why is this cryogenic application so popular?

In our recent blogs, we've talked about cryogenic applications in general and the cryogenic freezer that forms part of these applications. This blog will go further in-depth and review a specific *cryogenic freezer*: *the tunnel freezer*.

What is this application used for, and what are the characteristics of different types of *tunnel freezers*? Continue reading for all the answers.

The *Tunnel Freezer*

The *tunnel freezer* is a cryogenic freezing system prevalent in the food industry. In short, a tunnel freezer is a long cryogenic tunnel that is used to cool food products very quickly. The products enter the tunnel hot or at room temperature at one end and come out frozen at the other end.
How does this work? Most *tunnel freezers* use liquid nitrogen (at -196 °Celsius) or carbon dioxide (at -56,6 °Celsius).

A standard *tunnel freezer* consists of at least the following components:

- An insulated housing that keeps the products and cryogenic liquids at temperature.
- A conveyor belt by which the products are transported through the tunnel.
- An injection system that injects the cryogenic liquid into the system.
- Ventilators to ensure the cold air reaches the products.
- An exhaust system to discharge excess gases.

Source: Food Processing Technology

Various types of tunnel freezers

While the essential elements of most tunnel freezers are the same, the exact design can vary quite a bit. To show the differences between various tunnel freezers, we would like to briefly explain some of the various features:

Carbon dioxide versus liquid nitrogen

Tunnel freezers are almost always cooled with carbon dioxide or liquid nitrogen. The choice of one of these two refrigerants is complex and depends to some extent on the product to be cooled.

Extensive research has been conducted on the difference between carbon dioxide and liquid nitrogen, from which several interesting conclusions emerged. For example, liquid nitrogen does not impair microbial growth, while carbon dioxide does. However, the inhibition of bacterial growth caused by carbon dioxide is only permanent when the product is packaged in an atmosphere of carbon dioxide after cooling.

The same research revealed that refrigeration with carbon dioxide also positively affects the colour retention of certain meat products. However, it is also true that this effect is only permanent when the product is packaged in an atmosphere of carbon dioxide. If this is not the case, the colour develops similarly to products chilled with liquid nitrogen.

While carbon dioxide has attractive advantages, liquid nitrogen may have even more. This overview of Matheson Gas summarises many of them. One significant advantage is the safety of liquid nitrogen compared to carbon dioxide. In addition, cooling by liquid nitrogen is faster, and the maintenance costs of the freezing system are lower in most cases.

Various conveyor belts

Every *tunnel freezer* has at least one conveyor belt transporting the products through the tunnel. However, what this conveyor belt (or conveyor belts) looks like varies considerably. We distinguish the following varieties:

- A cryogenic freezer with **one conveyor**. This design is mainly efficient for cooling one type of product of which the surface must be frozen as quickly as possible to avoid dehydration.
- A cryogenic freezer with multiple conveyors. With **multiple belts** in one freezer, it is possible to cool different types of products simultaneously. Factors such as the temperature and the velocity of the conveyor belt can often be set individually for each conveyor.
- A cryogenic freezer with multiple **staggered conveyor belts**, ideal for **IQF** (Individually Quick Frozen) refrigeration. These freezers ensure that individual products remain in constant motion as they are moved along the staggered belts. This exposes all sides of the products to the refrigerant and, among other things, prevents them from freezing together.

A cryogenic freezer with **conveyor belts made from a particular material.** For delicate products, belts of smooth stainless steel are available, and this ensures that the products are not damaged by, for example, an imprint of a regular conveyor belt.

The flow of the cryogenic liquid

Finally, the flow of the cryogenic liquid is also an essential part of the design of a *tunnel freezer*. The flow can be configured in multiple ways:

- In a linear *tunnel freezer*, the cold air flow follows in the **direction of the product**. The cryogenic liquid is injected at the tunnel's entrance, and the gases are discharged at the end of the tunnel.
- In a counterflow freezer, the cryogenic liquid is injected at the end of the tunnel, and the gases move **against the flow of the product**. The exhaust gases are extracted at the entrance of the freezer. The advantage of a counterflow freezer is that products are exposed to cold gases for a longer period of time.

The advantages of a *tunnel freezer*

Tunnel freezers are popular for a reason. For many food producers, the application is an essential part of the production process for such reasons as the following:

- Cryogenic *tunnel freezers* are often **smaller than conventional freezing systems.** Due to the extremely low temperatures of these freezers, fewer long conveyor belts are required to freeze the product.
- With a cryogenic *tunnel freezer*, products are cooled **very quickly and efficiently**. Rapid cooling means that the production process is not hindered, thus facilitating additional production and, ultimately, additional sales.
- By cooling food using a cryogenic *tunnel freezer*, the quality of the food is optimally preserved. The rapid freezing process ensures that the cell structure remains intact and that nutrients and vitamins are relatively well preserved. However, this does not apply to all foods, and some products actually benefit from a slower freezing process. For these products, control rate freezing is often used.

A cryogenic infrastructure for *tunnel freezers*

Every *tunnel freezer* is different, and the cryogenic infrastructure to which it is connected has its requirements as well.
Demaco has many years of experience connecting and installing all types of tunnel freezers. Our team of experts will ensure that the freezer is connected to a storage dewar for the required cryogenic fluid and that it functions at its optimum.
A cryogenic infrastructure for *tunnel freezers* typically consists of vacuum-insulated transfer lines, the proper couplings, and any necessary quality enhancement products. This ensures that the used cryogenic liquid reaches the tunnel freezer in top quality.

Vacuum insulated transfer lines allow liquid nitrogen to safely transfer from a storage tank to a tunnel freezer.

Would you like to know more?

Do you have questions about the installation of a *tunnel freezer*? Or would you like to know more about Demaco's products and services? Feel free to contact us or visit our products and projects pages.
Our following blogs will discuss other cryogenic applications, such as the cryogenic storage dewar, nitrogen filling stations, and the freeze dryer. If you are interested, keep a close eye on our website.

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