FDE 447
COLD PRESERVATION TECHNOLOGY

Content:

Food freezing methods

*Immersion freezing

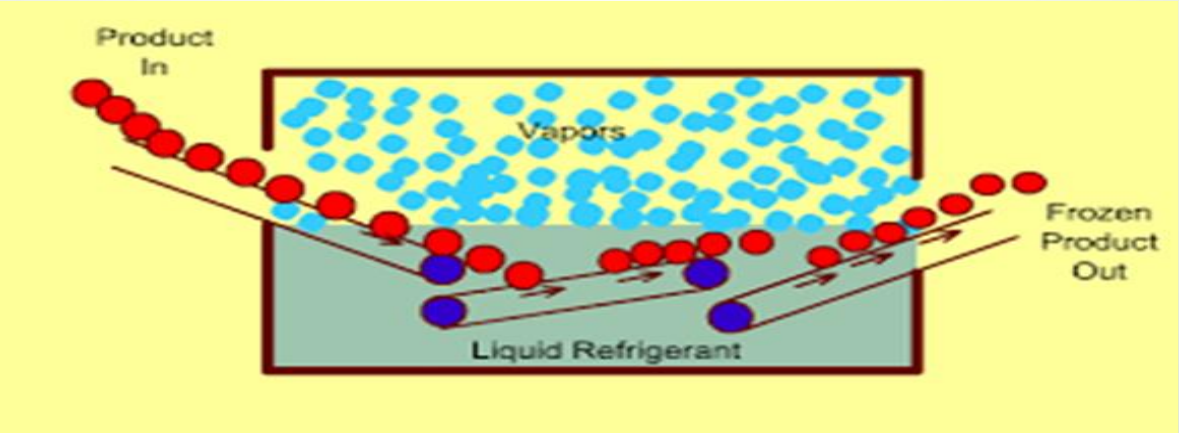
*Cryogenic freezing

Immersion freezing

- Food is immersed in a low-temperature brine to achieve fast temperature reduction through direct heat exchange.

<u>The fluids usually used:</u>

- salt solutions (sodium chloride),
- sugar solutions,
- glycol and glycerol solutions, and
- alcohol solutions.
- The solutes used must be safe to the product in terms of health, taste, color, and flavor, and the product must be denser than fluids.



Immersion freezing

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Dilution from the foods may change the concentration, thus it is necessary to control the concentration to maintain a constant bath temperature.

- To ensure that the food does not come into contact with liquid refrigerants, flexible membranes can be used to enclose the food completely while allowing rapid heat transfer.

The Coolants;

- should be non-toxic,
- should not contain foreign color, odor, taste
- should not change the color of the food
- its composition should not change

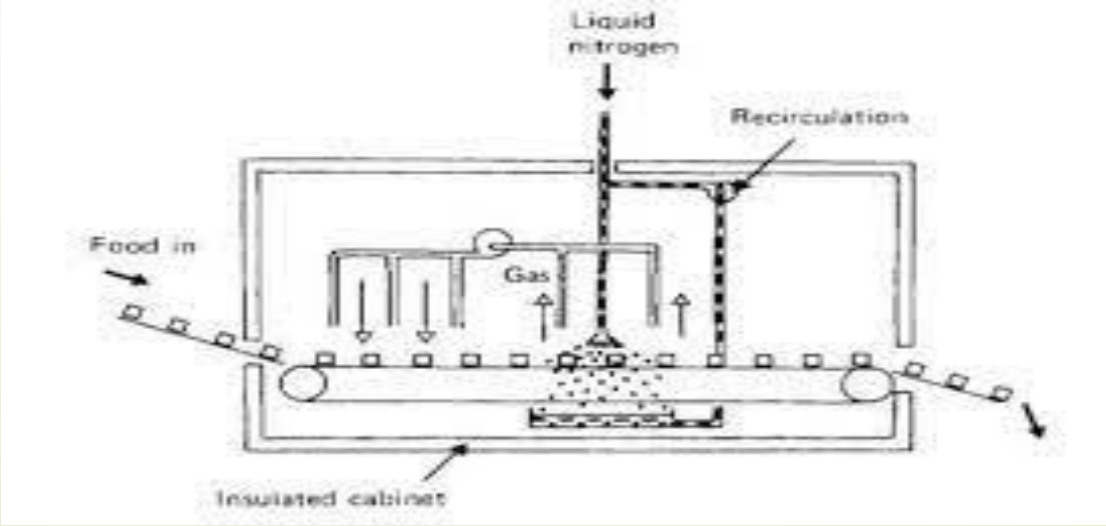
In the freezing of unpackaged foods; A perfect heat transmission is ensured between the food and the coolant and a fast freezing is achieved.

The coolants used in immersion freezing

- Salt solutions
  - Sodium chloride (23% eutectic point is -21°C)
  - Calcium chloride (31%, eutectic point is -50°C)
- Sugar solution (62%, eutectic point is -21°C)
- Glycol solution
  - Glycerol, 67% , eutectic point is -47°C)
  - Propylene glycol, (60%, eutectic point is -51°C)

Cryogenic freezing

- Liquid nitrogen (LN_2) or carbon dioxide (LCO_2) is sprayed directly onto small food items such as soft fruit and prawns.
- Due to the liquids' extremely low temperature (LN_2: -196°C and LCO_2: -78°C) freezing is almost instant.
- The nitrogen gas is removed by fans.
- CO_2 is used for larger products.



Cryogenic freezing

- In cryogenic freezing, liquefied gases are placed in direct contact with the foods.
- Food is exposed to an atmosphere below -60°C through direct contact with liquid nitrogen or liquid carbon dioxide or their vapor .
- This is a very fast method of freezing; thus, adequate control is necessary for achieving quality products.
- It also provides flexibility by being compatible with various types of food products and having low capital cost.
- The rapid formation of small ice crystals greatly reduces the damage caused by cell rupture, preserving color, texture, flavor, and nutritional value.
- The rapid freezing reduces the evaporative weight loss from the products, provides high product throughput, and has low floor space requirements.

Liquid nitrogen (LN_2)

- it is colorless, odorless, chemically inert, and boils at -195.8°C.
- It is usually used for high-value products due to the high capital cost for gas compression.

The product can be exposed to a cryogenic medium in three ways:

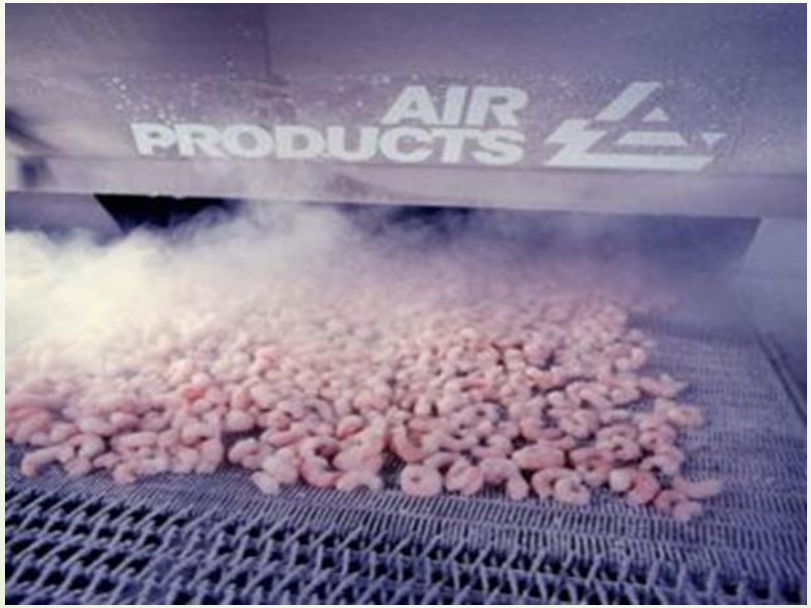
(a) the cryogenic liquid is directly sprayed on the product in a tunnel freezer,

(b) the cryogenic liquid is vaporized and blown over the food in a spiral freezer or batch freezer, or

(c) the product is immersed in cryogenic liquid in an immersion freezer.

Liquid carbon dioxide (LCO_2)

- The liquid phase exists only between the triple point (-56.6°C, 547 kPa) and the critical point (31°C, 7250 kPa).
- At atmospheric pressure it exists either in the gaseous or solid phase.
- When LCO_2, which is kept under high pressure, is released to atmospheric pressure, 50% turns into solid phase (dry ice) and 50% turns into cold gas at -79°C.
- 1 kg of dry ice absorbs 572.5 kJ of sublimation heat at atmospheric pressure and turns into gas phase spontaneously at -79°C.


AIR
PRODUCTS

Physical Properties of Some Freezing Systems and Food Products

Typical Surface Heat Transfer Coefficient and Foods Thermal Conductivity

Freezer Type	Conditions	h (W/m^2 K)	Example Foods Preserved by the Method
Cold room	Still air	5–10	Beef carcass, chicken, fruits, vegetables.
Air-blast	Air velocity: 2.5–5 m/s	15–30	Fruits, vegetables, fish fillets.
Tunnel	Counterflow of food item and air	15–60	Grains, soybean, fish fillets.
Fluidized-bed	Suspending airstream	80–120	Carrot cubes, peas, shrimp, strawberries.
Plates	Contact to solid	50–120	Meat steaks, fish fillets, leafy vegetables.
Cryogenic	Gas zone/spray zone	40–60/100–140	Ice cream, shrimp, berries.
Liquid immersion	Circulating brine	60–90	Chicken, turkey, canned foods.
	Specialized refrigerant	500–1200	Fruits, tomato slices, orange segments.