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Short Communication

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Cryogenic Freezing Technology

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ABSTRACT

We are living in 21 centuries and this time is totally based upon technology. In food processing sector many technology are used for many purpose. Cryogenic freezing technology is come and change the preservation process by which any living cells, tissues and food products are protected from spoilage or de cay by preserved them at very low temperature. In this technology all type of moisture are removed from the food product and make solid. When liquid N_2 or Co_2 (Cryogenic liquid) comes into contact with product it convert the phase from liquid to vapor with the help of Heat transfer. Boiling point of liquid nitrogen of -196 degree c. liquid nitrogen is converting from liquid to vapor at that low temp.

Key word: *Cryogenic freezing, Liquid nitrogen, Liquid carbon dioxide, Heat transfer, Low temperature.*

INTRODUCTION

Cryogenic technologies give low temperature application in food sectors. Cryogenic technologies are generally used for food processing and food preservation many industry are use cryogenic technology in this time for batter food quality and good products. Cryogenic may be defined as the branch of physics and engineering which deals with the production of freezing "cold" and the study of material at such low temperatures.

According to NIST (National Institute of Standard and Technology, US)[1]. Cryogenic is the science that address the production and effects of very low temperature. The word originates from the Greek words "Kryos" meaning "Frost" and "Genic" meaning "to produce" under the user definition it could be used to include all temperature below the freezing paint or water (^oC).

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Some thermo physical prosperity of liquid nitrogen and liquid carbon dioxide are given in below table –

Table – some thermo physical prosperity of liquid nitrogen and liquid carbon dioxide [3]

Property	**LN_2**	**LCO_2**
Density	808	464
Boiling point	-196	-78.5
Thermal conductivity	0.14	0.19
Specific heat of liquid	.05	2.26
Latent heat of evaporation	199	352

According to Balasubramanian *et al.*[5], reported that Cryogenics has numerous applications in space science, electronics, automobiles, the manufacturing industry, sports and musical instruments, biological science and agriculture, etc. Cryogenic freezing finds pivotal application in food, that is, spices and condiments.

According to Kadam[6], The process results in production of fine particles with a high level of quality. In addition, process volumes increase significantly. During the grinding process heat sensitive materials are cooled with cryogenic gases inorder to protect them from increase in temperature resulting from the heat generated by the process. This means that it is impossible for the powdered material to melt or become sticky.

According to Tridib Kumar Goswami[7] studied that processing or preservation techniques to enhance the storage life. Cryogenics is a branch of engineering wherein production of cryogen and the maintenance of low temperature technologies are studied. its also used for batter transportation for material.

Studied that one of the main limitations of the conventional grinding process is the thermal damage. One of the feasible methods to control the thermal damages is to perform grinding or comminution under controlled temperature conditions. Hence, it is especially important to perform the grinding at reduced temperatures[8].

Cryogenic freezing is an upcoming food processing technology that is ganing popularity because of the lower setup casts and improved food quality when comped to mechanical freezing. Cryogenic food freezing differs widely from mechanical ammonia of freon freezing systems. Mechanical freezers also known as blast freezers are indirect cooling. Where a refrigerant cools down the air surrounding the products (Which then freezes the products.) Cryogenic freezers, on the other hand are direct cooling systems. Where cold liquidized food grade gases are directly sprayed onto the product. These gases are liquid nitrogen and liquid Co_2 or solid Co_2 mechanical or blast freezer work with a controlled temperature range between - 35 to -40 degrees cryogenic freezers can reach significantly lower temperature. With liquid nitrogen you can work in range of -60 to -120 degrees and with liquid Co_2in ranges of -40 to -60 degrees. The significantly lower temperatures lead to higher freezing speed and much smaller ice crystals within the frozen product. The smaller ice crystals result in a better product quality compared to common mechanical or blast freezers.

Cryogenics is the cooling of materials to extremely low temperature using highly condensed gases. Cryogenics in volves refrigeration at temp below 120K (-153^{o}c). Cryogenic temperatures are generally achieved through a refrigeration cycle[2].

Type of Cryogenics freezer:-

A. Cabinet freezer
B. Tunnel freezer
C. Spraying freezer
D. Immersion Freezer

A. **Cabinet freezer -**
   - Frozen capacity - 500kg/h
   - Lowest Temp. - 150^{o}c
   - Maximum cooling rate - > 20^{o}c/min

B. **Tunnel Freezer –**
   - Frozen capacity - 300kg/h
   - Lowest Temp. - 100^{o}c
   - Maximum cooling rate - > 20^{o}c/min

C. **Spraying -** Liquid N or Co_2 sprayed on the food product.

D. **Immersion-** Food Product is immersion the bath container.

Immersion cryogenic freezing use tunnel through which passes a constant-speed horizontal conveyor belt. Which is based on

pulley. The unpackaged food product is placed on the horizontal belt and freezing is achieved by immersion cryogenic liquid refrigerant to dip on the product or by exposing the product. The food product is freeze with the help of liquid N and CO_2. There are convert the face with the help of heat transfer.

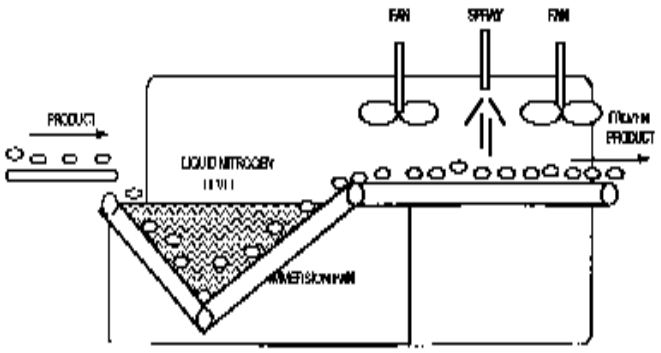

Fig. 1: Simple illustration of a typical immersion freezer

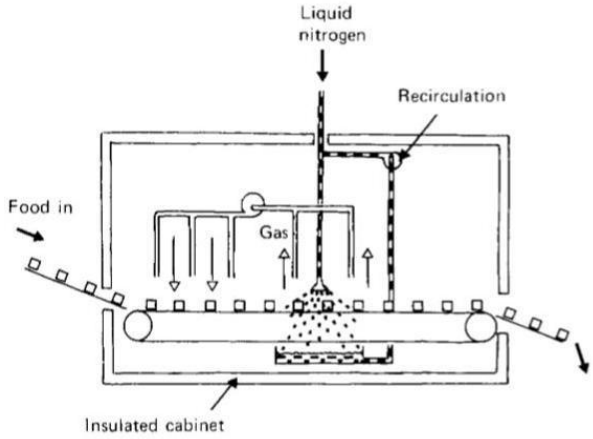

Fig. 2: Simple illustration of a typical immersion freezer

Application of these cryogens freezing in different aspects of food processing and preservation opens a new era of refrigeration. Like every operation has some advantage and disadvantage, cryogenic freezing application also has no exceptions.

Application-

Our liquid nitrogen freezers have been widely used in quick freezing of:-

- Food Packaging in industry
- Seafood and meat: - Fish, Shrimp, Lobster, Squid, Sea Cucumber, especially those high valued sea food, Beef, Chicken, Pork, Mutton etc.
- Fruits and vegetable: - Durian, strawberry, Dragon Fruit, Broccoli, Beans etc.
- Fast food: - Hamburger, cake, Shrimp rings, Squid, Rings etc.
- Biological laboratory: - Quick freeze the samples.
- Grinding Technology for Spices Processing

Advantage –

1. Low Investment cost
2. Very low dehydration

Disadvantage-

1. In tunnel freezer use belts. There are uses bearing for move the product due to cold environment. it are subject to significant maintenance.
2. High Consumption of N and Co_2
3. Floors are damage from leaking refrigerant.
4. Long Contractual period.

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