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Refrigerated transport systems, Cold chain, Improvements needed in transportation of fish and shellfish

INTRODUCTION

- Refrigerated transport:-
  - maintaining the quality,
  - prolong the shelf-life of fresh, frozen and perishable products during transportation.
  -Consumers appeal.
  -convenience in transportation and handling.
  -gives good profit,
  -minimize post harvest loses.

Improvements needed in transportations

- why products needed improved transport?
  - initial quality,
  - temperature,
  - humidity,
  - pH,
  - atmospheric composition,
  - physical injury.
- Extrinsic and intrinsic factors of the fish and environment.

Improvements in refrigerated transport system.

- Refrigerated vehicles.
  - mechanical refrigeration,
  - ice cooling,
  - cryogenic cooling,
  - solar powered refrigerated vans,
  - chilled air circulations.

MECHANICAL REFRIGERATION

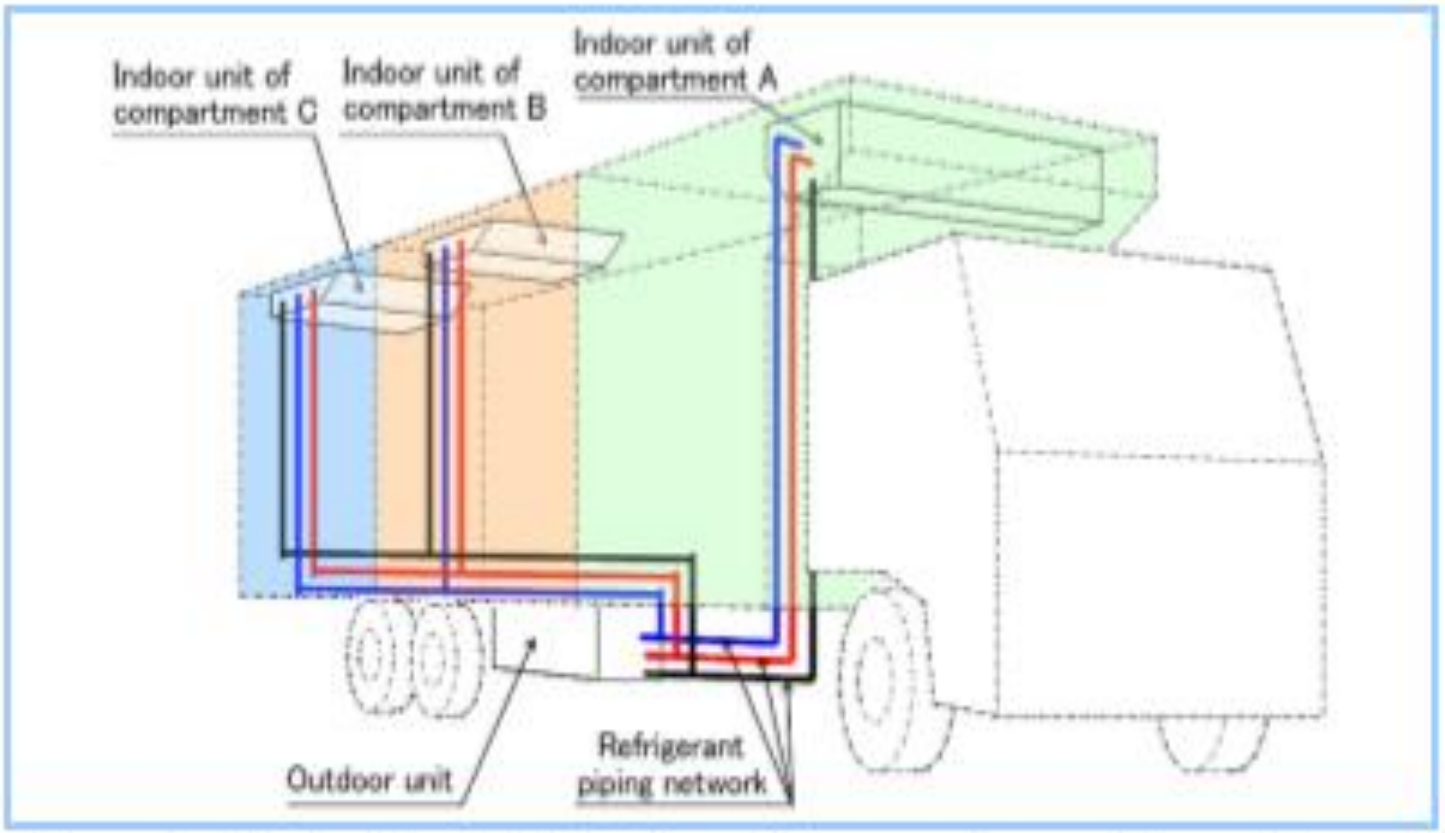

Figure 1 Typical installation of multi-temperature refrigeration unit
Example of multi-temperature refrigeration unit installation. The trailer is divided into three compartments along its length.

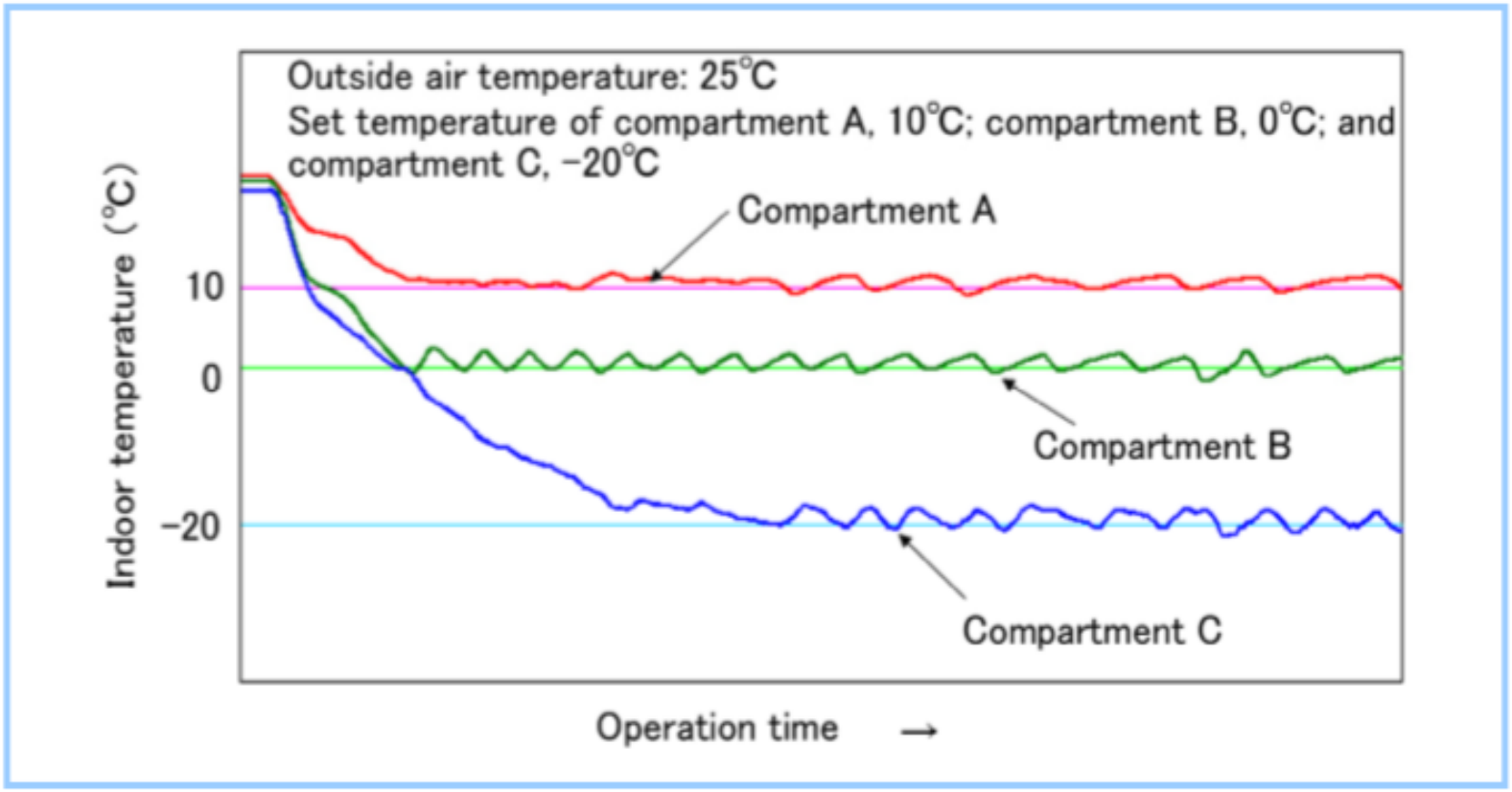

Figure 3 Simultaneous cooling operation in three compartments at different set temperatures using our new multi- temperature refrigeration unit

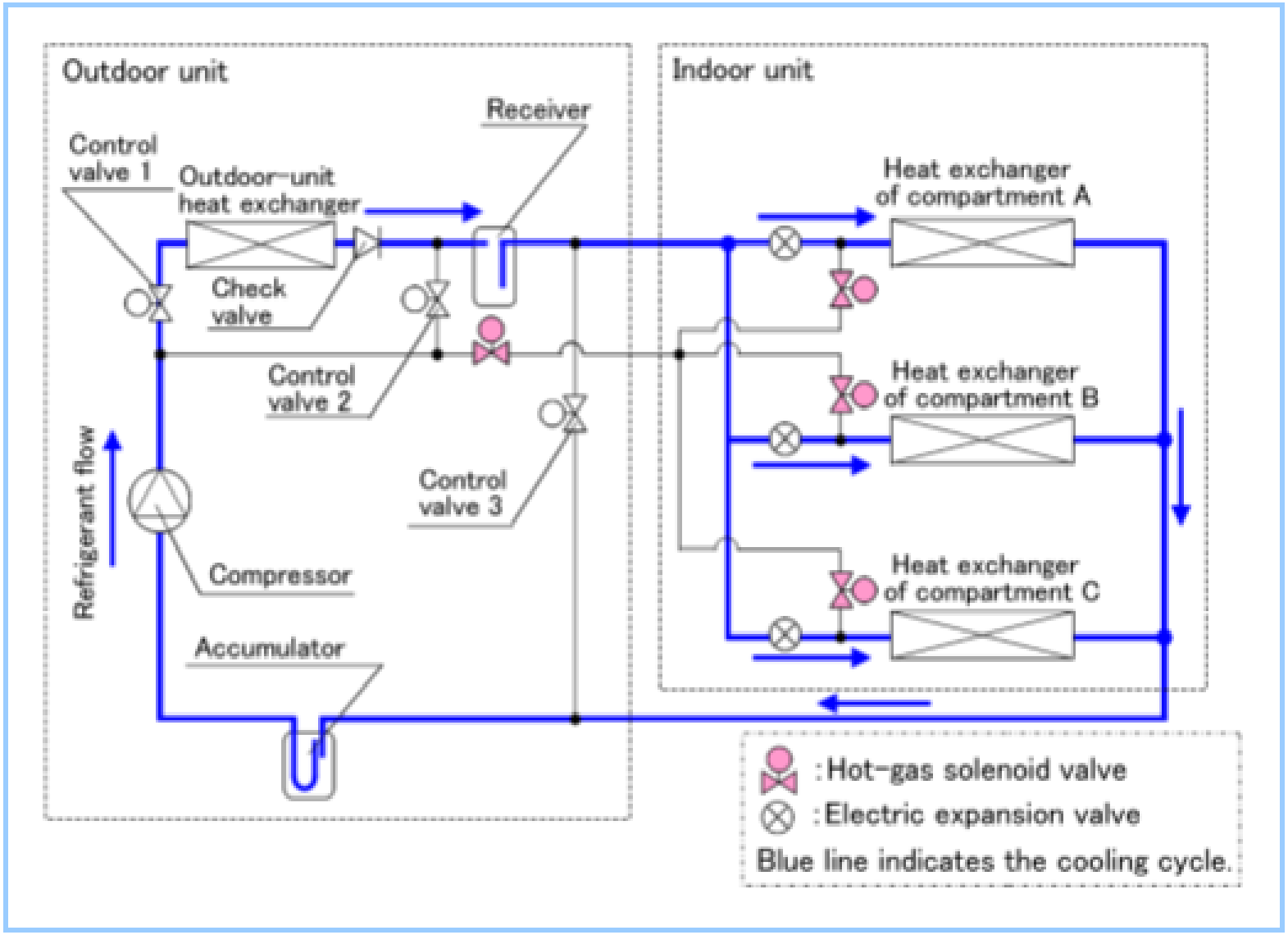

Figure 2 Refrigerant cycle of multi-temperature refrigeration unit (cooling cycle)
The refrigerant cycle of a multi-temperature refrigeration unit with three compartments is shown.

- The amount of refrigerant distributed to each indoor unit is dynamically controlled.
- Each indoor unit is equipped with an electric expansion valve to control the amount of refrigerant distributed.
- The electric expansion valves in all of the operating indoor units are controlled in a coordinated manner.
- Adjusting the refrigerant temperatures so that heat can be exchanged in the compartment with the lowest air temperature.

Ice cooling

- A) The cars were cleaned with hot water or steam.
- B) Depending on the cargo, the cars might have undergone four hours of "pre-cooling" prior to loading, which entailed blowing in cold air through one ice hatch and allowing the warmer air to be expelled through the other hatches.
- C) The cars ice bunkers were filled, either manually from an icing dock via mechanical loading equipment.
- E) The cars were delivered to the shipper for loading, and the ice was topped-off.
- F) Depending on the cargo and destination, the cars may have been fumigated.
- G) The cars were reiced in transit approximately once a day.

Cryogenic Refrigeration for Cold Transport

- Cryogenic refrigeration better than mechanical systems:
  - rate of temperature pull-down.
  - the ability to accurately maintain temperature.
  - have output power in excess of 3 times.
  - mechanical systems.
- Temperature distribution superior :- lack of sensitivity to wall roof and floor blockages.
- Cryogenic systems operated clean and with minimal noise.
- No fossil fuels are required.

Different types

- 1. Cryo-Trans Direct (CTD) Direct nitrogen injection into trailer.
- 2. Cryo-Trans Indirect (CTI) Indirect nitrogen injection through a heat exchanger.
- 3. Cryo-Trans Hybrid (CTH) Combination direct or indirect + mechanical.

CRYO-TRANS DIRECT(CTD)

- CTD involves the direct injection of cold nitrogen liquid/vapor into the insulated trailer body.
- CTD is the method first introduced in the 1960's under the Polarstream trade name.
- Direct injection of nitrogen is said to be the most efficient utilization of nitrogen's refrigeration energy
- Carries the risk of low oxygen levels within the trailer.

CRYO-TRANS INDIRECT

- CTI represents the system where nitrogen chills a heat exchanger mounted inside the trailer that cools air circulated across this exchanger.
- Spent nitrogen vapors from the heat exchanger are safely vented outdoors, hence indirect cooling.
- CTI systems can be designed as single or multiple temperature zone trailers.
- CTI advantage of being able to enter the trailer at any time without risk of low oxygen levels.

CRYO-TRANS HYBRID

- Cryo-Trans Hybrid (closed system):
- Incorporates both mechanical and CTI.
- A heat exchanger, an insulated vessel and a monitoring system are installed in addition to a mechanical cooling unit in order to boost refrigeration capacity.
- The main advantages are a quicker cool-down after door openings and
- Reduction or elimination of noise and emissions.

Figure 4 Cryo-Trans Direct (CTD)

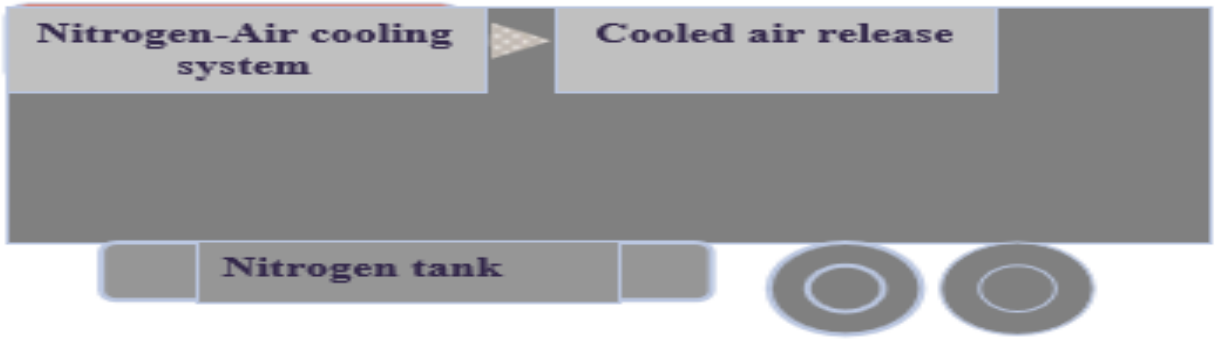

Figure 5 Cryo-Trans Indirect (CTI)

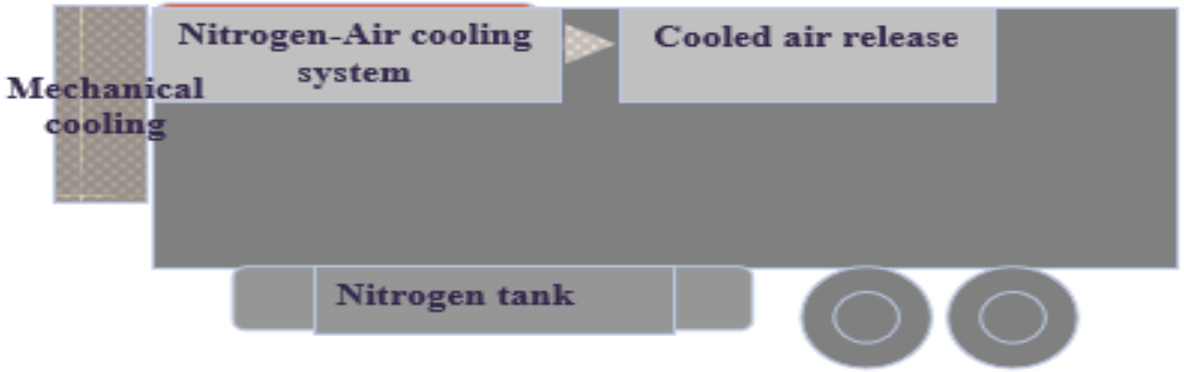

Figure 6 Cryo-Trans Hybrid (Mechanical + Cryogenic)

Solar Powered Refrigeration for Transport

- The key economic factors that led to the commercial development of these units were (1) the high cost of diesel fuel in England,

(2) the high cost of the diesel system maintenance, and

(3) the noise generated by the diesel engines during night-time delivery in residential areas.

- These solar refrigerated trailers are designed to maintain refrigerated conditions for a period of roughly six hours a day only.
- A total rated power of 5.7 kW was used, which was based on a fully covered 53’ trailer roof and a very high efficiency commercially available panel (136 watts/sq.m gross panel efficiency).

Technologies

- 1. Reduce the thermal load on the trailer.
- 2. Improve the refrigeration system efficiency.
- 3. Select and develop an optimal energy storage technology (Battery or Phase Change Material).
- 4. Develop a source of auxiliary power to augment and serve as a back-up to the available solar input.


SAINSBURY'S
SOLAR POWERED
© SERG

NOVEL REFRIGERATION SYSTEM

- Novel refrigeration system :- off-vehicle refrigeration unit and an on-vehicle latent heat thermal storage unit.
- Proposed refrigeration system can be used for local delivery.
- The energy cost saving depends on a number of factors, namely the cost of diesel and electricity and the efficiency of the refrigerated system and engine.
- The energy cost for the refrigeration system was up to 80.9% less than conventional systems.
- Produces much lower local GHG emissions and it has improved temperature control and reduced noise level

Chilled air refrigerated transport

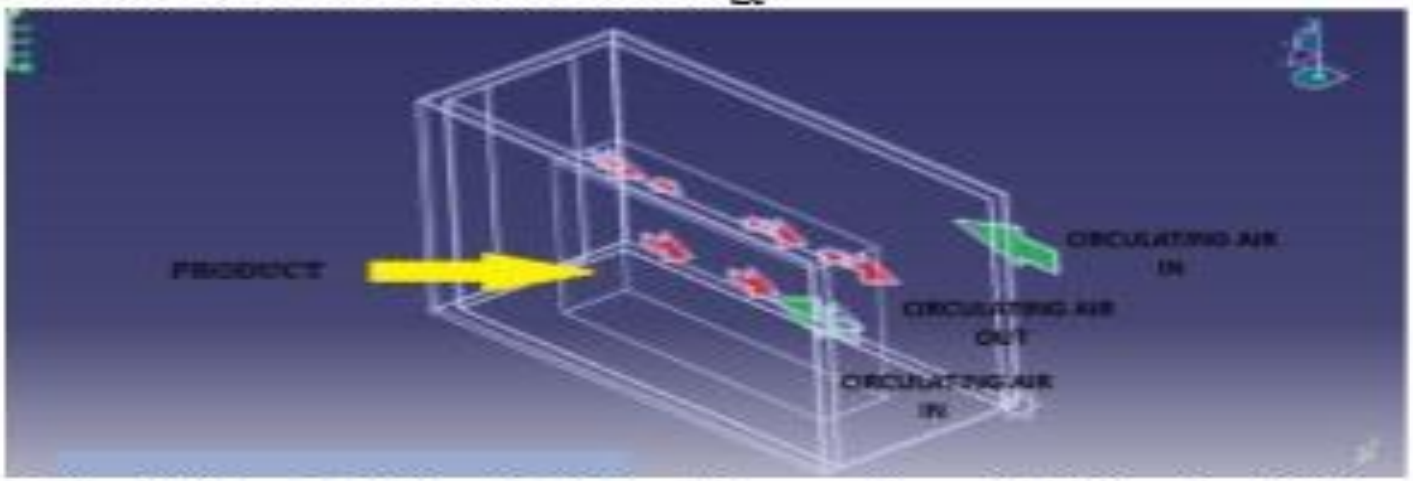

Fig. 2: Air circulation of refrigerating van for maintaining the inside temperature

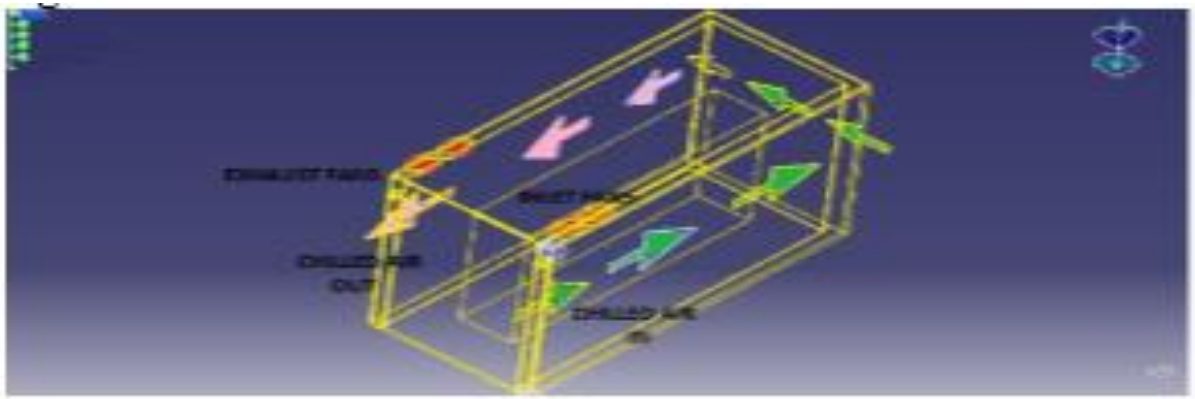

Fig. 1 Chilled air circulation of refrigerating van for charging the PCM cool pads

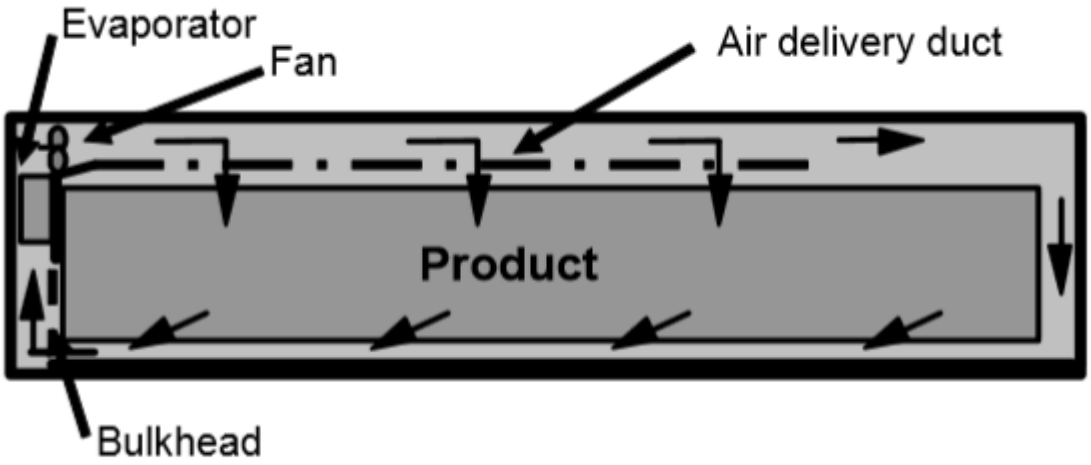

Figure 1. General aspect of a refrigerated container equipped with a top-air delivery system.

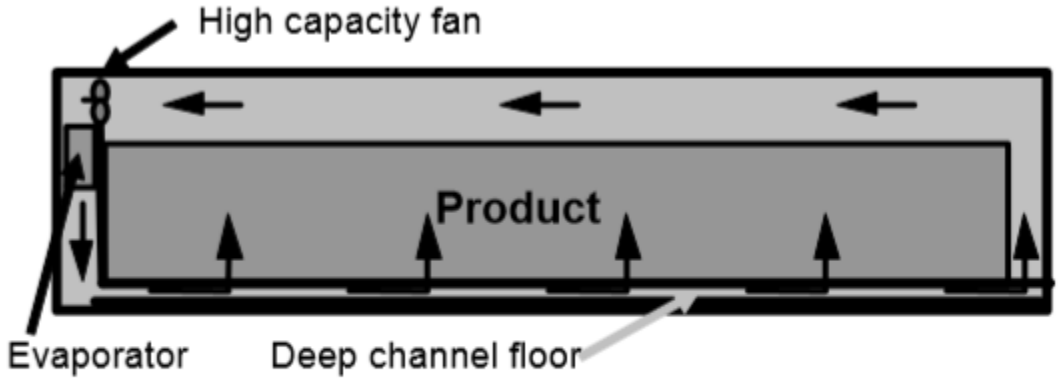

Figure 2. General aspect of a refrigerated container equipped with a bottom-air delivery system.

Classification of transport vehicles

- Land transport.
- Rail transport.
- Air transport.
- Water transport.

Land transport

- Less standardize
- Very quickly rise in temp.
- Insulated and refrigerated lorries –used – long distances- at 0^0 c temp.
- Truck and - both chilled and frozen fish
- Thicker insulation require – leads carriage of needless wt. when carrying

RAIL TRANSPORT.

- BOXES- LOADED ON VAN MEASURE 1300 cubic feet
- Insulated 5cm glass fiber layer sandwich between light alloy panels
- Van –cooled prior to loading
- Ice is sprayed over the load before sealed.

AIR TRANSPORTATION

- BY AIRCRAFT –EXOTIC AND EXPENSSIVE SP.
- Either fresh or frozen
- Insulated material - light wt. water proof one-way boxes – 35kg
- Refrigerated at 0 to -29^0 c
- Boxes , without container can be used – 1 to 2 hrs
- Boxes or cartons – impregnated corrugated cardboard –well insulated – telescopic type lids

- Fresh- pre-cooled :- -1 to -2^0 c temp.
- In jet – advantage of low temp. at high altitude - both fresh and frozen products

MARINE TRANSPORTATION

- Refrigerated vessels are designed - movement of frozen fish to market
- Insulated fish hold and refrigerated equipments.
- Temperature:– maintained by a combination - deck head , bulkhead and ships side cooling coils
- Central evaporators, fan for air distribution.

TRANSPORT AND RETAILING OF FROZEN FISH

- Majority - by road in insulated refrigerated trucks
- May be suitable for short trips depends on the following factors
- Size of load
- Insulation
- Ambient temp.
- Air ingress

CONCLUSION

- Mechanical refrigeration.
- Rechargeable eutectic plates.
- Solid or liquid CO_2 or liquid N_2.

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