Industrial Visit Report

Mayur Agrofresh, Mahape MIDC, Navi Mumbai

Date of Visit: 28/02/2025

Location: 429, MIDC Road, MIDC Industrial Area, Mahape, Navi Mumbai, Maharashtra 400701

Class: TE Mechanical

Subject: HVAC & Refrigeration

Introduction

The industrial visit to Mayur Agrofresh in Mahape, Navi Mumbai, offered a unique opportunity to explore the techniques and processes involved in food preservation and cold storage at a commercial scale. Located in the strategic MIDC industrial area, Mayur Agrofresh caters to the preservation needs of various agricultural products. The facility specializes in cold storage, freezing, and innovative preservation of fruits, vegetables, spices, crops, and sugarcane derivatives. The primary goal of the visit was to understand how modern technology and operational efficiencies help maintain food quality, extend shelf life, and support the agricultural supply chain. The visit was organized as part of an educational initiative to bridge the gap between theoretical knowledge and practical applications in the food industry.

Mayur Agrofresh is a leading facility dedicated to food preservation, focusing on reducing post-harvest losses for agricultural produce. Established to support farmers and distributors, the company plays a critical role in India's agricultural supply chain. They provide advanced cold storage solutions and employ freezing technologies that comply with international standards. Their services are crucial for exporters and wholesalers seeking to deliver quality products to domestic and global markets. The facility's expertise extends to handling perishable items like fruits, vegetables, and spices, along with sugarcane derivatives such as molasses and jaggery. Mayur Agrofresh emphasizes eco-friendly practices and energy-efficient systems to maintain sustainability.

Objective :

The visit aimed to enhance knowledge about food preservation and its significance in reducing food spoilage. Observing the facility’s processes allowed participants to understand the application of cold storage, freezing, and packaging techniques in extending the shelf life of perishable items. Another key objective was to learn about the integration of modern technology in maintaining product quality and meeting hygiene standards. The visit also focused on exploring the facility's contribution to reducing agricultural losses, creating economic opportunities for farmers, and promoting efficient logistics in the supply chain.

Understanding the role of sugarcane product preservation was an additional highlight.

The primary goals of the visit were:

- To observe the processes used to preserve freshness and prevent spoilage in perishable food items.
- To understand how cold storage facilities contribute to supply chain efficiency.
- To explore how sugarcane products and other items are handled and stored for long-term use.
- To gain insights into environmental and economic benefits of these technologies.

How System Works?

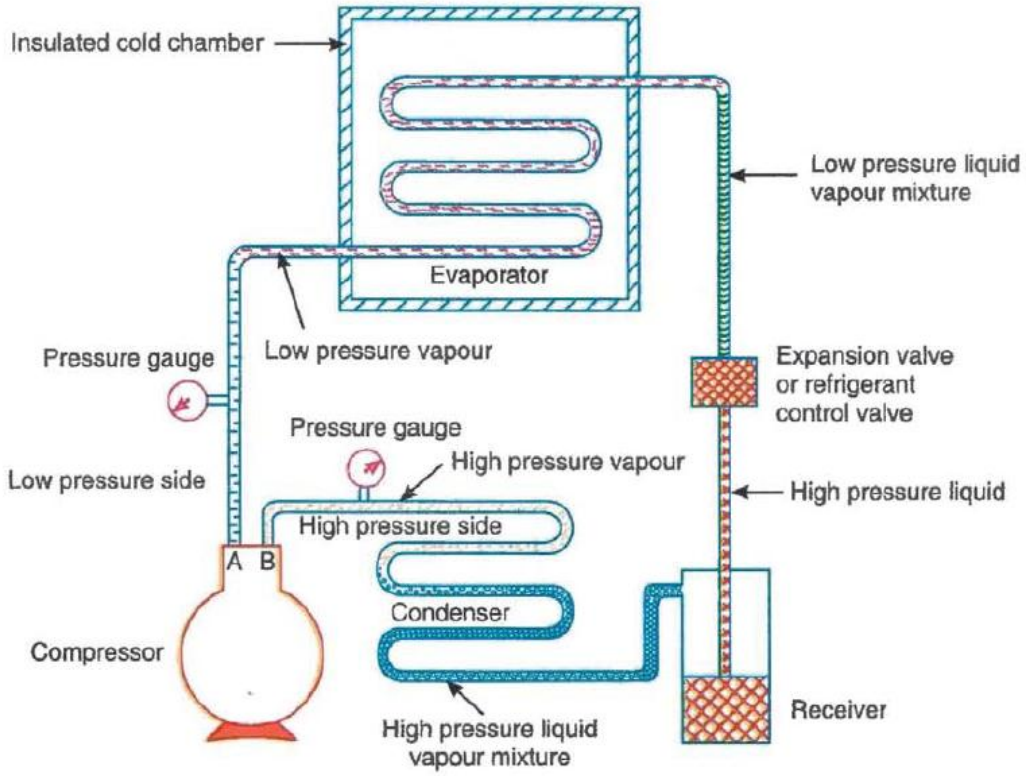


Fig. 4.1. Simple vapour compression refrigeration system.

The refrigeration system, such as the COMPAK AHP02150Z by Rinac India Ltd., operates based on the vapor compression refrigeration cycle. Here's a step-by-step explanation of how it works:

1. **Compression:** The refrigerant (R404A) enters the compressor as a low-pressure, low-temperature gas. The compressor compresses it into a high-pressure, high-temperature gas.

2. **Condensation:** The high-pressure gas flows into the condenser, where it releases heat to the surroundings (usually through air or water cooling). This process converts the refrigerant into a high-pressure liquid.
3. **Expansion:** The liquid refrigerant passes through an expansion valve, where its pressure drops suddenly. This causes the refrigerant to cool significantly and partially evaporate.
4. **Evaporation:** The low-pressure, low-temperature refrigerant enters the evaporator coils inside the cold storage area. Here, it absorbs heat from the stored food items, cooling them effectively. The refrigerant evaporates into a gas during this process.
5. **Cycle Repeats:** The refrigerant, now a low-pressure gas, returns to the compressor, and the cycle repeats.

The system is equipped with components like filters, driers, and sensors to ensure efficiency and reliability. Automation systems, such as programmable logic controllers (PLCs), monitor and control the temperature, pressure, and flow of the refrigerant to maintain optimal conditions.

Components in the Cold Storage Plant:

1. **Compressor (Green Units)**
    - The compressor is the heart of the refrigeration cycle. It compresses the refrigerant (R404A) from low pressure and low temperature to high pressure and high temperature, converting it into a superheated gas.
    - Reciprocating compressors, which appear to be in your system, are commonly used for their reliability in industrial applications.
2. **Refrigerant Piping System**

- The insulated pipes are responsible for transporting the refrigerant between components.
- These pipes ensure minimal heat loss or gain, maintaining efficiency.

3. **Refrigerant Receiver (Horizontal Tank)**
    - This tank stores excess refrigerant to manage varying system demands.
    - It ensures that sufficient refrigerant is always available to maintain continuous operation.
4. **Control Panel**
    - The control panel monitors and controls the entire system, including pressure, temperature, and flow rate.
    - It includes digital or analog indicators, switches, and alarms for efficient operation and troubleshooting.
5. **Filter/Drier (Blue Vertical Tank)**
    - This component removes moisture and impurities from the refrigerant, preventing damage to other equipment.
    - It plays a crucial role in maintaining the longevity and reliability of the system.
6. **Electrical Cabinet (Blue Box)**
    - Houses electrical components, such as circuit breakers, contactors, and relays, to control power supply and safety mechanisms.
7. **Evaporators (not directly visible)**
    - These are located inside the cold storage rooms or freezers.
    - The refrigerant absorbs heat from the stored food products, cooling them effectively.
8. **Condenser (not explicitly shown)**
    - Converts the high-pressure refrigerant gas into a liquid by releasing heat, usually through fans and coils.
9. **Expansion Valve (not directly visible)**
    - Reduces the pressure of the refrigerant, cooling it significantly before entering the evaporator.
10. **Auxiliary Cooling Unit (White Air Conditioner)**

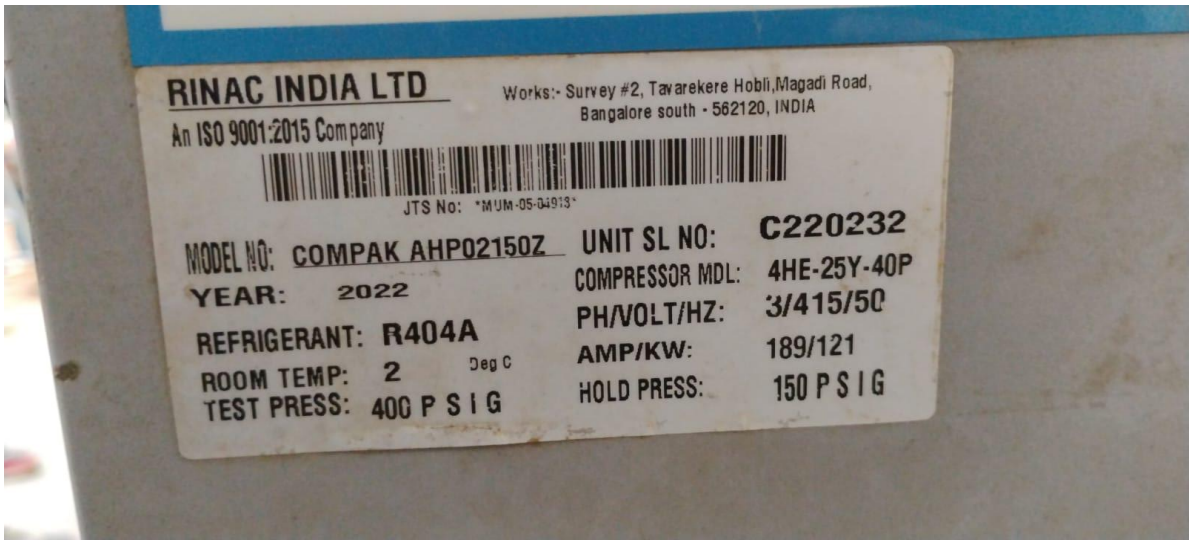
- This could be used to control the ambient temperature of the machine room or for additional cooling of components.

Which type of Cold Storage Technology they use?

The Air Blast Freezing/Chiller's technology used in Rinac's refrigeration systems, such as the COMPAK series, is designed for industrial applications like cold storage and food preservation. These systems typically incorporate advanced vapor compression refrigeration technology, which includes components like compressors, condensers, evaporators, and expansion valves. They use R404A refrigerant, known for its efficiency in low and medium-temperature applications.

Additionally, Rinac integrates energy-efficient practices into their systems, such as high-performance insulation (e.g., polyurethane foam) and automated controls for temperature and humidity regulation. These features ensure optimal performance while minimizing energy consumption.

System Specifications:



Refrigerant Use:

R404A is a hydrofluorocarbon (HFC) refrigerant widely used in commercial and industrial refrigeration systems, particularly for low and medium-temperature applications. It is a near-azeotropic blend of R-125 (44%), R-143a (52%), and R-134a (4%), offering excellent thermodynamic properties for food preservation and cold storage. While it has zero ozone depletion potential (ODP), its high global warming potential (GWP) of approximately 3,922 has led to regulatory measures for its phasedown under environmental guidelines.

The refrigerant operates efficiently in systems designed for freezing, chilling, and refrigerated transport. It is compatible with synthetic polyolester (POE) oils, ensuring smooth operation in modern refrigeration systems. However, due to its environmental impact, R404A is being gradually replaced by eco-friendly alternatives like R448A and R449A, which have significantly lower GWPs.

Regulations such as the American Innovation and Manufacturing (AIM) Act aim to reduce HFC usage by 85% by 2036, encouraging the adoption of sustainable refrigerants. Retrofitting existing R404A systems with alternatives like R449A is a viable option, requiring minimal modifications to equipment. These changes are part of a global effort to transition to refrigerants with lower environmental footprints.

storage methods in cold storage facilities:

1. **Spices:** Spices include dried whole spices (e.g., peppercorns, cloves, and cinnamon) and ground spices (e.g., turmeric powder, chili powder). Whole spices are stored for longer durations compared to ground spices. Cold

storage keeps them in a dry, cool environment at 10°C to 15°C, preserving their flavor and aroma by preventing moisture absorption.

2. **Vegetables:** Subcategories include leafy vegetables (e.g., spinach, lettuce), root vegetables (e.g., potatoes, carrots), and other vegetables (e.g., tomatoes, capsicum). Leafy greens are stored at 0°C with high humidity, while root vegetables like potatoes are kept at 4°C–7°C with moderate humidity, preventing spoilage and maintaining freshness.

3. **Fruits:** Fruits are divided into delicate fruits (e.g., berries, cherries), climacteric fruits that ripen after harvest (e.g., bananas, mangoes), and non-climacteric fruits (e.g., citrus, grapes). Berries are frozen at 0°C–2°C, while fruits like mangoes are stored in ripening chambers at 10°C–13°C initially and then refrigerated.

4. **Dry Fruits (Nuts and Seeds):** This category includes almonds, cashews, raisins, walnuts, and seeds like sunflower and flaxseeds. They are stored at 0°C–5°C in cold, dry chambers to prevent rancidity and preserve their crunch. Vacuum-sealing or nitrogen flushing is common for long-term storage.

5. **Sugarcane Products:** Subcategories include jaggery (solid blocks) and syrups (molasses or liquid sugar). Jaggery is stored at 10°C–15°C in dry conditions to avoid moisture absorption, while syrups are kept below 5°C to prevent microbial growth and crystallization.
6. **Grains:** Grains include cereals (e.g., rice, wheat, maize), pulses (e.g., lentils, chickpeas), and oilseeds (e.g., soybeans, mustard seeds). These are stored in silos at 10°C–15°C with controlled humidity, ensuring their longevity by preventing pests and mold growth.

ADVANTAGES OF FROZEN FRUITS AND VEGETABLES

- The fresh vegetables and fruits closely resemble their frozen counterparts in freshness, since the metabolic activities are arrested to such an extent that all the enzymes are inactivated and microorganisms are under control.
- The taste, flavour and colour of fruits and vegetables are preserved to a maximum.
- They have high nutritive value since the retention of nutrients is maximum.
- Since frozen vegetables have already been subjected to a heat treatment they require less time for cooking thus saves considerable time in kitchen and also saves fuel.
- Greater convenience in handling and preparation.
- Freezing is a suitable choice for preserving fruit juices containing anthocyanin and carotenoid pigments since the retention of pigments is maximum.
- They offer more hygienic food
- Cent percent edible portion of food of food in each package
- Since the degradative effect of heat treatment is bypassed in this, the method of freezing can retain the pigment of such fruit juices and concentrates in its best form
- Freezing can also serve as an intermittent technology for preserving commodities in bulk and supplying in a different form when demand arises eg peas can be frozen in bulk quantities and during demand defrosted put in a brine solution packed in flexible pouches and circulated in market whenever required.
- Value for money especially off-season
- No pollution problem in consuming areas
- The waste collected during freezing can be utilized for production of value added products.

FREEZING TECHNOLOGY

Air-Blast Freezing

What Is a Blast Chiller?

A blast chiller offers a unique advantage over regular refrigeration. It allows you to lower the temperature at the core of freshly cooked foods from +70°C to up to +3°C in less than 90 minutes, enabling you to take control of the cook-chill process.

What Is a Blast Freezer?

Blast freezer works on a similar principle but further lowers the temperature to freeze the food. It is ideal for all food products that need to be preserved at a storage temperature -of 18°C at the core of the product.

Blast freezer or shock freezer reduce cooked from +90°C to -18°C within a period of 240 minutes. Since the freezing process is rapid, only small ice crystals are formed in the food product as compared to large ones in traditional freezing. The large crystals when thawed can damage the cell wall and thus the integrity or quality of the food. Small crystals on the other hand do not cause such damage and keep the food texture, quality, and integrity intact.

Why Do you Need Blast Freezer and Chiller?

High bacterial proliferation is observed when the food temperature is between 10 and 65°C. According to HACCP (Hazard Analysis Critical Control Point) guidelines, cooked food which is not immediately served or held heated needs to be chilled in order to limit the growth of bacteria. To chill food to a safe holding temperature, it must be cooled from +70ºC to +3ºC or below within 90 minutes to maintain the consistency in quality, texture, taste and aroma.

Here are some of the benefits of using a blast freezer and chiller.

- **Improves food quality:** Cooked food starts losing its characteristics due to bacterial growth. Therefore, to maintain food quality, it is important to control the temperature at the right time. This is where the blast freezer and chiller can help keep the food quality intact due to rapid freezing under controlled conditions.
- **Prevents weight loss:** It is common for food items to lose moisture content and thereby weight over a period. With appropriate chilling methods using an industrial blast chiller, moisture content can be locked to avoid food dehydration.
- **Increases choices in commercial kitchens:** Commercial kitchens can get very busy and with a vast menu, food refrigeration becomes a necessity to cater a wide range of customers. This will give the staff more time for catering to the customers and keep them ready to meet any unexpected demands.
- **Improves food safety:** Correct use of blast chillers can help businesses achieve food safety standards outlined by the HACCP, i.e. cooling from +70ºC to +3ºC or below within 90 minutes for intact quality, aroma, and flavor.
- **Enhances shelf life and reduces wastage:** Since lower temperatures restrict bacterial growth, the shelf life of the food is improved. This means increased stick for sales as well as reduced food wastage.
- **Saves time and money:** Since commercial kitchens or caterers have the option to safely store large batches of food, they can buy ingredients in bulk without the fear of food wastage. Moreover, with more time, you can use your kitchen for better resource utilization and save energy by making better use of your kitchen equipment.

STORAGE CAPACITY

Blast Freezers (capacity of 250—3000 kg) & Blast Chillers (capacity of 60—500 kg)

These units are equipped with :

- Controlled air circulation system for uniform freezing whilst protecting the food surface
- ***Temperature control***
    1. Blast freezing to a temperature of -18 °C to -25 °C at the core of the products for micro crystallisation.
    2. Blast Chilling from 70 ºC to 2 ºC in 90 min
- Power-efficient refrigeration system
- Strengthened floor with synthetic, clean finish capable of sustaining total loading, eliminating the need for RCC (reinforced concrete) or tiling
- Robust white laminate exterior as standard–PVC (polyvinyl chloride) coated or SS (stainless steel) 304


WHEAT
JAGDISH
Galaxy A35 5G