A REPORT ON THE INDUSTRIAL VISIT TO

SHIVA SUPREME COLD STORAGE PLANT

MINJUR, CHENNAI

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Submitted by

M.E. THERMAL ENGG WITH SPLN. R & AC

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ACKNOWLEDGEMENT

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We solemnly express our gratitude to our Professor, **Dr. R. Saravanan,** R&AC Division, for providing us an opportunity to visit Shiva Supreme Cold Storage, Minjur, Chennai. We also extend our gratitude for his guidance, support and encouragement in learning the technologies employed in cold storage plant.

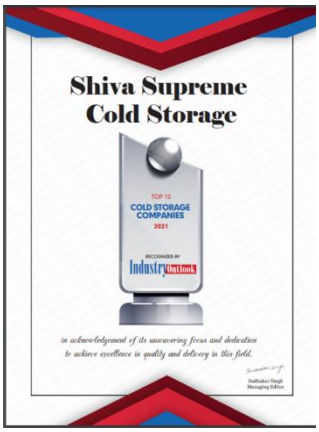
We sincerely thank our Assistant Professor, **Dr. P. Balachander**, R&AC division, for accompanying with us and giving insight about cold storage plant.

We specially thank the General Manager, **Mr. G. Muthumanickam** and Field Engineer **Mr. Pushparaj** and employees of **Shiva Supreme Cold Storage**, Minjur**,** Chennai, for their extended support for the successful completion of the visit.

We express our sincere thanks to Logistics Department, College of Engineering Guindy – Anna University, for providing us transport facility to visit the plant.

About the firm:

Shiva supreme cold storage facility is an exceptional cold room plant deployed for the storage of food products like grains, pulses, dry fruits, spices, and fruits, having a total cold storage capacity of **5000 metric tonne**.



Shiva supreme cold storage plant was awarded "**TOP 10 COLD STORAGE COMPANIES 2021**" by the *Industry Outlook* firm on behalf of offering best-in-class cold storage services and efficient food supply management solutions.

The facility maintains a temperature range of 6-10ºC depending on the nature of produce being stored. The facility is divided in two sub sections, Chamber A and B.

Introduction:

- Storage space temperature of about 6-10°C has been maintained inside both the chamber A and B.

- In chamber A pulses like black gram, bengal gram, green pea, chickpeas, split gram lentil, tur dhal etc., has been stored.
- In chamber B dry fruits and spices like cinnamon, dates, star aniseed, toor whole etc., has been stored.

Working compartment of the cold storage plant

1. Evaporator unit (Cold storage space)
2. Compressor unit
3. Condenser unit
4. VFD unit

System design and construction:

Food products on the ground floor was mounted on the raised floor of rectangular plastic pallets in order to diminish the transmission load from the floor area and to ensure the air circulation on the floor space. This is not needed on the upper floors as the intermediary floors are rack of metal rods which facilitate air flow by the nature of their construction.

Since the evaporator coil unit was mounted on the second floor of the cold room, hence the partition in between the floor was erected in the form of grill instead of concrete in order to ensure the complete flow of cold air from the evaporator end to the ground floor space.

Evaporator:

Being a medium sized facility, with 600 TR of refrigeration capacity, the refrigeration is done by the sole refrigerant R-404A through a simple vapor compression refrigeration cycle. The evaporator unit has a total capacity of 400 kW, with 10 separate units of 40 kW capacities with 5 units for each chamber.

The refrigerant is sent through a U tube line before evaporator which acts a receiver and helps in removal of air bubbles into the evaporator. The evaporator is a flooded type with axial fans circulating air through the coils and into the chamber. These fans are the only means of heat transfer as no additional duct works are present for further circulating air through these 3 storied storage facilities, as a result a noticeable temperature gradient is present in the facility across each floor.

Accumulator:

The refrigerant is then sent to the compressor through an accumulator which acts as a storage and a buffer unit during lean and peak periods respectively. A total of 800 kg of R404 A is present in the system and a majority is held in the accumulator during operation.

Compressor:

The compressor unit is a rack system of 5 individual 3-cylinder V-line reciprocating compressors of each 80 kW, totaling to a 160 kW of power. For most of the time, the compressor unit runs on standby mode i.e., part load condition.

In the rack system, only one compressor runs during this standby mode and the active compressor is chosen depending upon the number of hours ran.

This multi-compressor system allows for backup in case of failure of other compressor. Two visual dials are present to indicate oil levels in the compressor and the crankcase respectively. An oil separator separates oil and refrigerant with the oil passing into an oil storage tank and the latter passing on to a condenser.

Condenser:

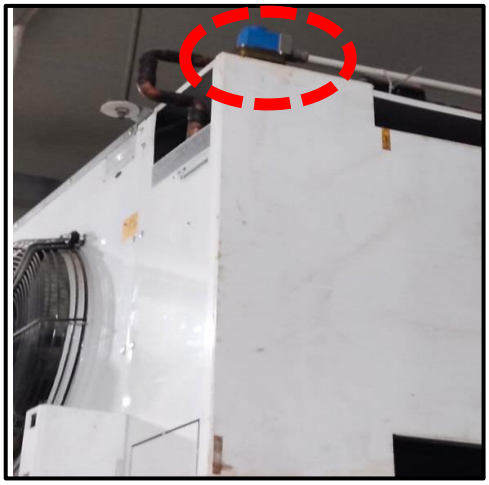
The condenser unit consists of two shell and tube heat exchangers with R404A as the tube fluid (Condensate) and water as the shell fluid (coolant). The condenser unit has a total of 480 kW capacity and hence runs on standby condition by using one of the either condenser. The twin condenser setup also allows for

redundancy and backup in case of repair and maintenance. A valve is present to allow for charging in refrigerants.

Cooling tower:

A 600 kW **blow through*** cooling tower unit with water as working fluid is used for condensing the Freon refrigerant. In order to prevent scaling and corrosion of water with working machinery, softeners are used. Softeners reduce the hardness of the locally sourced water by absorbing the salt present. These softeners are a mixture of lime, calcium and resin and are stored in two tanks.

Expansion device:



The refrigerant is then sent through a solenoid expansion valve for throttling and then into the evaporator to complete the refrigeration cycle.

The solenoid expansion valves are personalized for each evaporator unit so that in case of leakage the particular refrigeration circuit can be shut off for repair while the rest of the system can stay functional.

System Circuitry:

The entirety of the system is controlled and monitored with a PLC system circuit board. The circuitry is 66% star connection and 34% delta connection. The facility runs on a 240 Volt, 81 Ampere, 50 Hz frequency power supply. Data logging and monitoring is done manually with pen and paper with minimal automation.

Heat load mitigation and facilty design:

Being a medium temperature cold room, it does not require an anteroom for reducing infiltration heat load, as an air curtain suffices in its capacity. In order to prevent infiltration through walls, a PUF panel insulation of 20 cm thickness is placed on the inner walls and silicon panels are installed on the exterior to minimize solar heat gain. The panels are of white color to enhance reflectivity. To minimize heat loss through the floors of the facility the basement consists of a 10 feet concrete foundation with another layer of thermocol followed by a layer of

tar. Since the temperature doesn't go below subzero heating coils were not integrated to the foundation of the building.

Product processing and storage:

The entire storage facility is designed for 5000 metric tonnes of storage with a maximum of 500 tonnes of loading per day. Thorough inspection is done to ensure no wet commodity is allowed in as even a single wet sack will spoil a large number of other products in its vicinity. Quality control is done every week by measuring the temperature and moisture content of the products. Products of poor quality are removed from the facility and isolated and the client is informed as such. Fruits need closer monitoring as they are susceptible to spoilage more than any other product.

Fumigation is done off-site prior to loading into the cold room by the client. Pest and rodents are not an issue in the cold rooms as the low temperatures suffice in deterring them effectively. Once through these tests, the products are ready for long term storage depending upon client need.

The loading is done starting from the lower floors and then upper stories are filled. A conveyor belt mover is used for transporting the products across each floor during both loading and unloading.

Only in the ground floor, the product is stored on an elevated platform to have a continuous air flow circulation through the underside of the sacks for faster cooling.

Despite having R404A (Freon) as the working refrigerant, a flammable gas on exposure to air, the facility lacks in specialized fire retardation and mitigation accessories. Using conventional sprinkler with water is as detrimental to the produce as the fire hazard due to risk of spoilage. Currently it has only CO_2 canisters which will be operated by personnel to contain fire. The facility also has no means of monitoring fire in the remote parts.

Thanks note:

Overall we had a brief exposure about the complete working cycle of a cold storage plant of 5000 metric tonne capacity. It gave us the practical real perspective of vapour compression cycle operated for the purpose of food products cold storage unit.

It was an esteemed experience to actually take a look at whatever we had studied about the theory on cold storage unit design and working in our course "**RA5010 - Food Processing, Preservation and Transportation**".