COLD CHAIN DEVELOPMENT IN INDIA - MODERNIZATION OF THE INFRASTRUCTURE OF COLD STORAGE OF PERISHABLES

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ABSTRACT

COLD CHAIN is now recognized as a sunrise sector in India. It is true that in a country which ranks first in milk production in the world, is number 2 in fruits & vegetables production and has substantial production of marine, meat & poultry products, the country needed a fully developed cold chain sector. However the current scenario reveals that there is a tremendous scope for the development of cold chain facilities.

Cold stores form the heart of the cold chain. An overview of the cold storage industry in India indicates that the cold stores have been established initially right from the beginning of twentieth century but the further development was fairly slow. These units were mostly designed for storage of potato and were located in areas like UP, West Bengal, Punjab, Bihar etc. It was only in Sixties that the idea of multi product, multi chamber cold stores was introduced with Maharashtra taking the lead.

The cold storage sector is undergoing a major metamorphosis, with the Govt focusing on food preservation. A lot of stress is being laid on energy efficiency as the cold stores are energy intensive.

With the advent of newer materials / equipments, every part of a cold chain renders itself amenable for improvement. As a result type of construction, insulation, refrigeration equipment, type of controls – all of them are witnessing changes.

Realising the significance of the cold chain industry, it is heartening to note that the Govt has taken initiatives, thru bodies like NHB, to establish standards for all the arms of the cold chain. Efforts are also being made to evolve a new concept – 'Green Cold Chain'. In short the Cold Chain Industry is in the eye of a revolution.

The paper would cover the development of cold storage sector in India with progressive changes in pattern of utilization, designs, construction practices and energy saving concepts.

INTRODUCTION

At the time of Indian independence there were only a few cold stores mainly located in U.P, Punjab & West Bengal. Most of these were bulk cold stores designed for storage of potatoes. These were mainly based on old technology of construction, thermal insulation & refrigeration systems with practically no automation systems.

One of the oldest multi chamber cold stores was located in Fruit research station at Pune and was supposedly installed in 1932 during the British rule. This was mainly an experimental station with seven cold rooms which worked on a common brine chilling plant. The unit was mainly used for studying the cold storage parameters for a variety of fruit & vegetables grown in India. This showed that the concept of multi-product cold storage was realised even during the thirties. A few cold stores did exist in Mumbai in the '50s with a number of small chambers mainly used for potato, some fruits & dry fruits.

During the period between '50s & '60s the development of the cold storage industry was mainly confined to the states of UP, Punjab, Delhi, Bihar, West Bengal, MP & Gujarat where cold stores of medium and large sizes were set up, but these were mainly bulk storage units for potatoes.

However the major development of the concept of multipurpose cold storage unit happened between 1965 to 1970 when a few units were established for storage of a number of products in Bangalore & Pune.

MAFCO, a Govt. Undertaking in Maharashtra, established around 1970, played a significant role in promoting the concept of multipurpose cold storage, food processing, freezing & storage of frozen foods and was followed by some private promoters but they were few in numbers.

The capacities of multipurpose units, generally, ranged from 1000 MT to 20,000 MT. The largest multipurpose unit with a capacity of 22,000 MT is located in Turbhe industrial area in Navi Mumbai (M/s.Savla Foods & Cold Storage Pvt. Ltd). Presently the multipurpose units store a large number of food products such as fruits and vegetables, dry fruits, spices, milk products, confectionery, all types of frozen food etc.

Growth of Cold Storage Industry

The perishable food production is estimated as:

Milk	:	115 Million MT	(No.1 in the world)
F & V	:	200 Million MT	(No.2 in the world)
Fish	:	6.4 Million MT	
Meat	:	Largest cattle population in the world	

Food processing sector is growing year by year. From a small 2% processing of capacity, is now at 6% of Fruits & Vegetable production & the rate of growth is now 14 to 15%. The target for F & V processing in the next few years has been set at 20%. This shows that there is a great potential for growth of cold chain sector in India.

The growth of the cold storage industry in India from the year 1955 to 2008 is shown in Table 1. The distribution of cold stores in different regions of India has not been uniform as will be evident from Table-2 which shows regionwise break-up of numbers of cold stores in different regions based on data available for the year 2007. Fig-1, additionally shows this regionwise distribution. Table-3 indicates the capacities in MT of cold stores in different regions. Table 4 – shows sectorwise (Public, Private & The Cooperative sectors) distribution of cold stores based on year 2007. Table – 5 shows productwise distribution of the cold storage capacity in 2007.

Table 1 - Growth of Cold Storage Industry in India

Year	No.of Cold Stores	Installed Capacity in '000 MT
1955	83	43
1960	359	305
1965	600	682
1970	1218	1638
1975	1615	1994
1979	2266	3348
1986	2607	5402
2004	4748	19552
2006	5101	21694
2007	5316	23334
2008	~ 6000	~ 25500

Table – 2 Regionwise No. of Cold Stores in India

	CENTRAL	EAST	NORTH	SOUTH	WEST
Base year 2007	352	947	2386	778	853

Fig - 1 Regionwise distribution of Cold Stores in India

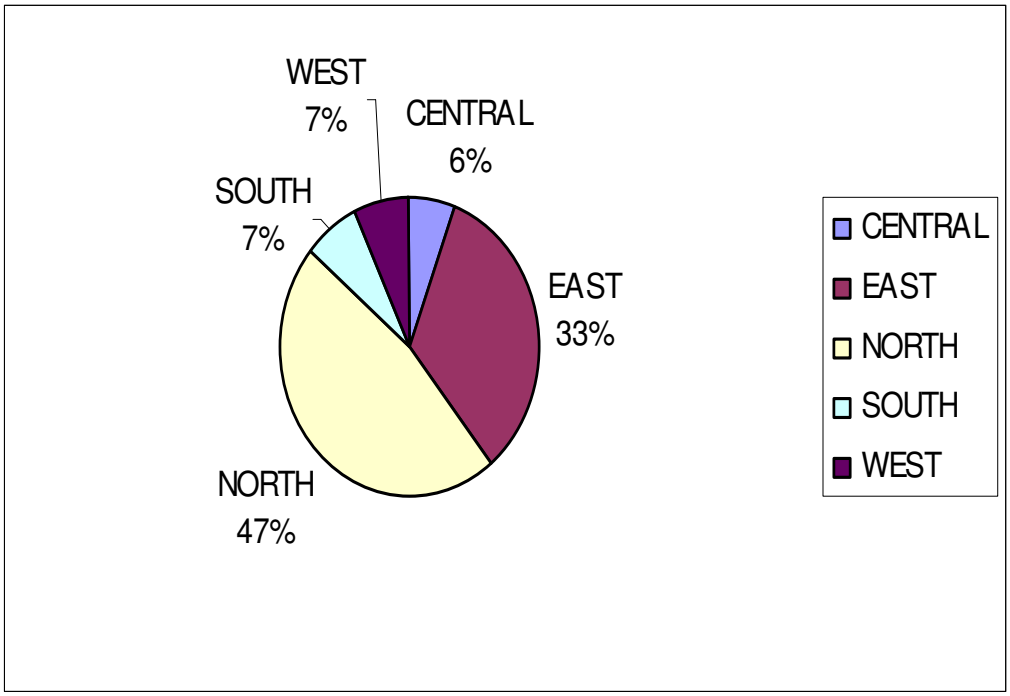


Table – 3 Regionwise capacity (in '000 MT) of Cold Stores in India

	CENTRAL	EAST	NORTH	SOUTH	WEST
Base year 2007	1367	7784	10968	1566	1647

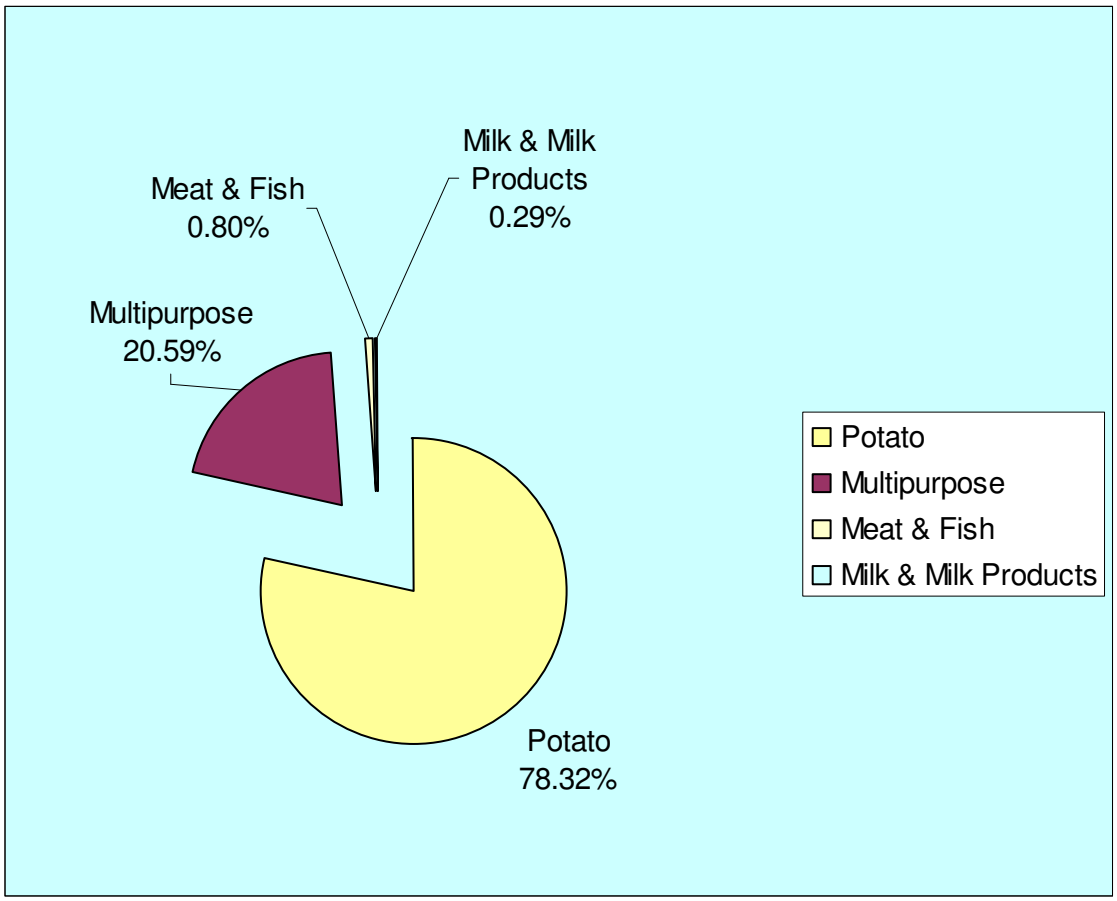
Table – 4 SECTOR-WISE DISTRIBUTION OF COLD STORES

	PRIVATE SECTOR		COOPERATIVE SECTOR		PUBLIC SECTOR		TOTAL NOS.	TOTAL CAPACITY IN '000 MTs
Base Year 2007	Nos.	Capacity In '000 MT	Nos.	Capacity In '000 MT	Nos.	Capacity In '000 MT		
	4820	22244	363	989	133	101	5316	23334

Table – 5 COMMODITY-WISE DISTRIBUTION OF COLD STORES

	POTATOES		MULTIPURPOSE		MEAT & FISH		MILK & MILK PRODUCTS	
Base Year 2007	No.	Capacity in '000MT	No.	Capacity in '000MT	No.	Capacity in '000MT	No.	Capacity in '000MT
	2992	18255	1386	4718	513	186	191	68

Fig - 2 Commoditywise distribution of Cold Storage capacities in India



Precooling of F & V

The concept of pre-cooling of grapes was introduced in the '80s primarily in Maharashtra, which is the leading grape growing state in India. This helped the farmers to export grapes to Europe, Gulf countries etc. Later this technology was adopted for other fruits like mango, pomegranate, oranges etc.

Controlled Atmosphere storage

With the onset of 21st century, the need was realized to set up controlled atmosphere following the trends in Europe, America & other countries. A number of CA stores have already been established in the northern part of the country at locations which have proximity to apple growing regions. The capacities generally ranged between 1000 MT to 12000 MT. The project of 12000 MT set up by CONCOR is the largest in the country so far. A few units of smaller capacities have also been established in west and south.

Ripening Units

There has been considerable interest in scientific ripening and storage of food like banana, mango etc. in recent years and the units are being established at a number of places. A good development in this direction can be seen in the south, Gujarat & Maharashtra.

Distribution centres

With the growth of cold chain in the country, the food distribution centres are also being established in the country, with the first such unit constructed in Navi Mumbai region. A number of smaller centres have been set up by the food retail sector and a further growth is expected in the coming years.

Cold Storage classification

As per the present day practice, the cold stores can be classified as follows:

1. Bulk Cold Stores – Generally for storage of a single commodity, which mostly operate on a seasonal basis e.g. stores for Potato, Chillies, Apples etc.

2. Multipurpose Cold Stores designed for storage of variety of commodities which operate, practically, round the year. The products stored in these types of cold stores are Fruits, Vegetables, Dry Fruits, Spices, Pulses, Milk Products etc. These units have been mainly located near the consuming centres.

3. Small cold stores with precooling facilities for fresh fruits and vegetables, mainly, for export oriented items like Grapes etc. The major concentration of

these units is in Maharashtra but the trend is now picking up in other states like Karnataka, Andhra, Gujarat etc.

4. Frozen food stores with or without processing and freezing facility for fish, meat, poultry, dairy products and processed fruits and vegetables. These units have helped the promotion and the growth of frozen foods sector, both in the domestic and the export markets. However the percentage of foods so processed is extremely low and a great potential exists for growth in this category.

5. Mini units / Walk-in cold stores located at hotels, restaurants, malls, supermarkets etc.

6. Controlled Atmosphere (CA) Stores for certain fruits/ vegetables like apples, pears, cherries.

7. Ripening chambers mainly setup for Bananas & Mangoes

Trends in Construction Practices

Whereas the bulk cold stores have fewer number of large sized chambers the multi-purpose units have a larger number of smaller chambers designed for simultaneous storage of a variety of items to suit the needs of the farmers, traders and other customers.

The general types of construction followed in Indian cold storage industry are as under :

1. Conventional buildings with RCC frames, brick walls and truss type sheet roofs or RCC slabs with internal floor structure of RCC or Steel frame with wooden or steel grating.

2. Buildings with single floor structure designed for mechanized loading and unloading of products.

3. Pre-engineered building structures designed with cold chambers constructed from sandwich insulated panels. The recent trend is to have cold chambers in single floor construction with heights varying from 5 to 12 M or higher with mechanized loading / unloading facilities. Some units have racks for stacking the goods.

Recent Practices are:

Walls & Ceiling	:	Insulated panel construction
Roof	:	Sheet metal roofing on trusses
Internal Structures	:	a) Steel structure with steel grille floors for conventional loading

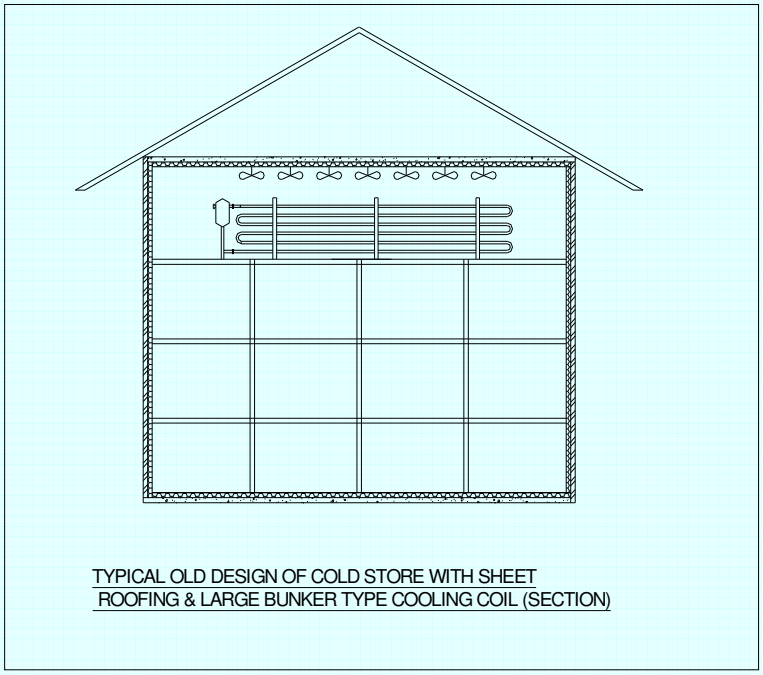
b) Racks for mechanized loading

The construction practices in India vary depending on the size of the unit, the location and the pattern of utilization.

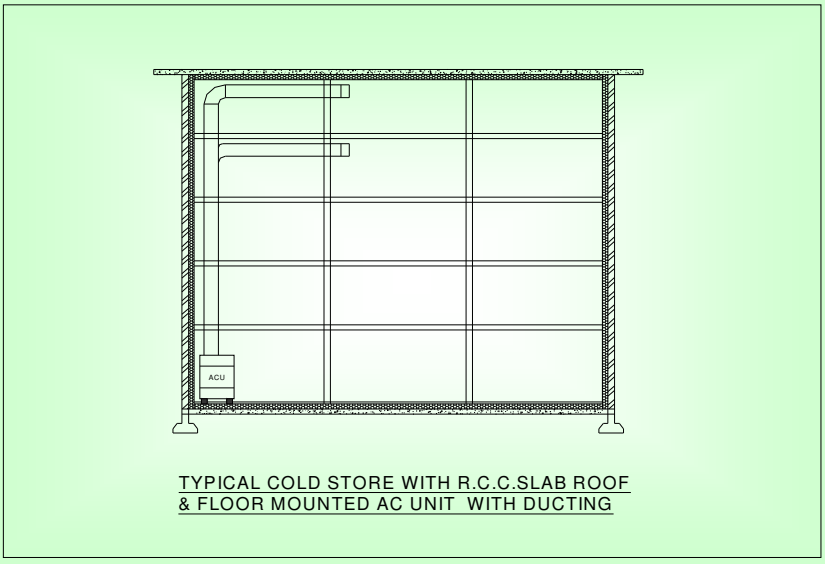
The small cold stores usually have sandwich panel construction.

In case of medium & large cold stores, the facilities involve a) Loading / Unloading areas b) Ante Rooms c) Cold Storage chambers d) Stair cases & Lifts e) Machine Room f) Office & Toilets etc. The conventional buildings have multi-floor chambers where loading and unloading is done manually. The floor height ranges from 2 to 2.5 M and the number of floors from 3 to 6.

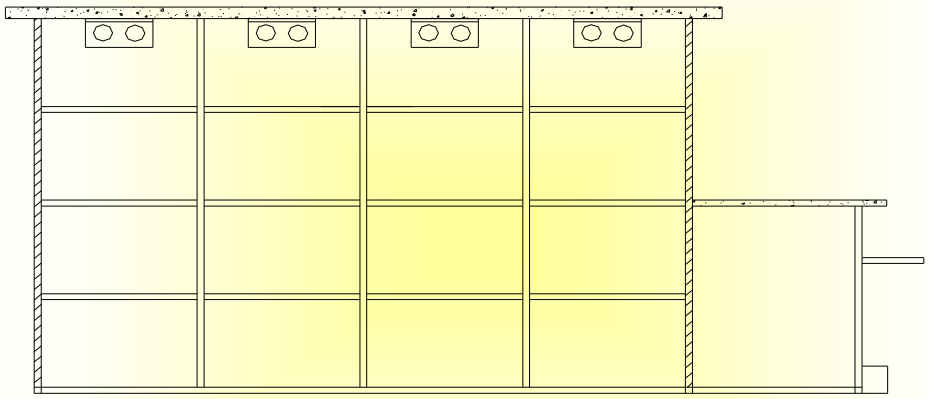
The evolution of the cold storage construction practice is shown below in four figures.



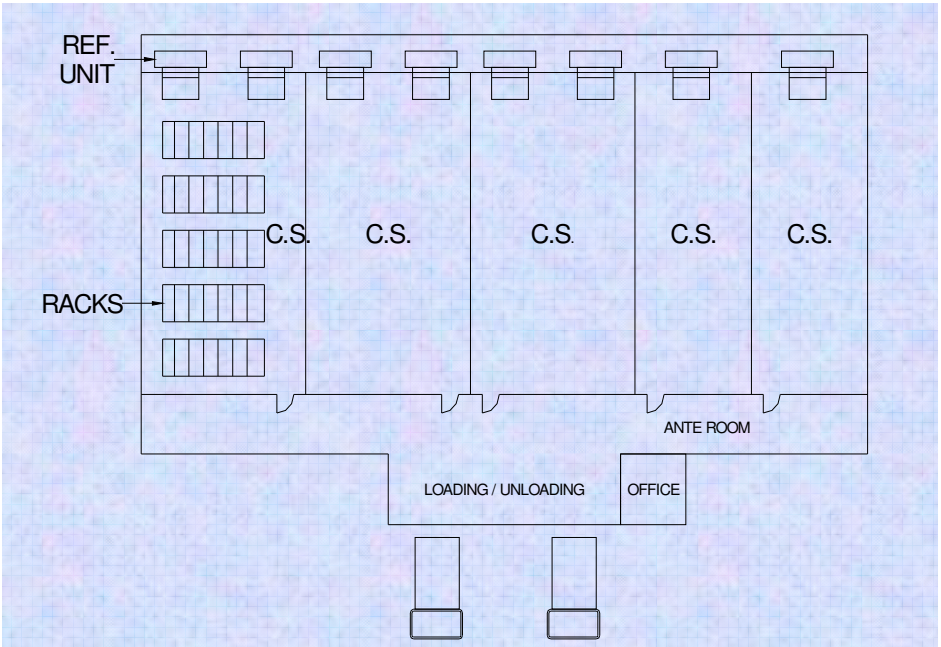
TYPICAL OLD DESIGN OF COLD STORE WITH SHEET ROOFING & LARGE BUNKER TYPE COOLING COIL (SECTION)



TYPICAL COLD STORE WITH R.C.C.SLAB ROOF & FLOOR MOUNTED AC UNIT WITH DUCTING



TYPICAL COLD STORE WITH CEILING
SUSPENDED AC UNIT



TYPICAL COLD STORE WITH INSULATED PANEL
STRUCTURE & MODULAR REF. UNIT
WITH MECHANISED HANDLING - PLAN

Trends in Thermal Insulation Practices

The Thermal Insulation is an extremely important component in a cold chain system. It has two vital functions to perform –

1. To minimize the flow of heat from the surrounding to the inside space
2. To minimize the flow of moisture from surrounding areas to cold chambers

It is, therefore, important to select proper material, thickness, vapour barrier, cladding & the method of application to ensure that the basic objectives of providing the thermal insulation are fulfilled in the best possible manner. Whereas the refrigeration system may work for certain number of hours, depending on the load requirement, the insulation has a continuous 24 x 7 duty to perform for the entire period of storage.

Insulation Materials

In some old units cheaper material like Rice Husk was used as the thermal insulation. Although the insulation itself is very cheap, it necessitated very large insulation thicknesses and also caused maintenance & hygiene problems. This method is almost extinct.

In cold stores, having conventional construction, built after '70s, the practice has been to use insulation materials like Expanded Polystyrene (EPS), Fiberglass, Polyurethane Rigid Foam (PUF) or similar materials. Recently materials like Extruded Polystyrene (XPS) has also been introduced.

The old practice in case of conventional construction was to fix the insulation with bitumen as vapour barrier and using wooden pegs and batten frame work, covered with chicken wire mesh and cement and sand plaster. However the current practice is to avoid the use of wooden battens and use metallic runners instead to support the sheet metal cladding which is generally profiled precoated sheets.

Sandwich Insulated Panel Structure

The development of insulated panels has brought in a revolution in cold storage construction the world over. Although, these panels have been in use for cold storage construction for over four decades in the developed countries, in India, the sandwich panels were introduced about 25 years ago. The sandwich panels are, mainly, available in two types.

1. Expanded Polystyrene (or popularly known as EPS) panels with EPS bonded to the sheet metal skins by using a special glue.

2. PUF panels using Polyurethane as insulation material foamed between the two metal skins. These panels are structurally strong and have a better insulation value as compared to EPS panels for a given thickness.

Insulated panels have been used for making cold stores, right from the small walk-ins to very large cold stores. In fact the application of panels has gone beyond the cold stores sector and the panels have been used for the construction of the processing plants, prefabricated houses, ware houses, clean rooms, etc. The panels have also been used for fabricating the doors for the cold stores which are light and simple in construction as compared to the conventional insulated doors.

The panels offer grater flexibility and a faster construction pace apart from better thermal efficiency due to better isolation between outside and inside. The use of panels eliminates brick walls and RCC slabs thereby increasing the cold store volume for a given foot print. The major advantage is the possibility of modular construction with ease of addition / expansion. Panels are available with different types of skin finish and offer a better hygienic quality of the structure.

Trends in Refrigeration System

Over 90% of the cold store units built in the north & eastern sector were based on old technology involving use of slow speed Ammonia refrigeration compressor without any capacity control, atmospheric condensers and either bunker type evaporator coils or floor mounted air cooling units (diffusers) with ducting for air distribution. These plants were not very energy efficient due to lack of capacity control, loss of expensive cold storage space for large sized bunker coils or diffuser units and associated ducting.

The current practices involve energy efficient designs of equipment and use reciprocating and screw compressors with capacity control, evaporative condensers with M.S (hot dip galvanized) or S.S coils and ceiling suspended finned air cooling units using M.S or S.S coils with Aluminium fins. The types of fans used in the units have S.S / Aluminium or FRP blades. The FRP option offers the benefit of lower H.P motors for the fans.

The Refrigeration Systems for the cold storage application can be classified as:

1. Modular units using HFC / HCFC refrigerant.

2. Central plants using HFC / HCFC refrigerants with air cooled / water cooled machines.

3. Central plants using ammonia refrigerant.

4. Vapour absorption system using ammonia water combination. This System is now being considered for rural areas due to availability of alternative fuels like biogas, agrofuel etc.

Material Handling

The flow of products to and from the cold store is an important aspect in cold storage functioning. In the conventional cold stores the loading and unloading of products is still done manually. However, in recent installations the practice is to use electrical hoists / lifts and / or fork lift trucks for handling of products. These storages incorporate rack structure in the chambers for storing the product in pallets or boxes. Arrangement for loading of pallets in Containers / Reefer Vans is also provided in the modern cold store units. Application of computers to control the loading, unloading operations and to maintain the record of stocks is also in practice in some of the recent colds stores.

Energy Saving

Cold storage is the heart of the cold chain. Refrigeration is the fundamental process for cooling, precooling, freezing & cold storage. Among the various methods of food preservation, refrigeration is the best one and there is no substitute for refrigeration in terms of quality and extended life. However, refrigeration is an expensive process, both in terms of first cost and energy cost. Lack of adequate energy supply and rising energy rates are serious problems faced by cold storage sector. The need for adopting various energy saving methods is now being increasingly realized by the Owners and Manufacturers in the sector.

The 'Green Building' movement has attracted the attention of the planners, designers, builders and contractors the world over. The author has also propagated the concept of 'Green Cold Chain' involving green cold stores in India.

Conclusion

An overview of the cold chain system in India over the past 50 to 60 years shows that the cold storage construction technology, the practices of thermal insulation, refrigeration plant technology, automation and material handling have undergone significant transformation. From the point of view of utilization also, the cold stores today offer much wider scope than in the past. Energy saving and the Green Cold chain concept are also being seriously looked at by the progressive entrepreneurs and designers.

However it must be realized that for a country which is No.1 in terms of milk production and No.2 in terms of F&V production, the overall storage capacity of around 25 million MT of cold storage available in the country cannot be

considered adequate and there seems to be a good potential for the development of modern & energy efficient storage units.

National Horticultural Board has taken a big step in creating technical standards for cold chain projects. The following three standards have been developed with help of experts in the industry and are available to the promoters & designers of cold chain projects for reference.

(i) Cold storages for storage of fresh horticulture products which do not require pre-cooling.

(ii) Multi-commodity Cold storages for short term and long term storage of fresh horticulture products which require pre-cooling and varying storage requirements.

(iii) Controlled Atmosphere (**CA**) Storages.

Apart from these, the standards on ripening chambers & refrigerated transport have also been recently released for public review.

It is worth mentioning that this is the first attempt of any Govt. agency to formulate such standards for cold chain projects in India. efforts are on, for making standards for Ripening chambers & Refrigerated Transportation. Govt. agencies like National Horticultural Board, National Horticultural Mission & Ministry of Food Processing have also offered higher financial incentives for the new projects as well as for expansion of existing units. However, these projects have to be, essentially, based on modern & efficient technology in tune with the technical standards.

A scientifically developed Cold Chain, designed to handle and preserve the substantial quantity and excellent quality of food products grown in the country, would turn into a ‘Gold Chain’ for the country.