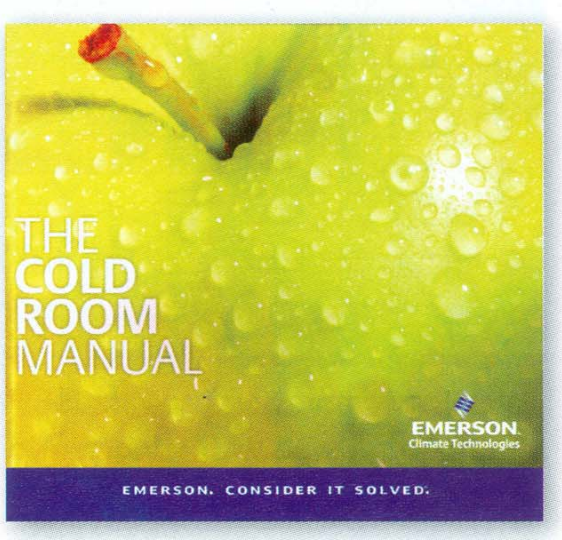
Emerson Climate Technologies releases The Cold Room Manual

At well attended functions held in Pune, New Delhi, Mumbai, Ahmedabad, Chennai and Bengaluru, Emerson Climate released a manual on cold room design, written by Ramesh Paranjppey, a well known consultant in Pune, ASHRAE Fellow Life member, past president of ISHRAE, Pune, with over years experience in the refrigeration and cold storage field.

The Manual includes all the basic information pertaining to design, construction and selection of equipment for cold rooms, is colourfully printed in easy-to-understand language and consists of a total of 74 pages only.The extensive information provided in these pages has been collected on the basis of feedback received from industry professionals during a series of technical seminars conducted jointly by Emerson Climate and Paranjpey in major cities of India.

An effort has been made to present the information in a simple step-by-step manner in four chapters and two annexures. The various chapters with their descriptions are:

1. **Introduction to a Cold Room:** Cold rooms can be termed as large size walk-in coolers for short term storage of perishables like fruits, vegetables, meat and fish, dairy products or special products like medicines, chemicals and films.
2. **Cold Room Design:** The process of designing cold rooms requires thorough understanding of key factors such as environment friendly equipment, high reliability, proper condenser air circulation, temperature control, minimum maintenance, adequate insulation and proper vapour barrier.
3. **Heat Load Contributors:** The amount of heat to be removed within a certain period has to be carefully worked out and the various contributors to the heat load are listed and preventive measures to reduce their impact are explained.
4. **Installation and Handling:** The best practises to follow, a list of Dos and Dont's, storage techniques, and the importance of humidity control are all explained, in addition to several other items



Those who wish to obtain a deeper insight of the subject can refer to the *ASHRAE Handbook on Refrigeration, Emerson Refrigeration Manual* and take also advantage of the Emerson Online University.

Common Problems Faced in Refrigerated Storages – Possible Causes & Likely Solutions

By Ramesh Paranjpey
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There is a sudden spurt in the cold storage industry due to various government incentives and increasing demand in the export market. Many entrepreneurs are entering this market and constructing cold rooms/cold storages for preservation of fruits/vegetables and other perishable commodities. This article will help in understanding various problems which are faced by cold storage owners and possible causes and suggestions to overcome them. The article does not address issues pertaining to the refrigeration system design and deals with common problems associated with construction, selection and other areas which need to be considered. so that subsequent problems are avoided.

There is Condensation on Walls and Ceiling

This condition is observed in most of the older cold storages where insulation is applied to the inner surfaces of walls and ceilings, especially on beams. Modern cold stores with PUF panels having lamination on either side generally do not have this problem.

Possible causes

a. Vapour barrier missing or punctured or not applied properly
b. Doors not sealing properly and allowing infiltration of outside warm air

Possible Solution

a. Replace wet insulation after providing vapour seal on the walls and ceiling and then re-apply insulation layers.
b. Inside surfaces to allow moisture access into the room so that moisture does not get trapped in the insulation. If at all, it penetrates from the exposed surfaces to room air, gets mixed with the air circulating in the cold room and finally deposited on the coils in the form of frost. Subsequently, it is removed during defrosting as condensate
c. Check cold room door gaskets, replace them if necessary to make doors air tight, check door alignment and floor level seals.

Ceiling is Dripping

Possible Causes

a. Poor attic ventilation allowing build up of hot, humid air in the attic
b. Insufficient attic insulation causing condensation which drips though cracks
c. Improper installation of or missing vapour barrier

Possible Solutions

a. Provide attic ventilation so that air does not stagnate
b. Add adequate insulation to prevent warm, attic side insulation from approaching the cold room temperature of the storage below the ceiling.
c. Determine vapour pressure drive direction. Vapours will flow from higher pressure region to lower pressure. Apply vapour barrier on the higher vapour pressure side.

Floor is Drying Quickly even when Water is Sprayed on the Floor

Possible causes

a. Storage relative humidity is too low
b. Floor has cracks from which water is escaping

Possible solutions

a. Install more coils and operate them at lower temperature difference between room air and cold air leaving the coil. This reduces dehumidification
b. Install humidification equipment to supply atomized mist. Remember, it is impossible to put water back into the product if it is getting dehydrated due to large temperature difference.
c. Flood water on the floor to detect cracks in the concrete foundation and seal them wherever necessary.

Walls and/or Ceiling is Rotting and Mouldy

Possible causes

a. Moisture migrating into wood cladding/structure
b. Improper installation of, or missing vapour barrier

About the Author

Ramesh Paranjpey is a mechanical engineer with an M.Tech in refrigeration from IIT Bombay with over 35 years experience. He has worked in very senior positions starting with Kirloskar Pneumatic in Pune, Carrier Transicold in Bangalore and Singapore as well as Voltas-Air International Pune. Presently he works for himself as a technical advisor & consultant. He is an ASHRAE Fellow, past president ASHRAE W.I. chapter and past president ISHRAE Pune chapter. He can be contacted at *pramesh@vsnl.com*

Possible solutions

a. Detect building air leakage paths and seal them
b. Clean and disinfect cladding
c. If replacement is necessary, determine why and how to prevent moisture from migrating in again.
d. Reinsulate if necessary possibly with different insulation
e. Vapour barrier for inside surface is not advisable

Cold Room Panels Bend or Move or Cold Room Collapses when Temperature is Brought Down

Possible causes

a. Pressure equalization inadequate or not provided
b. Excessive fan air quantity building pressures due to very high velocities.

Possible solution

a. An opening comprising of two side-by-side openings with hinged door known as a vent valve or pressure equalizing valves is essential for cold rooms constructed of panels. As the temperature is lowered in the cold room, air pressure also reduces due to air becoming denser and reduction in its volume. If vent valves of adequate capacity are not provided then it can lead to catastrophic effects, including damage to insulation or total collapse of the cold room panels. The required number of vent valves depends on the rate of cooling (Btu/h), vapour pressure difference between outside and inside conditions and temperature to be maintained inside the space.
b. Determine air velocity in the cold room, since excessively high velocities will get converted into static pressure head in addition to the vapour pressure difference and then the vent valve area provided may become inadequate. Provide extra valves in such a situation

Cold Room Floor Getting Damaged Quickly or Frost Heaving of Floor

Possible causes

a. Freezing of soil below cold room floor
b. A water source below floor
c. A sub grade that supports capillary movement of water
d. Inadequate floor insulation thickness
e. Poor quality of insulation having high moisture absorbing property
f. Low density of insulation and concrete of inferior quality
g. Floor unable to support load of racks or movement of goods and fork lifts

Possible solutions

a. Proper high density insulation slabs, with total thickness divided in staggered layers
b. Concrete slab of proper thickness and load bearing quality with water proofing
c. Vapour barrier of either PVC or other flexible material below and on top of insulation before concrete slab is constructed.
d. Provision of air vent pipes or electric heaters or circulation of glycol below the floor to ensure floor temperature never falls below 0°C
e. Elevated construction of cold room so that there is clear space between soil and cold room floor

Inside Air Temperature is not Uniform

This is observed in many cold storages and is a very common problem, especially in low temperature (–20°C) cold rooms

Possible Causes

a. Air flow not uniform and air distribution defective
b. Inadequate air flow
c. Short circuiting of air directly back to the evaporator coils because of poor product storage arrangement

Possible solutions

a. In cold rooms with precooled products, and with good insulation, the refrigeration load is very small and if coolers are selected only on the basis of refrigeration capacity, the air quantity of a standard cooler for the selected refrigeration capacity becomes inadequate. It is therefore essential to determine the minimum air changes required, based on room volume and provide adequate quantity of air besides enough refrigeration capacity. These vary from minimum 30 air changes to 120 air changes per hour based on the application, to ensure uniform air temperatures through out the cold rooms.
b. Use smoke generators to determine air paths and dead air pockets.
c. Relocate evaporator coils or increase fan capacity
d. Install air ducts /air socks
e. Provide baffles to block short circuiting paths
f. Rearrange product storage arrangement

Inside Temperature is Warmer than Desired

Possible causes

a. Inadequate refrigeration capacity
b. Insufficient or wet or deteriorated insulation
c. Vapour barrier missing or punctured
d. Poor attic ventilation
e. Poor thermostat location that senses cold air temperature rather than return air temperature.
f. Air flow not uniform or insufficient

Possible Solutions

a. Install more refrigeration capacity if found inadequate based on measurement of parameters.
b. Paint outside surfaces with white or light colours with reflective paints if they are dark coulours especially exposed roofs.
c. Relocate thermostats in the return air paths
d. Check cooler selection; the selection should not be for more than 5°C TD. TD is the temperature difference between room temperature measured at the inlet of coil in the return air and refrigerant evaporating temperature in the coil.
e. Install more coolers if necessary.
f. Install additional insulation if found inadequate
g. Check air distribution path and rectify

Inside Temperature Colder than Desired

Possible causes

a. Thermostats poorly located and senses warmer temperature

Possible Solution

a. Relocate thermostat in return air flow to evaporator coils
b. Avoid locating thermostat bulbs near doors or lights.

Inside Air Temperature Fluctuates During Storage

Possible causes

a. Frequent door openings
b. Air leakages
c. Product loading rate not as per design, excessive loading in short period
d. Liquid refrigerant feed to evaporator improper and too much on/off cycling
e. Frequent defrosting of coils

There is a Bad Smell inside the Cold Rooms or it is Difficult to Breathe

Possible causes

a. Gases like carbon dioxide or ethylene may be present in excessive quantities as a result of decay or respiration
b. Modern cold storages are generally very tight so there is no natural air change ventilation

Possible solutions

a. Install exhaust fan that provides ventilation of 1 or 2 air changes/day
b. Exhaust fan can be activated based on carbon dioxide or ethylene concentration whenever levels of concentration of these gases exceeds designed limits.
c. Disinfect rooms, carry out fumigation if required, clean the rooms, and remove decayed/spoilt products.

Evaporator Coils are Icing up and a Lot of Condensate is Removed

Probable Causes

a. Coils running at too low a temperature
b. Defrost system defective
c. Storage relative humidity is too high
d. Inadequate air flow
e. Coil constructed with very small tubing, very high fin density and more than required rows deep leading to removal of more moisture than necessary

Probable Solutions

a. Increase refrigerant temperature in the coil; this may require larger coils with more face area and less rows deep
b. Defrost system not proper; repair or replace with a more effective one. Defrost of any cooler should not take more than 20 minutes and during defrosting, the room temperature should not rise beyond 1°C.
c. Remember, if plant has only one or two evaporators, hot gas system will not work effectively. There should be a minimum of two coolers in operation and only then one cooler which is the third one can be defrosted. Working of two coolers provides enough hot gas for defrost.
d. Inadequate air circulation; fans need to be replaced with more powerful fans having bigger capacity. Select fans to maintain minimum velocity over the product.
e. Some commodities may require low humidity such as onions, garlic; two speed fans may be an alternative or VFD on fan motors to control speed sensing relative humidity.

Some Products are at Very Much Lower Temperature than Required and / or Freezeng

Probable Causes

a. Coil and supply air temperature lower than designed
b. Cold and heavier air directly impinging on some products
c. Poor air flow causing freezing of some product and dead spots at other locations
d. Product is touching or too near the coil or to freezing walls
e. Product stacked too high near the coil

Possible solutions

a. Adjust the coil thermostat setting so that coil operates at higher temperature
b. Install baffles to divert cold air from coil and allow it to warm up a little before it hits the product
c. Improve air distribution by using smoke generation method to identify dead air spots as well as short circuits
d. Use evaporators with draw through design so that air first travels to the farthest end products and then is sucked through pallets on the cooling coil, rather than blowing cold air directly and hitting the front row of products kept nearer the coils
e. Reinsulate floor if necessary and keep product away from cold walls
f. Stack product lower, especially the one which is near the cooling coil and evaporator fans

Some Products are Shrinking / Shrivelling

Probable causes

a. Storage relative humidity too low
b. Vapour pressure differential too high, warm moist product versus cold dry air.
c. Wooden container or storage racks are drawing moisture out of air and thereby from product
d. Products like cucumber look soggy or wrinkled when slightly frozen

Probable solutions

a. Reduce temperature difference between room temperature and refrigerant temperature in coil by installing more coils, operate coils at higher evaporating temperatures
b. Install ultra fine or atomized humidifiers
c. Pre-cool product before loading to remove field heat after harvesting so that there is less vapour pressure difference between product and storage air , thus leaving less incentive for moisture to leave the product, causing desiccation
d. Some commodities are susceptible to chilling injury if temperature is brought down lower than the threshold temperature, like mangoes, bananas, cucumbers

e. Wet the wooden containers before putting them in for long term storage or wet floor if required

Some Products are Sweating or have Free Water on Them

Probable causes

a. Warm moist air from recently loaded product is hitting stored cold product
b. Outside air is hitting cold product when it is removed from cold room
c. Defrost water from coils is dripping on the product
d. Humidification system droplets are too big.

Probable solutions

a. Use pre-cooling chambers where products are stored before they are loaded in the cold room
b. Allow product to warm up gradually; condensation is unavoidable if cold room product is directly brought in contact with warm, humid outside air
c. Drain condensate on to the floor so as to help humidify the store
d. Install humidification equipment supplying atomized mist.
e. Install bigger coils to reduce temperature difference between room air and evaporating temperature.

Product is Showing Premature Ripening, Discoloring, Loss of Leaves in Vegetables

Probable Causes

a. Ethylene gas may be present in higher concentration
b. Storage temperature may be too high

Probable solutions

a. Provide automatic exhaust systems to operate when concentration exceeds allowable limits
b. Do not store in the same room, products generating high ethylene, such as apples, pears, plums, peaches, tomatoes with other commodities
c. Avoid use of fork lifts that emit ethylene in the exhaust
d. Thoroughly ventilate storage room before use.
e. Lower storage temperature

Product has Odours or Off Flavours

Possible causes

a. Products generating cross contamination that readily transfer odours/flavours

Possible solutions

a. Avoid stocking such products with other commodities such as fish and milk in the same room, flowers and dairy products, garlic and other commodities, cabbages, potatoes, onions lettuce garlic etc. Storing compatible products in the same room is essential.
b. It is better to have small rooms storing different products in different rooms rather than one big cold room where all products are stored in the same space

Product is Rotting

Possible cause

a. Product is too warm and is respiring and ageing rapidly
b. Product damaged, overripe, or of poor quality before loading in the cold rooms

Possible solutions

a. Provide rapid and uniform pre cooling after harvesting;
b. maintain recommended temperature during storage
c. Do not overload rooms beyond allowable per day loading rate
d. Grading of product before loading in cold rooms to get rid of damaged, spoilt goods
e. Do not expect that cold room storage will turn poor quality products into a top quality products merely by storing in a cold room for a long duration.
f. Remember, a cold store will maintain the same product quality as loaded and cannot improve it

Product was Good at the Time of Loading but Deteriorated During Storage

Possible causes

a. Product quality not properly checked before loading
b. Inadequate refrigeration, unable to maintain design temperature or humidity
c. Loading rate much higher than the allowable daily design rate
d. Frequent door openings and too much movement in the cold room than planned
e. Poor insulation and vapour barrier
f. Inadequate air flow and improper product stacking leading to hot spots and short circuits

Possible solutions

a. Grading and checking product quality before loading is essential to avoid subsequent unpleasantness.
b. Cold room owner should ensure that he accepts only quality goods before storage
c. For low temperature storages at –20°C, it is essential to check product core temperature and not truck or container temperature. Many times product surface temperature is –20°C but the core temperature could be –15°C. When such products are accepted, they release heat to the cold room maintained at –20°C and in the process the product gets spoilt. This is very important for products like ice cream, fish which if not properly cooled to core temperature would deteriorate in the cold room maintained at –20°C.
d. Remember, low temperature cold rooms are not designed to cool the product and are designed only to maintain the product in the same condition as it is when loaded.
e. Solutions to other causes already covered elsewhere.

References

- *Trouble Shooting Cold Storage Problems* – Ministry of Agriculture, Food and Rural affairs Canada.
- *ASHRAE Handbook-Refrigeration 2006.*