



Cold Chain Facilities in USA

Photo 1 : A view of a shop at the Farmer's Market in Los Angeles

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Part 1 of 2

This article is written with the objective of giving the readers an idea of the cold chain scenario in United States of America. It comes as an outcome of the US Cold Chain Study Tour that the author was a part of, organised by the US Trade and Development Agency (USTDA) and sponsored by the Government of USA.

To start with, it does not, in any way, state a confirmation that the systems followed in the United States are technically the best, or, are completely acceptable to us in India as they are. It's only a statement of the systems followed as observed during the Cold Chain Study Tour. There are some comments provided at certain relevant places, as felt necessary, to make this a more complete article, rather than restricting it to being US-specific only. Of course, it is again, not claimed to be a complete thesis on the Cold Chain in US, but since it was a 15 day tour dedicated

only to cold chain, we can look at it as a reasonable overview.

So What's the US Cold Chain Study Tour all About ?

Going by figures, India is the second largest producer of fruits & vegetables in the world, producing close to 180 million tons. Owing to lack of good processing facilities, almost 30 ~ 40% of this is wasted. The figures are mind boggling! Even if a small percentage of this wastage was effectively utilised, India can become a supplier of food to the whole world! This fact is well understood even by the Americans, which is one of the reasons for this Study Tour.

In an effort to better trade relations, there have, recently, been many initiatives for trade development between the two countries. One such program implemented is called the AKI (Agricultural Knowledge Initiative) and this Study Tour is a part of the same initiative.

The US realises that for correct flow of produce from India to the United States and vice versa there needs to be a proper cold chain developed in India. This will facilitate imports as well as exports for both countries.

A group of 15 persons from various sectors of the cold chain industry was selected by the USTDA on the basis of their involvement in the cold chain industry. There were workshops organised in the four metropolitan cities and further, a rigorous selection procedure followed which involved submission of business plans, concept statements, commitment letters etc.

About the Author

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Photo 2 : Green building at Arizona State University

An Overview of the Tour

We visited Tempe, Arizona, Long Beach, California and Las Vegas, Nevada. The idea was to give a complete picture of the Cold Chain as it is, including the good and the 'not-so-good' parts of the system. The above locations were only 'base-points', so to say. A lot of travelling was involved, almost on a daily basis, for various site and farm visits.

Before we move into the details of the various systems, one thing that I found very striking is that India is not very far behind, as far as technology that has been adopted, on some of the recent Cold Chain projects carried out in India! What we saw was stuff very well done by engineers here. The only difference is that all the investments that go into a proper establishment of the Cold Chain in India were primarily in a scattered form, atleast for the local market, and in the US they were all put together for the major markets. Of course, there exist the local fresh stores pretty much like we have here, just much cleaner!

Cold Chain

As we know, the Cold Chain consists of the following:

- Post harvest procedures including pre-cooling, ripening, grading, sorting, packing, etc
- Storage, short term, medium term or long term in controlled environment
- Refrigerated transport including logistics



Photo 4 : Inside view of the ripening rooms with pallets loaded

- Loading / unloading in controlled environments with correct sealings
- Display cabinets in controlled environment

We will make this a two-part discussion where we will discuss the points related to post harvest and short term / long term storage in the first part and the remaining will be in the second part. The article will have a lot of visuals since I am a firm believer that pictures speak louder than words.



Photo 3 : Outside view of the ripening rooms

Post-Harvest

As mentioned earlier, there are times when post-harvest 'cooling' does not exist. In such cases, the produce is brought to the 'Farmer's Market' where it is displayed in an attractive manner. This can be very similar to our local vegetable market, but has a better display setup in the US. The picture shown in *Photo 1* is one from a Farmer's Market in Los Angeles.

The 'post harvest' topic is itself so vast that even today huge funds are devoted to research in this field. Here we will look at pre-cooling and ripening since these are important processes in post harvest. Other activities include sorting, cleaning grading, parking and the like.

Most people tend to know of University of California, Davis, as the premiere institute for research in post-harvest technologies. However, as we got to know, the Arizona State University (ASU), too, has a significant funding for research and has its own Department of Agriculture with some good faculty and facilities. More detailed information regarding ASU can be obtained at www.asu.edu

What is most interesting about ASU is that many of its buildings are green buildings, either Gold or Silver rating and it now plans to convert all its buildings into green buildings. A picture of one such building is shown in *Photo 2*, showing the natural light gathering features, for north light (reflectors) and west light (partial barriers). Of course, this is not the topic of discussion in this article, so we'll leave it at that!

Photos 3 & 4 show a banana / citrus fruit ripening chamber.



Photo 5 : Inside view of the pre-cooling rooms with pallets loaded for one cooler

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Photo 6 : Conveyor for pallets with strapping mechanism

The interesting part of the chamber is what it can do to levels of ripening by operating two-temperature cycles within the same chamber. There are no physical partitions within the chamber, but owing to two separate air circulation patterns this is possible. Air is discharged from the top of the chambers towards the side walls and suction is from the top. The temperatures maintained are in the range of 12.2°C (55°F) to 17.2°C (63°F) for varying time durations of the ripening process. It is capable of loading pallets upto 7 feet (2.1 m) in two layers as shown in Photo 4.

Another plant shown in Photo 5 is of a pre-cooling unit which we saw at a grape growers plant. This is the largest family-owned grape grower in the United States, as claimed by him, with 7000 acres of farm-land growing only grapes. They also have another 8000 acres growing other produce like potatoes, citrus, etc. This was an old plant, and hence the facilities also were a bit old. However, the plant is designed to process a very large quantity of grapes (around 90,000 ~ 1,00,000 boxes of grapes per day with one box of 16 lb amounting to 15,00,000 ~ 16,00,000 lb per day or 680 ~ 725 tons per day for the plant). Temperature maintained is 0 - 2°C with high humidity maintained by the chilled-water-based heat-exchange process. The pre-cooling plant as shown in the photo can hold about 7,000 to 7,500 boxes in one go. There are six such rooms.

[Author's note: Such large capacity rooms are ok only if the



Photo 8 : Automatic wrapping machine. The arm with the film goes around the pallet with the film roll moving downwards

batch size is very large, which is the case here. Else, running only one unit in three possible sets of units amounts to wasting energy. Also, note the system of marking the pallet positions in yellow leaving no room for ambiguity]

The feature to note, here, is the mechanised palletising system in which the grape boxes are strapped together using the same technology used for thermal sealing of our



Photo 7 : Typical bar code sticker illustration

bags at airports. The process takes place on a conveyor and an added feature of this is that each pallet is released on the last unloading point only after the earlier pallet is taken up for loading in the pre-cooling chambers. This is done using sensors on the conveyor that detect the pallet and release the one in line only after the last one is removed. The whole process is automatic and is shown in Photo 6.

[Author's note: It may be pointed out here that the grape fields are right next to the whole processing area which give the advantage of pre-cooling quickly and this gives the owner a very distinct advantage. Pre-cooling is a process which follows the principle of 'earlier-the-better'. We did taste some grapes there and they were nice and hard, not to mention very tasty as well!!!]

Storage – Short Term and Long Term

In the United States, there are multiple types of storage facilities. What is most interesting is one called a 'Self Storage'. You see many of these along the roads. We did not end up getting a chance to see one from the inside, but this article on the US cold chain would be incomplete if I didn't mention it! This is effectively a warehouse, but different chambers are given out to different parties. These may be cold storages or may be dry storages depending on the facility, but the idea is that there are almost no people working there.. apart from the security. Almost like a 'you-come-you-store-you-take-away' scheme!!

Distribution Centres

Most of the storage facilities that we saw were distribution centres, which include a lot of cold chain processes, including refrigerated transport, blast freezers, deep freezers, cold storages,



Photo 9 : Inside view of the of a dry storage unit

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Photo 10 : Duct piece for evaporative cooling air inlet

high humidity storages, low humidity storages, dry storages, etc all in one single location. This, effectively, means that all the requirements for a retail outlet like Walmart, Bashas, Whole Foods, etc are completely taken care of by the distribution centre (DC). If it were to be placed in the Indian context, in some ways you could call it a combination of Reliance Fresh and Shopper's Stop!

One DC can take care of multiple retail outlets also. Normally the DCs would be well spread out so as to cater to various retail locations around the DC.

A DC could be wholly owned by a retail company (like Walmart which has its own DCs) or could be an independently operating unit and would be acting as supply agents to many different outlets. This kind of a DC has been set up in Navi Mumbai.

Palletisation

In the US, palletisation is very strongly followed, as we noted in most of the locations we visited. Products that come in normally come in individual pieces. These are then palletised and individually numbered or recorded as a pallet depending on the system followed in the DC. In many cases, each individual box was assigned a bar code and each box had its bar-code sticker put up when it came in. This bar code is utilised to assign and track the storage location when storing and bringing it out for dispatch. Photo 7 shows a typical bar coding sticker.

Another significant point to be noted was the provision of polyethylene film wrapping. Every pallet is given a wrapping and only then is it loaded in the storage. Depending on the size of the DC, the wrapping would be done manually or automatically. An auto-

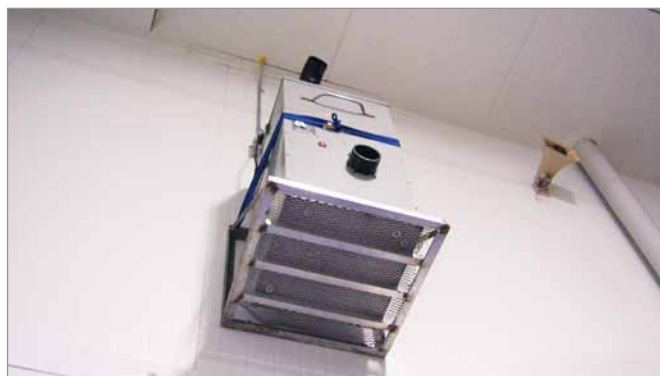


Photo 12 : Ethylene scrubber unit

matic wrapping machine is shown in Photo 8.

A typical view of a dry storage facility is shown in Photo 9. This place we visited was in a very dry location (Arizona), hence even the dry storage had ventilation using evaporative cooling technique. The entire ceiling was insulated with 100 mm rockwool. There were ducts as shown in Photo 10 pushing air inside the area. Not to forget, an exhaust provision was also there.



Photo 11 : Inside view of a cold store

[Author's note: Evaporative cooling remains a much 'un-used' technology in the Cold Chain sector in India, primarily owing to the lack of awareness of proper techniques for correct achievement of conditions. Proper exhaust is very critical. Proper application of evaporative cooling will enable huge energy savings since there are many cases where it can easily replace air conditioning. The concept of two-stage evaporative cooling which ends up giving very good results, (even lowering the RH to an acceptable level) especially in dry climates has been accepted. We, on our part, have started promoting use of two-stage cooling for process halls of pack-houses. I urge readers, by means of this article, to be open to the use of such techniques in an attempt to save energy for the country and the world]

Cold Stores

Mostly in DCs, they have mechanised operation, be it dry or cold type of application. Loading takes place by means of pallets as mentioned earlier in this article. The storage pattern is quite similar to dry, just that we now have an insulated chamber and an air-cooling unit cooling the area. Photo 11 shows a cold chamber, and to be very frank, you can't really make out from the photo that it's a cold chamber unless you are able to read what's written on the boxes!!

Ethylene scrubbers are used in cold storages where the ripening has to be elongated, like for storage of fresh vegetables, melons, etc. Since ripening is a direct function of the presence of



Photo 13 : Outside view of the cooling unit room or 'dog-house'

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Photo 14 : Inside view of a plant room

ethylene gas (which is, incidentally also generated while ripening), removal of ethylene results in delaying the ripening process and allows the fruits & vegetables to last longer in the cold storage. An ethylene scrubber unit is shown in Photo 12.

Air Cooling Units and 'Dog-houses'

An intriguing feature in many of the cold storages which we saw in the US, was the concept of 'dog-houses'. Though many cold stores did have the normal air cooling units that we see here, many had the cooling units located in these 'dog-houses'. The idea of a dog house is that the cooling unit is located in a small projection on the roof (like we have for lift machine rooms in buildings) and since it looks like a dog's kennel, is probably why it gets its name. There are certain advantages in this kind of design, and (obviously) certain disadvantages. Photo 13 will give an idea of what we're discussing. This is a view of the roof of a cold store. The cooling unit is located here and the air distribution is done using small duct pieces to direct the air into the cold room.

You would note that the controls, valves, etc are all located outside the room (dog-house, rather) and the access is also from the outside. These two become the basic advantages of this system since any maintenance activity happens in total isolation from the cold store activity. Possibly, the operators doing the material handling in the cold store would never have even seen the cooling unit. The system there is to completely automate the plant and give a maintenance contract to an agency which will have access to the terrace.



Photo 16 : Hemispherical mirror for safety of operators

But there are inherent disadvantages in the scheme which overshadow the operational ease. The cooling unit which is the coldest part of the cold room is located in the hottest part of the room. An inherent energy loss.

Another major issue in this design, which comes into play is that

the access door is directly open to the atmosphere! Anybody opens the door for access and a huge gush of outside air rushes into the dog-house (since there is a huge amount of suction force). Outside air not only means hot air (in most cases), but the bigger issue is the moisture it carries with it which goes and settles on the walls and ceiling of the cold room as condensation or ice (for deep freeze application).



Photo 15 : Another view inside the plant room

[Author's note: Personally I feel that this is specifically one of those cases where we should not go for some design simply because it is being done in the US. In fact when I went up to this dog house in one of the units that we visited, I pointed out to them that they should atleast have a strip curtain at the entrance so that there would be 'some' stoppage of the gush of outside air when the door is opened. They readily accepted the logic and started planning for the strip curtain]

Public Warehouses and Cold Storages

When a facility is meant for the sole purpose of storage of goods, then it is termed as a 'public warehouse' in the US. Here the owners of the cold storage have no goods of their own and are essentially only 'care-takers' of produce. Many of these provide transportation facilities also to their clients. These would include refrigerated warehouses as well in case of cold storages. The 'self storages' as mentioned earlier in this article form a part of the same scheme.

Storage at Airports & Ports

There are bonded warehouses and cold storage facilities at the ports and airports for storage of perishables and other goods in transit. The group's visit was arranged to LAX Airport and Los Angeles Port. For obvious security reasons, photography was not allowed. However, this is a facility that should be noted and good quality facilities should be provided at all ports and airports where flow of goods and perishables is expected.

Refrigeration Systems

The most striking fact observed in the whole study tour regarding the refrigeration system was that most of the large plants operated on



Photo 17 : Water shower and washing area for emergency treatment

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ammonia with pump recirculatory type of system. Compressors used were generally screw type, though in some cases reciprocating compressors were also used. Piping insulation was insitu PUF with PCGI or plastic based outer sheathing. Some views of the plant room are shown in *Photos 14* and *15*.

Evaporative condensers were used in all the plants using ammonia. The whole system was almost always completely controlled by a Building Management System. This system was able to not only control the system along with all parameters, but also send out emails / sms to the maintenance company.

[*Author's note:* This is one point where the right selection has been made in the US based systems. For large systems, ammonia pump re-circulatory system, generally, is the best bet. As a generic case, for Indian conditions we can safely consider the parameters of 1000 MT and above for an ammonia based system. Similarly, evaporative condensers work best when it comes to energy efficiency since it combines the effect of a water cooled condenser and cooling tower into a single system, at the same time utilising latent heat as a medium of heat rejection also]

Safety

This is one area where the group found a major difference. Safety is the foremost concern and this was observed in many features of design, both large and small features were built into the system we observed. Some of these are highlighted below:

1. Walkways are always marked and were very prominent, and kept clean.
2. Every time a motorised pallet truck moved around a turn of at a door, the operator honks, under ANY circumstances.
3. In most locations where a possibility of two or more trucks coming from different directions was observed, mirrors are installed. A photo of the hemispherical mirror is shown in *Photo 16*.
4. Doors for material and human movement are almost always kept separate.
5. Emergency systems are always in place in case of any eventuality. *Photo 17* shows the immediate relief centre for a possible ammonia leak.
6. The features mentioned above are operator-safety-related points. Further, there is a great concern for food-related-safety and hygiene. This concern is reflected in the behaviour of the workers who all know the importance of food safety and hygiene. It is observed that there is a much greater awareness regarding the standards for construction, operation and maintenance such as ASHRAE standards, ASME standards, HACCP, and the like.

Prelude to the Next Part of the Article

In the next article the other aspects of Cold Chain in US will be discussed. Further there are many smaller and other interesting features that would be shown along with illustrations like this article. Certain other important developments in related fields will also be discussed. The whole purpose of writing these articles is to let our readers know and be aware of what is happening in other countries in this field and where we need to do things differently. It is only through such awareness that the need for a better quality system is felt and our dream of a high end Cold Chain developing in India will near reality. ❖

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