

# **TECHNOLOGICAL ASPECTS OF CONTROLLED ATMOSPHERE STORAGE - IMPLEMENTATION FOR INDIAN PRODUCE BY FHEL-CONCOR.**

**D Ramesh Babu,**  
Sr. Manager,  
Fresh & Healthy Enterprises Ltd  
Container corporation of India  
Ministry of Railways.

## **Introduction:**

The Controlled Atmosphere Storage (CA) is one of the important Technology found beneficial in preserving the fresh fruits and vegetables for longer periods. This will minimize losses during storage and better quality retention is achieved.

The fundamental deterioration process of fresh produce is the basis for the technology development. The basic deterioration process of fresh produce includes ripening due to respiration, storage environment, composition of environment etc.,

As a living body the produce consumes oxygen from the atmosphere and liberates heat, carbon dioxide and converts starch components into sugars.

## **Critical requirements for Storage and transportation of fresh produce:**

Optimum Temperature  
Optimum Relative Humidity (RH)  
Optimum Atmosphere conditions (oxygen, carbon dioxide and nitrogen)  
Optimum air movement  
Optimum Stacking  
Condensation and water vapor on the product  
Sanitation.

## **Problems during perishable product storage and transportation:**

1. Ripening due to respiration ( conversion of starch into sugar due to the same)
2. Bio-chemical changes ( several reactions make the perishable cargo to loose nutrients, moisture, color, firmness, taste)
3. Microbial constituents ( fresh produce are prone for disorders due to the microbial population on the product surface and atmosphere)
4. Fruits and vegetables consume oxygen from the atmosphere and utilize for their respiration.

## **Benefits of CA Technology ;**

CA Technology constitutes the following critical activities of the atmosphere around the perishable products.

1. Lowering the oxygen - helps reduced respiration, thereby ripening
2. Increasing the CO<sub>2</sub> - makes the atmosphere inert, helps synergistically along with low oxygen,
3. Increasing the Nitrogen - makes the atmosphere inert
4. Controlling the Ethylene - helps in controlling the ripening process.

**The CA system along with the following conventional storage methods give synergistic effect for longer shelf life of the produce.**

1. Lowering the temperature - reduced respiration
2. Increasing and maintaining - reduced moisture loss from the produce and High Relative Humidity freshness is retained
3. Optimum air movement - keeps the entire produce at same atmospheric conditions like temperature and gas conditions

### **Add-on benefits:**

1. Several storage disorders are subsided due to inert atmosphere around the fruit.

### **Technological aspects;**

#### **Construction of Storage chambers**

Making the Chambers for creating gas tight environment is very important for maintaining low oxygen conditions. Insulation panels of steel with Low thermal conductivity insulation (PUF), Leak proof joints of panels make the right storage chambers for CA Technology. The international testing protocols are laid for the assurance of gas tightness, which are followed at each start of the fruit season.

#### **Equipment requirements for maintaining temperature, RH and gas conditions**

##### **1. Refrigeration equipment for cooling the produce:**

The capital and running costs of the cooling equipment depends on the design aspects and optimal utilization. Aspects like environmental factors, safety are taken into consideration while designing the equipment.

By selecting Ozone friendly and non-toxic, non-flammable refrigerant like R404A, R134a, and our FHEL has built the CA Store of 12000 MT capacity at Rai Sonapat. Variable Frequency Drives (VFD) are installed on the compressor racks and condenser pumps and fans for saving the energy.

## **2. Design and Maintenance of High RH coolers/ Humidifiers**

By proper design of the Evaporators/ cooling units the RH is maintained high and thereby minimizing the moisture loss from the produce.

## **3. Nitrogen generation:**

PSA (pressure swing adsorption) Nitrogen technology is being used in CA store, Rai for the generation of 99% pure nitrogen. Specifically designed molecular sieves are used for separating the nitrogen from the ambient air to make pure nitrogen. The basic input required is only a compressor and ambient air (which is available abundantly with no cost) By flushing the same into the storage containers/chambers, low oxygen is achieved and maintained. Other technologies include membrane utilization, but the cost of the maintenance and replacement of membranes is very high. The power consumption is low in case of PSA, even though the moving parts and maintenance is more compared to Membrane technology.

## **4. Carbon dioxide scrubbers:**

The scrubbers remove excess carbon dioxide from the storage space. Some quantity of ethylene is also removed by them. Carbon molecular sieves and activated alumina are the adsorbents used in the scrubbers. Sieves are used repeatedly by regenerating the same automatically. The life of the sieves is 10 years in normal design condition usage.

The equipment installed at CA Store, Rai are highly energy efficient (with VFD control) and low maintenance cost

## **5. Monitoring, controlling and recording instruments**

1. Oxygen and Carbon dioxide analyzers
2. Devices for precise control of oxygen and carbon dioxide
3. Data log and recording the parameters for analysis of conditions in the storage chambers and containers.

## **6. Safety arrangements :**

These includes sensors for avoiding injury to the produce due to freezing. Effect of toxicity due to the refrigerant (like ammonia) is avoided by selecting safe refrigerants.

All the CA Designs and instrumentation are supplied by International Controlled Atmosphere, UK.

Some of the best equipments in the globe are installed in our facility including fruit processing equipment.

**Implementation of Technology for the Indian varieties of fresh produce:**

Very limited research results are available on commercial storage of fruits and vegetables of Indian varieties. At present FHEL has mastered in the storage of Apples with own efforts on development of protocols by conducting experiments in the own highly sophisticated laboratory at CA Store, Rai. Several experiments were successfully carried on different varieties of apples. Experiments on Carrots, Oranges, kinnows, flower bulbs, Rice, garlic and given good results. Other achievements by FHEL include banana and mango ripening in the 40 feet containers and chambers. Very high equipment availability is achieved on the critical CA equipment with Zero breakdowns by careful and effective supervision.