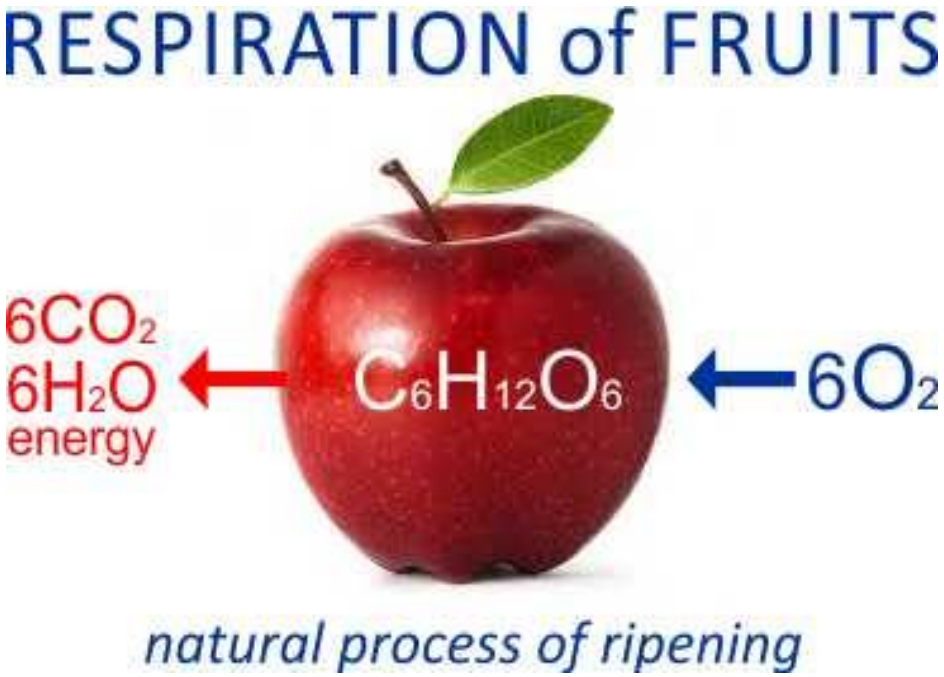
Explanation of CA storage



Explanation on CA technology

Index

1 PRINCIPLES FOR CA STORAGE OF FRUITS AND VEGETABLES

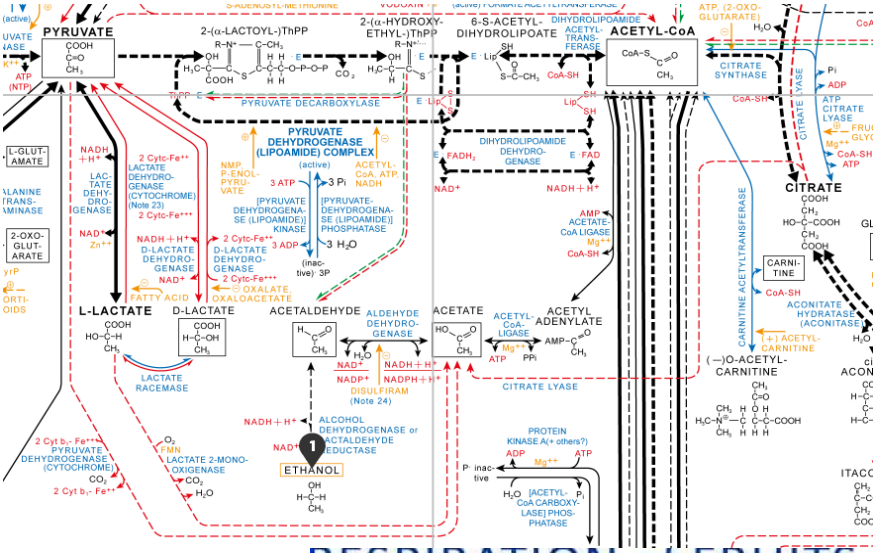
1.1 Principle of breathing / respiration

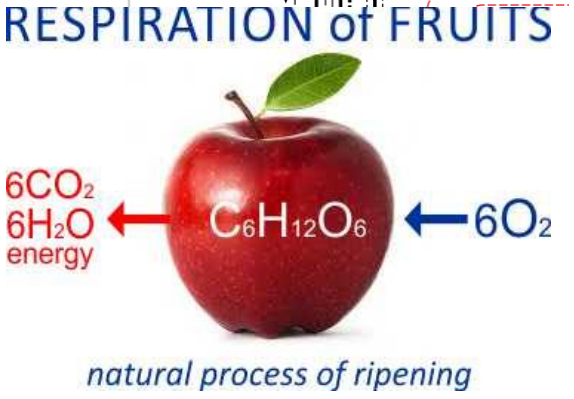
After the harvest of vegetables and fruits, the process of respiration / respiration continues. Respiration is the conversion of fruit sugars using oxygen into CO_2 and water, releasing energy necessary for the processes in the fruit. The respiration proceeds according to the formula below;

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{ATP energy} + \text{aromaten b.v. ethylene}$$

Sugars + Oxygen $\rightarrow CO_2$ + Water + energy ATP + aromatics e.g. Ethylene

The above formula is a simplification of reality in which all kinds of biochemical processes and conversions take place.





CA storage of fruits and vegetables is applied to many products worldwide. Below is a list of products where CA storage is often used

- Apples and pears,
- Kiwi
- Persimmon/Khaki, Garnet apples, grapes, mango,
- Soft fruits such as red berries and blueberries
- Cabbages, onions, garlic, celery, leeks etc.

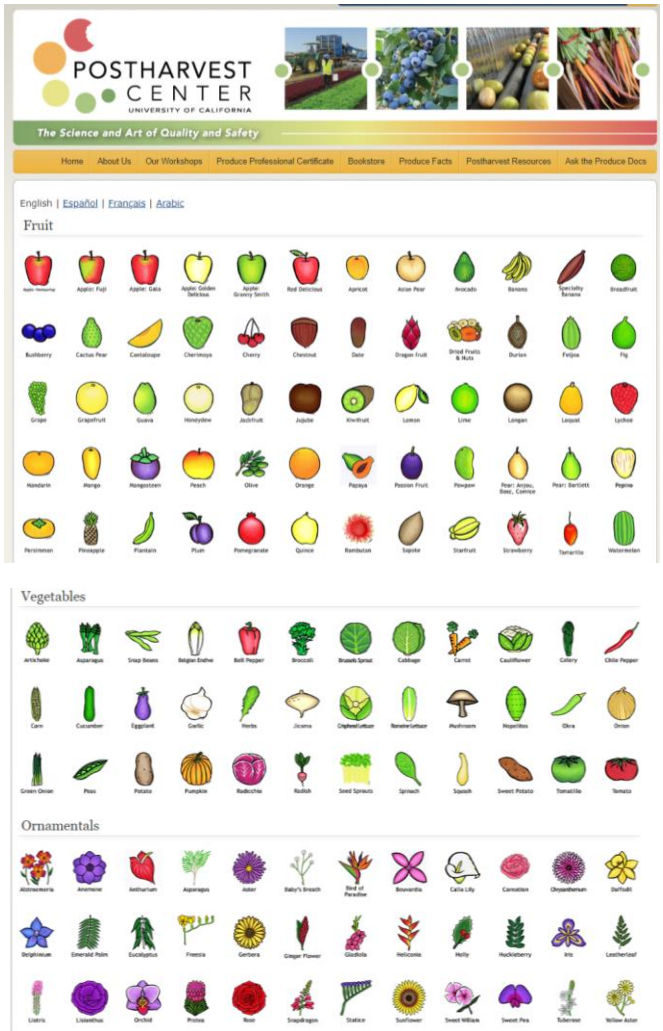
1.2 Advice on the optimal CA conditions.

There are many research institutes worldwide that are engaged in Post Harvest research and the best storage technology for fruit and vegetables. Consultants and suppliers of MCP-1 also play a significant role in this. There is a lot of literature available about the storage of agricultural products and the (optimal) CA conditions.

The optimal (CA) storage conditions for certain products of fruit and vegetables always depend on variety, time of harvest and, region, soil type, growing conditions, etc. Based on research and practical experience, storage specialists draw up recommendations per region for the optimal storage conditions. Information about CA storage and CA conditions for the storage of various products on this website have been given by Storex as a general example to explain the technique of CA storage and no rights can be derived from this. *IContact specialized CA consultants / research institutes for advice on the right CA storage method for your product for your situation.* Storex specializes in the supply of technology to measure and control the optimal CA conditions. For the right CA storage technology, we work together with CA consultants with knowledge about the product and the optimal CA conditions. It is recommended to follow a course for CA storage and/or to do this under the guidance of CA consultants. Storex can advise you on this.

A well-known site where information is given about the storage of fruit and vegetables and, among other things, about CA storage is the post harvest site of U.C Davis in California.

https://postharvest.ucdavis.edu/Commodity_Resources/Fact_Sheets/



Adviseslijst condities ULO bewaring appels en peren

Deze advieslijst is bestemd voor partijen die geschikt zijn voor (lange) ULO bewaring. Partijen van mindere dracht of van een later pluktijdstip kunnen meestal beter bij een lager CO_2 percentage of een hogere bewaartemperatuur bewaard worden. Een alternatief is mechanisch te koelen (condities zie achterzijde) en de bewaarduur aan te passen. Het ATO is nimmer aansprakelijk voor schade door de gegeven adviezen.

Ras	Tempe-ratuur	CO_2	O_2	Bewaarduur	Streef vochtverlies	Gevoelig voor
Appel	°C	%	%	Maanden	Liter/ton/maand	
Cox's O.P. 1e ULO maand en daarna	4 3,5 – 4	< 1,0 0,7	1,6 1,3	± 6 maanden	4 liter	KHB[2], zacht zuurstofschade
Elstar / mutanten 1e ULO maand en daarna	1,5 – 2 1,5 – 2	2 – 2,5 2,5	1,3 1 -1,2	± 8 maanden	2 tot 3 liter	LTB[1], OB[3], vruchtvleesbruin, schilvlekjes
Fiesta	4	1	1,2	± 6 maanden	3 liter	LTB[1]
Gala	1	1 – 2	1,2	± 7 maanden	2,5 liter	Schilafwijking
Gloster	1	3	1,2	± 8 maanden	2,5 liter	Koolzuurschade, glazigheid, KHB[2]
Golden Delicious 1e ULO maand en daarna	1 – 1,2 1 – 1,2	4 4	1,3 1 – 1,2	± 9 maanden	2,5 liter	Scald
Jonagold / mutanten 1e ULO maand en daarna	1 – 1,2 1 – 1,2	4 4	1,3 1 – 1,2	± 9 maanden	2 liter	Scald, zacht, vruchtvleesbruin
Karmijn de Sonnaville	4	1	1,2	± 5 maanden	4 liter	LTB[1], KHB[2], Vruchtvleesbruin,
Lombarts Calville	3 – 3,5	2	1,2	± 8 maanden	3 liter	LTB[1], scald Vettigheid
Melrose	3	<1	1,2	± 6 maanden	3 liter	Scald
Rafzubin / Rubinette	4	<0,5	1,2	± 5 maanden	4 liter	Vruchtvleesbruin KHB[2]
S v Boskoop 1e ULO maand en daarna	4,5 – 5 4,5 – 5	< 1 0,7	1,6 1,3	± 6 maanden	4 liter	Vruchtvleesbruin, LTB[1],scald, KHB[2]
Pinova	1	3	1,2	± 8 maanden	3 liter	
Topaz	1	1	1,2	± 5 maanden	3 liter	
Winston	3 – 4	3	3	± 7 maanden	3 liter	Scald

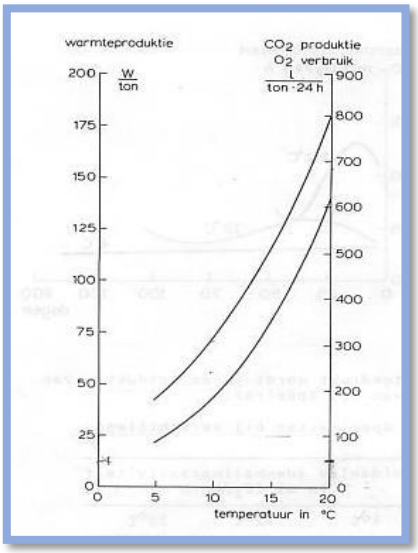
Ras	Tempe-ratuur	CO_2	O_2	Bewaarduur	Gevoelig voor
Peer	°C	%	%	Maanden	
Condo	-0,5	< 0,5	3	± 6 maanden	Hol en bruin
Conference 1e 3-4 weken 5-6 weken en daarna	-0,5 -0,5 -0,5 – -0,8	< 1,0 < 0,7 < 0,7	21 3 2,5	± 7,5 maand	Hol en bruin, slappe nekken
Dolacomi	-0,5	1	2	± 5 maanden	Buikziek
Doyenne du C. 1e 3-4 weken en daarna	-0,5 -0,5 – -0,8	< 1,0 < 0,7	21 2,5	± 5 maanden	Hol en bruin, buikziek

Bewaarcondities van rassen die niet op deze lijst voorkomen kunt u navragen bij ATO b.v.

Product			Bewaartem-peratuur. (°C)	Luchtsamenstelling	Bewaarduur
Houtig kleinfruit	Bessen	Rode bessen	0-1	Normaal	3-4 weken
			0-1	18% CO_2 , 2% O_2	15 weken
		Zwarte bessen	0-1	Normaal	1-2 weken
		Witte bessen	0-1	Normaal	1-2 weken
	Frambozen[3)]		0-1	Normaal	3-5 dagen
			0-1	15-20% CO_2 , 5-10% O_2	
	Bramen		0-1	Normaal	4-6 dagen
			0-1	15-20% CO_2 , 5-10% O_2	6-10 dagen
	Kruisbessen		0-1	Normaal	2-3 weken
	Bosbes-Achtigen	Bosbessen	0-1	Normaal	2-3 weken
		Blauwe bessen	0-1	Normaal	2-3 weken
			0-1	10-15% CO_2 , 5-10 % O_2	4-5 weken
	Cranberries		1-2	Normaal	4-6 weken
			1-2	3-5% CO_2 , 1-2 % O_2	6-8 weken
Aardbeien			0-1	Normaal	5-6 dagen
			0-1	18% CO_2, 3% O_2	10-12 dagen
Druiven			- 0.5-0	Normaal, + SO_2	3-4 maanden
			- 0.5-0	1-3% CO_2, 2-5% O_2[1)]	3-4 maanden
Steenvruchten	Perziken		0-1	Normaal	2-4 weken
			0-1	3-5% CO_2, 1-2% O_2	3-5 weken
	Abrikozen		0-1	Normaal	1-2 weken
			0-1	2-3% CO_2, 2-3% O_2	2-3 weken
	Pruimen		0-1	Normaal	1-3 weken
			0-1	1-5% CO_2, 1-2% O_2	2-4 weken
	Kersen	Zure kersen			
		met steel	0-1	Normaal	2-3 weken
			0-1	10-12 % CO_2, 5 % O_2	
		zonder steel	0-1	Normaal	2-3 dagen
		Zoete kersen	0-1	Normaal	2-3 weken
			0-1	15 -20% CO_2 , 5 % O_2	3-8 weken[2]

1.3 Temperature

The conditions under which the fruits are stored have a major influence on the course of breathing. The most importantfactoris temperature. If the temperature is lowered, breathing is slower. It is therefore important to proceed to the cooling of the product as soon as possible after the harvest of the product to ensure that the product temperature drops as quickly as possible.



1.4 Storage under atmospheric conditions / RA storage

The composition of the atmosphere under which the products are stored also has a lot of influence on the speed of respiration.
The composition of atmospheric air is approx. 78% Nitrogen (N 2), 21% oxygen (O 2) and 0.04% CO_2.
If products are stored refrigerated for a long time under atmospheric conditions, i.e. 21% O 2 and < 0.5% CO_2, this is also referred to as storage under atmospheric / RA (Regular Atmosphere) conditions.
If the cold stores are filled with agricultural productand then CO_2 levels rise, the oxygen content decreases under the influence of respiration. Depending on the temperature, for example, the oxygen content per day can decrease by 1% and the CO 2 content can increase by 1%. If this process takes place uncontrolled, damage can occur with sensitive products!
To keep such cold stores at RA conditions, sufficient ventilation will have to be provided and preferably this can be done on the basis of CO_2 measurement and controlled ventilation.

RA storage with a limited duration also often occurs in fruit storage during refrigeration and for a waiting period of e.g. 3-9 weeks based on the storage advice (e.g. for pears) or after treatment with 1-MCP before the CA storage can be started. It is important to keep the CO 2 content sufficiently low (<0.5% CO 2) during this period to prevent product damage due to too high a CO_2 content.
This can be achieved by (a combination of) actions such as keeping a window open, putting the door on a once or keeping a valve/tap open. Measuring CO_2 regularly is recommended. It is also possible to automate this using CO_2 measurement and control of one ventilation fan per cell.

1.5 CA storage

If the product is stored in an enclosed space and the oxygen content is reduced and the CO_2 content is increased, the process of respiration at a low temperature is even (much) moredifficult and the quality is better preserved. Increasing the CO_2 content also prevents moldgrowth and reduces the development of rot.
By controlling the atmosphere at the most optimal conditions, there is therefore a profit to be made for the quality and the fruits can be stored longer.

Controlled Atmosphere / CA storage is the general term for storage of fruit and vegetables in a closed space where the oxygen and CO_2 content is measured and controlled.

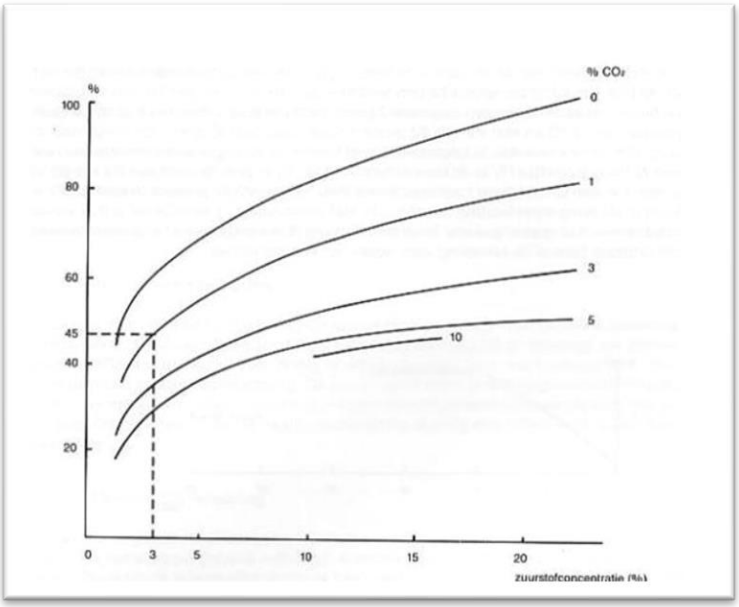
With the help of CA storage, many products can be stored much longer. Depending on the product up to 2 to 4 times longer. Certain apple varieties can be stored for up to 8-12 months!
Some examples of CA retention are:
Apples: (very) low oxygen values (1-3% O 2) and an increased CO 2 content 1- 3% CO_2
Pears, conference in NW Europe: 3% O 2 and 0.7% CO_2
Blueberries: 1.5-2% CO 2 and 9-10% CO_2.
Redcurrants: 1.5%$_{O2}$ and 18-20% CO_2.

Relationship Quality / Storage conditions for apples with weighting factor

Quality/ conditions	Quick cooling	Low temperature	Reduced oxygen	Increased CO_2
Preservation of green ground color	+	+++	+	++
Fresh look	++	+++	+++	+
Maintain hardness	+++	+++	+++	+
Uitstalleven		+++	++	+
Scald reduction			+++	+
Internal brown discoloration	+	+++	+++	---
Rot and mold growth		++	++	++

1.6 ULO storage

In the 70s of the last century it was established that with very low oxygen values there are substantial improvements in the storage of apples. When stored at low oxygen levels, breathing decreases sharply. Target values of 1-1.5% O_2 were recommended. In order to be able to regulate this properly, extra attention is given to the construction of very gas-tight cells, the use of nitrogen generators and low-oxygen CO_2 scrubbers. This technique was referred to as ULO storage in ULO cells. ULO stands for Ultra Low Oxygen.
ULO storage is therefore a form of CA storage.



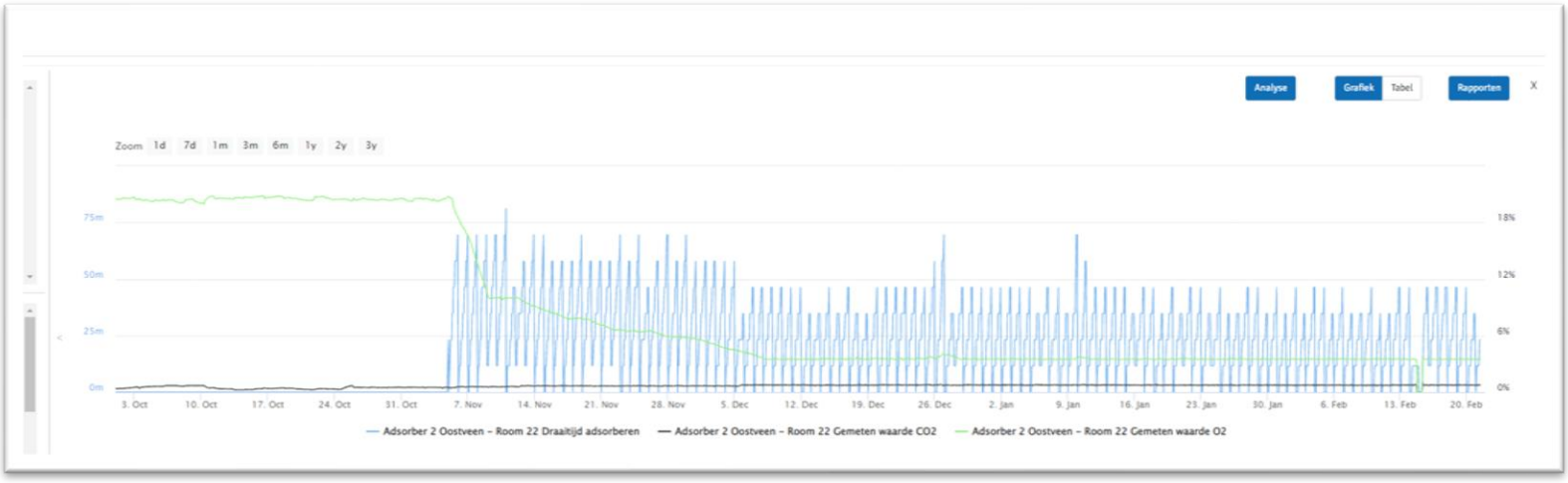
1.7 The application of MCP-1

MCP-1 is a chemical authorised in many countries that is used to stop/block the ripening of various fruits after harvest at the beginning of storage. MCP-1 occupies the so-called ethylene receptors in the fruit, which stops the ripening of the product. The application of this product was introduced by Agrofresh in about 2000. The application of MCP-1 effectively ensures the control of scald and the maintenance of hardness and prolongation of the display life. After its introduction, the agent was widely used on apples. After that, it was also introduced for the preservation of other fruits such as pears. Due to the extension of the display life, the chain store had fewer downtimes to throw away and partly because of this the application became a requirement. The hardness is better retained and that is also a pleasant property for the consumer. Conditions also apply to a successful application. If applied to unripe fruits, the fruits remain unfit for consumption. With pears, this is an additional risk. The natural ripening is stopped, which can have an effect on the taste experience. Misapplication to sensitive fruits can lead to quality problems. MCP-1 is also a cost factor that is often not paid extra for. On organic fruit, an MCP-1 treatment is not allowed. The advantages and disadvantages mentioned guarantee the necessary discussion. However, MCP-1 has occupied an important place in the preservation of fruit. After an MCP-1 treatment, CA storage for long-term storage of fruit is a requirement.
MCP-1 is now supplied by various parties. These parties provide advice on the exact application of MCP-1, the timing for the application of MCP-1 and any waiting times for the application of CA and the conditions for CA storage.
Depending on the variety and the chosen storage strategy, treatment of MCP-1 can be carried out.

1.8 The process of CA/ULO retention

In general, the following steps are followed when deploying CA/ULO custody.

1- The (quick) cooling of the fruits in the cold store to the recommended storage temperature.
2- Checking the fruit temperature. If the differences in fruit temperature are less than approx. 0.5C in the cold store, ca storage can be started. During this cooling period, it is ensured that the CO 2 content remains below approx. 0.6% CO_2.
3- Depending on the storage strategy and the product/variety, treatment of 1-MCP can be performed.
   Follow the advice of your supplier/consultant about the application of 1-MCP and the storage strategy to be followed with corresponding CA conditions specific to each variety. This is important to avoid problems.
4- If the cold store CA is closed, the CA control is also activated to control the entered target values based on the chosen storage strategy. In a closed space, the oxygen content will decrease by, for example, about 0.8% per day and the CO_2 content will also increase by 0.8%.
   The oxygen content can be reduced faster from 21% to e.g. 5% with the help of a nitrogen generator. By rinsing a cold store with nitrogen, (part of) the produced CO_2 is removed via the overpressure valve.
   If no or less nitrogen is blown into the cell, e.g. at 5% oxygen in the cold store, the CO_2 content will increase. The O 2 and CO_2 content is measured regularly. If the CO 2 rises above a set limit value, the CO 2 scrubber is switched on to periodically remove CO_2 from the CA cell. This happens automatically. The scrubber circulates the cell air over an activated carbon filter for about 10 minutes and the CO_2 is adsorbed. When the carbon is saturated, a regeneration action follows in which the activated carbon is "blown clean" / regenerated with outdoor light.
   To prevent a lot of oxygen from ending up in the CA cell after regeneration, the activated carbon oxygen is made low in oxygen via a process control so that only a limited amount of oxygen ends up in the cell. A good control of this process is important for a good O 2/CO_2 regulation.
   The oxygen content in the cell gradually decreases by respiration, about 0.8% every day, depending on the activity of the product. Temperature is an important factor. If the target value of oxygen is reached, the CA control controls an aeration fan to prevent the oxygen content from falling below the target value.



5- After this adjustment phase, the CA control (Autostore software) ensures that the target values in CA cold store are automatically maintained. The following action is important;

- Properly checking the control of temperature, operation of cooling, oxygen, CO_2, ethylene and moisture loss and periodically checking the fruit quality.
- O 2% control by aeration or N_2 blowing in
- Control CO_2% by adjusting the running times of the scrubber and properly controlling the process times.
- Ethylene content can be measured optionally. It can serve as an indicator of whether the MCP-1 treatment has succeeded, the development of the ripening of the product, the development of rot in a batch.
- Checking water loss by water meters that collect the moisture from the coolers after a defrosting action
- Check cooling operation for cooling times, evaporator and compressor set settings, ventilation and defrost actions
- Regular Inspections of fruit quality by cutting samples and assessing them for external and internal quality and hardness. If the quality gives reason for this, the product must be removed from the cell for processing / sale.

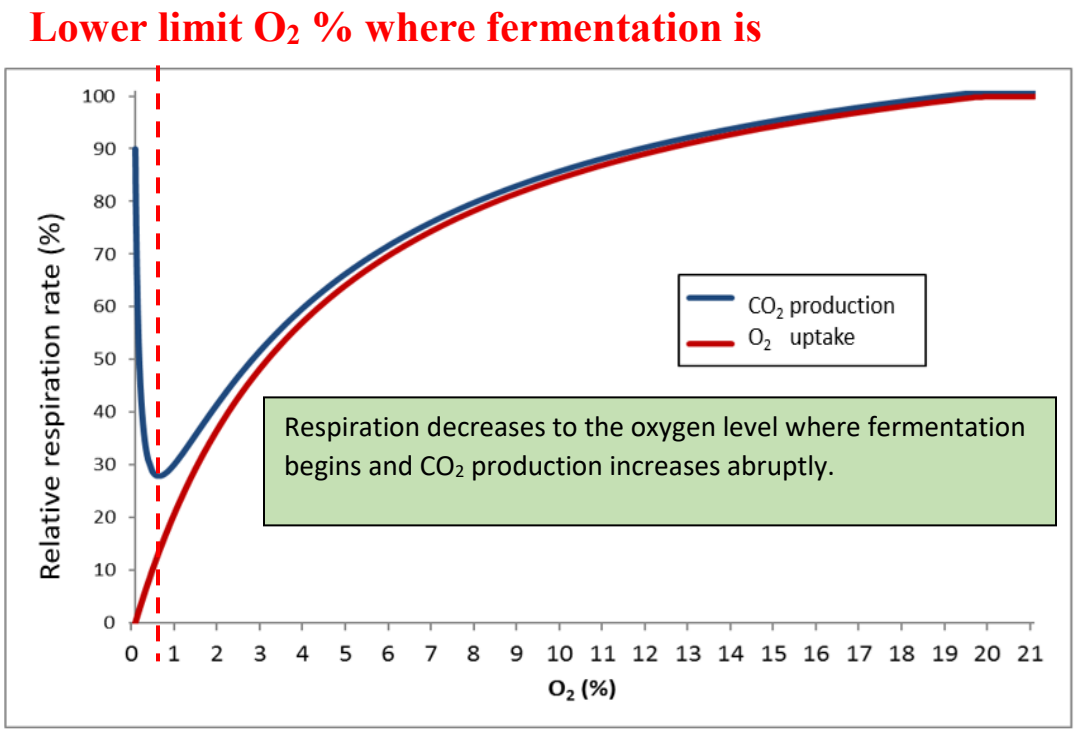
1.9 DCS/DCA bewaring

In 1997, the post harvest department of WUR Wageningen introduced the so-called DCS storage system. DCS stands for Dynamic Control System. With ULO storage wordand the products stored for safety reasons at oxygen levels of more than 1-1.2% O 2. If there is too little oxygen available for respiration, also called anaerobic conditions, fermentation can occur. During fermentation, the fruit sugars are converted into alcohol without oxygen and there is an increased CO_2 production.

$$C_6H_{12}O_6 \rightarrow C_5H_5OH + 2CO_2 + \text{energy in aromatity}$$

Sugars → Alcohol + CO_2 + energy + aromatics/ethylene

The diagram below shows the process schematically

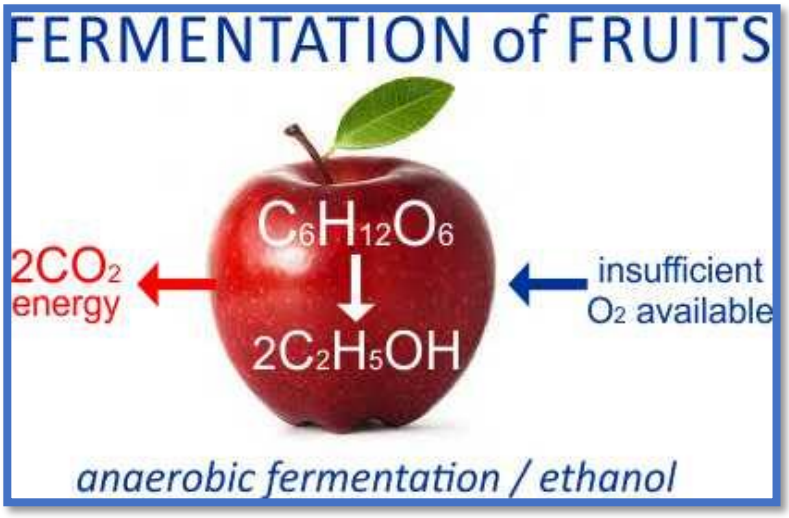


The formation of alcohol is undesirable because it affects the taste and can lead to brown discoloration. If fermentation is detected in time at the start and the oxygen content is increased, the ethanol can disappear from the fruit again.

However, it was found that if the apples were stored at lower oxygen levels than usual with ULO storage of 1.0% O_2, a significant improvement in quality could be achieved. The benefits manifested themselves in better preservation of hardness and the prevention of scald. It is notknown at whichk oxygen content fermentation will occur. A method was therefore developed or gradually reduced the oxygen content until it can be determined whether fermentation occurs. At that moment, action must be taken to increase the oxygen content in such a way that no fermentation occurs. This method for determining a low limit value for the oxygen content was called Dynamic Control System (DCS) because of its dynamic nature.

With the DCS system, the oxygen content is reduced in steps of e.g. 0.2% from e.g. 1.2% to 1.0% and then after a waiting period of e.g. 4-5 days a further reduction is set from 1.0% O 2 to 0.8% O_2, then another waiting period of e.g. 4-5 days etc. If an increased CO_2 production or ethanol formation is observed during the withdrawal period, this is an indication of fermentation and the reduction of oxygen should be stopped and the oxygen content should be reduced to at least the previous oxygen content to stop fermentation.

In addition to the term DCS, the term DCA (Dynamic Controlled Atmoshere) has now become established. Both terms DCS and DCA indicate that dynamic work is being done to gradually reduce the oxygen content in a storage cell to a certain level without damage being caused by fermentation. In some cases, fermentation can occur immediately after cooling at e.g. 0.8 or 0.9% oxygen. If the DCA reduction of oxygen is done gradually, the oxygen content can drop to 0.4% or lower without fermentation occurring.
When storing apples at low DCA values for oxygen, the sensitivity to CO 2 increases and adjusted lower CO_2 values are recommended.



The lower limit of oxygen at which the fruits can be stored is determined by the occurrence of fermentation and the opinion of the fruit keeper to what oxygen content he considers it responsible/safe enough to store his product.
Storage of apples at low oxygen values contributes to the preservation of hardness, display life and a fresh appearance. It is known that in scald sensitive apples the chance of scald decreases sharply when stored at 0.6% oxygen.

To check that no ethanol formation occurs in the fruits, a number of techniques have been developed.

1. DCS Automatic; Ethanol is a direct marker of fermentation. However, ethanol is difficult to measure in a cold store because it dissolves easily in water and there is also a lot of similarity with the measurement of ethylene. Storex has developed DCS automatically for this purpose. In a cold store, a sample of the fruits in the cold store is stored in a measuring box. The measuring box is continuously ventilated with cell air. A measurement action is carried out 1x per day. The measuring box is then closed and the amount of ethanol emitted by the fruits is measured in controlled conditions. There is always a minimal production of ethanol by e.g. damaged cells. If a sudden increase in ethanol is measured as a result of an oxygen drop, this is an indication of starting fermentation. Based on this, the oxygen content is increased.
2. Pulp analysis. During the waiting period during the DCS pull down and during the DCA storage, analyses can be done regularly on sample pulp to determine how much ethanol is in the pulp. Experienced custodians can also determine whether there is ethanol in the fruits based on tests.
3. Tracking the respiration quotient. In principle, the ratio of oxygen decrease versus CO_2 increase is 1 :1. If the oxygen content decreases by 0.8%, the CO 2 content in a DCA cell should increase by 0.8% with normal respiration. The respiration quotient (RQ) is determined by dividing the increase in oxygen content by the decrease in oxygen content. In this case, that's 1. If fermentation occurs due to lack of oxygen, more CO_2 is produced than oxygen is ventilated.

The RQ will then rise. The beginning of fermentation can therefore be determined by regularly determining the respiration quotient during the oxygen drop.

4. Measuring color change in the peel as an indication of stress due to fermentation.

So there are different systems to measure (starting) fermentation. It is important that the indications for fermentation can be measured reliably. DCS / DCA storage is a technique in which the quality of the apples can be better preserved.
A number of preconditions apply to DCS/DCA storage:

- Perfect gas tightness of the cold stores so that the low O_2 target values can be achieved.
- A perfect low-oxygen effect of the CO_2 scrubber
- Sufficient capacity of the N_2 generator
- An adequate measuring system for registering starting fermentation
- A tailored DCA/DCS control.

Storex specializes in DCA/DCS storage. Ask Storex about the application of this technique for your situation.

1.10 Climacteric fruits andnon-clima cteric fruits

A distinction is made between limacteric/ non-climacteric fruits

- Climacteric fruits are fruits that ripen after harvest.
- Non-climacteric fruits are fruits that must be harvested at the point of commercial maturity and have the right taste, quality and shelf life.

Climacterisch :	Non-climacteric :
• call	• Citroen
• peer	• mandarijntje
• nectarine	• grapefruit
• banana	• grape

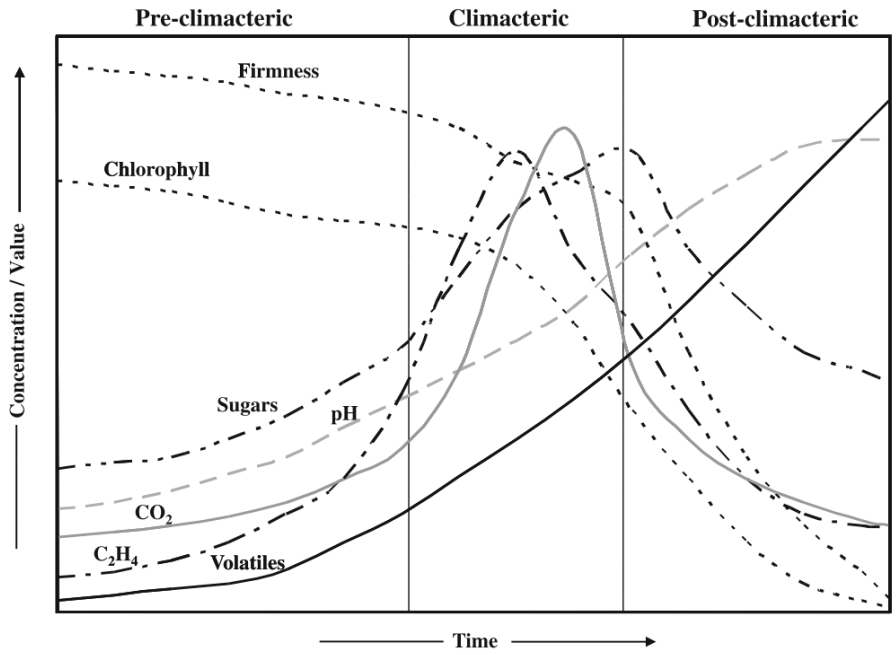
• mango • kiwi • peach • apricot • melon • watermelon • plum • papaya • avocado • tomato • persimmon • fig	• pineapple • strawberry • raspberry • cherry • olive • pepper • cucumber • Blueberries • Red currants • sla

During the ripening of climacteric fruits, the stages below are passed through. The graph shows schematically how a number of properties in the ripening processes of the fruits are:

Decrease: Hardness and chlorophyll

Increase and decrease: Sugars,$_{CO2}$, Ethylene

Increase: Div. Organic components, pH



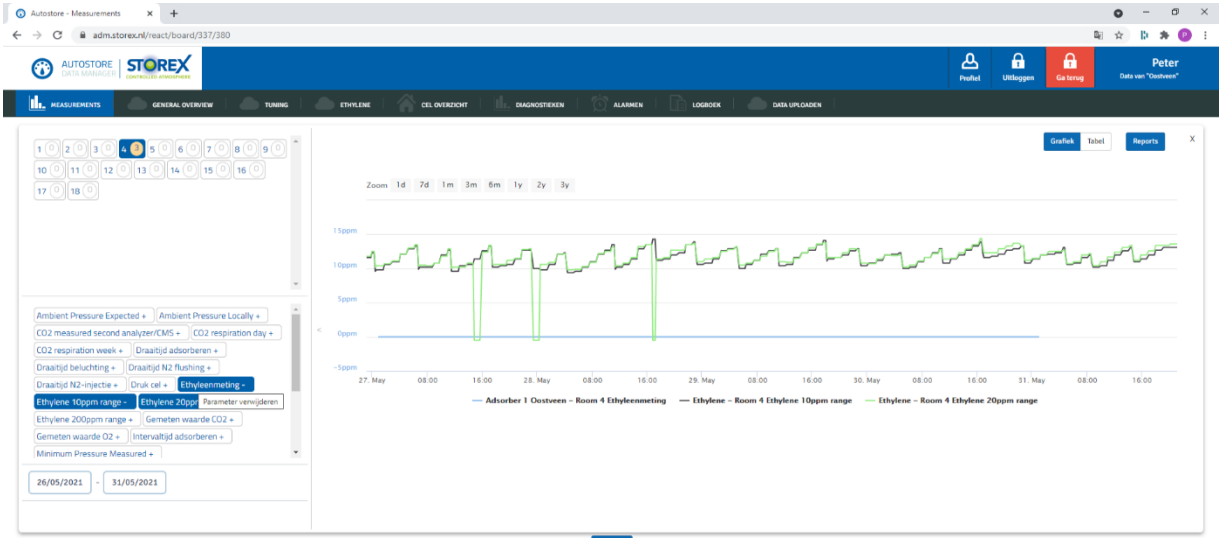
1.11 Ethylene meting

Ethylene is produced by fruits in the ripening process.
Ethylene administration of ethylene can stimulate the ripening of fruits. A well-known example is the ripening of e.g. bananas or mango by administering ethylene in combination with a temperature treatment.
When storing apples and pears, ethylene production is reduced when the oxygen content is reduced.
Administration of 1-MCP hinders the production of ethylene.
The removal of ethylene during the storage of apples and pears is hardly applied.

It is possible to measure the trend of ethylene production during storage in CA cells.

- Check if the 1-MCP treatment has worked properly
- Tracking the ripening of fruits
- A sharp increase in ethylene content may be an indication of the development of rot

There are fruits that are sensitive to accelerated ripening during storage if ethylene is present. Kiwi are enorm sensitive. The ethylene content in cold stores must remain below 20 ppb. To be able to measure this, special measuring equipment is required. Ethylene converters are connected to cold stores where kiwifruit is stored, which convert the ethylene into CO 2 and H_2O.



2 CA STORAGE REQUIREMENTS

(D) CA cold stores are characterized by the following properties:

2.1 CA cold stores; correctly dimensioned, well insulated and gas-tight

CA cold stores mustbe well insulated to allow good loading with good air circulation.

The insulation must be sufficiently thick for local conditions. The CA cells can be placed in (insulated) buildings. Depending on your product and the local conditions, the design can be made.

It is important that a good gas-tight floor is installed.

The panels must be placed and seamed with care. After installation, the seams of the insulation panels can be finished with a gas-tight coating.

Gas-tight doors are placed in front of the doorway. The design and placement deserves care to prevent leaks.

After the construction of the cold stores has been completed and the cooling and CA technology has been installed, the cold store must be tested for gas tightness. Strict standards apply to DCA storage. A good gas density is important to enable storage at low oxygen levels with preferably as little use of nitrogen as possible.

Storex can assist you in the design and construction of the cold stores, the supply of materials to make the cold store gas-tight, the installation of gas-tight doors and the testing of CA cells for gas tightness.

2.2 Cooling for CA cells.

The design of a refrigeration installation for fruit storage is essential for good CA storage. The cooling must be adjusted to the temperature of the fruit at entry and the tonnages of fruit that must be cooled per day. A quick cooling is of great importance for the storage result. For this, sufficient capacity must be available for the compressors and condenser and the correct evaporator in the cold store. The dimensioning of the cooler has a lot of influence on the operation of the cooling and the moisture loss of the product. Cooling is drying. If you work with relatively small coolers with a small cooling capacity and ventilation capacity and a large temperature difference between the product and the cooler, more moisture loss will occur compared to coolers with a large capacity and small temperature difference between product and coolers.

The pipes must be installed gas-tight. The coolers can be equipped with a central drainage of the defrosting water after a cooling action with a water measurement included. Based on the moisture loss of the product, the operation of the cooling can be checked.

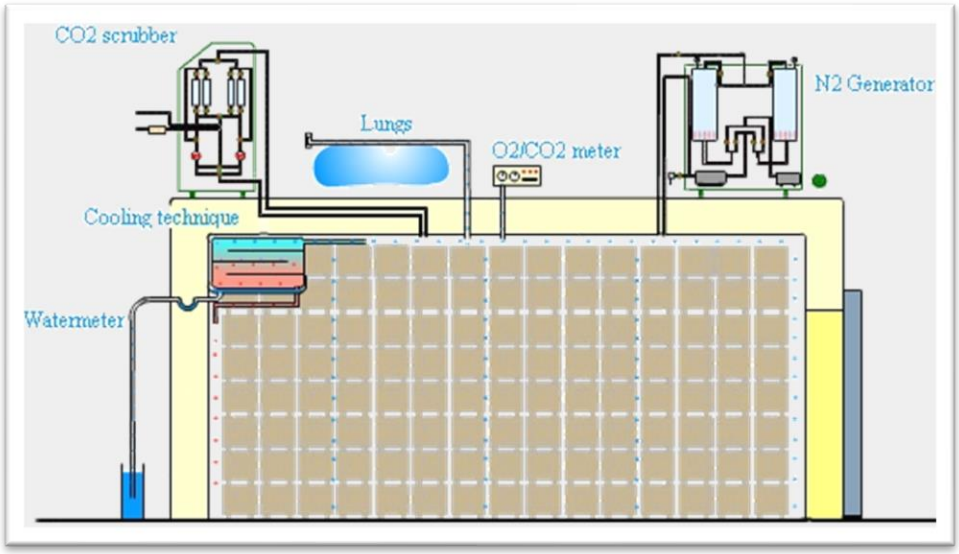
Storex works together with various parties and consultants in the field of refrigeration technology and can advise you with partners on the design and choice of cooling installation.

2.3 CA technique for CA cells

The CA technique for CA cells consists of:

- N_2 generator for lowering oxygen content
- CO_2 scrubber for removing CO_2
- O 2/CO_2 measurement and control system
- Cloud based data registration system and remote control via APP
- Accessores for the cold store such as:
    - Cell valves and pipes for N 2 generator and CO_2 scrubber
    - Beluchtingsventilator
    - Water meter
    - Gas measuring tap, throughput for testing gas tightness,
    - Air buffer to flexibly resolve air pressure fluctuations
    - Under / Overpressure valve
- Options such as:
    - Ethylene meter
    - DCS system
    - Ethylene converter
    - Luchtbevochtiging
    - Luchtvochtigheidsmeters
    - Ontvochtiging

Storex develops and manufacturesa complete package of these products. We are happy to advise you on the selection of the most suitable CA technique for your project and the use of this equipment for the best storage result.


CO2 scrubber
Lungs
O2/CO2 meter
N2 Generator
Cooling technique
Watermeter

3 CA STORAGE FOR SOFT FRUIT IN PALLET HOEZEN OR CA CELLS

Long-term storage of soft fruit products requires proper control of CA conditions and the necessary flexibility.

Berries are often stored at higher CO_2 levels. Blueberries at 9-10% CO_2 and red berries at 18-20%. A reduced oxygen content ensures that breathing takes place more slowly and that there is therefore less fluid loss of the product.

The Storex Pallistore solo system can control the oxygen and CO_2 content in individual pallet covers. The Storex Pallistore section system is mainly used for blueberries.

3.1 Storex Pallistore Individual CA System

The Storex Pallistore system is ideally suited to control the oxygen and CO_2 content for individual pallet covers at any desired target value.
The Pallistore system includes the following components:

- Covers for pallet with pallet sizes with 1 x 1.2 meters a height of 2 to 5 meters. At the pallet place, 1000 to 2000 kg of product can then be stored under CA conditions.
- A choice of 3 closing systems for the pallet cover;
    - And clamp profile to clamp the folded tops of the pallet cover.
    - A pallet with double bottom plate between which the foil of the pallet cover can be clamped.
    - And bottom tray with water for a water seal.
    - A pallet with a bottom plate with a notch underneath. When the pallet cover is pulled over the box with product on the pallet, the pallet cover is pressed into the notch with a rubber band to seal it gas-tight.
- Accessories to connect a measuring hose and a hose for the supply of CO_2 and a combined hose for the supply ofnitrogen or atmospheric air.
- A nitrogen generator, bottles with CO_2 (to be controlled by the user) and a compressor
- The Storex Radar System:
    - an oxygen/$_{CO2}$ measurement and control system
    - per pallet connection a measuring valve for O 2/CO 2 measurement, a valve for N 2 supply, a valve for CO_2 supply and a valve for aeration.
      The pallet covers are measured several times a day and corrected where necessary by nitrogen, CO_2 supply or aeration.
      The CO_2 comes from bottles, the nitrogen from a nitrogen generator and the aeration is done with filtered compressed air.
    - The measuring valves consist of boards with 10-20 connections and can be expanded to approx. 200 pallets per measuring system.
    - The ADM data registration system and our app for remote control and control

The Pallistore has the following advantages:

- Pallistore Radar system modular and suitable for 10-200 pallet covers

- Individual CA control per cover
- Pallet covers are reusable with careful use
- No cross-contamination between different pallets
- Easy access to product per pallet through easy disconnection of the CA system
- Temperature measurement in the product
- Pre-programmed storage protocols adjustable in the software
- Afstandsbediening via App of ADM
- Choice of 4 pallet cover sealing systems to suit your situation

3.2 Storex Pallistore Group CA system with circulation system

The Pallistore with circulation system is often used for the storage of blueberries.
The system consists of a supply and return pipe with a Circulation unit.
From the supply and return pipe, the pallet cover is connected with 2 flexible hoses.
Up to 50 covers can be connected to 1 section. The pallet covers can be individually connected and disconnected.
The oxygen and CO 2 content is regulated in the circulation system by the supply of nitrogen, CO_2 and aeration. Due to the circulating air in section, the target values are easily maintained and the CA climate in a newly connected pallet cover is quickly adjusted.

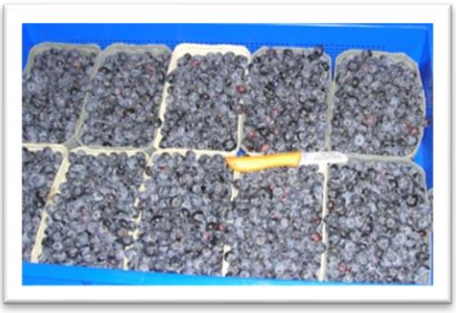
The Pallistore section system consists of the following components:

- Covers for pallet with pallet sizes with 1 x 1.2 meters a height of 2 to 3 meters
- A choice of 4 closing systems for the pallet cover;
    - And clamp profile to clamp the folded tops of the pallet cover.
    - A pallet with double bottom plate between which the foil of the pallet cover can be clamped.
    - And bottom tray with water for a water seal.
    - A pallet with a bottom plate with a notch underneath. When the pallet cover is pulled over the boxes with product on the pallet, the pallet cover is pressed into the notch with a rubber band to seal it gas-tight.
- A central supply and return pipe with 2 connections for 2 flexible hoses with hand crane per pallet cover. Up to approx. 50 pallet covers per section.
- A circulation unit consisting of a fan, overpressure valve and connection points for a measuring hose, supply of nitrogen, CO_2 and aeration
- Accessories to connect the 2 hoses of the circulation system to the pallet cover.
- A nitrogen generator, bottles with CO_2 (to be controlled by the user) and a compressor
- The Storex Radar System:
    - an oxygen/$_{CO2}$ measurement and control system
    - per section a measuring valve for O 2/CO 2 measurement, a valve for N 2 supply, a valve for CO_2 supply and a valve for aeration.
      The circulating air in the sections is regularly measured and, where necessary, corrected by supplying nitrogen, CO_2 or aeration.
      The CO_2 comes from bottles, the nitrogen from a nitrogen generator and the aeration is done with filtered compressed air.
    - The number of sections per Pallistore section system is expandable to 10 sections. .
    - The ADM data registration system and our app for remote control and control

The Pallistore sectie has the following advantages:

- Pallistore Radar system modular and suitable for 1-10 section with connected 10 – 500 pallet covers-
- Individual CA control per section
- Pallet covers are reusable with careful use
- Stable control of the CA climate in the connected covers. Newly connected covers simply come on regime.
- Easy access to product per pallet through easy disconnection of the CA system

- Temperature measurement in the product
- Pre-programmed storage protocols adjustable in the software
- Afstandsbediening via App of ADM
- Choice of 4 pallet cover sealing systems to suit your situation



3.3 CA rooms for berry storage 10 – 100 Tons

As an alternative to storage with a Pallistore system, the product can also be stored in (small) CA cold stores. These cold stores can be built up similarly to CA cells for apples and pears.
The advantage of CA storage in cold stores is that the circulation in the cell can easily be controlled by cooling. In CA cells, the RH is lower than in cover storage, which can be beneficial for reduced rot development. The moisture loss is controlled using water meters.
Depending on the storage strategy, CO_2 may or may not be scrubbed onto the CA cells.
Storex is happy to advise you on the design of CA cells for berry storage.