èÐÕõ¸üÒøýÛÕõ Òãú ÕÒûÛ ÕõÐøÒÜÛ õÛÚüãÐÿÐÜÞ Ðû ÒÜøÙÚÝÿõÝøÒÿ đøÐúÝÚõÕ

KOPIA Dominican Republic
Gyuhwa Lee(Martin)

ÅÐãõÛãõÕ

1. Necessity of low temperature storage
2. Purpose of low temperature Factors affecting quality after harvest
3. Type of storage
4. Types and Principles of storage facilities
5. Management and Shipping Guidelines of agricultural products after Harvesting
6. Management of storage facilities

ëÛÚÛÕÕÙõÞ Đû ÿĐĐ õÛÃđÛøÒõÝøÛ ÕõĐøÒÜÛ

Agricultural and livestock products are primary commodity. The yields depend on the weather condition and the Production increases in certain seasons, for that reason the price of agricultural products fall in shipping time due to overage, on the other hand the Price rise suddenly in non-shipping time because of shortage of goods. This can cause confusion in the distribution system, insecurity of dietary safety and a health hazard. To solve this problem, Low temperature storage facilities and methods are highly required

èÝøđÐÕÛ Đû ÿĐĐ õÛÃđÛøÒõÝøÛ ûÒÚõĐøÕ ÒûûÛÚõÙãÜ ØÝÒÿÙõÞ ÒûõÛø ûÒøýÛÕõ

❖ Extension of expiration date :

qualitative and quantitative lose protection

❖ Control of market shipment quantity, variety

and supply : stabilization of distribution

❖ Improvement of nutrition and flavor

: storage, afterripening, fermentation etc.

❖ Use inoperative law food

❖ Simplification of transportation and storage

: seal, sterilization

❖ increase of agricultural added value

çÒøýÛÕõ ÿÐÕÕ Đû ûøÝÙõ ýÛÜÛõÒòÿÛÕ

Table. Harvest loss of fruits and vegetables(%)

	Storage	Selection & Packing	Transport ation	Sales	Retail	Total
Radish	-	6.0	12.0	10.1	5.9	34.0
Chili	7.0	2.3	2.8	3.5	4.8	20.4
Garlic	9.1	3.1	1.8	6.3	6.4	26.7
Apple	5.7	6.3	0.8	4.7	1.8	19.3

ËÒÙã æÒÚõÐø Ðû ÒÜøÙÚÝÿõÝøÒÿ ðøÐúÝÚõ ÕÐõøÒÜÜÛ

Factors	Subsections	Contribution (%)
Cultivate Factors	Variety	20
	Field(Wet/dry)	15
	Fertilization	25
	Irrigation	10
	Pest control	30
	Subtotal	100
Before-Storage Factors	Harvest time	20
	Package selection	10
	Storage container	10
	Curing and Precooling	45
	Warehousing	15
	Subtotal	100
Storage Factors	Maintain temperature	30
	65-70% humidity maintain	40
	0.2-0.5m/s wind maintain	15
	Disinfection of storage	10
	Decompose check	5
	Subtotal	100

ÍÝÒÿÙõÞ ÒÕÕÝøÒãÚÚÛ ûÐø ÒûõÛø üÒøýÛÕõ

Physiological function after harvesting	Distribution environment	Quality assurance technology
○Respiration ○Transpiration ○Ethylene occurrence ○Ripning ○Disorder -Physiologycal : high, low temperature, freeze, gas -physical : shake, shock -pathology : bacteria, fungi	○Temperature ○humidity ○gas composition ○ethylene ○Light ○Shake, Shock ○Chemical	○Precooling(Air,Water,Vacumm, Ice) ○Preprocessing(clean , disinfection, Curing) ○package(Cardboard, MAP) ○Storage(Low tem. ,CA,freeze) ○Transportation(room, low temperture, Freeze)

æÒÚõÐøÕ ÒûûÛÚõÙãÜ ØÝÒÿÙõÞ ÒûõÛø üÒøýÛÕõ

1. Respiration
2. transpiration
3. Ethylene effect
4. Pathological disorder : fungal, microbial decay
5. Physiological disorder : high, low tem. Freeze, gas
6. Physical disorder : shake, shock
7. ripening : aging

I. Respiration

- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 674kcal$

(glocose)(oxygen) (Carbondioxide) (water) (thermal energy)

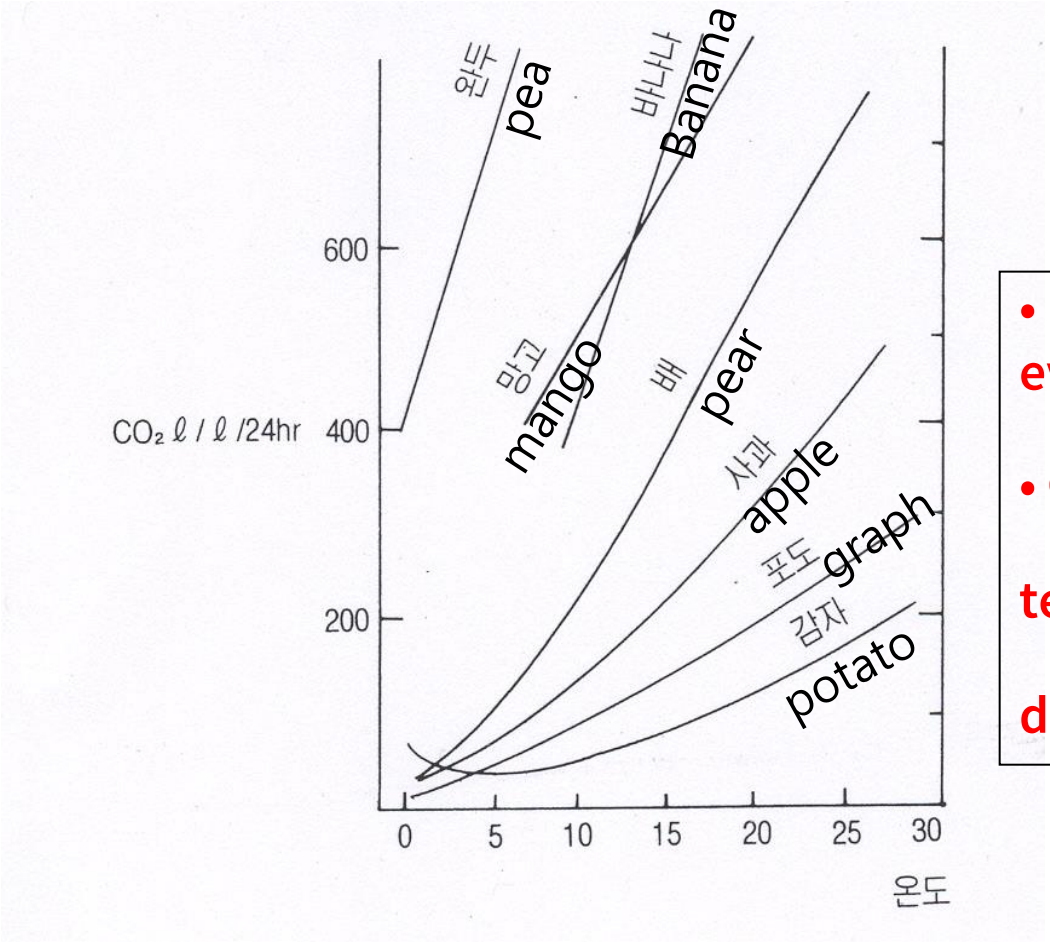
-When 1g of glucose is broken down by respiration,

1.47g of carbon dioxide, 0.6g of water, 3.74kcal thermal energy are generated

- Decomposition of reserve substance, Weight decrease and freshness decline due to respiration→ more respiration, more acceleration

- If the heat is not removed, the ambient temperature and respiration are higher, which reduce the quality of products

● Temperature and respiration



- Respiration is 1.6 to 2.0 times for every 5 ℃ increase in temperature
- Conversely, for every 5 ℃ drop in temperature, the respiration rate decreases by 50% to 70%

- To prevent respiration, cooling(pre-cooling, cold storage) is requered

● Respiration and weight reduction(example)

➢Weight reduction when 100 tons of apples are stored at 0 and 10 for 300days

▪ 0 Storage

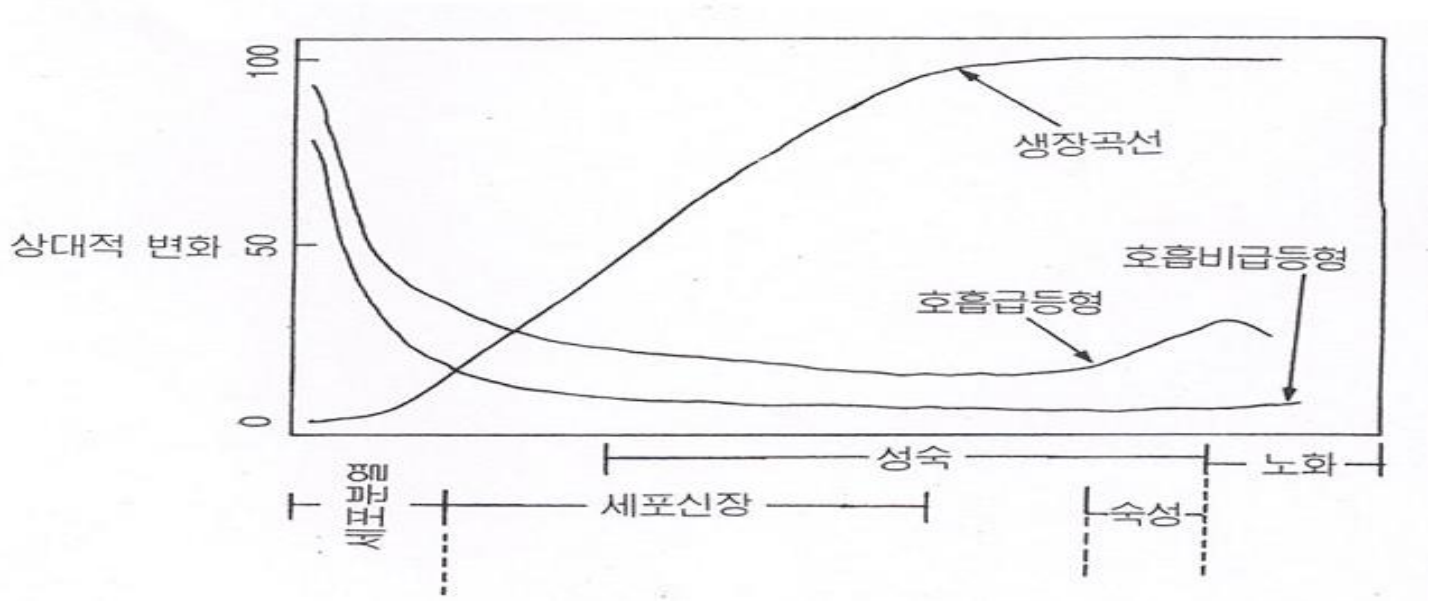
$$\text{Weight loss(ton)} = \frac{100\text{ton} \times 300\text{days} \times 3\ (\text{mg } CO_2/\text{hour}\cdot\text{kg})}{38{,}194} = 2.4\text{ton}$$

▪ 10 Storage

$$\text{Weight loss(ton)} = \frac{100\text{ton} \times 300\text{days} \times 9\ (\text{mg } CO_2/\text{houe}\cdot\text{kg})}{38{,}194} = 7.1\text{ton}$$

● Respiration aspect and Quality change

Physiological, Chemical and organizational changes are rapidly occurring in climacteric fruits when respiration rises, and storage is clearly impaired based on this. Therefore, the principle of long-term storage Is to harvest at a time when respiration is the smallest (preclimacteric minimum) before the respiratory rise, and to devise methods such as low temperature and low pressure storage. However, if harvest time is advanced, storage is good, but quality is poor, so it must be harvested in a balance between storage and quality



Respiration rate by storage temperature of agricultural products

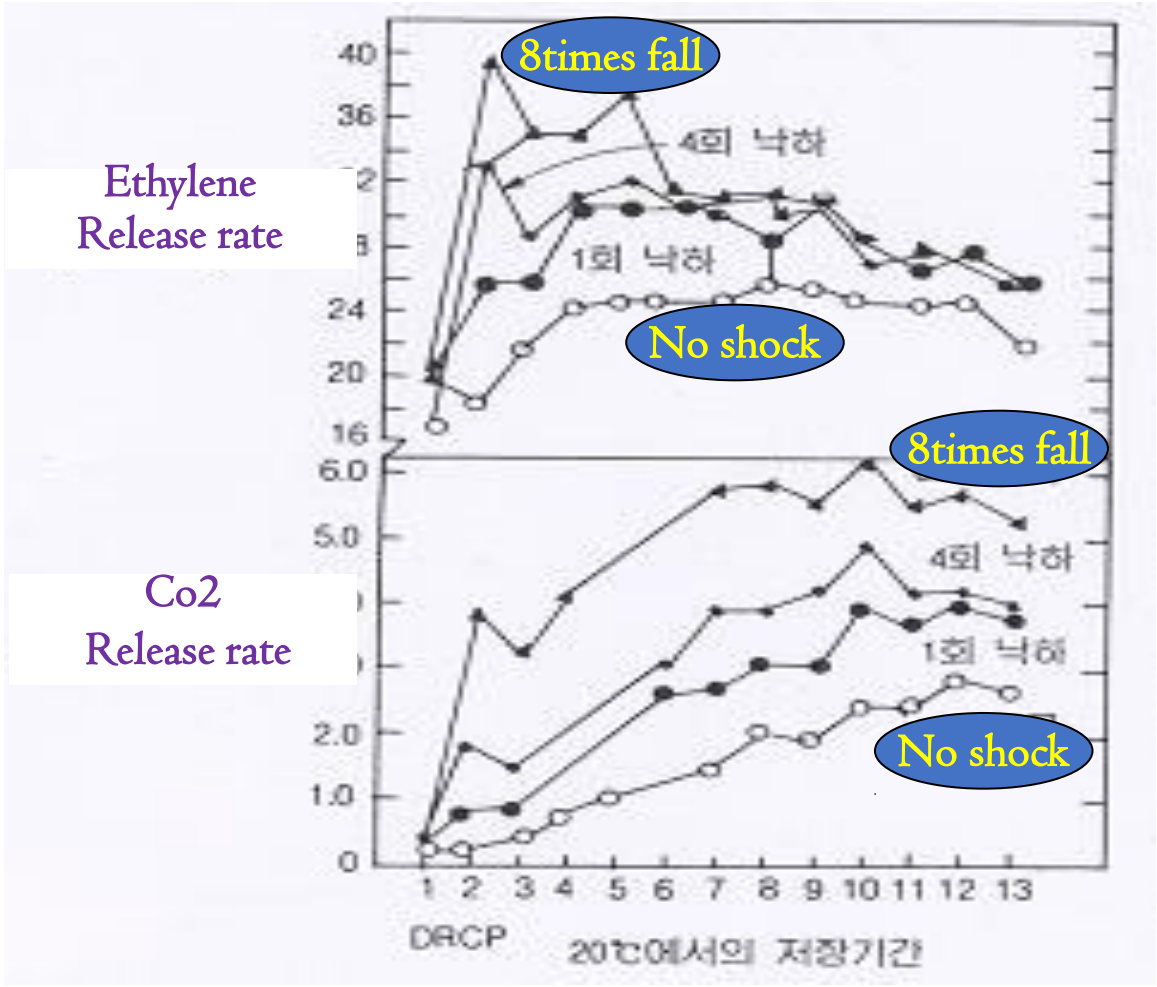
Items	0℃	10℃	20~21℃	25~26℃
Lettuce	330~930	1,760~2,500	2,820~3,330	4,060~5,070
Spinach	1,006~1,240	7,430~12,400	9,550~15,930	
Cabbage	250~350	1.030~1,440	1,540~2,720	2,700~3,530
Sweetcorn	1,660~2,850	8,390~11,110	11,440~13,360	
Cucumber	-	830~1,840	780~2,670	1.060~3,050
Tomato	-	1,340~1,610	1,340~2,440	1,660~2,900
Bell pepper	-	1,110~3,180	1,260~3,600	1,990~4,110
Carrot	530~1,130	1,440~2,970	2,550~5,270	-
Potato	-	330~660	450~880	-
Sweet potato	-	1,080~1,340	-	-
Apple	130~230	760~1,710	930~1,940	-
Peach	230~350	1,840~2,340	3,286~5,670	4,510~6,750
Graph	80~130	1,870~2,140	2,470~3,580	3,450~3,960
Persimmon	-	660~780	1,110~1,340	1,610~2,220
Strawberry	680~980	3,930~5,120	5,670~10,860	9,370~11,690

● Classification according to the aspect of respiration

Climacteric type	Non-climacteric type
Persimmon Apple Mango Mango Apricot Melon Waternelon fig Avocado Banana Kiwi Pear Tomato Peach Papaya	Eggplant Orange Chili pepper Cucumber Strawberry Olive Lemon Pineapple Mandarin Graph Cherry

- Harversting and cooling periods are important for suppressing respiration

● Physical stress and respiration rate



Fall from
30cm height

- Vibration and shock suppression is necessary to suppress breathing

2. Transpiration

● Transpiration and epidermal dry

● Cause of Transpiration

High steam pressure(Temperature,Humidity) ⇨ Low steam pressure (Tem.,Himidity)

Moisture migration

⇨ Storage condition

0°C, 100% relative humidity

Moisture migration

⇨ Storage condition

0°C, 80% Relativie humidity

æÒÚõÐøÕ ÙãýÐÿýÛú Ùã đÐÕõ¸ üÒøýÛÕõ õøÒãÕđÙøÒõÙÐã

1. maturity : young cell -> increase

2. temperature : High -> increase

3. Humidity : Low -> increase

4. Wind : High speed-> increase

5. Pressure : Low -> increase

6. Light : Vibration, Shock

7. Damage : aging

îøÒãÕđÙøÒõÙÐã ÚüÒøÒÚõÛøÙÕõÙÚÕ Đû æøÝÙõÕ Òãú ýÛÜÛõÒòÿÛÕ

Charcateristic		Vegetables	Fruits
A type	Low temperature -> extremely decrease transpiration	Potato, Sweet potato, Onion, Pumpkin, Cabbage, Carrot	Mandarin, Apple, Pear, Watermelon
B Type	Low temperature -> Decrease transpiration	Radish, Cauliflower, Tomato, Pea	Chestnut, Peach, Melon, Graph(Western), Fig,
C type	Temperature -> No effect on transpiration	Celeri, Asparagus, Eggplant, Cucumber, Spinach, Mushroom	Strawberry, Graph(american) Cherry

● **Weight reduction by Transpiration (Example)**

➢ Weight reduction when 100tons of apples are stored at **0℃, and 85% relative humidity for 300days**

$$\text{Weight reduction(t)} = \frac{100(t)\times 300(days)\times 42(ng/S.kg.Pa)\times 134.1(Pa)}{11{,}574{,}000} = 14.6t$$

Vapor pressure deficit(Pa) = surface vapor pressure(Pa) – atmosphere vapor pressure(Pa) = 894.1 – 760.0 = 134.1(Pa)

- **Weight reduction by Transpiration (Example)**
  - Weight reduction when 100tons of apples are stored at **0℃, and 95% relative humidity for 300days**

$$\text{Weight reduction(t)} = \frac{100(t)\times 300(days)\times 42(ng/S.kg.Pa)\times 44.7(Pa)}{11{,}574{,}000} = 4.9t$$

Vapor pressure deficit(Pa) = surface vapor pressure(Pa) – atmosphere vapor pressure(Pa) = 894.1 – 849.4 = 44.7(Pa)

- Rapid cooling and high humidity maintenance are essential to prevent water loss

3. Ethylene action

- Etyhlene production is associated with an increased respiration
- Causes discoloeration, aging, corruption, etc.

High ethylene crop	**Apple, Pear, Apricot, Peach, Tomato, Plum, Banana(full ripe), Kiwi(full ripe), Mango, Fig, Melon**
Ethylene-sensitive crop	**Apple, Pear, Apricot, Peach, Tomato, Plum, Orange, Banana(unripe), Broccoli, Chinese cabbage, Carrot, Cauliflower, Cucumber, Eggplant, Kiwi(unripe), Mango, Lettuce, Chili pepper, Spinach, Watermelon, Sweetpotato**

● Ethylene counterplan

-Avoid : Avoid high levels of ethylene

- Be careful of vibration and shock when harvesting, transporting, wiring, or packing
- In storage, remove wounds, disease-infested insects, overripen fruits
- Avoid mixed storage, transportation, and vibration by considering ethylene gerneration and sensitivity
- Disinfecting and maintaining cleanliness in the storage area

-Remove Ethylene : adsorption, decomposition, $KMnO_4$, ozone ventilation

-Inhibit : Appropriate cold management(pre-cooling, cold storage)

4. fungal, microbial decay

Air

Environment

tool

Container

Storage environment

4. Corruption prevention from fungi, microbe

- Fungi growth conditions: temperature, moisture, nutrients
- Caused by the growth of the infected fungus during or after cultivation
- Counterplan
  - ➢Disinfection : Greenhous, Carrying box, Harvesting tool, Storage, Fruit surface
  - ➢Low temperature storage
  - ➢Handling : Prevention of tissue softening due to injury or shock
  - ➢Strenthening epidermal tissue : Curing, Precautions

ÎõÐøÒÜÛ Đû ÒÜøÙÚÝÿõÝøÒÿ đøĐúÝÚõÕ òÞ đøÛ¸ÚÐĐÿÙãÜ

Pre-cooling is the quick cooling of the heat from the agricultural produce to a certain temperature in the production area before transport or storage

Agricultural products are particularly high in respiration at the time of harvest and are the main contributors to the reduction of lead and deterioration of quality by respiration. We must reduce the temperature of agricultural products as soon as possible to prevent deterioration. The thickness of the pre-cooling material is proportional to the time required to reduce the temperature, therefore Proper use of agricultural container boxes are required

Since pre-cooling in box conditions causes unsuitable and dampness of box, the thinner and bricklying are more effective.

● Effects of pre-cooling

Category	Items	Room tem. distribution	Pre-cooling/Cold chain
Nutrient ingredient	Spinach	30℃/3days later loss of 85% Vitamin C	After precooling 10℃/21days later 20% loss of Vitamin C
Weight loss	Cherry	10℃/3days later 4.4% loss	0.6℃precooling/3days later 1.9% reduction
Discoloration	Spinach	30℃/3days later chlorophyll 55% loss	After precooling 10℃/3days later chlorophyll 2% loss
Damage in Transporting	Strawberry	10kg/3bundle/room temperature occur 65% damaged fruits	After precooling 500g small packing under 5% occur damaged fruits
Expire date	Lettuce	in 15℃ -> 3days	after precooling in 1℃ -> 35days

● Precooling effects by crops

category	High in effect	Normal in effect	Low in effect
Leaf vegetables	Lettuce, Spinach, Broccoli, Asparagus, Celery, Parsley, Chrysanthemum, Chive, water celery, chinese cabbage, Cauliflower	Chinese cabbage, Spring onion, Cabbage	-
Fruit vegetable	Strawberry, Sweetcorn, Pea, Cucumber, bell pepper	Cucumber, Tomato, chili pepper	pumpkin, watermelon. melon
Root crop	Carrot	Radish	onion, garlic, Potato
The others (forest product)	Mushroom(shiitake, oyster mushroom, etc.)	Chestnut	Pine nut
Fruits	Apple, Peach, Graph	Apple, Pear, kiwi fruit	Late maturing variety, mandarin

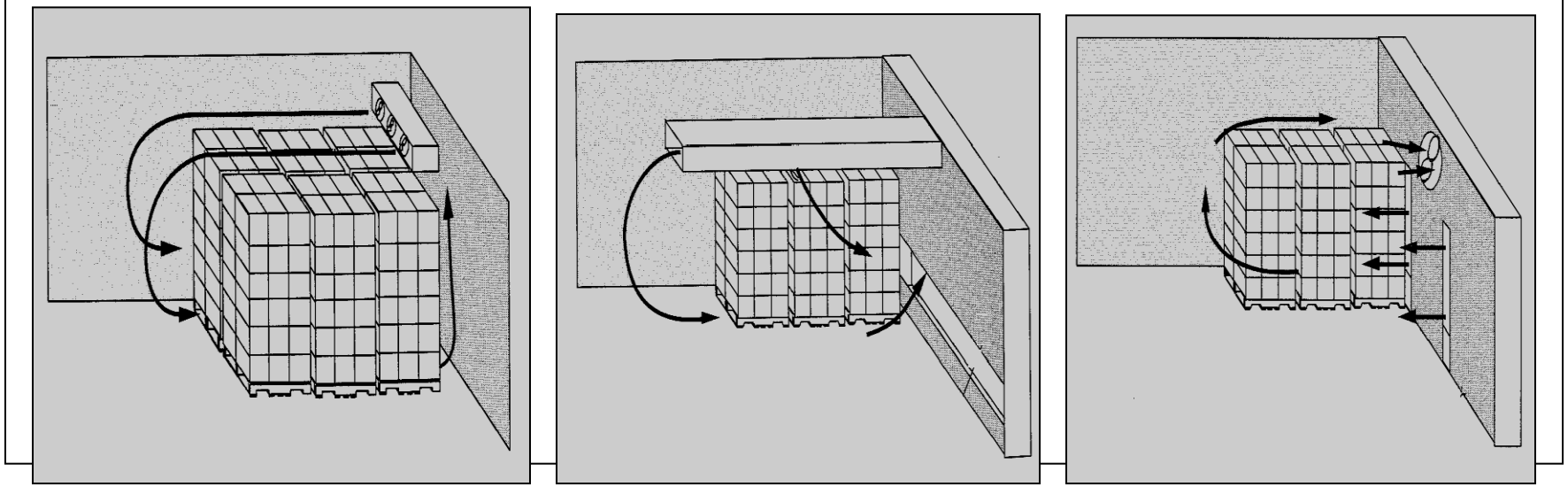
● Pre-cooling use time

Crops	Pre-cooling use time			
	Differential pressure	Forced draught type	Vacuum type	Water cooling type type
Pear	5~6 Hours	24~48 Hours		
Graph	5~6	20~25		
Peach	6~8	24~48		
Strawberry	3~4	10~15		
Bean	3~4	20~24		
Broccoli	3~5	10~15		
Chrysanthemum	10~15	24~28		
Spinach	2~3	10~15		
Radish	7~10	20~24		
Carrot	3~5	24~28		
Chinese Cabbage			18min.	
Lettuce			24min.	
Mushroom			24min.	
Potato				34min.
Carrot				10min.

● Force blower precooler

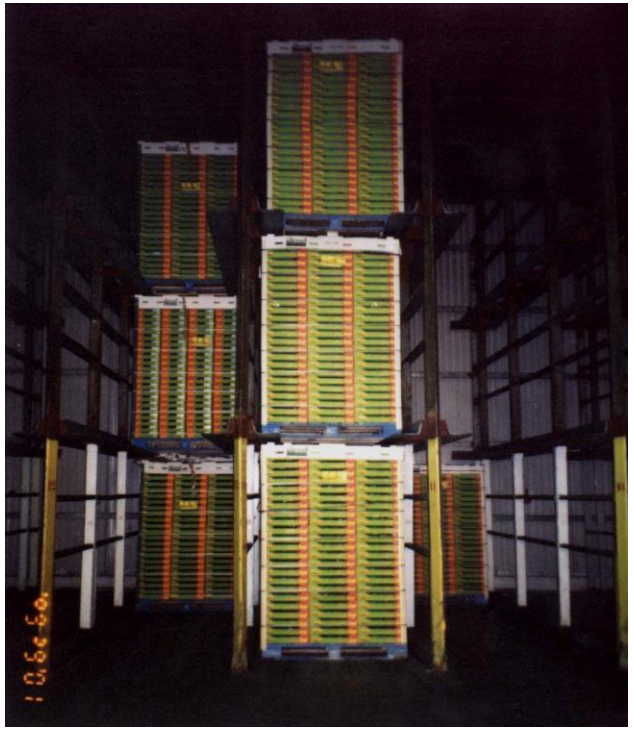
➢ Air flow rate ： beginning 0.005 ㎥/s.kg → after freeze 0.001~0.002

➢ circulate cool air



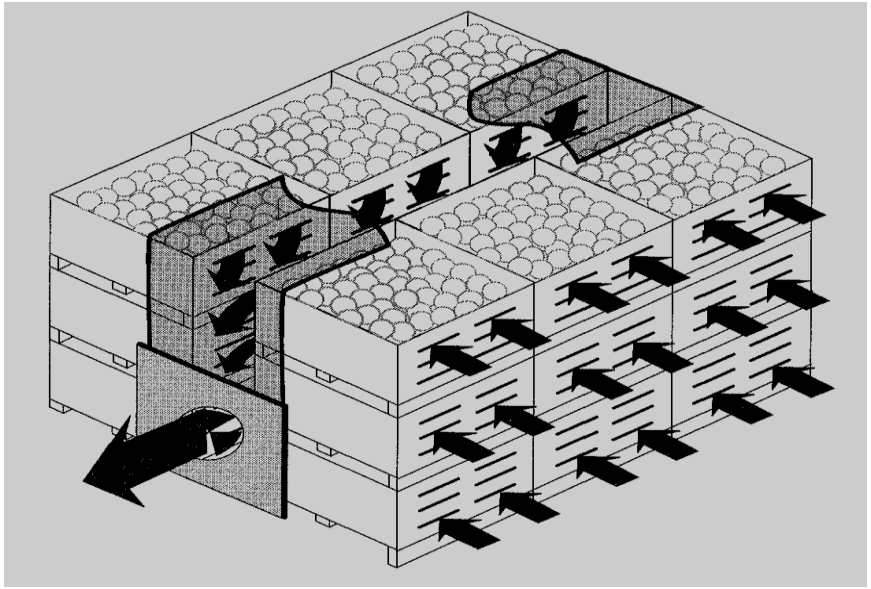
➢ Packaging box and load method and cooling speed

Air hole ratio(%)	*space (cm)*	*form*	*Cooling time(hr)*
0	0	-	84
4	2.5	Air hole dislocation	22
4	2.5	Air hole arrayed	18

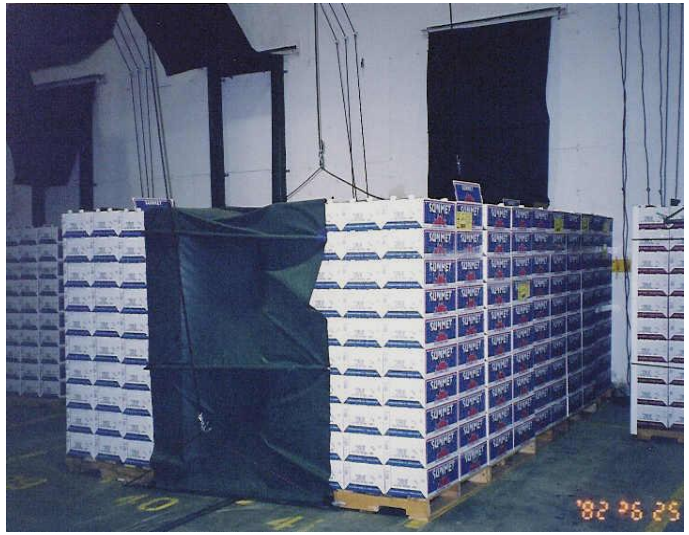



Agrexco
EcoFresh
Carmel

● pressure cooling system

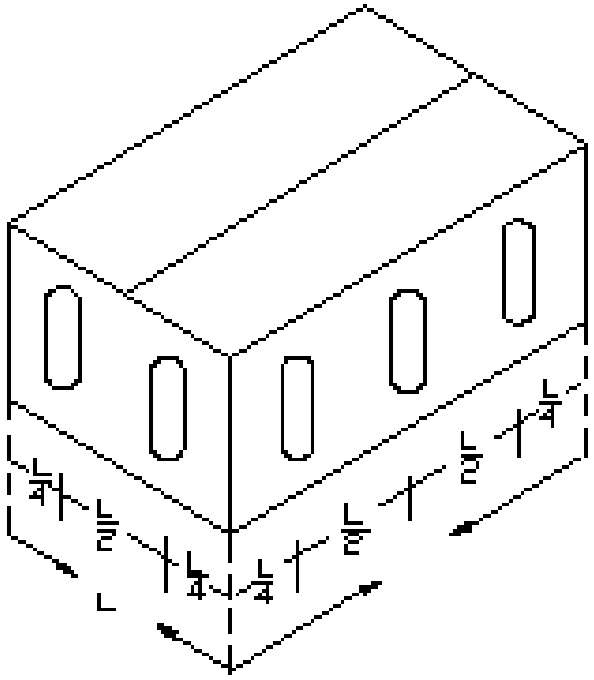


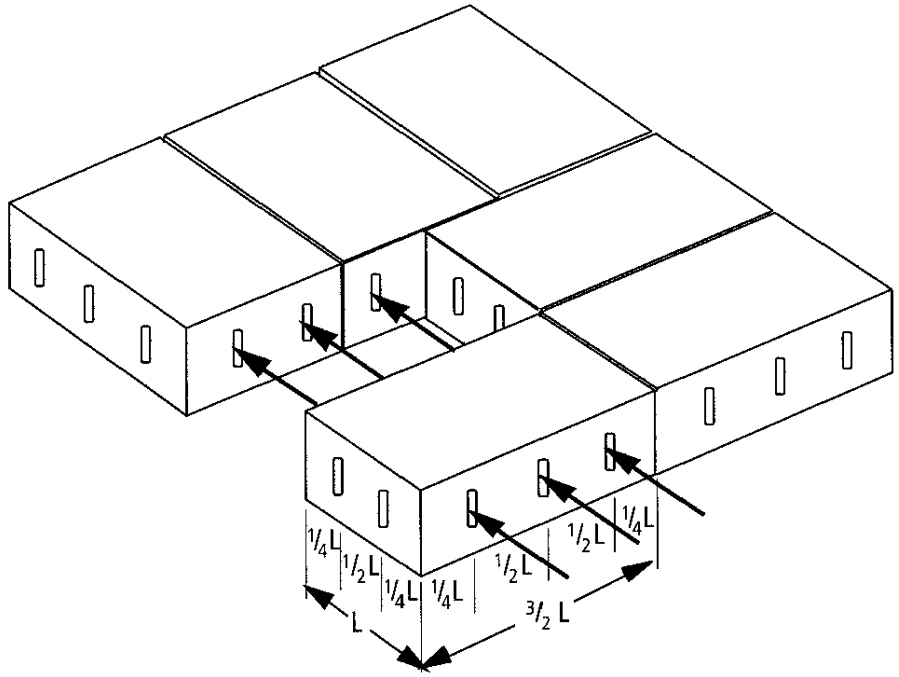
< Center suction type>



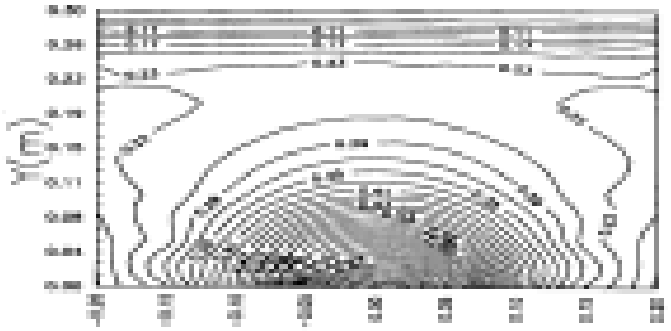
< Wall suction type >

- **Packaging box : 3 or more vents, hole area 5%,**
  hole area in middle block is 10%,
  Caution of the position of the vents

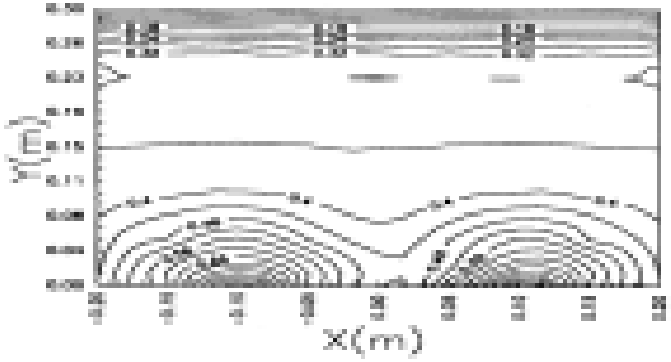




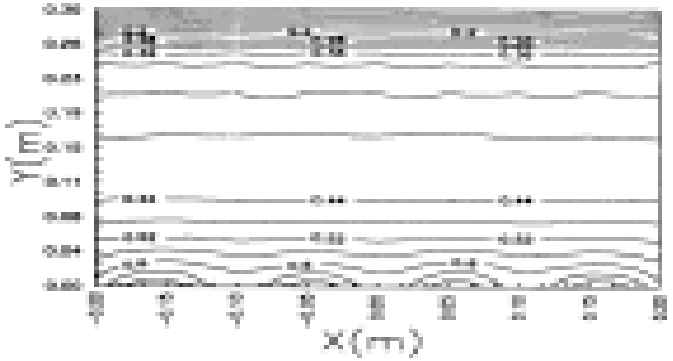
➢ Number of vents and distribution of airflow in boxes



1 vent



2 vents

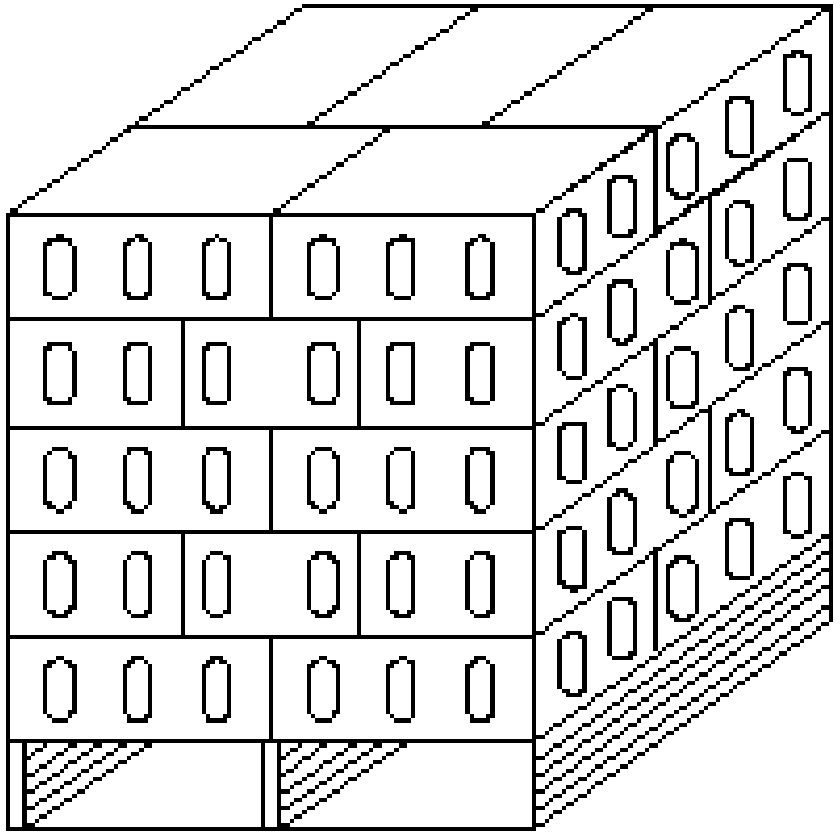


4 vents

➢ Loading of packing boxes

: Keep ventilation airtight

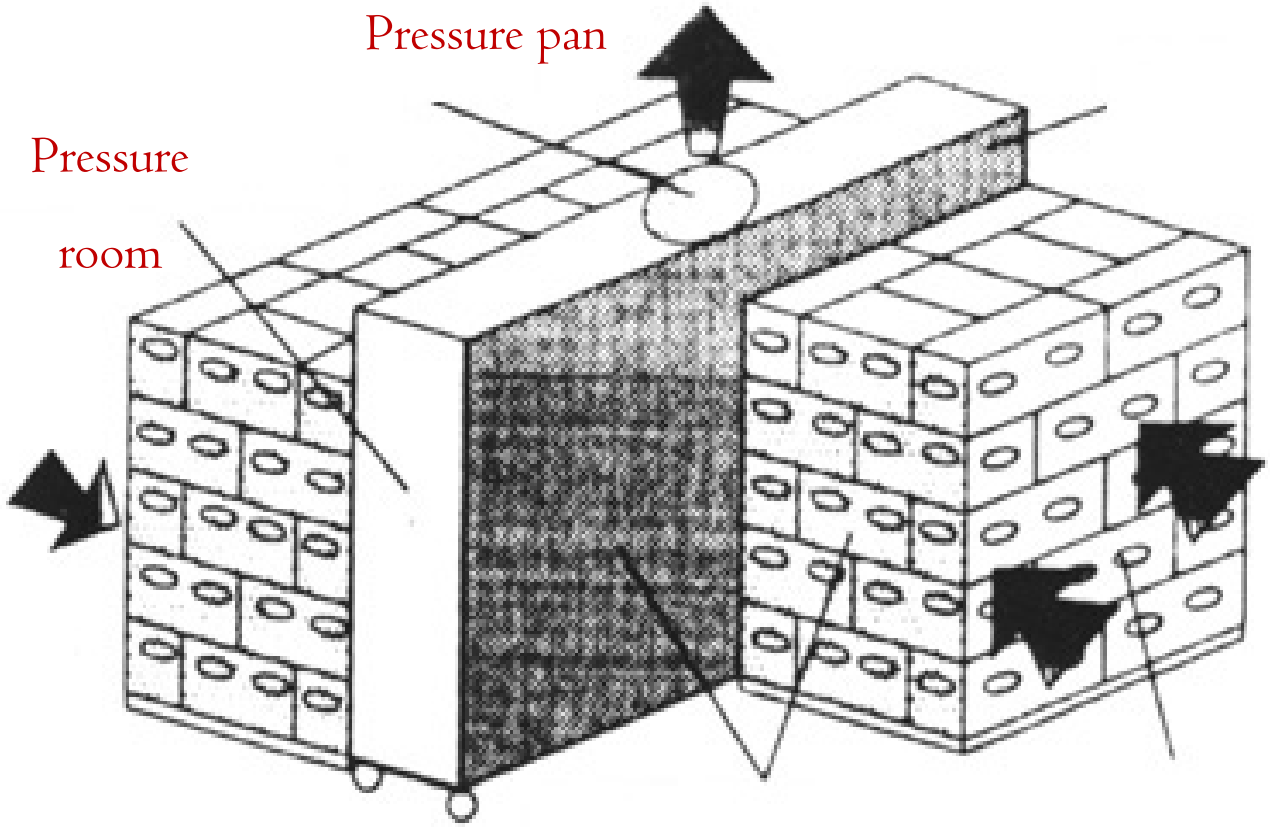
Block palette section



- Airflow and cooling rate: 0.04㎥/min. water for freezing kg
- temperature measurement location : 1 point for each cold air inlet(air) and cold outlet (air temperature)

Crops	Air flow flow rate(m^3 /min)	½ Cooling time(min)					
		entrance		center		exit	
		center	wall	center	wall	center	wall
mandarin	0.03	27	38	62	70	107	96
	0.04	25	37	48	55	80	77
	0.05	23	29	39	49	64	65
Tomato	0.03	42		93		110	
	0.04	41		78		94	
	0.05	43		78		96	

➢ simplified pressure cooling system



ÎõÐøÒÜÛ Ðû ÒÜøÙÚÝÿõÝøÒÿ đøÐúÝÚõÕ òÞ úøÞÙãÜ

(I) Natural drying (Sun curing)

(2) Artificial drying

I) Heated air dryer

2) Dryer by heat plate contact

① Vacuum band drier

② Freeze drier

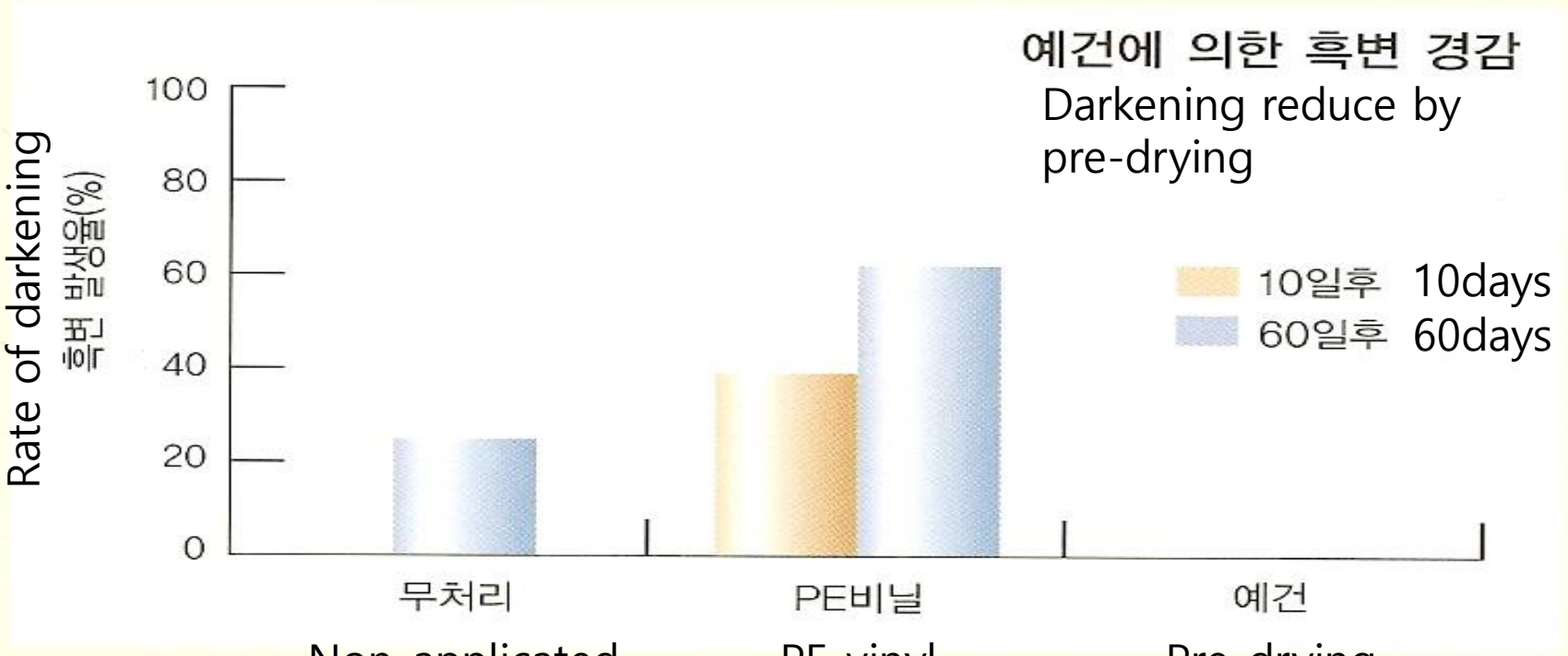
ÎõÐøÒÜÛ Đû ÒÜøÙÚÝÿõÝøÒÿ đøĐúÝÚõÕ òÞ đøÛ¸úøÞÙãÜ

- Drying the epidermis slightly before low temperature ware housing
- Mandarin, Garlic, Pear, Sweet potato

- Mandarin : 1 to 2 weeks for 3~4% weight reduction(natural pre-drying)
- pear : 7~10days top cover storage

- pre-drying and pericarp darkening of pear
  - ➢Because the pear is not dense with percutaneous tissue, it is easy for fungi or viruses to in vade, which causes many cases of darkening during sotrage
  - ➢ pre-dry for 5~7 days to prevent darkening

íÛúÝÚÙãÜ ÛûûÛÚõ Đû đÛÒø úÒøŸÛãÙãÜ òÞ đøÛ¸úøÞÙãÜ



ÎõÐøÒÜÛ Ðû ûøÛÕü ýÛÜÛõÒòÿÛÕ

Leaf vegetable rapid cooling and clean with cold water

Strawberry distribution keeps fresh by ‘microbial

Kiwi fruit use of cut-off bottle and cake ingredients

îÞđÛÕ Đû ÚĐÿú ÕõĐøÒÜÛ ûÒÚÙÙÿÙõÙÙÛÕ ûĐø ÒÜøÙÚÝÿõÝøÒÿ đøĐúÝÚõÕ

Cold storage
(-5~-25℃)

Refrigeration
(-25~-40℃)

Precooling
(0~25℃)

Low temperature
(-5~20℃)

C.A storage
(0~25℃)

Cold chain system

Drying storage
(room, low tem.)

ÅÐÐÿÙãÜ ÕõÐøÒÜÛ

˝¯ òÒãŸ ÕõÐøÒÜÛ

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(B)

¸¯ ÅÐÿú ÕõÐøÒÜÛ

ÎõÐøÒÜÛ Ðû ÒÜøÙÚÝÿõÝøÒÿ đøÐúÝÚõÕ Òõ Ò õÛÃđÛøÒõÝøÛ ûøÐÃ · õÐ ″′ õüÒõ ÒøÛ ãÐõ ûøÐþÛã ÙÕ ÚÒÿÿÛú ÚÐÿú ÕõÐøÒÜÛ’ ÅÐÿú ÕõÐøÒÜÛ Ðû ûÒøÃ đøÐúÝÚõÕ üÒÕ ÿÐãÜ òÛÛã ÝÕÛú Ùã ÎÛÐÝÿ ÒøÛÒ ÐãÿÞ ÝÕÙãÜ ãÒõÝøÒÿ ÙÚÛ Òãú ÕãÐÐ’ òÝõ õüÙÕ ÚÐÿú ÕõÐøÒÜÛ ÙÕ ÝÕÛú ûÐø ÕÒûÛ ÕõÐøÒÜÛ Ðû ûøÛÕü ûÒøÃ đøÐúÝÚõÕ úÝÛ õÐ õüÛ ÒúýÛãõ Ðû õüÛ Ðû õüÛ ÚÝøøÛãõ ÚÐÿú¸ ÃÐõÐø ÕÞÕõÛÃ Ùã õüÛ ûÙøÕõ üÒÿû Ðû õüÛ ″κ^{õü}

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ÇÛãÛøÒÿÿÞ’ òÿÒãÚüÙãÜ ýÛÜÛõÒòÿÛÕ’ đÿÝÃ’ ÕõÛÒÃÛú

˘¯ ÅÐÿú ÚüÒÙã ÕÞÕõÛÃ

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Å’À ÎõÐøÒÜÛ ¨ÅÐãõøÐÿÿÛú ÒõÃÐÕđüÛøÛ ÎõÐøÒÜÛ¯

CA storage is a method of artificially adjusting the air composition of agricultural storage containers and storing them at low temperatures. The atmosphere is mixed with $O_2$21%, $CO_2$0.035%, $N_2$78% and other trace gases. Harvested Agricultural products like vegetables, fruits, mushrooms and grains are living organics that can respiration, if they are put in a sealed container and the $O_2$is reduced 3~5%, $CO_2$is stored up to 3~5%, it can be stored for a long time while suppressing metabolic effects such as respiration. In addition, even if agricultural products are stored in PE film, after a certain period time, O_2 in the package is reduced due to respiration and $CO_2$is increased to create and stored the environment like CA storage, which is also known as the simplified CA storage method

Å’À ÎõÐøÒÜÛ ¨ÅÐãõøÐÿÿÛú ÒõÃÐÕđüÛøÛ ÎõÐøÒÜÛ¯

In Italy, about 70 to 80 percent of the apple is stored in CA storage, while the United States stores about 50 percent of the harvest and Japan about 40 percent.

I) CA Storage facilities

(1) Storehouse : Complete Storage

(2) N_2generator : Rapid C.A storage

(3) CO_2disposal equipment

- absorbent(lime, Potassium carbonate, NaOH)

(4) Cooling, dehumidification device

(5) Breather bag : pressure change device

2) CA storage method

(1) Practical CA storage

- use 2.5~5% oxygen concentration, CO_2increase

(2) low oxygen CA storage(Ultra Low Oxygen, ULO storage)

- reducing oxygen concentration below 2% to 1% limit

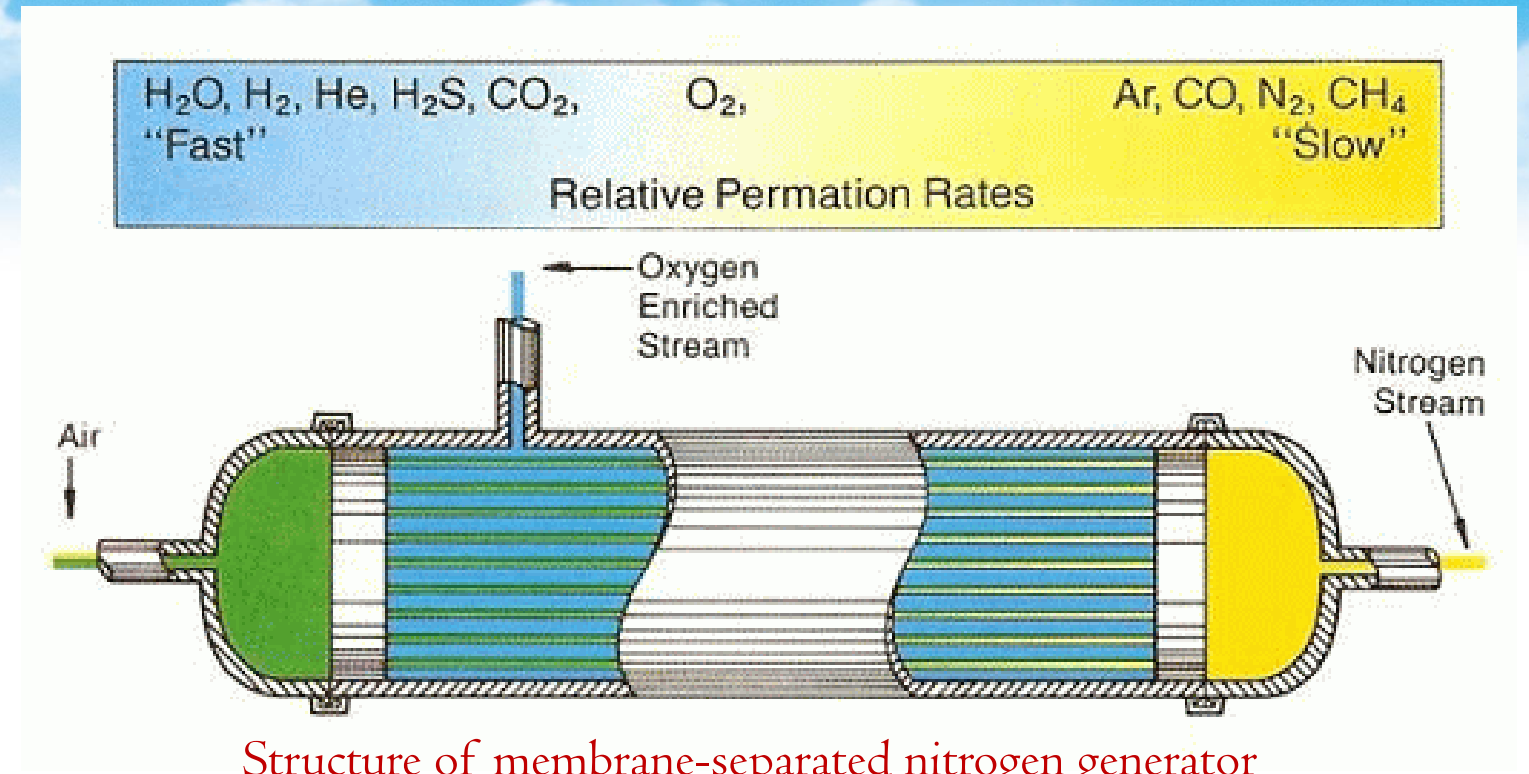
(3) Rapid CA Storage : use Pressure Swing Adsorption

- suitable for small storage area such as 100~150㎥

(4) Low ethylene CA storage : Using the ethylene remover, reduce the ethylene concentration in the CA storage to tens of ppm.

(5) MA Storage (Modified Atmosphere)

- Storage method that obtains CA storage effect by using proper gas permeability packaging material.

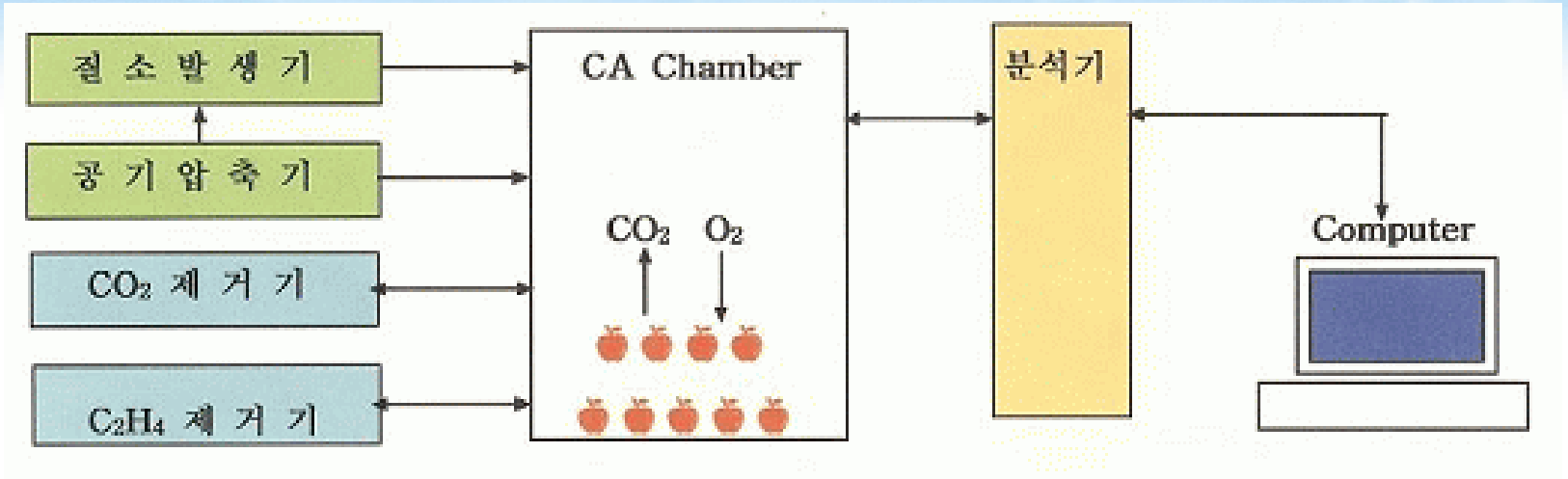


Structure of membrane-separated nitrogen generator

The membrane-separated nitrogen generator consists of a nitrogen separator containing a bunch of capillary tubes in a permeable membrane with air cleaner and air compressor, and the nitrogen separator has the function to produce nitrogen by removing oxygen, carbon dioxide, etc. from the air.

Structure of CO_2 remover

The inside of the carbon dioxide remover is filled with activated carbon and during the absorption process, carbon dioxide in the storage area is absorbed by the activated carbon and carbon dioxide is released out of the storage area.



Principles of removable CA storage

After putting the fruit in the storage, pump nitrogen gas produced by generator into the storage to reduce the oxygen concentration in the storage to a certain level. If the concentration of carbon dioxide increases due to breathing of the nitrogen, the CO2 extractor is activated to remove carbon dioxide.

3) CA Storage effect

(1) Inhibiting the generation of ethylene : long duration of quality maintenance

(2) suppressing the decomposition of chlorophyll

(3) suppress of fruit softening

(4) Inhibiting physiological function and delaying the reduction of organic acids

(5) Inhibition of germination and uprooting

● Effect of extended storage period by CA Storage

Item	Storage possibility period	
	Low temperature Storage	CA Storage
Apple(Fuji)	6 Months	11 Months
Pear (Singo)	6 Months	9 Months
Kiwi fruit	4 Months	7 Months
Persimmon	4 Months	7 Months
Onion	7 Months	9 Months
Chestnut	6 Months	9 Months
Peach	2 Weeks	40 Days
Cabbage	3 Months	7 Months
Tomato	2 Weeks	2 Months
Watermelon	1 Months	2 Months

● CA Storage items(Fruits)

Items	Tem.(℃) Range	CA Condition		CA Effect	Note
		O_2(%)	CO_2(%)		
Apple	0~5	1~3	1~5	excellent	Storage as 50% CA storage of yield(USA)
Kiwi	0~5	1~2	3~5	excellent	Limited commercial use
Peach	0~5	1~2	3~5	good	Limited commercial use
Pear(Asia)	0~5	2~4	0~1	good	Limited commercial use
pear(Europe)	0~5	1~3	0~3	excellent	Limited commercial use
Persimmon	0~5	3~5	5~8	good	Limited commercial use
Walnut,	0~25	0~1	0~100	excellent	Pest control
chestnut	12~15	2~5	2~5	excellent	Partial Transport use
Banana	10~15	5~10	0~10	excellent	No commercial use
Lemon	5~10	5~10	0~5	excellent	No commercial use
Orange					

● CA Storage items(Vegetables)

Items	Tem.(℃) Range	CA Condition		CA Effect	Note
		O_2(%)	CO_2(%)		
Asparagus	0~5	air	5~10	Excellent	Limited commercial use
Cabbage	0~5	2~3	3~6	Excellent	Limited commercial use
Carrot	0~5	-	-		Maintain relative humidity 98~100%
Corn	0~5	2~4	5~10	None	Limited commercial use
Cucumber	8~12	3~5	0	good	No commercial use
Chives	0~5	1~2	3~5	Normal	No commercial use
Lettuce	0~5	1~3	0	Good	Limited commercial use
Mushroom	0~5	air	10~15	Good	Limited commercial use
Onion	0~5	1~2	10~20	Normal	Limited commercial use
Potato	4~12	-	-	Normal	No commercial use
Radish	0~5	-	-	None	Maintain relative humidity 98~100%No commercial use
Spinach	0~5	air	10~20	None	Limited commercial use
Tomato	12~20	3~5	0~3	Good	
				Good	

● Low temperature Storage

➢ Orchard management

- Remove infected fruits

- No sun exposure
- No Ground contact

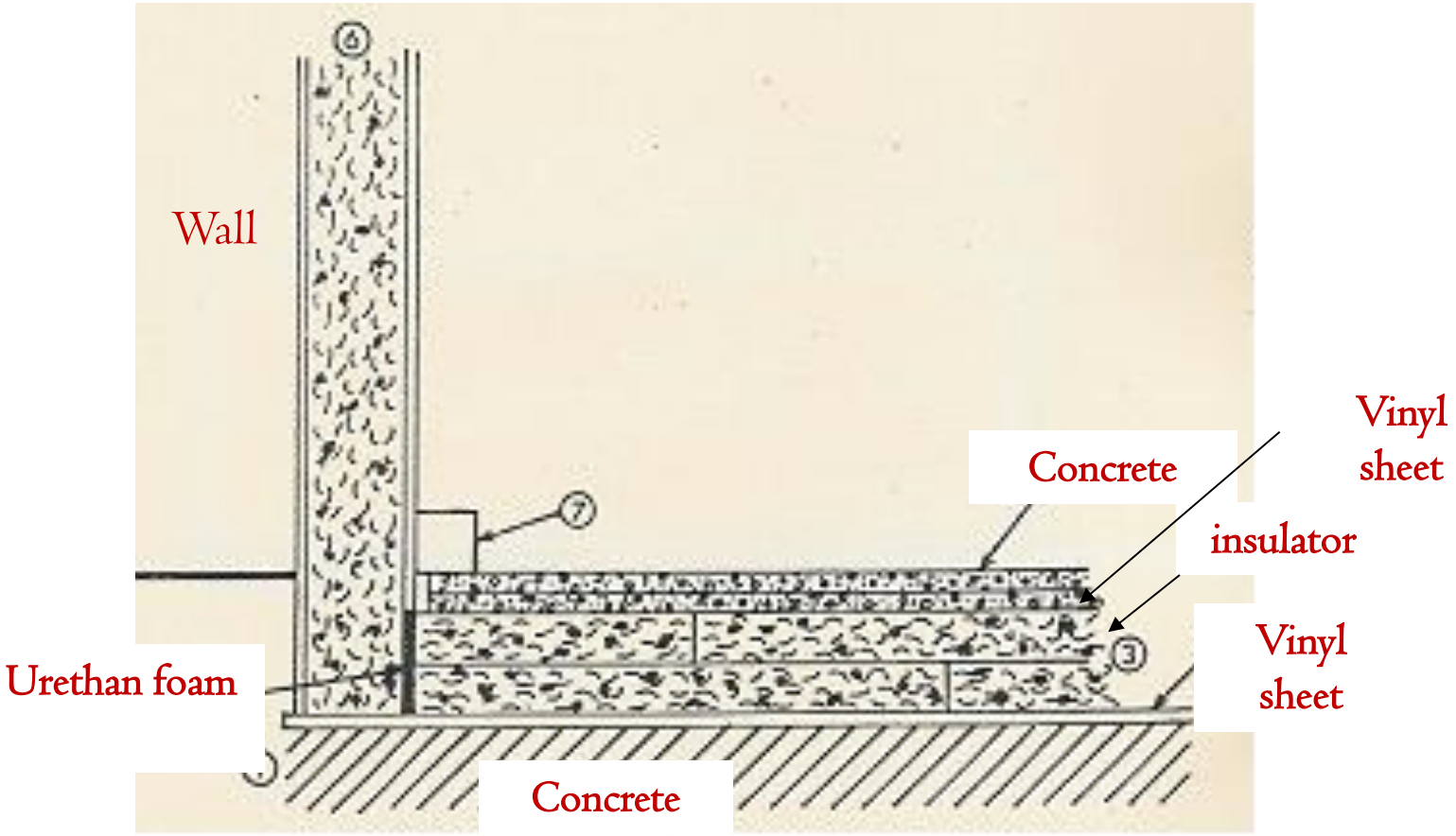
➢ Low temperature storage management

- Keep airtight
  - Fill gaps in storage walls
  - Minimize opening and closing of doors while saving
  - Separation of long-term and short-term storage rooms

- Insulation
  - Insulation prevents cold air from the storage area.
  - Materials : Polyurethan, Polystyrene
  - Form: Sandwich panel(for freezing, architecture)
  - Thickness(for freezing) : Polyurethan 10cm, Polystyrene 15cm

- Insulation and airtightness can result in longer operating hours of the chillers, resulting in ore frost in the unit cooler and lower humidity, resulting in more water loss and higher power costs.

- **Storage of floor and wall**

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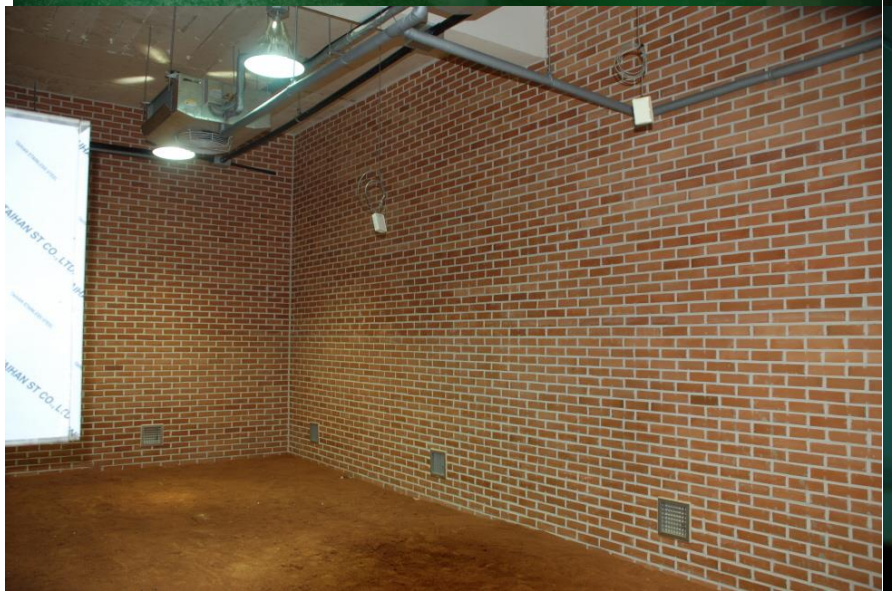
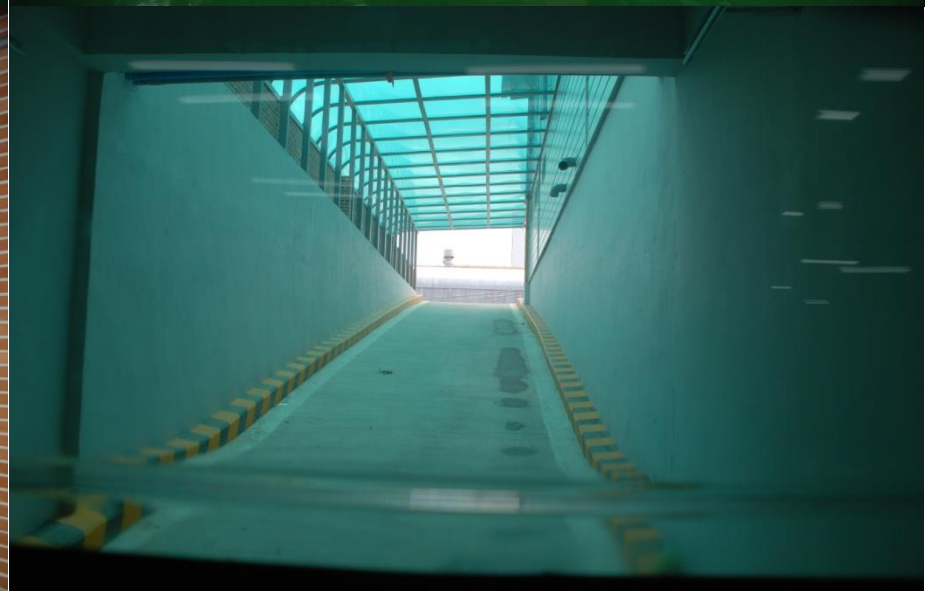
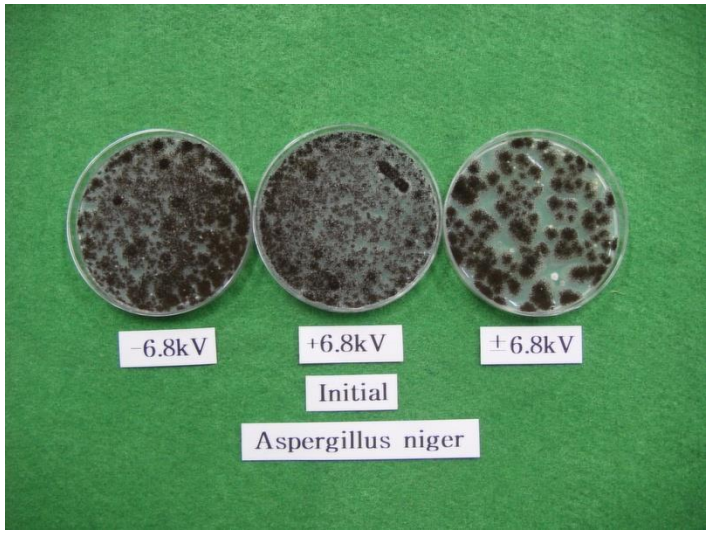
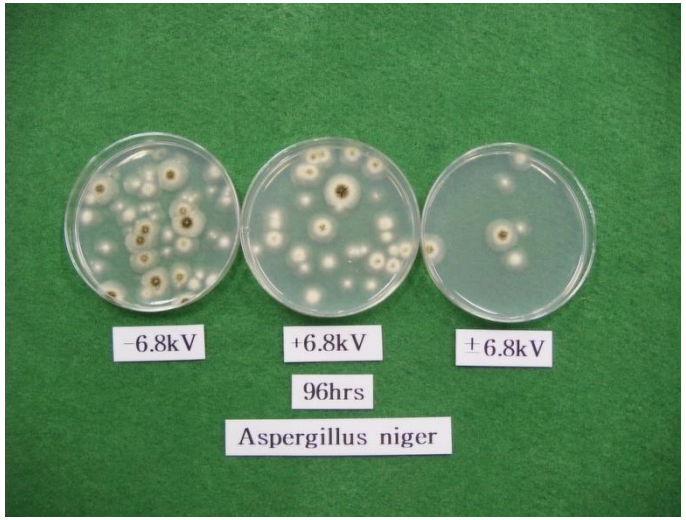




- **Disinfection**
  - Storage and Storage containers
  - Wash chlorine or kitchen cleaners with water
  - Dry it completely after cleaning



(Before Disinfection)

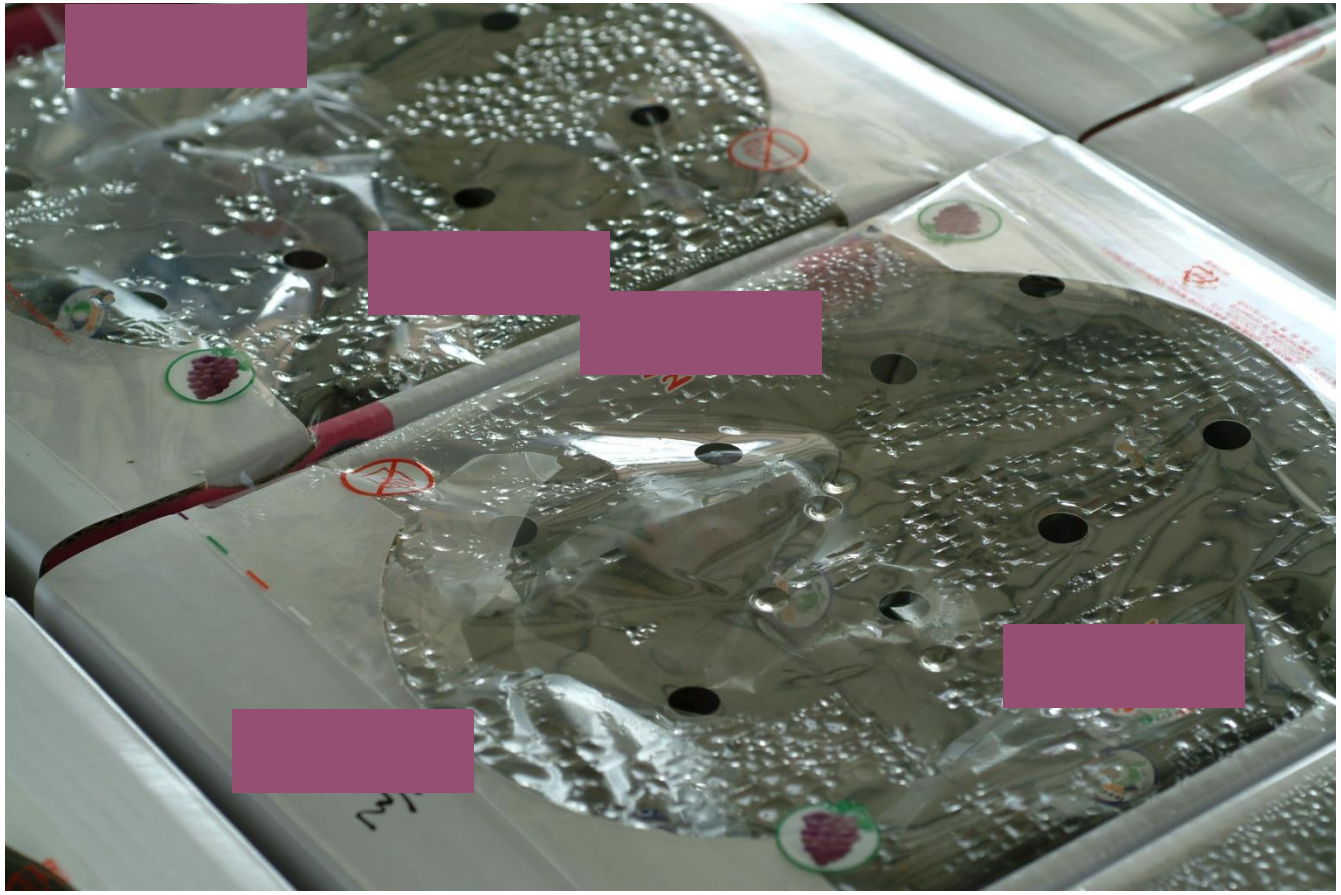


(After Disinfection)

- Storage goods preparation
  - Remove rot or wound, bruised, over-aged
  - Pre-treatment : Pre-drying, Curing
- Insert goods
  - Storage is pre-cooled
  - Cooler shutdown during warehousing operations
  - Receiving time : When the ambient temperature is lowest (Morning, Evening)
  - Daily receiving volume : 1/5 ~ 1/7(reducing cooling load, preventing condensation)

- Pile-up of storage
  - To ensure that the first thing is to leave first :
    mark the date of warehousing
  - 20~30cm from the wall
  - Place 20cm of space on each One meter of storage box
  - Put at least 60cm above the ceiling
  - Place palettes on the floor : be careful of airways
  - The storage box must have a lot of ventilation.

- Internal dew condensation in high temperature and poor ventilation



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- Maintain proper temperature and relative humidity
  - Appropriate conditions are different for each crop
  - Prevent Respiration and water loss
- Inhibition and elimination of ethylene production
  - Do not store ethylene-producing and sensitive crops mixed
  - Corrupted, damaged, over-ripened fruits elimination
  - Storage Container disinfection
  - Ventilation
  - No engine operation, smoking, oil or gas stove
  - Ethylene remover : Absorption, Decomposition

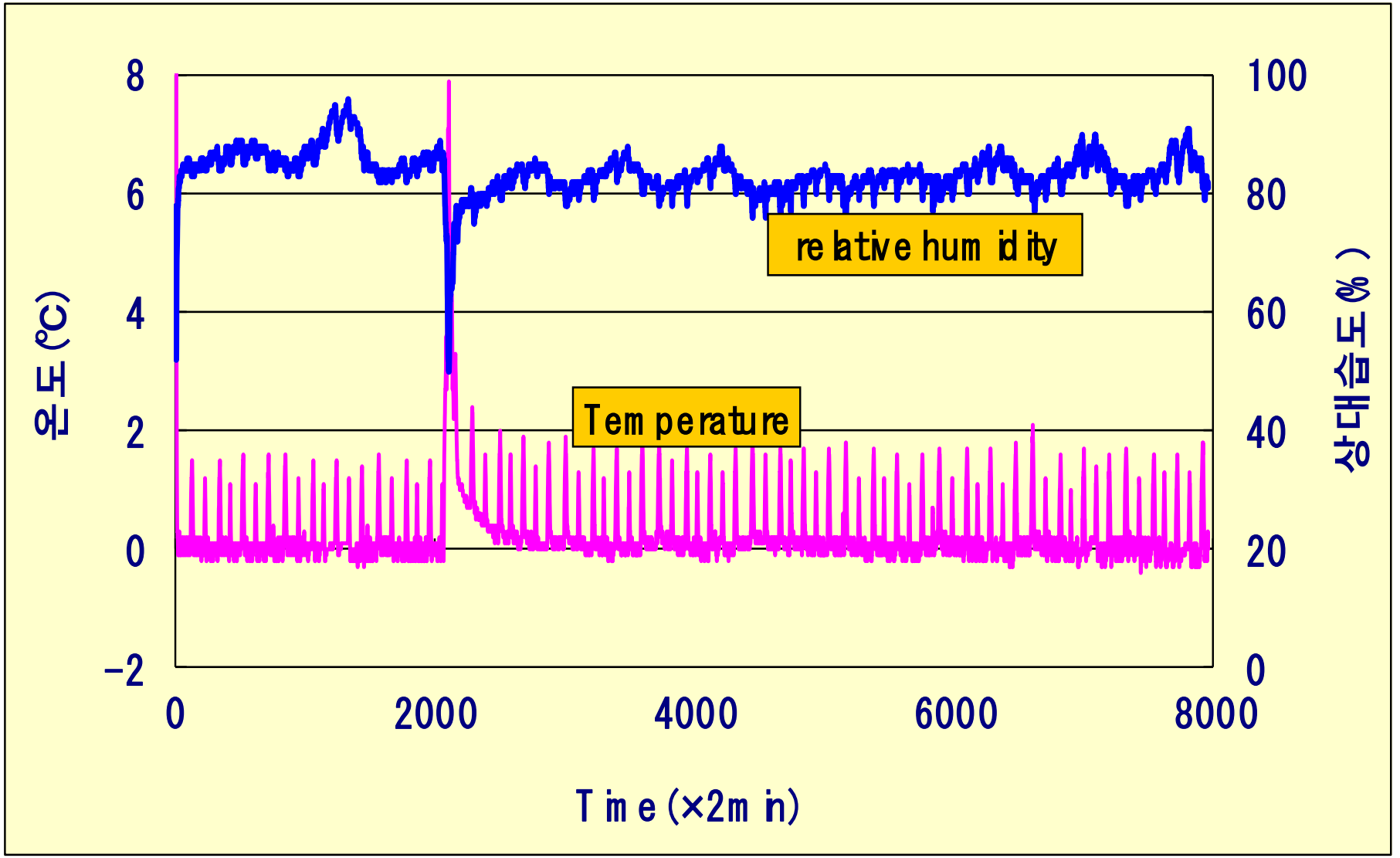
- Forwarding : Prevention of condensation
  - Low-temperature transport
  - Refrigerate transport
  - use condensation protect cover
  - Elevation Temperature

● New technology for storage management

➢ Distribution period according to temperature and relative humidity(Graph)

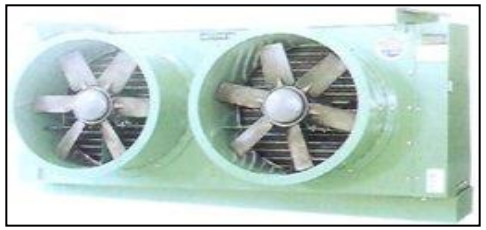
Temperature(℃)	0				25			
Humidity(%)	65	75	85	95	65	75	85	95
Weight reduction(%/day)	0.33	0.24	0.14	0.05	2.00	1.44	0.88	0.32
Expire date (days)	9	13	21	60	1	2	3	9

➢ Temperature and relative humidity of practice low temperature storage



➢ Causes of low humidity in low temperature storage

Air moisture freezing

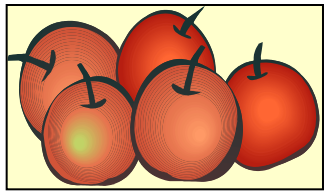


Unit Cooler

Relative humidity degradation (Relative humidity 80%)

Weight loss

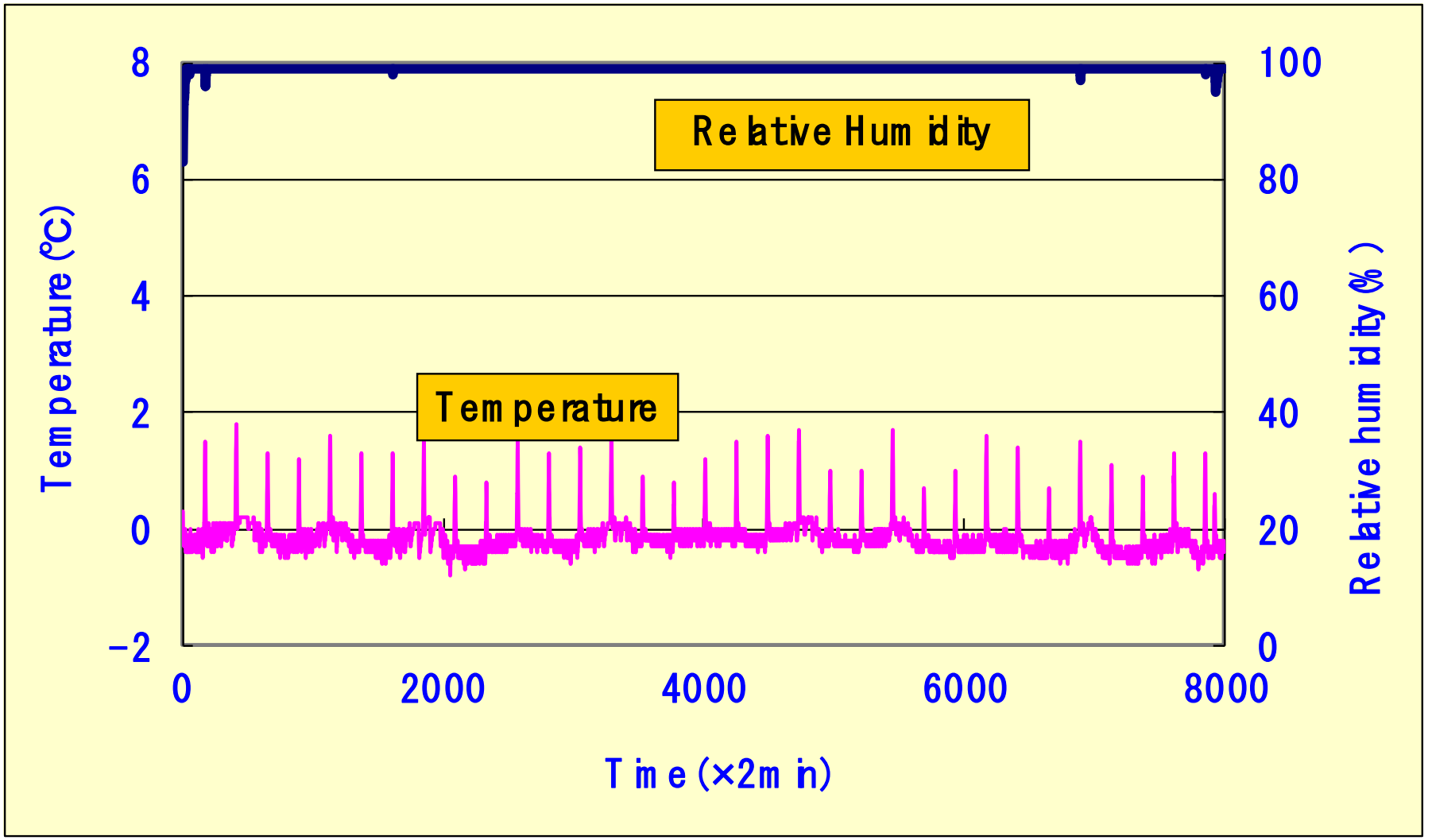
High humidity air (more than relative humidity 90%)



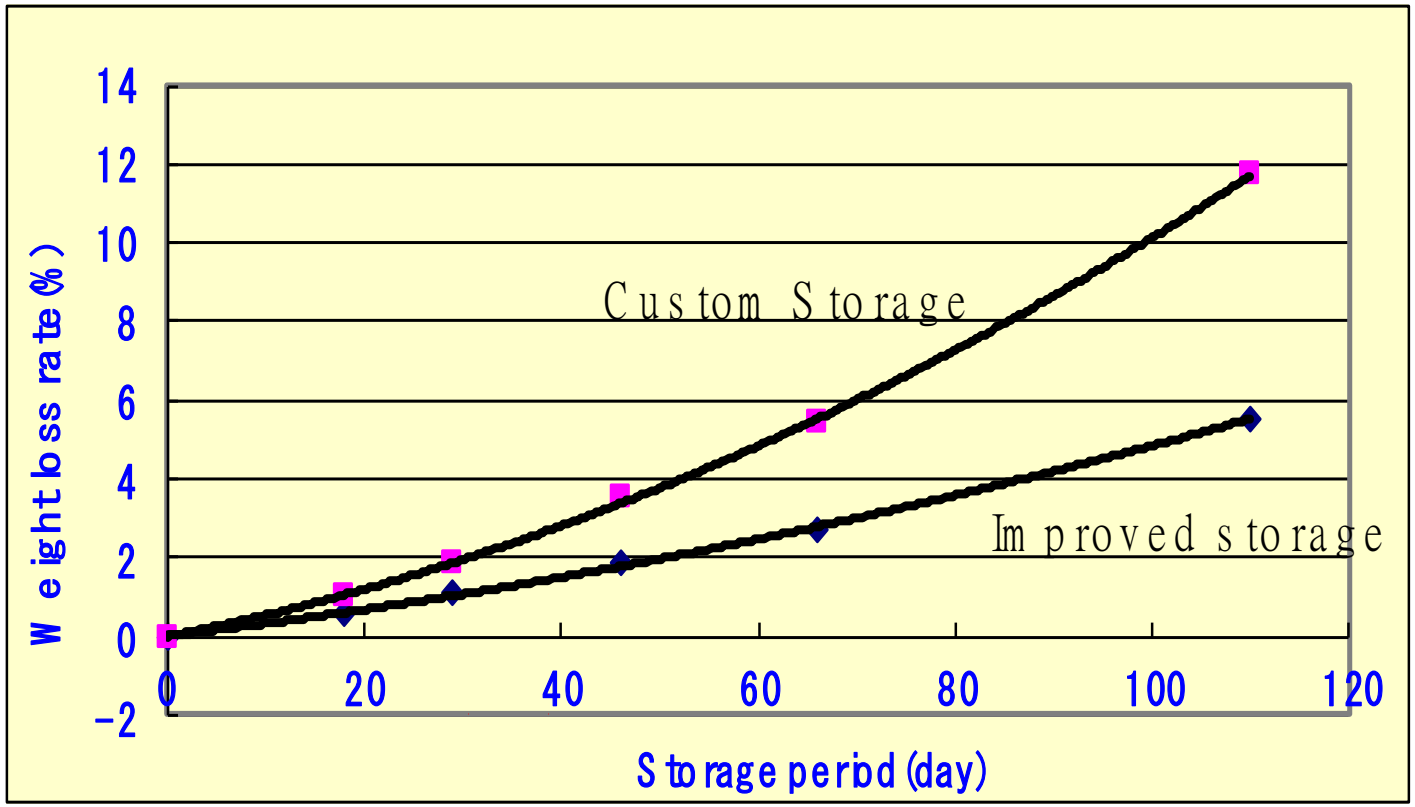
transpiration

humidification

➢ Effect of high humidity unit cooler



➢ Reduced weight loss(pear)



➢ Reduce power consumption

(Unit : kWh)

division	’02.Dec	’03.Jar	’03.Feb	index(%)
Custom type	1,044	1,062	928	100
Improved type	529	414	368	43

- **prevent condensation**

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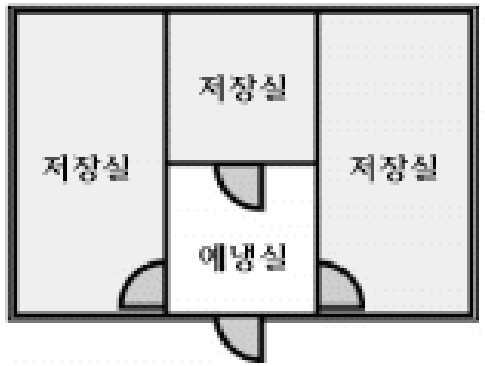
a) Use a pre-cooling facility. (Figure 1)

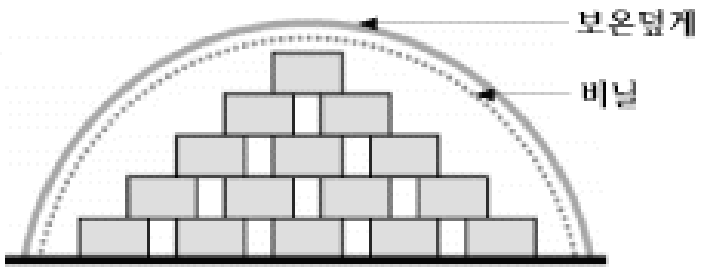
If the temperature in the storage room rise slowly, there is not condensation.

b) Solve it by building brick.(Figure 2)

c) Use a lagging cover. (If container box is used)



(Figure 1)



(Figure 2)

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Mucahs Gracias !!!