

## THE CARGOFRESH GUIDE FOR TRANSPORT OF FRUIT AND VEGETABLES UNDER CONTROLLED ATMOSPHERE IN REEFER TRUCKS



## Contents

1. *Biology and physiology of fruits and vegetables*
  - 1.1 *Postharvest quality*
  - 1.2 *Climacteric and non-climacteric fruit*
  - 1.3 *Ripening and ethylene*
2. *Controlled atmosphere storage*
  - 2.1 *CA storage of fruits and vegetables*
  - 2.2 *Effects of atmospheric composition*
  - 2.3 *Effect of CA storage on flavour and nutritional value*
3. *Optimal stowage and packaging for CA transport of tropical fruits and vegetables*
4. *Environmental impact of CA*
5. *CA set-points for fruits*
6. *CA set-points for vegetables*
7. *The Cargofresh CA product range*
8. *More than just products: service and training from Cargofresh*
9. *Contact*
10. *Disclaimer*

# 1. Biology and physiology of fruits and vegetables

## 1.1. Postharvest quality

After harvesting, fruit continues to absorb oxygen ( $O_2$ ) and release carbon dioxide ( $CO_2$ ), depending on factors such as temperature, time and atmospheric conditions. Refrigeration during storage after harvest slows down these processes considerably.

In addition to refrigeration, Controlled Atmosphere (CA) has an important beneficial effect, lowering the atmospheric oxygen content by raising nitrogen ( $N_2$ ) concentration, putting the fruit into dormancy, a kind of “deep sleep”. When returned to ambient conditions after CA storage, the fruit “awakens”, and its metabolism continues in the normal way. Quality is retained, and the fruit has a much better shelf-life quality from the outset. The sooner the harvested fruit is stored under CA conditions, the more positive the effect on postharvest quality and shelf life.

## 1.2. Climacteric and non-climacteric fruit

Fruits and vegetables can be divided into two groups according to their ripening pattern: climacteric and non-climacteric. Climacteric produce is characterised by a sudden, strong increase in postharvest ripening associated with a similar pattern in its respiration rate, which cannot be stopped, whereas non-climacteric products ripen more gradually over time. Climacteric produce such as mangos, tomatoes, bananas and papayas should be subjected to CA at the earliest possible stage after harvest. Non-climacteric fruits such as pineapples, grapes and limes have greater flexibility in the after-ripening process.

## 1.3. Ripening and ethylene

An important factor for climacteric ripening is the natural plant hormone ethylene ( $C_2H_4$ ), which is produced by the fruit itself and released as a gas into the surrounding atmosphere. The released ethylene accelerates the ripening and senescence processes, and climacteric fruit reacts very strongly to it (autocatalytic ripening). In order to preserve postharvest quality during CA transport, ethylene is considered an undesirable gas, and the Cargofresh CA technology purges it from the container.

## 2. Controlled atmosphere storage

Controlled atmosphere is an agricultural storage method in which oxygen, carbon dioxide and nitrogen concentrations are regulated, in addition to temperature and humidity. Cargofresh CA technology constantly and actively controls and corrects all these factors throughout the storage period. Successful application requires a thorough knowledge of atmosphere and temperature management. Controlled atmosphere storage is being used commercially for an increasing range of perishables. The mobile application of CA during transport in containers is a relatively new and promising technology. Optimum storage conditions for fruits and vegetables require consideration of various aspects:

## **Temperature control**

Fresh produce are preserved in storage or during long-distance transport by combining refrigeration (above freezing point) with CA.

## **Humidity control**

The higher the relative humidity, the less the product will dehydrate during transport. A high relative humidity should be close to saturation point (e.g. 95%), but without condensation on the product itself.

## **Gas control**

Oxygen (O<sub>2</sub>) levels range from 1 to 10% and carbon dioxide (CO<sub>2</sub>) levels from 0 to 20%, depending on the type of fruit and its varieties. The levels of CO<sub>2</sub> and O<sub>2</sub> in the environment surrounding climacteric fruit will influence its ripening rate. Some products, such as banana and avocado, produce considerable amounts of CO<sub>2</sub> during storage, and are therefore able to create their own optimal CO<sub>2</sub> concentrations.

### **2.1. CA storage of fruits and vegetables**

The use of CA lowers ripening rate and slows decay, decreases postharvest losses, and preserves nutritive value and flavour components. Consumer expectations of a year-round supply of seasonal fresh fruit and vegetables also drive the necessity to employ CA storage and transport.

### **2.2. Effects of atmospheric composition**

The effects of changed gas levels during storage and postharvest of fruits, vegetables and flowers can be summarised as follows:

#### **Reduced oxygen level:**

- Reduced respiration rate
- Delayed ripening of climacteric fruit
- Delayed breakdown of chlorophyll
- Retention of firmness
- Decrease of (peel) discolouration
- Reduced rate of production of ethylene and carbon dioxide
- Prolonged freshness

#### **Increased carbon dioxide level:**

- Inhibition of chlorophyll breakdown
- Retarded fungal development
- Inhibition of the effect of ethylene
- Retention of firmness

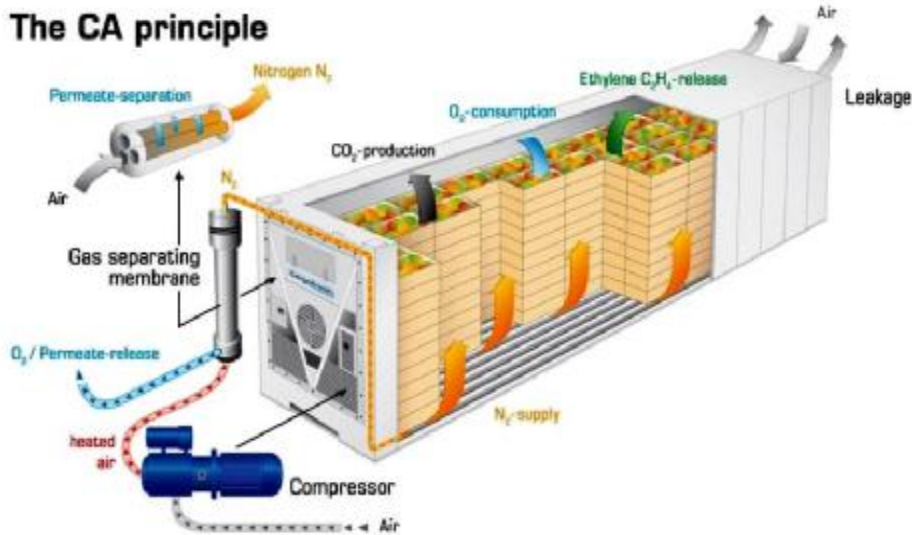


Figure 1. Illustration of Cargofresh CA principle

### 2.3. Effect of CA storage on flavour and nutritional value

CA has no proven influence on flavour, although off-flavours and odours can be produced during prolonged storage at suboptimal gas concentrations.

### 3. Optimal stowage and packaging for CA transport of tropical fruits and vegetables

Packaging and stowage for CA storage with bottom airflow has the same basic requirements as any refrigerated storage/transport. The packaging (usually palletised cardboard boxes secured with plastic straps) should provide sufficient support and protection for the product, as well as a continuous airflow through the cargo in order to remove ethylene, heat, O<sub>2</sub> and/or CO<sub>2</sub> (depending on the set points). This is achieved by adequate perforations of the top, bottom and preferably also the sides of the packaging.

During stowage in the container, care should be taken to avoid leaving space between container walls and pallets, in order to force the airflow to actually pass through the cargo, instead of moving around it. Top-blocking of the last two pallets near the doors can also be helpful.

#### 4. Environmental impact of CA

There is growing global awareness of the so-called environmentally friendly production and transport of fruits and vegetables, which is now an important factor in consumer purchasing. As a comparison: a container ship carrying 4500 tonnes burns about 6.2 g of oil per tonne of transported goods per kilometre. This produces CO<sub>2</sub> emissions of 20 g per tonne-kilometre. A jumbo jet burns 100–200 g of kerosene per tonne of freight per kilometre and produces 315–630 g CO<sub>2</sub>. Bearing these emissions in mind, some companies now prohibit all air transport of fruit, and others label the CO<sub>2</sub> balance of their goods. Governments are even analyzing the introduction of taxes on CO<sub>2</sub>.

By using CA, the quality of fruits and vegetables can be preserved for longer, and expensive and environmentally damaging air transport can be avoided, even for highly sensitive types of fruit.

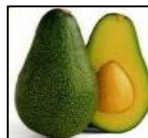
Table 1. CO<sub>2</sub> emissions of air and ocean freight

|                               |  |
|-------------------------------|--|
| Ocean freight                 | CO <sub>2</sub> emissions in 12 days (kg)  |
| Reefer 1 x 40 ft with CA      | 116 kg/ wton                               |
| Reefer 1 x 40 ft with SWITCH  | 104 kg/ wton                               |
| Airfreight                    | CO <sub>2</sub> emissions in 11 hours (kg) |
| Payload jumbo jet 747 = 124 t |  |
| Cargo compared = 20 ton       | 2728 kg/wton                               |

(wton = weight ton)

26.23 X more

## 5. CA Set-points for fruit



| Fruit                       | Apple   | Apricot   | Avocado  |
|-----------------------------|---|---|--|
| Variety                     | Various   | Various   | Various  |
| CA Potential                | Excellent   | Moderate  | Excellent  |
| Climacteric                 | Yes   | Yes   | Yes  |
| Ethylene production         | Very high   | High  | High   |
| Ethylene Sensitivity        | High  | High  | High   |
| <b>Suggested Trailer CA</b> | <b>3% O<sub>2</sub></b>   | <b>3% O<sub>2</sub></b>   | <b>3%-5% O<sub>2</sub></b>   |
| T (°C) settings             | depending on varieties<br>-1°C to 0°C or<br>3°C to 4°C  | -0.5°C to 0°C   | 5°C to 8°C<br>5,5°C  |
| RH settings                 | 90%-95%   | 90%-95%   | 90%-95%  |
| Comments                    | Reduced O <sub>2</sub> slows ripening, retains firmness and acidity, and prevents bitter pit and internal breakdown. Increased CO <sub>2</sub> retains firmness, skin color, acidity and taste, slows ripening. | Reduced O <sub>2</sub> delays ripening. Increased CO <sub>2</sub> retains firmness. | Reduced O <sub>2</sub> delays ripening, reduces rate of CO <sub>2</sub> and ethylene production. Increased CO <sub>2</sub> delays softening, reduces chilling injury symptoms. |

(\* ) CO<sub>2</sub> levels above 5% require addition from external source.



| Fruit                       | Banana  | Berries   |  |
|-----------------------------|---|---|--|
| Variety                     | Cavendish, Baby, Plantain   | Blackberries  | Blueberries  |
| CA Potential                | Excellent   | Good  | Good   |
| Climacteric                 | Yes   | No  | Yes  |
| Ethylene production         | Medium  | Low   | Low  |
| Ethylene Sensitivity        | High  | Low   | Low  |
| <b>Suggested Trailer CA</b> | <b>3%-5% O<sub>2</sub></b>  | <b>5%-10% O<sub>2</sub></b>   | <b>3%-5% O<sub>2</sub></b>   |
| T (°C) settings             | 13,2°C-14,4°C<br>Above 14°C under CA  | 0°C   | 0°C  |
| RH settings                 | 90%-95%   | 90%-95%   | 90%-95%  |
| Comments                    | Reduction of O <sub>2</sub> and increase of CO <sub>2</sub> reduce respiration rate and delays ripening. High CO <sub>2</sub> also inhibits the synthesis of ethylene. High humidity prevents water loss. | Reduced O <sub>2</sub> reduces respiration rate. Increased CO <sub>2</sub> reduces decay and retains firmness | Reduced O <sub>2</sub> reduces respiration rate. Increased CO <sub>2</sub> reduces decay |

(\* ) require addition of CO<sub>2</sub> from external source.





| Fruit                       | Berries  |   | Cherry   |
|-----------------------------|--|---|--|
| Variety                     | Cranberries  | Raspberries   | Various  |
| CA Potential                | Moderate   | Good  | Good   |
| Climacteric                 | No   | No  | No   |
| Ethylene production         | Low  | Low   | Very low   |
| Ethylene Sensitivity        | Low  | Low   | Low  |
| <b>Suggested Trailer CA</b> | <b>3% O<sub>2</sub></b>  | <b>5%-10% O<sub>2</sub></b>   | <b>3%-10% O<sub>2</sub></b>  |
| T (°C) settings             | 2°C to 4°C   | 0°C   | -1°C/0°C   |
| RH settings                 | 90%-95%  | 90%-95%   | 90%-95%  |
| Comments                    | Low O <sub>2</sub> reduces respiration rate and retards decay. High CO <sub>2</sub> maintains firmness | Low O <sub>2</sub> reduces respiration rate. Increased CO <sub>2</sub> reduces decay and retains firmness | Low O <sub>2</sub> retains firmness. High CO <sub>2</sub> controls decay |

(\*) require addition of CO<sub>2</sub> from external source.



| Fruit                       | Fig   | Grapefruit  | Grapes   |
|-----------------------------|---|---|--|
| Variety                     |   |   | Various  |
| CA Potential                | Slight to moderate  | Slight to moderate  | Slight to moderate   |
| Climacteric                 | Yes   | No  | No   |
| Ethylene production         | Moderate  | Very Low  | Very low   |
| Ethylene Sensitivity        | High  | Moderate  | Moderate   |
| <b>Suggested Trailer CA</b> | <b>3%-5% O<sub>2</sub></b>  | <b>3%-10% O<sub>2</sub></b>   | <b>3%-5% O<sub>2</sub></b>   |
| T (°C) settings             | 0°C   | 10-15°C   | -0.5 to 0°C  |
| RH settings                 | 90%-95%   | 85%-90%   | 90%-95%  |
| Comments                    | Low O <sub>2</sub> reduces respiration and ethylene production rate. High CO <sub>2</sub> maintains firmness and reduces decay. | Low O <sub>2</sub> delays senescence and retains firmness. Increased CO <sub>2</sub> reduces stem-end breakdown and some chilling injuries. | Low O <sub>2</sub> delays senescence. Increased CO <sub>2</sub> reduces decay. CA permits to avoid SO <sub>2</sub> pads. |

Granadilla: See Passion Fruit

(\*) require addition of CO<sub>2</sub> from external source.



| Fruit                       | Guava  | Kiwi  | Lemon   |
|-----------------------------|--|---|---|
| Variety                     |  |   |   |
| CA Potential                | Low to slight  | Excellent   | Moderate  |
| Climacteric                 | Yes  | Yes   | No  |
| Ethylene production         | Low  | Low   | Very low  |
| Ethylene Sensitivity        | Medium   | High  | Moderate  |
| <b>Suggested Trailer CA</b> | <b>3%-5% O<sub>2</sub></b>   | <b>3% O<sub>2</sub></b>   | <b>5%-10% O<sub>2</sub></b>   |
| T (°C) settings             | Mature-green<br>8°C-10°C<br>Ripe-soft<br>5°C-8°C   | 0°C   | 10°C-12°C<br>yellow<br>12°C-14°C<br>green   |
| RH settings                 | 90%-95%  | 90%-95%   | 90%-95%   |
| Comments                    | Ethylene can accelerate ripening of mature-green to full-yellow. Delays color, reduce chilling injury. | Low O <sub>2</sub> delays ripening. High CO <sub>2</sub> aids in retaining firmness | Low O <sub>2</sub> delays senescence. Increased CO <sub>2</sub> delays loss of green color. |

(\*) require addition of CO<sub>2</sub> from external source.



| Fruit                       | Limes  | Litchi   | Mandarins   |
|-----------------------------|--|--|---|
| Variety                     | Various  |  | Various   |
| CA Potential                | Well suited  | Moderate to good   | Slight  |
| Climacteric                 | No   | No   | No  |
| Ethylene production         | Very low   | Medium   | Very low  |
| Ethylene Sensitivity        | Moderate   | Medium   | Moderate  |
| <b>Suggested Trailer CA</b> | <b>5%-10% O<sub>2</sub></b>  | <b>3%-5% O<sub>2</sub></b>   | <b>5%-10% O<sub>2</sub></b>   |
| T (°C) settings             | 8°C-10°C   | 1°C-5°C  | 4-8°C<br>Mandarins;<br>4-5°C<br>Clementine & Minneola   |
| RH settings                 | 90%-95%  | 90%-95%  | 90%-95%   |
| Comments                    | Low O <sub>2</sub> retards senescence. High CO <sub>2</sub> retards degreening | Low O <sub>2</sub> reduces skin browning. High CO <sub>2</sub> slows the loss of ascorbic acid, acidity, and soluble solids. | O <sub>2</sub> below 5% can cause off-flavor. CO <sub>2</sub> above 5% can cause off-flavors. |

(\*) require addition of CO<sub>2</sub> from external source.



| Fruit                       | Mango   | Melon   | Melon  | Melon  |
|-----------------------------|---|---|--|--|
| Variety                     | Various   | Cantaloupe  | Galia, Orange flesh  | Honeydew, Piel de Sapo                           |
| CA Potential                | very good   | slight to moderate  |  |  |
| Climacteric                 | Yes   | Yes   | Yes  | Yes  |
| Ethylene production         | Moderate  | Moderate to significant   | Moderate to significant  | Moderate to significant                          |
| Ethylene Sensitivity        | High  | Moderate to High  | Moderate to High   | Moderate to High                                 |
| <b>Suggested Trailer CA</b> | <b>3%-7% O<sub>2</sub></b>  | <b>3%-5% O<sub>2</sub></b>  | <b>3%-5% O<sub>2</sub></b>   | <b>3%-5% O<sub>2</sub></b>                       |
| T (°C) settings             | 10°C – 12°C   | 2°C-4°C   | 8°C  | 10°C   |
| RH settings                 | 90%-95%   | 90%-95%   | 90%-95%  | 90%-95%  |
| Comments                    | Low O <sub>2</sub> delays ripening. High CO <sub>2</sub> maintains firmness. Do not ship with ethylene producing commodities. | Low O <sub>2</sub> reduces ripening, respiration and ethylene production. | High CO <sub>2</sub> reduces ripening, sugar loss and surface molds. | Do not ship with ethylene producing commodities. |

(\*) require addition of CO<sub>2</sub> from external source.



| Fruit                       | Orange   | Papaya                              |  |  |
|-----------------------------|--|-------------------------------------|--|--|
| Variety                     |  | Various                             |  | Green maturity stage                             |
| CA Potential                | slight   | very good                           |  |  |
| Climacteric                 | No   | Yes                                 | Yes                                      | Yes  |
| Ethylene production         | Very low   | High                                | High                                     | High   |
| Ethylene Sensitivity        | Moderate   | High                                | High                                     | High   |
| <b>Suggested Trailer CA</b> | <b>5%-10% O<sub>2</sub></b>                            | <b>3%-5% O<sub>2</sub></b>          | <b>3%-5% O<sub>2</sub></b>               | <b>3%-5% O<sub>2</sub></b>                       |
| T (°C) settings             | Various depending on variety and origin                | 10°C-12°C                           | 10°C-12°C                                | 7°C-10°C green                                   |
| RH settings                 | 90%-95%  | 90%-95%                             | 90%-95%                                  | 90%-95%  |
| Comments                    | Low O <sub>2</sub> delays senescence, retains firmness | Low O <sub>2</sub> delays ripening. | High CO <sub>2</sub> maintains firmness. | Do not ship with ethylene producing commodities. |

(\* ) require addition of CO<sub>2</sub> from external source.



| Fruit                       | Passion fruit           |                         | Peach & Nectarine  | Pear  |
|-----------------------------|-------------------------|-------------------------|--|---|
|                             | Variety                 | Purple                  | Granadilla or yellow   |   |
| CA Potential                | Unknown                 | Unknown                 | Moderate to well suited  | Excellent   |
| Climacteric                 | Yes                     | Yes                     | Yes  | Yes   |
| Ethylene production         | Very High               | Very High               | High   | High  |
| Ethylene Sensitivity        | High                    | High                    | High   | High  |
| <b>Suggested Trailer CA</b> | <b>3% O<sub>2</sub></b> | <b>3% O<sub>2</sub></b> | <b>3% O<sub>2</sub></b>  | <b>3%O<sub>2</sub></b>  |
| T (°C) settings             | 3°C-5°C                 | 7°C-10°C                | 0°C (Wide range among cultivars)   | -1°C to -0.5°C  |
| RH settings                 | 90%-95%                 | 90%-95%                 | 90%-95%  | 90%-95%   |
| Comments                    | Reduced shrivel.        | Reduced shrivel.        | Low O <sub>2</sub> delays ripening and retains firmness. High CO <sub>2</sub> reduces internal browning. | Low O <sub>2</sub> and high CO <sub>2</sub> retain firmness, green color and acidity. Delays ripening and senescence. |

(\* ) require addition of CO<sub>2</sub> from external source.



| Fruit                       | Physalis                             | Persimmon  | Pineapple  |
|-----------------------------|--------------------------------------|--|--|
| Variety                     |                                      |  | MD2  |
| CA Potential                |                                      | Well suited  | slight to moderate   |
| Climacteric                 |                                      | Yes  | No   |
| Ethylene production         |                                      | Low  | Low  |
| Ethylene Sensitivity        |                                      | Medium   | Low  |
| <b>Suggested Trailer CA</b> | <b>3% O<sub>2</sub></b>              | <b>3%-5% O<sub>2</sub></b>   | <b>3%-5% O<sub>2</sub></b>   |
| T (°C) settings             |                                      | 0°C-1°C  | Mature green 10°C-13°C.<br>Turning 7°C - 10°C.<br>Ripe 7°C.  |
| RH settings                 |                                      | 90%-95%  | 90%-95%  |
| Comments                    | Limited information available on CA. | Low O <sub>2</sub> delays ripening.<br>High CO <sub>2</sub> retains firmness | Low O <sub>2</sub> delays senescence<br>reduces respiration.<br>High CO <sub>2</sub> delayed degreening,<br>reduces chilling injury. |

(\*) require addition of CO<sub>2</sub> from external source.





| Fruit                       | Plum   | Rambutan   | Strawberries   |
|-----------------------------|--|--|--|
| Variety                     | Various  |  |  |
| CA Potential                | Good   | Limited information  | Good to very good  |
| Climacteric                 | Yes  | No   | No   |
| Ethylene production         | Moderate   | High   | Low  |
| Ethylene Sensitivity        | High   | High   | Low  |
| <b>Suggested Trailer CA</b> | <b>3% O<sub>2</sub></b>  | <b>3%-5% O<sub>2</sub></b>   | <b>5%-10% O<sub>2</sub></b>  |
| T (°C) settings             | 0°C (Wide range among cultivars)   | 8°C-15°C   | 0°C-1°C  |
| RH settings                 | 90%-95%  | 90%-95%  | 90%-95%  |
| Comments                    | Low O <sub>2</sub> delays ripening. High CO <sub>2</sub> retains firmness. | Low O <sub>2</sub> reduces respiration rate. High CO <sub>2</sub> retains firmness, reduces decay, extends post harvest life | Low O <sub>2</sub> reduces respiration rate. High CO <sub>2</sub> retains firmness, reduces decay, extends post harvest life |

(\*) require addition of CO<sub>2</sub> from external source.

## 6. CA set-points for vegetables



| Vegetable                   | Asparagus  | Beans   | Broccoli  |
|-----------------------------|--|---|---|
| Variety                     | White  | (snap)  |   |
| CA Potential                |  | moderate  | Moderate to high                                  |
| Climacteric                 | No   | No  | No  |
| Ethylene production         | Very low   | Low   | Very low  |
| Ethylene Sensitivity        | Moderate   | Medium  | Very high   |
| <b>Suggested Trailer CA</b> | <b>No</b>  | <b>3%-5% O<sub>2</sub></b>  | <b>3% O<sub>2</sub></b>                           |
| T (°C) settings             | 0°C-2°C  | 5°C-7°C   | 0°C-1°C   |
| RH settings                 | 90%-95%  | 90%-95%   | 90%-95%   |
| Comments                    | High CO <sub>2</sub> enhances tenderness, retains solids and green color. Reduced O <sub>2</sub> no benefit. | Low O <sub>2</sub> reduces color loss. High CO <sub>2</sub> reduces color loss. | Ideal for shipments of fresh product without ice. |

Green asparagus: please revert to Cargofresh AG  
 (\*) require addition of CO<sub>2</sub> from external source.



| Vegetable                   | Bell pepper   | Cabbage                    | Eggplant  |
|-----------------------------|---|----------------------------|---|
| CA Potential                | None to Slight  | high                       | Slight  |
| Climacteric                 | No  | No                         | No  |
| Ethylene production         | Low   | Very low                   | Very low  |
| Ethylene Sensitivity        | Low   | High                       | Medium  |
| <b>Suggested Trailer CA</b> | <b>3%-5% O<sub>2</sub></b>  | <b>3%-5% O<sub>2</sub></b> | <b>3%-5% O<sub>2</sub></b>                                  |
| T (°C) settings             | 7°C-10°C  | 0°C                        | 10°C-12°C   |
| RH settings                 | 90%-95%   | 90%-95%                    | 95%   |
| Comments                    | Low O <sub>2</sub> reduces respiration, ripening and ethylene production. High CO <sub>2</sub> retains green color. | Extends storage period.    | Low O <sub>2</sub> delays deterioration and onset of decay. |

(\*) require addition of CO<sub>2</sub> from external source.



| Vegetable                   | Tomato   | Peas                                       | Sweet corn   |
|-----------------------------|--|--|--|
| CA Potential                | Slight to moderate   | Slight                                     |  |
| Climacteric                 | Yes  | No   | No   |
| Ethylene production         | Very low   | Very low                                   | Very low   |
| Ethylene Sensitivity        | High   | Medium                                     | Low  |
| <b>Suggested Trailer CA</b> | <b>3%-5% O<sub>2</sub></b>   | <b>3% O<sub>2</sub></b>                    | <b>3% O<sub>2</sub></b>  |
| T (°C) settings             | Mature green 12°C-15°C.<br>Turning 10-12°C.<br>Ripe 8°C-10°C   | 0°C-1°C                                    | 0°C-1°C  |
| RH settings                 | 90%-95%  | 90%-95%                                    | 90%-95%  |
| Comments                    | Low O <sub>2</sub> reduces ripening respiration and ethylene production. High CO <sub>2</sub> delays ripening. | CA delays deterioration and retains color. | Reduced O <sub>2</sub> and elevated CO <sub>2</sub> reduce respiration and slow sucrose loss, and prevent decay. |

(\*) require addition of CO<sub>2</sub> from external source.

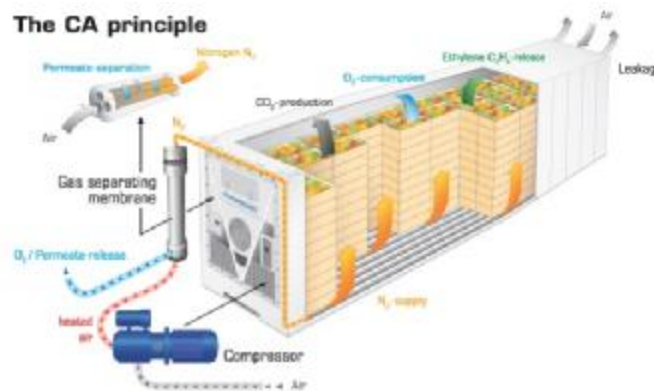
## 7. The Cargofresh CA product range

### Over the seas with guaranteed reliable technology

#### The Cargofresh sea container

##### The Cargofresh standard CA container series 009

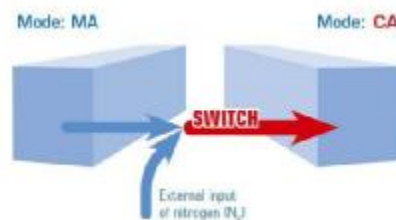
- ✓ Atmosphere building within 15 hours until set point of  $O_2 < 6\%$
- ✓ Active support of humidification control
- ✓ Optional  $CO_2$  control
- ✓ CA container series 009 in 40 ft or 20 ft versions \*\*



#### For more sensitive cargo

##### The Cargofresh CA container series 008

- ✓ Quick atmosphere building: only 15 hours until set point of  $O_2 < 3\%$
- ✓ Active support of humidification control (in Thermo King Magnum)
- ✓ Optional:  $CO_2$  control
- ✓ CA container series 008 in 40 ft or 20 ft \*\* version



#### MA or full CA: sometimes flexibility is everything

##### The Cargofresh switch system

System works optionally in Modified Atmosphere (MA) or CA mode with external  $N_2$  connection

Active support of humidification control

Optional:  $CO_2$  control

Cargo switch 40 ft or 20 ft \*\*

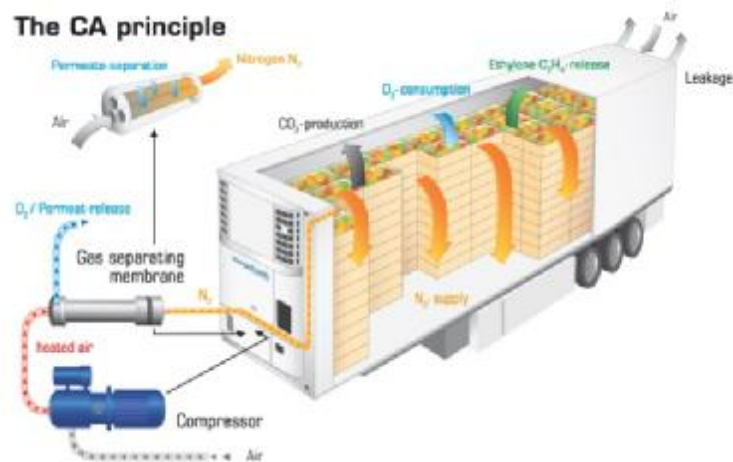
(\*\*) These units can be integrated with Thermo King and Carrier refrigeration engines

# Safely through the streets with Cargofresh technology

## The Cargofresh CA trailer technology – the roadrunner!

Irrespective of whether the compact front or under slung version, Cargofresh CA truck technology keeps your perishable cargo fresh, no matter how long the traffic jam.

- Ø Set points are reached in less than 24 hours until  $O_2 < 5\%$
- Ø Active support of the humidification control
- Ø Data download via GPS; minimal installation and service work



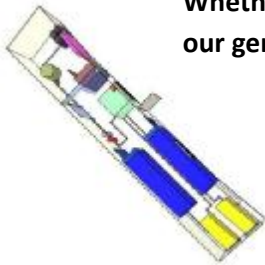
## Freshness until consumption

### Cargofresh CA warehouse technology

- Ø Stationary warehouses
- Ø N<sub>2</sub>/h output of 7–100 m<sup>3</sup>
- Ø O<sub>2</sub>/CO<sub>2</sub> control
- Ø Optional ethylene control



## Cargofresh nitrogen generators



Whether a mobile container system for on-deck operation, or fully integrated under deck, our generators will always have their place

- \* N<sub>2</sub> generator with N<sub>2</sub>/h output of 100–1500 m<sup>3</sup> N<sub>2</sub>/h
- \* Compact design
- \* Custom-made to space
- \* Optionally with nitrogen distribution
- \* Active O<sub>2</sub>/CO<sub>2</sub> control

## 8. More than just products: service and training from Cargofresh

Professional service from a single source



### Local technical training

Cargofresh trains local reefer and depot staff worldwide in specially structured courses. Maintenance and repair work can then be done quickly and cost-efficiently.

### Local safety training



In order to work safely with and around CA equipment, safety instructions are also given to third parties (e.g. police, customs), together with the reefer and depot staff.

### Spare parts

Cargofresh offers to expedite spare parts kits worldwide with major couriers.



## **Always knowing what happens**

### **Cargofresh transport data download**

After completion of shipment, the data generated during transport can be downloaded from the CA controller. The information is kept available in the controller for one year.

## **What we can do together...**

### **Quality management service**

Cargofresh has a holistic understanding of quality management, with benefits for growers, exporters, shipping services, insurance companies and retailers.

### **Growers and exporters**

Cargofresh provides a wide spectrum of benefits and services in postharvest technology, optimal packaging, set points and shipment reports, including independent quality control inspections at origin and destination.

### **Shipping services**

For shipping and freight forwarders we offer thorough knowledge in mobile and stationary CA technology, from retrofitting to completely new design and service, as well as guidance on the appropriate set points (O<sub>2</sub>/CO<sub>2</sub>/Temp./relative humidity) for each commodity.

### **Insurance companies**

CA technology aims to preserve freshness and quality. This has a direct impact in reducing risk effectively and decreasing loss ratios.

### **Retailers**

Our service to retailers and importers includes quality control inspections and guidance in determining optimal ripeness and shelf-life quality.



## 9. Contact

### Cargofresh quality management



Head office:

An der Strusbek 60–62

22926 Ahrensburg

Germany

Phone: + 49 (4102) 457260

[info@cargofresh.com](mailto:info@cargofresh.com)



Cargofresh do Brasil Logistica:

Av. Nacoes Unidas

Sao Paulo

Brasil

Tel: + 55 (11) 3443 / 1544

[cgalvao@cargofresh.com](mailto:cgalvao@cargofresh.com)



Cargofresh de Costa Rica:

PO Box 11637-1000

San Jose

Costa Rica

Tel: +506 (2) 2401519

## 10. Disclaimer:

Transit times, optimal set points and benefits of Controlled Atmosphere depend on initial product quality and product variability. Results obtained by CA are also determined by correct pre- and postharvest treatment, packaging and correct ripeness. All information is understood to be a recommendation only, without prejudice. For the reasons given above, Cargofresh AG assumes no liability for the accuracy of the information provided, or of the consequences of incorrect usage.

**[WWW.CARGOFRESH.COM](http://WWW.CARGOFRESH.COM)**