

## **EcO<sub>2</sub> Controlled Atmosphere; Low-Oxygen disinfestation of post harvest Commodities, Structures, Silos and (export/import) Containers**

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### **Abstract**

The EcO<sub>2</sub> Controlled Atmosphere treatment (CA), based on low-oxygen is commercially used world-wide to control insects in post harvest commodities, structures, silos, and container cargo (imported and exported and treated according Quarantine and Pre-shipment regulations). CA treatments have gained industry and government acceptance as the non-toxic fumigant technology for a variety of applications.

Treatments are carried out by applying them in climate controlled rooms, silos, barges or containers with fixed or mobile installations. CA has shown to be effective in controlling eggs, larvae and pupae, present in different sorts of (dried) commodities.

CA treatments have many advantages over traditional fumigants, including no pest resistance, residue-free and safe. In addition, installations equipped to carry out CA treatments are yet available in 14 countries serving a wide variety of industries.

### **Keywords:**

Controlled Atmospheres, heat, disinfestations, stored product pest control, fumigation, quality preservation, and insects.

### **Introduction**

The use of Controlled Atmospheres (CA) to control insect in post-harvest durables is growing rapidly and replacing toxic chemicals such as Methyl Bromide and Phosphine more and more. In the past, CA had some disadvantages in price, longer treatment times and availability but at the moment these are taken away by the developments of the Dutch company EcO<sub>2</sub>.

CA are based on the establishment of a low-oxygen environment which kills insects. The EcO<sub>2</sub> b.v. developed commercial application of CA to control all stages of insects, rats and mice in food, associated products, artefacts, silos, food (processing) facilities, airplanes and barges.

CA are established by means of an oxygen burner system or a nitrogen generator. The low-oxygen atmospheres are applied in airtight environments which range from 1 m<sup>3</sup> to 1000 m<sup>3</sup>. Insects in all stages, present in the products treated, are eliminated (99.9 % It) due to oxygen suffocation and dehydration. One unique effect of CA is that insects do not die inside the product. The insects are trying to escape the low-oxygen by moving towards the doors of the chambers, thus moving out of the product.

### **Materials & Methods**

#### **Exposure time with CA**

The up to date application of CA (= EcO<sub>2</sub> Rapid Treatment<sup>®</sup>) decreases treatment times for stored products pests to an acceptable level. This decrease in treatment time was managed because of mechanical developments in the technology and the machinery used to perform CA. Treatments now vary between 3 to 5 days, which depends on the type of product (density level) and type of insect (exposure level).

To create the decrease in treatment time, improvements in airflow in the airtight treatment chambers are developed and the time to heat up the products was shortened. Tests conducted in several EcO<sub>2</sub> service centers showed very positive results. The results of one test conducted with dried organic peaches from South Africa are shown in the next figures. Figure 1 visualises the rapid increase in temperature measured by 5 different data loggers, placed in the dried peaches at different positions in the treatment chamber. The increase in temperature is equally throughout the cargo. Figure 2 shows the former situation when the improvements were not yet applied to the existing equipment.

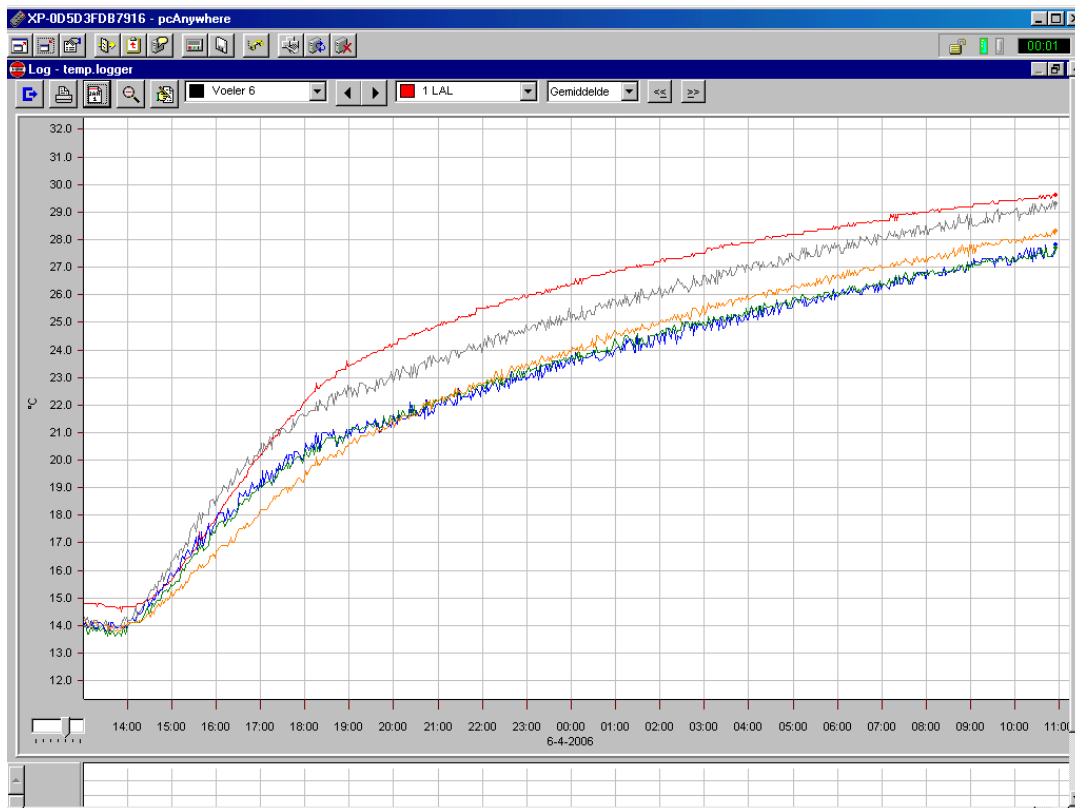


Figure 1: Decreased heat-up times with the EcO<sub>2</sub> Rapid treatment<sup>®</sup>

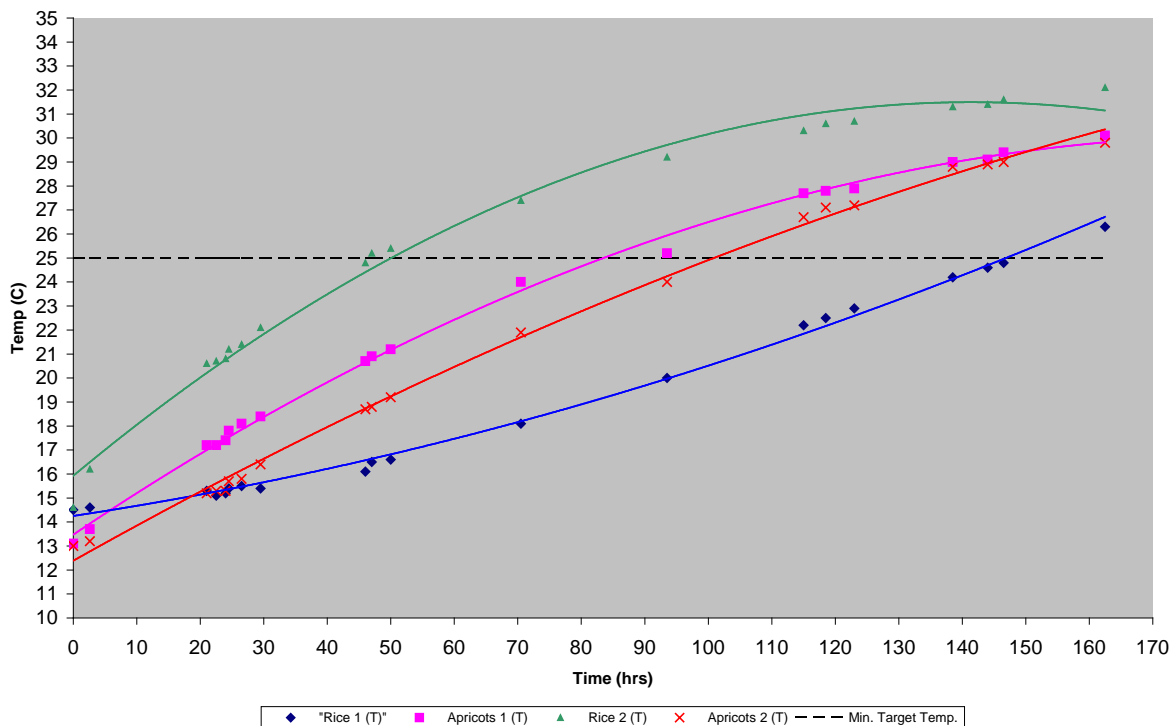


Figure 2: Standard heat-up times using CA without the EcO<sub>2</sub> Rapid treatment<sup>®</sup>

### Control of insects with CA

Each insect has different exposure times to control each stage of development. When lower product temperatures are used, exposure times will increase. When higher product temperatures are used, exposure times will decrease. This effect is very important for the industry where time is money.

Given this valuable information, the EcO<sub>2</sub> Rapid Treatment<sup>®</sup> was developed to create an optimum environment for the insects to be dehydrated and suffocated from a lack of oxygen. During the development of the treatment time improvement, different insect species were tested. All stages of the insects were tested (including adult, larvae, eggs). Treatment was carried out using the EcO<sub>2</sub> Controlled Atmosphere including Rapid Treatment<sup>®</sup>. Insects were treated according to the parameters stated in Table 1.

**Table 1: Insect species treated with EcO<sub>2</sub> Controlled Atmosphere incl. Rapid Treatment<sup>®</sup>**

Insect	Stage	Type	Parameters
Carpoglyphus lactis	All stages	CA	CA, 38 °C, 24hrs
Acarus spp.	All stages	CA	CA, 32 °C, 24hrs
Carpophilus dimidiatus	All stages	CA	CA, 40 °C, 16hrs
Ephestia elutella	All stages	CA	CA, 35 °C, 10hrs
Ephestia Cautella	All stages	CA	CA, 35 °C, 10hrs
Plodia interpunctella	All stages	CA	CA, 34 °C, 16 hrs
Oryzaephilus mercator	All stages	CA	CA, 36 °C, 16hrs
Oryzaephilus surinamensis	All stages	CA	CA, 30 °C, 24hrs
Sitophilus oryzae	All stages	CA	CA, 35 °C, 48hrs

Sitophilus granarius	All stages	CA	CA, 30 °C, 4days
Stegobium paniceum	All stages	CA	CA, 32 °C, 24hrs
Tribolium castaneum	All stages	CA	CA, 34 °C, 24hrs
Bruchus ssp.	All stages	CA	CA, 32 °C, 2days
Rhizopertha dominica	All stages	CA	CA, 32 °C, 3days
Sitotroga cerealella	All stages	CA	CA, 30 °C, 3days
Tribolium confusum	All stages	CA	CA, 30 °C, 36hrs

Each insect species was controlled according the given parameters. Control samples of insects were prepared similarly but not subjected to treatment.

Test showed 100% effective control of all tested insect species according the given parameters.

### **Price and Availability fumigation with CA**

Toxic fumigants are still widely used but due to the phase out of Methyl Bromide consumers are pushed to use other fumigants or technologies. Phosphine is a world-wide fumigant and is affordable. However, the fumigation takes long exposure times to be effective and the product is meeting increased levels of pest resistance. Sulfuryl Fluoride is another fumigant which however cannot guarantee an effectiveness of 99.9% It, and is not yet registered in every country to be used for insect control on food commodities. Phosphine and Sulfuryl Fluoride need investments in fumigation rooms and information technology to be applied on an acceptable level.

CA are most efficient in airtight climate rooms which are made of isolated panels. These rooms require an investment and a vast amount of space. EcO<sub>2</sub> managed to implement the converter based system in a 20ft container which is moveable and connectable to different areas, as long as the proposed treatment area can be made gastight. The system can even be connected to a 40ft isolated container and the smallest treatment unit is 24 m/ton per treatment. With the system, constructed this way, prices of the treatments are at more expectable levels and thus also available for small and medium sized companies. Company can have there own system, constructed turn-key at the desired location. Treatment prices range between a few EUR per metric tonnes (depending on yearly volume).

The installations and the facilities are currently available in 14 countries in Latin – America, Asia, Africa, Middle East and Europe. These facilities consist totally of more than 105 treatment rooms of which some have 12 rooms on one machine (Picture 1 & 2). Questionable remarks about the efficiency of the treatments are unnecessary. The system is proven in practice many times and is a valuable pest control application.



Pict. 1: CA facility in Greece (total 1029 m<sup>3</sup> treatment rooms)



Pict. 2: CA facility which fits 2 TEU in one treatment room

### **Usability of CA**

Treatment of durable commodities with CA as developed by EcO<sub>2</sub> are carried out in gastight climate chambers, isolated containers, silo's, warehouses, barges etc. The machinery is moveable and can even be placed outside and connected to the treatment area inside. Small rooms are available for yearly volumes of 1300 metric tonnes and can be upgrade to rooms with a yearly volume of more than 20.000 metric tonnes. Computer software makes it possible to monitor and control the entire process on-line and trained operators at a central treatment location are monitoring each individual treatment to maintain a constant level of quality. The whole process is easy to use and owners of such systems only have to take care of loading and unloading the rooms and closing the doors. The rest of the system is entirely automatic.

Products that are exposed to CA in the facilities as just described are a variety of food commodities, harvested world wide. Each individual facility is equipped to handle variable sorts

and quantities of products depending on the requirements of the user. A wide variety of cereals, pulses, nuts, spices, dried fruits, seeds and others are treated every day.

CA is also highly effective on the control of insects in silo's, barges, furniture, art, antique and library or museum items. The technology will not deteriorate the products and their value will not be destroyed.

## Conclusions

The use of Controlled Atmosphere is more competitive than a few years ago. Barriers of treatment time, price, availability and usability have been lowered considerably. The growing trend in awareness and food safety will force the industry to implement better and safer fumigation technologies. The use of CA has several advantages towards the existing methods for chemical insect treatments on products:

- Insects do not die inside the product. The insects try to escape the low oxygen by moving towards the chamber doors, thus moving out of the product.
- There is no use of insecticides and thus no residues
- The method is environmental friendly
- The system is used without waiting for a fumigator
- Each treatment is followed by an internationally known certificate
- No insect resistance is found with the use of Controlled Atmosphere
- There is practically no danger for the working personnel

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