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CONTROLLED ATMOSPHERE FOR PEST CONTROL IN CLIMATE CHAMBERS AND SILOS

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Abstract The controlled atmosphere (CA) principle is based on low-oxygen in combination with increased temperatures. CA treatments are commercially used world-wide and have gained acceptance from both governments and industries as the non-toxic fumigant technology for a variety of applications. As a pest control method CA has many advantages over traditional fumigants like products are free of residues and safe for people and the environment. The treatments are independent of atmospheric influences. CA can be used for quality preservation purposes for long term storage of food and feed commodities. It does not compromise the treated products in any way. CA treatments are applied in airtight climate controlled environments like climate chambers, barges or containers with the use of fixed or mobile installations. To apply CA in existing silos, a pressure tests needs to be conducted in order to establish the level of gas tightness of the silo.
Key words Fumigation, insects control, silo treatments, tobacco

INTRODUCTION

Low oxygen atmospheres have been used for many years to control stored product pests (De Lima, 1990). When O2 in the environment is reduced, insects lower their metabolic rate, and very low metabolism imposes stress on the insects (Mitcham et al., 2006). Studies have concluded that the oxygen level needs to be below 3% for this stress to be lethal; in most cases, it needs to be below 1% for rapid kill.

Controlled atmosphere treatments can be applied in airtight environments (like custom made climate chambers) ranging from 1 to 1000 cubic meters. The atmosphere is established by means of a converter that is able to create inside the airtight environments O_2 levels varying between 0% and 1.5%. The treatment eliminates the insects regardless their life stages. The lack of oxygen causes the eggs, larvae, pupae and adults to dry out and suffocate. Each treatment is fully monitored and controlled 24/7 via remote control. Each treatment has its own parameters based on the treated product and the type of insect(s) that need to be controlled. These parameters are based on a database of insect control data and knowledge of products. The treatment data are recorded using software programmes for full traceability

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Stored and processed tobacco can be infested by the *Lasioderma serricorne* and *Ephestia elutella*. These insects need an O_2 level of 0.5% to be killed. To study the effectiveness and the duration time of the controlled atmosphere treatment on stored tobacco, several tests and trials where done over a period of 8 years. Besides testing the effectiveness in killing of the insects in all life stages and the most efficient duration time, these tests can also indicate if and if so what kind of (unwanted) side effects of the treatment might occur. Like discolouring or decolouring, taste deviations and loss of moisture in the tobacco.

Different varieties of tobacco were used for the tests: From tobacco seeds to raw tobacco in transport boxes to cigarettes and cigars packed in commercial packaging and packed in carton transport boxes. Some carton boxes were placed on pallets and wrapped in plastic transport foil. Holes were made in the foil so that the flow could go through the pallets more easily, (Figure 1). The tests where conducted in Vietnam, Indonesia, United Kingdom, Africa and the Netherlands. The products are placed in an airtight chamber or container. Various sensors are placed throughout the chamber or container at certain set points. These sensors measure the oxygen level and temperature. The moisture level of the cigarettes and cigars were measured separately before and after the tests were ended. Samples of *Lasioderma serricorne* and *Ephestia elutella* including eggs, larvae, pupae and adults were put in glass bottles, covered with a net on top, and placed inside the carton boxes.

The various tests indicate that within 9 hours, the required level of 0.5% O_2 was reached in the core of the products (Figures 2, 3). The commercial and transport packaging did not hinder the effectiveness or the duration of the controlled atmosphere treatment. There were no signs of living insects found. Regardless the life stages, all insects were killed. The quality of the products were in no way compromised; no decoloring or discoloring of the tobacco or tobacco products occurred, no taste deviation and the moisture level of the products stayed stable.

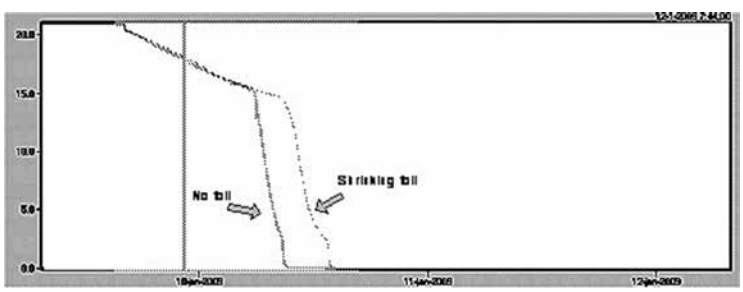

Figure 1. Influence shrinking foil on the flow air through pallets.

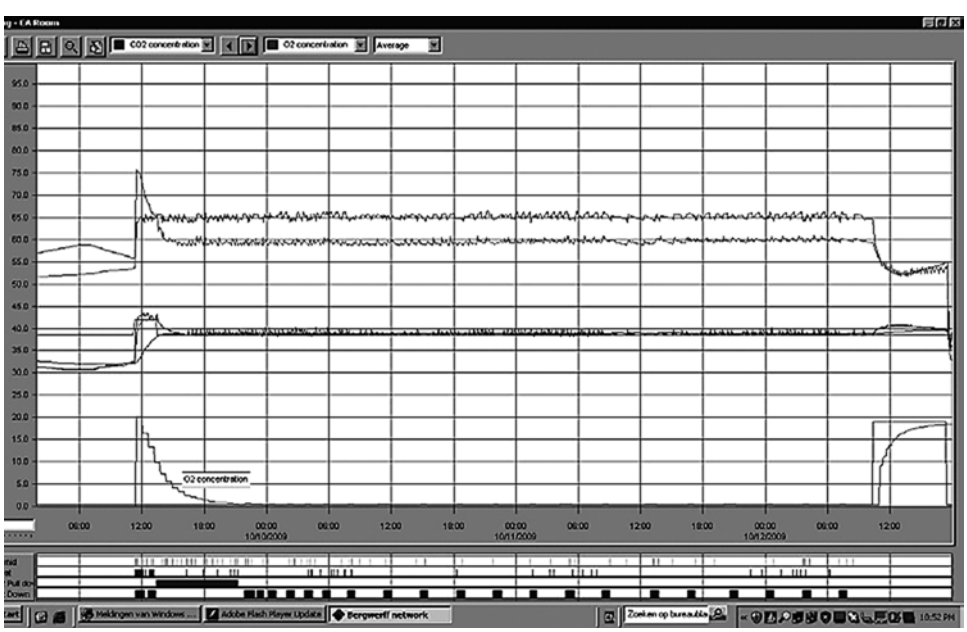

Figure 2. Test result reaching the 0.5% O_2 level within 9 hours.

CONTROLLED ATMOSPHERE IN SILOS

Since a very large portion of the storage of food and feed commodities is done in silos, there is a need for the application of controlled atmosphere in silos. Silos are constructed in various manners, different materials are used and the usage may differ. Some silos are only used for storage, others for storage and as a treatment facility. The most important aspect is the air tightness of the silo. The more air tight the silo is, the quicker the right low oxygen level will be reached within the silo. This can be established after conducting a pressure test.

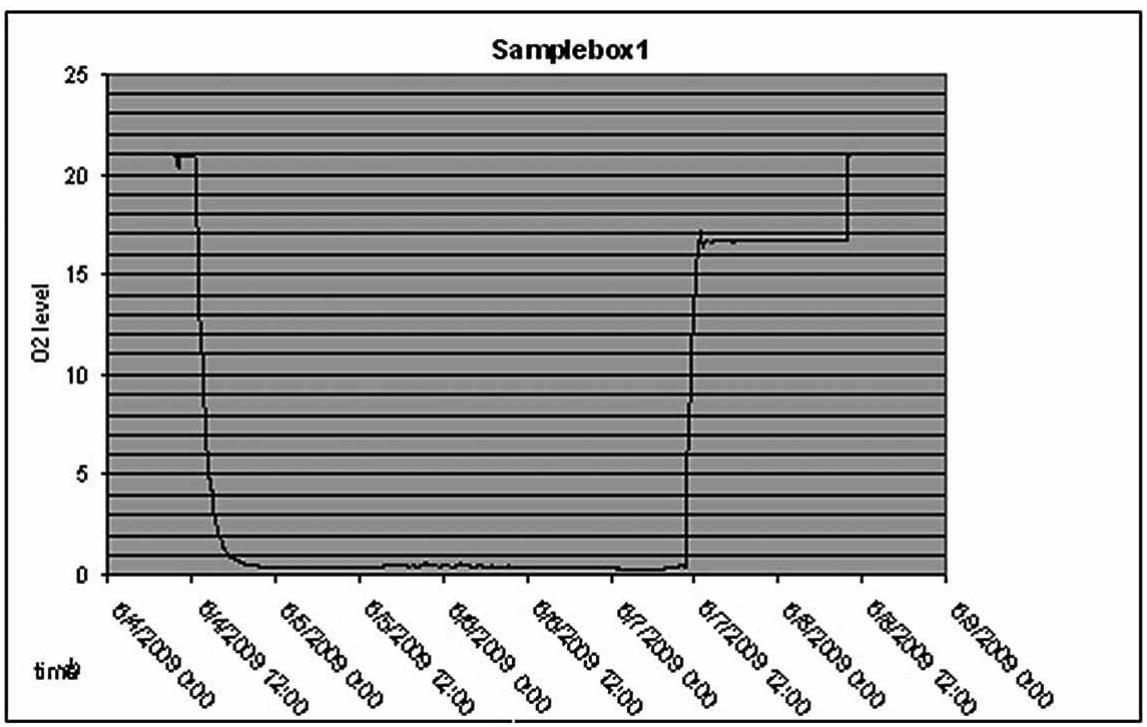

Figure 3. Test result reaching the 0.5% O_2 level within 9 hours.

SILOS TESTS

Several tests were conducted in silos in Switzerland with Desinfecta, CDL in Italy and together with Agrospecom in Greece. The various tests where done to establish the level of gas tightness of the silos, what time duration was needed to reach and keep an oxygen level of 0.5% . This O_2 level is required to kill of the *Sitophilis granarius*.

The tests silos were wheat filled corrugated silos with an open top. That means that in the roof of the silo air openings are present. To measure the pressure, the top of the silos needed to be closed. It was covered with thick plastic sheets. All seams were taped to prevent air leakage and dust. Kit was used to close any gaps around the valves, walls and floor. The parameter for this test was set for 0.5%, this to kill of the *Sitophilis granarius*. This test showed that it took 18 hours to reach 0.5% O_2 level within the silos. (Figures 4, 5, 6). The term for reaching the 0.5% O_2 level was set within 24 hours. The test showed that the existing silos reached the required level well within the set time frame. This level was held for the whole duration of the test, even though there were only minimum measures taken to make these corrugated silos more gas tight.

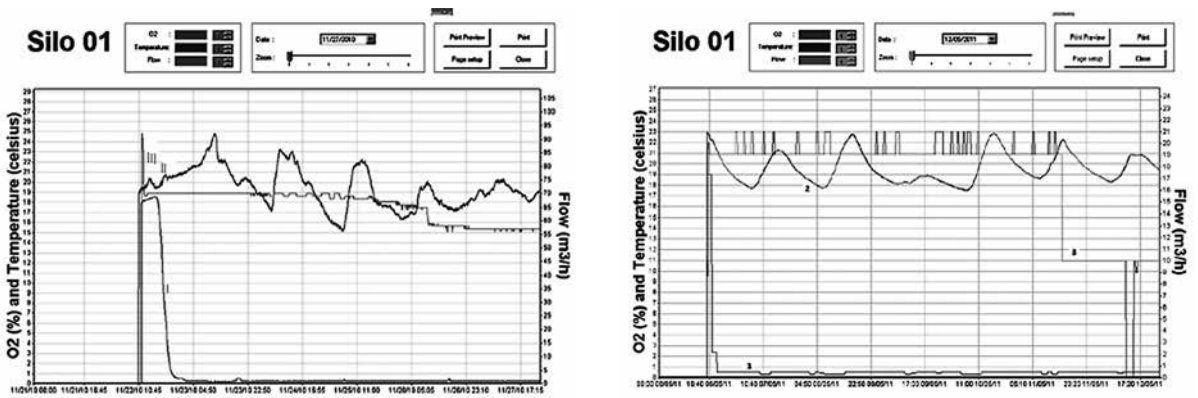

Figure 4, 5. The 18 hours to reach 0.5% O_2 level within the silos. I = O_2 level, II = Temperature, III = Flow; 1= O_2, 2 = Temperature, 3 = Flow.

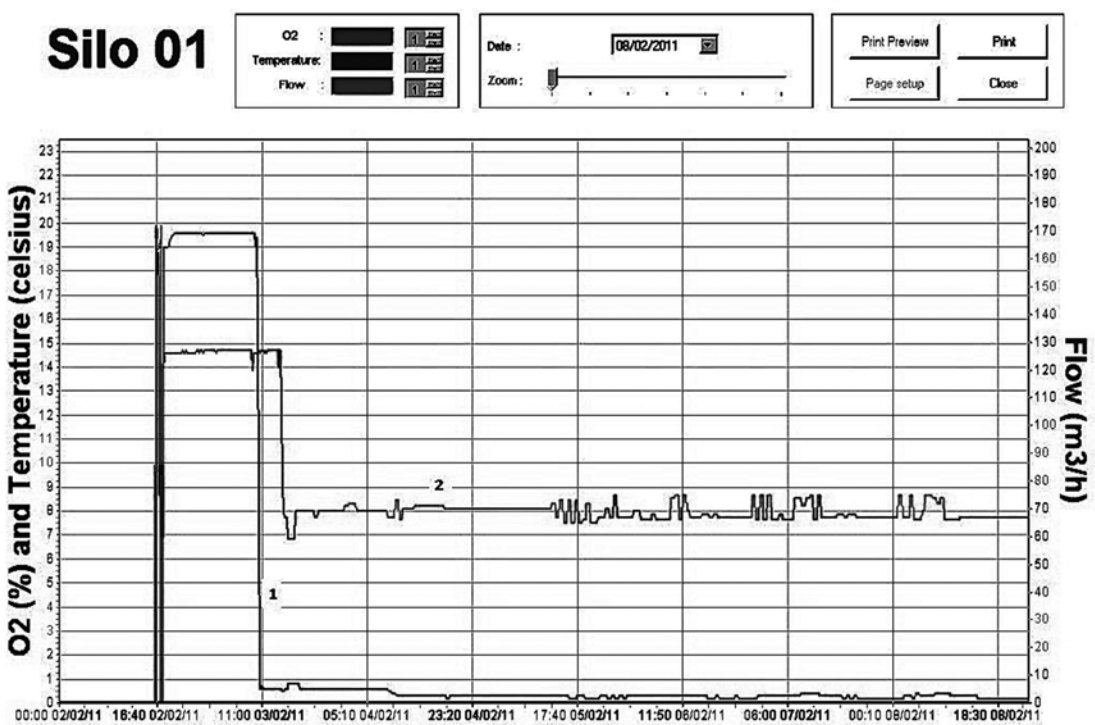

Figure 6. Test showed that it took 18 hours to reach 0.5% O_2 level within the silos. 1= O_2 level, 2= Flow

CONCLUSIONS

Controlled atmosphere treatment is an effective alternative for chemical fumigants. It holds it competiveness against the chemical fumigants on points as price, treatment time, availability and usability. Chemical fumigants like Phosphine face problems of causing resistance, leaving residues, long treatment duration, affecting the ozone and a negative image; they become overall less competitive in comparison to natural alternatives. The conventional food products market will choose for this

alternative more often because of the growing trend in awareness of food safety. Controlled atmosphere treatments reduce the risk for working personnel and consumers. All systems are used without waiting for a fumigator.

The principle of the treatment is simple; without oxygen no insect can survive. Each insect stage of the insect species is controlled, taking into account that pupae and eggs are the most difficult ones. Each treatment is adjusted to the insect specie that needs to be controlled and the product that is treated regardless if it is applied in a treatment chamber or a silo.

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