ECOGEN TECHNIQUE, USED FOR THE EXTERMINATION OF INSECTS IN FOOD SUPPLIES AND SHIPS.

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ABSTRACT:
The objective of this study was to investigate the possibility of using controlled atmosphere to exterminate insects and other pests at all stages of development in all kinds of food supplies, buildings, silos and ships. During the study, the following levels were monitored accurately: O2, CO2, N2, temperature and relative humidity. Experiments were conducted to test the efficacy of various percentages of the factors mentioned above in various combinations. The times needed for pest eradication varied with temperature, ranging from 2 to 9 days for stored product pests at 27-28°C. The results of the study mentioned below are a short summary of the original study. A copy of the original study can be furnished on request.

INTRODUCTION:

In the Netherlands the Ministry of Housing, Spatial Planning and the Environment instructed Ecogen to develop an alternative for this fumigant based on the principle of Controlled Atmosphere (CA). In collaboration with 'TNO Industrie' (the Netherlands Organization for Applied Scientific Research, section Industry), various tests were carried out with a variety of insects and pests, including *Sitophilus spp., Rhyzopertha dominica, Tribolium spp., Plodia interpunctella, Ephestia spp., Blattella germanica, Xyleborus dryographus, Rattus norvegicus, Rattus rattus* and *Mus musculus domesticus.* The products and situations in which research was conducted, included rice and corn in grain silos and ships, various spices, cocoa beans, ginger, peanuts, furniture and floorboards in airtight environmental test chambers with a capacity of 160 m^3.

The tests were carried out using a gas burner producing carbon dioxide (CO2), nitrogen (N2) and oxygen (O2) with an output capacity of 150 m^3/h, the gas burner being fuelled with natural gas or propane gas and a 380V electric supply. The heat that is thus released is reused to heat the products by means of a closed circulation system, while at the same time it is used to control the relative humidity (r.h.) of the products during the treatment. To plan the tests, the research results reported by Annis (1987);, Bell and Armitage (1992), Banks and Fields (1995) and Navarro and Jay(1987) were used as guidance.

EXPERIMENTAL 1. ECOGEN TECHNIQUE FOR SHIPS

The tests were carried out in six different ships three filled with Surinam rice contaminated with *Sitophilus oryzae*, treating bulks of 400 t, 800 t, and 1500 t, and three filled with wheat contaminated with *Plodia interpunctella*, treating bulks of 500, 750 and 1500 t. An injection system was installed in the cargo consisting of pipes, hoses and distribution stations to achieve optimal distribution of the inert gas, while at critical locations, meters were installed to measure the levels of O2, temperature and r.h. Once this was done, the ships holds were well sealed in order to guarantee that the atmosphere composition required to exterminate the insects could be maintained. The temperatures that were used on rice were 22°C and 28°C, at an r.h. of 50% and on wheat were 18°C and 27°C, at an r.h. of 50%. The atmosphere applied contained 1% O2 and 12% CO2. The treatment times applied were 20 days at 22°C and 9 days at 28°C against *S. oryzae* on rice, and 6 days at 18°C, and 4 days at 27°C against *P. interpunctella* on wheat, in each case after achieving the target atmosphere, which , depending on the ship, required from 12 to 36 h. In all tests, all of the insect stages, eggs, larvae, pupae and adults, were exterminated. Samples taken after treatment that were stored in an incubator in the laboratory for 6 weeks following treatment, showed the same result. In the holds there where placed, four test boxes, with approx 6000 pcs off all stages of insects. The study also investigated whether the CA technique left any residues on the rice cargo that was treated. No residues were identified.

EXPERIMENTAL 2. ECOGEN TECHNIQUE IN ENVIRONMENTAL TEST CHAMBER 160 M^3

During these tests, the following products were treated, which were contaminated with insects as follows:

- Ginger; *Tribolium spp.,*
- Various spices; *Rhyzopertha dominica*

The environmental test chambers were constructed from aluminium PUR panels, measuring 160 m^3, which could be closed by gastight doors. A closed heat system was built in that allowed for separate product and room temperature control and monitoring. Humidity was controlled and monitored via the PLC. The whole installation is fully automated and computer-controlled. The controls and drives can be regulated and adjusted by remote control.

The conditions in which these tests were conducted varied per product, as listed below:

- **Ginger, *Tribolium spp.*; 18° C and 28° C at 50% r.h., air composition consisting of < 1% O2 and 12% CO2.**
- **Various spices, *Rhyzopertha dominica*; 15º C and 27º C at 45% r.h., air composition consisting of < 1½% O2 and 12% CO2.**

A) TEST WITH GINGER CONTAMINATED WITH *TRIBOLIUM SPP.*;

For this test, we treated a total of 1000 tons of ginger, of which 500 tons at 18º C and 50% r.h. for a test period of 5 days, and 500 tons at 28º C and 50% r.h. for a test period of 2 days. It took 7 hours to reach the pull down

For the experiment at each temperature, the ginger was placed on pallets in the environmental test chamber, including 4 test boxes of *Tribolium* in all stages, following which the doors were closed and the installation was switched on. Heating the product 18º C took 8 h. and to 28º C took 12 h. During the tests, 5 days after reaching experimental conditions at 18ºC and 2

days after reaching experimental conditions at 28 °C, the 4 test boxes were removed from the environmental test chamber and placed in a kiln at 28º C and 50% r.h.. After six weeks, the test boxes were removed from the kiln and investigated by 'Handels Laboratorium Verweij' in Rotterdam. No survivals from an estimated minimum sample size of 8.000 pcs of each stage at either temperature were recorded.

B) TEST WITH VARIOUS SPICES CONTAMINATED WITH *RHYZOPERTHA DOMINICA*;

For this test, a total of 800 tons of spices was treated, of which 300 tons were exposed at 15º C and 45% r.h. for a test period of 12 days, and 500 tons at 27º C and 45% r.h. for a test period of 6 days, after establishing experimental conditions (SAY HOW LONG).

The spices were placed on pallets in the environmental test chamber, including 4 test boxes of *R. dominica* in all stages, following which the doors were closed and the installation was switched on. Heating the product to 15º C took 6 h, and to 27º C, 14 h. During the test, 12 days after reaching experimental conditions at 15 °C, and after 6 days at 27ºC, the 4 test boxes were removed from the environmental test chamber and placed in an incubator at 28º C and 45% r.h..

After six weeks, the test boxes were removed from the kiln and investigated by 'Handels Laboratorium Verweij' in Rotterdam. No survivals from an estimated minimum sample size of approx 7.500 pcs of each stage at either temperature were recorded.

CONCLUSIONS:

Based on the results yielded by the tests, we reached the conclusion that the Ecogen technique, based on the principle of Controlled Atmosphere, constitutes a good alternative for Methyl Bromide and also for Phosphine, without leaving residues on the treated products.

What became apparent from the tests, was that the time required for treatment depended on the following data: correct temperature level, air composition, r.h., type of product and type of pest present.

The tests showed that treatment at lower temperatures and for extended periods of time will produce the desired result. However, with an average temperature of between 25º and 27º C and the right air composition, the Ecogen technique constitutes a very good and economically sound alternative.

Finally, it should be pointed out that the studies mentioned above only form a part of the total volume of studies conducted by Ecogen over the past years.