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The degesch phosphine generator – a fast phosphine application

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Abstract

The Degesch Phosphine Generator is a device for the fast production of phosphine gas and its injection into structures which have to be fumigated.

The different fumigations conducted highlight some particular advantages of the Degesch Phosphine Generator. The treatment of three stacks shows the possibility of multiple fumigations from a central location using a gas distribution system. The fumigation container demonstrates the fast generation of phosphine with a nearly rectangle concentration profile. That means that the maximum phosphine concentration is reached within 10 minutes. In the case of the silo the fumigation generator is used together with the J-system. Due to the ease of redosing we obtain an uniform distribution of phosphine throughout the treated commoditiy.

As a result a 100-%-mortality of all species of stored-product insects and life stages is achieved, confirming that the fumigation system of the Degesch Phosphine Generator and the Degesch Granules is effective for the disinfestation of stacks, containers and silos as well as other kinds of warehouses.

Key words: degesch phosphine generator, phosphine, degesch granules, fumigation.

Indroduction

Stored product pest may appear in storage facilities (stacks or silos) or during transportation (containers). They are spread throughout the world, exist in the commodities or in the means of transportation. The most widely used chemical to control stored product pests is Phosphine. Only a gas (fumigant) will reach the pest in their most remote hiding places and is able to penetrate infested products like the grain kernel where some of the pests develop. Therefore aluminium and magnesium phosphide-based formulations have been used successfully to treat stored commodities. Usually these formulations require 24 to 48 h to reach an effective concentration. In contrast, the Degesch Phosphine Generator/ Degesch Granules system is a device for the rapid production of phosphine gas and it is already recognized as a replacement for methyl bromide or for mixtures of phosphine in carbon dioxide in cylinders.

Luzaich and Mathews (2002) examined the production and distribution of large quantities of phosphine in an empty fumigation chamber (2,633 m³) with the Degesch Phosphine Generator. The generator introduced 2,975 g of phosphine within 53 minutes and a homogenous concentration of approximately 750 ppm was reached after 6 hours.

GEP mortality tests were conducted in stacks (tobacco) and containers (pulses) as well as an application trial in a silo with wheat was carried out confirming that the fumigation system of the Degesch Phosphine Generator and the Degesch Granules is effective for the disinfestations of these structures.

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Material and methods

Degesch Phosphine Generator

The generator was positioned outside the structure where it generated phosphine by the reaction of Degesch Granules with water in an inert atmosphere of carbon dioxide. The phosphine was then pumped from the generator into the structure through a recirculation system. Water for the reaction was used from the common water tap. The used water with the by-products were collected in a drum and disposed separately.

Insects

Strains of *Sitophilus granarius*, *Lasioderma serricorne*, *Cryptolestes ferrugineus* and *Plodia interpunctella* were used for the mortality tests.

All strains originate from laboratory cultures reared in our laboratory. The insect samples contained all development stages.

Structures

The tests were conducted in a 475 m³ silo with 330 t of wheat, in a stack of 344 m³ of empty cartons, in a 441 m³ stack of tobacco and in a 40 m³ fumigation chamber with pulses.

Fumigation

The structures were sealed with gas-tight plastic sheets ("Sperrfolie", Detia Degesch GmbH) which were fixed to the structure with a strong adhering tape and the Degesch Phosphine Generator was connected to the structures with plastic hose. The phosphine concentration (Dräger tubes and ATI sensor) as well as the climatic conditions (Escort data logger) were monitored at different positions during the complete fumigation. The plastic cages with the insects were placed next to the measure point. To the bottom and the lid of the cages a metal screen was fixed. Magtoxin Granules were used to achieve the target concentrations in the structure. The Magtoxin Granules formulation releases approximately 0.5 g phosphine gas per gram of product.

Results

Silo fumigation

Figure 1 shows the schematic assembly of the silo fumigation and the measure points for the phosphine concentration. A fan sucked the air from the bottom of the silo and relegated the air to the generator at the top of the silo. Inside the generator the atmosphere was enriched with phosphine and pumped into the head of the silo.

During the first application period 2 kg of phosphine corresponding to 4 kg of Magtoxin Granules were introduced into the silo. Within 60 minutes the phosphine concentration achieved approximately 1,500 ppm at the top and in the middle of the silo, respectively, 600 ppm at the

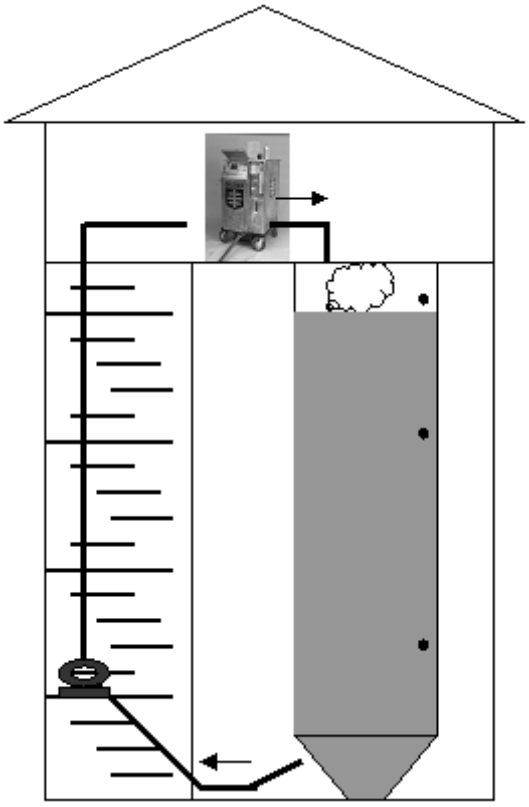

Figure 1. Schematic assembly of the silo fumigation. Circles: measure point of the phosphine concentration.

bottom. After 24 hours the phosphine was well distributed in the silo and after 48 hours additional 850 g of Phosphine (= 1.7 kg Magtoxin Granules) were added to reach phosphine concentrations of 1050, 700 and 550 ppm (Figure 2). Before the start of the ventilation the concentrations were 650 ppm at the bottom, 500 ppm in the middle and 200 ppm at the top of the silo.

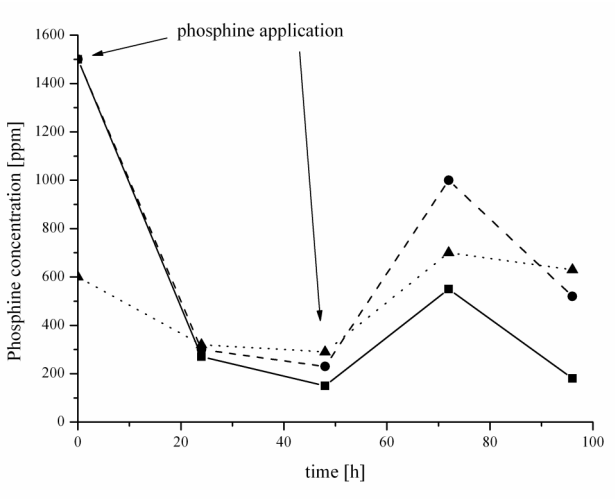

Figure 2. Phosphine concentration during the application of Phosphine in a silo with the Degesch Phsophine Generator. Triangle: measure point at the bottom of the silo. Circle: measure point at the top of the silo. Rectangle: measure point in the middle of the silo.

Stack fumigation

Two stacks next to each other were fumigated with 1.25 g / m³ phosphine. Due to a even and fast distribution of the gas the phosphine containing atmosphere leaving the generator was pumped into the one end of the stack and sucked from the other end of the stack back to the generator (crossing air-flow) (Figure 3).

The hoses connecting the generator with the stack contained a tap to interrupt the phosphine application. Therefore, it was easy and fast to disconnect the generator from the first stack and connect it to the other one (Figure 4).

Within one hour the phosphine concentration at one side of the stack increased very fast from 0 to 3,000 ppm. After 24 h the phosphine was well distributed in the stack and before the ventilation started the concentration was still above 500 ppm (Figure 5).

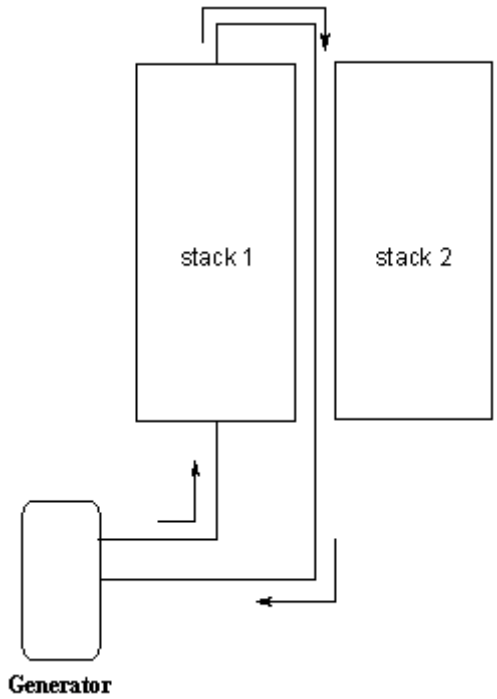

Figure 3. Schematic assembly of the stack fumigation.

Figure 4. Connection hose with a tap between Degesch Phosphine Generator and stack.

Mortality tests were conducted with *Lasioderma serricorne*, *Cryptolestes ferrugineus* and *Plodia interpunctella*. Directly after the fumigation no living adults as well as no hatch during the breading period could be observed.

Therefore 100 %-mortality was reached in all treated insect samples whereas the control sample showed a normal development.

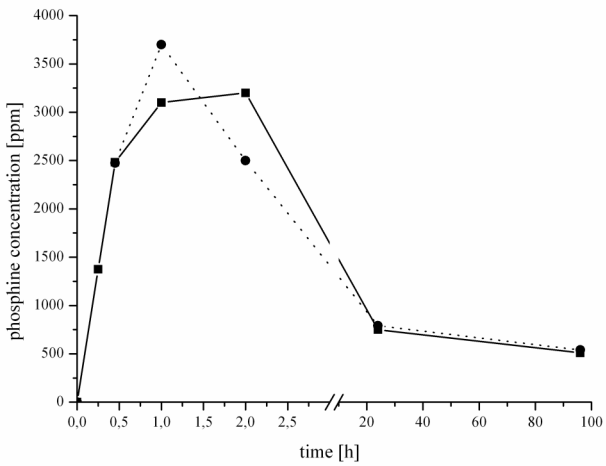

Figure 5. Phosphine concentration in the stacks. Rectangle: stack 1. Circle: stack 2.

Container fumigation

Analogous to the stack fumigation the generator was connected to the container to achieved a crossing air flow. The application of the phosphine to achieve the target concentration of 700 ppm (= 1 g / m³) was already finished after 5 minutes and the maximum concentration of 1360 ppm was reached after 15 minutes. After the distribution process the concentration amounted to 850 and 650 ppm (Figure 6).

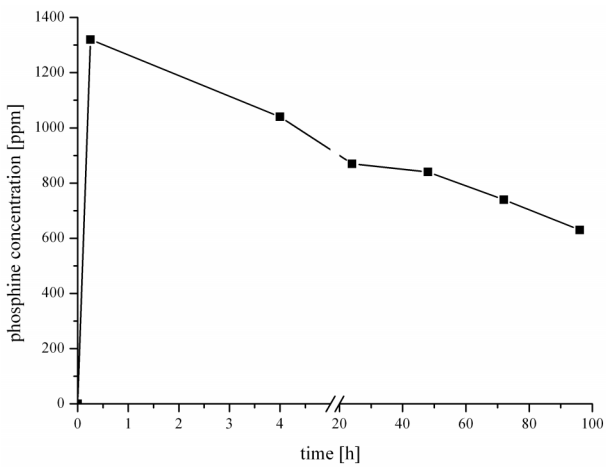

Figure 6. Phosphine concentration in the container.

A mortality test was conducted with *Sitophilus granarius*. Directly after the fumigation no living adults as well as no hatch during the breading period could be observed. Therefore this insect strain was treated with a 100 %-mortality whereas the control sample showed a normal development.

Discussion

The Magtoxin Granules formulation will release 50 % phosphine by weight whereas a bottled CO_2/phosphine formulation contains only 2 %. For instance, we used 2.85 kg phosphine or respectively 5.7 kg Magtoxin Granules for the fumigation of a silo. This corresponds to 142.5 kg of a CO_2/phosphine mixture.

Furthermore, the silo treatment point out that phosphine can be added easily with the Degesch Generator without opening the structure and therefore the phosphine concentration can be controlled and corrected during the whole exposure time. Thus the Degesch Phosphine Generator facilitates constant phosphine concentrations.

If the stacks are prepared with hoses containing a tap multiple treatments are possible without moving the generator. After treating the first stack with phosphine the generator is set into the pause mode, the taps are closed and the hoses connected to the other stack. This technique is very helpful for neighboured structures which have to be fumigated with e.g. different concentrations or exposure times or if different commodities have to be kept seperately.

The container treatment shows how fast small structures can be fumigated with the Degesch Phosphine Generator. For a target concentration of 1 g/m³ which is common for many commodities the fumigation speed was 8 m³/min. Hence, within one hour 12 neighbouring 40 m³ containers can be fumigated and therefore the generator may be an alternative to common wood fumigations with methyl bromide.

The mortality trials confirm the efficacy of the full-scale techniques of the Degesch Phosphine Generator.

Reference

Luzaich, G., Mathews, M., 2002. Treatment of an empty fumigation chamber using the Degesch Phosphine Generator. Proceedings of the 8th Internatinal Working Conference on Stored Product Protection, 646-647.