

Cryogenic cleaning with pellets of CO<sub>2</sub> to remove food residues that act as a refuge for pest in machines and hiding places is an alternative used in some food facilities. Diatomaceous earths are registered as a food additive. However, their use is not widespread.

Biological control is not used and still not known as an alternative control method by the agro-food industry. However, natural enemies, parasitoids and predators, are abundant and present throughout the whole year in the food factories in Spain. They are not only present in organic food factories but in factories applying chemical control. This is probably due to the presence of refuges where chemical insecticides cannot reach.

More recently, companies are considering the use of some plant extracts containing bioactive compounds as repellents or to prevent insect development. Substances must be considered as safe (GRAS) and are normally blended with the final product or integrated in the packaging materials as a barrier to prevent cross contaminations.

Controlled or Modified Atmospheres are increasingly in use for either fumigation of commodities or packaging of final food products. Modified atmosphere treatments are safe and environmentally friendly ways of controlling pests that affect a large number of raw and manufactured food products. Application of high CO<sub>2</sub> modified atmospheres have tended to focus on the control of pests affecting raw or semi-processed food products in silos and warehouses as an alternative to using conventional chemical fumigants and insecticides. However, this technology is also being applied to final products during the packaging process, to prevent the development of pests that are found after the manufacturing process. Modified atmospheres are used with consumer packages that involve the use of modified flow pack machinery, when storing intermediate food products into large big bags or when preparing final products for pallet storage. Modified atmospheres are equally flushed into either small (1 kg) plastic packages or large (1000 kg) big bags. Different types of plastic film are available and these offer different barrier properties for gases and make it possible to maintain a given gas mixture throughout the treatment. CO<sub>2</sub> at high pressure for treatment of spices and herbs and vacuum packaging for rice and dried fruits are two technologies now established in a number of processing companies.

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## 24 - Reaction of Polish industry to reduction of pesticides suitable for stored product protection

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### Abstract

Methyl bromide (MB) had been widely used for fumigation of durable commodities, perishable products, structures and transport vehicles. This good gaseous pesticide may not be replaced by one alternative, but various methods and means have to be used. Contact insecticides may be used as MB alternatives on stored grain and in storage structures and food production plants. These insecticides are applied directly to grain during handling on grain conveyors and elevators, or sprayed onto the surface of bag stacks, walls and floors of empty structures and transport vehicles. Spaces of structures are sometimes treated by "fogging" to control of flying insects. However, the number of available contact insecticides was recently limited by the Directive 91/414/EEC and the others will be restricted in the EU by a new Thematic Strategy on Pesticides. Thus, the following measures are currently used in Poland: (a) phosphine, (b) a few contact insecticides, (c) heat, (d) high pressure and CO<sub>2</sub>, and (e) Integrated Pest Management (IPM). The most important mean is phosphine (PH<sub>3</sub>) from solid phosphides. The following techniques for application of solid phosphides were adopted: (a) Speedbox, (b) dispenser technique, (c) phosphine recirculation system (J-System). Speedboxes seems to be popular in Poland as handling and maintenance of them is

simple, and the gas concentration required for killing the pests is reached in shorter time. J-System has been installed in a silo of the ZZZ Company in Zamosc, Poland, and it is already used in fumigation treatments of stored grain. The high pressure chambers that hold 20-30 bars of pressure and 100% carbon dioxide are now being used in Bialystok and Lublin for medicinal herb treatments.

## Introduction

Methyl bromide (MB) had been widely used for fumigation of durable commodities, perishable products, structures and transport vehicles. This good gaseous pesticide may not be replaced by one alternative, but various methods and means have to be used. Contact insecticides (Table 1) may be used as MB alternatives on stored grain and in storage structures and food production plants.

In Poland, in 1995/1996 two products were registered for smoke generating treatment, 11 products for spraying, and 5 products for fogging (Table 1). In 2000/2001, the situation was still similar with two products for smoke generating treatment, 10 products for spraying, and 4 products for fogging (Table 2). However, in 2004/2005 an abrupt decline in the number of available products was observed with no more products for smoke generating treatment, 5 products for spraying and one product for fogging (Table 3).

**Tab. 1** Insecticides for stored product pest control in empty enclosures in Poland, 1995/1996

Treatment	Product name	Active substance
Smoke	Actellic 20 FU	pirimifos-methyl
	Coopex 13 FU	permethrin
Spray	Actellic 500 EC	pirimifos-methyl
	Alfasetc 05 SC	alfa-cypermethrin
	Ambusz 25 EC	permethrin
	Coopex 25 WP	permethrin
	Kordon 10 WP	cypermethrin
	K-Othrine 2,5 WP	deltamethrin
	K-Othrine 25 SC	deltamethrin
	Nuvan 7	dichlorfos
	Permasect 10 WP	permethrin
	Permasect 250 EC	permethrin
	Pybuthrin 6/60	pyrethrin + piperonylbutoxyd
Fog	Actellic 500 EC	pirimifos-methyl
	Ambusz 25 EC	permethrin
	Nuvan 7	dichlorfos
	Permasect 250 EC	permethrin
	Pybuthrin 6/60	pyrethrin + piperonylbutoxyd
Dust	-	-

**Tab. 2** Insecticides for stored product pest control in empty enclosures in Poland, 2000/2001

Treatment	Product name	Active substance
Smoke	Actellic 20 FU	pirimifos-methyl
	Coopex 13 FU	permethrin
Spray	Actellic 500 EC	pirimifos-methyl
	Alfasetc 05 SC	alfa-cypermethrin
	Ambusz 25 EC	permethrin
	Coopex 25 WP	permethrin
	K-Othrine 2,5 WP	deltamethrin
	K-Othrine 25 SC	deltamethrin
	Nuvan 7 070 OL	dichlorfos
	Permasect 10 WP	permethrin
	Permasect 250 EC	permethrin
	Pro-Store 420 EC	malathion + bifenthrin
Fog	Actellic 500 EC	pirimifos-methyl
	Ambusz 25 EC	permethrin
	Nuvan 7 070 OL	dichlorfos
	Permasect 250 EC	permethrin
Dust	-	-

The number of available contact insecticides was recently limited by the Directive 91/414/EEC and the others will be restricted in the EU by a new Thematic Strategy on Pesticides.

**Tab. 3** Insecticides for stored product pest control in empty enclosures in Poland, 2000/2001

Treatment	Product name	Active substance
Smoke	Actellic 20 FU	pirimifos-methyl
Spray	Actellic 500 EC	pirimifos-methyl
	Alfasect 05 SC	alfa-cypermethrin
	K-Othrine 2,5 WP	deltamethrin
	K-Othrine 25 SC	deltamethrin
	Pro-Store 420 EC	malathion + bifenthrin
Fog	Actellic 500 EC	pirimifos-methyl
Dust	-	-

The following measures are currently used in Poland:

- a few contact insecticides (Table 4),
- phosphine,
- heat treatment,
- high pressure and CO<sub>2</sub>,
- Integrated Pest Management (IPM).

The contact insecticides are applied directly to grain during handling on grain conveyors and elevators, or applied onto the surface of bag stacks, walls and floors of empty structures and transport vehicles.

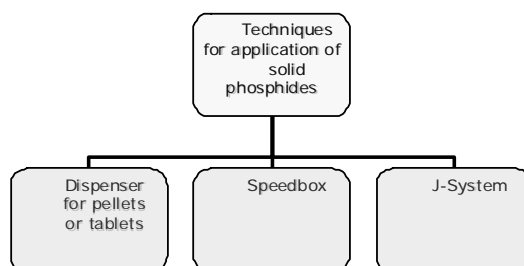
**Tab. 4** Contact insecticides for stored product pest control in Poland, 2009

Treatment	Product name	Active substance
empty enclosures		
Smoke	Actellic 20 FU	pirimifos-methyl
Spray	Actellic 500 EC	pirimifos-methyl
	K-Othrine 2,5 WP	deltamethrin
Fog	-	-
Dust	K-Obiol 02 DP	deltamethrin
Stored grain and seeds		
Smoke	-	-
Spray	Actellic 500 EC	pirimifos-methyl
Fog	-	-
Dust	K-Obiol 02 DP	deltamethrin

Phosphine is available in solid preparations of Al or Mg phosphide. Insect resistance is a serious concern. Improved application techniques are necessary (Fig 1).

Phosphine generating products are:

- Delicia-Gastoxin 56 GE
- Magnaphos Pellets 66 GE
- Magnaphos Tablets 66 GE
- Magtoxin 66 GE
- Quickphos Bags 56 GE
- Quickphos Belts 56 GE
- Quickphos Blankets 56 GE
- Quickphos Pellets 56 GE
- Quickphos Tablets 56 GE

**Fig. 1** Techniques for application of solid phosphides.

Application of tablet and pellets (Fig. 2) is more economic and safer.



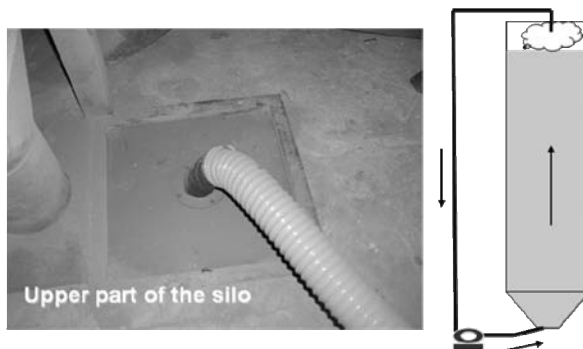
**Fig. 2** Dispenser for pellets or tablets

Speed boxes (Fig. 3) seem to be popular in Poland as handling and maintenance of them is simple, and the gas concentration required for killing the pests is reached in shorter time. Plates with magnesium phosphide are used in Speed boxes.



**Fig. 3** Speed box for plates with magnesium phosphide

The Phosphine recirculation system (J-System) (Fig. 4) has been installed in a silo of the Grain Company in Zamość, and it is already used in fumigation treatments of stored grain.



**Fig. 4** Phosphine recirculation system (J-System)

Phosphine resistance test kits (Fig. 5) are applied testing the behaviour and the activity of insect pests in a defined atmosphere containing phosphine (3,000 ppm). If tested flour beetles are still alive after 8 minutes at a concentration of 3.000 ppm, then they are considered resistant. Urgent elimination of this insect strain is required.



**Fig. 5** Phosphine resistance test kit.

Heat treatment:

- The need for rapid large scale treatment still exists.
- Thermal remediation
- Full scale
- Spot treatment
- Silo treatments

Spot treatments are zone oriented, they are as small as possible because size is money (Fig. 6).



**Fig. 6** Spot heat treatment

Heat treatments are accompanied by pest monitoring to answer the questions „Where are the insects?“ and „How often is heat required?“.

High pressure + CO<sub>2</sub>: The high pressure chambers (Fig. 7) that hold 20 bars of pressure and 100% CO<sub>2</sub> are now being used in Białystok and Lublin for medicinal herb treatments.



**Fig. 7** high pressure chambers

**Integrated Pest Management (IPM):** Integrated Pest Management is a process that combines as many control measures as possible to reduce the pest population in the way which is efficient, economical and safe to the environment and humans. IPM is implemented into the food industry as a requirement of systems HACCP, AIB, and IFS/BRC.



**Fig. 8** Funnel trap for stored-product moths in a mill

Relevant key-words for Integrated Pest Management are:

- Monitoring of pest(s) (Fig. 8);
- Identification of pest(s);
- Threshold level and pest control decision (comparison of the infestation level to the threshold level);
- Pest control – use the combination of different methods;
- Follow-up evaluation and corrective actions.
- IPM uses the combination of two or more methods: sanitary, mechanical, biological, physical or chemical.
- Pest-proof buildings
- Proper storage techniques
- Sanitation
- Hygiene measures
- Action levels

Last but not least, the cooperation between the plant co-ordinator, the plant employees and the pest control company is necessary for the successful implementation of IPM.