



WORLD HEALTH ORGANIZATION

ORGANISATION MONDIALE DE LA SANTE

FOOD AND AGRICULTURE

ORGANIZATION

ORGANISATION POUR L'ALIMENTATION
ET L'AGRICULTURE

VBC/DS/80.46

ORIGINAL: ENGLISH

DATA SHEETS ON PESTICIDES No. 46

PHOSPHINE

It must be noted that the issue of a Data Sheet for a particular pesticide does not imply endorsement of the pesticide by WHO or FAO for any particular use, or exclude its use for other purposes not stated. While the information provided is believed to be accurate according to data available at the time when the sheet was compiled, neither WHO nor FAO are responsible for any errors or omissions, or any consequences therefrom.

The issue of this document does not constitute formal publication. It should not be reviewed, abstracted or quoted without the agreement of the Food and Agriculture Organization of the United Nations or of the World Health Organization.

Ce document ne constitue pas une publication. Il ne doit faire l'objet d'aucun compte rendu ou résumé ni d'aucune citation sans l'autorisation de l'Organisation des Nations Unies pour l'Alimentation et l'Agriculture ou de l'Organisation Mondiale de la Santé.

CLASSIFICATION:

Primary use: Insecticidal fumigant

Secondary use: Rodenticide

Chemical group: Phosphide

Date issued:

1. GENERAL INFORMATION

1.1 COMMON NAME:

Phosphide

1.1.1 Identity:

Hydrogen phosphide, PH₃

1.1.2 Synonyms:

Phosphorus trihydride
Phosphoretted hydrogen

Local synonyms: Phosphine for use in pest control is usually generated from phosphide salts. One synonym for this is Phostoxin^(R).

1.2 SYNOPSIS:

A gas of very high mammalian toxicity which affects the gastrointestinal tract and central nervous system, without cumulative effect. It is used for the fumigation of insect pests of stored grains and is released by exposure of phosphide tablets to moist atmosphere.

1.3 SELECTED PROPERTIES

1.3.1 Physical characteristics

A colourless, inflammable gas with carbide or fish-like odour, B.p. 87.4°C, f.p. 132.5°C.

1.3.2 Solubility

Slightly soluble in water: 228 ml gaseous phosphine/l at 17°C.

1.3.3 Stability

Spontaneously flammable in air with a lower explosion limit of 26.15 to 27.06 g/m².

1.3.4 Vapour pressure

Not applicable. Phosphine odour (decaying fish) is detectable at 1.5-3 ml/m³ of air.

1.4 AGRICULTURE, HORTICULTURE AND FORESTRY:

No specific use except for the fumigation of stored products to which the paragraphs below apply.

1.4.1 Common formulations

As aluminium phosphide or other salts in tablets, pellets, and

powder in bags. These are usually used in phosphine generators in which the salts are exposed to moisture.

1.4.2 Susceptible pests

All insects and their developmental stages: mites and rodents.

1.4.3 Use pattern

For fumigation of stored food products in gas tight areas: sacked goods 0.75-1.5 g/m³ of piles, grain in silos 1-3 g/tonne.

1.4.4 Unintended effects

No information.

1.5 PUBLIC HEALTH PROGRAMMES

No recommended use.

1.6 HOUSEHOLD USE

No recommended use.

2. TOXICOLOGY AND RISKS

2.1 TOXICOLOGY - MAMMALS

2.1.1 Absorption route

Absorbed by inhalation of gas and from the gastrointestinal tract after ingestion of a salt (as aluminium calcium or zinc phosphide). It is not absorbed percutaneously.

2.1.2 Mode of action

Not clear: possibly phosphorylation of enzymes.

2.1.3 Excretion products

See also data sheet No. 24, zinc phosphide. Phosphine is easily oxidized; it is excreted in urine either as a hypophosphite or as dissolved phosphine. Other metabolites include phosphoric acid and phosphate; it can also be exhaled from the lungs.

2.1.4 Toxicity, single dose

Oral: Not applicable in gaseous form: as zinc phosphide, rat: 41 mg/kg.

Inhalation of phosphine gas.

Rat: LC₅₀ 0.68 g/m³ - 65-75 minutes exposure.
1.47 g/m³ 35-50 minutes exposure.

Cat: LC₅₀ 25 ppm - 2-4 hours daily during three days.

2.1.5 Toxicity; repeated doses:

Inhalation: Cats, guinea pigs and rats were exposed to 1.4 or 3.5 mg phosphine/m³ for more than 800 hours. No haemolysis or formation of methemoglobin was observed in the erythrocytes or haemoglobin. There was no evidence of cumulative poisoning. It has been suggested that, at these levels, an equilibrium is attained between the intake of phosphine and the detoxification and excretion and cell repair. The threshold for behavioural changes and alterations in blood parameters and liver function was 7 mg/m³ in air.

Cumulation of compound: Phosphine is not cumulative in body tissues.

Cumulation of effect: See 2.1.5.

2.1.6 Dietary studies

Short-term: Rats fed with grain which had been fumigated at excessive dosages, showed no ill effects, even when the grain was not cleaned before consumption.

Long-term: Rats were fed for two years a diet exposed to high concentrations of phosphine released from aluminium phosphide pellets. Behaviour, general appearance, survival, body weight, food consumption, haematology, blood chemistry, urine analyses and bone marrow data, as well as gross and microscopic findings and rate of tumour development did not reveal any toxic effects.

Supplementary studies of toxicity

Carcinogenicity: see 2.1.6.

Teratogenicity: No information.

2.1.8 Modification of toxicity.

No information.

2.2 TOXICOLOGY - MAN

2.2.1 Absorption

Inhalation of phosphine gas or ingestion of phosphide formulations are main routes of absorption.

2.2.2 Dangerous doses

Single: 9.8 mg phosphine/m³ air gives rise to grave symptoms after several hours. 14 1 280 mg/m³ are tolerated for 60 minutes. 560 mg/m³ is lethal in 60 minutes - 2.8 g phosphine/m³ is lethal in a short time.

Repeated: A review of 59 poisonings suggests that the minimum lethal concentration in air is 7-14 mg/m³ inhaled for two or four hours for several days.

2.2.3 Observations of occupationally exposed workers

Although phosphine is highly toxic, cases of poisoning are rare and generally due to careless handling.

2.2.4 Observations on exposure of the general population

With good practice in stored food fumigation the general population will not be exposed to phosphine.

2.2.5 Observations of volunteers

None.

2.2.6 Reported-mishaps

One fatal and three non-fatal accidental cases of phosphine poisoning are reported due to an unprofessionally performed fumigation of stored grain on a tug boat using aluminium phosphide tablets. Six hundred and seventy-five tablets (675 g of PH_3) were used for the fumigation of 500 t of oats.

Two families with four children who were moved before the fumigation returned to the area 72 hours afterwards. The onset of the poisoning signs occurred 24 hours afterwards and the next day one child aged six, died while being transported to the hospital.

2.3 TOXICITY TO NON-MAMMALIAN SPECIES

2.3.1 Fish

No data available but solubility in water slight.

2.3.2 Birds

No data available.

2.3.3 Other species

Frog LC_{50} : 0.56 mg/l for 30 minutes
0.84 mg/l for 15 minutes.

3. FOR REGULATORY AUTHORITIES - RECOMMENDATIONS ON REGULATION OF COMPOUND

Phosphine is not used as such, but is generated by action of moist air on aluminium phosphide and other salts.

3.1 RECOMMENDED RESTRICTIONS ON AVAILABILITY

(For definition of categories, [see introduction](#)).

All formulations, Category 2

3.2 TRANSPORTATION AND STORAGE

All formulations - Should be transported and stored in clearly labelled, hermetically sealed containers; away from sunlight,

oxidizing agents, acids; away from living quarters, under lock and key, and secure from access by unauthorized persons and children. They must not be stored in damp condition or allowed to become damp. No food or drink should be stored in the same compartment.

3.3 HANDLING

All formulations - Full respirator protection should be used by all those handling this compound. Adequate washing facilities should be available at all times during handling and should be close to the site of handling. Eating, drinking and smoking should be prohibited during handling and before washing after handling. Keep well away from naked lights.

3.4 DISPOSAL AND/OR DECONTAMINATION OF CONTAINER

Containers must be either burned or crushed and buried below topsoil. Decontamination of containers in order to use them for other purposes should not be permitted.

3.5 SELECTION, TRAINING AND MEDICAL SUPERVISION OF WORKERS

All formulations - Pre-employment and routine medical examination of workers desirable. Workers suffering from active hepatic renal or haematological disease should be excluded from contact. Special account should be taken of workers' mental ability to comprehend and follow instructions. Training of workers in respiratory protection is essential.

3.6 ADDITIONAL REGULATIONS RECOMMENDED IF DISTRIBUTED BY AIRCRAFT

All formulations - Not applicable.

3.7 LABELLING

All formulations - Minimum cautionary statement - "POISON" (skull and cross-bones insignia). Aluminium phosphide is a very toxic substance. Do not inhale dust or fumes. Keep this material out of reach of children and domestic animals and well away from foodstuffs, animals feed and their containers. Keep dry; away from sunlight and acids of all kinds. Open only in open air and keep away from naked lights. No smoking allowed in vicinity.

3.8 RESIDUES IN FOOD

Preparations of aluminium phosphide which evolve hydrogen phosphide by reaction with moisture in the surrounding atmosphere are used for the post-harvest fumigation of a wide range of produce including processed foods. The powder remaining after the use of the fumigant preparation is mainly aluminium hydroxide, but may contain a small amount (up to 5%) of the original content of aluminium phosphide. The normal cleaning of cereals before milling is effective in eliminating almost all of this powder. For other foods which cannot be so cleaned before processing, good practice requires that the fumigant preparation residues does not come into contact with the food.

3.8.1 Maximum residue levels

Maximum residue levels have been recommended by the joint FAO/WHO. Meeting on Pesticide Residues.

4. PREVENTION OF POISONING IN MAN AND EMERGENCY AID

4.1 PRECAUTIONS IN USE

4.1.1 General

Aluminium phosphide decomposes on exposure to humidity to liberate phosphine gas which is highly hazardous. It is readily absorbed from the gastrointestinal tract and dust may be absorbed by inhalation. It is not readily absorbed through the intact skin.

4.1.2 Manufacture and formulation

T.L.V.: 0.3 mg/m³ (USSR) 0.1 mg/m³ (ACGIH). Closed systems and forced ventilation are required to reduce as much as possible the exposure of workers to the chemical.

4.1.3 Applicators

Particularly when opening the container, boots, clean overalls, gloves and respirator must be worn. All protective clothing should be washed immediately after use and respirator filters must be regularly renewed. Before eating, drinking or smoking, hands and other exposed skin should be washed.

4.1.4 Other associated workers including flagmen in aerial operations)

Not applicable.

4.1.5 Other populations likely to be affected

With good practice, the general population will not be exposed to phosphine after the use of the fumigant preparation.

4.2 ENTRY OF PERSONS INTO TREATED AREAS

After adequate ventilation after use, treated areas should be checked for residual gas concentrations before any unprotected persons enter these areas.

4.3 DECONTAMINATION OF SPILLAGE AND CONTAINERS

Residues in containers should be buried in a deep well away from any habitation and taking care to avoid contamination of ground waters. Decontamination of containers in order to use them for other purposes should not be permitted. Spillage should be removed as much as possible into a deep dry pit as above and the remainder washed away with large quantities of water. It should be borne in mind that

during these operations and in the presence of water, phosphine gas will be liberated and therefore a respirator must be worn, and the

whole area of spillage thoroughly aerated until checked for zero gas concentration.

4.4 EMERGENCY AID

4.4.1 Early symptoms of poisoning

Earliest symptoms are usually nausea, abdominal pain, vomiting and diarrhoea, dyspnoea, chilliness, thirst, headache which may be followed by convulsions or coma.

4.4.2 Treatment before person is seen by a physician if these symptoms appear following exposure

The person should stop work and move away from the area of treatment into fresh air. If swallowed, vomiting should be induced if the person is conscious. The person should be kept at complete rest until the physician arrives.

5. FOR MEDICAL AND LABORATORY PERSONNEL

5.1 MEDICAL DIAGNOSIS AND TREATMENT IN CASES OF POISONING

5.1.1 General information

Upon exposure to moisture, aluminium phosphide liberates phosphine, a gas of very high toxicity which affects the gastrointestinal tract and central nervous system. It is readily absorbed by inhalation and from the gastrointestinal tract, but not through the skin.

5.1.2 Symptoms and signs

Earliest symptoms are usually restlessness and fatigue, disturbances of speech, vision and gait, nausea, abdominal pain, vomiting and diarrhoea, headache, thirst, chilliness. Respiratory symptoms include dyspnoea, tightness of the chest and pulmonary oedema. These may be followed by convulsions and coma. Death may occur from heart failure within four days or be delayed one to two weeks. Chronic inhalation of subtoxic doses has been said to lead to toothache, swollen jaw and mandibular necrosis. Other symptoms are anorexia and weight loss, anaemia and a tendency to spontaneous bone fracture. The patient's breath may smell of phosphine (fish-like odour) and there may be coughing with green, fluorescent sputum.

5.1.3 Laboratory

No specific test is known to confirm exposure.

5.1.4 Treatment

Treatment is mainly symptomatic. If ingested, vomiting should be induced immediately followed by gastric lavage with two to four litres of water. Acute pulmonary oedema should be treated by oxygen inhalation and prophylactic penicillin. The patient should be kept at rest.

5.1.5 Prognosis

If the patient survives for four days the prognosis is good. However, recovery is slow and there may be irreversible lesions of the kidneys and liver.

5.1.6 References of previously reported cases

Cases of poisoning are documented in: Harper, R. N. & Spolyar, L. W. (1958) Archs. Industr. Hlth, 18, 497. Sovljanski, R. et al. (1969) Arhiv. Big. Rada Toksi. 20 (2), 209. Van Oettingen, E. W. The toxicity and potential dangers of zinc phosphide and of hydrogen phosphide, Public Health Report, 203.1, 1947.

5.2 SURVEILLANCE TESTS

There are no readily available surveillance procedures to determine the degree of absorption prior to the appearance of symptoms.

5.3 LABORATORY METHODS

References only are given.

5.3.1 Detection and assay of compound

For the estimation of phosphine in air, aspirate through mercurous chloride solution and note the change of pH: Taylor (1968). Very low concentrations of phosphine in air can also be detected by gas chromatography: see Dumas (1969) and Berck (1970).

5.3.2 Other tests in cases of poisoning

Estimation of methaemoglobin.

= = =

See Also:

[Toxicological Abbreviations](#)
[Phosphine \(HSG 28, 1989\)](#)
[Phosphine \(ICSC\)](#)
[Phosphine \(PIM 865\)](#)