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1. GENERAL INFORMATION

1.1 COMMON NAME – DDT (ISO)

Identity: 2,2–bis–(p–chlorophenyl)–1,1,1–trichloroethane

![Chemical Structure of DDT]

Synonyms
Chlorophenothane Dicophane Dichlorodiphenyltrichloroethane OMS–16

1.2 SYNOPSIS:

A persistent organochlorine pesticide of moderate mammalian toxicity. No ill effects have been observed in personnel exposed for many years both in its manufacture and field use. It accumulates in body fat to a plateau level related to absorption. It is cumulative in the natural environment.

1.3 SELECTED PROPERTIES

Physical characteristics:

Technical DDT is of variable composition and may consist of 11 or more compounds of which the pp’–isomer of DDT contributes 63–77%, the op’–isomer 8–21% and the oo’–isomer 0.1–1.0%. Pure pp’–DDT is a white crystalline solid of melting point 108.5–109°C. The technical material, however, takes the form of a white or cream coloured waxy solid or amorphous powder of indefinite mp.

Solubility

Practically insoluble in water. Moderately soluble in hydroxylic and polar solvents and in petroleum oils. Readily soluble in most aromatic and chlorinated solvents.
Stability

Dechlorinated at temperatures above its melting point into a non–insecticidal ethylene derivative, a reaction catalysed by ferric and aluminium chloride and by UV light. In solution it is readily dehydrochlorinated by alkalies or organic bases, otherwise it is stable being unattached by acid and alkaline permanganate and by aqueous acids and alkalis. With technical DDT dehydrochlorination may proceed at temperatures as low as 50°C.

Vapour pressure (volatility)

pp′–isomer $1.9 \times 10^{-7}$ mm Hg at $20^\circ$ C

1.4 AGRICULTURE, HORTICULTURE AND FORESTRY

Common formulations

Wettable powders, dusts, aerosols, emulsifiable concentrates. Concentrations of solid and liquid formulations are mostly between 20% and 25%.

Susceptible pests

In agriculture and horticulture for control, where permitted, of susceptible pests (e.g. cutworms, leafhoppers, leatherjackets, midgets, millepedes, mushroom flies, thrips, sandflies, wasps, weevils, whiteflies, woodlice).

Use pattern

Cotton, 2 quarts of 25% emulsifiable concentrate (e.c.) in sufficient water to give good cover per acre; brassicae 56 lbs 5% dust per acre, cornborer in maize, 3 quarts 25% etc. in 10 gallons applied at 15 gallons per acre.

Unintended effects

It should not be used on curcubits and certain barley varieties as damage may occur. It should also not be used on permanent and temporary grass for grazing, silage or hay, brassicae seed crops, peas, beans and bush fruit.

1.5 PUBLIC HEALTH PROGRAMME

Still widely used in public health programmes where the vector is not resistant. The predominant use is for residual indoor application against anopheline mosquitos in malaria control programmes using 5% w.d.p. applied at 1–2 g/m$^2$.

In tsetse fly control, 25% etc. has been applied as a residual insecticide on vegetation. Until recently, DOT was used extensively for blackfly (Simulium) control being introduced into streams at 0.1–1 mg/l using 20–25% etc. As a general mosquito larvicide 1.25–5% e.c. is used.
1.6 HOUSEHOLD USE

Active against most household pests, including ants, cockroaches, house−flies, mosquitos, bedbugs and fleas, etc. Some strains of insect species have developed resistance. Bedbugs 5% spray, also for fleas, ticks, wasps 5% to 10% dust.
2. TOXICOLOGY AND RISKS

2.1 TOXICOLOGY – MAMMALS

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Absorption route:
Absorbed from the gastrointestinal tract and by inhalation. It may also be absorbed by the intact skin when in oily solution.

Mode of action:
Central nervous system stimulant producing hyperactivity and tremor; convulsions may occur but are less common than with other organochlorine pesticides.

Excretion products:
Intact DDT is found in fatty tissues along with its metabolites DDD and DDE. DDD may be further metabolized to DDA and excreted in urine.

Toxicity, single dose:
- Oral: LD50 Rats (M and F) 250 mg/kg
- Dermal: LD50 Rat
  - Sex not stated.
  
  250–500 mg/kg in oil 3000 mg/kg as powder Rat (F) 2510 mg/kg as powder
- Dermal: LD50 Rabbit\(^{1}\) 300 mg/kg in oil 2820 mg/kg as powder
- Most susceptible species: rat

Toxicity, repeated dose
DDT administered as a 10% solution in kerosene at 100 mg/kg/day orally to five rabbits proved fatal in six days. Similarly 200 mg/kg was fatal to five guineapigs and five rats in 12 and 14 days respectively when dosed under the same conditions.

- Dermal: Rats treated with 200 mg/kg/day in kerosene were severely affected, with some fatalities after 14 days.
- Inhalation: Exposure of rats to a concentration of 1000 ppm DDT in air for two hours a day caused some deaths after 4–10 exposures.
- Cumulation of compound: DDT and its metabolites accumulate in body fats and other tissues, either as pp’−DDT, DDD or DDE. Under normal circumstances a plateau level is reached where intake and
storage are in equilibrium with excretion, therefore the amount stored in fat will remain constant as long as exposure remains constant. Central nervous stimulation is related to brain level of DDT; this may be reached by a single acute dose or by smaller repeated doses.

**Dietary studies**

- Short−term 2000 ppm in rats gave a 50%; kill in nine days. 600 pip was tolerated for 14 weeks but was 100% fatal after 52 weeks.
- Long−term: 250 ppm produced no toxic effects over one year in rats. However, dietary feeding as low as 5–10 ppm has been reported to produce slight hepatic cell enlargement especially centrolobularly and increased cytoplasmic oxyphilia. At higher doses, 500 and 1000, ppm focal necrosis, atrophy and hydropic degeneration were observed.

**Supplementary studies of toxicity**

- Carcinogenicity:

DDT has been shown to be carcinogenic in a two−generation life span study. (CF 1 mice) at 7, TO, 50 and 250 ppm, all levels increased tumour incidence in females and two highest levels in males. While early work of DDT suggested that it might be tumorigenic in rats, no convincing evidence of carcinogenicity to this species has been provided. The significance of the finding in mice for man cannot yet be assessed. No increased incidence of tumours has been observed in formulators and spraymen exposed to excessive quantities of DDT for 20 or more years (see ).

- Teratogenicity:

DDT has been shown not to be teratogenic in rats in a three−generation study at dose levels of 20 and 200 ppm DDT. The number of pregnancies and fertility were unaffected at these dose levels. Survival of offspring during weaning at 200 ppm was reduced.

- Mutagenicity:

DDI caused moderate mitotic inhibition at 20–50 \(\mu\)g/ml in an in vitro test using a kangaroo rat cell line culture. At 10 yg/ml pp’−DDT, chromosome aberrations and damage were observed in 22.4% of cells. Test in mice to determine whether DDT produces dominant lethal mutations proved negative.

**Modification of toxicity**

The chronic toxicity of DDT has been shown to increase in association with lowering of the protein content of the fat.

### 2.2 TOXICOLOGY – MAN

**Absorption: (see )**

Only massive ingestion (accidental or suicidal) has given rise to cases of poisoning.
Dangerous doses

- Single: 10 mg/kg produces illness in some but not all subjects. 16 mg/kg or above will cause convulsions. Dosages as high as 285 mg/kg have been taken without fatal results. Estimated lethal dose for man 500 mg/kg and in kerosene solution 150 mg/kg.
- Repeated: Exposure to an aerosol mist containing 80 mg DDT in a room of 113 m\(^3\) or five consecutive days for two hours twice a day gave no evidence of toxic effects.

Observations of occupationally exposed workers

Over 150 persons with heavy and prolonged occupational exposure to DDT in manufacturing plants have been subjected to exhaustive medical examinations. The only relevant findings were increased storage and excretion of DDT and its metabolites and a mild stimulation of microsomal enzymes of the liver.

Extensive observations of spraymen heavily exposed both with and without protective clothing have revealed no evidence of ill effects with regard to the clinical examination, blood picture and urine tests.

Spraymen recruited from areas where the normal diet is of a poor nutritional standard have shown no predisposition to poisoning with DDT.

Observations on exposure of the general population

Food is the main source of exposure and due to its low biodegradability and high lipophilic properties, traces of DDT (and its analogues) are found in adipose tissue. The mean levels vary from country to country (in recent years, 2.3–21.3 ppm, expressed as total DDT), while age, sex, race and social class have been described as important demographic variables influencing the frequency distribution of DDT residue in the general population. Accumulation in other tissues is markedly smaller, and is proportional to their neutral fat content.

A high degree of safety of DDT for the general population is indicated by the studies on people occupationally exposed (2.2.3) and volunteers (2.2.5).

Observations in volunteers

Exposure to 1 mg DDT/3 m\(^3\) for 1 h/day for six days produced no untoward effects. Oral dosage with 500 mg in olive oil gave no toxic effect and 11 mg/kg (770 mg total) pure DDT in 25 cc olive oil gave no subjective signs, tremor, twitching or EEG abnormalities. Twenty-four volunteers ingested technical or p,p′−DDT at rates up to 35 mg per man per day for 21.5 months. They were then observed for an additional 25.5 months and 16 were followed up for five years. Storage of DDT and DDE and excretion of DDA were proportional to dosage. The fat of those receiving technical insecticide at the highest rate contained 105 to 619 ppm of DDT when feeding stopped. The average dosage of p,p′−DDT administered in this study was 555 times the average intake of all DDT−related compounds by 19−year−old men in the general population and 1250 times their intake of p,p′−DDT. Since no definite clinical or laboratory evidence of injury by DDT was found in this study, these factors indicate a high degree of safety of DDT for the general population.

Reported mishaps

In spite of the prolonged exposure of the entire population of the world and the heavy occupational exposure of a substantial number, the only reported poisoning cases were due to intentional or accidental ingestion. In
most of these cases only moderate nervous symptoms were observed and convulsions were rare.

2.3 TOXICITY TO NON–MAMMALIAN SPECIES

Fish: Harmful

Birds: Moderately toxic

Other species: Harmful to bees.
3. FOR REGULATORY AUTHORITIES

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RECOMMENDATIONS ON REGULATION OF COMPOUND

3.1 RECOMMENDED RESTRICTIONS ON AVAILABILITY

(for definition of categories, see introduction)

Formulations of 10% and above and all liquid formulations over 2% – category 4. Formulations below 10% – category 5.

3.2 TRANSPORTATION AND STORAGE

- Formulations in category 4

Should be transported or stored in clearly labelled rigid leak-proof containers and away from containers of food and drink. Storage should be under lock and key and secure from access by unauthorized persons and children.

- Formulations in category 5

Should be transported or stored in clearly labelled leak-proof containers, out of reach of children and away from food and drink.

3.3 HANDLING

- Formulations in category 4

Protective clothing should be used by those handling concentrates. Adequate washing facilities should be available close at hand. Eating, drinking and smoking should be prohibited during handling and before washing, after handling.

- Formulations in category 5

No special facilities other than those needed for handling of any chemicals need be required.

3.4 DISPOSAL AND/OR DECONTAMINATION OF CONTAINER

Containers containing residues must either be burned or crushed and buried below topsoil. Care must be
taken to avoid subsequent contamination of water sources. Decontamination of containers in order to use them for other purposes should not be permitted.

3.5 SELECTION: TRAINING AND MEDICAL SUPERVISION OF WORKERS

- Formulations in category 4

Pre-employment medical examination desirable. Workers suffering from active hepatic or renal disease should be excluded from contact. Monitoring of DDT levels in fat, gives little or no indication of degree of acute exposure.

- Formulations in category 5

Warning of workers to minimize contact essential.

3.6 ADDITIONAL REGULATIONS RECOMMENDED IF DISTRIBUTED BY AIRCRAFT

Pilot and loaders should have special training in application methods.

3.7 LABELLING

- Formulations in category 4

*Minimum cautionary statement*

This formulation contains DDT, a toxic substance which is poisonous if swallowed. Keep the material out of the reach of children and well away from foodstuffs, animal feed and their containers.

- Formulations in category 5

*Minimum cautionary statement*

DDT is an organochlorine insecticide. Keep the material out of the reach of children and well away from foodstuffs, animal feed and their containers.

3.8 RESIDUES IN FOOD

Maximum residue limits for DDT have been recommended by the Joint FAD/WHO Meeting on Pesticide Residues.
4. Prevention of poisoning in man and emergency aid

- Common name: DDT
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4.1 PRECAUTIONS IN USE

General

DDT is a moderately toxic organochloride insecticide which is slowly metabolised and stored in body tissues and can act as both an acute and chronic poison. It can be absorbed by mouth, by inhalation of dust and also through the intact skin when in an oil-based formulation. It is important that concentrated formulations be washed immediately from the skin and eyes.

Manufacture and formulation

(ACGIH) 1 mg/m^3 (USSR) 0.1 mg/m^3. Although volatility is low, vapour and dust should be controlled preferably by mechanical means. Protective equipment for the skin and respiratory protection is advisable.

Mixers and applicators

When opening the container and when mixing care should be taken to avoid contact with the mouth and eyes. If necessary a facial visor and gloves should be worn. Mixing, if not mechanical, should always be carried out with a paddle of appropriate length. Before eating, drinking, or smoking, hands and other exposed skin should be washed.

Other associated workers (including flagmen in aerial operations)

Persons exposed to DDT and associated with its application should observe the precautions described abode in 4.1.3 under "mixers and applicators".

Other populations likely to be affected

With good agricultural practice subject to 4.2 below other populations should not be exposed to hazardous amounts of DDT.

4.2 ENTRY OF PERSONS INTO TREATED AREAS

The general population should be kept out of treated areas for at least one day.
4.3 DECONTAMINATION OF SPILLAGE

Spillage of DDT and its formulations should be removed by washing with large quantities of water.

4.4 EMERGENCY AID

Early symptoms of poisoning

Early symptoms may include paresthesia (tingling) of the tongue, lip and parts of the face, in severe cases extending to the extremities. The patient may have a sense of apprehension and disturbance of equilibrium, dizziness, confusion and a characteristic tremor. In severe poisoning, convulsions occur.

More general symptoms include headache, nausea and fatigue. Sensitivity to touch and pain are exaggerated in areas in which paresthesia is evident.

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

Remove contaminated clothing and wash the affected skin with water and soap and flush the area with large quantities of water. If swallowed, vomiting should be induced if the person is conscious. Patient should be calmed and kept in quiet, shaded conditions until medical help arrives.
5. FOR MEDICAL AND LABORATORY PERSONELL

- Common name: DDT
- Data sheet: No. 21
- Date issued: December 1976

5.1 MEDICAL DIAGNOSIS AND TREATMENT IN CASES OF POISONING

General information

DDT is an organochlorine insecticide of moderate toxicity. It is absorbed from the gastrointestinal tract and by inhalation. It may also be absorbed through the intact skin, more especially in the case of oil–based formulations. Cases of poisoning reported only after massive ingestion. Its mode of action is by stimulation of the CNS. It is slowly metabolized and eliminated from the tissues and may be stored in body fat.

Symptoms and signs

Symptoms of poisoning may include headache, nausea and vomiting, weakness, dizziness and confusion, disturbances of equilibrium, paresthesia and a characteristic tremor. In more severe poisoning convulsions occur.

Laboratory

Measurement of blood or fat levels of DDT and urine levels of DDA will confirm absorption of DDT but will not necessarily reflect degree of poisoning. High levels of DDT and its metabolites will be found in body fats, these levels may continue to increase after acute dosage, when symptoms of poisoning have abated. Treatment should never be deferred pending the results of a laboratory test.

Treatment

If the pesticide has been ingested, rapid gastric ravage should be performed using 5% sodium bicarbonate, if available. For skin contact, the skin should be washed with soap and water. If the compound has entered the eyes they should be washed with isotonic saline. There is no specific antidote and treatment must be symptomatic. Soluble barbiturate, diazepam or paraldehyde should be used to calm patient and control convulsions.

Prognosis

If the acute toxic effect is survived the chances of complete recovery are good with great improvement within 24–48 hours after ingestion.
References of previously reported cases

Case histories and general methods for treatment are given in:

1. Cunningham & Hill (1952) Pediatrics, 9, 745

5.2 SURVEILLANCE TESTS

There are no readily available techniques to determine the degree of exposure prior to the appearance of symptoms.

5.3 LABORATORY METHODS

Detection and assay of compound

The analysis of blood, urine and faeces is of extreme importance when studying transport and elimination of p,p′–DDT and p,p′–DDT–derived metabolites. The examination of urine is of particular interest because p,p′–DDA, a predominant metabolite of p,p′–DDT, is excreted by this route. Excretion levels of this metabolite have been established as sensitive indicators of exposure to p,p′–DDT. A rapid sensitive gas chromatographic procedure for the analysis of this metabolite was developed as a dual analytical procedure to determine DOT and its polar and non–polar metabolizes in human urine. Utilizing electrolytic conductivity, or micro–colorometric detection, the procedure can be readily adapted for the exclusive determination of p,p′–DDA excretion levels.

Other tests in cases of poisoning

Liver function.

REFERENCES

