CH₃ structure

Thioldiazinon

Thioldiazinon

Using 2-isopropyl-4-methyl-6-mercaptopyrimidine for the condensation with O,O-diethyl chlorophosphate, Thioldiazinon should result. A wide variety of reaction conditions was chosen, without getting even small amounts of a pure Thioldiazinon. Under mildest condensation conditions at temperatures as low as 30° C. the reaction between 2-isopropyl - 4 - methyl - 6 - mercaptopyrimidine and O,O-diethyl chlorophosphate did not take place in the expected way, and under more drastic conditions nothing but the intermediates could be isolated in a pure state. So it seems very unlikely that Thioldiazinon can be formed during the synthesis of technical Diazinon effected at temperatures of 80° C. or more. The stability of Thioldiazinon or the tendency for its formation is evidently poor even at considerably lower temperatures. Similar attempts to make Isodiazinon, using 2-isopropyl-4-methyl-6-hydroxypyrimidine as a starting material and S-ethyl O-ethyl chlorophosphate, failed completely. This second theoretical possibility of an isomerization can be also excluded. The oxidation product of Diazinon, O-Diazinon, was taken into consideration, as a further potential candidate with a high anticholesterase activity.
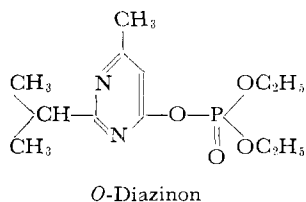
O-Diazinon

Using 2-isopropyl-4-methyl-6-hydroxypyrimidine and O,O-diethyl chlorophos-

phate as starting materials under similar condensation conditions as for Diazinon, the oxygen analog (O-Diazinon) was obtained. The purified and distilled product boils at 123–5° C. at 0.03 mm. of mercury. This O-Diazinon always contains, after distillation, small amounts of 2-isopropyl-4-methyl-6-hydroxypyrimidine and probably small amounts of TEPP which may be formed due to the influence of heat. O-Diazinon is considerably less stable to hydrolysis than Diazinon, at a pH of 7 the rate being about 10 times as high. The anticholinesterase activity proved to be by far higher than the anticholinesterase activity of Diazinon. O-Diazinon could explain the higher cholinesterase inhibition of partly decomposed Diazinon.

Cook (3) demonstrated that spots of pure Diazinon on paper chromatograms exhibited very high cholinesterase inhibition after bromine treatment, the inhibition being about 5000 times greater than that of the untreated, pure Diazinon. Cook assumed that in the case of parathion, the oxygen analog, paraoxon, product of bromine treatment, was responsible for the increased ChE inhibition. Cook's inhibition values found with his paper chromatogram technique are in good agreement with the figures obtained by measuring Diazinon and synthetic O-Diazinon with a method mentioned earlier, similar to the one used by Cook. The amount causing 50% inhibition of cholinesterase is 1 mg. %, it is higher for purified nondistilled Diazinon and about 0.0002 mg. % for O-Diazinon.

A fact excluding O-Diazinon as the substance causing the mentioned spots in paper chromatography with an R_F value of 0.7 to 0.8 is, however, the observation that washing of Diazinon with diluted acid or alkali hydroxide solution did not eliminate the occurrence of the spots.

Further investigations based on paper chromatography of technical, distilled, and purified Diazinon, known and

potential by-products, did not lead to the determination of the compounds or breakdown products responsible for the increased anticholinesterase activity of distilled Diazinon, even occurring when oxygen is carefully excluded.

The fact that none of the above cited decomposition or by-products was able to explain the increased mammalian toxicity as well as the higher cholinesterase inhibition found in technical Diazinon indicated that a special study was needed to clarify the phenomena which can occur when technical Diazinon or its formulations are stored. The results of this special study have been reported (8).

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ACARICIDE FORMULATION

Stabilization of Aramite by Glycols

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STABILIZATION OF TOXIC INGREDIENTS in dusts and wettable powders is a major problem of the pesticide formulator. Technical Aramite is an example of a toxic compound which undergoes decomposition in formulated products. The active ingredient of Aramite (a trade-mark of the U. S. Rubber Co.) is 2-(p-tert-butylphenoxy)-1-methylethyl-2-chloroethyl sulfite, which is used as a

miticide on agricultural crops. The technical material contains propylene oxide as a heat and light stabilizer, which protects the active ingredient in the unformulated state, under ordinary temperature conditions (2).

Technical Aramite, formulated in wettable powders and dusts, decomposes in most commercial diluents when stored in paper bags and cartons at

temperatures normally encountered in warehouses. Experience has shown that when propylene oxide is added to these formulations in excess of that which is present in the technical product, the Aramite is not protected against decomposition. This lack of stabilization is probably due to the volatility of propylene oxide.

Various factors have been studied

The compound, 2-(p-*tert*-butylphenoxy)-1-methylethyl-2-chloroethyl sulfite, is unstable and decomposes when formulated as a commercial pesticide, in certain fillers. It contains 0.5% propylene oxide as a stabilizer. This inhibitor was found to be ineffective in wettable powder or dust formulations in laboratory and field studies. The rate of decomposition was influenced by temperature, pH, moisture, and catalytic activity of various diluents. The compound was stabilized in wettable powder and dust formulations by the use of simple and polyglycols.

which affect the stability of Aramite in formulated products: moisture content, pH, temperature, and type of diluent. Data are also presented which show the effect of several glycols toward inhibiting decomposition.

Materials

Although a large number of diluents decomposed Aramite, the results reported in this paper are confined to formulations made with Anhydrite filler, Attaclay, and talc. Anhydrite filler is prepared by calcining under controlled temperatures, a mixture composed of 90% calcium sulfate and 10% diatomaceous earth. Attaclay, which is a fuller's earth type of material of high absorptivity, was used to prepare the wettable powder formulations described. Two types of talc, soapstone and Clear Lake talc, included as examples of low absorptive carriers, were used in the preparation of the dust formulations. Technical Aramite containing 0.5% propylene oxide was employed in all formulations. All glycols used were of technical grade.

Methods

The dusts and wettable powders were made by atomizing a mixture of the Aramite and stabilizer onto the filler in a laboratory dust mixer. The resulting mixture was first pulverized in a hammer mill and then reblended. Each formulation was sealed in a glass jar and analyzed before and after various intervals of storage at 25° and 50° C. in a constant temperature oven.

The analytical method used for determining the Aramite content in these formulations was a modification of the standard volumetric chloride and sulfite assays. The extract from the clays was evaporated to dryness to rid the sample of free ethylene chlorohydrin and sulfur dioxide which are formed during the decomposition of Aramite. If these decomposition products are not separated, erroneously high results are obtained. After evaporation, the remaining residue was hydrolyzed in a methanol–potassium hydroxide solution under reflux conditions and analyzed for chloride or sulfite.

Factors Affecting Decomposition

Temperature. At normal temperatures (25° to 30° C.) the rate of Aramite
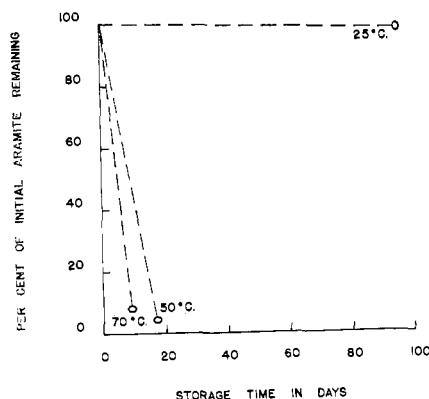

Figure 1. Effect of temperature on decomposition of Aramite formulated in Attaclay

decomposition is slow in fillers of pH less than 9 or greater than 5, while at elevated temperatures the rate is accelerated. The degradation of 15% Aramite in Attaclay is illustrated in Figure 1. Figure 2 shows the decomposition of 3% Aramite in soapstone. In a highly absorptive-type clay such as Attaclay, Aramite decomposes more rapidly than in a low absorptive clay such as soapstone.

pH Value. The pH of decomposed Aramite wettable powders in Attaclay is illustrated in Figure 3. The slope of the line shows that when Aramite decomposes a large amount of acid is formed. The speed of this change depends on the amount of acid present. When the pH is not below 6.5, the rate of Aramite decomposition is slow. At pH values below 5 and over 9, as observed in other tests, decomposition is appreciable at room temperature and very fast at 50° C. Both acids and alkalies catalyze the decomposition.

No sulfur dioxide odor was detected when technical Aramite containing 0.5% propylene oxide was heated at 50° to 70° C. for an extended time in a closed container, or when refluxed for one hour. Passing dry sulfur dioxide through technical Aramite did not decompose it. A strong sulfur dioxide odor was given off when Aramite decomposed in the presence of water and the product had a pH lower than 6.5.

Moisture Content. Almost all commercial diluents used in insecticidal formulations contain moisture which will dissolve the sulfur dioxide liberated from Aramite to form sulfurous acid. The accumulation of this acid reduces the
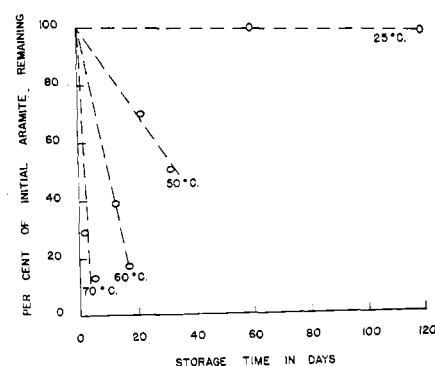

Figure 2. Effect of temperature on decomposition of Aramite formulated in soapstone
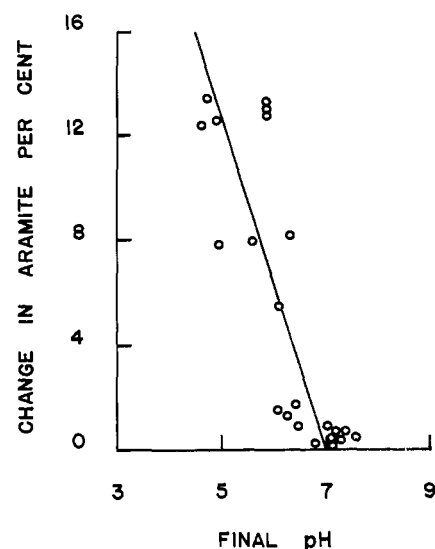

Figure 3. pH values of decomposed Aramite wettable powders containing Attaclay

pH and progressively accelerates the decomposition. The effect of different percentages of water in 15% Aramite wettable powder is shown in Table I. When the percentage of water in the carrier was very small (less than 0.2%), Aramite was stable at 50° C. When the moisture content varied from 0.5 to 10%, the rate of decomposition was high. In this range the half life, calculated on the basis of a zero-order reaction, increased with the addition of more water. Further increases in the range from 15 to 21.2% showed significantly lower rates of degradation.

Under ordinary storage conditions, the amount of water in the formulation may vary depending on the volatilization that takes place, because of differ-

Table I. Effect of Water in 15% Aramite-Wettable Powders

Initial pH	Total Water, %	Days Stored	Aramite Decom- position, %	Half Life, Days
8.95	<0.2	76	9.9	>76
8.21	0.6	19	98.0	4
6.66	2.8	22	79.4	8
7.85	9.2	22	63.2	17
8.21	10.2	56	69.0	20
7.90	12.0	86	77.3	71
8.02	15.0	86	9.6	>86
8.05	21.2	86	6.1	>86

Table II. Effect of Glycols and Other Additives on Aramite Stability in 15% Wettable Powders Containing Attaclay at 50° C. in Sealed Glass Jars

Additive	%	Days Stored	Aramite De- composition, %	Half Life, Days
None		20	95.8	9
None		20	85.5	10
Mineral oil	3.0	9	77.2	8
D-Sorbital	5.0	15	91.4	8
Ethylene glycol mono-N-butyl ether	5.0	18	82.0	11
Ethylene glycol	5.0	45	87.2	26
Diethylene glycol	5.0	45	87.8	26
2,3-Butylene glycol	5.0	45	79.0	28
Propylene oxide	4.0	30	52.3	29
1,3-Butylene glycol	5.0	45	65.2	35
Glycerol	5.0	109	41.2	132
Polyethylene glycol 400	6.0	37	4.6	402
Propylene glycol	5.0	45	3.9	577
Dipropylene glycol	4.0	86	6.0	716

ences in storage temperature and humidity.

Catalytic Activity of Carrier. Another important factor of Aramite decomposition is the type of carrier used in the formulation. With few exceptions, most of the common commercial carriers exhibit catalytic activity at elevated temperatures (50° to 70° C.). This property, which accelerates the rate of decomposition, is dependent on surface activity, porosity, and chemical composition of the diluent. The effect of this activity varies greatly with the type of carrier (1, 2). Aramite begins to decompose almost immediately after formulation in a kaolin-type diluent, but in calcium carbonate decomposition of Aramite proceeds very slowly at room temperature. In almost all fillers Aramite decomposes rapidly at 50° C. unless stabilized.

Stabilization of Aramite by Glycols. Although technical Aramite contains 0.5% propylene oxide, which prevents decomposition of the technical material in a storage at normal warehouse temperatures, the formulated dusts or wettable powders should be further stabilized when they are stored at higher temperatures (35° to 50° C.). Laboratory and field studies have shown that propylene oxide volatilizes from wettable powders and dusts at 35° C. or higher. In Table II the effect of various glycols and some other additives is given. These tests were made in sealed glass containers. The half life of the wettable powder was significantly increased by the use of 4% propylene oxide, but it was not sufficient to warrant its use under commercial conditions.

As shown in Table I the half life of Aramite was increased almost twentyfold when formulated with Attaclay in which the moisture content was lowered from 0.6 to less than 0.2%. This suggested that the addition of a humectant might accomplish similar inhibition, because the amount of the moisture content would be controlled within narrow limits. Glycerol increased the half life 13 times over that of a similarly prepared unstabilized formula. This significant increase in stability led to the investigation of various glycols.

Table III. Effect of Dipropylene Glycol in 3% Aramite Dust Formulations at 50° C. in Sealed Glass Jars

Diluent	Di- propylene Glycol, %	Days Stored	Aramite Decom- position, %
Clear Lake talc	None	31	54.75
Soapstone-Attaclay	None	31	49.42
Anhydrite filler	None	31	45.80
Clear Lake talc	3.0	75	3.56
Soapstone-Attaclay	1.0	42	5.23
	2.0	42	5.24
Anhydrite filler	1.0	50	3.71
	2.0	42	4.27

Table IV. Effect of Dipropylene Glycol on Aramite-Aldrin and Aramite-Dieldrin Formulations Stored at 50° C. for One Month

(3.6% Aramite present)

Technical Insecticide	%	Dipropylene Glycol, %	Aramite Decom- position, %
Aldrin	2.0	None	60.13
Dieldrin	1.0	None	97.31
Dieldrin	2.0	None	91.67
Aldrin	2.0	1.0	3.50
Dieldrin	1.0	1.0	8.57
Dieldrin	2.0	1.0	12.57

All of the unsubstituted glycols tested inhibited the decomposition to some degree. Propylene, dipropylene, and polyethylene glycol 400 were the most effective additives investigated. Some of the glycols tested did not show any improvement over propylene oxide.

When one of the hydroxy groups was blocked as in the case of ethylene glycol mono-N-butyl ether (Table II), the stabilizing influence was nullified. Apparently the glycol must contain two or more free hydroxyl groups to possess this stabilizing function.

Table III illustrates the stabilizing effect of dipropylene glycol in several Aramite 3% dusts prepared with three different fillers. The optimum per cent of glycol necessary for adequate stabilization is dependent on the type of diluent used. This will vary between 2 and 5%.

The glycol stabilizes Aramite in the presence of other chlorinated hydrocarbons such as DDT, DDD, methoxychlor, aldrin, dieldrin, and toxaphene when these are used alone or in combination. An illustration of the stabilizing function of dipropylene glycol in formulations of Aramite and aldrin or Aramite and dieldrin is given in Table IV. In the combination of tetraethyl pyrophosphate

with Aramite, the glycols were of no value in inhibiting the decomposition, because of the initial high acidity associated with technical tetraethyl pyrophosphate. This latter combination liberates sulfur dioxide within 24 hours.

Dipropylene glycol has been used satisfactorily to stabilize Aramite dusts and wettable powders for several years (3). The degree of stabilization afforded is dependent upon the choice of the glycol, the selection of the diluent, and the type of wetting agent, dispersant agent, or other additives incorporated. This necessitates that each formula be evaluated individually.

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