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Geneva, 13–17 February 2006
Item 5 (b) of the provisional agenda*

Inclusion of chemicals in Annex III of the Rotterdam Convention: review of notifications of final regulatory actions to ban or severely restrict a chemical: cyhexatin

Cyhexatin – supporting documentation provided by Canada

Note by the secretariat

1. The annex to this present note contains the supporting documentation provided by Canada in support of their final regulatory action on cyhexatin. .

* UNEP/FAO/RC/CRC.2/1.

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Annex

List of supporting documentation on Cyhexatin from Canada annexed to UNEP/FAO/RC/CRC.2/12/Add.1

- Focussed Summary
- Decision Document E 89-01
- Capco Note C87-11
- Webpage: HSDB Trycyclohexyltin Hydroxde.htm

Focussed Summary for Cyhexatin (Canada)

Introduction

a) The events that led to the final regulatory action;

As part of the re-registration process in the United States, the registrant undertook new studies which indicated that cyhexatin (tricyclohexyltin hydroxide) was teratogenic. The registrant subsequently withdrew cyhexatin from sale in Canada, and requested discontinuation of registration for the product Plictran 50W Miticide, which contained cyhexatin,

Based on a review including a characterization of risks, and recognizing that the manufacturer had voluntarily withdrawn the product from the Canadian market, registration of cyhexatin was cancelled and maximum residue limits were revoked.

b) The significance of the regulatory action, e.g., one use or many uses, level or degree of exposure;

All pest control uses and formulations of cyhexatin are prohibited as of December 31, 1989. Unless registered under the Canadian Pest Control Products Act, pesticides may not be imported, sold or used in Canada. Cyhexatin is not registered for pest control use in Canada.

c) An overview of the regulatory system of the notifying country, if relevant;

At the time the regulatory decision was taken, the Department of Agriculture was the federal department responsible for the regulation of pest control products in Canada. The Department of Agriculture, the Department of Health and Welfare, the Department of Environment, the Department of Natural Resources and the Department of Fisheries and Oceans provided advice to the Minister of Agriculture with regard to the health, environmental and value assessments required by the *Pest Control Products Act*.

Since 1995, Health Canada's Pest Management Regulatory Agency (PMRA) is the federal agency responsible for the regulation of pest control products in Canada and undertakes review of all aspects of pesticide pre and post market assessment, including health, environment and value assessments.

Before a pesticide is considered for registration in Canada, it must undergo extensive testing to determine the potential risks posed to human health and the environment and the pesticide's value. New pest control products cannot be marketed unless the risks to health and the environment associated with their use, and their value are, acceptable. Their continued acceptability over many years on the market must be ensured through re-evaluation and special review.

d) The scope of the regulatory action: a precise description of the chemicals subject to the regulatory action.

All pest control uses and formulations of cyhexatin are prohibited. Unless registered under the Canadian Pest Control Products Act, pesticides may not be imported, sold or used in Canada. Cyhexatin is not registered for pest control use in Canada.

Risk evaluation

a) Key findings of the national risk evaluation;

Cyhexatin was found to be teratogenic in both the rat and rabbit with a NOEL of 1.0 mg/kg bw/day for

teratogenicity. The application of a 1000-fold safety factor resulted in an acceptable daily intake (ADI) of 0.001 mg/kg bw/day. This ADI provided a 500-fold safety margin to the embryofetotoxicity NOEL of 0.5 mg/kg bw/day in the rabbit which was based on an increased incidence of post implantation losses at 1.0 mg/kg bw/day.

b) Key data reviews consulted together with a brief description;

Cyhexatin Risk Characterization Document, Department of Food and Agriculture, State of California. (http://www.cdpr.ca.gov/docs/toxsums/pdfs/1638.pdf also provides information)

FAO/WHO documentation (1981) (http://www.inchem.org/documents/jmpr/jmpmono/v81pr09.htm)

U.S. EPA Studies (as described in E89-01)

c) Reference to national studies, e.g. toxicological and ecotoxicity studies;

Agriculture Canada. 1989. Decision Document E89-01: Cyhexatin. (www.pmra-arla.gc.ca/english/pdf/rdd/rdd_e8901-e.pdf)

d) A summary of actual or potential human exposure and/or environmental fate.

The dietary exposure associated with the established maximum residue limits (MRLs) exceeded the allowable daily intake (ADI).

Occupational exposures were estimated for the major uses of cyhexatin (orchard crops, hops, strawberries, greenhouse/ornamentals). Many of the crops are treated intensively and hence users have the potential for high exposure. The margin of safety for occupational exposure was low, even in cases where a rubber suit and gloves were utilized.

Risk reduction and relevance to other States

a) Estimates of the quantity of chemicals used, or imported/exported, at the time of the regulatory action and, if possible, information on ongoing trade;

Information on quantity of chemicals used, imported/exported at the time of the regulatory action is not currently available.

All pest control uses and formulations of cyhexatin are prohibited in Canada. Existing MRLs were revoked.

b) Relevance of the control action to other States, i.e., those with similar conditions of use;

Restrictions to the use of cyhexatin may be relevant to other States, as conditions for occupational exposure may be relevant in other States using cyhexatin for orchard crops, strawberries, hops or ornamental plants. Please refer to section c) below for typical use conditions in Canada. Also, risks from food residues of cyhexatin may be relevant to States importing food from countries where cyhexatin use may continue.

c) Comments on the typical use of the chemical in the notifying country, with comments on possible misuse if appropriate.

Cyhexatin was used in Canada on fruit crops as a miticide, and was used worldwide on fruit and nut crops. Application of cyhexatin in orchards employed airblast equipment, with a recommended application rate of 0.67 lb a.i./acre. Field applications were conducted using ground boom equipment, with a recommended maximum application rate of 1.1 lb a.i./acre. Cyhexatin was also likely used in greenhouses using several types of application equipment.

Risks from occupational exposure and potential food residues were associated with normal practices.

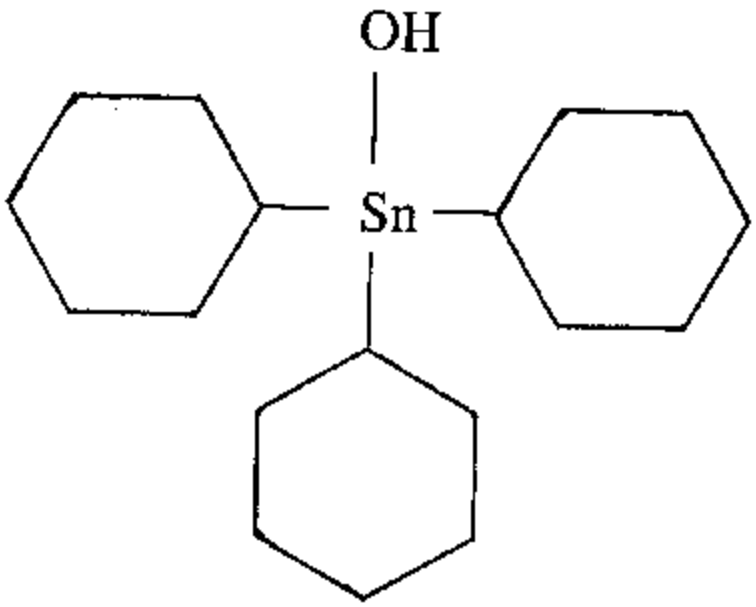
Agriculture Canada

Food Production and Inspection Branch
Direction générale, Production et inspection des aliments

Plant Industry Directorate
Direction de l'industrie des prodiuts végétaux

Decision Document E89-01

CYHEXATIN



Miticide

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FOREWORD

CYHEXATIN

As part of the ongoing efforts to provide background information to explain regulatory decisions, a Decision Document has been prepared on cyhexatin. This document reflects input from Agriculture Canada specialists and key interdepartmental advisors. Recognizing that the manufacturer has voluntarily withdrawn cyhexatin from the market and Health and Welfare Canada has revoked the maximum residue limits for the product, Agriculture Canada has cancelled the registration of cyhexatin.

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June 1989

CYHEXATIN (PLICTRAN) DECISION DOCUMENT

1. SUMMARY

The purpose of this document is to summarize information on the risks and benefits of cyhexatin miticide and to announce formal regulatory action.

The benefits of cyhexatin have been assessed by Agriculture Canada while the risks have been characterized by Health and Welfare Canada. The results of these reviews serve as the basis for a recommended action/regulatory position.

Based on this review, and recognizing that the manufacturer has voluntarily withdrawn the product from the market and that Health and Welfare Canada has revoked the maximum residue limits (MRL's) for the product, Agriculture Canada has cancelled the registration of cyhexatin.

2. BACKGROUND

Cyhexatin is the active ingredient in Plictran, a miticide which has been used on fruit crops in Canada since 1971 and worldwide on fruit and nut crops for many years without any reported adverse effects on humans or the environment. MRL's of 0.3 to 4.0 parts per million (ppm) were established under the Food and Drug Regulations to cover residues on almonds, apples, citrus fruit, peaches, pears, plums, strawberries and walnuts. These MRL's were recently revoked by Health and Welfare Canada.

As part of an Environmental Protection Agency (EPA) "Data Call-In" requirement on cyhexatin in the United States, Dow Chemical undertook teratology studies in rats and rabbits. These new oral teratology studies indicated that cyhexatin was teratogenic. Dow Chemical subsequently withdrew cyhexatin from sale in Canada and worldwide in August 1987. In early October 1987, Dow officially requested that Agriculture Canada discontinue the current registration of Plictran 50W Miticide, which contains cyhexatin.

3. HEALTH AND WELFARE ASSESSMENT

3.1 Toxicology

3.1.1 Acute Toxicity

The acute oral Lethal Dose 50% (LD_{50}) studies in the rat demonstrated a moderate order of toxicity with values ranging from 85 to 820 mg/kg body weight (bw) depending upon the strain and vehicle employed. Additional studies with the mouse, rabbit, guinea pig and chicken indicated a slight or low acute oral toxicity (500-1150\mg/kg bw).

3.1.2 Short-Term Toxicity

A 90-day dietary feeding study in the Wistar rat reported a No Observable Adverse Effect Level (NOAEL) at the lowest dose of 25\ppm, equivalent to approx. 1.5 mg/kg bw. The only effect noted at 25 ppm was a non-significant decreased body weight gain (females) when compared with a biologically significant weight loss at the next dose of 50\ppm (both sexes). Treatment related changes at the higher dose levels of 400 and 800 ppm were associated significant mortality and histopathologically- revealed bile duct inflammation and hypertophy.

[Further sub-acute studies conducted in the rat under conditions of dietary exposure for up to15 and 16 weeks duration, respectively, were judged to be unacceptable].

Dietary administration of cyhexatin to mice (ICR) for 90 days revealed a No Observable Effect Level (NOEL) set at the low dose of 25\ppm (equivalent to approximately 3.75 mg/kg bw) based on the observation of decreased body weight gain at the next higher level of 50 ppm.

For the purpose of determining the respective copper levels in tissue (liver), blood and urine - a 90 day dietary feeding study was undertaken in the beagle dog. The NOEL was assigned to the highest dose of 3 mg/kg bw based on the absence of any adverse or treatment-related effects on copper levels or other clinical parameters investigated.

3.1.3 Chronic/Long Term Toxicity

A 2-year chronic feeding study with Long Evans rats revealed a NOAEL of 6 mg/kg bw as a result of a slight non-significant effect on decreased body weights at this level when compared with a significantly decreased weight gain at the next higher level of 12\mg/kg bw. With respect to the evaluation of carcinogenic potential, the present study would serve as a carcinogenesis screen (negative) due primarily to the limited tissue and gross lesion histopathology.

[A second 2-year chronic rat study has apparently been evaluated by EPA. This study, which was not submitted to or evaluated by Food Directorate (FD), Health and Welfare Canada, indicated a NOEL for in-life parameters of <1 mg/kg bw due to an increased incidence of focal bile duct hyperplasia in both sexes at all dose levels. There was no evidence of any treatment-related neoplastic activity up to or at the highest dose level of 6 mg/kg bw. The EPA has stated that this study was not acceptable as a chronic or combined study due to the absence of clinical laboratory assessment, e.g., hematology, blood chemistry].

[FAO/WHO documentation (1981) with reference to the 2-year chronic rat (mentioned above): In an attempt to elucidate the significance of the incidence of focal bile duct hyperplasia noted in the rats, all of the prepared liver slides were re-evaluated microscopically by an independent pathologist Dr. van der Heijden. He has been quoted as stating that focal bile duct hyperplasia is a common finding in livers of aging rats of various strains and is oflittle pathological significance. However, it appears likely that some environmental factor, e.g., contaminants of food or deficiency, is responsible for the frequently found high incidence. The occurrence of focal bile duct hyperplasia in control and treated rats is considered "spontaneous" and generally not associated with a particular condition of treatment. There is no association between focal bile duct hyperplasia and tumours of liver or bile ducts and no evidence to relate focal bile duct hyperplasia to any preneoplastic condition].

[Results of a 2-year dietary oncogenicity study in the $B_6C_3F_1$ mouse were reportedly evaluated by EPA (study report not submitted to or evaluated by FD). The NOEL was determined to be 3 mg/kg bw with no evidence of an oncogenic effect at levels of up to 6\mg/kg bw].

Two-year dietary administration of cyhexatin to beagle dogs failed to indicate a NOEL, the lowest dose of 3 mg/kg bw resulting in a slight tendency toward anemia, decreased urinary copper and grossly observed intestinal discoloration. Furthermore, the acceptability of the study was considered doubtful in light of the significant variability in the ages of the dogs used. A supplementary dietary level of 0.75 mg/kg was introduced with a concomitant control approximately 4 months following the start of the primary study. A NOAEL of 0.75 mg/kg bw or more accurately, the actual intake of 0.69\mg/kg bw was assigned with only one treated male presenting at the 2-year term with intestinal discoloration.

3.1.4 Mutagenicity

No mutagenicity studies have been submitted to or evaluated by FD. [EPA evaluation of the relevant genotoxicity assays has failed to uncover any mutagenic potential for point mutation, chromosome abberations or DNA repair activity].

3.1.5 Teratogenicity

In a recent study, cyhexatin was found to be teratogenic in the New Zealand White Rabbit resulting in a NOEL of 1.0 mg/kg bw as evidenced by an increased incidence of hydrocephaly at the high dose of 3.0 mg/kg bw. The NOEL for embryo/ fetotoxicity was established to be 0.5 mg/kg bw based on the increased incidence of post implantation loss at the next dose level of 1.0 mg/kg bw. The highest dose revealed a greater frequency of abortions and only a slight effect on maternal body weight gain.

Cyhexatin when administered to Sprague-Dawley rats on days 6 through 15 of gestation failed to reveal any signs of maternal toxicity. An increased number of malformations (i.e., tail malformations, microphthalmia) was observed at the high dose of 5 mg/kg bw. The isolated malformations and/or anomalies observed at the mid-1.0 mg/kg and low dose-0.5 mg/kg bw groups confounded an unequivocal assessment; however, the questionable significance of these observations suggested that a NOAEL of 1.0\mg/kg bw could be acceptable for the rat.

3.1.6 Reproduction

A multi-generation study in Long Evans rats with cyhexatin* indicated a NOEL of 12.5 ppm, equivalent to approximately 0.75 mg/kg bw. The only effect noted at the next higher dietary level of 50 ppm was a slight depression in weaning weight and in the parental weights in several generations. A teratological component revealed no treatment-related abnormalities. (A replacement reproduction study in the Fischer 344 rat was anticipated in 1988).

Treatment with cyhexatin* for reproductive/teratological assessment in the New Zealand White Rabbit failed to elicit any adverse maternal effects at the highest dose of 3 mg/kg bw. The NOAEL, in the absence of any reproductive effects would be set at $\geq$3 mg/kg bw. This study has been superceded by the teratology study discussed above and is mentioned only for the sake of completeness.

3.1.7 Metabolism

Metabolic studies with rats and dogs fed cyhexatin for up to 2 years indicated equilibrium levels of tin (Sn) in the tissues which were comparable between sexes and which were attained only after several months to one year. The highest distribution and accumulation of Sn appeared in the liver and kidney with the lowest concentrations identified in the fat and muscle. Sn levels were slowly eliminated from the tissues uponwithdrawal of treated diets with little long-term storage of inorganic Sn.

An experiment with Wistar rats receiving a single oral dose of 25 mg/kg bw suggested limited intestinal absorption with approximately 98% of the dose recovered in the feces and 2% in the urine within 10 days of administration.

* Cyhexatin Risk Characterization Document, Department of Food and Agriculture, State of California, states that the study was conducted with a wettable powder formulation of unknown purity.

3.1.8 Summary of the Toxicity Data

Review of the presently available toxicity data has revealed that the previously assigned acceptable daily intake (ADI) of 0.0069\mg/kg/day (based on the NOEL of 0.69\mg/kg from the 2-year dog study) requires revision. Since cyhexatin (tricyclohexyltin hydroxide) was found to be teratogenic in both the rat and rabbit, a 1000-fold safety factor may be recommended based on a NOEL of 1.0 mg/kg bw (for both rat and rabbit). The resulting ADI of 0.001 mg/kg bw would also provide a 500-fold safety margin with respect to the embryofetotoxicity NOEL of 0.5 mg/kg bw which was based on an increased incidence of post implantation losses at 1.0 mg/kg bw in the rabbit.

The margins of safety with regard to other effects on intestinal discoloration in the dog (2-year study: NOAEL = 0.69 mg/kg bw) would be almost 700-fold and with respect to the reported focal bile duct hyperplasia in the rat (2-year study: assuming a Lowest Observed Effect Level (LOEL) = 1.0 mg/kg bw) up to 1000-fold.

3.2 Food Exposure

Presently established MRL's result in a theoretical daily intake of 0.004-0.008 mg/kg, well in excess of the revised ADI. If the MRL's for cyhexatin were revoked, the general regulation B.15.002(1) would apply, (i.e., 0.1 ppm limit). At this level the theoretical daily intake would be 0.0003 mg/kg/day which is approximately one-third of the new ADI (0.001\mg/kg bw/day).

3.3 Occupational Exposure

An attempt was made to estimate occupational exposurefor the major uses of cyhexatin (Plictran): orchard,ground boom (strawberries) and greenhouse/ ornamentals. Orchard crops and hops are treated intensively and hence the farmers have the potential for high exposure.

3.3.1 Orchard Use (Airblast Equipment)

The registrant submitted two exposure studies in which workers using cyhexatin in orchards were monitored. One of the studies was conducted in Japan and involved an application method that is very different from methods used in Canada; it was therefore not used to estimate exposure to the Canadian worker. The other study, although limited by study design, was used for estimating exposure to mixer/ loader/applicators (M/L/A) as well as to harvesters. The limitations of the study include:

a) A small number of workers (4 M/L/A's and 2 harvesters) were monitored for a short period of time (about 30-60 min.); this cannot be expected to indicate the range of exposures encountered by typical workers during a normal work day.

b) The limit of detection for patch samples was very high.

c) Exposure was not monitored during clean-up or repair.

d) It does not appear that field recoveries were carried out for all sampling media; the details of the quality-assurance data were not included in the report and have been requested from the registrant.

e) Hand exposure underneath gloves was not monitored; we therefore have had to assume 100% protection from gloves.

Except for the high limit of detection (b), all other limiting factors would lead to an under-estimate of exposure. Therefore, despite our limited confidence in the precision of the data, this study was used to quantitatively estimate exposure.

Table 1 presents the exposure estimates, based on this study, for a M/L/A (70-kg man or 55-kg\woman) treating 50 acres of a fruit orchard at the maximum Canadian recommended label application rate of 0.67 lb ai/acre (0.75\kg\ai/ha). Exposure estimates are also presented for fruit harvesters assuming they pick for about 7 hours/day on the seventh day after application. This is the preharvest interval recommended on the Canadian label for peaches and nectarines; it is 14 days for apples and pears. The study measured dermal exposure to workers at 18 days and they were all less than the limit of detection (LOD) (although a high exposure is still estimated based on the LOD, i.e., about 2 mg/kg bw/d).

Our estimate of exposure for M/L/A is therefore in the range of 3.5-22.5 mg/kg bw/d for males and 4-29\mg/kg bw/d for females wearing short sleeves and no gloves. If the M/L/A is wearing a rubber suit and gloves (assuming 100% hand protection), the exposure is estimated to range from 7 to 13 and from 9 to 16.5 mg/kg bw/d for males and females respectively. For fruit pickers wearing short sleeves and no gloves and picking on the seventh day post application, exposure is estimated to be 5 mg/kg bw/d for males and 6.5 mg/kg bw/d for females. If the harvesters are wearing long sleeves and gloves (assuming 100% protection), the estimates are 2.5 and 3.5 mg/kg bw/d for males and females respectively.

We compared our exposure estimates to surrogate data on wettable powder formulations applied with airblast orchard equipment. The surrogate data generated slightly lower estimates for workers in short sleeves and no gloves but there was a definite overlap in the range of exposures. The surrogate estimates for workers wearing long sleeves and gloves was lower than that estimated from the Dow study, but the Dow workers (long sleeves and

gloves) were all in an open cab. It should also be noted that it is extremely difficult to compare studies in which clothing scenarios and methods of data collection and analysis are all different.

3.3.2 Field Use (Ground Boom Equipment)

The registrant did not submit any studies that could be utilized to estimate exposure to workers using ground boom equipment, (e.g., for strawberries). We therefore considered surrogate data. Unfortunately, no appropriate studies were available in which workers were monitored during the M/L/A of WP formulations with ground boom equipment. For the M/L component, therefore, three studies were considered in which airblast or aerial applications with very similar tanks to those used for ground boom application were used. The obvious shortcoming is that we are using surrogate data from different scenarios on only one aspect of the use, without including spraying, cleanup and repair. Nevertheless, the exposure for workers mixing sufficient Plictran to treat 50 acres/day at the maximum application rate of 1.1 lb ai/acre and wearingshort sleeves and no gloves is estimated to be 0.2-7.8 and 0.2-9.9 mg/kg bw/d for males and females respectively (Table 1). If short sleeves and gloves (100% hand protection assumed) were worn, the estimates would be 0.3-1.6 and 0.04-2.0 mg/kg bw/d for males and females respectively.

3.3.3 Greenhouse Use

The registrant did not submit any exposure information for the greenhouse scenario. A published study conducted in Florida several pesticides and several types of application equipment was reviewed and considered but the large number of assumptions necessary to estimate exposure for the Canadian worker made the extrapolation very tenuous. For that reason a quantitative estimate of exposure for the greenhouse scenario has not been presented. Little exposure information exists on the greenhouse setting but it is assumed that the potential for exposure is high. Because the NOEL for teratology with cyhexatin is very low and because a proportion of greenhouse workers are women, exposure data on the greenhouse scenario is essential for an assessment of safety.

Since no estimate of dermal absorption is available, it was necessary to assume 100% absorption for estimates used in this report.

Table 2 presents margin of safety (MOS) calculations for the toxicological endpoints, fetotoxicity and teratology.

TABLE 1 EXPOSURE TO CYHEXATIN FOR CANADIAN WORKERS

Use Scenario	Clothing	Exposure mg/kg bw/d			
		Males		**Females**	
Orchard (Airblast Equipment)		**Open Cab**	**Closed Cab**	**Open Cab**	**Closed Cab**
M/L/A[1]	Short Sleeves	8.4 - 22.6	3.5 - 4.3	10.7 - 28.8	4.5 - 5.5
	No Gloves				
	Rubber Suit, Gloves[2]	7.2 - 13.0	---	9.1 - 16.5	---
Picking (7 d)[3]	Short Sleeves, No Gloves	5.0		6.3	
	Long Sleeves, Gloves[2]	2.6		3.3	
Field (Ground Boom)					
M/L[4]	Short Sleeves, No Gloves	0.2 - 7.8		0.2 - 0.9	
	Short Sleeves, Gloves[2]	0.03 - 1.6		0.04 - 2.0	
Greenhouse	INSUFFICIENT DATA TO QUANTITATE				

1 Based on a worker (70-kg male or 55-kg female, treating 50 acres in one day at the maximum application rate of 0.67/lb ai/acre.

2 Assuming gloves provide 100% hand protection, a known overestimate.

3 Based on a worker (70-kg male or 55-kg female) picking fruit for 7 hours /day.

4 Based on a worker (70-kg male or 55-kg female) treating 50 acres in one day at maximum application rate for strawberries of 1.1 lb ai/acre.

TABLE 2 MOS CALCULATIONS FOR DIFFERENT USE SCENARIOS[1]

Use Scenario	Margins of Safety	
	Fetotoxicity (NOEL - 0.5 mg/kg bw/d)	**Teratology (NOEL = 1.0mg/kg bw/d)**
Orchard (Airblast)		
a) M/L/A		
Short Sleeves, No Gloves	No MOS	No MOS
Rubber Suit, Gloves[2]	No MOS	No MOS
b) Picking (7 days post-application)		
Short Sleeves, No Gloves	No MOS	No MOS
Long Sleeves, Gloves[2]	No MOS	No MOS
Field (Ground Boom)		
M/L[3]		
Short Sleeves, No Gloves	0-2.5	0-5
Short Sleeves, Gloves[2]	0-12.5	0-25
Greenhouse	INSUFFICIENT DATA TO QUANTITATE	
Hops	INSUFFICIENT DATA TO QUANTITATE	

1 These MOS calculations are based on fetotoxicity and teratology. As pointed out in the toxicology section, there are many data gaps and there may well be other toxicologic endpoints that affect both sexes. Exposure during only M/L/A was considered. Exposure during cleanup and repair could not be assessed.

2 Assuming gloves provide 100% hand protection, a known overestimate.

3 Only M/L component considered; exposure during spraying, cleanup and repair could not be assessed.

4. RESIDUE MONITORING IN 1987

In August 1987, Agriculture Canada initiated a national sampling and analysis program to assess cyhexatin levels remaining at harvest on apples and pears. Samples of apple juice and apple sauce were analyzed by Health and Welfare Canada.

Seventy-one per cent (71%) of pears and 85% of apples had levels less than the reporting level of 0.2 ppm or 10x less than the then current maximum residue level of 2 ppm. Only trace levels of cyhexatin and its metabolites were found ($\leq$ 0.05 ppm) in apple sauce or apple juice. These results indicate exposures to cyhexatin from food residues were minimal and covered by a newly revised ADI established by Health and Welfare Canada.

Continued exposure through imported food products are not expected since Dow has discontinued worldwide production of this compound. Analysis of imported products in 1987 did not find levels of cyhexatin which would raise concern.

5. THE ECONOMIC BENEFITS OF PLICTRAN IN CANADA

5.1 Agronomics of Cyhexatin (Plictran)

Plictran is an organotin miticide which was used for the control of plant-feeding mites such as European red mite, two-spotted spider mite, apple rust mite, pear rust mite, and McDaniel spider mite. Its effectiveness in terms of speed of action, tolerable effects on predator mites and low toxicity to bees made Plictran a valuable chemical in the production of apples, pears, peaches, strawberries and hops.

5.2 Damage

In 1986, the farm value of the above-mentioned crops in Canada was estimated at approximately $230 million, that is, $122 million for apples, $13 million for pears, $21\million for peaches, $47 million for strawberries and $27\million for raspberries. While pears and peaches are grown mostly in Ontario and British Columbia and hops are produced only in specific areas of British Columbia, apples, raspberries and strawberries are grown widely across the country. For the latter three commodities, Ontario and British Columbia remain, however, the main production centers.

The control of mites is particularly important tofruit growers because of the adverse effects they haveon yield and product quality. The extent of thedamage mites can cause varies widely between areas andcrops. While the yield drop can average 10% to 35%for apples, it can vary from 20% to 100% forraspberries and strawberries, and as much as 25% forhops. The decrease in quality is even moresignificant, ranging from 10% to 50% for apples andfrom 50% to 100% for raspberries, strawberries andhops. The latter estimates reflect an extreme case of infestation where the fragile crops would become completely unmarketable.

5.3 Pesticide Usage

Plictran usage varied substantially by crop as follows: apples - 60%, strawberries - 30%, pears\-\4%, peaches - 3%, hops - 3%, raspberries\-\22%. In the four main use areas, Ontario (44%), Quebec (29%), British Columbia (20%) and the Maritimes (6%), a similar pattern emerged with the exception of Quebec and Atlantic Canada where the use on strawberries was greater than on apples. Based on estimates provided by regional industry experts, nearly all areas in apple, pear and peach production in Ontario were treated with Plictran whereas the chemical was sprayed on less than 5% of the strawberry fields in that province. In British Columbia, the situation was reversed as only 10% of the total orchards were treated compared to 95% for strawberries.

Finally, all of the 329 hectares in hop production in British Columbia were treated with this chemical.

5.4 Efficacy

Plictran offered a high degree of protection against mite damage. Depending on the timing, frequency and rate of application, it could reduce by as much as 95% the detrimental effects mites have on fruit size, color, quality (due largely to russetting) and crop vitality (defoliation). This was particularly true for apples, pears and strawberries. Species of mites, crop varieties, regional growing conditions as well as the complexity of the disease and insect control programs in a region also impacted on the efficacy of Plictran. For example, a survey conducted in 1984, of 45 commercial sites in Ontario where mite control failures were reported, showed that 27% of orchards exhibited evidence of Plictran resistance. This could have resulted from the fact that by 1982, the majority of growers in the area relied mostly upon the use of that chemical for mite control. Under normal circumstances, the development of mite resistance to Plictran was not a problem when other chemicals were used alternately with Plictran in an integrated pest management program.

5.5 Alternatives

Agriculture Canada has recently granted registration for clofentezine (Apollo) for mite control on apples. In addition, products such as dicofol (Kelthane), fenbutatin-oxide (Vendex, Torque), propargite (Omite), formetanate hydrochloride (Carzol), chinomethionat(Morestan) and dormant oils are registered for mite control. Omite, Dicofol and Superior Oil are the most often used of the registered alternatives in Canada, particularly on apple.

The Pesticides Directorate, Agriculture Canada, in conjunction with advisors in Health and Welfare Canada, Environment Canada, and Fisheries and Oceans Canada are currently

reviewing data to support registration of another new miticide. While these new products may be considered as replacement compounds for cyhexatin, all miticides have to be carefully used and managed to avoid possible resistance development.

5.6 Economic Benefits

The data used in the assessment of Plictran were very limited and allowed measurement of only part of its economic impact. The lack of information on mite damage on pears and peaches in Ontario, Nova Scotia and British Columbia, as well as on strawberries and raspberries in all growing areas except Columbia, restricted the analysis to the evaluation of the benefits and cost of using Plictran in the apple sector across Canada and in the strawberry, raspberry and hop industries in British Columbia only.

Although the validity of extrapolating the results presented below in terms of dollar value is debatable, it is possible to use them as an indicator of the magnitude of returns fruit growers were able to from using Plictran. At present, there are insufficient data to evaluate the net benefits of alternative chemicals. However, none of the three most popular pesticides, Omite, Dicofol and Superior Oil, appears to be quite as effective as Plictran the overall control of mite damage. As a result, in this case, the values of the benefits of Plictran could not be discounted by the full amount of returns expected from the use of substitute chemicals since they were not simply substitutes but, to a extent, complemented the use of Plictran. The findings of this study should, therefore, interpreted with caution, in the context of this analysis only.

Plictran usage was estimated to decrease apple yield losses by 38 Kilo-tonnes (kt) in Ontario, 11 kt in Quebec, 3 kt in Nova Scotia and a little over 1 kt New Brunswick and British\Columbia. Based on the 1986 crop market conditions, the total value of these yield losses amounted to $18.2 million. The yield losses that strawberry, raspberry and hop growers would have incurred without the use of this miticide were valued at $3.5 million, $0.1 million and $0.6 million, respectively. For apple growers, Plictran did not generate as much revenue from reducing quality losses as it did from reducing yield losses, because the total gains in quality amounted to only $4.7 million. The reverse was true for strawberry and hop producers because they were able to reduce their quality losses by $5.1 million and $2.2 million, respectively.

For apple growers alone, the gross benefits of Plictran could, therefore, be as high as million. Considering that, in most provinces, two applications of Plictran on orchards could produce a desirable level of mite control, using this chemical cost $2.7 million, which meant that the net benefits amounted to $20.2 million. As for the other fruit crops, the benefits of Plictran were valued anywhere from $3.5 to $5.1 million in the case of British Columbia strawberries and from $0.6 million to $2.2\million in the case of hops. Treating these crops with Plictran was relatively less expensive than spraying it on orchards ($0.2

million and $0.3\million, respectively). This meant that the benefits of Plictran relative to the value of the crops for British Columbia producers were extremely high, that is, from 46% to 64% for strawberries and from 27% to 100% for hops. This reflects the level of vulnerability of these crops to mite damage and the market sensitivity to their quality.

In the absence of Plictran, the efficacy of each the alternatives may be reduced considerably given that a viable mite control program requires proper alternation of chemicals in order to minimize the possibility of pesticide resistance development.

5.7 Conclusions of Economic Benefit Study

Judging by the partial results of this analysis, Plictran was an effective miticide which generate high returns to fruit producers. For example, for each dollar spent on Plictran, apple growers could expect benefits worth $8.50. Because of the fragility of strawberries and hops and the threat of mites, producers in British Columbia could gain even more from each dollar invested in that chemical ($17 to $25 for strawberries and $20 to $74 for hops).

In addition to providing a direct protection against mite damage to yield and fruit quality, Plictran offered the indirect advantage of maintaining the efficacy of other chemicals used in mite control. The availability of a sufficient number of effective miticides is crucial to preventing pest resistance development.

The results of this study indicate that Ontario fruit growers benefited the most from the use of Plictran. Based on the use pattern and the economic value of apple, strawberry and raspberry production, Quebec was likely the next largest beneficiary, followed by British Columbia and the Maritimes.

The economic benefits of Plictran were higher in relation to the crop value of small fruit (raspberries and strawberries) and hop crops. However, in real dollar terms, the returns of Plictran in orchards were much higher.

It is difficult to anticipate the long-term consequences of removing Plictran from the market. In the short term, it is evident that the use of other chemicals such as Apollo, Omite, Dicofol and Superior Oil will increase. However, in the long run, alternating these chemicals might not be sufficient to prevent pest resistance. In this case, unless other pesticides are introduced onto the market, some industries like raspberry, strawberry and hop production would likely become too vulnerable to mite damage to remain viable.

6. CANCELLATION CONDITIONS

In the summer of 1987, Dow announced voluntary withdrawal of the product from the market, supported by a stock return and refund program coordinated through local dealers.

By means of a CAPCO Note in August 1987 and based on concerns expressed by Health and Welfare Canada, Agriculture Canada cautioned women who are or may be pregnant against working in treated orchards or fields.

In the interim, Dow has taken a corporate decision to abandon further interest in Plictran and has asked that the original registration be cancelled. Agriculture Canada is taking this action in response to Dow's request and in recognition of Health and Welfare Canada's review, to formally remove this registration from the record.

Agriculture Canada also puts growers on notice that Health and Welfare Canada has revoked residue tolerances, effective January 29, 1989.

7. FUTURE DIRECTIONS IN MITE CONTROL

Much effort in mite control research in horticultural crops has been directed toward developing Integrated Pest Management (IPM) programs which allow for conservation of mite predators. Without these programs, frequency of miticide applications would dramatically increase.

Significant research is also being directed toward understanding the mechanisms underlying resistance so that compounds of different chemistry can be rotated against diseases and insect pests, thus slowing development of resistance to key compounds and maintaining stability in IPM programs.

Much more data are required to critically examine the economic impact of mite species on yield and quality of affected crops. These data would allow economic treatment levels to be established so that miticides are only applied when needed.

CAPCO Note 87-14

CYHEXATIN

Agriculture Canada is advising growers to stop use of products containing cyhexatin. Cyhexatin is the active ingredient in Plictran 50% WP (Reg. No. 10,936) which is used to control various mite species on apples, pears, peaches, strawberries, hops and ornamentals. Cyhexatin products are not available for home and garden use.

This insecticide is being voluntarily withdrawn from the marketplace. The registrant, Dow Chemical Company, has advised distributors to discontinue sale of the product and to contact customers they have supplied. Growers are urged to contact distributors. Regional staff of Agriculture Canada will monitor the withdrawal program.

This action is being taken as a result of a recently completed rabbit dermal teratology study which showed an increased incidence of hydrocephaly in the offspring of female rabbits exposed to cyhexatin under the conditions of the study.

The dermal study was undertaken as a result of a U.S. EPA Data Call-In requirement. The study itself is not yet available to the federal government. The Dow Chemical Company is in the process of documenting the laboratory results.

In order to inform growers of the decision, Agriculture Canada is contacting grower organizations. By means of this CAPCO Note, provinces are being requested to assist in transmitting this information to users.

In the interim, based on concerns expressed by Health and Welfare Canada, Agriculture Canada is cautioning women who are or may be pregnant against working in treated orchards or fields. Agriculture Canada will consider further regulatory action in light of ongoing assessments by Health and Welfare Canada of the newly emerging studies.

Agriculture Canada, with co-operation from Health and Welfare Canada, will be monitoring fresh and processed fruit for residues of cyhexatin. Provinces, wishing to undertake a co-operative residue monitoring program, are invited to contact J.B. Reid at the Pesticides Directorate, (613) 993-4544.

Please direct inquiries regarding cyhexatin to the National Pesticides Call Line: 1-800-267-6315.

DISTRIBUTION:

Canadian Association of Pesticide Control Officials

Public Interest and User Groups

August 21, 1987

SUBSTANCE IDENTIFICATION

HSDB Chemical Name TRICYCLOHEXYLTIN HYDROXIDE
HSDB Number 1782
Last Revision Date 2003/03/26
Last Review Date Reviewed by SRP on 5/10/2001
CAS Registry Number 13121-70-5

Synonyms

M 3180; Acarstin (Sipcam) [REF-1, p.256]; Aracnol F (Diachem) [REF-1, p.256]; CYHEXATIN; DOWCO-213; ENT 27,395-X; ENT 27395; Pesticide Code: 101601 [REF-2]; HYDROXYTRICYCLOHEXYLSTANNANE; Mitacid (Sipcam) [REF-1, p.256]; Plictran 5OW miticide [REF-3]; OMS 3029 [REF-1, p.256]; PLICTRAN; Ortho Plictran 50 wettable miticide [REF-3]; PLYCTRAN; STANNANE, TRICYCLOHEXYLHYDROXY-; TCTH [REF-4, p.432]; TIN, TRICYCLOHEXYLHYDROXY-;

TRICYCLOHEXYLHYDROXYSTANNANE; TRICYCLOHEXYLHYDROXYTIN; TRICYCLOHEXYLSTANNANOL; TRICYCLOHEXYLZINNHYDROXID (GERMAN)

Molecular Formula C18-H34-O-Sn [REF-4, p.432]

Shipping Number/Name

UN 3146; Organotin cmpd, solid, not otherwise specified UN 2788; Organotin cmpd, liquid, not otherwise specified IMO 6.1; Organotin cmpd, liquid or solid, not otherwise specified

DESCRIPTION AND WARNING PROPERTIES

Color/Form

White crystalline powder [REF-7, p.466]

Odor

Nearly odorless [REF-15, p.86]

SAFETY HAZARDS AND PROTECTION

FIRE AND REACTIVITY

Toxic Combustion Products

- When heated to decomp ... emits acrid smoke and irritating fumes. [REF-18, p.976]

Reactivities and Incompatibilities

- Strong oxidizers, ultraviolet light. [REF-19, p.86]
- Should not be applied in combination with wetting agents. [REF-1, p.256]

Decomposition

- When heated to decomp ... emits acrid smoke and irritating fumes. [REF-18, p.976]
- Degraded by u.v. light. [REF-1, p.256]

PROTECTIVE EQUIPMENT AND CONTROLS

Protective Equipment and Clothing

- Wear appropriate personal protective clothing to prevent skin contact. [REF-19, p.86]
- Recommendations for respirator selection. Max concn for use: 3.2 mg/cu m. Respirator Class(es): Any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust and mist filter. Any supplied-air respirator. [REF-19, p.86]
- Recommendations for respirator selection. Max concn for use: 8 mg/cu m. Respirator Class(es): Any supplied-air respirator operated in a continuous flow mode. Any powered, air-purifying respirator with organic vapor cartridge(s) in combination with a dust and mist filter. [REF-19, p.86]
- Recommendations for respirator selection. Max concn for use: 16 mg/cu m.

Respirator Class(es): Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter. Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter. Any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter. Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode. Any self-contained breathing apparatus with a full facepiece. Any supplied-air respirator with a full facepiece. [REF-19, p.86]

- Recommendations for respirator selection. Max concn for use: 80 mg/cu m. Respirator Class(es): Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. [REF-19, p.86]
- Recommendations for respirator selection. Condition: Emergency or planned entry into unknown concn or IDLH conditions: Respirator Class (es): Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode. [REF-19, p.86]
- Recommendations for respirator selection. Condition: Escape from suddenly occurring respiratory hazards: Respirator Class(es): Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter. Any appropriate escape-type, self-contained breathing apparatus. [REF-19, p.86]

Other Preventative Measures

- Keep out of reach of children. Keep away from living quarters. Keep away from food, drink & animal feeding stuffs. [REF-20, p.187]
- The worker should immediately wash the skin when it becomes contaminated. [REF-19, p.86]
- Work clothing that becomes wet or significantly contaminated should be removed or replaced. [REF-19, p.86]
- Workers whose clothing may have become contaminated should change into uncontaminated clothing before leaving the work premises. [REF-19, p.86]

STORAGE, CLEANUP AND DISPOSAL

Stability/Shelf Life

- STABLE TO 100 DEG C IN AQUEOUS SUSPENSIONS FROM SLIGHTLY ACID (PH 6) TO ALKALINE; DEGRADED BY U.V. LIGHT. [REF-1, p.256]

Storage Conditions

- Keep in cool place. Keep contents under ... (appropriate liquid to be specified by the manufacturer). Keep under ... (inert gas to be specified by the manufacturer). Keep container tightly closed. Keep container dry. Keep container in well-ventilated place. Do not keep the container sealed. [REF-20, p.187]

Disposal Methods

- SRP: At the time of review, criteria for land treatment or burial (sanitary

landfill) disposal practices are subject to significant revision. Prior to implementing land disposal of waste residue (including waste sludge), consult with environmental regulatory agencies for guidance on acceptable disposal practices.

HEALTH HAZARDS AND TOXIC EFFECTS

Non-Human Toxicity Values

LD50 Rat oral 190 mg/kg [REF-33]
LD50 Rat intraperitoneal 13 mg/kg [REF-33]
LD50 Rabbit percutaneous >2000 mg/kg [REF-12, p.C-65]
LD50 Rabbit oral 500-1000 mg/kg [REF-1, p.257]
LD50 Guinea pig oral 780 mg/kg [REF-1, p.257]
LD50 Rat skin 446 mg/kg [REF-18, p.976]
LD50 Rabbit oral 458 mg/kg [REF-18, p.976]
LD50 Rabbit skin 2422 mg/kg [REF-18, p.976]
LD50 Chicken oral 654 mg/kg [REF-18, p.976]

Human Toxicity Excerpts

Harmful by inhalation. Harmful in contact with skin. Harmful if swallowed. [REF-20, p.187]

Non-Human Toxicity Excerpts

IN 2 YR FEEDING TRIALS THE NO-EFFECT-LEVEL ... FOR DOGS /WAS/ 0.75 MG/KG DAILY; FOR MICE 3 MG/KG DAILY; FOR RATS 1 MG/KG DAILY. [REF-1, p.257]

RATS WOULD NOT ACCEPT DIET CONTAINING 25 MG/KG/DAY ... SO 25 MG/KG/DAY WAS FED BY SINGLE DOSE GAVAGE FOR 2 WEEKS. AT THIS LEVEL OF TREATMENT MICROSCOPIC CHANGES WERE FOUND IN LIVER, KIDNEY, AND ADRENAL GLANDS. IN ... 2 YEAR ... FEEDING STUDY WITH BEAGLE DOGS, 3 MG/KG/DAY WAS NO EFFECT LEVEL BASED ON BODY WT GAINS. DOGS FED 6 MG/KG/DAY FOR 2 YEARS EXHIBITED SLOWER GROWTH RATE BUT EXHIBITED NO TOXICOLOGICAL OR PATHOLOGICAL CHANGES. [REF-22, p.165]

RATS FED TRICYCLOHEXYLTIN HYDROXIDE AT LEVELS UP TO & INCLUDING 12 MG/KG/DAY ... FOR 2 YR EXHIBITED NO TREATMENT CAUSED CHANGES IN BEHAVIOR, RATE OF MORTALITY, GROSS OR MICROSCOPIC APPEARANCE OF TISSUES, & HEMATOLOGICAL OR BIOCHEMICAL VALUES. RATS INGESTING 12 MG/KG/DAY WERE SMALLER THAN CONTROLS. ... BASED ON BODY WT GAINS, 6 MG/KG/DAY ... IN DIET FOR 2 YR IS CONSIDERED NO-EFFECT LEVEL FOR RATS. ... NO EFFECTS ON FERTILITY, GESTATION, VIABILITY OR LACTATION WERE OBSERVED IN RATS FED 4 TO 6 MG/KG/DAY FOR 3 GENERATIONS. [REF-22, p.165]

IN REPRODUCTION AND TERATOLOGY STUDIES, FEMALE RABBITS RECEIVED ORAL DOSES OF 3 MG/KG/DAY ON 8TH THROUGH 16TH DAY OF GESTATION. THERE WAS NO EVIDENCE OF ILL-EFFECTS AS JUDGED BY INDICES OF FERTILITY, GESTATION, VIABILITY & LACTATION, OR BY EXAMINATION OF FETUSES FOR TERATOGENIC EFFECTS. [REF-22, p.165]

30 ADULT SHEEP OF BOTH SEXES WERE TREATED INTRARUMENALLY WITH TRICYCLOHEXYLTIN HYDROXIDE. GROUPS OF 5 SHEEP EACH WERE TREATED WITH 750, 500, & 250 MG/KG; 4 SHEEP EACH WERE GIVEN 150, 25 & 15 MG/KG; & 3 SHEEP RECEIVED 50 MG/KG. SHEEP TREATED WITH 750 & 500 MG/KG HAD SEVERE CARDIOVASCULAR & RESP CHANGES AT NECROSPY. 8 YEARLING CATTLE SPRAYED WITH SUSPENSIONS OF 0.025, 0.05, 0.1, & 0.5 HAD NO ILL EFFECTS FROM THIS DERMAL TREATMENT. 3 YEARLING CATTLE WERE ANORECTIC AFTER BEING SPRAYED WITH 1.0% SUSPENSION. 2 BABY CALVES (1/GROUP) TOLERATED SPRAYING @ 0.075% & 0.1%. TRANSITORY ANOREXIA & EYE IRRITATION WERE NOTED IN 3 ANGORA GOATS SPRAYED WITH 2.0% SUSPENSION. 3 OF 5 SHEEP WERE MILDLY

AFFECTED WHEN SPRAYED @ 0.5%. OF 2 PREGNANT SHEEP SPRAYED @ 2.0%, ONE WAS MILDLY AFFECTED & SURVIVED; THE OTHER ABORTED, & DIED OF COMPLICATIONS. [REF-23]

IN A 2 YR FEEDING STUDY ON RATS, THERE WAS NO INCR IN NUMBER OF BENIGN OR MALIGNANT TUMORS, BUT THERE WAS SIGNIFICANT, DOSE-DEPENDENT INCR IN INCIDENCE OF FOCAL BILE DUCT HYPERPLASIA. [REF-24]

BOBWHITE QUAIL WERE EXPOSED TO TRICYCLOHEXYLTIN HYDROXIDE AT DIETARY LEVELS OF 5.0 & 20.0 PPM FROM PRIOR TO THE ONSET OF EGG LAYING THROUGH THE NORMAL EGG PRODUCTION CYCLE. NO REPRODUCTIVE IMPAIRMENT OCCURRED. [REF-25]

Incubation of plictran (1x10-6 M) with rat liver homogenates caused a time dependent 50% inhibition of adenylate cyclase activity. The basal form of adenylate cyclase was more sensitive to plictran than the fluoride stimulated form. [REF-26]

SINGLE DOSES OF PLICTRAN ADMIN TO RATS AS LOW AS 3.75 MG/KG BW RESULTED IN INDUCTION OF HEME OXYGENASE & DECR IN CYTOCHROME P450 & CYTOCHROME B5 CONTENTS AT 72 HR IN LIVER. [REF-27]

In sheep, a single intraruminal injection of 25 mg/kg tricyclohexyltin hydroxide made the animals slightly anorexic; 50 mg/kg caused anorexia, CNS depression, & fluid diarrhea. [REF-28, p.V2 587]

The toxic effects of organotins were examined in rat brains, livers, & kidneys. Male albino Wistar rats received sc injections of 25 umol/100 g bw dioctyltin oxide, tricyclohexyltin hydroxide or tributyltin oxide. Animals were starved overnight & killed 24 hr after injection. Livers, kidneys, & brains were removed immediately & processed for determination of enzymic activity & biogenic amine concn. The activity of alkaline-phosphatase & adenosine triphosphatase significantly incr & monoamine oxidase activity significantly decr in the liver & kidney. Lactate dehydrogenase activity & succinate dehydrogenase activity significantly decr as compared to controls in livers of dioctyltin oxide & tricyclohexyltin hydroxide treated animals, but remained unaltered in the livers of tributyltin oxide treated animals. Succinate dehydrogenase activity was significantly inhibited in the kidneys of dioctyltin oxide treated rats only. Lactate dehydrogenase activity in kidneys was not altered by any of the organotins. Gamma-aminobutyric acid & dopamine concn were significantly lowered in the brains of all organotin treated rats. Monoamine oxidase activity in the brain was also significantly decr in all organotin treated animals. Dioctyltin oxide & tricyclohexyltin hydroxide reduced gamma-aminobutyric acid & dopamine concn more effectively than tributyltin oxide. /It was/ concluded that these organotins impair enzymic activity & reduce biogenic amines. Dioctyltin oxide & tricyclohexyltin hydroxide are more toxic than tributyltin oxide. [REF-29]

The effect of organotins on the rat platelet 5-hydroxytryptamine system was investigated. For in vitro tests, 11 different organotins were tested for inhibition of 5-hydroxytryptamine uptake as well as release 5-hydroxytryptamine in platelets from male Sprague-Dawley rats. For in vivo tests, male Sprague-Dawley rats were injected ip with 5 mg/kg of tricyclohexyltin hydroxide, 2.5 mg/kg of fenbutatin oxide, or 5 mg/kg of tri-n-butyltin-chloride. At 30 minutes & 24 hr after treatment, blood samples were taken & assayed for inhibition of 5-hydroxytryptamine uptake. Endogenous 5-hydroxytryptamine was determined by high performance liquid chromatography. In vitro, the compds with three organic moieties were the most potent inhibitors of 5-hydroxytryptamine uptake. The most active inhibitor was bis(tri-n-butyltin)-oxide, & the weakest was phenyltin trichloride. As releasers of 5-hydroxytryptamine, bis(tri-n-butyltin)-oxide was the most active, & hexaphenylditin was least active. All compds decr endogenous 5-hydroxytryptamine, but only fenbutatin oxide caused a significant decr. In vivo, 5-hydroxytryptamine uptake was decr by 27.8, 37, & 39.8% at 30 min by fenbutatin oxide, tri-n-butyltin chloride, & tricyclohexyltin hydroxide, respectively. At 24 hr, 5-hydroxytryptamine uptake was slightly, but insignificantly, reduced. Only fenbutatin oxide caued a significant reduction in endogenous 5-hydroxytryptamine. /It

was/ suggested that the organotins may interfere with adenosine-triphosphatase mediated system. [REF-30]

Male Japanese white rabbits were given orally two doses of tricyclohexyltin hydroxide, (150 mg/kg bw) at 48 hr intervals & their carbohydrate & lipid metabolisms were investigated 48 hr after the last admin. Elevated fasting blood glucose levels & a significant inhibition of insulin (IRI, immunoreactive insulin) release in response to the iv glucose infusion were observed. Microscopic exam of pancreatic islets did not reveal any histological alteration. Plasma triglyceride levels were elevated in the tricyclohexyltin hydroxide treated rabbits. Ultracentrifugation of plasma lipoproteins revealed a marked incr in chylomicron + very low density lipoprotein fraction. Rates of triglyceride secretion into plasma were not different between the tricyclohexyltin hydroxide treated & the control animals. These data suggest that tricyclohexyltin hydroxide induces hyperglycemia & hyperlipidemia in rabbits, & the disturbance of metabolism seems to be related to the inhibition of insulin release from the pancreatic islets by tricyclohexyltin hydroxide. [REF-31]

Rats fed low to moderate (up to 12 mg/kg BW) doses of tricyclohexyltin hydroxide for 2 yr had incr in the number of tumors, but their patterns & distributions were fairly random & did not exhibit a dose-dependent relationship. [REF-32, p.269]

Virtually non-hazardous to honeybees (dermal LD50 0.032 mg/bee) at the recommended rates of use. [REF-1, p.257]

Virtually non-hazardous to most predacious mites and insects at the recommended rates of use. [REF-1, p.257]

Rats fed low to moderate (up to 12 mg/kg BW) doses of tricyclohexyltin hydroxide for 2 years had increases in the number of tumors, but their patterns and distributions were fairly random and did not exhibit a dose-dependent relationship. [REF-32, p.269]

Evidence for Carcinogenicity

A4; Not classifiable as a human carcinogen. [REF-21, p.25]

METABOLISM AND PHARMACOLOGY

Absorption, Distribution, and Excretion

IN METABOLIC STUDY IN RATS GIVEN 25 MG/KG (119)TIN LABELED TRICYCLOHEXYLHYDROXYTIN ORALLY, ALMOST ALL RADIOACTIVITY WAS RECOVERED IN THE URINE & FECES DURING A 9 DAY PERIOD WITH ABOUT 80% IN THE FIRST 4 DAYS, THE FECES CONTAINING 98%, & THE URINE 2%. [REF-33]

(119)TIN LABELED TRICYCLOHEXYLTIN HYDROXIDE ADMIN ORALLY TO RATS WAS 99.9% EXCRETED AFTER 9 DAYS, MOSTLY BY WAY OF THE FECES. AFTER ORAL ADMIN OF DIET CONTAINING 100 PPM TO RATS FOR APPROX 90 DAYS, THE LOWEST TIN LEVELS WERE IN THE BLOOD AND FAT AND THE HIGHEST IN THE KIDNEYS. TRICYCLOHEXYLTIN HYDROXIDE WAS THE PRIMARY TIN COMPOUND IN MUSCLE TISSUE 2 DAYS AFTER WITHDRAWAL OF PLICTRAN FROM THE DIET. [REF-35]

Metabolism/Metabolites

ANALYSIS FOR METABOLITES IN TISSUE /RATS/ THAT HAD BEEN ON DIETARY LEVEL OF 3 MG/KG /TRICYCLOHEXYLTIN HYDROXIDE/ FOR 90 DAYS SHOWED 45% OF THE TOTAL TIN TO BE IN FORM OF THE ORIGINAL CMPD IN THE LIVER WITH ONLY SLIGHTLY GREATER AMT FOUND AS METABOLIZED PRODUCTS, DICYCLOHEXYL TIN OXIDE AND INORGANIC TIN. [REF-33]

PLICTRAN YIELDS PRODUCTS WITH THE ANTICIPATED CHROMATOGRAPHIC PROPERTIES FOR 2-, 3-, & 4-HYDROXYCYCLOHEXYLDICYCLOHEXYLTIN DERIVATIVES. THE 2-HYDROXY METABOLITE IS READILY DEGRADED TO CYCLOHEXANE &

DICYCLOHEXYLTIN COMPOUNDS. [REF-36]

When (114)tin-tricyclohexyltin hydroxide was given as single oral doses to rats, dogs, cattle & sheep, the label was excreted almost entirely in feces. Only traces of residues occurred in tissues. Evidence indicated that such metabolism as did occur converted this compound by sequential removal of cyclohexyl groups to dicyclohexyltin oxide, cyclohexylstannoic acid, & to inorganic tin. [REF-37, p.520]

ENVIRONMENTAL FATE AND EXPOSURE POTENTIAL

Environmental Fate/Exposure Summary

Tricyclohexyltin hydroxide's former use as an acaricide resulted in its direct release to the environment. Its former production may have resulted in its direct release to the environment. If released to air, an estimated vapor pressure of 2X10-9 mm Hg at 25 deg C indicates tricyclohexyltin hydroxide will exist solely in the particulate phase in the ambient atmosphere. Particulate-phase tricyclohexyltin hydroxide will be removed from the atmosphere by wet and dry deposition. Tricyclohexyltin hydroxide may undergo direct photolysis. 65% and 96% photodegradation was observed after 8-10 and 30 hours of irradiation, respectively. The observed products of photodegradation included inorganic tin compounds, dicyclohexyltin oxide, cyclohexylstannoic acid, and unchanged tricyclohexyltin hydroxide. If released to soil, tricyclohexyltin hydroxide is expected to have no mobility based upon a Koc of >4365. Volatilization from moist soil surfaces is not expected to be an important fate process since tricyclohexyltin hydroxide will dissociate in water to the tricyclohexyltin cation and ions will not volatilize. Biodegradation in soil or water is not expected to be an important environmental fate process. If released into water, tricyclohexyltin hydroxide is expected to adsorb to suspended solids and sediment based upon the Koc. A BCF range of 5-112 suggests bioconcentration in aquatic organisms is low-to-moderate. Occupational exposure to tricyclohexyltin hydroxide may have occurred through dermal contact with this compound at workplaces where tricyclohexyltin hydroxide was produced or used. Monitoring data indicate that the general population may be exposed to tricyclohexyltin hydroxide via ingestion of contaminated food. (SRC)

Ecotoxicity Values

- LC50 MICROPTERUS SALMOIDES (LARGEMOUTH BASS) 2.1 UG/L/96 HR AT 18 DEG C (95% CONFIDENCE LIMIT 1.9-2.3 UG/L), WT 0.8 G /STATIC BIOASSAY, TECHNICAL MATERIAL 95% IN HARD WATER/ [REF-34, p.67]
- LC50 GAMMARUS FASCIATUS (SCUD) 5 UG/L/96 HR AT 15 DEG C; MATURE, /STATIC BIOASSAY, TECHNICAL MATERIAL, 95%/ [REF-34, p.67]
- LC50 LEPOMIS MACROCHERIS (BLUEGILL) 6.7 UG/L/96 HR AT 18 DEG C (95% CONFIDENCE LIMIT 5.8-7.7 UG/L), WT 1.1 G, /STATIC BIOASSAY, TECHNICAL MATERIAL, 95%/ [REF-34, p.67]
- LD50 Bobwhite quail oral 520 mg/kg in 8 day diet [REF-1, p.257]

Environmental Fate

- TERRESTRIAL FATE: Based on a classification scheme(1), a Koc value of >4365 (2), indicates that tricyclohexyltin hydroxide is expected to have slight mobility in soil(SRC). Volatilization from moist soil surfaces is not expected to be an important fate process since tricyclohexyltin hydroxide will dissociate in water to the tricyclohexyltin cation and ions will not volatilize(SRC). Tricyclohexyltin hydroxide is not expected to volatilize from dry soil surfaces(SRC) based upon an estimated vapor pressure of 2X10-9 mm Hg(SRC), determined from a fragment constant method(3). The field half-life for tricyclohexyltin hydroxide is reported to be 50 days(2). Biodegradation in soil is not expected to be an important environmental fate process as evidenced by the lack of dicyclohexyl and monocyclohexyl degradation products in soils under aerobic or anaerobic conditions(4). [REF-39]

- AQUATIC FATE: Based on a classification scheme(1), a Koc value of >4365(2), indicates that tricyclohexyltin hydroxide is expected to adsorb to suspended solids and sediment(SRC). Volatilization from water is not expected to be an important fate process since tricyclohexyltin hydroxide will dissociate in water to the tricyclohexyltin cation and ions will not volatilize(SRC). According to a classification scheme(3), a BCF range of 5-112(4,5), suggests the potential for bioconcentration in aquatic organisms is low-to-moderate(SRC). Biodegradation in water is not expected to be an important environmental fate process as evidenced by the lack of dicyclohexyl and monocyclohexyl degradation products in soils under aerobic or anaerobic conditions(6). [REF-40]
- ATMOSPHERIC FATE: According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere(1), tricyclohexyltin hydroxide, which has an estimated vapor pressure of 2X10-9 mm Hg at 25 deg C(SRC), determined from a fragment constant method(2), is expected to exist solely in the particulate phase in the ambient atmosphere(3). Particulate-phase tricyclohexyltin hydroxide may be removed from the air by wet and dry deposition(SRC). Tricyclohexyltin hydroxide may undergo direct photolysis. 65% and 96% photodegradation was observed after 8-10 and 30 hours of irradiation, respectively(4). The observed products of photodegradation included inorganic tin compounds, dicyclohexyltin oxide, cyclohexylstannoic acid, and unchanged tricyclohexyltin hydroxide(4). [REF-41]

Biodegradation

- Studies with plictran indicated degradation proceeded to inorganic tin compounds with stannic acid as the main product. [REF-37, p.519]
- Studies were conducted with Plictran 50W. This was applied to orchard crops 3 to 6 times. Maximum levels of organotin ranged from 1.3 ppm to approx 2.5 ppm; inorganic tin, 0.3 to 1.5 ppm above controls. The presence of 3 organotin fractions was shown; unchanged compound, dicyclohexyltin oxide, and monocyclohexylstannoic acid, and inorganic tin compounds, mainly stannic acid. [REF-37, p.520]
- The half-life for disappearance of tricyclohexyltin hydroxide from soil has been estimated to be approx 50 days in soil following the spraying of the insecticide in an orchard in spring in a field study(1). No attempt was made to determine the relative contributions to degradation from biodegradation, soil catalyzed degradation, and photolysis on the soil surface(1). No methylation of tricyclohexyltin hydroxide degradation products was observed in soils under aerobic or anaerobic conditions(2). [REF-42]

Abiotic Degradation

- TRICYCLOHEXYLTIN HYDROXIDE RAPIDLY UNDERGOES PHOTODECOMPOSITION, THE MAIN PRODUCTS BEING INORGANIC TIN (80%) WITH TRACES OF DICYCLOHEXYLTIN OXIDE, CYCLOHEXYLSTANNIC ACID, AND TRICYCLOHEXYLTIN HYDROXIDE UNCHANGED. THE LONGER THE EXPOSURE AND THE MORE INTENSE THE LIGHT, THE MORE TRICYCLOHEXYLTIN HYDROXIDE WILL BE DECOMPOSED. [REF-43]
- The half-life for tricyclohexyltin hydroxide on the surface of fruits is approx 20 days, the degradation purportedly due mainly to photolysis(1). Degradation proceeds to inorganic tin through the isolated intermediates, dicyclohexyltin oxide and cyclohexylstannoic acid(1). The half-life for disappearance of tricyclohexyltin hydroxide from soil has been estimated to be approx 50 days in soil following the spraying of the insecticide in an orchard in spring in a field study(1). No attempt was made to determine the relative contributions to degradation from biodegradation, soil catalyzed degradation, and photolysis on the soil surface(1). Tricyclohexyltin hydroxide may dissociate to a certain extent into tricyclohexyltin and hydroxide in solution and may exist as or be rapidly converted to oxides or carbonates(2) which may affect the chemical's reactivity and transport processes(SRC). Tricyclohexyltin hydroxide coated on pyrex glass

slides was observed to rapidly photodegrade when irradiated with a sunlamp(3). 65% and 96% photodegradation was observed after 8-10 and 30 hours of irradiation, respectively(3). The observed products of photodegradation included inorganic tin compounds (80%), dicyclohexyltin oxide (10%), cyclohexylstannoic acid (5%), and unchanged tricyclohexyltin hydroxide (4%)(3). The presence of waxy material from the surface of apples did not have an observable effect on the photodegradation(3). [REF-44]

Bioconcentration

- An experimental BCF of 5 has been determined for tricyclohexyltin hydroxide in static ecosystems tests using an unreported species of fish(1). The BCFs in crucian carp obtained in a 7-day experiment were 50(muscle), 50 (vertebra); 112 (liver); and 31 (kidney)(2). According to a classification scheme(3), these BCF values suggest the potential for bioconcentration in aquatic organisms is moderate(SRC). [REF-45]

Soil Adsorption/Mobility

- The Koc for tricyclohexyltin hydroxide is >4365(1). According to a classification scheme(2), this Koc value suggests that tricyclohexyltin hydroxide is expected to be immobile in soil. Tricyclohexyltin hydroxide appears to be strongly bound to soil based on a field experiment in which 90% of the cyclohexyltin compounds found in the soil of an orchard sprayed with a tricyclohexyltin hydroxide formulation was present in the uppermost 1 cm layer of the soil(3). [REF-46]

Volatilization from Water/Soil

- Volatilization from moist soil surfaces is not expected to be an important fate process since tricyclohexyltin hydroxide will dissociate in water to the tricyclohexyltin cation and ions will not volatilize(SRC). Tricyclohexyltin hydroxide is not expected to volatilize from dry soil surfaces(SRC) based upon a an estimated vapor pressure of 2X10-9 mm Hg(SRC), determined from a fragment constant method(1). [REF-47, p.31]

SOURCES AND CONCENTRATIONS

Artificial Sources

- Tricyclohexyltin hydroxide's former(2) use as an acaricide(1) resulted in its direct release to the environment(SRC). Tricyclohexyltin hydroxide's former (2) production may have resulted in its direct release to the environment (SRC). [REF-38]

Food Survey Values

- After the multiple application of tricyclohexyltin hydroxide to apples and pears, the mean fruit concn of tin was 0.3 mg/kg, and a maximum below 2.0 mg/kg. The miticide decomposed with a half-time of 3 weeks, and most could be removed by washing and peeling. [REF-28, p.V2 574]
- Tricyclohexyltin hydroxide was detected in 142 of 19,851 samples of various foods and animal feeds analyzed from Oct 1981 to Sept 1986; the numbers of samples found at various concn ranges were as follows: 11 samples at >0.05 to 0.10 ppm; 49 samples at >0.10 to 0.50 ppm; 27 samples at >0.50 to 1.0 ppm; 26 samples at >2.0 ppm(1). [REF-48]
- The concn of tricyclohexyltin hydroxide in produce like tomatoes, cucumbers and bell peppers grown in green houses were unlikely to exceed 0.5 mg/kg(1). Tricyclohexyltin hydroxide residues were found in raw agricultural commodities by the US FDA during regulator monitoring in 1978-1982(2) and 1983-1986(3). During each of these periods about

49,000 samples were analyzed. Similarly tricyclohexltin hydroxide residues were found in food samples collected and analyzed by 10 state food laboratories in 1988 and 1989 (27,000 samples)(4). The number of samples containing residues and the concn found in these studies were not reported. [REF-49]

Plant Concentrations

- Apples and pears sprayed four times with tricyclohexyltin hydroxide had maximum organotin residues of 2 mg/kg of whole fruit on the day of final application; the concn was reduced to about half in 3-5 wks as a result of photodegradation(1). The residue consisted mostly of tricyclohexyltin hydroxide with very little degradation product; total tin concns were below 0.2 mg/kg. [REF-50]

HUMAN ENVIRONMENTAL EXPOSURE

Probable Routes Of Human Exposure

- Occupational exposure to tricyclohexyltin hydroxide may have occurred through dermal contact with this compound at workplaces where tricyclohexyltin hydroxide was produced or used. Monitoring data indicate that the general population may be exposed to tricyclohexyltin hydroxide via ingestion of contaminated food. (SRC)

STANDARDS AND REGULATIONS

Immediately Dangerous to Life or Health (IDLH)

- 80 mg/cu m [REF-15, p.86]

Acceptable Daily Intakes

- FAO/WHO ADI: 0.001 mg/kg bw [REF-51, p.634 FAO]

Allowable Tolerances

- Tolerances are established for combined residues of the pesticide cyhexatin (tricyclohexylhydroxystannane; CAS Reg No 13121-70-5) and its organotin metabolites (calculated as cyhexatin) in or on the following food commodities: almonds, 0.5 ppm; almond, hulls, 60 ppm; apples, 2 ppm; cattle, fat, 0.2 ppm; cattle, kidney, 0.5 ppm; cattle, liver, 0.5 ppm; cattle, mbyp (excluding kidney, liver), 0.2 ppm; cattle, meat, 0.2 ppm; citrus fruits, 2 ppm; citrus pulp, dried, 8 ppm; goats, fat, 0.2 ppm; goats, kidney, 0.5 ppm; goats, liver, 0.5 ppm; goats, mbyp (excluding kidney, liver), 0.2 ppm; goats, meat, 0.2 ppm; hogs, fat, 0.2 ppm; hogs, kidney, 0.5 ppm; hogs, liver, 0.5 ppm; hogs, mbyp (excluding kidney, liver), 0.2 ppm; hogs, meat, 0.2 ppm; hops, 30 ppm; hops, dried, 90 ppm; horses, fat, 0.2 ppm; horses, kidney, 0.5 ppm; horses, liver, 0.5 ppm; horses, mbyp (excluding kidney, liver), 0.2 ppm; horses, meat, 0.2 ppm; macadamia nuts, 0.5 ppm; milk, fat (=N in whole milk), 0.05 ppm; nectarines, 4 ppm; peaches, 4 ppm; pears, 2 ppm; plums (fresh prunes), 1 ppm; prunes, dried, 4 ppm; sheep, fat, 0.2 ppm; sheep, kidney, 0.5 ppm; sheep, liver, 0.5 ppm; sheep, mbyp (excluding kidney, liver), 0.2 ppm; sheep, meat, 0.2 ppm; strawberries, 3 ppm; and walnuts, 0.5 ppm. [REF-52]

Niosh Recommendations

- Recommended Exposure Limit: 10 hr Time-Weighted avg: 5 mg/cu m [REF-15, p.86]

Threshold Limit Values

- 8 hr Time Weighted Avg (TWA): 5 mg/cu m. [QR] [REF-53, p.22]
- Excursion Limit Recommendation: Excursions in worker exposure levels may exceed three times the TLV-TWA for no more than a total of 30 min during a work day and under no circumstances should they exceed five times the TLV-TWA, provided that the TLV-TWA is not exceeded. [QR] [REF-53, p.5]
- A4; Not classifiable as a human carcinogen. [QR] [REF-53, p.22]

State Drinking Water Guidelines

- (FL) FLORIDA 4,200 ug/l /Tin/ [QR] [REF-54]
- (MN) MINNESOTA 4000 ug/l /Tin/ [QR] [REF-54]

FIFRA Requirements

- Tolerances are established for combined residues of the pesticide cyhexatin (tricyclohexylhydroxystannane; CAS Reg No 13121-70-5) and its organotin metabolites (calculated as cyhexatin) in or on the following food commodities: almonds; almond, hulls; apples; cattle, fat; cattle, kidney; cattle, liver; cattle, mbyp (excluding kidney, liver); cattle, meat; citrus fruits; citrus pulp, dried; goats, fat; goats, kidney; goats, liver; goats, mbyp (excluding kidney, liver); goats, meat; hogs, fat; hogs, kidney; hogs, liver; hogs, mbyp (excluding kidney, liver); hogs, meat; hops; hops, dried; horses, fat; horses, kidney; horses, liver; horses, mbyp (excluding kidney, liver); horses, meat; macadamia nuts; milk, fat (=N in whole milk); nectarines; peaches; pears; plums (fresh prunes); prunes, dried; sheep, fat; sheep, kidney; sheep, liver; sheep, mbyp (excluding kidney, liver); sheep, meat; strawberries; and walnuts. [REF-52]

MONITORING AND ANALYSIS METHODS

Analytic Laboratory Methods

- AOAC Method 988.02. Technical Cyhexatin in Pesticide Formulations by Liquid Chromatographic Method. /Cyhexatin/ [REF-55]
- NIOSH Method 5504. Analyte: Tricyclohexyltin hydroxide. Matrix: Air. Procedure: Atomic absorption, graphite furnace. For tricyclohexyltin hydroxide, this method has an estimated detection limit of 1 ug tin per 300 liter sample. The overall precision/RSD is 7.1%. Applicability: The working range is 0.015 to 1 mg/cu m (as tin) for a 300 liter air sample. Interferences: Organotin compounds not separated chromatographically will mutually interfere. Other compounds with similar retention times will not interfere unless they contain tin. [REF-56]
- DETERMINATION OF TRIPHENYLTIN COMPOUNDS & TRICYCLOHEXYLTIN HYDROXIDE BY GAS CHROMATOGRAPHY OF THEIR DERIVATIVES. A GAS-LIQUID CHROMATOGRAPHIC METHOD IS REPORTED FOR THE DETERMINATION OF TRIPHENYLTIN DERIVATIVES & TRICYCLOHEXYLTIN HYDROXIDE AFTER THEIR CONVERSION (BY WAY OF GRIGNARD REACTION CATALYZED BY COPPER CHLORIDE) TO TETRAPHENYLTIN & TRICYCLOHEXYLPHENYLTIN. THE RECOVERY OF TETRAPHENYLTIN & TRICYCLOHEXYLPHENYLTIN WAS SATISFACTORY IN THE RANGE OF 50 TO 3000 UG. DIFFERENT COLUMNS WERE TESTED USING FLAME-IONIZATION DETECTION. FOR BOTH DERIVATIVES, THE RESPONSE WAS LINEAR FROM 0.05 TO 3.00 UG. RESULTS OF THERMAL ANALYSIS, IR SPECTROSCOPY, & MASS SPECTROMETRY ARE REPORTED. [REF-57]

MANUFACTURING AND USE INFORMATION

Methods of Manufacturing

- For the preparation of tricyclohexyltin chloride, the Kocheshkov redistribution reaction is not suitable. ... Two alternative routes are practiced for the manufacture of tricyclohexyltin chloride. The closely controlled reaction of

cyclohexylmagnesium chloride and stannic chloride in a three-to-one molar ratio can be made to give the desired product in good yield. Another method involves 2 steps for the prepn. ... In the first step, butyltin trichloride reacts with 3 moles of cyclohexylmagnesium chloride forming butyltricyclohexyltin. This tetraorganotin then reacts with stannic chloride under mild conditions in an inert solvent, cleaving a butyl group and yielding tricyclohexyltin chloride and butyltin trichloride. The latter is recovered and recycled. ... Tricyclohexyltin chloride is converted to the hydroxide with sodium hydroxide. [REF-5, p.V24 139]

- GRIGNARD REAGENT IS REACTED WITH TIN TETRACHLORIDE. [REF-6, p.151]
- Preprn: E.E. Kenaga U.S. Patent 3,264,177 (1966 to Dow) [REF-7, p.466]

Formulations/Preparations

- USEPA/OPP Pesticide Code 101601; Trade Names: Plictran, Dowco 213. [REF-2]
- 'PLICTRAN 50 W', WETTABLE POWDER (500 G AI/KG); IN AFRICA, EUROPE AND THE MIDDLE EAST: 'PLICTRAN 25W', WETTABLE POWDER (250 G/KG); PLICTRAN 600F, SC (600 G/L). MIXTURES INCLUDE: DORVERT, SC (150 G CYHEXATIN + 50 G TETRADIFON/L). [REF-8, p.210]
- Plictran 50W miticide; wettable powder, 50.0% cyhexatin (tricyclohexylhydroxystannane). [REF-3]
- Ortho Plictran 50 Wettable Miticide; wettable powder, 50.0% cyhexatin (tricyclohexylhydroxystannane). [REF-3]
- Tricyclohexyltin hydroxide; technical chemical, 95% cyhexatin (tricyclohexylhydroxystannane). [REF-3]
- Wettable powder, suspension concentrate [REF-9, p.303]

Manufacturers

- Dow Chemical USA, Hq, 2020 Dow Center, Midland, MI 48674, (517) 636-1000; Production site: Main St, Midland, MI 48667 [REF-10, p.825]
- M&T Chemicals Inc, Hq, Woodbridge Rd & Randolph Ave, PO Box 1104, Rahway, NJ 07065, (201) 499-0200; Production site: Carrollton, KY 41008 [REF-10, p.825]
- Elf Atochem North America, Inc., Hq, 2000 Market Street, 21st Floor, Philadelphia, PA 19103-3222, (215) 419-7219 [REF-11, p.C 113]

Other Manufacturing Information

- Developed from a joint project of Dow Chemical Co. and M&T Chemicals Inc. and introduced by Dow Chemical Co. (patents: US 3264177; US 3389048) development code: Dowco 213. [REF-9, p.305]
- Plictran (cyhexatin) /is/ discontinued by Dow Chem Co. [REF-12, p.C-177]
- Introduced into the U.S. market by Dow Chemical Company as Plictran. [REF-13, p.V24 139]

Major Uses

- For Tricyclohexyltin (USEPA/OPP Pesticide Code: 101601) there are 0 labels match. /SRP: Not registered for current use in the U.S., but approved pesticide uses may change periodically and so federal, state and local authorities must be consulted for currently approved uses./ [REF-2]
- Non systemic acaricide with contact action. Used to control the motile phase of phytophagous mites on pome fruit, stone fruit, vines, hops, nuts, bush fruit, strawberries, vegetables, cucurbits and ornimentals. /Former use/ [REF-9, p.303]

U.S. Production

(1978) 3.63X10+8 GRAMS (CONSUMPTION) [REF-14]

CHEMICAL AND PHYSICAL PROPERTIES

Molecular Weight 385.18 [REF-7, p.466]
Melting Point 196 deg C [REF-16, p.3-139]
Vapor Pressure Negligible (25 deg C) [REF-9, p.303]

Solubilities

- In water [REF-17]
- In acetone 1.3 g/kg at 25 deg C; in chloroform 216 g/kg at 25 deg C; in methanol 37 g/kg at 25 deg C; in toluene 10 g/kg at 25 deg C; in dichloromethane 34 g/kg at 25 deg C; in carbon tetrachloride 28 g/kg at 25 deg C; in benzene 16 g/kg at 25 deg C; in xylene 3.6 g/kg at 25 deg C [REF-9, p.303]

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