

INDOOR AIR CONCENTRATIONS OF ETHYLENE
GLYCOL MONOETHYL ETHER FOLLOWING
APPLICATION OF PROPETAMPHOS INSECTICIDE
EMULSIFIABLE CONCENTRATE

By

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SUMMARY

This study was conducted to assess exposures of workers and occupants to ethylene glycol monoethyl ether. Air concentrations of ethylene glycol monoethyl ether solvent were measured following indoor applications of propetamphos emulsifiable concentrate for flea control. Two applications were monitored, one a routine household application by a structural pest control operator, the other a test application designed to determine the influence of room ventilation on the glycol ether concentrations. Employee inhalation exposure to the glycol ether during mixing, loading, or applying were not detectable (minimum detectable level = 0.5 ppm). Skin exposure to the glycol ether was not measured in this study; however, this was probably minimized through the work practices used. No inhalation exposure to propetamphos was detected. Total hand exposure to propetamphos was 40 micrograms. Glycol ether concentrations in non-ventilated rooms were 1.8 to 2.2 ppm at two hours following application. Concentrations in ventilated rooms were not-detectable (minimum detectable level = 0.6 ppm). Toxicological studies have shown adverse reproductive effects in laboratory animals exposed to some glycol ethers at 150 to 250 ppm in the air.

INTRODUCTION

Ethylene glycol monoethyl ether (Cellosolve^R) is used as a solvent for resins, lacquers, textile dyes, in varnish removers, in cleaning solutions, and as an anti-icing additive in aviation fuels^{1/}. It is also used as a solvent in pesticide formulations. Ethylene glycol monoethyl ether is considered low in oral toxicity, not significantly irritating to the skin, slightly irritating to the eyes and mucous membranes, readily absorbed through the skin, but low in toxicity with skin exposure, and somewhat toxic when inhaled. Toxic effects are primarily in the blood^{2/}.

Recently, toxicological concerns have focused on the potentially adverse reproductive effects from exposure to ethylene glycol monomethyl ether and ethylene glycol monoethyl ether. A Material Safety Data Sheet (MSDS) issued by the manufacturer gives recommendations that pregnant women limit their exposure to these glycol ethers. It reports that, "in laboratory inhalation studies, birth defects, increased fetal lethality and delayed fetal development have been observed in offspring of female animals exposed during pregnancy, with a threshold response level in the range of 150 to 250 ppm concentration in air^{3/}." The California Department of Health Services recently summarized the data on the reproductive toxicity of glycol ethers. It was reported that 160 ppm inhalation exposures of ethylene glycol monoethyl ether were teratogenic to the offspring of rabbits. A 30 ppm no-effect level for teratogenic effects has been suggested, based upon animal studies. Larger doses, administered orally to male mice, produced testicular atrophy and retardation in sperm development. Conclusive evidence for adverse effects in humans is not available at this time^{4/}.

Propetamphos, the active ingredient in Safrotin^R, is a cholinesterase-inhibiting organophosphorus insecticide. Toxicological evaluation of propetamphos included teratology and multi-generation reproductive studies, oncogenic/lifetime feeding studies, and neurotoxicity studies. No adverse effects were noted under the conditions of the studies^{5/}.

The California Department of Food and Agriculture became concerned about the potential health hazards from exposure to propetamphos emulsifiable concentrate (EC) after some illnesses following exposure to this pesticide in 1982 and 1984 were reported. In 1982, sixteen telephone company employees sought medical attention following an application of propetamphos. Propetamphos was applied to the carpet while employees were in the office^{6/}. A second incident occurred in 1984 when four women employees entered work areas several hours following treatment. An added concern was that two of the four women reportedly were pregnant. Following the 1984 incident, a review of the registration records at CDFA for this pesticide revealed that the major inert ingredient in the EC formulation was ethylene glycol monoethyl ether. An air sampling study measuring potential exposures following the use of propetamphos EC was initiated to provide data for risk assessment of potential reproductive toxicity in occupants of treated structures and employees applying this pesticide.

STUDY SITES

Two pesticide applications were monitored in this study. Site #1 was a Sacramento home which underwent a routine treatment by a structural pest

control operator. Approximately 2,000 square feet of carpeted area was treated for fleas. The spray mixture consisted of one ounce of propetamphos emulsifiable concentrate per gallon of water. One gallon of spray was applied with a hand-pump sprayer. The spray mixture was prepared by hand pouring the formulation; rubber gloves were worn by the employee. Mixing, loading, and applying required approximately 20 minutes.

Site #2 consisted of two vacant apartments in a complex, each having 488 square feet of carpeted area treated. Application rate was 1.25 ounces per gallon of water with 42 ounces of finished spray applied to each room. A hand-pump sprayer with a fine nozzle was used, operating at a nozzle pressure of 25 psi. Mixing, loading, and applying required approximately 20 minutes. The effect of natural ventilation on glycol ether vapor concentrations was studied by opening all the windows in one apartment following application and leaving the windows closed in the second apartment.

MATERIALS AND METHODS

Air samples were collected to measure glycol ether concentrations inside treated structures. Employee inhalation exposures to propetamphos and the glycol ether were measured by collecting air samples from employee breathing zones. Appropriate collection media (activated charcoal tubes for glycol ether vapors; glass fiber filters and porous polymer resin tubes for propetamphos aerosols and vapors) and battery-powered portable air sampling pumps operating at various flow rates (calibrated from 0.2 to 2 L/min.)^{7/},^{8/},^{9/}. Pump flow rates were determined with a Kurz Model 540S electronic mass flow indicator.

Potential skin exposures were measured with Kodak cotton photographic gloves worn by the employee. Separate sets of gloves were worn for mixing/loading and for application^{10/}.

At Site #1, glycol ether concentrations were measured beginning 20 minutes following application. Duplicate samples were collected for a single 20 minute period from one room in the structure. This room was 2,500 cubic feet in volume, with one entrance, no windows opened, and a ceiling fan operating during the sampling period.

At Site #2, glycol ether dissipation was measured with samples drawn at 20 minutes, 60 minutes, and 120 minutes following the completion of application. Sampling durations were approximately 15 minutes. Samples were drawn from two locations in each apartment (the living room and one bedroom). A separate air sampler operated continuously in each apartment for 120 minutes, beginning 20 minutes post-application, providing time-weighted-average concentration measurements.

All samples were stored in glass jars, chilled on ice, and submitted to the Department's Chemistry Laboratory Services for chemical analysis. Propetamphos and ethylene glycol monoethyl ether levels were determined with gas chromatography. Instrument sensitivity was 60 ug per sample. Glycol ether samples collected at Site #1 were analyzed by the California Department of Health Services (instrumental sensitivity was 10 ug per sample).

RESULTS

Indoor concentrations of ethylene glycol monoethyl ether following propetamphos applications are summarized in Tables I and II. Concentrations at Site #1 were approximately 1 ppm 20 minutes following application. Concentrations at Site #2 (unventilated apartment) were 3.2 to 3.7 ppm 20 minutes following application. These declined from 1.8 to 2.2 ppm at 2 hours following application. Two hour time-weighted average concentration was 3 ppm. Ventilation provided by open windows kept concentrations below 0.6 ppm (measured with the two hour time-weighted average sample).

Employee exposure measurements are summarized in Table III. Air sampling results revealed no detectable potential inhalation exposures to propetamphos or the glycol ether. During mixing/loading, 4 ug of propetamphos were detected on cloth gloves, with 36 ug detected during application. Diazinon was also detected on the cloth glove samples (74 ug during mixing/loading, 373 ug during application).

DISCUSSION

Employee exposures to ethylene glycol monoethyl ether were probably acceptably low in the applications study. The handling of very small volumes of emulsifiable concentrate and the use of gloves should reduce dermal exposure potential. The lack of detectable inhalation exposures is probably a result of the glycol ether being delivered as an aerosol, so insufficient time elapses for vapors to form while the employee treats the structure. Should a substantially greater length of time be required to treat a structure (than was observed in this study), excess inhalation exposure becomes possible. Propetamphos inhalation did not occur probably because the samples were collected from the breathing-zone, while the aerosol, during this application, was directed at the floor.

Hand exposures to propetamphos were relatively low, when compared to mixers/loaders/applicators in agricultural pest control, again probably due to the handling of small amounts of the pesticide. Exposure during application was higher, since a spray aerosol provides a greater opportunity for skin contact. Diazinon exposure probably originated from residues contaminating the hand sprayer from previous applications.

Applications of propetamphos emulsifiable concentrate resulted in detectable concentrations of glycol ether in the air in structures with limited ventilation. Based on the 2-hour time-weighted-average samples at Site #2, glycol ether concentrations were at least five times greater in the unventilated apartment than the ventilated apartment (respectively, 3 ppm and less than 0.6 ppm). Reducing the potential teratogenic hazard for pregnant women or animals occupying a treated structure could be accomplished by providing ventilation (opening windows) following application and specifying a reentry time interval. A teratogenic no-effect threshold for humans should be considered when designing ventilation and reentry requirements, though currently, a no-effect threshold has not been proposed for exposure to humans.

Zoecon Corporation, the manufacturer of Safrotin^R, voluntarily withdrew remaining stocks of the insecticide left in California, re-introducing a new

formulation (see Appendix I) because of CDFA's concern about difficulties in regulating levels of exposure to this glycol ether in rooms where pregnant women might work or reside.

CONCLUSION

Ethylene glycol monoethyl ether, a solvent in the emulsifiable concentrate formulation of propetamphos insecticide, has been determined to be teratogenic in animal toxicity studies. Low concentrations of this glycol ether were detected in the air inside structures treated with propetamphos. Lack of ventilation appears to be associated with higher air concentrations. In an unventilated structure, concentrations up to 2 ppm in the air were detected 2 hours following application.

The toxicological significance of glycol ether exposure for occupants of treated structures is uncertain with regard to teratogenic risk. Mixer/loader/applicator exposures to propetamphos and the glycol ether that were measured in this study were probably not excessive.

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TABLE I

Concentrations of Ethylene Glycol Monoethyl
Ether Following Indoor Applications of
Propetamphos Emulsifiable Concentrate

Site #1 - Sacramento August 28, 1984

<u>Sampling Period</u>	<u>Sampling Duration (min.)</u>	<u>Sample Volume (L)</u>	<u>ppm Detected</u>
20 minutes post-application	15	8.1	1.0
20 minutes post-application	15	3.0	0.94

TABLE II

Concentrations of Ethylene Glycol Monoethyl Ether Following Indoor Applications of Propetamphos Emulsifiable Concentrate

Site #2 - San Jose September 6, 1984

Sampling Period	<u>Ventilated Apartment</u>				<u>Living Room</u>		<u>Bedroom</u>		
	MDL ^{a/} (ppm)	Sampling Duration (minutes)	Sample Volume (L)	ppm Detected	MDL (ppm)	ppm Detected	MDL (ppm)	Sampling Duration (minutes)	Sample Volume (L)
Pre-Application	0.91	19	35.2	ND	1.02	ND	1.02	19	31.4
20 Minutes Post-Application	1.53	15	21	ND	1.34	ND	1.34	16	24
60 Minutes Post-Application	1.41	16	22.8	ND	1.83	ND	1.83	16	17.6
120 Minutes Post-Application	1.21	18	26.6	ND	2.82	ND	2.82	19	11.4 ^{c/}
20 Minutes Post-Application	0.55	116	58	-	-	-	-	-	-

TABLE II (Continued)

Unventilated Apartment

<u>Sampling Period</u>	<u>Living Room</u>				<u>Bedroom</u>			
	<u>ppm Detected</u>	<u>MDL (ppm)</u>	<u>Sampling Duration (minutes)</u>	<u>Sample Volume (L)</u>	<u>ppm Detected</u>	<u>MDL (ppm)</u>	<u>Sampling Duration (minutes)</u>	<u>Sample Volume (L)</u>
Pre-Application	ND	1.26	17	25.5	ND	1.26	17	25.5
20 Minutes Post-Application	3.67	-	16	28.8	3.16	-	16	22.4
60 Minutes Post-Application	3.02	-	15	26.6	2.58	-	16	22.4
120 Minutes Post-Application	2.21	-	16	27.6	1.8	-	15	21
20 Minutes Post-Application	3.06	-	118	43.1	-	-	-	-

a/MDL - minimum detection limit

b/ND - none detected (less than the MDL)

c/Small sample volume due to erratically operating pump

TABLE III

Employee Exposures During Mixing,
Loading and Applying Propetamphos
Emulsifiable Concentrate

<u>Application Site</u>	<u>Compound Monitored</u>	<u>Job Type</u>	<u>Exposure Type</u>	<u>Concentration or Amount Detected</u>
Sacramento	Propetamphos	M/L ^{a/}	Inhalation	Sample Lost
		A ^{b/}	Inhalation	ND ^{c/}
		M/L	Hands	3.9 ug
		A	Hands	36.0 ug
	Glycol ether	M/L	Inhalation	ND ^{d/}
		A	Inhalation	ND ^{d/}
	Diazinon	M/L	Hands	74.2 ug
		A	Hands	373 ug
San Jose	Glycol ether	M/L/A	Inhalation	ND ^{e/}

^{a/} M/L - Mixing and loading

^{b/} A - Application

^{c/} ND - None detected, minimum detection limit was 2 ppb.

^{d/} ND - None detected, minimum detection limit was 0.5 ppm.

^{e/} ND - None detected, minimum detection limit was 1.6 ppm.

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