TREATMENT OF PESTICIDE-CONTAINING SOIL

Ian L. Pepper and John E. Watson
Department of Soil and Water Science
University of Arizona
Tucson, Arizona 85721

ABSTRACT

Large amounts of pesticides have accumulated in soils adjacent to aerial applicator landing strips. These soils are currently considered to be toxic waste materials and must be decontaminated. Pesticides of concern include methyl and ethyl parathion and toxaphene. Of these toxaphene is the most resistant to degradation. Since toxaphene is toxic to animals, and is also carcinogenic, then methods to detoxify toxaphene contaminated soils must be found. The objective of this current project is to identify a time and cost effective detoxifying treatment. Specific alternatives are ultraviolet (UV) photo decomposition and microbial degradation. The project was initiated in November 1985. Preliminary data indicate that a UV treatment reduced toxaphene in soil by 27.8% after 42 days. When a UV treatment was combined with microbial degradation, the reduction was 4.9%. However, this latter treatment contained lower initial toxaphene concentrations.

INTRODUCTION

Until recently, toxaphene has been one of the most extensively used chlorinated pesticides in the United States. It was predominantly applied in combination with methyl parathion to cotton fields to reduce insect damage. Since the pesticide was usually applied via aerial applicators, then large amounts of toxaphene have accumulated in soils adjacent to the landing airstrips. Toxaphene is toxic to animals and is also a carcinogin. Hence, soil contaminated with toxaphene is considered to be a hazardous toxic waste material and must be detoxified. Sales of toxaphene in Arizona are shown in Table 1 from the years 1966 to 1980 when it was banned.

TABLE 1. SALES OF TOXAPHENE

Year	lbs. sold (in thousands of lbs.)
1966	1028.5
1968	2028.2
1970	1932.6
1972	1468.3
1974	2031.7
1976	518.5
1978	858.3
1980	0.5

Less is known about toxaphene than any other organo chlorine. This is due to the complexity and variability of its components. It is produced by chlorinating comphene via photolysis in the presence of a catalyst. The resulting insecticide is a conglomerate of at least 177 C_{10} polychlorinated derivatives. Each C_{10} derivative contains 7 to 11 chlorine atoms accounting for approximately 68% of the total weight. The empirical formula is $C_{10}H_{10}Cl_8$ with an average molecular weight of 414 (2).

Over the years, toxaphene has been applied to soils in vast quantities. However, concentrations in soil may be reduced by photodecomposition, or chemical and/or microbial degradation. Toxaphene may leave soils via volatilization, or leaching, or be inactivated by adsorption to inorganic or organic colloids. Volatilization has been documented by Williams and Bidleman (3) while Clark and Matsumura (1) have shown that *Pseudomonas putida* can microbially degrade toxaphene.

concentration of pesticide contaminated waste-water and required the largest dosage of chemicals. Even with these high dosages, the supernatant remained turbid. The original results from the jar test, indicating that less chemicals are required to treat diluted mixture, held true for the larger scale trials.

Limited data on the concentration of pesticide in the effluent is available at this time. The initial analysis indicates that the concentration of permethrin in the effluent is about 0.2 mg/L. The supernatant after ferric sulfate and alum flocculation all had essentially the same concentration of pesticides.

To obtain additional information on the toxicity of the effluent, bio-assays using mosquito fish were conducted. The fish were taken from a drainage ditch on the LSU campus. Four fish were place in a solution of 0.5 L of ditch water and 0.5 L of the effluent from the carbon columns. The beaker was aerated and after 5 days all fish were alive and appeared healthy.

CONCLUSIONS

The major objective of this study was to develop a simplified procedure for selecting flocculants for use in the two stage treatment process that had been previously developed. Several commercially available "one-step" flocculants were compared to ferric sulfate and aluminum sulfate. Because of the very large dosages required to break the emulsion, it was found that aluminum or ferric salts followed by the addition of hydroxide produced the most consistent results. Dosages as high a 600 mg/L aluminum were required. It was also determined that the ferric hydroxide would form a denser precipitate.

It is doubtful that most pesticide applicators would have the patience to conduct the numerous jar test needed to find the right dosage, without some "hands-on" training.

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The overall objectives of this current project was to identify a time and cost effective land treatment of soil contaminated with pesticides.

Specific objectives are to evaluate the following land treatment systems: a) a surface treatment, in which the mode of pesticide degradation was primarily UV photodecomposition; and b) a sub-surface treatment, where the mode of degradation was essentially microbial decomposition plus UV photodecomposition.

In achieving these objectives, emphasis was placed on practical solutions to the problem of decpntamination of pesticide contaminated soils. These solutions must be time and cost effective.

The source of pesticide containing soil in this study was from aerial applicator airstrips in Arizona. Through the years, these soils have acquired large amounts of toxaphene. Large samples of such pesticide laden soils were thoroughly mixed to insure uniform composition. The soil was screened and sieved (<2mm) prior to use.

Wooden boxes were constructed 1 m^2 by 10 cm, lined with plastic, and placed out in the field at the University of Arizona, Marana Agricultural Center. The toxaphene contaminated soil (TCS) was applied evenly in the boxes to a depth of 5 mm. This treatment allowed maximum photodecomposition of the pesticide. Microbial degradation of the pesticide was encouraged by diluting the TCS with 50% Pima clay loam (PCL) which initially contained no toxaphene. The resulting mixture was similarly placed in the boxes, allowing photodecomposition and microbial degradation. Treatments were replicated four times, and left exposed to the atmosphere for a 6-month period. Samples were sacrificed with time and analyzed for toxaphene and methyl and ethyl parathion by gas chromatography.

RESULTS AND DISCUSSION

This project was initiated in November 1985, thus only preliminary data have been obtained. The toxaphene concentration of soils after 0 and 42 days are shown in Table 2.

Thus it can be seen that after 42 days exposure, the toxaphene in the contaminated soil (TCS) was reduced 27.8%, mainly by ultraviolet photodecomposition, whereas when deluted 50% with PCL, the toxaphene was reduced 4.9%. This latter treatment reflects the combined effects of photodecomposition and microbial degradation, but on a soil with a lower initial toxaphene concentration. Note that in both treatments volatilization will most likely have occurred, however the extent of this in unknown.

TABLE 2. TOXAPHENE CONCENTRATION IN SOIL

Time	ppm toxaphene	
days	TCS	50% TCS + 50% PCL
0	19850	9415
42	14340	8958

The initial methyl and ethyl parathion concentration in the contaminated soil are shown in Table 3.

TABLE 3. INITIAL METHYL AND ETHYL PARATHION CONCENTRATIONS IN SOIL

	ppm	
Pesticide	TCS	50% TCS + 50% PCL
Methyl Parathion	0.09	0.06
Ethyl Parathion	0.37	0.24

Since the values were so low, it was decided not to analyze for these contaminants at later sampling periods. It is of interest that the concentrations were so low and reflects the increased rate of degradation of these pesticides in soil as compared to toxaphene.

CONCLUSIONS

Conclusions are really not appropriate, at this early stage of the project. However, it is encouraging that toxaphene concentrations in both treatments were reduced after 42 days in the field.

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