

PERSISTENCE OF TETRACHLORODIBENZO-P-DIOXIN IN SOIL: TIMES BEACH CASE STUDY

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ABSTRACT

The rate of migration and loss of polychlorinated dibenzo-p-dioxin and related compounds is being investigated at Times Beach under natural conditions at Times Beach over a 5 order of magnitude concentration range.

INTRODUCTION

There is considerable uncertainty as to the concentration levels of 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD) at the time of initial release in such contaminated areas as Times Beach (Missouri) and Seveso (Italy). Part of the uncertainty is related to the deficiencies in the analytical methodologies, as in the case of Seveso during the initial analyses (1,2,3), or the long delay between the time of the accident and the time of analysis, as in the case of Times Beach (4).

Furthermore, there are discrepancies in the reported soil half-life estimates for even the most studied and toxic of the tetrachloro congeners. The values have ranged from 3 months to more than 10 years (5-8). The variability in half life is in part due to the differences in environmental factors and the depth of the initial penetration. It has been shown that the chemical and microbial degradation of TCDD under most soil environments is negligible. The predominant path for loss of these compounds from soil is through volatilization and subsequent photodegradation (9-10). However, volatilization losses are significant only from the top few millimeters of most soils other than sands. From the top layers under otherwise constant conditions the rate of loss is governed by pseudo first order kinetics and the loss is dependent on concentration.

A study has been initiated to monitor the rate of migration and loss of polychlorinated dibenzo-p-dioxins and related compounds under varied contamination scenarios such as the surface contamination which occurred at Times Beach and Seveso as well as the contamination in deep saturated soil zones as is the case with many wood treatment facilities.

EXPERIMENTAL

The studies are being conducted under natural conditions at the Dioxin

prepared using soil which was contaminated in 1972, when waste oil containing TCDD was sprayed on unpaved roads at Times Beach to control dust. The details of the research plots have been reported earlier (11).

A comprehensive sampling program was conducted immediately after the bins were filled in 1984. Five core samples were taken from each bin (one from each corner and one in the center) using a flux split-spoon sampler. Half of each core sample was archived and has been held at -40°C since that time. These frozen core samples can be compared with core samples taken more recently from similar positions in the same plots to determine if there are differences in the amount of TCDD or its location in the cores taken several years apart.

The soil samples are analyzed using an analytical scheme developed at ETSRC (12). It is similar to the method recommended by USEPA, the major difference being the use of dimethyl sulfoxide extraction/back extraction of the initial hexane extract to remove the interferences caused by the high oil content of the soil. The final analyses are carried out with a capillary gas chromatograph interfaced with a low resolution mass spectrometer monitoring for ions m/e 257, 320, 322, 328, 332 and 334.

The analyses of core samples taken during the summers of 1988, 1989 and 1990 are currently being carried out. In addition, column studies are also being carried out at TCDD concentrations ranging from 50 ppb to 100 ppm. The column equilibration periods range from 24 hours to two years.

RESULTS AND DISCUSSION

Little or no loss of TCDD from soil was observed in earlier laboratory column and experimental plot studies. Both of these studies were conducted at concentration levels which were present at various contaminated sites in Missouri, typically under 1,000 ppb. However, since the mass flow rates from an adsorptive surface such as soil are affected by the concentration of the adsorbate, the environmental stability studies need to be conducted over a much wider range of concentration. These studies are being conducted to measure the loss of TCDD from soil under varied conditions and to determine the major routes of the loss. It is anticipated that the results obtained will allow the calculation of concentration levels at the time of the accident as well as the stability of the contamination.

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