Effects of Co-Contaminants on Photodegradation Kinetics of Octachloro-dibenzo-dioxin

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The removal and destruction of polychlorinated compounds from solid matrices such as soil is a very difficult task. The widely accepted technique for decontamination of soil is high temperature incineration. Due to refractory nature of soil this technique is energetically inefficient and consequently expensive. A number of low cost alternate techniques are being explored for this purpose. One new technique makes use of solvent extraction followed by photolytic degradation. Photodegradation has received considerable interest in the past and shows high efficiency. Promising results have also been obtained with solvents extraction coupled with the photodegradation approach. Decontamination efficiencies of approximately 90% have been achieved with 15 cm deep soil layer. One of the principal problems in successful implementation of the technique is inefficiencies caused by co-contaminants. The term co-contaminantsin the present context refers to any natural or xenobiotic soil constituents that are extracted along with OCDD. In the case of soil from wood treatment sites, the major co-contaminants are creosote constituents, light petroleum oil and chlorinated phenols, especially pentachlorophenol. Present studies were undertaken quantitatively to make a assessment of their effects.

EXPERIMENTAL STUDY

Experiments were carried out under both the natural and simulated sunlight conditions in alkane/alcohol mixtures, such mixtures have been shown to be quite effective for removing PCDDs from soils by Overcash and co-workers (1,2). The simulated experiments were carried out with a modified photometer with a xenon arc lamp. Effects of the intensity and duration of exposure were monitored. OCDD concentration was varied over a otwo orderds of magnitude (50 ppb-5ppm, w/v). Four co-comtaminants i.e., napthalene, alkyl naphthalenes, phenanthrene and pentachlorophenol that are generally present at wood treatment were used during the present study. The concentration of co-contaminants was varied over 1-500 fold of OCDD concentration.

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RESULTS AND DISCUSSION

As expected the OCDD photolysis follows first-order rate kinetics in absence of co-contaminants. The typical linear relationship between ln (Ct/Co) and exposure period is shown in figure 1. The linear relationship was observed over a two orders of magnitude concentration range. The major photodecorination products were found to be the heptachloro and pentachloro dibenzo-p-dioxins. The predominant products resulted from preferential dechlorination at the ortho postions, relative to the peri postions. These results are in agreement with photolysis studies with pure solvents[1-4].

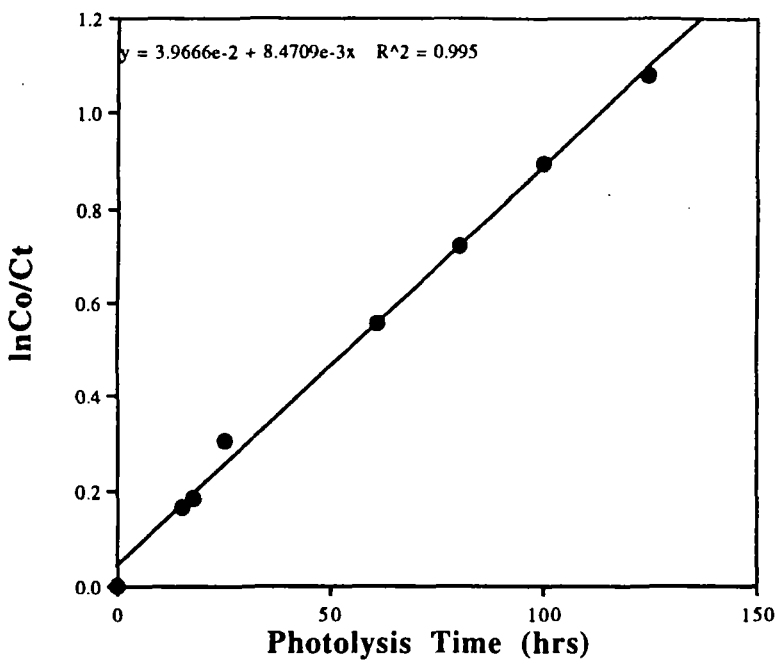

Fig. (1) First Order Treatment of Photolysis for OCDD in 20% Butanol in Decane

Concentration of OCDD: 3.0x10-5 M (10ng/ul). Total volumn: 2.5 ml. Irradiation wavelength: 313nm

Effects of co-contaminants on OCDD photolysis were found to be concentration dependent. At lower concentrations the co-contaminants had little or no effect. Higher concentrations of co-contaminants inhibited OCDD photodegradation, (Figure 2). The mode of inhibition and its effect on photodegradation pathways are currently being investigated. From these woks, It is imperative that in any photodegradation based decontamination technique inhibitory role of co-contaminants should be taken into consideration.

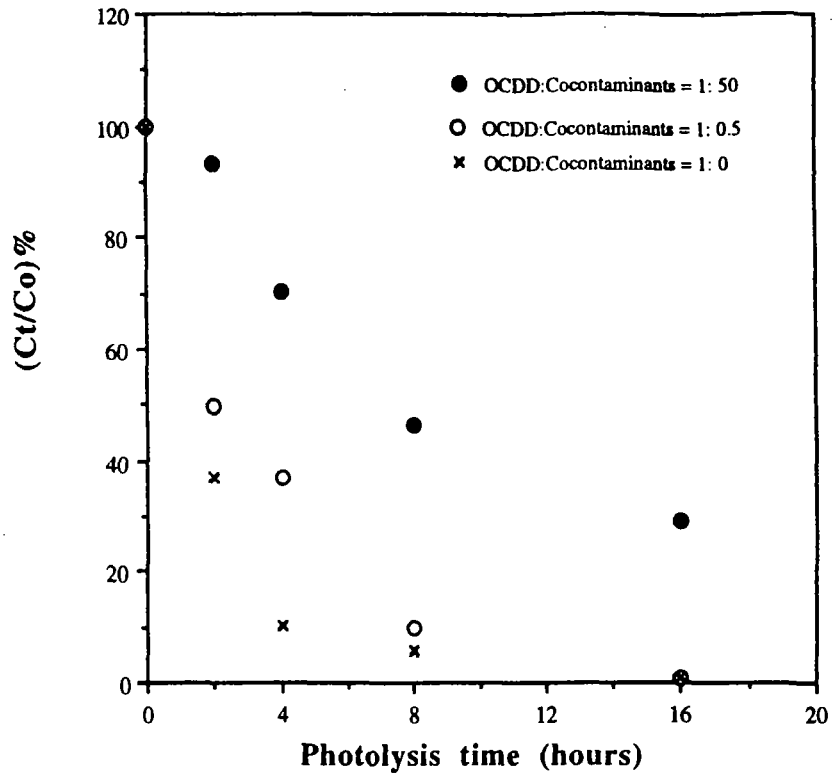

Fig. (2) the Effect of Co-Contaminants on Photolysis of OC under Sunlight Exposure in Vasilia, CA

Starting OCDD concentration: 3 ng/ul; Cocontaminants: anthracene, napthalene, phenanthrene and pentachl Exposure temperature: 100 °F; Exposure time; between 10 am and 5 pm. Solvent; 20% Butanol in Decane

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