

Comparative photosensitised transformation of polychlorophenols with different sulphonated metallophthalocyanine complexes in aqueous medium

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Abstract

The relative efficiencies for the oxidation of trichlorophenol (TCP) and pentachlorophenol (PCP), sensitised by sulphonated phthalocyanine complexes containing Zn, Al, Sn and Si as central metals, were studied in aqueous solutions. For the first time, sulphonated silicon and tin phthalocyanines were synthesised and their activity towards photosensitisation of singlet oxygen and photo-oxidation of polychlorophenols was examined. The efficiency of the sensitised photo-oxidative degradation of polychlorophenols depends not only on singlet oxygen quantum yield of sensitiser, but also on its stability. The influence of substrate structure and the pH of the solution on the photo-oxidation efficiency, as well as on the sensitiser photodegradation were studied. It was found that the contribution of the Type II (singlet oxygen-mediated) mechanism to the relative efficiency of the photosensitised photo-oxidation of the phenol, decreased from phenol to *p*-chlorophenol, TCP and PCP, whereas Type I radical pathway increased. The results obtained for PCP give evidence that electron transfer from the excited sensitiser to the substrate in its unionised form is responsible for enhanced sensitiser photodegradation. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Trichlorophenol (TCP) and pentachlorophenol (PCP) are commonly used as pesticides, germicides, fungicides, herbicides, molluscicides, algacides and insecticides [1]. These polychloroaromatics are well-known environmental pollutants and have been listed [2] as top priority pollutants because of their toxicity, persistence and bioaccumulation in aquatic organ-

isms. Their toxicity and resistance to degradation increase with the number of halogen substituents [3–5]. There have been several reports on the degradation of these compounds under UV irradiation [1,6–9]. Unfortunately, direct irradiation of these complexes in water has been found to generate more toxic and persistent compounds (like the polychlorinated dibenzo-*p*-dioxins) than the parent compound. On the other hand, the use of photocatalysts and photosensitisers has resulted in the production of less harmful photoproducts [10–13].

Metallophthalocyanines (MPc) have proved to be efficient photosensitisers and catalysts for many reactions [14–22]. It has been shown before [22] that due to their superior light absorption and photostability,

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