

Journal of Environmental Management 85 (2007) 345-349

Journal of Environmental Management

www.elsevier.com/locate/jenvman

## Oxidation and detoxification of pentachlorophenol in aqueous phase by ozonation

Jin Anotai<sup>a,\*</sup>, Rosawan Wuttipong<sup>a</sup>, Chettiyappan Visvanathan<sup>b</sup>

<sup>a</sup>National Research Center for Environmental and Hazardous Waste Management, Department of Environmental Engineering,

Faculty of Engineering, King Mongkut's University of Technology Thonburi, Bangkok 10140, Thailand

<sup>b</sup>Environmental Engineering and Management Program, Asian Institute of Technology, P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand

Received 23 July 2005; received in revised form 1 October 2006; accepted 6 October 2006 Available online 22 November 2006

## Abstract

The degradation and detoxification performance of ozonation in treating pentachlorophenol (PCP) contaminated wastewater was determined. All experiments were conducted in a bench scale glass column equipped with ceramic diffuser and a lab-scale ozone generator under ambient temperature and pH 7. The decomposition rate of PCP in this study was primarily controlled by the ozone mass transfer rate from gas to liquid phases. Principal intermediates found were 2,3,4,6- and 2,3,5,6-tetrachlorophenols (TeCP) and phenol. PCP seems to be more vulnerable to ozone than its intermediates. A bioluminescence technique was used to evaluate the toxicity of PCP with *Vibrio fisheri* NRRL B-11177 as the test bacterium, and the EC<sub>50</sub> of PCP was found to be  $1.0 \text{ mg l}^{-1}$ . Detoxification occurred as the PCP and TeCP reacted with ozone and decomposed to less chlorinated congeners and phenol.  $\bigcirc$  2006 Elsevier Ltd. All rights reserved.

Keywords: Kinetics; Pentachlorophenol; Toxicity; Ozonation

## 1. Introduction

As Thailand is moving toward industrialization, several serious environmental problems have evolved which have affected local communities and the natural ecosystems in many different ways. A number of contaminated sites have been recently identified including a canal in Bangkok vicinity which receives secondary effluent discharge from an industrial estate and several factories in the neighborhood (Brigden et al., 2003). The effluent carried in this canal is ultimately discharged to the Gulf of Thailand. A wide range of activities primarily involving chemical and electrical products are established in this industrial area. Numerous chemicals are used at these facilities including organic substances as well as heavy metals and their compounds. Analysis of canal waters and sediments demonstrated widespread contamination particularly from refractory organic pollutants, including chlorophenols which have a wide spectrum of toxic effects. Chlorophenols are known or suspected human carcinogens (Singh and Mishra, 1993; Coggon and Acheson, 1982; Slein and Sansone, 1980). They were also found to have adverse impacts on reproduction systems, embryonic and fetal development, and neonatal survival in rats (Schwetz et al., 1974a, b, 1978).

Among chlorophenols, pentachlorophenol (PCP), which is the highest chlorine-substituted species of chlorophenols, is one of the most widely used and toxic compounds to living organisms. PCP is mainly applied as a wood preservative and pesticide, and is classified in the priority list of organic micropollutants (USEPA, 1978). PCP is ranked among the most toxic and recalcitrant compounds to biological processes (Mueller et al., 1991). Several treatment technologies have been applied to treat PCPcontaminated wastewater with different outcomes. Carbon adsorption requires lower retention time and simpler operation than biological approaches; however, it can be an expensive alternative because it produces a waste residue which must be disposed of in a suitable way to protect the environment (Zhang and Nicell, 2000). Extensive mineralization of organic carbon and complete

<sup>\*</sup>Corresponding author. Tel.: +6624709166; fax: +6624709165. *E-mail address:* jin.ano@kmutt.ac.th (J. Anotai).

 $<sup>0301\</sup>text{-}4797/\$$  - see front matter C 2006 Elsevier Ltd. All rights reserved. doi:10.1016/j.jenvman.2006.10.001