PHOTOCHEMICAL AND MICROBIAL REMOVAL OF CHLOROPHENOLS FROM WASTEWATERS

by

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CERTIFICATE

This is to certify that the thesis entitled, ***"Photochemical and Microbial Removal of Chlorophenols from Wastewaters"***, being submitted by ***Mr. Mukesh Goel***, to the Indian Institute of Technology Delhi, for the award of the degree of ***Doctor of Philosophy***, is a record of bonafide research work carried out by him under my supervision. The results contained in this dissertation have not been submitted in part or full to any other University or Institute for the award of any degree or diploma.

T. R. Sreekrishnan
Professor

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ABSTRACT

The ever more increasing use of chemicals in industries and household activities has resulted in increased generation of hazardous chemical waste that results in severe environmental pollution. These chemicals have known carcinogenic and other kinds of harmful effects. This work was taken up to study the effectiveness of integrated biological and chemical/physical treatment to remove chlorophenols, known toxic pollutants. Three different chlorophenols, 4-chlorophenol (MCP), 2,4-dichlorophenol (DCP) and pentachlorophenol (PCP) were used in our study.

Shake flasks with different inocula were run for the aerobic acclimatization of chlorophenols to mixed culture. The three different inocula were obtained from – Sewage Treatment Plant (STP), refinery Effluent Treatment Plant (ETP) and paper mill ETP respectively. The aerobic acclimatized cultures were able to degrade as high as 350 ppm MCP, 250 ppm DCP and 250 ppm PCP in the shake flask.

It was found that inoculum from paper mill ETP yielded highest degradation rate for all the three chemicals – MCP, DCP, PCP. Effect of a biogenic substrate (glucose) concentration on the acclimatization of chlorophenols was also investigated. The result with anaerobic acclimatization showed that anaerobic cultures were able to degrade up to 200 ppm MCP, 200 ppm DCP and 250 ppm PCP.

The acclimatized mixed culture developed in aerobic environment by the process of selection and acclimatization was used to test their performance for continuous system,

Two continuous reactors were used: Activated Sludge Process (ASP) and Fluidized Bed Reactor (FBR).

However, in all cases, either in aerobic or in anaerobic or in a batch or continuous system, though target compounds were degraded, **total mineralization** was not achieved. HPLC analysis showed the presence of many toxic products. It was therefore decided to use a combination of photo-oxidation and biological treatment. The studies on photo-oxidation of chlorophenols are well documented and it has shown very attractive features like rapid reaction rate, capacity to degrade almost all organics, and so on.

Integrated biological and photochemical degradation were carried out in an individual as well as in mixed system containing the mixtures of the three chlorophenols. TiO_2 was used as a photocatalyst for photochemical degradation of chlorophenols.

The results obtained from integrated treatment of chlorophenols revealed several interesting features. For individual systems treating chlorophenols separately, integrated biological and photochemical degradation was found to be more effective for treating higher concentrations of chlorophenols. Complete mineralization was achieved in 96 hrs for synthetic effluent containing 400 ppm of MCP, whereas biological degradation alone required 264 hours for the complete mineralization. The results obtained for integrated treatment of synthetic effluents containing DCP and PCP were of similar nature. For mixed system containing all the three chemicals (MCP, DCP and PCP), complete mineralization was achieved in 120 hours for process combination whereas biological treatment alone taken 360 hrs for the same. This study is the first of its kind reporting complete mineralization of mixed system containing high concentrations of MCP, DCP and PCP for integrated biological and photochemical degradation

Photo-oxidation of chlorophenols for photo-oxidation system: $UV/TiO_2+H_2O_2$ to eliminate/reduce chlorocatechol and other toxic components were also conducted. It was observed that the combination of $UV/TiO_2 + H_2O_2$ had produced less toxic intermediates. This has increased the efficiency of integrated treatment of chlorophenols. Complete mineralization of MCP was achieved in 84 hours as against 96 hours taken by integrated treatment of MCP without using H_2O_2. Integrated treatment using H_2O_2 was also operated in continuous mode using ASP as bioreactor.

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