بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

بعض الوثائق
الأصلية تالفه

بالرسالة صفحات
لم ترد بالاصل

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
CIVIL ENGINEERING DEPARTMENT

DEVELOPMENT OF A CONTINUOUS FLOW SYSTEM FOR THE REMOVAL OF SELECTED TOXIC SUBSTANCES FROM INDUSTRIAL WASTE STREAMS USING VARIOUS ENZYMES

By

Mohamed Sobhy AbdelRahman Ibrahim

Assistant Lecturer in Public Works Section
Civil Engineering Department,
Faculty of Engineering, Ain Shams University

1998

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A Thesis Submitted in Partial Fulfilment for the
Requirements of the Degree of

DOCTOR OF PHILOSOPHY

IN

CIVIL ENGINEERING

By

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STATEMENT

This dissertation is submitted to "Ain Shams University" for the degree of

"Dector of Philosophy in Civil Engineering"

The work included in this dissertation was carried out during the period from 1992 to 1998 under "The Channel System" between The Public Works Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt and The Department of Civil and Environmental Engineering, University of Windsor, Windsor, Ontario, Canada.

No part of this dissertation has been submitted for a degree or qualification at any university or institution

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APPROVAL SHEET

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AIN SAHMS UNIERSITY
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CIVIL ENGINEERING DEPARTMENT, PUBLIC WORKS SECTION
Name: Mohamed Sobhy A.Rahman Ibrahim
Degree : Ph.D. in Civil Engineering
Title: Development of a Continuous Flow System for the Removal of Selected Toxic Substances from Industrial Waste Streams Using Various Enzymes
Supervisors: Prof.Dr.J.K.Bewtra (Canada), Prof.Dr.Hamdy I.Ali (Egypt)
Registration : 11/9/1994 Defence: 6 / 5 / 1998

ABSTRACT

The main purpose of this study was to demonstrate the ability of *Arthromyces ramosus* peroxidase (ARP) to catalyse the removal of phenol in the concentration range of 1-10 mM. A series of batch reactor studies were conducted to optimize the treatment process. It was found that the optimum pH was 7.0, optimum molar ratio of hydrogen peroxide and phenol was around 1.0. Also, both the optimum polyethylene glycol (PEG) dose and the required minimum enzyme dose were dependent on the initial phenol concentration. The presence of PEG had a significant effect on improving the removal efficiency. Two empirical models were developed to determine the optimum PEG and the required minimum enzyme dose.

Application of these optimum doses in different continuous flow systems was tested and a final flow line was recommended and tested on a large scale. The continuous flow system gave the same removal efficiency when using the optimum doses obtained with batch reactors. Step feeding of the enzyme over the length of the reactor did not improve the removal efficiency. However, step feeding of hydrogen peroxide reduced the required enzyme dose at high phenol concentrations.

Certain kinetic parameters for the enzyme activity were determined by measuring the initial velocity of the enzymatic reaction. Inactivation constant due to hydrogen peroxide, and Michaelis constants for phenol and hydrogen peroxide were also determined. By using these constants, a kinetic model has been developed that can predict the time-dependent removal of phenol under different reaction conditions. The model is also able to predict the depletion of hydrogen peroxide and the enzyme inactivation.

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SUMMARY

Arthromyces ramosus peroxidase (ARP), like many other peroxidases, catalyses the oxidation and polymerisation of aromatic compounds such as phenol by reducing hydrogen peroxide. The polymerised products have a low solubility and high molecular mass and are readily precipitated from solution. The ability of ARP to catalyse this reaction has been demonstrated in this study with phenol concentrations of 1 to 10 mM.

The first phase of this research studied the optimisation of the factors that control the enzymatic reaction in the phenol concentration range of 1-10 mM. It was found that the reaction can take place at a pH value of 6-9, with an optimum pH of 7.0. The optimum molar ratio of hydrogen peroxide and phenol was around 1.0. The optimum PEG dose and the required minimum enzyme dose were found to be dependent on the initial phenol concentration. Using the data collected in this phase, two empirical models were developed. These two models were able to predict the required doses of PEG and enzyme to remove more than 95% of phenol in the phenol concentration range of 1-10 mM.

The second phase of this research studied the application of the enzymatic treatment on bench-scale continuous flow system. The system was tested using different flow lines and an optimum flow line was

established. The recommended flow line consists of two stages; first the enzymatic treatment takes place and this is followed by conventional flocculation and sedimentation processes.

The third phase of this research studied the kinetic behaviour of ARP. Initial reaction rate velocity studies were conducted to determine the inactivation pathways of the enzyme by hydrogen peroxide. Michaelis constants for phenol and hydrogen peroxide were determined in this phase.

The last phase was to develop a kinetic model that can predict the time-dependent phenol removal, hydrogen peroxide depletion and change in the enzyme activity. Kinetic data were collected for the calibration and validation of the model in the phenol concentration of 0.5-5.0 mM. Enzyme inactivation is caused both by the free radicals, formed during the catalytic cycle, and by hydrogen peroxide. The conversion of phenol was modelled by using two-substrate Michaelis-Menten equation. Hydrogen peroxide depletion was modelled to be proportional to the conversion of phenol. The proportion coefficient take the value of the observed stoichiometry. The model was calibrated by means of genetic algorithm applied to the data collected from bench-scale kinetic batch reactor. The model showed a good prediction for the phenol removal, enzyme inactivation, and hydrogen peroxide depletion.

TABLE OF CONTENTS