ENVIRONMENTAL RESEARCH IN INDIA

(A Compendium of Executive Summaries of various completed projects funded under the Research Programme of the Ministry of Environment and Forests)

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Foreword

The Ministry of Environment and Forests serves as a focal point for planning, promotion and coordination of environmental and forestry programmes. Research promotion constitutes an important component of the various activities of the Ministry and is taken up through supporting research investigations in identified Thrust Areas at Universities, R & D institutions and Non-Governmental agencies throughout the country. Research is also undertaken by various agencies in specialised fields and associated autonomous institutions of the Ministry.

The ability of a nation to manage its environment is largely dependent to some extent on the availability of experts possessing competence and knowledge about various environmental issues. The knowledge base can be deepened through high quality research. Continual research is required to be focussed on emerging problems and areas, and keep pace with the technology. To fulfill these objectives, the importance of promoting and funding research in the environmental issues has been recognised by the Government.

This is the third compendium of the executive summaries of the research projects in the following research schemes of the Ministry:

Environment Research Programme
Ecosystem Research Scheme
Research Programme on Eastern & Western Ghats

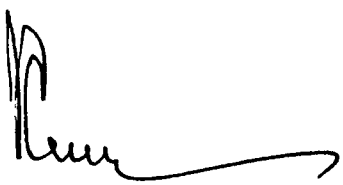
This volume contains 114 executive summaries, which have been subdivided in 18 specific thematic areas. It brings out information and knowledge generated as a result of experimentation by the investigators in multi-disciplinary aspects of environmental management.

Environmental research results as generated in the reports contain facts, observations, synthesis and methods of investigations. These results would be extremely important in developing approaches to a wide range of environmental subjects like -water pollution, air pollution, noise

pollution, development of process/system for control of pollution, health and toxicology, management of biotic and abiotic resources, survey and documentation of flora and fauna, ethnobiology, ecological restoration, socio-economic studies, conservation of biological resources and impact of anthropogenic activities.

I complement the Environmental Research Division for taking up this arduous job and completing it efficiently.

It is hoped that this publication would be useful to policy makers, regulatory agencies, environmentalist and all those who are interested in environmental issues and in creating consciousness for better environment.



(K.C Misra)

Secretary
Ministry of Environment and Forests
Government of India

INTRODUCTION

The Ministry of Environment & Forests supports research in multi-disciplinary aspects of environment protection, conservation and development in identified thrust areas. The objectives of the research are to develop strategies, technologies and methodologies for better environment management and to create infrastructure and a pool of trained manpower to shoulder the responsibility of environment management in the country. Environmental Research particularly aims at attempting solutions to the practical problems of resource management and provides necessary inputs for twin objective of conservation of natural resources and restoration of environmental quality.

The Environmental Research Division in the Ministry of Environment & Forests provides funding support for the projects under the following programmes/schemes:

Environment Research Programme (ERP)
Ecosystem Research Scheme (ERS)
Research Programme for Eastern and Western Ghats

Environmental Research Programme specifically deals with the brown agenda i.e problems related to pollution, chemical, biochemical and engineering investigation, technology development for waste minimization, waste recycling recovery, effluent treatment and other environmental studies related to pollution control, development of instruments for pollution measuring and control, development of eco-friendly and cleaner technologies.

Ecosystem Research Scheme is an inter–disciplinary programme of research which focuses on ecological approach for studying all the relationship between man and environment. The objective of the programme is to develop a basis within the field of natural and social sciences for national use and conservation of resources for general improvement of the relationship between man and its environment. Under the scheme, emphasis is laid on multi-disciplinary aspects of environmental conservation with emphasis on eco-system approach consistent with the identified thrust areas and orientation.

The Eastern and Western Ghats Research Programme addresses itself to location specific problem of resource management in the Eastern and Western Ghats regions of the country. Under this programme, studies

relating to Bio-diversity, landuse, impact of development activities etc are taken up in the region.

Evaluation of the Projects

Monitoring of the on-going projects is done through assessment of Annual Progress Reports departmentally and also by undertaking annual review and monitoring meetings with the assistance of experts in relevant subject areas. The distinctive feature of these fora is the involvement and participation of the user agencies in sharing the outcome of the research and investigation with a view to enhancing the utility of the same.

The findings of the research projects are brought out as departmental publications, besides the results of the projects are also disseminated through the leading National and International journals, which are widely consulted by scientists and other user agencies. The executive summaries of the completed research projects are prepared by the Division and put on the website of the Ministry. The schemes of R & D have made significant contributions towards the development of scientific capabilities and have also led to broad basing the infrastructural facilities for research.

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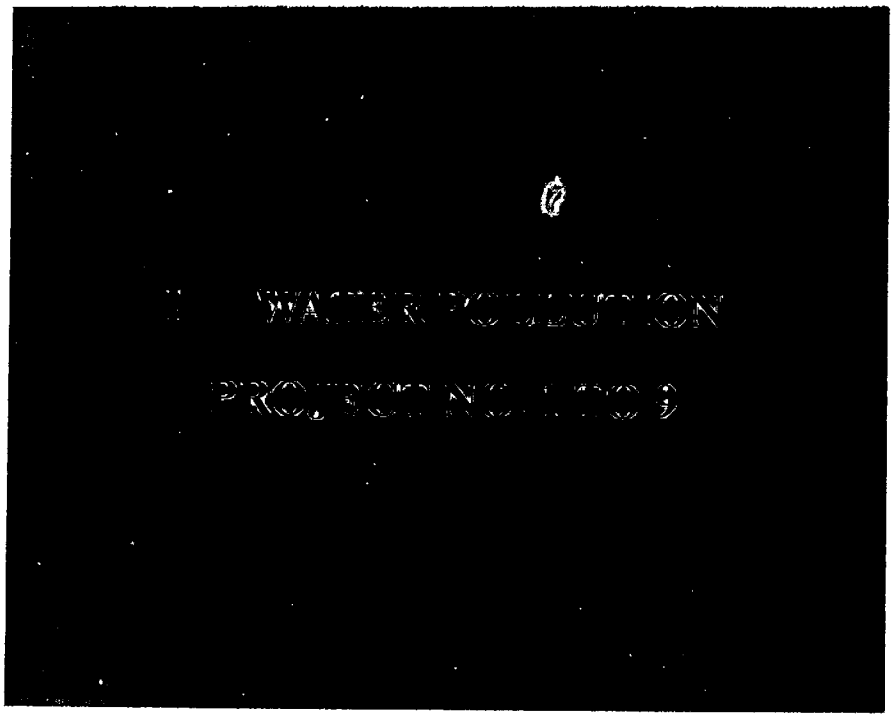

Project No. 1

1. Title of the Project : Toxic Organic Removal from Waste Water Hybrid Adsorption Supercritical Desorption Process

2. Name and address of the Project Investigator :

Dr. K. Krishnaiah
Associate Professor
Department of Chemistry
S.V. University
Tirupati- 517 502

3. Introduction

Chemical industry generates a large amount of toxic waste and wastewater. Wastewater containing organic chemicals has been treated mostly by activated carbon as the adsorbent. Resin adsorption is an alternative treatment technology for the removal of organic contaminants from wastewater streams. The economic success of the adsorption technique depends on the regeneration of the adsorbent. The regeneration methods such as solvent washing, steaming etc., pose problem when the solvent or condensed water is loaded with hazardous chemicals. One way to handle the situation is through the use of supercritical fluids like CO_2 for the regeneration of the adsorbent. Regeneration of resign by supercritical CO_2 is less energy intensive and environmentally safe compared to other methods of regeneration.

4. Objectives

The project was initiated to determine at laboratory bench scale level the removal characteristics of phenol and substituted phenols individually and combined through adsorption on synthetic resins, to investigate the effect of pH on the extent of adsorption, andto study the technical feasibility of regenerating resins by supercritical carbon dioxide and to model the adsorption- desorption process.

5. Methodology

Aqueous solution of phenol or p-nitrophenol or p-chlorophenol of 2000 ppm was prepared by dissolving the required amounts of components. Adsorption equilibrium concentration of individual adsorbents was determined. Stainless steel tube of 0.8-cm id and 10 cm length was used as a column for adsorption studies. The single-solute adsorption data were fitted to Langmuir and Freundlich adsorption isotherms and the parameters of isotherms were evaluated following least square procedure.

6. Results

The study indicated that phenol, p-nitrophenol and p- chlorophenol could be removed through adsorption on synthetic resins from aqueous solution of a single solute or a bisolute system. Presence of substituted phenol reduces extent of adsorption of phenol on XAD-2, XAD-4, XAD-7 and XAD-16. Phenol was found to have a very little effect on the extent of adsorption of substituted phenols. Adsorption of phenol or substituted phenol was maximum, in the pH range of 5-6. The resin was reported to be re-generated by supercritical carbon

dioxide. The adsorption capacity was found to decrease in the second cycle and remained constant in the subsequent cycles.

The study suggested removal of phenol and substituted phenolic compounds such as p-nitorphenol and p- chlorophenol from water through adsorption on synthetic resins individually and combined. The resin could be used for several adsorption's, desorption to remove phenolic compounds from aquatic environments.

7. Usefulness of the findings and their application

The information will be useful to the chemical industries and to the State Pollution Control Board.

Keyword Hybrid adsorption
supercritical desorption process for removal of toxic organics

Project No. 2 ***Water Pollution***

1. Title of the Project : Development of Nitrate Selective Resins for Removing Nitrate from Potable Water

2. Name and address of the Project Investigator : Dr. P.S.Anand
Separation Technology Discipline
Central Salt & Marine Chemicals
Research Institute Gijubhai Badheka
Marg, Bhavnagar-364 002

3. Introduction

The growing food demand due to increase in the population has necessitated increase in the food production in India and the chemical fertilisers play a important role. The increased use of nitrogenous fertilisers has increased the concentration of nitrate ion in well waters. The excess of nitrates (10 mg/lit. as N) in drinking water causes ***methomoglobinemia*** in infants under the age of six months. This disorder causes the reduction in oxygen carrying capacity of the blood affecting the nervous system directly. Several types of cancers in human beings have been found to be due to excessive nitrate ion in water.

4. Objective

The project aimed to develop an anion exchanger, capable of removing nitrate ion selectively in presence of divalent ions like sulphate and carbonate etc from drinking water and to study this resin exhaustively for removing nitrate from potable water in a column filled with resin and to establish the suitability of resin synthesised.

5. Methodology

A series of macroporous polymeric structures based on the cross-linked product of styrene-divinyl benzene were synthesised. The degree of cross-linking of copolymers was kept at 10, 15 and 20 percent and the Fm value (ratio of monomers to monomers plus dilute) was varied from 0.5 to 0.6 to 0.7. The copolymers were characterised for porosity, surface area etc. BET method was followed to characterise the copolymers. The copolymers were chloromethylate and the degree of chloromethylation was determined. The copolymers were ammoniated with secondary and tertiary amines and with a mixer of two amines. The resulting anion-exchanger was evaluated for anion-exchange capacity and further evaluated for nitrate uptake from tap water spiked with extra nitrate ion.

6. Results

Styrene-divinylbenzene copolymer chloromethyled and animated with a mixture of two amines namely tripropyl amine and dimethyl amoniethanol in different ratios .The resin having 60:40 ratio of TPA:DMAE showed adequate capacity and Kd values of 853and 171 for nitrate and sulphate ions respectively. The effect of increasing concentration of nitrate ion in the equilibrating solution on its uptake by the resin showed nearly constant uptake after the equilibrating concentration reached 100 ppm. The selectivity of the resins having

diethylaminoethanol and tributylamine revealed that the resin having tributylamine moiety showed higher selectivity for the nitrate ion as compared to the other resin.

The study revealed that it was possible to reverse the selectivity of strongly basic anion exchangers from divalent ions like sulphate or carbonate to monovalent ions like nitrates etc if the anchoring groups responsible for exchange were changed from usual tri methyl to tri-propyl or even tri butyl. The exhausted resin beds regenerated with salt solutions.

7. Usefulness of the findings and its application

The results would be of use to the State Pollution Controls Boards, Ion-exchange resin manufacturers and people living in affected areas.

Keywords Nitrate removal
by nitrate selective resins

Project No. 3 ***Water Pollution***

1. Title of the Project : Biological Treatment of WasteWater From Nitrogenous Fertiliser Industry: Nitrification Denitrific- Action Studies

2 Name of the Project Investigator : Dr S.K Gupta
CESE, IIT,
Mumbai-400 076

3. Introduction

During the manufacture of various types of fertilisers related chemicals and intermediates, wastewater of varying qualities and quantities are generated depending upon the sections of the plant. Almost all components present in the wastewater can have direct or indirect impact on the receiving water stream. The contaminants are well above the tolerance limits in many cases. Main constituents in the wastewater from nitrogenous and phosphoric fertiliser plants are carbon particles, oil, Sulphur compounds, arsenic, nickel, ammonia, cyanide. phenol, phosphate, fluorides etc. These pollutants have severe impact both on the surface and ground water.

4. Objectives

The main objective of this research included acclimation of biomass, determination of rate of urea biohydrolysis, performance evaluation and estimation of kinetic parameters of nitrification and de-nitrification processes and the effect of environment variables on nitrification and de-nitrification processes.

5. Methodology

The biomass was acclimated in a continuous flow stirred- tank reactor up to 1000mg/L. Pharmaceutical wastewater was used for nitrification studies The study conducted at varied SRTs and HRTs showed that 97.5% of urea (initial urea of 1071 mg/L) can be biohydrolysed at HRT of 24 hrs and SRT of 25 days. All the experimental data were obtained during pseudo-steady-state operation periods for each study.

6. Results

Nitrification studies were conducted in a bench scale CSTR on fertiliser wastewater. Nitrification study conducted at average TKN of 520 mg/L gave 89.7% nitrification at HRT of 1.5 days and SRT of 41.8 days. Nitrified bio mass concentration increased from 400 to 706 mg/L with increase in sludge age from 10 to 30 days and decrease of COD/TKN ratio of 2.22 to 0.676.Optimum rate of nitrification and growth was observed at pH of 8. The half saturation constant for *Nitrosomonas* and *Nitrobacter* was found to be 0.35 mg/L of NH4+-N and 0.53 mg/L of NO_2-N respectively a TKN shock loading of 6012 mg/L to nitrification unit for 2 hrs every day for a period of 10 days did not significantly affect its performance in terms of effluent TKN.

7. Usefulness of the findings and their application

A process of biological hydrolysis of urea, nitrification and de-nitrification process in suspended growth systems for the treatment of nitrogenous wastewater from a fertiliser industry containing high concentrations of urea, ammonia and nitrate was developed.

The information will be of use to the State Pollution Control Board and the fertiliser industry.

Keywords Nitrification denitrification studies of waste water

Nitrification de nitrification studies

1. Title of the Project : Separation of Hazardous Organics for Detoxification of Waste Water by Supercritical Fluid CO_2 Processing

2. Name and Address of the Project Investigator : Prof. M. Mukhopadhaya
Department of Chemical Engineering, IIT, Bombay

3. Introduction

Supercritical fluid processing of industrial effluent water is a promising new technique for separation of hazardous organic pollutants. A simple supercritical fluid, such as, carbon dioxide at high pressures and moderate temperatures has the ability to solubilize heavy non-volatile hazardous components directly from the waste water or indirectly from the solid adsorbent. Such as, granulated activated carbon used for its regeneration. Following a simple pressure reduction, the solubilized materials can be completely precipitated from the solvent and the much reduced volume of the contaminants can be further treated for detoxification, such as, by combustion. These environment friendly processes have advantages over the existing one in that the non-biodegradable contaminants could be effectively removed from water.

4. Objectives

The investigation is aimed at generation of a technical data for evaluation of two alternative supercritical fluid processes for removal of hazardous organic contaminants from the wastewater stream and screening of two operating conditions. High pressure equilibrium cell was initially charged with around 400-500 ml of aqueous sample containing the organic contaminant. The condensed and compressed CO_2 was stored in surge tank. From the surge tank CO_2 was charged into the auto clay and was heated to the desired temperature and pressure of extraction. The system was stirred and left for about two hours to attain equilibrium. The trap liquid sample was expanded in a separator and CO_2 liberated from the liquid phase was measured. The supercritical phase trapped in the sampling cylinder was slowly de-pressurised and the CO_2 to release from the supercritical phase sample was measured using a wet test meter.

5. Methodology

High pressure phase equilibrium for direct removal of contaminant was employed. The high pressure equilibrium cell was charged with around 400-500 of aqueous sample containing the organic contaminant. Activated carbon was used for adsorption of contaminants from aqueous solution. Carbon dioxide was used to regenerate the activated carbon.

6. Results

Experiments on regeneration of activated carbon loaded with Chlorobengene, Benzidine and Benzoyl Chloride were performed at various operating conditions. Effect of

pressure ,temperature and equilibrium time was investigated. At 60 º C, the solvent loading of benzidine was reported to increase with pressure at lower temperatures. A reverse trend was observed at 80 º C. The solvent loading decreased from 16.5 mg/g to 7 mg/g with increase in pressure from 120 bar to 195 bar. At activated carbon loading of 0.4 mg/g the solvent loading of chlorobenzene decreased linearly with increase in pressure. The desorption constant for static and dynamic regeneration showed that the desorption rate was not solely controlled by the adsorption /desorption equilibrium but by the super critical fluid phase resistance. Out of the nine pollutants studied for regeneration of activated carbon, benzedene was found to be the most difficult to remove from activated carbon. For the Chlorinated compounds, supercritical fluid - CO_2 regeneration of activated carbons reported to be promising.

7. Usefulness of the findings and their application

The study recommended the use of SCF CO_2 regeneration of activated carbon for chlorinated compounds and did not recommend the use of benzene. Direct recovery of PVA from dilute aqueous solution was recommended for using supercritical CO_2 at 105 bar and 60 º C.

The data generated in this project will be useful to a large number of chemical industries in and around Maharashtra for the treatment of their effluents. The data can be utilised for understanding the SCFE phase behaviour of organics-water-CO_2, which are highly complex and non -ideal systems. The data can be utilised for the development of mass transfer models with a view to scaling up of the process.

Keywords Detoxification of hazardous organisms
by supercritical fluid processing

1. Title of the Project : Degradation of Organic Pollutants by Ligninases of Phanenochaete Chrysosporium

2. Name and Address of the Project Investigator :

Dr. K.D.S. Yadav
Department of Chemistry
Deen Dayal Upadhyaya
Gorakhpur University
Gorakhpur- 273 009

3. Introduction

Ligninases are especially important in the degradation of organic pollutants. Ligninases belong to peroxidase group of enzymes Ligninases on reaction with hydrogen peroxide, an intermediate compound is formed which has higher oxidising potential than the same intermediates formed from other peroxidases. Thus ligninases could oxidise organic pollutants which could not be oxidised by other enzymes or microorganisms.

4. Objectives

The project was initiated to study the degradation of organic pollutants present in the base water from the pulp and paper industries and dying industries in neighbouring districts of Gorakhpur in general and Sanjai Paper and Chemical Industries at Khalilabad in particular.

5. Methodology

One bacterial strain was isolated from the soil sample collected from site of wastewater discharge of Sanjai Paper and Chemical Industries, Khalilabad. The strain was identified as Bacillus sp using standard techniques. Three fungus strains were isolated and identified as Aspergillus terreus, Penicillium citrinum and Fusarium oxysporum. The study investigated the optimum conditions for lignin per peroxidase enzyme for the degradation of the organic pollutants in the samples collected from the Sanjai Paper and Chemical Industries.

6. Results

The secretion of lignin peroxidase in the liquid culture medium of Pleurotus sajor-caju and Rhizopus nigricans was reported. The pH and temperature optima of the above lignin peroxidases using veratryl alcohol as the organic substrate were determined. The pH and temperature optima of *Pleurotus sajor-caju* ligninperoxidase were reported to be 9° and 50 ° whereas for Rhizopus nigricans the corresponding values were 6° and 50°. Phanerochaete chrysosporium lignin peroxidase showed optimum pH at 3 and temperature of 25°. The wastewater of pulp and paper industries was alkaline and the lignin peroxidase showed pH optima in the alkaline range. Ligninperoxidase of *Pleurotus sajor-caju* was found to be more suitable for the removal of organic pollutants present in wastewater of paper and pulp industries.