BIO-DATA

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3. Date of Birth: 02/10/1990

4. Gender: Female

5. **Academic Qualifications:**

	Degree	**Year**	**Subject**	**University/Institution**	**% Marks**
1.	B.Tech	2009-2013	Chemical Engineering	Calcutta Institute of Technology (WBUT)	9.05
2.	M.E	2013-2015	Chemical Engineering	Jadavpur University Kolkata	85.33
3.	Ph.D Completed on 17/07/2020	2015-2020	Chemical Engineering Environmental Chemical Engineering and Biotechnology)	National Institute of Technology Durgapur	N/A

8. **Ph.D Details:**

Simultaneous Physicochemical Separation, Treatment and Reuse of Industrial Wastes to save the Natural Resources.

Prof. Tamal Mandal, Dept. of Chemical Engineering, National Institute of Technology Durgapur.
Prof. Tarakeshwar Kumar, Dept. of Petroleum Engineering, ISM (IIT) Dhanbad
Prof. Papita Das, Dept. of Chemical Engineering, Jadavpur University Kolkata.

9. Work/Research experience:

- Research Experience with analytical potential in handling sensitive and complicated instruments like GC-MS, Fluorescence spectrophotometer, FTIR and TGA analyzer, Ion detection electrodes, UV spectrophotometer sponsored by central government agencies (DST and DBT, India).
- Volunteered various government projects and technical proposal writing like SPARC, BRICS, DST, DBT, SERB, Govt. of India with detailed Budget estimation.
- Supervised B.Tech, M.Tech projects and summer interns from same/different institutes.
- Regular B.Tech and M.Tech laboratory classes in every semester (8 hours/week).
- Experience in handling NBA/NAAC documentation w.r.t Laboratory development.
- Examination invigilation duty for UG/PG semesters.
- Experience in volunteering and organizing seminar, short term courses, and workshops in joint collaboration with Ph.D Supervisor.

List of Courses Taught

SL. NO.	Name of the Course	Level	Number of Students	Number of Times Taught
1.	Chemical Reaction Engineering Laboratory	UG	60	4
2	Fluid Mechanics Laboratory	UG	60	3
3	Unit Operations Laboratory	UG	60	1
4	Environmental Engineering Laboratory	PG	10	1

10. Professional Recognition/ Award/ Prize/ Certificate, Fellowship

SL No.	Name of the Award	Awarding Agency	Year
1.	Full time Institute Ph.D Research Fellowship	MHRD, India	2015-2020
2.	Top Downloaded Paper for 2018-2019	Asia-Pacific Journal of Chemical Engineering, Wiley	2020
3.	Online Course **in Wastewater Treatment and Recycling** and scored 83% marks	NPTEL	2018
4.	Gate Qualified		2014

11. Journal Publications *(List of papers published in SCI Journals, in year wise descending order).*

SL No.	Author	Title	Journal Name	Page/Volume/ Doi	Year	Impact Factor
1	**Uttarini Pathak,** Patali Mogalapalli, Dalia Dasgupta Mandal, Tamal Mandal	Biodegradation efficacy of coke oven wastewater inherent co-cultured novel sp. Alcaligenes faecalis JF339228 and Klebsiella oxytoca KF303807 on phenol and cyanide-Kinetic and Toxicity Analysis	Biomass Conversion and Biorefinery	https://doi.org/10.1007/s13399-021-01323-1	2021	2.602
2.	**Uttarini Pathak,** A. Jhujhunwala, A. Roy, P. Das, T. Kumar, T. Mandal	Efficacy of spent tea waste as chemically impregnated adsorbent involving Ortho-phosphoric and Sulphuric acid for abatement of aqueous phenol - Isotherm, Kinetics and Artificial Neural Network Modeling	Environmental Science and Pollution Research, Springer	DOI: 10.1007/s11356-019-06014-z Vol: 27, Pages 20629–20647	2020 Accepted 2019	3.056
3.	**Uttarini Pathak,** A. Banerjee, T. Roy, S. Das, P. Das, T. Kumar, T. Mandal.	Evaluation of mass transfer effect and response surface optimization for abatement of Phenol and Cyanide using immobilized carbon alginate beads in a fixed bio-column reactor.	Asia-Pacific Journal of Chemical Engineering, Wiley	DOI: 10.1002/apj.2405. Vol: 15, pp: e2405	2020	1.06
4.	**Uttarini Pathak,** S. Kumari, A. Kumar, T. Mandal	Process parametric optimization towards augmentation of silica yield using Taguchi technique and artificial neural network approach	Energy, Ecology and Environment, Springer	Vol: 5, pp 294-312 DOI:10.1007/s40974-020-00152-8	2020	Scopus
5.	**Uttarini Pathak**, Ananya Roy, Dalia Dasgupta Mandal, Papita Das,	Bioattenuation of Phenol and Cyanide involving immobilized spent tea activated carbon with Alcaligenes faecalis JF339228 -Critical	Asia-Pacific Journal of Chemical Engineering,	https://doi.org/10.1002/apj.2278 Vol: 14,	2018	1.06

	Tarkeshwar Kumar, Tamal Mandal	assessment of the degraded intermediate	Wiley	pp: e2278		
6.	A. Jhunjhunwala, **U. Pathak**, K.K. Sarkar, S. Majee, D.D. Mandal, T. Mandal	Removal of Levosulpiride from pharmaceutical wastewater using an advanced integrated treatment strategy comprising physical, chemical and biological treatment.	Environmental Progress and Sustainable Energy, Wiley	doi: 10.1002/ep.13482 Vol 40 pp: e13482	2020	1.989
7.	Kalyan Kumar Sarkar, Subhasish Majee,**Uttarini Pathak**, Sainath Polepali, Gopinath Halder, Dalia Dasgupta Mandal, Tamal Mandal	Development of an integrated treatment strategy for removal of ondansetron using simultaneous adsorption, oxidation and bioremediation technique.	Journal of Environmental Chemical Engineering, Elsevier	https://doi.org/10.1016/j.jece.2019.103020. Vol: 7; pp: 103020	2019	4.3
8.	KK Sarkar, S Majee, **Uttarini Pathak,** DD Mandal, T Mandal.	Design and development of an integrated treatment system for pharmaceutical waste with toxicological study.	Desalination and Water Treatment	https://doi.org/10.5004/dwt.2019.24341 Corpus ID: 208002922	2019	Scopus Web of Science
9.	**Uttarini Pathak,** Papita Das, Prasanta Banerjee, and Siddhartha Datta	Treatment of Wastewater from Dairy Industry Using Rice Husk as Adsorbent: Treatment Efficiency, Isotherm, Thermodynamics, and Kinetics Modelling	Journal of Thermodynamics	https://doi.org/10.1155/2016/3746316 vol. 2016, Article ID 3746316, 7 pages	2016	Scopus

12. Book Chapters (Descending Order)

SL No.	Title	Author Name	Year	Publisher
1.	A consolidated stratagem towards defenestration of coke oven wastewater using various advanced techniques - An analogous study	**U. Pathak**, D.D Mandal, S.K. Jewrajka, P. Das, T. Kumar, T. Mandal	2020	Recent Trends in Waste Water Treatment and Water Resource Management, Springer, Singapore. pp 57-66. **https://doi.org/10.1007/978-981-15-0706-9_6**
2.	Bioattenuation of Poly-aromatic Compounds by an isolated Bacterial Strain: Process optimisation and toxicity analysis.	**U. Pathak**, D.D Mandal, P. Das, T. Kumar, T. Mandal	2020	Advances in Bioprocesses and utilization of Biomass, Springer Accepted
3.	Study of ammonia removal from simulated coke oven wastewater using commercial charcoal activated carbon.	**Uttarini Pathak,** Tamal Mandal, Papita Das, Dalia Dasgupta Mandal, Siddhartha Datta, T.Kumar	2019	Waste Management and Resource Efficiency Springer ISBN 978-981-10-7289-5 ISBN 978-981-10-7290-1 (eBook). pp 1197-1205 http://doi-org-443.webvpn.fjmu.edu.cn/10.1007/978-981-10-7290-1_99
4.	Role of Advanced Oxidation Process in Treatment of Coke Oven Wastewater—A Review	**U. Pathak**, S. Kumari, P. Das, T.Kumar, T. Mandal	2019	Waste Water Recycling and Management. Springer eBook ISBN: 978-981-13-2619-6; pp 37-51 https://doi.org/10.1007/978-981-13-2619-6_4

13. Paper Presented in National and International Conferences (Descending Order: 10 Nos.)

Title of the Paper	Author/Co- Author	Name of the Conference	Date
Simultaneous bioremediation of polycyclic aromatic hydrocarbons by an isolated bacterial strain	**Uttarini Pathak,** Tamal Mandal	International Conference On Recent Technologies And Advanced Materials For	12-13 March, 2021 National Institute of Technology,

Klebsiella oxytoca KF303807: Critical assessment of secondary intermediates		Green Energy And Sustainable Environment (RTAMGESE-2021)	Tiruchirappalli
Bioattenuation of poly-aromatic compounds by an isolated bacterial strain: Process optimization and toxicity analysis.	**U. Pathak**, D.D Mandal, P. Das, T. Kumar, T. Mandal	9th ICONSWM 2019.	November 27-30, 2019 Bhubaneswar
Intensive insight into the bio attenuation of phenol and cyanide using co-culture microbial strain- Kinetic and Toxicity analysis	**Uttarini. Pathak,** A. Jhunjhunwala, P. Mogalapalli, D. Dasgupta Mandal, P. Das, T. Kumar, T. Mandal.	HERAKLION 2019 "7th International Conference on Sustainable Solid Waste Management.	26-29 June 2019 Heraklion, Greece
Optimization of process parameters using Taguchi and artificial neural network approach coupled with membrane desalination for augmentation of silica yield	**Uttarini Pathak**, S. Kumari, A. Kumar, T. Mandal	HERAKLION 2019 "7th International Conference on Sustainable Solid Waste Management.	26-29 June 2019 Heraklion, Greece
A consolidated stratagem towards defenestration of coke oven wastewater using various advanced techniques - An analogous study	**U. Pathak**, D.D Mandal, S.K. Jewrajka, P. Das, T. Kumar, T. Mandal	8th ICONSWM 2018,	November 22-24 Vijayawada, Andhra Pradesh
Bioremediation of Napthalene and Acenapthene by *Klebsiella oxytoca* KF303807: Analogous study for process optimization and toxicity analysis	**Uttarini Pathak**, D.D Mandal, P. Das, T. Kumar, T. Mandal	BIOSPECTRUM 2018	27-28, July, 2018. UEM Kolkata
A compendious approach towards obliteration of rice husk ash and rice mill wastewater: Recuperation and waste to energy conversion	**Uttarini Pathak**, Papita Das, T. kumar, T. Mandal	CHEMCON 2017	December 27-30, 2017. HIT, West Bengal
A Critical Overview on Petroleum Wastewater: Origin Treatment and Management. International Conference on Challenges and Prospects of Petroleum Production and Processing Industries	**Uttarini Pathak,** S. Majee, P. Das, T. Kumar, T. Mandal	International Conference on Challenges and Prospects of Petroleum Production and Processing Industries	January 12-14, 2017. ISM Dhanbad, Jharkhan
Study of ammonia removal from simulated coke oven wastewater using commercial charcoal activated carbon	**Uttarini Pathak,** T. Mandal, P. Das, DD Mandal, S. Datta, T. Kumar.	6th International Conference on Solid Waste Management Air and Water. **Awarded Best Paper in this event.**	November 24-26, 2016 Jadavpur University, Kolkata India.
Treatment of Dairy wastewater using Coagulation and Adsorption technique	**Uttarini Pathak,** P. Das, P. Banerjee, S. Datta.	10th AIPTC organized by Forum of Scientists, Engineers and Technologists (FOSET)	February 6-7, 2016. Calcutta University Campus

14. Seminars/ Short Term Courses Attended (Ascending Order)

Sl. No.	From	To	Institute/ Industry	Sponsored By	Name of the course
1.	17th June 2016	21th June 2016	NIT Durgapur West Bengal	TEQIP II	Recent Advancement in upstream and downstream operation of petroleum Industries-UDOPI 2016
2.	8th July 2016	12th July 2016	NIT Durgapur West Bengal	TEQIP II	Emerging Trends in Waste Management and Valorization-ETWMV 2016
3.	20th July 2016	24th July	NIT Durgapur	TEQIP II	Current Advances in Bioprocess

		2016	West Bengal		Technology-CABT 2016
4.	14th November 2016	18th November 2016	NIT Durgapur West Bengal		Recent Trends in Biotechnology RTIB 2016
5.	1ST August 2016	5th August 2016	ISM Dhanbad Jharkhand		Modern Petroleum Industry and its Challenges-MPIC 2016
6.	4th March, 2016	4th March 2016	Jadavpur University, Kolkata	University Grants Commision-DRS III	Industrial Pollution Control using Emerging Technologies
7.	10th September, 2016	10th September, 2016	Jadavpur University, Kolkata	LEAD INTERNATIONAL	Serve Model Leadership Training
8.	7th September, 2012	7th September, 2012	Jadavpur University, Kolkata	IICHE	Wastewater Management: Municipal and Industrial Applications
9.	5th April,2016	5th April,2016	Calcutta Institute of Technology, West Bengal		Chemical Engineers In The Industrialization Of The Country
10.	December 17, 2018	December 28, 2018	NIT Durgapur	GIAN 2018	Extremozymes for Carving better tomorrow
11.	February 17, 2020	February 21, 2020	NIT Durgapur	TEQIP III	Process Modeling and Simulation using **ASPEN PLUS** and Application of AI in Process Industries.
12.	24th August, 2020	28th August, 2020	NIT Warangal	Centre for Continuing Education	Machine Learning in Real Time Applications
13.	20, December 2020	20, December 2020	Jadavpur University, Kolkata	SERB DST	Recent trends of pollution control strategies for wastewater treatment (RTPCSWT – 2020)

15. Projects at UG and PG Level:

Master Degree Project: **Treatment of Dairy Wastewater using Coagulation & Adsorption (Graphene oxide & Hydroxyapatite Nano-adsorbents)** under Prof. Siddhartha Dutta and P.K Banerjee.

B.Tech Project: Lipase Catalyzed Rice Bran Oil Hydrolysis: Enhancement by Ferric Chloride.

16. Software Skills:

Expertise in data evaluation using optimization software like Design Expert-RSM-CCD, Minitab-Taguchi, Process Modeling and Simulation- ASPEN PLUS, Artificial Neural Network using MATLAB

Referees

1) **Prof. Tamal Mandal, Professor,** Dept. of Chemical Engineering, National Institute of Technology Durgapur, **Email: tamal.mandal@che.nitdgp.ac.in; (M) 9434788078**

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3) **Prof. Siddhartha Datta, Ex Pro-Vice Chancellor and Professor ,** Dept. of Chemical Engineering, Jadavpur University Kolkata, **Email: sdatta.che@gmail.com, (M) 9830108902**

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Biomass Conversion and Biorefinery
https://doi.org/10.1007/s13399-021-01323-1

ORIGINAL ARTICLE

Biodegradation efficacy of coke oven wastewater inherent co-cultured novel sp. *Alcaligenes faecalis JF339228* and *Klebsiella oxytoca KF303807* on phenol and cyanide—kinetic and toxicity analysis

Uttarini Pathak[1] · Patali Mogalapalli[1] · Dalia Dasgupta Mandal[2] · Tamal Mandal[1]

Received: 23 October 2020 / Revised: 8 January 2021 / Accepted: 22 January 2021

Abstract

Coke oven sector emanates phenol and cyanide as the eminent virulent compounds due to abrupt industrialization which is detrimental in aqueous state, and its severity is increased on simultaneous coexistence even at low concentrations that eventually causes extensive damage to the peripheral ecosystem. The efficacy of isolated mixed bacterial culture comprising of *Alcaligenes faecalis* JF339228 and *Klebsiella oxytoca* KF303807 in wastewater treatment was investigated following a batch study. The impact of initial concentration of phenol (100–1500 mg L^{-1}) and cyanide (10–150 mg L^{-1}) on the growth and treatment by the mixed microbial cultures were evaluated over a time period of 72 h. The biodegradation mechanism was explained by Monod, Haldane, Aiba and Edward kinetic models. The maximum specific growth rate was reported to be 0.096 h^{-1} and 0.126 h^{-1} for phenol and cyanide respectively. The substrate inhibitory effect became eminent after a concentration of 450 mg L^{-1} for phenol and 45 mg L^{-1} for cyanide. Based on the lower sum of squared error (SSE) values, Haldane model for phenol and Edward model for cyanide was found to be favourable for substrate inhibition kinetics. The fate of the secondary intermediates produced after microbial degradation was assessed by phytotoxicity studies using *Vigna radiata*. The interactive binding of the pernicious pollutants and resultant biodegraded compounds with the DNA (herring sperm DNA) was examined following spectrofluorometric and spectrophotometric anatomization. Toxicity studies revealed that biological treatment was viable for eco benign disposal and results also depicted that both the strains have potential in remediation of phenol and cyanide from coke oven wastewater.

Keywords Phenol · Cyanide · *Alcaligenes faecalis* JF339228 · *Klebsiella oxytoca* KF303807 · Kinetics · Toxicology

1 Introduction

The existence of phenol and cyanide in different industrial discharges becomes an eminent problem when released to the environment from major sectors like oil and petrochemical, solvent and paint, pharmaceutical, mining, pesticides and explosives units [1–7]. However, the contribution of coke oven and steel manufacturing industries has been found to be most significant with a range of 300–500 mg L^{-1} of phenol and 10–50 mg L^{-1} of cyanide respectively [8–10]. The inflated levels of these toxicants have a consequential impact on the flora and fauna when the industrial discharge exceeds more than the natural degradation rate causing these substances to accumulate in the environment. The virulent effects of phenol and cyanide as observed on humans include severe damage to cardiac, gastrointestinal and central nervous systems; major organs like the liver, kidney, skin and eye; and especially respiratory system as the cytochrome oxidase is targeted by potential toxicity [11, 12]. The exorbitant limits of phenol and cyanide in the industrial effluent have caused several environmental organizations to impose a prohibitive limit (MCL or maximum contaminant level) of 0.5 mg L^{-1} and 0.2 mg L^{-1} respectively [13, 14].

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Environmental Science and Pollution Research
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ADVANCES AND CHALLENGES FOR SUSTAINABLE ECOSYSTEMS

Efficacy of spent tea waste as chemically impregnated adsorbent involving ortho-phosphoric and sulphuric acid for abatement of aqueous phenol—isotherm, kinetics and artificial neural network modelling

Uttarini Pathak[1] · Aastha Jhunjhunwala[1] · Ananya Roy[1] · Papita Das[2] · Tarkeshwar Kumar[3] · Tamal Mandal[1]

Received: 11 March 2019 / Accepted: 22 July 2019

Abstract
The current study emphasises on sorptive expulsion of phenol from aqueous solution using ortho-phosphoric acid (STAC-O) and sulphuric acid (STAC-H)-activated biochar derived from spent tea waste. STAC-O and STAC-H were instrumentally anatomised using scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), BET surface area and thermal gravimetric analyser. Equilibrium and kinetic data were implemented for the investigative parametric batch study to prospect the influence of adsorbent dosage, contact time, initial concentration and pH for eradication of phenol from aqueous solution. The maximum phenolic removals by STAC-O and STAC-H are 93.59% and 91.024% respectively at the parametric conditions of adsorbent dosage 3 g/l time 2 h, initial phenol concentration 100 mg/l and pH 8. Non-linear regression of adsorption isotherms and kinetics was accomplished using the equilibrium data. Both the specimens were compared, and it delineated that Temkin isotherm model is contented. The maximum adsorption intakes for STAC-H and STAC-O were 185.002 mg/g and 154.39 mg/g respectively. Pseudo-second-order kinetic model was best fitted for portraying the chemisorption phenomena. Boyd kinetic and intra-particle diffusion model were investigated to elucidate the diffusion mechanism involved in the process. Desorption study was employed for determining the regeneration proficiency of the adsorbents using water, ethanol and NaOH with maximum 93% and 51.16% extrusion for STAC-O and STAC-H respectively. The process parameters involved in this study were further analysed using artificial neural network perusal to determine the input–output relationships and data pattern. The overall adsorption study along with cost estimation exhibited that bidirectional activation of spent tea biochar was prospective in abatement of phenol from aqueous media.

Keywords Phenol · Adsorption · Spent tea waste · Artificial neural network · Desorption · Cost estimation

Introduction

Phenol, a protoplasmic toxicant and important group of organic pollutants, remains a repugnant contaminant within the ecosystem. After releasing from coal and petroleum industrial sectors, it is transferred to the aqueous system directly or indirectly from volatile compounds ejection. Phenols are carcinogenic compounds that eventually have a propensity of undertaking transmutation into other moieties which are more indefatigable and pernicious to human health (carcinogenic), wildlife and aquatic community (Aksu and Yener 2001; Busca et al. 2008; Calace et al. 2002; Rao and Viraraghavan 2002). Thus, several environmental organisations like USEPA have imposed a permissible limit of 1 mg/l for phenol in industrial discharge (ATSDR 1990). World Consumption data reports that after water, tea is the second popular beverage in the world imbibed by substantial mass of people globally. India produces 857,000 t of tea per year approximately (27.4% of total world production), engendering about 190,400 t of tea factory waste from processing units (Wasewar 2010). It has

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DOI: 10.1002/apj.2405

RESEARCH ARTICLE

Asia-Pacific Journal of Chemical Engineering WILEY

Evaluation of mass transfer effect and response surface optimization for abatement of phenol and cyanide using immobilized carbon alginate beads in a fixed bio-column reactor

Uttarini Pathak[1] | Avishek Banerjee[1] | Teetas Roy[1] | Subham Kumar Das[1] | Papita Das[2] | Tarkeshwar Kumar[3] | Tamal Mandal[1]

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Funding information
Ministry of Human Resource Development (MHRD), Government of India

Abstract

Coke oven sectors dispense phenol and cyanide into the circumferential ecosystem, which becomes a serious concern to the subsistence of the flora and fauna. The current study investigates phenol–cyanide treatment using carbon alginate beads immobilized with mixed bacterial consortium. Response surface using central composite design was contrived for the batch and packed bed bio-column optimization study. The optimal removal conditions obtained in batch study were 89.77% and 82.33% for phenol and cyanide, respectively, with 10-g/L adsorbent dosage, time 2 hr, and particle diameter 0.3 cm, whereas 87.22% and 90.97% with 22-cm column height, column diameter 3 cm, 10-ml/min flow rate, and 1-hr operation time. The actual exposure time of the pollutants in the bio-column reactor was calculated to be 22.15 min. Analysis of variance and model statistics predicted a high coefficient of determination for column operation with $R^2 = .9950$ (phenol), $R^2 = .9976$ (cyanide), and p values $< .0001$ stating significant model. The quantitative estimation of the combined external mass transfer and biodegradation effect was performed to evaluate correlation as (phenol) and (cyanide) with $k_m = 0.052$ and $k_m = 0.055$ cm/hr, respectively. The surface morphological study was executed by field emission scanning electron microscopy and Brunauer–Emmett–Teller surface area analysis depicting bacterial film development on the porous carbon matrix for effective treatment of binary system.

KEYWORDS

phenol, cyanide, calcium alginate carbon bead, *Alcaligenes faecalis* JF339228 and *Klebsiella oxytoca* KF303807, central composite design, external film diffusion

1 | INTRODUCTION

Due to abrupt industrialization, eminent virulent compounds like phenol and cyanide are emanated from coal and steel sector that eventually exudes to the encompassing ecosystem. The exorbitant levels of these toxicants have a pernicious consequence on the flora and fauna as well as human respiratory system.[1,2] Thus, a prohibitive limit for phenol and cyanide in industrial effluent has been set to be 0.5 and 0.2 mg/L, respectively,

Energ. Ecol. Environ.
https://doi.org/10.1007/s40974-020-00152-8

ORIGINAL ARTICLE

Process parametric optimization toward augmentation of silica yield using Taguchi technique and artificial neural network approach

Uttarini Pathak[1] · Snehlata Kumari[1] · Anuj Kumar[1] · Tamal Mandal[1]

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Received: 7 October 2019 / Revised: 3 March 2020 / Accepted: 5 March 2020

Abstract This study was attempted towards the retrieval of silica from rice husk ash to annihilate the local problems of disposal from the rice milling industries for enhancement of silica purity. Optimization of process factors using the Taguchi technique involved variation in sodium hydroxide concentration (NaOH), alkali impregnation volume per unit weight of the rice husk ash, and reaction time for designing the experimental matrix utilizing L16 orthogonal array at four different levels. The maximum silica extraction was 98.26% obtained with 4 N of NaOH, 20 ml/g of alkali volume, and treatment time 60 min. The identical experimental data set was also applied to an artificial neural network model (ANN) with the LM algorithm for predicting the feasibility of the extraction process. Both Taguchi and neural networks suggested a high coefficient of determination and a satisfactory correlation between experimental and predicted silica recovery values. The detailed characterization of the synthesized silica powder and residual rice husk ash was executed using field emission scanning electron microscopy (energy-dispersive spectroscopy), Fourier transform infrared spectroscopy, thermogravimetric, Brunauer Emmett Tellet surface area, and particle size analysis. The simultaneous reuse of residual ash and silicate was performed to ensure the best possible reclamation of silica and reusability of rice husk ash. The detailed cost estimation of the synthesized silica powder further suggested the effectiveness of the optimized process. Thus, a comprehensive approach for enhancement of the silica yield and purity by adopting Taguchi and ANN optimization proved to be useful in this study.

Keywords Rice husk ash · Silica · Taguchi approach · Artificial neural network modeling · Cost estimation

1 Introduction

Production and purification in the field of rice culture emerge out as a strategic part in the global frugality. Ease of availability at indented cost and chemical stability fabricates rice husk a contrivance for the Asian countries in terms of energy and reusable material generation. Rice or *Oryza sativa* projects out as the universally devoured staple food with the third-highest worldwide production of 758.9 million tons, where the Asian farmers (FAO 2017; Prasad and Pandey 2012) contribute 90% of the total output. Parboiling and paddy processing escalates the production of rice husk as a by-product. This rice husk is either used as a cattle feed (not appropriate due to low cellulose and sugar content) or combusted at elevated temperatures as fuel for energy resulting in the generation of rice husk ash that eventually becomes a severe and intense problem for both rice mill industries and environment. Reports from the survey suggest that 25 million tons of rice husk ash in India and 70 million tons globally are engendered from 0.23 tons of rice husk per every ton of rice produced (Kumar et al. 2016a).

Rice husk ash emerges as a significant waste product from rice production practices. The presence of substantial content of silica (about 60–95%) in rice husk ash has gained notable attention in exploring techniques for its

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s40974-020-00152-8) contains supplementary material, which is available to authorized users.

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RESEARCH ARTICLE

WILEY Asia-Pacific Journal of Chemical Engineering | Curtin University

Bioattenuation of phenol and cyanide involving immobilised spent tea activated carbon with *Alcaligenes faecalis* JF339228: Critical assessment of the degraded intermediates

Uttarini Pathak[1] | Ananya Roy[1] | Dalia Dasgupta Mandal[2] | Papita Das[3] | Tarkeshwar Kumar[4] | Tamal Mandal[1]

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Funding information
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Abstract

The current study is designed for the eradication of phenol and cyanide from a simulated binary mixture involving acetic acid modified spent tea activated carbon (STAC-C), isolated bacterial strain *Alcaligenes faecalis* JF339228, and immobilized *A. faecalis* JF339228 onto spent tea biochar by an amalgamated approach of sorption coupled with biodegradation. Characterisation of the biosorbent was ascertained by field emission scanning electron microscopy, thermogravimetric analysis, and Fourier transform infrared spectroscopy. The viability for eco-benign expulsion of the pernicious pollutants, and the resultant compounds after treatment was examined by fluorescence and UV-visible spectrophotometry with comprehensive elucidation of the interactions with DNA. Gas chromatography–mass spectrometry (GC-MS) anatomization was conducted for the evaluation of degraded derivatives post-treatment. The chemical and structural analysis of the degraded compounds and its impact upon disposal on the basis of degree of toxicity and reactivity were evaluated using TOXTREE software. Batch studies were implemented for the evaluation of process parameters like pH, reaction time, biosorbent or inoculum dosage, initial concentration, and temperature. Mono and binary component isotherm modelling was executed. Immobilised cells and free cells could accomplish better removal efficacy of 94.71% and 92.25% for cyanide, respectively, whereas adsorption using STAC-C was responsible for maximum removal of phenol up to 86.29%.

KEYWORDS

Alcaligenes faecalis JF339228, DNA interaction, immobilised spent tea activated carbon, phenol and cyanide, toxicity evaluation

A Consolidated Stratagem Towards Defenestration of Coke Oven Wastewater Using Various Advanced Techniques—An Analogous Study

U. Pathak, D. D. Mandal, S. K. Jewrajka, Papita Das Saha, T. Kumar and T. Mandal

Abstract Coke oven wastewater produced from steel industry contains hazardous constituents like phenols, cyanides, ammonia, SCN^-, etc., which needs to be treated before expulsion to the environment. Therefore, pre-treatment of these large volume of wastewater is required for maintaining environmental standards. Simulated coke oven wastewater pertaining to effluent characteristics discharged by industrial sector was synthesized. Initially, treatment of wastewater was performed with ozone which was used in combination with activated carbon (AC) and H_2O_2 to increase the degradation of COD. The maximum degradation achieved in the O_3/AC was 76.8% while in with O_3/H_2O_2, the COD removal was 75.8%. The O_3/AC process was found more acceptable in terms of fast rate of COD degradation, time and economy efficiency suitable for handling large volume of wastewater. However, problems of sludge disposal and process hazards diverted the adoption towards microbial treatment using bacterial strain *Alcaligenes faecalis* JF339228 where phenol was degraded up to 80.88% in 76 h from the coke oven mixture. Due to the high toxicity level of coke oven wastewater, only biological treatment fails to treat them effectively. Combined microbial treatment as well as membrane-based separation process (thin-film composite—reverse osmosis membrane) for wastewater purification was also applied. Thin-film composite (TFC) RO membrane was used to treat this solution at pressure of 200 and 300 psi and at different pH of 5, 7 and 8, respectively. The maximum *quantity of* phenol *removed by TFC RO membrane* at 300 psi pressure and pH of 8

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Role of Advanced Oxidation Process in Treatment of Coke Oven Wastewater—A Review

U. Pathak, S. Kumari, P. Das, T. Kumar and T. Mandal

Abstract Coke oven wastewater contains principal compounds like phenol, ammonia, cyanide, thiocyanate, sulphide, etc. in high amounts. The presence of such chemicals makes it toxic and recalcitrant in nature. Conventional methods like activated sludge process are utilised for the remediation of coke oven wastewater, but the effluent generated by this process does not comply with the effluent quality standards. Moreover, due to the high toxicity level of coke oven wastewater, biological treatment also fails to treat them effectively. In such cases, advanced oxidation processes become an attractive option as a pretreatment stage. Advanced oxidation processes includes Fenton's reaction, UV (ultraviolet)/H_2O_2, UV (ultraviolet)/O_3, photo-Fenton reaction and ultrasonic disintegration. The mechanism associated with these methods is based on the inception of free hydroxyl radicals. Literatures suggest that the application of Fenton's reagent for the abatement of coking wastewater containing compounds possessing virulent effects as the most promising technology due to its high oxidative potential and rapid oxidation kinetics. Fenton's reagent is inclusive of hydrogen peroxide (H_2O_2) with ferrous iron as a catalyst which is used to oxidise the contaminants of wastewater. The implementation of Fenton's reagent in the mitigation of wastewater is known to increase the biodegradability of wastewater and improve sludge dewaterability. The oxidation method produces secondary products which are biodegradable and mineralises the toxicants effectively when the prime operational constraints like pH, H_2O_2 dosage, catalyst dosage and temperature are at their optimum level. But, the requirement of large concentrations of hydrogen peroxide (H_2O_2) adds to its cost and results in massive sludge generation. The sludge has detrimental effects on the ecosystem and thus requires further treatment.

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Study of Ammonia Removal from Simulated Coke Oven Wastewater Using Commercial Charcoal Activated Carbon

Uttarini Pathak, Papita Das, Dalia Dasgupta Mandal, Siddhartha Datta, Tarkeshwar Kumar and Tamal Mandal

Abstract Organic pollutants from iron steel, coke, petroleum and other chemical process industries are basically responsible for releasing phenols, cyanides, ammonical and phenolic compounds, biphenyls, thiocyanates and various complex hydrocarbons that pose a threat to the existing flora and fauna of the ecosystem. Individual as well as combined treatment for phenol and cyanide using commercial and low-cost adsorbents has been investigated. But inadequate focus on removal of ammonical compounds leads to algal growth due to conversion into nitrites and nitrates. Thus, elimination of ammonia from simulated wastewater was studied using commercial grade charcoal activated carbon and acid-modified charcoal activated carbon from a mixture of phenol, cyanide and ammonia. The nature of the uptake was investigated and was observed that phenol removal showed a wide range of variation in percentage removal in terms of effect of initial concentration, pH and adsorbent dosage while the removal was enhanced for modified activated carbon. This has been found similar with the literature as reported earlier. But for ammonia, the removal was quite satisfactory irrespective of the variation of mentioned parameters. Also, it was found that modified activated carbon could bring about better removal in case of phenol, but ammonia removal was unaltered.

Keywords Ammonia · Phenol · Cyanide · Activated carbon · Chemical oxygen demand

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Development of an integrated treatment strategy for removal of ondansetron using simultaneous adsorption, oxidation and bioremediation technique

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ABSTRACT

The Ondansetron degradation by adsorption using activated carbon produced from coffee husk (CBH), chemical treatment by Ozone (O_3) and biochemical treatment by *A. faecalis* JF339228 and *E. aurantiacum* has been investigated in the present study. The percentage removal of ondansetron from its synthetic aqueous solution of 800 ppm concentration using 2 g/l activated carbon, 5.2 g/h ozone treatment and biological treatment by *A. faecalis* JF339228 and *E. aurantiacum* in 72 h were 81.25%, 58.80%, 70.15%, and 65.12% respectively. Simultaneous treatment of adsorption and ozone treatment followed by biological treatment with *A. faecalis* JF339228 and *E. aurantiacum* has been employed in this study. The integrated treatment has shown a synergistic effect in the degradation of Ondansetron at minimum consumption of chemical and time. The percentage removal was observed to be 90% and 71% respectively where employment of biological process reduced the treatment cost. Therefore the integrated treatment system proved to be economical, efficient and partially eco-benign.

1. Introduction

The Pharmaceutical business is one of the significant industries across the globe, which receives huge foreign revenues through the medicine trade to USA, EU, and Russia [1]. Although India is receiving huge foreign currency from this, but at the same time concentrations of pharmaceuticals in factory wastewater effluents is increasing more prominently than the concentration found in sewage effluents [2]. The untreated release of pharmaceutical effluents containing highly toxic virulent pharmaceutical ingredients (API) and various other microbial and toxic elements, to the natural aquatic bodies. The unused medicine disposal and drug metabolite excretion by humans and animals also increase the pollutant load to the domestic or municipal waste. These could affect plant life and wildlife of the ecology and upturns the health hazard of the human being. Several studies proved that pharmaceutical manufacturing plants could be a local source of pharmaceutical compounds in aquatic ecosystems [2–6]. Different sources of water pollutants from pharmaceuticals have been presented in Fig. 1. Countries like India, appropriate controls characterize the observing principle of industrial effluents including releases from pharmaceutical industrial facilities [7]. Ondansetron is an antiemetic drug; this pharmaceutical is widely used to inhibit nausea and vomiting triggered by cancer chemotherapy, radiotherapy, and surgical cases and also useful in gastroenteritis. In medical toxicology review, 2002; It was clearly indicated the ondansetron absorption to human may cause of diarrhea, hepatic failure etc. although it was difficult to quantify the contribution of ondansetron to this adverse effect. But when ondansetron is released to the open aquatic system by direct and indirect pathway. Direct pathway by medicine disposal and indirectly by intravenous administration of radio labeled ondansetron in which more than 60% of its metabolites are excreted in urine. This may effect severely to the aquatic plants and animals and effect the food chain [8,9]. There are several techniques presently being used to treat wastewater in different industries like adsorption treatment [10–13], biochemical treatment [14–16], advanced oxidation process treatment [17–22] membrane filtration treatment [23] for removal of waste from industrial wastewater but the membrane fouling is the key responsible for reducing its efficiency in wastewater treatment. Recently Arsalan Sepehri et al. (2018) has shown their study that some nitrifying bacterial community is capable of overcoming the situation rationally [24]. Adsorption and Fenton's oxidation process has proved to be expensive with high sludge generation [25]. All though bioremediation is a low-cost process, but time-

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Design and development of an integrated treatment system for pharmaceutical waste with toxicological study

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In the present study, sole adsorption, Fenton's oxidation, ozone treatment and biochemical treatment by *Alcaligenes feacalis (A. feacalis)* and *Exiguobacterium aurantiacum* (*E. aurantiacum*) and combination of the above treatments have been studied. It was observed that Fenton's treatment is efficient for degradation of Pantoprazole in any concentration pantaprazole. In Fenton's process, the degradation obtained 56.77% at pH 3.5 in an hour and in ozone treatment, 36% removal was achieved in 8 min for 600 ppm concentration. The microbial treatment is proved to be a good one but in the lower range of pantoprazole about 200 mg/L. The degradation of pantoprazole was achieved 58.40% and 60.08% by using *A. feacalis and E. aurantiacum* respectively in 72 h. Combination treatment has been designed, and the system worked efficiently. In the first step either Fenton's treatment, activated carbon or ozone treatment were performed followed by biochemical treatment. The maximum percentage removal of pantoprozole was observed 90.17%, 81.57%, and 71.07% respectively. The process also proves that it is partially cost effective, energy saving and environmentally safe operation.

Keywords: Wastewater; Pharmaceutical; Pantoprazole; Integrated wastewater treatment; Toxicological study

1. Introduction

The pharmaceutical industry is one of the important life-saving industries in India, which earns large foreign exchange through the medicine export to USA, EU, Russia [1]. The Indian pharmaceutical industries becoming a great contributor of delivering drugs in the world [2]. Pantoprazole is a proton-pump inhibitor (PPI), which inhibits gastric acid secretion. This is used in the treatment of peptic ulcers, gastro-oesophageal reflux diseases etc. [3]. Pantoprazole may cause long-term adverse effects in the aquatic environment [4]. The worldwide production and consumption of medicines provide a continuous release of these substances or their metabolites to the environment through industrial wastewater and domestic sewage [5]. The occurrence and fate of emerging micro-pollutants like pharmaceuticals are under attracted considerable attention in recent years. An extensive variability of these compounds (e.g. antibiotics, analgesics, anti-inflammatories, antiepileptics, hypnotics) has been reported to be present in aquatic systems worldwide [6–12]. The impact of pharmaceutical on the ecosystem is behavioral alteration in aquatic living beings are reported [13]. This rising concern of the pharmaceutical wastes in the aquatic environment is due to their potential impacts on the aqueous ecosystems and eventually human health [14–16]. Moreover, the additive effects with other micro-pollutants have been observed. Thus the release of these bioactive pharmaceutical compounds has to stop totally or has to degrade it for safe disposal. There are several treatment technologies has been reported in the literature, like advance oxidation

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REMEDIATION TREATMENT

ENVIRONMENTAL PROGRESS & SUSTAINABLE ENERGY

Removal of levosulpiride from pharmaceutical wastewater using an advanced integrated treatment strategy comprising physical, chemical, and biological treatment

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Abstract

In recent times the impact of pharmaceutical wastes generated from the pharmaceutical industry and domestic sewages on the aquatic ecosystem has become a major concern. The traditional sole treatment processes are not adequate for the elimination of these wastes. To overcome the lack of the individual treatment processes, integrated treatment methodology has been devised in the present study. The degradation of the pharmaceutical, levosulpiride, by using Ozone (O_3), activated carbon (AC) and biological treatment by *A.faecalis* JF339228 and *E. aurantiacum* KX008295.1in its aqueous solution has been investigated. The percentage removal of Levosulpiride from its synthetic aqueous solution of 600 mg/L concentration using 2 g/L activated carbon and 5.2 g/h ozone and biological treatment by *A.faecalis* JF339228 and *E. aurantiacum* KX008295.1 in 72 hr were 51.60, 53.50, 39.97, and 37.51% respectively. Simultaneous treatment using adsorption and ozone followed by biological treatment with *A. faecalis* JF339228 and *E. aurantiacum* KX008295.1 has been employed in this study. To overcome the demerits of the individual treatment process, the integrated treatment is employed which has shown a synergistic effect in the degradation of levosulpiride with minimal doses of activated carbon, ozone, and minimum time of operation. The percentage removal of levosulpiride achieved was about 76 and 61% for 800 mg/L levosulpiride wastewater, respectively. Therefore, the integrated treatment system is rendered economical, efficient, and safe.

KEYWORDS

A.faecalis JF339228 and *E. aurantiacum* KX008295.1, activated carbon, biodegradation, levosulpiride, ozone

1 | INTRODUCTION

Pharmaceuticals are essential for human beings worldwide for various purposes. However, in spite of its benefits, pharmaceuticals can also be adversarial for nature resulting in deleterious effects on the environment and aquatic life. Indian pharmaceuticals industry is one of the fastest-growing in the world, playing a vital role in the Indian economy and healthcare system across the world. At present, India exports generic medicines to the United States, European Union, and Canada (Table 1).[1,2] To meet the global demand, Indian pharmaceutical manufacturers are evolving their business by establishing multiple fabrication factories across India, such as Vizag, Hyderabad, Sikkim, Himachal Pradesh, Assam, and so forh. The expansion of the pharmaceutical manufacturing business has increased in wastewater generated through the disposal of manufacturing wastes, old medicines, metabolic products from patients, and so forh. The production process of pharmaceuticals, as shown in Figure 1a involves cleaning of the manufacturing equipment which generates a large volume of

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Research Article

Treatment of Wastewater from a Dairy Industry Using Rice Husk as Adsorbent: Treatment Efficiency, Isotherm, Thermodynamics, and Kinetics Modelling

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Effluent from milk processing unit contains soluble organics, suspended solids, and trace organics releasing gases, causing taste and odor, and imparting colour and turbidity produced as a result of high consumption of water from the manufacturing process, utilities and service section, chemicals, and residues of technological additives used in individual operations which makes it crucial matter to be treated for preserving the aesthetics of the environment. In this experimental study after determination of the initial parameters of the raw wastewater it was subjected to batch adsorption study using rice husk. The effects of contact time, initial wastewater concentration, pH, adsorbent dosage, solution temperature and the adsorption kinetics, isotherm, and thermodynamic parameters were investigated. The phenomenon of adsorption was favoured at a lower temperature and lower pH in this case. Maximum removal as high as 92.5% could be achieved using an adsorbent dosage of 5 g/L, pH of 2, and temperature of 30°C. The adsorption kinetics and the isotherm studies showed that the pseudo-second-order model and the Langmuir isotherm were the best choices to describe the adsorption behavior. The thermodynamic parameters suggested that not only was the adsorption by rice husk spontaneous and exothermic in nature but also the negative entropy change indicated enthalpy driven process.

1. Introduction

Dairy industry, one of the largest types of food industry, contributes to a great extent to pollution with pollutants being organic in nature normally consisting of 1/3 dissolved, 1/3 colloidal, and 1/3 suspended substances, while inorganic materials are usually present mainly in solution [1]. Considering the ever increasing demand for milk, the dairy industry in India arises as the largest industry to have the maximum waste generation and related environmental problems are of increasing importance. Thus the rapid growth of industries has not only enhanced the productivity but also resulted in the release of toxic substances into the environment, creating health hazards and hampering the normal activity of flora and fauna. The dairy industry converts the raw milk into various products like butter, cheese, yogurt, and processed milk as condensed milk and dried milk (milk powder) involving processes such as chilling, pasteurization, and homogenization. Water is used in all processes in the dairy industry in the ratio of 1 : 10 (water : milk) per liter of milk [2], containing high concentration of organic materials, and all these components contribute largely towards their high values of biological oxygen demand (BOD), inflated rates of chemical oxygen demand (COD), high concentration of suspended solids and oil greases, liquid effluents, and slurries containing a spectrum of large quantities of casein, lactose, and fats in addition to inorganic salts, besides detergents, sanitizers, and so forth used for washing [3]. The volume of the wastewater produced depends largely on the quantity of milk processed and type of product manufactured. It appears white in colour with heavy black sludge and strong butyric acid odors due to the decomposition of casein [4]. It is slightly alkaline in nature and becomes acidic quite rapidly, because of the fermentation of milk sugar to lactic acid. The COD of dairy wastewater is mainly due to milk, cream, or whey. Casein and whey are the main components of dairy wastewater which are relatively hydrophobic, making it poorly soluble in water, and have a negative charge in milk. The casein micelles exist in milk as a