SUNIL KUMAR SRIVASTAVA, PH.D.

Assistant Professor (Sr. Grade)

PROFILE

I am working in the area of water quality, water resource management, and solid waste management since Aug 2000. I have completed one MPCST sponsored research project entitled "Hydrogeochemical Assessments of Groundwater Quality Using Graphical & Multivariate Statistical Method, Guna District" in Oct. 2018 and one ongoing project since April 2018 sponsored by Jaypee Group, a research project entitled "*Optimization of Raw-water Treatment plant*". I have also worked as expert member for the **DISTRICT ENVIRONMENTAL IMPACT ASSESSMENT AUTHORITY (DEIAA)** for Guna, Ashok Nagar and Shivpuri district of M.P. DEIAA works under guidance of MINISTRY OF ENVIRONMENT and FOREST, Government of India for looking environmental issues related sand/stone mining up to 5 hectares (**April 2016 to March 2019).**

I am working as an independent consultant for villagers/people of the Guna district for installation of Biogas/ Energy. Recently, I have started to work on the impact of irrigation water quality on crop yields. I have also started to work harvesting of solar energy by using nanomaterials.

CONTACT

Department of Chemistry,
Jaypee University of Engineering & Technology, Guna, MP, India- 473226
Phone NO: +91-9425722644

EMAIL:
sunil16sster@gmail.com

HOBBIES

1. Reading Book, Journals etc.
2. Playing Cricket, Soccer etc.
3. Listening Music and writing poem.

LANGUAGE

1. English and Hindi (Writing & Speaking).
2. Swedish and French (Beginner).

EDUCATION

[Jawaharlal Nehru University, New Delhi, India]
[3rd Aug 2000 to 26th May 2006]

1. ***Ph.D. (2006)*** *in* ***Environmental Science*** *from Jawaharlal Nehru University (JNU, NIRF Ranking 2nd in 2019), India.*

   Thesis Topic- *"Study of the Ground Water Quality Variations in the Vicinity of the Selected Landfill Sites in Delhi, India"*
2. ***M.Phil. (2002) in Environmental Science*** *from Jawaharlal Nehru University (JNU, NIRF Ranking 2nd in 2019)* ***(FIRST DIV.),*** *India.*

[Banaras Hindu University, Varanasi, India]
[11th Aug 1993 to 26th May 1999]

3. ***M.Sc****. (1999) in* ***Analytical Chemistry*** *from Banaras Hindu University (BHU, NIRF Ranking 3rd in 2019)* ***(FIRST DIV.)****, India.*
4. ***B.Sc. (HONS.) (1997)*** *in* ***Chemistry (HONS.)*** *from Banaras Hindu University (BHU, NIRF Ranking 3rd in 2019),* ***(FIRST DIV.),*** *India*

WORK EXPERIENCE

[Jaypee University of Engineering & Technology, India]
[Assistant Professor (Sr. Grade)] ***[1st July 2011 to till Date]***
Teaching to Under Graduate (B. Tech. and B.Sc.), Post Graduate (M.Tech., M.Sc. and Ph.D.] students and research activity including consultancy.

[Sr. Lecturer] [1st July 2010 to 30th June 2011]
Teaching to Under Graduate (B. Tech. and B.Sc.), Post Graduate (M.Tech., M.Sc. and Ph.D.] students and research activity.

[Lecturer] [2nd July 2008 to 30th June 2010]
Teaching to Under Graduate (B. Tech. and B.Sc.), Post Graduate (M.Tech., M.Sc. and Ph.D.] students and research activity.

[IMS Engineering College, India] [Lecturer]
[24th May 2006 to 1st July 2008]
Teaching to Under Graduate (B. Tech. and B.Sc.), Post Graduate (M.Tech. and M.Sc.] students and research activity.

SKILLS

Research Area: *Water Resource, Energy, Nanomaterial, Agriculture.*
Software-*Microsoft Office, Window-10, MiniTab-14, Pro-Origin, Visual MODFLOW/MT3D, WATCLAST, AQUACHEM, SURFUR, MAPSCAN, MAPINFO, ARCVIW, SPSS, STATISTICA, PHREEQC, MATLAB etc.*
Instrument: *AAS, Spectrophotometer, TGA, NMR, IR, GC, ICP-MS etc.*

PH.D./M.TECH./M.SC THESIS SUPERVISED AND COMPLETED (03)

1. Number of Ph. D. = 01
2. Number of M. Tech. = 01
3. Number of M. Sc. = 01

RESEARCH PUBLICATIONS

2020

1. Advancement in biogas production from the solid waste by optimizing the anaerobic digestion-A Review. Waste Disposal and Sustainable Energy 2020 **(Springer)** vol 2, issue 2, page 85-103. https://doi.10.1007/s42768-020-00036-x.

2019

2. Assessment of groundwater quality for the suitability of irrigation and its impacts on crop yields in the Guna district, India. Agricultural Water Management 2019 **(Elsevier Pub.)** vol. 216, page 224-241 **(IF 4.021).**
3. The mathematical modeling for the optimization of triacylglycerol Acylhydrolases Production Through Artificial Neural Network and Genetic Algorithm". International Journal of Pharma and Bio Sciences. Vol. 10 (3), page 135-143 **(SJIF 7.446).**
4. Production of microbial enzyme triacylglycerol Acylhydrolases by ASPERGILLUS SYDOWII JPG01 by in submerged fermentation using agroresidues". Asian Journal of Microbiology, Biotechnology and Environmental Sciences. Vol 21, issue 4, 2019**.**

2018

5. Geochemical assessment of fluoride enrichment and nitrate contamination in groundwater in hard rock aquifer by using graphical and statistical methods. Journal of Earth System Science 2018 **(Springer Pub.)** Vol 127, issue 7, pp 104 (1-23) **(Impact Factor 1.423).**
6. Engineering aspects of immobilized lipases on esterification: A special emphasis of crowding, confinement and Diffusion effects. Jan. 2018 **(Wiley VCH Pub.)**, Engineering in Life Science, vol 18, page 308-316. **(Impact Factor 1.934).**
7. Assessment of landfills vulnerability on the groundwater quality located near floodplain of the perennial river and simulation of contaminant transport. Modeling Earth System and Environment 2018" **(Springer Pub.)** vol 4 Issue 2 page 729-752.

2017

8. An assessment of hydrogeochemistry of two wetlands located in Bihar State in subtropical climatic zone of India. Environmental Earth Sciences, 2017 **(Springer Pub)** vol 76 (1); pp 1-19**; (IF 2.180**).
9. Design of anaerobic digester for producing biogas from Municipal Solid Waste. Poster presentation in International Workshop on Sustainable Energy, Kalmar Institute of Technology, Sweden, 6-8th Dec. 2017, poster No 20.

2016

10. Statistical evaluation of Recovery of copper from ewaste by using Hydrometallurgical Method and RSM model" Journal of Environmental Science, Toxicology and Food Technology" Oct. 2016, vol 10, issue 7 ver. II pp 31-43 **(IF 1.832).**

2012

11. Groundwater in Vicinity of landfill. 2012 (LAMBERT ACADEMIC PUBLISHING), GERMANY, Jan. 2012 ISBN: 9783847328858.

2011

12. Bottom Up approach: A versatile approach nanomaterial synthesis. Poster presentation in National Conference, Recent Trend in material Science (RTMS) from 8th to 10th October 2011.

2008

13. Geochemical Assessment of Groundwater Quality in vicinity of Bhalswa landfill using Graphical and multivariate statistical method, Delhi, India. Environmental Geology, 2008**, (Springer Pub.)** Vol. 53, 1509-1528. **(IF 2.180).**
14. Hydro- geochemical studies around the Bhalswa landfill in Delhi, India. AA Balkema **(Taylor and Francis Group London UK)** "Groundwater for Sustainable Development: Problems, Perspectives and Challenges (2008) "ISBN: 9780415407762, ISBN-10: 0415407761 Chap 8, 69-85.

2007

15. An Aquifer Vulnerability Assessment Using the DRASTIC Model in Landfill Sites, Delhi, India. In proceeding an international Conference on Coastal Zone Environment and Sustainable Development, Vulnerable, Adaptation and Beyond. (12th to 14th Feb 2007) pp 103.
16. An Approach to Manage Groundwater Aquifers Including Coastal City Aquifer of India. In proceeding an international Conference on Coastal Zone Environment and Sustainable Development, Vulnerable, Adaptation and Beyond. (12th to 14th Feb 2007) pp 104.

2006

17. Metal fractionation studies in Surfacial and Core sediments in the Achankovil River basin, India. Environmental Monitoring and Assessment 2006 **(Springer Pub.)** (Volume 121, NO. 1-3, Page 77-102) **(IF 1.903).**
18. Hydrogeochemistry of groundwater in vicinity of Bhalswa Landfill, Delhi, India. In proceeding of International Conference on Groundwater for Sustainable Development, Problem Perspective and Challenges since 1st Feb to 4rth Feb 2006.
19. Simulation of Solute Transport in South Delhi, Using Okhala Phase II as point source, Delhi, India. In proceeding of International Conference on Groundwater for Sustainable Development, Problem Perspective and Challenges since 1st Feb to 4rth Feb 2006.

2005

20. An overview of the Hydrogeochemical Water Quality Model" (2005) Mathematical Models in Hydro-geochemistry, Assessment of Quality and Management (sept 19th to 5th Oct 2005) (pp 49-59).
21. Groundwater Resource Management. In proceeding an international workshop conducted by SIS, Jawaharlal Nehru University (7th to 8th April 2005) (unpublished).
22. Groundwater quality in vicinity of Bhalswa Landfill, Delhi, India. In proceeding of National Workshop conducted by IIT, Delhi (18th-19th May 2005).

2004

23. An over view of Mathematical Modelling. Hands on Training in Mathematical Modelling, Prashant Publishing Co. (2004), New Delhi, India pp 48-57.

(Dr Sunil Kumar Srivastava)

Enrolment No. 2K/20/ME/17

जवाहरलाल नेहरू विश्वविद्यालय
नई दिल्ली

Jawaharlal Nehru University

New Delhi

Upon the recommendation of the Academic Council
hereby confers the Degree of

Doctor of Philosophy

On Sunil Kumar Srivastava

who has successfully completed in the year 2006 the requirements prescribed under the Ordinance for the award of this degree.

Title of Thesis :

"Study of the Ground Water Quality Variations in the Vicinity of the Selected Land-Fill Sites in Delhi, India"

Given this day under the seal of the University at New Delhi in the Republic of India.

The 29 AUG 2007

JNU

Registrar

Vice-Chancellor

जवाहरलाल नेहरू विश्वविद्यालय
नई दिल्ली

Jawaharlal Nehru University

New Delhi

Upon the recommendation of the Academic Council

hereby confers the Degree of

Master of Philosophy

On Sunil Kumar Srivastava

who has successfully completed in the year 2002 the requirements prescribed under the Ordinance for the award of this degree.

Title of Dissertation :

"Sediment Characteristics of the Achankovil River Basin, Kerala."

Given this day under the seal of the University at New Delhi in the Republic of India.

The 15 OCT2003

JNU

Registrar

Vice-Chancellor

क्रमाङ्क 38 परीक्षा अनुक्रमाङ्क 1144

काशी हिन्दू विश्वविद्यालयः

मास्टर ऑफ़ साइंस

श्री सुनील कुमार श्रीवास्तव इति नामा/नाम्नी

अस्य विश्वविद्यालयस्य १९९९ तमे ईसवीयवत्सरे परीक्षायां केमिस्ट्री विषये

प्रथम श्रेण्यां समुत्तीर्य मास्टर ऑफ़ साइंस पदवीं प्राप्नोदिति प्रमाणयति ।

काशी हिन्दू विश्वविद्यालय

मास्टर ऑफ़ साइंस

प्रमाणित किया जाता है कि

श्री सुनील कुमार श्रीवास्तव

ने काशी हिन्दू विश्वविद्यालय की सन् १९९९ की परीक्षा में प्रथम श्रेणी में

उत्तीर्ण होकर मास्टर ऑफ़ साइंस केमिस्ट्री उपाधि प्राप्त की ।

BANARAS HINDU UNIVERSITY

Master of Science

This is to certify that

Shri Sunil Kumar Srivastava

obtained the degree of Master of Science *in this University in the Examination of* 1999 , *in* Chemistry *and that he/she was placed in the* First *Class.*

वाराणसी–VARANASI
दिनाङ्क–DATE May 4, 2000

कुलपतिः/कुलपति/VICE-CHANCELLOR

Serial No : 20

BANARAS HINDU UNIVERSITY

OFFICE OF THE CONTROLLER OF EXAMINATIONS

MARKSHEET

M.SC. (FINAL) CHEMISTRY (ANALYTICAL)
EXAMINATION-1999

Name of the Candidate : Shri **Sunil Kumar Srivastava**

Exam. Roll No. : **1144** Enrolment No. : 218013

Father's Name : Shri Mukut Dhari Lal Srivastava

Mother's Name : Smt. Asha Srivastava

PAPERS		Marks Obtained	Full Marks
Theory :			
Compulsory:			
Paper I :	Principles of Analytical Chemistry	51	100
Paper II :	Micro-Analytical Technique	70	100
Paper III :	Electro-Analytical Chemistry	67	100
Paper IV :	Separation Techniques	76	100
Paper V :	Special Topics in Analytical Chemistry	72	100
Elective:			
Paper VI :	(d) Medicinal Chemistry	69	100
Practicals :			
Practicals A		58	75
Practicals B		52	75
Total Marks of M.Sc. (Final) Examination		**515**	750
Marks obtained at M.Sc. (Previous) Examination		430	750
	Grand Total...	**945**	1,500

Passed in First Class

Date of Declaration of Result : **14.05.1999**

Prepared by : .....

Checked by : 1.....

: 2.....

Controller of Examinations

P.T.O.

क्रमाङ्क 959

परीक्षा अनुक्रमाङ्क 94CH66

काशी हिन्दू विश्वविद्यालयः

बेचॅलर ऑफ़ साइंस (आनर्स)

(१०+२+३)

श्री सुनील कुमार श्रीवास्तव इति नामा/नाम्नी

अस्य विश्वविद्यालयस्य १९९७ ईसवीयसंवत्सरीयां परीक्षां समुत्तीर्य बेचॅलर ऑफ़ साइंस (आनर्स) उपाधिं प्राप्नोदिति प्रमाणयति।

आनर्स विषयः— केमिस्ट्री

श्रेणीः— प्रथम

काशी हिन्दू विश्वविद्यालय

बेचॅलर ऑफ़ साइंस (आनर्स)

(१०+२+३)

प्रमाणित किया जाता है कि

श्री सुनील कुमार श्रीवास्तव

को इस विश्वविद्यालय की सन् १९९७ ईसवी की परीक्षा उत्तीर्ण होने पर बेचॅलर ऑफ़ साइंस (आनर्स) उपाधि प्रदान की गई।

आनर्स विषय— केमिस्ट्री

श्रेणी— प्रथम

BANARAS HINDU UNIVERSITY

Bachelor of Science (Honours)

(10+2+3)

This is to certify that

Shri Sunil Kumar Srivastava

having passed the Examination of 1997, is admitted to the degree of Bachelor of Science (Honours) *of this University.*

Honours Subject: Chemistry

Division: First

वाराणसी-VARANASI

दिनाङ्क-DATE March 28, 1998

कुलपतिः/कुलपति/VICE-CHANCELLOR

S. No. 63

BANARAS HINDU UNIVERSITY

OFFICE OF THE CONTROLLER OF EXAMINATIONS

MARKSHEET

Dated 4-7-1997.

B.Sc. (HONOURS) PART III EXAMINATION

Marks obtained by Shri/Smt./Km. Sunil Kumar Srivastava

Examination Roll Number 94CH66 at the B.Sc. (Honours) Part III Examination of 1997.

Subjects	Marks obtained	Full Marks
Subject :—CHEMISTRY		
Theory Papers :		
Paper I : Analytical ..	47	75
Paper II : Inorganic ..	33	75
Paper III : Organic-I ..	37	75
Paper IV : Organic-II ...	42	75
Paper V : Physical-I ..	53	75
Paper VI : Physical-II ..	54	75
Practicals :		
Section A : Physical ..	38	50
Section B : Inorganic ..	34	50
Section C : Organic ..	40	50
Total marks of B.Sc. (Hons.) Part III Examination ..	378	600
Marks obtained at B.Sc. (Hons.) Part II (excl. Lang.) Examination ..	401	600
Marks obtained at B.Sc. (Hons.) Pt. I (excl. Lang.) Examination ..	330	600
Grand Total ..	1109	1,800
Marks obtained at B.Sc. Part II Examination in Hons. Subject only ..		200
Marks obtained at B.Sc. Part I Examination in Hons. Subject only ..		200
Grand Total of Marks (Parts I, II, III Examinations) in Hons. Subject only ..		1,000

Passed in First Class ~~OR Failed~~

Prepared by : Mal

Checked by : 1. F. Ahmad

2. Anshant

V.N. Pandeya

Controller of Examinations.

Few Recent Published Research Paper

Contents lists available at ScienceDirect

Agricultural Water Management

journal homepage: www.elsevier.com

Assessment of groundwater quality for the suitability of irrigation and its impacts on crop yields in the Guna district, India

Sunil Kumar Srivastava

Department of Environmental Science/Chemistry, Jaypee University of Engineering and Technology, A.B. Road, Raghogarh, Guna, MP, India

ARTICLE INFO

Keywords:
Geochemical modeling
Sodium absorption ratio (SAR)
Salinity-hazard
Sodium-hazard
Crop yield

ABSTRACT

This study was performed to understand the impact of groundwater quality on the crop yields and its suitability for the irrigation. The hydrogeochemical assessment indicates chemical weathering is prevalent in the aquifer system. Low sodium-hazard observed in almost all samples. High salinity-hazard observed in the shallow aquifer indicates leaching of contaminants from the surface. Salinity-hazard statistics indicates ~27.60% groundwater suitable for irrigation, ~47.65% groundwater considerable for irrigation of selected crops whose salinity tolerance limit is high, ~13.44% groundwater (fresh-brackish) cause problem in the soil and ~11.31% groundwater unsuitable for the irrigation.

Salinity tolerance limit indicates yield (%) of the few crops remain unaffected. These crops are Hordeum vulgare (Barley), Gossy pium (Cotton), Beta vulgaris (Sugar-beet), Cynodon dactylon (Bermuda-grass), Thinopyrum ponticum (tall Wheat-grass), Thinopyrum intermedium (Wheat-grass) etc. The yield potential (%) partially affected in the few crops like Arachis hypogaea (Groundnut) (~95.30%), Oryza sativa (Rice) (~93.29%), Carthamus tintorius (Safflower) (~97.32%), Sorghum bicolor (Sorghum) (~95.97%), Glycine max (Soybean) (~97.32%), Triticum aestivum (Wheat) (~99.33%), Brassica oleracea var. italica (Broccoli) (~92.62%), Cucumis sativus (Cucumber) (~90.60%), Solanum lycopersicum (Tomato) (~90.60%), Phalaris aquatic (Harding-grass) (~97.96%), Lolium perenne (Perennial ray-grass) (~97.99%), Sorghum drummondii (Sudan-grass) (~92.62%), Festuca arundinacea (tall-Fescue) (~95.30%), Lotus corniculatus (Trefoil-small) (~97.32%), Phoenix dactylifera (Date-palm) (~95.97%), Ficus carica (Fig) (~95.97%), Olea europaea (Olive) (~95.97%). Punica granatum (Pomegranate) (~91.28%) etc. Few crops sensitive to salinity-hazard indicate low-yield potential listed as Phaseolus vulgaris (Bean) (~36.91%), Daucus carota (Carrot) (~36.91%), Fragaria ananassa (Strawberry) (~36.91%). This groundwater is suitable for the irrigation of crops like Barley, Cotton, Sugar-beet, Wheat, Wheat-grass, Bermuda-grass, etc. But this groundwater can be used for irrigation after salinity management for the crops like Groundnut, Rice, Soybean, Broccoli, Cucumber, Tomato, Harding-grass, tall Fescue, Trefoil-small, Date-palm, Fig, Olive, and Pomegranate. The similar range of the crop yields observed in both Soil Water Salinity (SWS) Model and Ayers and Westcot Model, if the salinity of the irrigation water is low (≤1.5 mS/cm). While low reduction in crop yields observed according to SWS Model in comparisons to Ayers and Westcot Model if the salinity of the irrigation water is high (>1.5 mS/cm). The major reduction in crop yields observed in Ayers and Westcot Model, while the moderate decline in crop yields observed in SWS Model at higher salinity. Crop yield in the study area can be improved by implementing proper irrigation water management.

1. Introduction

The yield of field and vegetable crops depends on the quality of soil and water uses in irrigation. Soil quality affected by the various factors like soil type, slope, drainage patterns, types of irrigation, fertilizer, and water uses for irrigation of the crops (Bauder et al., 2011). Assessment of irrigation water quality is essential for the planning of long term management of the crop yields since high electrical conductivity of water (EC_w) causes the inability of the plant to compete with ions in the soil solution (Bauder et al., 2011). Surface water (river, lake, and pond) and subsurface water (groundwater) extensively use for irrigation worldwide. Subsurface water is preferably using worldwide for irrigation purpose due to its easy availabilities in comparison to surface water. The yields of crop significantly affect the quality of irrigation water (Maas and Hoffman, 1977; Bauder et al., 2011; Straten Van et

Email address: sunil16sster@gmail.com (S. Kumar Srivastava)

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Engineering in Life Sciences

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www.els-journal.com

Surendra Kumar Parashar[1]
Sunil Kumar Srivastava[1]
N. N. Dutta[1]
Vijay Kumar Garlapati[2]

[1]Department of Chemical Engineering/Chemistry, Jaypee University of Engineering and Technology, Guna, Madhya Pradesh, India

[2]Department of Biotechnology and Bioinformatics, Jaypee University of Information Technology, Waknaghat, Himachal Pradesh, India

Research Article

Engineering aspects of immobilized lipases on esterification: A special emphasis of crowding, confinement and diffusion effects

Cross-linked enzyme crystal (CLEC) and sol-gel entrapped pseudomonas sp. lipase were investigated for the esterification of lauric acid with ethanol by considering the effects of reaction conditions on reaction rate. The activation energy for the reaction was estimated to be 1097.58 J/mol and 181.75 J/mol for sol-gel and CLEC entrapped lipase respectively. CLEC lipase exhibited a marginal internal diffusion effect on reaction rate over sol-gel lipases and found to be interesting. The overall reaction mechanism was found to conform to the Ping Pong Bi Bi mechanism. The higher efficiency of sol-gel lipases over CLEC lipases in esterification reaction is mainly due to the combined effects of crowding, confinement and diffusional limitations.

Keywords: CLEC lipase / Confinement / Crowding / Diffusion / Ethyl laurate / Sol-gel lipase

Received: April 17, 2017; *revised:* November 8, 2017; *accepted:* January 24, 2018

DOI: 10.1002/elsc.201700082

1 Introduction

Retaining the primary, secondary, tertiary and quaternary structures are prerequisite for enzymes to maintain the catalytic activity under harsh industrial process conditions (high temperature, extreme ph, operation parameters) by devoiding the substrate/ product inhibition. Cross-linked enzyme crystal (CLEC) and sol-gel immobilizations are a choice of interest in protein stabilization techniques and find practical importance in biocatalysis domain [1,2]. Sol-gel entrapped lipases on a thin film of inert support facilitate reuse of enzymes by overcoming diffusion limitations and also the structural aspect makes them an easy usage in enzymatic bioreactors [3–5]. The sol-gel entrapped lipases also avoid the problems incurred during covalent immobilization techniques where strong binding affect the catalytic triad residues or desorption (van der Waals, hydrogen or ionic binding), which usually encountered during conventional immobilization techniques [6]. As entrapped in a thin film of inert support, sol-gel lipases also overcome the activity inhibition by reaction components such as alcohols, water-miscible solvents, high temperatures and pressures sensitivities of lipases. In case of CLEC, the high catalytic activity of purified lipase is immobilized by crosslinking with a suitable crosslinker such as glutaraldehyde [1].

Once lipase interacts with inert support, the conformation will be changed due to the folding/unfolding phenomenon in a crowded and/or confined environment. The free volume space of the lipase is limited either by the dense surrounding biomolecules, or by the small confinements which eventually affect the protein stability in terms of thermal stability, and chemical reactivity [7,8]. Hence, the knowledge of crowding and confinement of proteins on immobilization drive the researcher for better understanding the folding and its stability in crowding and/or confinement conditions. The profound effects of crowding and confinement on the dynamic and functional properties of enzymes and subsequently on the dependent bioprocess have been started to acknowledge by the researchers [9, 10]. Several studies have been carried out using these immobilized benign catalysts in the esterification and transesterification reactions [11–17]. These studies are mainly targeting the selection/ optimization of the process conditions, reaction mechanism and reusability studies by devoiding the crowding and confinement effects on the enzyme stabiity and subsequent bioprocess. Hence, in this paper, we have attempted the relative assessment of CLEC and sol-gel entrapped lipases for esterification of lauric acid with ethanol in terms of crowding and confinement effect on reaction rates along with the selection of process conditions.

2 Materials and methods

2.1 Materials

Lipase from Pseudomonas sp. L9518 containing ≥ 15 U/mg (Sigma), Lauric acid, ethanol, solvents of analytical grade were

Correspondence: Dr. Vijay Kumar Garlapati (shanepati@gmail.com), Department of Biotechnology and Bioinformatics, Jaypee University of Information Technology, Waknaghat, Himachal Pradesh 173234, India

Abbreviations: **CLEC**, cross-linked enzyme crystal; **PAMS**, poly (ethoxymethyl) siloxane; **PHOMS**, poly (hydroxymethyl) siloxane

J. Earth Syst. Sci. (2018)127:104
https://doi.org/10.1007/s12040-018-1006-4

Geochemical assessment of fluoride enrichment and nitrate contamination in groundwater in hard-rock aquifer by using graphical and statistical methods

SUNIL KUMAR SRIVASTAVA[1,*] and A L RAMANATHAN[2]

[1]*Department of Chemical Engineering/Chemistry, Jaypee University of Engineering and Technology, Guna 473 226, India.*
[2]*School of Environmental Science, Jawaharlal Nehru University, New Delhi 110 067, India.*
**Corresponding author. e-mail: sunil16sster@gmail.com*

MS received 1 September 2017; revised 30 January 2018; accepted 4 February 2018

This systematic study was carried out with objective to delineate the various sources responsible for NO_3^- contamination and F^- enrichment by utilizing statistical and graphical methods. Since Central Ground Water Board, India, indicated susceptibility of NO_3^- contamination and F^- enrichment, in most of the groundwater, NO_3^- and F^- concentration primarily observed >45 and >1.5 mg/L, respectively, i.e., higher than the permissible limit for drinking water. Water Quality Index (WQI) indicates ~22.81% groundwater are good-water, ~71.14% groundwater poor-water, ~5.37% very poor-water and 0.67% unsuitable for drinking purpose. Piper diagram indicates ~59.73% groundwater hydrogeochemical facies are Ca–Mg–HCO_3 water-types, ~28.19% Ca–Mg–SO_4–Cl water-types, ~8.72% Na–K–SO_4–Cl water-types and 3.36% Na–K–HCO_3 water-types. This classification indicates dissolution and mixing are mainly controlling groundwater chemistry. Salinity diagram indicate ~44.30% groundwater under in low sodium and medium salinity hazard, ~49.66% groundwater fall under low sodium and high salinity hazard, ~3.36% groundwater fall under very-high salinity hazard. Sodium adsorption ratio indicates ~97% groundwater are in excellent condition for irrigation. The spatial distribution of NO_3^- indicates significant contribution of fertilizer from agriculture lands. Fluoride enrichment occurs in groundwater through the dissolution of fluoride-rich minerals. By reducing the consumption of fertilizer and stress over groundwater, the water quality can be improved.

Keywords. Hydrogeochemistry; fluoride; nitrate; Guna; hard-rock.

1. Introduction

The nitrate contamination and enrichment of fluoride in groundwater is a very common problem observed worldwide by various researchers (Bohlke 2002; Kundu *et al.* 2008; Jalali 2009; Kyoung-Ho *et al.* 2009; Suthar *et al.* 2009; Akao *et al.* 2014; Subba Rao *et al.* 2016; Sajil Kumar 2017). Nitrate contamination in groundwater occurs due to leaching of nitrate from agriculture lands, sewage effluent or fertilizer sink (Bohlke 2002; Kundu *et al.* 2008; Jalali 2009; Kyoung-Ho *et al.* 2009; Suthar *et al.* 2009; Ngounou Ngatch and Djoret 2010; Akao *et al.* 2014). India is also suffering from nitrate contamination and fluoride enrichment problems (Handa 1975; Sajil Kumar *et al.* 2014; Subba Rao *et al.* 2016). According to UNICEF (1999), India possesses ~14.1% of total fluoride deposits

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ORIGINAL ARTICLE

An assessment of the hydrogeochemistry of two wetlands located in Bihar State in the subtropical climatic zone of India

Ravi Ranjan[1] · Sunil Kumar Srivastava[2] · A. L. Ramanathan[1]

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Abstract A total of 30 water samples and 8 sediment samples were collected and chemically analysed for major ions (Na^+, K^+, Mg^{2+}, Ca^{2+}, HCO_3^-, SO_4^{2-}, Cl^-, NO_3^-, silica, PO_4^{3-}, F^-), trace elements (Fe, Mn, Ni, Cd, Zn, Pb, Cu), minerals and nutrients to determine the factors that control the chemistry of water in the Kawar-Tal and Kusheshwar-Asthan wetlands in the Bihar State of India. These analyses indicate that Ca^{2+} and HCO_3^- ions are the most dominant ions in both of the wetlands. It also indicates rock weathering is a major source of ions in these wetlands, particularly the dissolution of carbonate minerals. The hydrogeochemistry of water in Kusheshwar-Asthan is favouring kaolinite formation and in Kawar-Tal favouring kaolinite–gibbsite formation. Quartz (~36%), clay minerals (~21%) and chlorite (~10%) are the dominant minerals in both the wetlands. Orthoclase (~12.49%), calcite (~7.51%) and illite (4.89%) minerals are only available in Kawar-Tal surface sediment, while albite (6.29%) and biotite (~13.6%) minerals are only available in Kusheshwar-Asthan. Total carbon (~3%), inorganic carbon (0.9%), organic carbon (~2.1%), total sulphur (~0.0008%), nitrogen (~0.55%) and phosphate (~0.96%) are available in Kawar-Tal surface sediments, while total carbon (~2.38%), inorganic carbon (0.55%), organic carbon (~1.84%), total sulphur (~0.001%), nitrogen (~0.62%) and phosphate (~0.64%) are available in Kusheshwar-Asthan surface sediments. The study indicates wetlands are rich in nutrient for biological activities and are sufficient to support the biodiversity, but few locations are influenced by anthropogenic activities which cause the increase of sulphur, chloride, iron and lead.

Keywords Hydrogeochemistry · Kawar-Tal · Kusheshwar-Asthan · Bihar · Wetland

Introduction

Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life (Ramasar 2007). The UNEP-World Conservation Monitoring Center has suggested that wetlands cover a land area of about 570 million hectares, roughly 6% of the Earth's land surface, of which 2% is lakes, 30% bogs, 26% fens, 20% swamps and 15% floodplains (Ramasar 2007). India has a rich variety of wetland habitats. The total area of wetlands (excluding rivers) in India is 58,286,000 ha or 18.4% of the country, 70% of which comprises areas under paddy cultivation (Green 1990). A total of 1193 wetlands, covering an area of about 3,904,543 ha, were recorded in a preliminary inventory coordinated by the Department of Science and Technology (DST), of which 572 were natural (Green 1990). In a recent review of the India's wetlands, 93 were identified as being of conservation importance (Scott 1989). India's 19 most important wetlands that cover a total area of 648,507 ha have been designated under the convention of wetlands of international importance as being especially significant waterfowl habitats (Ramsar Convention 2003). The interactions of physical, biological and chemical components of a wetland, such as soils, water, plants and animals, enable the wetland to perform

✉ Sunil Kumar Srivastava
sunil16sster@gmail.com

[1] School of Environmental Sciences, Jawaharlal Nehru University (JNU), New Delhi 110067, India

[2] Department of Chemistry/Chemical Engineering, Jaypee University of Engineering and Technology (JUET), Guna 473226, India

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ORIGINAL ARTICLE

Assessment of landfills vulnerability on the groundwater quality located near floodplain of the perennial river and simulation of contaminant transport

Sunil Kumar Srivastava[1] · AL Ramanathan[2]

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Abstract
This investigation was carried out with the objective to understand the impacts of landfill leachate on groundwater quality. This study also explained the movement of trace metals in groundwater by using Visual MODFLOW/MT3D. It also delineates the various factors controlling the suitability of groundwater for domestic, agriculture and drinking purpose. The statistical assessment shows ~ 60.09% groundwater are in good condition, ~ 35.38% in poor condition and 4.53% in very poor condition. The spatial distributions of water quality index (LWQI) around landfills indicate landfills are in depleted condition. Hydrogeochemical classification indicates ~ 90.91% groundwater shows Ca–Na water-type cation facies and Cl^- water-type anion facies. While 9.09% groundwater shows Ca–Na water-type cation facies and Cl^-–SO_4^{2-}–HCO_3^- anion hydrogeochemical facies. The mineral equilibrium diagram of groundwater has revealed that it is in equilibrium with silicate minerals and favors kaolinite formation. The saturation index indicates chrysotile ($Mg_3Si_2O_5(OH)_4$) (2.84), dolomite ($CaMg(CO_3)_2$) (0.45), ferric hydroxide ($Fe(OH)_3$) (1.97–3.58), goethite (FeOOH) (7.86–9.47), hematite (Fe_2O_3) (17.73–20.95), hydroxyapatite ($Ca_5(PO_4)_3OH$) (2.38–4.62), jarosite-K ($KFe_3(SO_4)_2(OH)_6$) (0.22–1.92), cerussite ($PbCO_3$) (0.39), vivianite ($Fe_3(PO_4)_2{\cdot}8H_2O$) (0.39) and willemite (Zn_2SiO_4) (0.35) are reactive mineral in groundwater aquifer of study area. The seasonal and temporal variation indicates anthropogenic influence. The calibration and validation of model show > 90% models correct with 95% confidence. The contaminant transport simulated in groundwater aquifer with the high accuracy (estimated standard error 0.049 m) for the large area (~ 300 km^2). The trends of contour lines of trace metals concentration indicate; it will contaminate study area within few years of its release through the landfill.

Keywords Groundwater modeling · Landfill · LWQI · Contaminant transport · Chemical speciation

Introduction

Water is essential for the survival of all the living being, the most precious gift of nature. Groundwater is one of the major sources of freshwater in the densely populated study area. Increasing demand of groundwater due to ever-increasing population has initiated the need for an effective management of available groundwater resource (Arrieta et al. 2016; Ghiani et al. 2012; Ljunggren 2003; Zhao et al. 2012; Yalew et al. 2016). Further industrialization in all cities and dumping of their effluent/waste in the unplanned landfill causes a great concern to environmentalist (Das 2017; Srivastava and Ramanathan 2008; Jang and Chen 2015; Li et al. 2017; Kumar and Alappat 2005; Jang and Hong 2002).The availability of geogenic trace metal in groundwater in fractured crystalline bedrock aquifers (semiconfined) is the major concern in these areas, which rely on private bedrock borewells for their domestic/agriculture water supply (Ryan et al. 2013; Zheng and Ayotte 2015). The concentration of trace metal further increases in groundwater due to leaching of these metals through unplanned landfill located in the floodplain of the perennial river (Bezama et al. 2007; Finnveden et al. 1995; Radnekova-Yaneva et al. 1995; Jha et al. 2011; Renou et al. 2008; Tchobanouglus et al. 1998; Zamorano et al. 2009; Olaniya et al. 1991; Srivastava and Ramanathan 2012;

✉ Sunil Kumar Srivastava
sunil16sster@gmail.com

[1] Department of Chemistry/Chemical Engineering, Jaypee University of Engineering and Technology, A.B. Road, Raghogarh, Guna, MP, India

[2] School of Environmental Sciences, Jawaharlal Nehru University (JNU), New Delhi, India