ENVIRONMENT 2024

An International Conference on

Environmental Challenges, Opportunities and Sustainable Solutions

09-11 December 2024

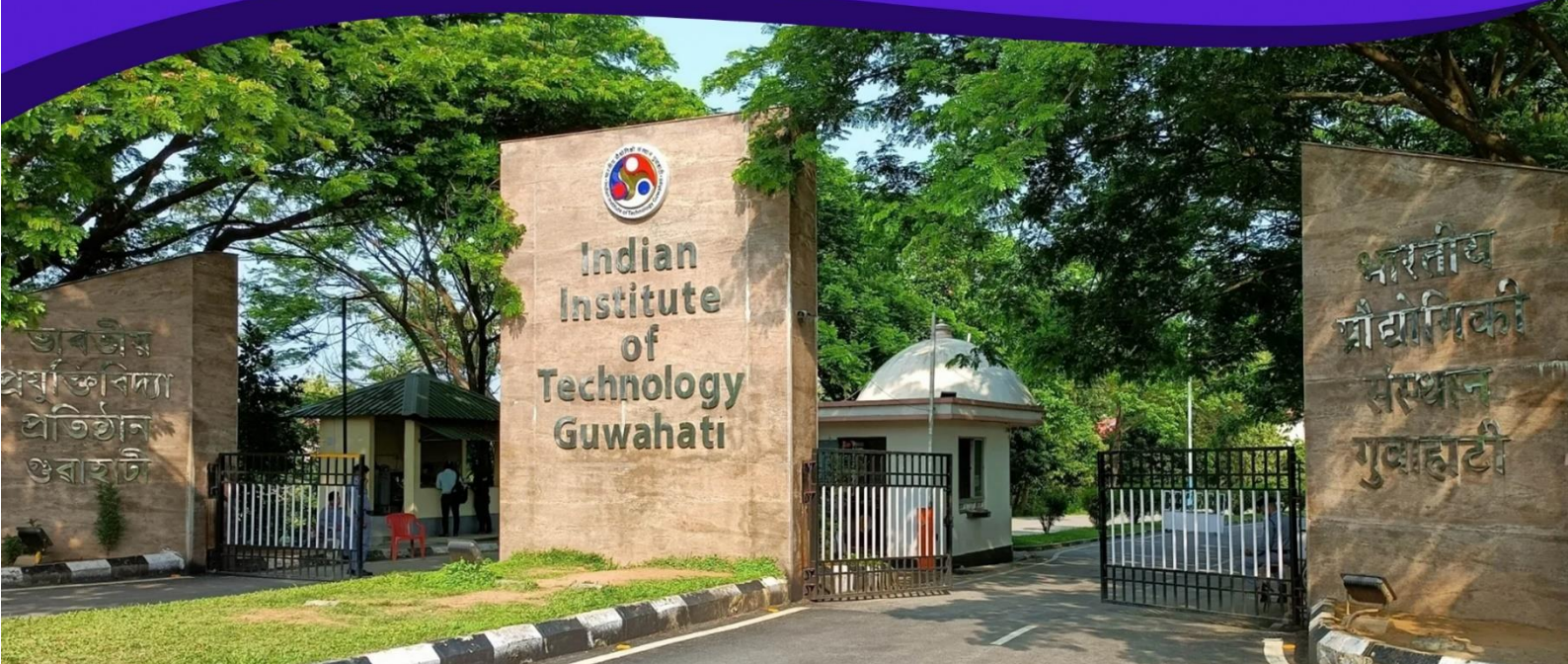
Organized
by

Centre for the Environment

Indian Institute of Technology Guwahati

Venue: Academic Complex | Core 5

ABSTRACT BOOK



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Indian Institute of Technology Guwahati

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Abstract Book

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Indian Institute of Technology Guwahati

Guwahati – 781039, Assam, India

Index

Prof. Animes Kumar Golder
Head, Centre for the Environment
Professor, Department of Chemical Engineering
Indian Institute of Technology Guwahati
Assam, India - 781039

Message from Chair

Please accept my warm greetings and best wishes from IIT Guwahati.

As the Conference Chair, with spirited and charged enthusiasm, I welcome everyone to "Environment 2024", an International Conference on Environmental Challenges, Opportunities and Sustainable Solutions being hosted by the Centre for the Environment at IIT Guwahati. Serving as a pivotal and vital platform through the experts, researchers and practioners for the global discourse on translational topics related to environmental sustainability, Environment 2024 strives to address and resolve the most pressing environmental challenges that we face in the contemporary world.

Encouraging interdisciplinary collaboration, Environment 2024 hosts keynote lectures, scintillating sessions, highly effective interactive sessions and Environmental Hackathon. Through the conference kaleidoscope, we intend to seek innovative, pragmatic and cost-effective solutions across wider themes that range from climate change and renewable energy to sustainable processes and environmental policy. For the emerging researchers and students, the conference also provides a unique platform for substantial improvisation in the know-how of the discussed topics. Accordingly, opportunities through effective networking are sought to showcase novel yet fascinating ideas and consortium models for deeper analysis and engagement with established experts in the ever-evolving transdisciplinary research culture in the vast domain of Environmental Science.

Environment 2024, through its associated deliberations, underscores the commitment of IIT Guwahati to foster rapid advances in environmental science and technology. Collectively, Environment 2024 aims to envision a greener, and enhanced sustainability of sciences, technologies, policies and all associated interfaces. On behalf of the conference organizing team, we look forward for the emergent yet impactful exchanges and transformative ideas that have a greater potential to revolutionize our research pedagogies and bring them even closer to the nature and natural phenomena.

Let us work together to build a resilient, sustainable world for the future generation.

Warm regards,

Prof. Animes Kumar Golder
Chair, Environment 2024

Message from Convenor

Dear Colleagues

It is my honor and privilege to welcome you to the International Conference on Environmental Challenges, Opportunities, and Sustainable Solutions (ENVIRONMENT 2024), hosted by the Centre for the Environment, Indian Institute of Technology Guwahati. Scheduled for December 2024, this conference serves as a vibrant platform for global thought leaders, researchers, policymakers, and industry professionals to converge and address pressing environmental challenges.

ENVIRONMENT 2024 seeks to delve into transformative themes such as climate resilience, renewable energy transitions, sustainable urbanization, biodiversity conservation, and environmental governance. Through an array of keynote addresses, technical sessions, and panel discussions, we aim to stimulate meaningful exchanges of knowledge, foster interdisciplinary collaborations, and inspire actionable strategies that align with the vision of a sustainable and equitable future.

To Our Esteemed Industry, Government, and Academic Sponsors:

Your support plays a vital role in shaping the success of ENVIRONMENT 2024. As leaders in your respective domains, your commitment to fostering innovation and advancing sustainable solutions is instrumental in addressing global environmental challenges. This conference offers you an opportunity to showcase your organization's contributions, engage with a diverse audience of global stakeholders, and strengthen partnerships that pave the way for impactful environmental initiatives.

We are deeply grateful for your support, which underscores your dedication to creating a greener, more sustainable world. Your involvement not only elevates this event but also inspires others to join hands in this collective endeavor.

In addition to academic and professional discussions, ENVIRONMENT 2024 is deeply committed to nurturing emerging talent. Dedicated sessions for students and young researchers, including workshops, poster presentations, and mentoring opportunities, will provide a unique platform to showcase their innovative ideas and contributions to environmental science and solutions.

This conference represents more than an academic gathering; it is a call to action. At IIT Guwahati, we strive to be a beacon of innovation and collaboration, and this event underscores our dedication to tackling environmental challenges with a spirit of partnership and ingenuity.

I warmly invite you to join us at ENVIRONMENT 2024, to share your insights, engage in rich discussions, and become part of a global movement driving impactful change. Together, let us turn challenges into opportunities and pave the way for a sustainable future for generations to come.
I look forward to welcoming you to Guwahati this December!

Warm regards,

Prof. Senthilmurugan Subbiah
Convenor, ENVIRONMENT 2024
Indian Institute of Technology Guwahati

भास्कर ज्योति फुकन
प्रबंधक निदेशक
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Message from Chief Guest

I am happy to know that the Centre for Environment, IITG is organizing an International Conference on Environment - Challenges, Opportunities and Sustainable Solutions (ENVIRONMENT 2024) from 9-11 December and is bringing out a souvenir to mark the occasion. It is indeed an honour to be part of ENVIRONMENT 2024 and deliberate on this very pertinent and topical subject.

The whole world is now concerned about climate emergencies and hastening the process of energy transition. A general consensus has emerged on the adverse impact of fossil fuels on climate change globally. However, we often tend to overlook other aspects impacting our climate particularly the aggressive alteration of natural landscapes, flora and fauna which has had a profound and discernable impact on overall ecology and environment.

It is said that nature has the power of restoring itself, if left alone. On the other hand, developing countries like India face enormous challenge in balancing developmental needs to its people by raising their income level and increasing their purchasing power, which is invariably linked with capital investment triggering infrastructure projects. These new infrastructures lead to alteration of nature and resultant negative impact on climate. Therefore, the challenge is to strike a balance between the ecology and development needs.

This conference will provide the perfect platform to deliberate on the future course of action to save our environment, while pursuing India's dream to become a developed nation primarily by adoption of right technologies.

I take the opportunity to wish the ensuing event all success.

With sincere regards,

Bhaskar Jyoti Phukan
Managing Director
Numaligarh Refinery Limited

27-11-24

Shri. Mahesh Gupta
Chairman
Kent RO Systems

Message from Guest of Honor

I am honored to address the Environment 2024 Conference, organized by the Centre for the Environment at IIT Guwahati, scheduled from December 9 to December 11, 2024. This gathering is pivotal as we confront pressing environmental challenges that threaten our planet's future.

The excessive use of fossil fuels has led to elevated emissions of CO_2, NO_2, methane, and other greenhouse gases, contributing to global warming. A temperature rise exceeding 1.5 °C could have catastrophic consequences for humanity. Additionally, the continuous degradation of water quality poses a significant risk to the availability of safe drinking water.

Addressing these issues requires a comprehensive approach. Transitioning to renewable energy sources, reducing greenhouse gas emissions, and implementing innovative carbon capture technologies are essential steps. Equally important is ensuring sustainable water management practices to preserve this vital resource.

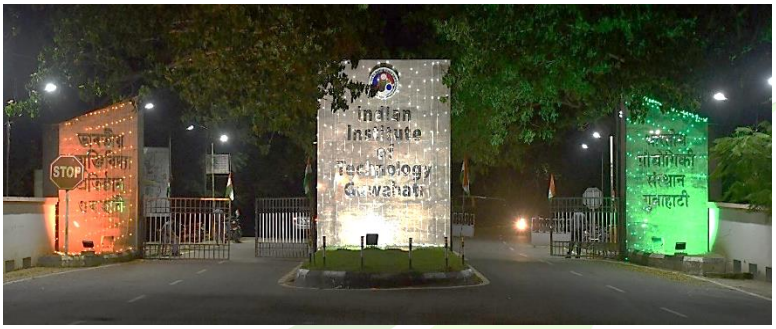
This conference serves as a crucial platform for experts, researchers, and policymakers to collaborate on sustainable solutions. I commend IIT Guwahati for facilitating this dialogue and contributing to global environmental sustainability efforts.

Let us commit to creating a cleaner, greener, and safer planet for future generations.

Warm regards,

Mahesh Gupta
Chairman, Kent RO Systems
Guest of Honor, Environment 2024 Conference

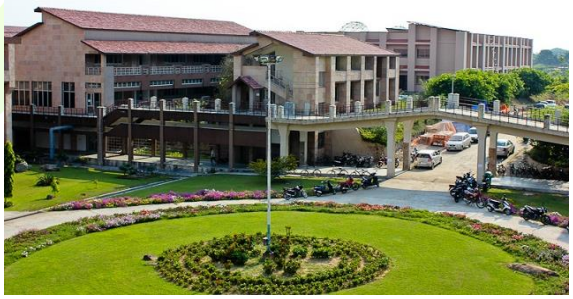
About IIT Guwahati



Indian Institute of Technology Guwahati, the sixth member of the IIT fraternity, was established in 1994. The academic programme of IIT Guwahati commenced in 1995. At present the Institute has eleven departments, seven inter-disciplinary academic centres and five schools covering all the major engineering, science, healthcare, management and humanities disciplines, offering B.Tech., B.Des., M.A., M.Des., M.Tech., M.Sc., MBA and Ph.D. programmes. Within a short period of time, IIT Guwahati has been able to build up world class infrastructure for carrying out advanced research and has been equipped with state-of-the-art scientific and engineering instruments. Besides its laurels in teaching and research, IIT Guwahati has been able to fulfil the aspirations of people of the North East region to a great extent since its inception in 1994. Indian Institute of Technology Guwahati's campus is on a sprawling 285 hectares plot of land on the north bank of the river Brahmaputra around 20 kms from the heart of the city. With the majestic Brahmaputra on one side, and with hills and vast open spaces on others, the campus provides an ideal setting for learning.

IIT Guwahati is the only academic institution in India that occupied a place among the top 100 world universities – under 50 years of age – ranked by the London-based Times Higher Education (THE) in the year 2014 and continues to maintain its superior position even today in various International Rankings. IIT Guwahati gained rank 32 globally in the 'Research Citations per Faculty' category and overall 364 rank in the QS World University Rankings 2024 released recently. IIT Guwahati has retained the 7th position among the best engineering institutions of the country in the 'India Rankings 2023' declared by the NIRF of the Union Ministry of Education. IIT Guwahati has been also ranked 2nd in the 'Swachhata Ranking' conducted by the Govt. of India. IIT Guwahati has been ranked as the top-ranked University in 2019 for IT developers by HackerRank in the Asia-Pacific region. Also, IIT Guwahati ranks 6th globally in Sustainable Development Goal 7 (Affordable and clean energy) of the Times Higher Education Impact Rankings 2023.

About Centre for the Environment



The Indian Institute of Technology Guwahati has visualized an active role in dealing with new directions and concerns emerging from various day to day environmental problems. In order to give a concrete shape to this visualization, IIT Guwahati established full-fledged Centre for the Environment, in May 2004. Since its inception, it has successfully completed ten years of its formation. It has started the interdisciplinary research programme from the academic year 2005-2006 leading to PhD degree.

As of now, the Centre has 52 faculty members across various departments of the Institute involved in providing guidance to the students. The Centre has well-furnished four different laboratories namely Analytical, Computational and Research I and Research II and has also provided rooms for teacher-students interaction. In addition, the Centre has provided dedicated rooms and space for establishing the Institutional Biotech Hub funded by DBT, GOI under special programme for the North-Eastern States and the same is functioning from the Centre.

About the Conference: Environment 2024

The "Environment 2024" International Conference, organized by the Centre for the Environment at the Indian Institute of Technology (IIT) Guwahati, is set to be a pivotal event in the global discourse on environmental sustainability. Scheduled to take place in early December 2024, this conference will bring together leading experts, researchers, policymakers, and practitioners worldwide to discuss pressing environmental issues and explore innovative solutions.

The conference will feature a series of keynote speeches, panel discussions, and technical sessions covering various topics, including climate change, biodiversity conservation, sustainable agriculture, renewable energy, and environmental policy. Attendees will have the opportunity to present their research findings, share best practices, and engage in collaborative discussions to foster an endurant and sustainable future.

"Environment 2024" aims to facilitate knowledge exchange and promote interdisciplinary collaborations that can drive meaningful environ mental action. The event will also include workshops and poster presentations, providing a platform for emerging researchers and students to showcase their work and gain valuable feedback from established experts in the field.

By hosting this international conference, IIT Guwahati, underscores its commitment to advancing environmental science and sustainability. "Environment 2024" is poised to be a significant milestone in the global effort to address environmental challenges and promote a greener, more sustainable world.

Conference Themes

- Advanced Separation and Purification Techniques
- AI and ML in Environmental Sciences
- Atmospheric Chemistry
- Carbon Capture and Sequestration
- Environmental Biotechnology
- Environmental Law, Economics and Management
- Environmental Nanotechnology
- Green Chemistry
- Other Environmental Topics
- Remote Sensing and Environmental Monitoring
- Resilience and Adaptation to Climate Change
- Safe Water Storage and Distribution Systems
- Solid Waste Management
- Sustainable Processes Development

Programme Schedule

ENVIRONMENT 2024

International Conference on Environmental Challenges, Opportunities and Sustainable Solutions

09-11, Dec 2024 | Academic Complex (Core 5)

Day 01 | 09th December, 2024

08:00-09:30	**Registration (Ground floor foyer) cum Breakfast (1st floor foyer)**
Inauguration | Venue: 5G1	
09:30-10:30	Institute Song and Lamp Lighting Ceremony
	Welcome address by the Convener, Environment 2024, Prof. Senthilmurugan Subbiah
	Address by the Chair, Environment 2024, Prof. Animes K Golder
	Address by the Guest of Honour, Sri Mahesh Gupta, Chairman, Kent RO Systems
	Address by the Patron, Prof. Devendra Jalihal, Director, IIT Guwahati
	Unveiling of 'Environment 2024 Abstract Book'
	Vote of Thanks by Co-convener, Environment 2024, Prof. Chandan Mukherjee
	Conference Photography
10:30-10:45	**High Tea | Core 5 (foyer)**
Plenary and Keynote Lectures | Venue: 5G1	
10:45-11:30	**Plenary Talk:** Navigating Environmental Challenges: Pathways to a Sustainable Future **Sri Mahesh Gupta** | Chairman, Kent RO Systems
11:30-12:00	**KL-01:** Membrane Technologies for a Sustainable Environment **Dr. S. Sridhar** | Principal Scientist, IICT Hyderabad
12:00-12:30	**KL-02:** Sustainability through Product Design and Manufacturing Practices: Harpic Case Study **Dr. Debjyoti Bandyopadhyay** | Senior Scientist, Reckitt Benckiser (India) Ltd.
12:30-14:30	**Poster Session 1 & Poster Session 2 | Core 5 (foyer)**
13:00-14:30	**Lunch Break | Core 5 (1st floor)**
Keynote Lectures | Venue: 5G1	
14:30-14:55	**KL-03:** Transitioning from Linear to Circular Economy: A Roadmap for Sustainable Development **Prof. Arup Kumar Misra** | Chairman, Pollution Control Board (Assam)
15:00-15:25	**KL-04:** Research on Adsorptive Removal of Organic Micropollutants in Wastewater and Drinking Water Treatment **Prof. Aki Sebastian Ruhl** | Technical University of Berlin, Germany

15:30-15:55	**KL-05:** Creating Ocean Forests to Combat Climate Change **Prof. Dinabandhu Sahoo** | University of Delhi		
15:55-16:10	**Tea Break I Core 5 (foyer)**		
Technical Sessions			
16:10-18:50	**SESSION-I** **Theme:** Advanced Separation & Purification Techniques **Venue: 5003**	**SESSION-II** **Theme:** Sustainable Processes Development **Venue: 5004**	**SESSION-III** **Theme**: Environmental Nanotechnology **Venue: 5005**
19:00-21:30	**Gala Dinner | Venue: Core 5 (1st floor)**		

DAY 02 | 10th December, 2024

08:00-09:30	**Breakfast (1st floor foyer)**		
Plenary and Keynote Lectures | Venue: 5G1			
09:30-10:00	**Plenary Talk:** Fostering Industry-Academia Synergy: Sustainable Environmental Innovations for Northeast India's Energy Sector **Sri Bhaskar Jyoti Phukan** | Managing Director, Numaligarh Refinery Limited		
10:00-10:25	**KL-06:** Hybrid Water Treatment Processes with Large-Scale Potential: Integrating Nano-material and Membrane Processes **Dr. Abhijit Maiti** | IIT Roorkee		
10:30-10:55	**KL-07:** Energy Integration in Distillation Based Processes: Reducing Cost, Energy Consumption and CO_2 Emission **Prof. Amiya Kumar Jana** | IITKGP		
10:55-11:10	**Tea Break I Core 5 (foyer)**		
Technical Sessions			
11:10-13:30	**SESSION-IV** **Themes:** Atmospheric Chemistry/ Carbon Capture and Storage/ Green Chemistry **Venue: 5003**	**SESSION-V** **Themes**: Remote Sensing and environmental monitoring **Venue: 5004**	**SESSION-VI** **Themes:** Solid Waste Management/ Safe Water Storage and Distribution Systems **Venue: 5005**
13:00-14:30	**Poster Session 3 & Poster Session 4 | Core 5 (foyer)**		
13:30-14:30	**Lunch Break | Core 5 (1st floor)**		
Keynote Lectures | Venue: 5G1			
14:30-14:55	**KL-08:** Tannic Acid-Based Sustainable Materials – from Protein and Enzyme Binding to Antimicrobial and Toxic Metal Ion Sorption Activity **Prof. K.H. Aaron Lau** | University of Strathclyde Glasgow, UK		
15:00-15:25	**KL-09:** Hollow Porous Fiber-Based Cartridges and Pre-Filters Towards Water Sustainability at Hostile Conditions **Dr. Subhash Mandal** | Scientist-E, DRDO, Kanpur		

15:30-15:55	**KL-10:** Aspects of Ceramic-Polymer Nanocomposite Membranes Towards Sustainable Environmental Solutions: Prospects and Challenges **Dr. Sourja Ghosh** | CGCRI, Kolkata		
15:55-16:10	**Tea Break I Core 5 (foyer)**		
Technical Sessions			
16:10-18:10	**SESSION-VII** **Theme:** Environmental Biotechnology **Venue: 5003**	**SESSION-VIII** **Themes**: AI/ML/Environmental Science/ Law Economics & Management/ Resilience and Adaptation to Climate Change **Venue: 5004**	**SESSION-IX** **Theme:** Other Environmental Topics **Venue: 5005**
18:15-19:15	**Musical Evening by IITG Students | Venue: 5002**		
19:15-21:30	**Dinner | Academic Complex, Core 5 (1st floor)**		

DAY 03 | 11th December, 2024

08:00-9:30	**Breakfast (1st floor foyer)**		
Keynote Lectures | Venue: 5G1			
09:30-09:55	**KL-11:** Greener synthetic methodologies toward novel heterocycles **Dr. A.T. Khan** | IITG		
10:00-10:25	**KL-12:** Nature-Based Solutions for Wastewater Treatment in a River-bank Villages: A Case Study of Jalmana Near Panipat in Haryana **Prof. M.L. Kansal** | IIT Roorkee		
10:30-10:55	**KL-13:** Sustainable Solutions to Mitigate Environmental Pollution using Isolated Microalgae and Cyanobacteria **Prof. Kalyan Gayen** | NIT Agartala		
10:55-11:10	**Tea Break I Core 5 (foyer)**		
11:10-13:00	**Environmental Hackathon 2024 | Venue: 5G1**		
11:10-13:00	**Technical Sessions**		
	SESSION-X **Theme:** Other Environmental Topics **Venue: 5003**	**SESSION-XI** **Theme:** Other Environmental Topics **Venue: 5004**	--
13:30-14:30	**Lunch | Core 5 (1st floor)**		
14:30-15:30	**Award Ceremony and Valedictory Session | Venue: 5G1** **Vote of Thanks by Prof. Ranjan Tamuli**		
15:30-16:00	**High Tea | Core 5 (foyer)**		

KL: Keynote Lectures

Dr. S. Sridhar

Chief Scientist, Membrane Separations Laboratory, Chemical Engineering and Process Technology Division, CSIR-IICT, Hyderabad

Membrane Technologies for a Sustainable Environment

Abstract

Membranes play a crucial role in the field of chemical engineering owing to inherent advantages of low capital investment and running costs, process safety, and environmental benignity. Membrane processes have made rapid stripes in various areas of R&D, including water and wastewater management, food and dairy, petroleum, mining, pharmaceutical industries, etc. Membrane applications have been significantly exploited which has designed newer membranes and separation processes for various industrial and societal applications.

Niche applications for the mitigation of environmental pollution are demonstrated by highlighting different case studies. Extensive inroads were made to develop newer technologies to address challenging problems in multiple fields for fulfilling industrial growth and domestic, besides mitigation of global warming, environmental pollution, pandemics, and disasters. An electrodialysis-distillation hybrid process comprehensively treated pharmaceutical effluent to separate the hazardous sodium azide and corrosive ammonium chloride salts to recover DMSO, used as a solvent medium for synthesis of the antiretroviral drug, Zidovudine. Similarly, other case studies include successfully establishing ETPs with zero liquid discharge (ZLD) by treating acrylic fiber and aromatics manufacturing industrial effluents, besides coke oven wastewater, in the steel industry. Several membranes have been developed for application in fuel cells, which are eco-friendly alternatives with zero emissions without noise pollution. The first indigenous pilot gas separation pilot plant was commissioned for natural gas sweetening at ONGC, Hazira, Surat, to reduce circulation rates of the environmentally polluting amine solvent used to absorb acid gases.

To save groundwater resources and also provide safe drinking water in the water-scarce arid zones, hilly terrains, border areas, and coastal belts for schools, armed forces, and coast guard, and CSIR-IICT designed Atmospheric Water Generators (AWG) that harvest the relative humidity. Process design was undertaken to install 15 model defluoridation plants of 600-4000 L/h capacity for purification of groundwater and 25 highly compact low-cost Nanofiltration systems of 250-1000 L/h capacity to treat surface water for more than 5 Million population affected by fluorosis, gastroenteritis, jaundice, typhoid and other water-borne diseases in villages of Telangana, Andhra Pradesh, Karnataka, and Tamil Nadu. More than 25 hand pump-operated systems have been deployed in response to floods to clarify and disinfect the highly

turbid and pathogen-infested flood water in seven affected states, including Kerala, West Bengal, Assam, and Bihar.

As an import substitute, a cascaded RO membrane-resin hybrid system was designed to produce ultrapure water for medical, biotechnology, laboratory, hand sanitizer, and battery applications. More than 2 lakh kidney patients have been treated at Nephroplus and ESIC hospitals using dialysis-grade water produced by IICT's medical-grade water pilot plants. The institute has aimed to develop an indigenous low-cost hemodialysis membrane module for treating patients suffering from chronic kidney disease (CKD) with a more prominent motto of making healthcare affordable to the common man. A manual hollow fiber spinning machine was designed to incorporate an indigenous spinneret to synthesize ultrafine hollow fiber membranes from Polysulfone in DMF solvent with PEG/PVP additives to enhance hydrophilicity and decrease the dialysis duration. Dialysis modules developed were observed to efficiently remove uremic toxins from the heparinized goat blood at a lab-scale dialysis process. No such Indian-made products are commercially available, so they have high commercial viability for industrial clients.

The institute focused on creating user-friendly technologies in the recent pandemic to mitigate COVID-19, including multilayered masks, face shields, ultrapure water for hand sanitizers, and a touch-free dispenser. Around 6 lakh washable face masks and 2000 face shields were distributed in 20 States of India, including 1 lakh free face masks for frontline COVID warriors, to earn Rs 2 Crore for NGOs with employment for 500 women from self-help groups and senior citizens. Other healthcare devices were developed, such as membrane-aided devices for producing alkaline water as an immunity booster, a UV chamber for disinfecting edible and non-edible items, and a ventilator for emergency medical care.

Dr. Debjyoti Bandyopadhyay

R&D Manager
Reckitt Benckiser (India) Pvt. Ltd.,
Gurgaon, India

Sustainability through Product Design and Manufacturing Practices: Harpic Case Study

Abstract

Reckitt employs "sustainable by design" as a guiding principle, to bring products and technologies to the market that acts as a source of competitive advantage, offering consumers choice of effective solutions, bringing environmental, economic and social values. We are one of the few consumer goods companies using quantitative methods to measure impact of our innovations on the environment. Water usage has been growing globally at more than twice the rate of population increase in the last century. It outlines the need to drive water usage down in manufacturing and when consumers use our products. Harpic liquid toilet bowl cleaner (TBC) is a bespoke formulation designed specifically for cleaning the tough stains that are found inside toilet bowls. These tough stains are due to limescale or rust or a combination of these. Many consumers in India still use detergent powders to clean their toilets – something that has been designed for cleaning dirt and other stains from fabrics! In a robust scientific study conducted by an external testing agency, it was reported that cleaning typical tough limescale and rust stains found in toilets using regular detergent powders needed 4 times more water than that required while cleaning the same stains with Harpic liquid TBC. Consumers also use much more detergent powder and time to clean toilet and bathroom stains. Using products which are designed for specific consumer needs can help in saving time, efforts and more importantly water. Harpic is also using some amount of recycled plastic in its bottles and cutting down the use of virgin plastic. In addition, there is a concerted effort at Reckitt to reduce the water footprint of our products through more sustainable use of ground water during manufacturing. By using soft water instead of deionized water for manufacturing, we were able to reduce ground water wastage very significantly. One of our manufacturing sites takes pride in being water positive through water re-use and water harvesting. By utilizing these practices, Reckitt is making a sincere effort to reduce its carbon, plastic, and water footprint.

Keywords: Water Conservation, Efficiency, Manufacturing, Sustainability, Water Footprint

Dr. Arup Kumar Misra

Chairman
Assam Pollution Control Board
Guwahati, India

Transitioning from Linear to Circular Economy: A Roadmap for Sustainable Development

Abstract

We live in an era defined by unprecedented environmental challenges and unseen miseries brought about by global climate change. After sustained efforts to contain the damages and fight pollution at all levels, we have realized that only innovative solutions can bring respite to the environmental crises looming large over humanity. UN-Aligned Group International Resource Panel says, the global use of materials has more than tripled since 1970 and could double again by 2050. This has major implications for climate change and climate action. Because 62% of global greenhouse gas emissions —excluding those from land use and forestry — are released during the extraction, processing and manufacturing of goods to serve human needs. *A central part of the solution to climate change lies in the so-called "circular economy", which is a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops.*

Several concepts and approaches are emerging for promoting sustainability, reducing environmental impact and fostering a more harmonious relationship between human activities and the planet. These concepts often intersect and reinforce each other, offering a holistic framework for addressing environmental challenges. The key is to integrate these principles into various aspects of society, including business, policymaking, and individual behavior to create a more sustainable and resilient future. **The concepts that are becoming popular are**

Sustainable Development: Sustainable development seeks to meet the needs of the present generation without compromising the ability of future generations to meet their needs. It encompasses economic, social, and environmental dimensions, emphasizing importance of balance and integration.

Cradle to Cradle (C2C) Approach: Cradle to Cradle is a design framework that focuses on creating products and systems that are not only environmentally friendly, but also regenerative. It encourages the development of products that can be easily disassembled and their components reused or recycled.

Biomimicry: Biomimicry involves drawing inspiration from nature's designs and processes to solve human challenges. By emulating nature's efficiency and sustainability, Biomimicry aims to create technologies and systems that are in harmony with the natural environment.

Blue Economy: The Blue Economy emphasizes on sustainable use and conservation of ocean

resources. It promotes the development of economic activities that benefit both human well-being and the health of marine ecosystems.

Zero Waste: Zero Waste is a philosophy that aims to minimize the generation of waste by redesigning products, processes, and systems. The goal is to send little to no waste to landfills and incinerators through recycling, composting, and other waste reduction strategies.

Regenerative Agriculture: Regenerative agriculture focuses on farming practices that not only sustain the health of the soil but also contribute to ecosystem health. It aims to enhance biodiversity, improve water quality, and sequester carbon in the soil.

Sharing Economy: The Sharing Economy promotes the shared use of resources, reducing the need for ownership and decreasing overall consumption. Examples include car-sharing programs, peer-to-peer accommodation platforms, and shared workspaces.

Slow Movement: The Slow Movement advocates for a slower, more intentional approach to various aspects of life, including food, travel, and consumption. It emphasizes quality over quantity and encourages a more mindful and sustainable lifestyle.

Industrial Ecology: Industrial Ecology explores ways to optimize industrial systems by modeling them after ecological systems. It seeks to minimize waste, promote the efficient use of resources, and foster symbiotic relationships between industries.

Lean Manufacturing: Lean Manufacturing principles focus on eliminating waste in production processes, improving efficiency, and reducing resource consumption. Although not exclusively an environmental concept, lean practices often align with sustainability goals.

Besides the above concepts and strategies, *"Circular economy",* which has received immense global attention and sounds like a catch-phrase created by the economists, might be one package that could address the current problems. And it's a solution hiding in broad daylight.

Three words: **re-use, re-manufacturing and re-cycling are the three foundations of circular economy.** Developed economies, especially when times are good, love to simply throw away what they don't use. They do not build structures with the future in mind; just tear them down and build new ones. We do the same with old computers, old clothes, old sports equipment, old food, and especially old appliances. Each year we dump more than **2.12 billion tonnes of waste**. If all this waste was put on trucks, they'd go around the world 24 times. Most waste isn't even old…much of it is still new. In fact, 99% of the things we buy are trashed within 6 months. Experts say that circular economy can be best achieved through **long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling.**

Dr. Aki Sebastian Ruhl

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Technical University of Berlin, Germany

Research on Adsorptive Removal of Organic Micropollutants in Wastewater and Drinking Water Treatment

Abstract

Adsorption onto activated carbon is one of the preferred options to eliminate organic micropollutants (OMP) in treated wastewater and in drinking water. Different options for the applications of powdered activated carbon (PAC) and granular activated carbon (GAC) provide challenges and research questions a number of which were addressed in recent research projects. Different test methods were developed and investigated for the selection of suitable activated carbons from a huge number of commercial products and for the quality control of batches. Different surrogates were addressed to find correlations with the elimination of OMP. Different dosing options for advanced wastewater treatment were investigated, ranging from the direct PAC dosing into the biological reactors of a wastewater treatment plant to the recirculation of PAC in stirred reactors to the embedding of PAC in rapid filters. A thermogravimetric method was established to quantify PAC in complex mixtures like activated sludge. Both PAC and GAC were also investigated for the removal of mobile and persistent OMP in drinking. While some substances are very well removed, other substances cannot be fully removed by adsorption onto activated carbon. The prediction of the adsorptive behavior of individual substances by considering molecule properties is still challenging.

Dr. Dinabandhu Sahoo

Professor and Head,
Marine Biotechnology Laboratory, Department of Botany, University of Delhi, India

Creating Ocean Forests to Combat Climate Change

Abstract

Ocean is the biggest sink for heat and Carbon dioxide. It absorbs nearly 90% of the excess heat and 25% of CO_2 emissions caused due to Anthropogenic activities. This has not only resulted in acidification of ocean, bleaching of coral reefs but also creating huge impact on the health of ocean ecosystems. Although, ocean is central to reducing global Green House Gas emissions and stabilizing Earth's climate, it's ability to absorb CO_2 is slowly reducing. Marine plants like Mangroves, sea grasses and seaweeds play a significant role in in sequestration of CO_2 from the ocean and can take up to 3-4 times higher CO_2 than the terrestrial plants. Amongst these marine plants, seaweeds are unique as these are used as source of food, feed, fodder, fertilizer and have various industrial applications in tooth paste, ice cream, food processing, tomato ketchup, chocolates, textile printing, biofuel production, besides it's role in CO_2 capture. The demand for seaweeds and their products are increasing globally. Global efforts are going on to create kelp (*Laminaria*) forests in few countries. India has a coast line of more than 7000 km and nearly 770 species of seaweeds have been reported from different Parts of the Indian coasts. We are mainly focusing on growing four different taxa with special emphasis on *Gracilaria* species and creating Artificial Reefs to combat climate change. Details will be discussed.

Dr. Abhijit Maiti

Associate Professor,
Department of Polymer and Process Engineering,
Indian Institute of Technology Roorkee, India

Hybrid Water Treatment Processes with Large-Scale Potential: Integrating Nano-material and Membrane Processes

Abstract

The cost-effective and net-zero solutions for the widespread emerging contaminations in water are urgently required to meet the water demand of modern society. Mixed-metals oxyhydroxides nanoparticles are highly efficient in removing emerging pollutants but agglomerate easily due to their high surface activity and are difficult to separate from aqueous medium after use. These drawbacks restrict its use in large-scale and even small-scale applications. Still, their preparation from natural clay in the form of composite/nano-structured material and application potential in large-scale application after combining with membrane processes (hybrid process) has not been explored more. Hybrid adsorption (using nano-materials)-membrane processes provide a suitable alternative for treating large volumes of contaminated water with many advantages over any stand-alone processes. We have evaluated the use of in-situ precipitated iron oxyhydroxide chitosan beads (IICB) and nano-structured laterite-derived adsorbent (LDA) in combination with cross-flow Ultrafiltration (UF) for the treatment of arsenic-contaminated water. The performance of the combined adsorption-UF process was assessed at three different TMPs (0.2-0.6 MPa). Combined Hermia's model modified for cross-flow UF was found to be a good fit for permeate flux profiles of contaminated groundwater treated using the IICB-UF process. The combined UF process could bring down arsenic-spiked groundwater at a dose of 2 g/L IICB to permissible limits (<10 µg/L) and reduce irreversible fouling by up to 32±2 %. The reduction of free energy of adhesion and UV254 absorbance values indicated an overall decrease in the fouling potential of contaminated feed. Thus, arsenic removal by nano-structured laterite-derived adsorbent followed by UF (separation of adsorbent before UF) has operational advantages. The cost of production of treated water in a decentralized facility producing 200 m^3 water per day from arsenic-contaminated groundwater, using the LDA-sand filter bed-UF process, would be 0.78±0.05 USD/m^3 for a membrane with a life-span of 3 years. Similar hybrid technology using varying scavengers can be successfully applied to remove other toxic pollutants as well.

Keywords: Hybrid Water Treatment, Arsenic Removal, Adsorption, Membrane

Dr. Amiya Kumar Jana

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Indian Institute of Technology Kharagpur, India

Energy Integration in Distillation Based Processes: Reducing Cost, Energy Consumption and CO_2 Emission

Abstract

Distillation, which is the workhorse of chemical process industries, is quite energy intensive and it accounts for an estimated 3% of the world energy consumption. It is reported that in the US, about 10% of the industrial energy consumption accounts for distillation alone. Unfortunately, the thermodynamic efficiency of this separation unit is only around 5-20%. In this light, distillation has emerged as a potential candidate for thermal integration. The proper utilization of energy not only reduces energy consumption and cost, but also leads to secure a cleaner environment by minimizing greenhouse gas emissions. Motivated by this fact, attempt is made to develop a number of novel energy efficient distillation configurations toward making them energy efficient, cost effective and eco-friendly. This concept is extended to algal biodiesel production via reactive distillation route. The potential application of thermal integration is further shown through developing an innovative zero-discharge carbon-neutral bi-fuel production process that yields biodiesel and green hydrogen.

Dr. K.H. Aaron Lau

Professor
Pure and Applied Chemistry
University of Strathclyde Glasgow, UK

Tannic Acid-Based Sustainable Materials – from Protein and Enzyme Binding to Antimicrobial and Toxic Metal Ion Sorption Activity

Abstract

Advanced sustainable and biodegradable materials are required to continue technological progress while moving towards carbon-neutrality and enabling equitable development. This talk will introduce my group's work in developing easily prepared, low-cost, bio-resourced materials, especially systems based on the tannic acid TA, a common plant polyphenol. Since our original publication demonstrating crosslinked TA coatings, we have shown that such coatings are even more effective than polydopamine in immobilizing enzymes and proteins, especially on polysaccharide materials such as nanocellulose and cotton fabrics. These results are consistent with a natural function of TA in binding peptidoglycans and plant fibres. Thus, we have more recently developed composite hydrogels of TA and low-cost alginate polysaccharides to enable antimicrobial activity and enhanced sorption of metal ion contamination. These properties are enabled by very high TA content, up to an unprecedented 75%, which may furthermore induce ferrous nanoparticle incorporation to bring additional enhancements in removing highly toxic metal ions such as arsenic and chromium ions. Efforts are also underway to further functionalize alginate materials with cell-adhesive peptides and antimicrobial "peptoids" for biomaterial applications.

Dr. Subhash Mandal

Scientist 'E' and Deputy Director
DMSRDE, DRDO, Kanpur
Ministry of Defence, Govt. of India

Hollow Porous Fiber-Based Cartridges and Pre-Filters Towards Water Sustainability at Hostile Conditions

Abstract

A key obstacle for mobile water filtration technology is insufficient filtration rate, as conventional systems lack adequate gravitational pressure. To address this, a novel approach has been developed using nanotechnology to create multifunctional polymer membranes that purify water without the need for chemicals or electricity. The membranes consist of hollow, porous polymer fibers designed to adsorb contaminants on a chemically treated surface, allowing for swift removal of impurities. This technology is packaged as a compact filtration cartridge that can easily fit into standard water bottle nozzles. In the aftermath of flooding, when access to clean water is severely limited, these cartridges are designed to be air-droppable, enabling widespread, rapid distribution of safe drinking water. This fully Make-In-India product has already completed successful field trials with both the CRPF and NDRF under the Ministry of Home Affairs. Additionally, hydration packs with these filtration cartridges have been created for the Indian Armed Forces, ensuring a dependable water supply during extended patrols and surveillance missions. Compared to international solutions, this innovative product offers a higher filtration rate, simpler operation, and customized designs to meet the unique challenges of contaminated water treatment—all at a significantly lower cost.

Keywords: Water Filtration, Membrane, Hollow Porous Fiber, Nanotechnology

Dr. Sourja Ghosh

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Membrane and Separation Technology Division,
CSIR-Central Glass & Ceramic Research Institute

Aspects of Ceramic-Polymer Nanocomposite Membranes Towards Sustainable Environmental Solutions: Prospects and Challenges

Abstract

Development of nanocomposite membranes on inorganic ceramic support with engineered pore sizes and surface property can play a crucial role in advanced treatment of industrial effluents for recycling purpose along with removal potential of various emerging contaminants detected in low level in surface water and industrial wastewater treatment plants and even in groundwater. Such compounds include but not limited to pesticides, herbicides, various pharmaceuticals and personal care products (PPCPs). While conventional water treatment processes show limitation in adequate removal of such contaminants, several issues such as formation of toxic by-products and production of large volume of sludge needs attention.
At CSIR-CGCRI indigenous development of novel ceramic membranes in microfiltration (MF) and ultrafiltration (UF) range of pore sizes have been undertaken for remediation of wide range of wastewater. With an innovative approach for nanocomposite membranes development, the pore sizes of the membranes have been engineered by coating with graphene oxide/ green synthesized metal oxide nanoparticles/ nano clay over macroporous clay-alumina based tubular ceramic support resulting in pore sizes (avg.) of 5-50 nm. Further the hydrophilic surface of ceramic membranes has been modified into hydrophobic one by silane based treatment for selective removal of drugs such as ciprofloxacin owing to the hydrophobic interaction of surface-solute and for water recovery from oil contaminated wastewater. While the removal efficiency of various contaminants is obtained as >95-99%, the nanocomposite membranes prove to be efficient candidates from fouling mitigation and membrane regeneration aspects due to their robust ceramic support along with selective separation potential imparted by the polymeric counterparts and thus carries significant potential for long term applications in industrial wastewater treatment, recycling and sustainable water management prospects.

Keywords: Ceramic Supported Nanocomposite Membranes, Emerging Contaminants, Functional Membranes, Environmental Remediation, Sustainable Solution

Dr. Abu Taleb Khan

Professor
Department of Chemistry
Indian Institute of Technology Guwahati, India

Greener Synthetic Methodologies Toward Novel Heterocycles

Abstract

Organic synthesis lies at the core of every advanced technology in our modern world, in a desire to improve the life of humankind. Green Chemistry is necessary for chemical synthesis to reduce the environmental damage caused by using hazardous chemicals in this rapid growth. In that case, multi-component and cascade reactions have been widely recognized to cut costs, decrease solvent usage, and reduce cycle times in chemical processes embracing greener organic synthesis. In this lecture, the exploration of naphthylamine, 4-hydroxycoumarin, 4-hydroxythiocoumarin, and 4-hydroxydithiocoumarin will be discussed in relation to synthesising novel heterocycles using a multicomponent reaction strategy.

Dr. M. L. Kansal

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Indian Institute of Technology Roorke, India

Nature-Based Solutio ns for Wastewater Treatment in a River-bank Villages: A Case Study of Jalmana Near Panipat in Haryana

Abstract

Sustainable Development Goal (SDG) 6 emphasizes the need for equitable sanitation and protection of water ecosystems, especially in regions with limited infrastructure. Globally, over 80% of wastewater is untreated, posing serious health and environmental risks. Around 2.4 billion people need improved sanitation, and 3.6 billion in developing countries lack access to safely managed sanitation services. Most civilizations and developmental activities occur on the banks of the waterbodies like rivers, as water is an essential element for the survival of life. The river Yamuna, a major tributary of the Ganges, is one of the most sacred rivers in India; it originates at an elevation of about 6320 m in the Himalayas and joins the Ganges after traversing about 1500 km at an elevation of about 100 m. It traverses through various states, including Uttarakhand, Himachal Pradesh, Haryana, Uttar Pradesh, Rajasthan, Delhi, and Madhya Pradesh. It is vital for irrigation, drinking, industrial use, and local livelihoods. More than 1,500 villages and several cities (including the National Capital Territory of Delhi) are located along it. These villages grapple with significant water pollution challenges from untreated sewage, industrial effluents, and agricultural runoff. These villages are pivotal in India's broader sanitation and hygiene efforts as India is a rural based economy with about 6, 49, 491 villages. Moreover, their circumstances are closely tied to the country's commitment to achieving the targets of SDG 6, which aims to ensure universal access to clean water and sanitation by 2030. It is felt that Nature-based solutions (NBS) are essential for addressing environmental sustainability challenges in such rural areas, including poor sanitation, water quality issues, and climate vulnerability. Keeping these in mind, this study focuses on designing a model NBS for wastewater treatment for the village Jalmana in the Panipat district of Haryana, which is on the right bank of the river Yamuna. The village currently generates 495 m3/day of wastewater treated in locally constructed anaerobic and facultative ponds. Currently, the effluent levels for BOD (35.64 mg/l), COD (67.43 mg/l) and pH (9.57) slightly exceed the Bureau of Indian standard limits of 30 mg/l for BOD, 65 mg/l for COD and a pH range of 5.5-9.0. The research explores technologies like waste stabilization ponds, constructed wetlands and decentralized systems, which are cost-effective, support local biodiversity, and enhance ecosystem resilience. These solutions aim to reduce pollution and protect the River Yamuna, a critical water source and place of holy activities for similar riverbank villages on a sustainable basis.

Dr. Kalyan Gayen

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Department of Chemical Engineering
National Institute of Technology Agartala, India

Sustainable Solutions to Mitigate Environmental Pollution using Isolated Microalgae and Cyanobacteria

Abstract

Microalgae are under research focus for the dual mode applications namely bioremediation of toxic substances from wastewater along with production of biomolecules (e.g., carbohydrates, proteins, pigments and lipids). Current study deals with investigations towards the capability of two isolated microalgae (*Chlorella thermophilia and* (*Desmodesmus subspicatus*) for the removal of hexavalent chromium [Cr(VI)] and trivalent arsenic [As(III)]. These isolated microalgae were found to high tolerance in both As(III) and Cr(IV). *Chlorella thermophilia* showed the removal of As(III) within the range of 70-91% (at arsenic concentration of 0.5 – 10 mg/L), while removal of Cr(VI) was within 50-65% (at chromium concentration of 0.2-0.6 mg/L). Whereas, *D. subspicatus* shows 70% decline in carbohydrate accumulation was observed at 10 mg/L of As(III). An increased content of proteins (+28%) and lipids (+32%) within the cells was observed while growing in 0.5 and 0.2 mg/L of As(III), respectively. Our results showed the prospects of *Chlorella thermophilia* as a sustainable resource for the removal of heavy metals (Chromium and Arsenic) from waste water. In addition, enrichment of carbohydrate in microalgae during their growth would be supportive for the production of bio-fuels.

Keywords: Bioremediation, Microalgae, Chromium(VI), Arsenic(III), Carbohydrate, Bio-Energy

Dr. Priyamjeet Deka

Postdoctoral Researcher
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Advances in Conductive Membranes for Enhanced Water Desalination and Purification: Integration of Electrochemical Functionality And Filtration

Abstract

Conductive membranes have emerged as promising materials for advanced water desalination and purification processes. Their unique ability to combine conventional filtration mechanisms with electrochemical properties enables enhanced contaminant removal, improved fouling resistance, and increased water flux. By incorporating conductive materials such as carbon nanotubes, graphene, conductive polymers, and metallic nanoparticles, these membranes leverage external electric fields to drive electrochemical processes that improve ion selectivity, reduce concentration polarization, and mitigate fouling one of the key limitations in conventional membrane systems. This dual function of filtration and electrochemical manipulation opens new possibilities in rejecting salts, organic compounds, heavy metals, and pathogens from water. Conductive membranes also show great potential in energy-efficient processes, such as electrochemical desalination, electrodialysis, reverse electrodialysis, and hybrid filtration systems. Moreover, their anti-fouling properties, enabled through in situ cleaning via electrochemical reactions, significantly extend operational lifetimes and reduce maintenance costs. Challenges remain in terms of material stability, scalability, and costeffectiveness for large-scale applications. However, continued advancements in membrane engineering, material science, and process integration are expected to drive the future development of conductive membranes, positioning them as key components in nextgeneration water treatment technologies aimed at addressing global water scarcity and pollution challenges.

Keywords: Conductive Membranes, Water and Wastewater Treatment, Membrane Fouling

ENVIRONMENT 2024

ORAL PRESENTATIONS

DAY 1 : SESSION I (Theme: Advanced Separation & Purification Techniques)

Date: 09-12-2024 & Time: 16:10 - 18:50

Venue: Room no. 5003

Sl No.	Time Slot	Abstract ID	Name	Title
1	16:10-16:20	ASPT02	Dr. Arijit Das	*Fe doped ZnO nanoparticles: Synthesis, Characterization and Its Application for The Photocatalytic Degradation of Ciprofloxacin*
2	16:20-16:30	ASPT01	Aman Shukla	*Harnessing Catalytic Activity of CaCu3Ti4O12 Nanoparticles by Inducing Mechanical Strain Via Ball Milling*
3	16:30-16:40	ASPT05	Gunanka Hazarika	*pH-Responsive Covalent Organic Networks for Selective Phosphate Removal from Wastewater with Morphological Transformations*
4	16:40-16:50	ASPT06	Ravi	*Electrifying CQDs-Doped PANI Embedded Membrane for Enhanced Self-Cleaning Targeting Wastewater Treatment*
5	16:50-17:00	ASPT07	Anubhab Das	*Evaluation of synergistic effects of Nano Adsorbent- embedded Graphene Oxide doped Polysulfone based mixed matrix membranes for efficient heavy metal separation from wastewater*
6	17:00-17:10	ASPT08	Ahana Dutta	*Amino-Modified MIL-100(Fe): A Dual-Function Platform for Sensitive Detection and Efficient Removal of Diclofenac in Wastewater*
7	17:10-17:20	ASPT09	Abhishek Verma	*Carbon Sequestration and Pollutant Removal Using Laterite-Modified Biochar Composites Utilized in Adsorption of NO_2 from Air and Arsenic from Water*
8	17:20-17:30	ASPT10	Hina Fatima	*Lithium Ions Selective Composite Membranes for Concentrating: Emphasized On MOF-Based Materials*
9	17:30-17:40	ASPT11	Sravan Bokka	*Mg-Al-Layered Double Hydroxide: A Multi Anionic Dye Adsorbent*

10	17:40-17:50	ASPT12	Afroj Surya	*A Review on Poly(Tetrafluoroethylene) Membrane Fabrication: Structure, Properties and Applications*
11	17:50-18:00	ASPT13	Monish Goswami	*Comparison of Pre-Treatment Methods for Swine Wastewater: Optimization of Electrocoagulation for Improved Effluent Quality and Residue Utilization in Brick Manufacturing*
12	18:00-18:10	ASPT14	Rashi Srivastava	*Decanoic Acid-Based Nades for Enhanced Extraction of Aegeline from Aegle Marmelos: Optimization and Recovery Analysis*
13	18:10-18:20	ASPT15	Shanmugam V	*Process Modelling and Validation of Vacuum Membrane Distillation Process for concentration and crystallization*
14	18:20-18:30	ASPT16	Aswani K Viswanath	*Ultrafiltration of Treated Petroleum Refinery Wastewater Using a Novel Extruded Tubular Ceramic Membrane Developed from Pyrophyllite and Coconut Shell-Derived Activated Carbon*
15	18:30-18:40	ASPT17	Debasish Pal	*Comparative Studies on Tetracycline and Ciprofloxacin Degradation Under Ambient Conditions in Presence of Microporous Ammonium Phosphomolybdate as A Catalyst*
16	18:40-18:50	ASPT21	Subrata Dey	*Sustainable Polymers for Pharmaceutical Removal*

DAY 1 : SESSION II (Theme: Sustainable Processes Development)				
Date: 09-12-2024 & Time: 16:10 - 18:40				
Venue: Room no. 5004				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	16:10-16:20	SPD08	Prof. Meghal A. Desai	*Sequential Extraction of Mangiferin and Pectin from Waste Mango Peel using Ionic Liquid in the Presence of Microwave Radiation*
2	16:20-16:30	SPD16	Dr. Abhilasha Sharma	*Millets as a Catalyst for Sustainable Environmental Development: Integrating Animal Studies*
3	16:30-16:40	SPD20	Sonia Raj Gurung	*Environment Assessment Impact Model for Enzyme Induced Calcite Precipitation in Soil*

4	16:40-16:50	SPD01	Komal Verma	*Revolutionizing Industrial Wastewater Treatment: Harnessing Ultrasound-Enhanced Laccase Immobilization on Magnetic Fe3O4 Nanoparticles for Superior Efficiency and Optimization*
5	16:50-17:00	SPD12	Koshalya Godha	*FTIR Analysis of Sustainable Green Concrete Incorporating Copper Mine Tailings*
6	17:00-17:10	SPD15	Abhinayaa S R	*Sustainable Leather Processing: Biopolymer Retanning Agents for Environmental Impact Reduction*
7	17:10-17:20	SPD26	Rinki Lodhi	*Environmental Impact Assessment of Biodiesel production from Croton macrostachyus Leaves Oil*
8	17:20-17:30	SPD28	Debolina Ghosh	*Quinoxaline-Probe embedded Injectable Fluorogenic Hydrogels from Guar Gum and i-Carrageenan for Sensitive Volatile Organic Compound Detection*
9	17:30-17:40	SPD29	Neha Gautam	*Impact of Pyrolysis Temperature and Duration on the Adsorption of Drug Pollutants: A Study of Biochar Derived from Dillenia indica*
10	17:40-17:50	SPD30	Krishna Kanta Bora	*Biochar Derivation from Biomass: A Sustainable Approach for the Carbon Sequestration and Soil Enrichment*
11	17:50-18:00	SPD33	Stuti Dubey	*Adsorption and Interfacial Phenomena of Natural Surfactants for Environmentally Sustainable Process of Oil Recovery*
12	18:00-18:10	SPD34	Aindrila Goswami	*Challenges and Promises in Revival of Tramways: A Case of Kolkata*
13	18:10-18:20	SPD35	Fahami Zaya	*Assessing the Role of Litter Dynamics of Different Economically Important Trees: Implications for Sustainable Land Management in Dry Tropics*
14	18:20-18:30	SPD37	Anil Kumar	*Development of green corrosion inhibitor using Duranta erecta leaves*
15	18:30-18:40	SPD38	Amogh M	*Evaluating The Potential of Biosurfactant Treated Wastewater for the Removal of Diclofenac Along with A Conventional Treatment Option*

DAY 1 : SESSION III (Theme: Environmental Nanotechnology)				
Date: 09-12-2024 & Time: 16:10 - 18:20				
Venue: Room no. 5005				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	16:10-16:20	EN22	Dr. Ardhendu Sekhar Giri	*Synthesis of Carbon Quantum Dots (CQDs) From Renewable Sources and Its Catalytic Applications for Organic Synthesis*
2	16:20-16:30	EN01	Mritunjoy Prasad Ghosh	*Tuning of Photocatalytic Ability of Sm Doped Cu-Ni Spinel Ferrite Nanoparticles and its Use in Wastewater Treatment*
3	16:30-16:40	EN07	Vartika Anand	*A Comparative Study of Green Synthesized Nanoparticles in Decolourization of Tannery Effluent*
4	16:40-16:50	EN08	Purushattam Gayen	*Photocatalytic Degradation of Synthetic Dyes from Wastewater Using Biogenically Synthesized Silver Ferrite Nanocomposites*
5	16:50-17:00	EN11	Alakananda Ghosh	*1O2 Radical Accelerated C doped MnFe2O4 for Thermal Oxidative Activation of Peroxymonosulfate Towards Degradation of Textile RO Reject*
6	17:00-17:10	EN12	Saurabh Dubey	*Magnetically Actuated μ-RH@Bots: A Biocompatible and Cost-Efficient Approach for Targeted Micro-Nanoplastic Removal from Aqueous Environments*
7	17:10-17:20	EN13	Rituparna Biswas	*Advancement, and Multifaceted Characteristics of Shikakai (Acacia concinna) Seed Oil (SSO) Pickering Nanoemulsion for Potential Pharmaceutical Applications*
8	17:20-17:30	EN14	Sushil Nagar	*Development of Dot Assay Based Colorimetric Aptasensor for Highly Selective and Sensitive Detection of Acetamiprid*
9	17:30-17:40	EN16	Pramod M Gawal	*Plant-based Phytochemicals for the Synthesis of p-n Junction CuO/CdS Heterostructures for Photocatalytic CO2 Reduction to Ethanol and Carbon Monoxide*
10	17:40-17:50	EN17	Mrinal Kanti Dolai	*Development of Bio-inspired CuInS2 for Photocatalytic CO2 Reduction to Value-Added Products*
11	17:50-18:00	EN18	Biswajit Bhattacharjya	*Synthesis of Bio-based Gadolinium Doped Magnetic Fe3O4 Nanoparticles for Photocatalytic Treatment of Wastewater*
12	18:00-18:10	EN19	E Babu Vamsi	*Efficacy of Green Synthesized Silver Nanoparticles for the Elimination of Drug-Resistant Pseudomonas aeruginosa Isolates from Wastewater*

13	18:10-18:20	EN20	Sneha Singh	*Synthesis of Rice Husk Derived Silica Nanoparticles Through Chemical Method*

DAY 2 : SESSION IV (Themes: Atmospheric Chemistry/ Carbon Capture and Storage/ Green Chemistry)				
Date: 10-12-2024 & Time: 11:10 - 13:10				
Venue: Room no. 5003				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	11:10-11:20	CCS08	Dr. Dinesh Panneerselvam	*An EFG Based Numerical and Experimental Studies of Mechanical Properties of Reservoir Rock and Caprock Specimens Under Brine Saturation*
2	11:20-11:30	GC04	Dr. Sarita Kalla	*Green Nanopesticides for Fungal Control: Synthesis and Comparative Analysis*
3	11:30-11:40	AC01	Samrat Santra	*Gourd-level Ozone and Air Quality from a Road-Side Ambient Air*
4	11:40-11:50	AC03	Shivani Koshtha	*Statistical Analysis of Parameters Influencing the Air Quality in Lucknow City*
5	11:50-12:00	CCS03	Caroline Akoijam	*Assessing the Role of Macrophytes in Carbon Sequestration: Evidence from Keibul Lamjao National Park of Manipur, Northeast India*
6	12:00-12:10	CCS04	V Yuringwon Zimik	*Assessment of Carbon Storage in a Community-Protected Grassland of Ukhrul, Manipur*
7	12:10-12:20	CCS09	Rahul Kumar	*Climate Change Mitigation in Dry Tropics: Impact of Urban Tree Plantations on Soil Organic Carbon Fractions*
8	12:20-12:30	CCS10	Amrita Kumari	*Role of Medicinal Trees in Urban Planning in Dry Tropics: Strategies for Climate Mitigation through Soil Carbon Dynamics*
9	12:30-12:40	CCS11	Sujit Yuvraj Pimple	*Phase Separation Evaluation, Absorption-Desorption Performance, Regeneration Heat Duty and Speciation Analysis for Post-Combustion CO2 Capture into Triethylenetetramine/ Tetramethyl-Ethylenediamine Blend*
10	12:40-12:50	GC03	Annesha Basu	*Active Packaging: Biopolymeric Film Based on Chitosan-Polyvinyl Alcohol (PVA) and Mango (Mangifera Indica) Seed Kernel Extract with High Antioxidant Activity*

11	12:50-13:00	GC06	Shubham Raj	*Loading of Tin Based Dichalcogenide Over Metal Organic Framework Z-Scheme Heterojunction Asisted with Peroxymonosulfate for Boosting Visible-Light Photocatalytic Degradation of Antibiotics*
12	13:00-13:10	GC07	Ardhendu Mandal	*Synthesis of nanocellulose from biomass cellulose using a synergistic action of recombinant cellulases and its application as hydrogel*

DAY 2 : SESSION V (Themes: Remote Sensing and Environmental Monitoring)				
Date: 10-12-2024 & Time: 11:10 - 13:20				
Venue: Room no. 5004				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	11:10-11:20	RSEM07	Dr. Kirti Avishek	*Assessing the Spatio-Temporal Changes in Kabartal Wetland (Ramsar Site) using Field and Geospatial Analysis*
2	11:20-11:30	RSEM05	Dr. Shivani	*Impact of Dust Storms on Particulate Matter (PM10 &PM2.5) over Indo Gangetic Plain India*
3	11:30-11:40	RSEM04	Dr. Sarika Jain	*Evaluating Land Use and Land Cover Data in WRF Simulation over NCR, India*
4	11:40-11:50	RSEM09	Karuna Singh	*Defining the Invisible: Why Quality Assurance Matters in Microplastic Research*
5	11:50-12:00	RSEM11	Chandra Bhan	*Phyto-Analytic Development of V2O5 Nanostructures for Ultra-Selective Electrochemical Detection of Phenylbutazone*
6	12:00-12:10	RSEM13	Rameez R. Gazi	*LULC Change Analysis of Umiam Catchment in Meghalaya using High-Resolution Satellite Imagery*
7	12:10-12:20	RSEM14	K Zamminsion	*Spatiotemporal Variability of Key Parameters in A River System with Non-Point Industrial Pollution Sources*
8	12:20-12:30	RSEM15	Sabrina Begum	*Capturing Channel Bar Dynamics in the Mid Brahmaputra Using Long Term Sequential Data*
9	12:30-12:40	RSEM16	Boishali Dutta	*Groundwater Quality Mapping of Parts of UBVZ of Assam*

10	12:40-12:50	RSEM17	Abhishek Kumar Srivastava	*Assessing the Urban Spatial Pattern and Urban Heat Island Effects to Anticipate Potential Risks in Noida City*
11	12:50-13:00	RSEM18	Tunija Basumatary	*Spatial Distribution of Drinking Water Quality Parameters in Barak Valley Region, North-east India*
12	13:00-13:10	RSEM19	Debashree Dutta	*Estimating Rice Biophysical Parameters and Soil Moisture from Agricultural Fields by using Optical and SAR data in Conjunction with In-situ Data*
13	13:10-13:20	RSEM03	Shilpi Mondal	*Polycyclic Aromatic Hydrocarbons (PAHs) in Urban Road Dust of Guwahati, Assam: Distribution, Sources, and Human Health Risk Assessment*

DAY 2 : SESSION VI (Themes: Solid Waste Management/ Safe Water Storage and Distribution Systems)				
Date: 10-12-2024 & Time: 11:10 - 13:20				
Venue: Room no. 5005				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	11:10-11:20	SWM05	Dr. Priya V	*Reuse of Carbon Dust (Waste/by Product) Generated from Selected Industries as Toner Component - Profitable Solution of Waste to Wealth*
2	11:20-11:30	SWM12	Dr. Sanjukta Sahoo	*Surface Modification-A Promising and Sustainable Solution to use Bio-medical Plastic Waste in Concrete*
3	11:30-11:40	SWM06	Ashish Malik	*Insight on Pollution and Energy Recovery Potential of Leachate from Landfill Sites of Northern India*
4	11:40-11:50	SWM02	Nabanita Ghosh	*Evaluation Phytotoxicity and Ecological Risks of Biomined Good Earth product as a Soil Nutrient: Dhapa Landfill*
5	11:50-12:00	SWM04	Suparna Ganguly	*Analysis of the Sustainability of the Existing Solid Waste Management System of Newtown, a Smart City*
6	12:00-12:10	SWM10	Vaishnavi Jahagirdar	*Characterization and Determination of Pollution Risks caused by Landfill-Derived Soil from Four Different Cities*

7	12:10-12:20	SWM21	Moanaro Ao	*Current State and Pathways for Sustainable Solid Waste Management in Kohima*
8	12:20-12:30	SWM24	Rajkumari Joyshree Devi	*GIS-Based Evaluation of Municipal Solid Waste Management in Dimapur District, Nagaland: A Case Study*
9	12:30-12:40	SWM27	Ajay Kumar Shakya	*Innovations and Challenges in Solid Waste Management: Towards Sustainable and Efficient Solutions*
10	12:40-12:50	SWM30	Nuthalapati Mahesh Babu	*Assessment of Waste Tire Fibre Mixed Black Cotton Clay Engineering Performance Inundated by Various Heavy Metal Concentrations*
11	12:50-13:00	SWM32	Kamalesh Roy	*Catalyst-Free Polyethylene Terephthalate (PET) Waste Degradation at Room Temperature for High-Value Metal Organic Frameworks (MOFs): A Waste to Wealth Approach*
12	13:00-13:10	SWM35	Isha Arora	*Kinetics Governing Colloidal Gas Aphrons Generation and Stability: The Foundation for Sustainable Aerated Concrete*
13	13:10-13:20	SWSDS02	Sumona Koley	*Assessing the Health Risks Associated with Exposure to Chlorinated By- products in Indian Drinking Water*

DAY 2 : SESSION VII (Theme: Environmental Biotechnology)				
Date: 10-12-2024 & Time: 16:10 - 17:30				
Venue: Room no. 5003				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	16:10-16:20	EB05	Aishwarya Das	*Synergistic Bacterial Consortium in Treatment of Pharmaceutical contaminants: A Sustainable Environmental Clean-up Approach*
2	16:20-16:30	EB06	Nishan Sengupta	*Remediation of Arsenic ions from Drinking Water by Utilizing Biomass of a Purple Non-Sulfur Bacteria*
3	16:30-16:40	EB08	Naorem Bela Devi	*Value-added Products from Carbon Monoxide Bioconversion using Clostridium carboxidivorans: Effect of Different Trace Metals and Optimization Employing Taguchi Experimental Design*
4	16:40-16:50	EB10	Dimple Singh	*Production of Poly(3-hydroxybutyrate) Bioplastic by Bacillus Subtilis utilizing Waste Biomass*

5	16:50-17:00	EB11	Pooja Bechuprasad Jaiswal	*Biodegradation of Polyethylene film by Brucella intermedia MR-B1*
6	17:00-17:10	EB14	Avinash Anand	*Optimization of Biohydrogen Production from Food Waste and its Process Intensification*
7	17:10-17:20	EB17	Shilpa Nandi	*Production and Characterization of Autochthonous Bacillus-Derived Biosurfactant and Biopolymer from Assam Oil Reservoirs for Application in Microbial Enhanced Oil Recovery*
8	17:20-17:30	EB19	Shalini Prajapati	*The Screening for the Sustainable Substrate in the Production of Biosurfactants and its Application in Microbial Enhanced Oil Recovery*

DAY 2 : SESSION VIII (Themes: AI/ML/Environmental Science/ Law Economics & Management / Resilience and Adaptation to Climate Change)				
Date: 10-12-2024 & Time: 16:10 - 18:10				
Venue: Room no. 5004				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	16:10-16:20	RACC04	Dr. Jayanti Tokas	*Moringa Oleifera: A Superfood with Nutritional and Antioxidant Potential for Functional Foods*
2	16:20-16:30	AIML03	Prof. Sanjaykumar R. Patel	*Estimation of Solubility of Albendazole in Binary Solvent of Water and Ethanol by Thermodynamic Models*
3	16:30-16:40	ELEM07	Dr. Jayesh Ruparelia	*An Overview of Existing Industrial Effluent Collection/Conveyance System of CETPs in Gujarat*
4	16:40-16:50	ELEM01	Sai Dinesh Shetty	*Legislative Developments in E-waste Management in India*
5	16:50-17:00	AIML04	Souvik Chongder	*AI for Ocean: A Sustainable Path to Save Biodiversity from Climate Crisis*

6	17:00-17:10	AIML05	Chowdary Rohith	*Assessing the Impact of Traffic Composition on Prediction of Vehicular Emission Accuracy Using Machine Learning Approach*
7	17:10-17:20	ELEM09	Anjali	*Integrated Floodplain Management: Balancing Flood Risk Mitigation and Ecosystem Conservation*
8	17:20-17:30	ELEM10	Anweshan	*Establishing a Holistic Water Quality Index for Real-Time Identification of Unsafe Water Parameters*
9	17:30-17:40	RACC08	Rajkumari Dayarani Devi	*A Preliminary Work on the Population Study of Earthworms in different land-use of Thoubal district, Manipur*
10	17:40-17:50	RACC10	Gitima Das	*Navigating sustainability: A Transboundary Socio-Ecological Study of the Brahmaputra River Basin*
11	17:50-18:00	RACC11	Shipra	*Assessing the Impact of Future Climate Change on the Distribution of Tea (Camellia Sinensis L.) Growing Areas in the Eastern Himalayan Region of India*
12	18:00-18:10	RACC12	Nidhi Singh	*Role of Biochar as a Sustainable Soil Management Strategy for Climate-Resilient Agriculture in Dry Tropics*

DAY 2 : SESSION IX (Theme: Other Environmental Topics)				
Date: 10-12-2024 & Time: 16:10 - 18:00				
Venue: Room no. 5005				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	16:10-16:20	OET28	Mahesh Kumar Gagrai	*Re-Refining of Waste Engine Oil: A Review*
2	16:20-16:30	OET02	Garimella Venkata Koulini	*Breaking Down PFAS: Advanced Degradation Through Adsorptive Photocatalysis*
3	16:30-16:40	OET05	Parvathy R Pillai	*Green Finance as a Catalyst for Viksit Bharat: Insights from Coimbatore's Banking Sector*

4	16:40-16:50	OET06	Nongmaithem Anand	*Phytoremediation of Acid Mine Drainage: Comparative Analysis of Constructed Wetlands for the Removal of Cu, Mn, Al and Cd*
5	16:50-17:00	OET17	Satpal Baloda	*Collection and Evaluation of Different Germplasm of Pomegranate*
6	17:00-17:10	OET22	Aniket Choudhary	*Impact of Silicate and Iron Oxide Mineral Weathering Sequence on the Fate and Transport of Emerging Contaminant (Nanoplastics) in the Environment*
7	17:10-17:20	OET23	Anurag Mishra	*Synergetic Effect of Biosurfactant and Surfactant with Alkali for MEOR Application*
8	17:20-17:30	OET24	Dhruti Sundar Pradhan	*In-cabin Particulate Matter Exposure of Heavy Earth Moving Machinery operators in a Highly-Mechanized Opencast Coal Mine*
9	17:30-17:40	OET25	Modam Khazra Shahid	*Integrated Riverfront Revitalization and Urban Redevelopment in Howrah Municipal Corporation Area: Issues and Challenges*
10	17:40-17:50	OET26	Aniket Banerjee	*Expanding the Genetic Code: Site-Specific Incorporation of Triazolyl Unnatural Amino Acids into Super Folder GFP*
11	17:50-18:00	OET31	Lamyanbi Naorem	*Understanding Soil Nutrient Changes Following Insecticide Treatment: Insights from a 120-day Mesocosm Study*

DAY 3 : SESSION X (Theme: Other Environmental Topics)				
Date: 11-12-2024 & Time: 11:10 - 12:30				
Venue: Room no. 5003				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	11:10-11:20	KL14	Dr. Priyamjeet Deka	*Advances in Conductive Membranes for Enhanced Water Desalination and Purification: Integration Of Electrochemical Functionality and Filtration*
2	11:20-11:30	OET32	Dheepak R	*Sustainable Biosurfactant Production from Bacillus subtilis IS5 for Detergent Applications*
3	11:30-11:40	OET33	Anisha Ganguly	*Bioremediation of As(III) Using Biowaste-Derived Cellulosic Aerogel*
4	11:40-11:50	OET35	Tongbram Ashiskumar Singh	*A Review on Phytoremediation of Contaminated Soils by using Chromolaena Odorata, an Invasive Terrestrial Weed*

5	11:50-12:00	OET37	Anshu Meena	*Nitrate Removal from Wastewater Using Copper*
6	12:00-12:10	OET39	Krishna Das	*Structural Insights into ASL-1/ATF-1 in Fungal Pathogenicity*
7	12:10-12:20	OET40	Rama Karn	*Metal-responsive Fluorophore and Amikacin Conjugated Heparin for Bacterial Cell Imaging and Antibacterial Applications*
8	12:20-12:30	OET41	Sriya Naik	*Development of Light Weight Porous Alumina-Ceramic Foam Structure for Effective De-Fluoridation of Industrial Wastewater Treatment*

DAY 3 : SESSION XI (Theme: Other Environmental Topics)				
Date: 11-12-2024 & Time: 11:10 - 12:00				
Venue: Room no. 5004				
Sl No.	**Time Slot**	**Abstract ID**	**Name**	**Title**
1	11:10-11:20	SPD39	Soumya R	*Slope Stability Analysis and Performance Evaluation of Lithomargic Clay with Phosphorous Slag as Additive- A Review*
2	11:20-11:30	SPD40	Pitta Sekhar	*Feasibility Studies on Biomass Briquettes Production from Organic Solid Waste Feedstocks in Bule Hora Town, West Guji, Ethiopia*
3	11:30-11:40	OET43	Adil Nawab	*Brick Kilns and Air Quality: Cutting-Edge Technologies, Pollution Battles, and Environmental Impact*
4	11:40-11:50	OET05	C. Athena	*Green Finance as a Catalyst for Viksit Bharat: Insights from Coimbatore's Banking Sector*
5	11.50-12.00	OET16	Siddhartha	*Balancing Charging Demand and Emissions: A Grey Wolf Optimization Model for EV Charging Station Location*

Theme: ASPT

Advanced Separation and Purification Techniques

Oral Presentations

Environment 2024
International Conference on Environmental Challenges, Opportunities and Sustainable Solutions

Harnessing Catalytic Activity of $CaCu_3Ti_4O_{12}$ Nanoparticles by Inducing Mechanical Strain Via Ball Milling

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Abstract

$CaCu_3Ti_4O_{12}$ (CCTO) is a widely studied ceramic material due to its exceptional dielectric properties, including a colossal dielectric constant. However, its centrosymmetric cubic structure prevents it from exhibiting piezoelectricity. Mechanical processes, however, can induce surface charge separation, mimicking piezoelectric behavior and enabling CCTO for catalytic applications. In this study, we investigated the mechano-catalytic activity of CCTO nanoparticles for the degradation of methylene blue (MB) dye. Ball milling, a versatile technique traditionally used for the synthesis of nanomaterials, was employed to activate CCTO for catalytic dye degradation. It has been hypothesized that the mechanical forces and surface modifications introduced by ball milling could increase the material's catalytic efficiency. Experimental results demonstrated that 0.3 g of CCTO nanoparticles when subjected to ball milling at a speed of 400 RPM with 10 zirconia balls, could degrade 87% of a 10 ppm MB dye solution within 1 hour. A comprehensive parametric study was conducted to evaluate the effects of various process conditions, such as catalyst dosage, dye concentration, milling speed, and the number of milling balls, on the degradation efficiency. Scavenger tests were also performed to identify the reactive species responsible for dye breakdown, providing further insight into the underlying catalytic mechanism. To assess the efficacy of ball milling, the results were compared with those of the conventional ultrasonication method, where only 30% degradation of MB was achieved within the same timeframe. The significant improvement in degradation performance observed with ball milling highlights its potential as a superior catalytic technique. Moreover, ball milling offers several advantages, including precise control over reaction parameters, scalability, and simplicity, making it an environmentally sustainable approach for addressing dye pollution. Overall, this study demonstrates the synergistic effects of combining CCTO's unique dielectric properties with the catalytic potential of ball milling, providing a novel and efficient method for water purification.

Keywords: Ball Milling, Dye Degradation, Piezo Catalysis, Surface Charge Separation

Fe doped ZnO nanoparticles: Synthesis, Characterization and its Application for the Photocatalytic Degradation of Ciprofloxacin

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Abstract

In advanced oxidation processes, the application of photocatalysis has been immensely used in recent years for the treatment of effluent water from various chemical industries. In this study, pure zinc oxide (ZnO) and iron-doped zinc oxide (Fe: ZnO) photocatalysts with varying doping percentages (1%, 3%, and 5% by weight) were synthesized through the co-precipitation method. Various analytical tools were employed to assess and characterize the structural, morphological, optical, and elemental properties of the synthesized nanomaterials. The XRD outcomes validated the nano-crystalline nature of the synthesized ZnO material, displaying a well-defined hexagonal wurtzite structure. Additionally, the photocatalytic activity of the synthesized photocatalysts was tested under visible light irradiation, employing ciprofloxacin (CIP) as the target pollutant. The experimental findings revealed that the 3% Fe-doped ZnO nanoparticles displayed notably enhanced degradation performance compared to other photocatalysts. Under the experimental conditions of an initial CIP concentration of 5 ppm, a nanoparticle dose of 0.2 g, and a solution pH of 9, approximately 85% of the CIP was effectively removed through the process of photodegradation. Further, the present study also included the kinetic behavior and degradation mechanism of the CIP.

Keywords: Ciprofloxacin, Fe-doped ZnO Nanoparticles, Kinetics, Photocatalytic Degradation, Wastewater Treatment

pH-Responsive Covalent Organic Networks for Selective Phosphate Removal from Wastewater with Morphological Transformations

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Abstract

Phosphate is a vital nutrient for the growth of various organisms, but its increasing infiltration into aquatic environments due to human activities poses environmental risks. Recovering phosphates from wastewater is a promising strategy to combat eutrophication and conserve diminishing global phosphate reserves. To tackle this issue, we developed a pH-responsive two-dimensional covalent organic network (2D ag-CON) with multiple anion interaction sites. Upon phosphate adsorption, the surface morphology changes from spherical to sheet-like structures, a unique feature of the ag-CON. The tris-aminoguanidine-based 2D ag-CON exhibits pH-dependent adsorption and desorption properties, allowing selective phosphate capture and release by adjusting the pH of the aqueous solution. The polymer shows high selectivity for phosphate ions even with excess competing anions, with a maximum adsorption capacity (Qmax) of 719 mg/g at pH 6, and enables efficient phosphate ion release at pH ~11.5. This study highlights the development of a water-insoluble covalent organic framework that effectively captures phosphate from wastewater, helping to mitigate the adverse effects of water eutrophication.

Keywords: Morphology Changes, pH Responsive, Phosphate Capture and Release, Covalent Organic Framework

Electrifying CQDs-Doped PANI Embedded Membrane for Enhanced Self-Cleaning Targeting Wastewater Treatment

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Abstract

Rapid industrialization and urbanization have drastically increased global water consumption, leading to widespread wastewater dispersal and creating an urgent demand for sustainable and efficient treatment technologies. Conventional membrane-based filtration systems are widely used for wastewater treatment. However, they suffer from membrane fouling affecting its operational efficiency in a longer run. Electrically conductive membranes (ECMs) have recently emerged as a promising solution, offering self-cleaning properties that effectively reduce its fouling.

In this study, we synthesized electrically conductive polyaniline (PANI) and carbon quantum dots-doped PANI (CQDs/PANI), using *Piper longum* plant extracts, by incorporating them into polysulfone/polyvinylpyrrolidone (PSF/PVP) membranes for improved self-cleanliness by minimizing membrane fouling. CQDs synthesized using DI water exhibiting the highest fluorescence intensity were used to fabricate CQDs/PANI composites. Optimized PANI and $CQDs_{40}$/PANI (with 40% CQDs) achieved notable electrical conductivities of 513.4±24.1 µS and 997.3±29.7 µS, respectively. The preparation of PSF/PVP membranes were optimized at varying precursors concentrations, having an optimal composition to be 12.5% PSF and 2% PVP ($PSF_{12.5}/PVP_2$). The incorporation of 2% PANI and $CQDs_{40}$/PANI into the membranes (denoted as $PANI_2$-$PSF_{12.5}/PVP_2$ and $CQDs_{40}/PANI_2$-$PSF_{12.5}/PVP_2$) significantly enhanced membrane conductivity to 4.23×10^{-3} S cm^{-1} and 5.3×10^{-3} S cm^{-1}, respectively. Additionally, the hydrophilicity and porosity of the membranes improved, with water contact angles decreasing from 72.5° ($PSF_{12.5}/PVP_2$) to 69.2° for $PANI_2$-$PSF_{12.5}/PVP_2$ and to 58.6° for $CQDs_{40}/PANI_2$-$PSF_{12.5}/PVP_2$, and porosity increases from 12.01 to 56.21% and to 66.07%, respectively.

Membrane maintained its structural and compositional integrity as evidenced from FESEM, FTIR, TGA, and EDX analyses. The water flux of the $PSF_{12.5}/PVP_2$, $PANI_2$-$PSF_{12.5}/PVP_2$, and $CQDs_{40}/PANI_2$-$PSF_{12.5}/PVP_2$ membranes was measured to be 21.71, 435.37, and 485.74 $Lm^{-2}h^{-1}$, respectively. Filtration of synthetic *E. coli* wastewater through these membranes demonstrated significant fouling mitigation, with a reduced fouling rate from 69.1 to 49.3% and 34.5% for PANI and $CQDs_{40}$/PANI membranes, respectively. Flux recovery improved correspondingly, from 46.4 to 74.4% and to 83.7%, incorporating PANI and $CQDs_{40}$/PANI, respectively. Thus, the developed membranes exhibit strong potential for mitigating fouling through self-cleaning mechanism under an electric field, enhancing the efficiency of wastewater treatment.

Keywords: CQDs/PANI-based PSF Membrane, Conductive Membrane, Membrane Regeneration, Self-Cleanliness

Evaluation of Synergistic Effects of Nano Adsorbent- Embedded Graphene Oxide Doped Polysulfone based Mixed Matrix Membranes for Efficient Heavy Metal Separation from Wastewater

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Abstract

Extensive research on nano-adsorbent embedded polymeric membranes is of immense importance in the present context of potable water crisis in various regions across the globe. Conventional techniques like Reverse Osmosis involve a large sum of initial capital investment. This study aims to fabricate a highly efficient nano-filtration membrane with the aim of superior performance for heavy metal removal compared to existing technologies. In this study, we report the synthesis and evaluation of nano Adsorbent-embedded Graphene Oxide (GO) doped Polysulfone (PSF) based mixed matrix polymeric membranes (MMMs) for the efficient separation of heavy metals from wastewater. The integration of nano-adsorbents and GO into the PSF matrix aims to enhance the membrane's separation efficiency, mechanical stability, and anti-fouling properties. GO's excellent surface area and functional groups allow for superior metal ion adsorption, while the nano-adsorbents introduce synergistic effects that enhance metal capture and flux performance. The membranes were synthesized via phase inversion, and their performance was evaluated through batch adsorption and filtration experiments targeting common heavy metals such as Pb, As and Cd. Characterization techniques including SEM, EDX, FTIR, and XRD were employed to analyse the morphology, structural integrity, and surface characteristics of the membranes. The results demonstrated that the GO-doped PSF membranes showed high removal percentage of 97%, 92% and 99% against Pb, As and Cd respectively. Improved heavy metal removal efficiency, higher water permeability, and excellent fouling resistance compared to pristine PSF membranes. This work underscores the potential of these hybrid MMMs as effective solutions for sustainable wastewater treatment, contributing to water purification technologies that mitigate environmental pollution.

Keywords: Anti-Fouling, Heavy-Metal-Separation, Mixed-Matrix-Membranes, Nano-Adsorbents, Waste-Water-Treatment

Amino-Modified MIL-100(Fe): A Dual-Function Platform for Sensitive Detection and Efficient Removal of Diclofenac in Wastewater

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Abstract

The discharge of pharmaceuticals into wastewater poses serious environmental risks, impacting both aquatic ecosystems and human health. These pollutants contribute to antibiotic resistance, produce toxic byproducts, and disrupt aquatic organisms. Diclofenac, a widely used NSAID, is particularly concerning due to its chemical stability and persistence, making it challenging to treat. This study explores the synthesis of amino-decorated MIL-100(Fe) as a versatile sensing and removal platform for diclofenac. MIL-100(Fe)-NH_2 displayed strong fluorescence due to linker emission, enabling sensitive detection of diclofenac. Additionally, MIL-100(Fe)/PPD demonstrated good adsorption capacity and reusability, achieving around 70% removal of diclofenac from aqueous solutions within 5 minutes. Extensive characterization was performed using techniques such as XRD, FTIR, TGA, BET, EDX, FESEM, and FETEM to understand the structure and performance of the material. Mechanisms of fluorescence quenching and adsorption were also investigated. The results indicate that MIL-100(Fe)-NH_2 is not only effective in detecting diclofenac with high specificity but also serves as a powerful adsorbent, making it a promising solution to reduce the environmental and health impacts of pharmaceutical contaminants in wastewater.

Keywords: Metal-Organic Framework, MIL-100(Fe), Diclofenac, Fluorescence Sensing, Wastewater Treatment

Carbon Sequestration and Pollutant Removal using Laterite-Modified Biochar Composites Utilized in Adsorption of NO_2 from Air and Arsenic from Water

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Abstract

Rising atmospheric CO_2 levels from unwanted crop burning, such as from hemp waste, necessitate effective, low-cost carbon sequestration methods. Biochar has emerged as an economical and effective solution for this purpose, with modifications to biochar broadening its potential applications. This study presents a modified biochar composite derived from waste hemp stems and natural laterite soil, developed through acid leaching and precipitation. By precipitating modified laterite onto biomass, followed by pyrolysis at 673 K, a stable and highly porous composite material is obtained. Laterite deposition on the biomass effectively reduces CO_2, SO_2, and NO emissions during pyrolysis by 35%, 41%, and 43%, respectively, compared to unmodified biochar. XRD and EDX analyses confirm the formation of Fe and Al minerals on the biochar surface, while FTIR and XPS analyses further validate the composite's capacity to adsorb NO_2 and arsenic. Accelerated aging tests using H_2O_2 oxidation reveal a 16.17% increase in carbon stability, with the R_{50} value from TGA thermograms reaching 0.63, signifying high stability of the Laterite Biochar Composite (LBC). The Van Krevelen diagram demonstrates low H/C and O/C molar ratios for LBC, indicating enhanced aromaticity and reduced polarity relative to raw biochar. LBC achieves a carbon sequestration potential of 33.64%, compared to 22.03% for pristine biochar, with this stability attributed to the aromatization process and the formation of a mineral layer on the biochar, creating a durable organo-mineral composite. Adsorption tests reveal that the LBC composite can adsorb NO_2 from ambient air at a capacity of 14.65 mg/g, as well as arsenic from groundwater at capacities of 13.86 mg/g for As(III) and 13.92 mg/g for As(V). During NO_2 adsorption from ambient air, CO_2 was also adsorbed confirmed by the XPS and FTIR, providing an added benefit for the removal of atmospheric gaseous pollutants. Additionally, the LBC composite demonstrates strong recyclability for NO_2 adsorption and decomposability in soil, underscoring its environmental sustainability.

Keywords: Adsorption, Arsenic Removal, Carbon Sequestration, NO_x Removal, Waste Utilization

Lithium Ions Selective Composite Membranes for Concentrating: Emphasized on MOF-Based Materials

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Abstract

The increasing demand for renewable energy and the global transition toward a low-carbon footprint have heightened the need for the energy-harnessing element lithium in various applications, such as electric vehicles, fuel cells, drone technology, and lithium-ion batteries. Lithium sources like brine, seawater, and mining ores are realized based on the present state of the art. Numerous methods for extracting lithium from the above sources are explored, such as adsorption, ion exchange, direct carbonation, electrochemical, and membrane separation. Among these methods, membrane-based separation processes using metal-organic frameworks (MOFs) have emerged as effective for selective Li^+ separation in aqueous medium. MOF-based porous materials offer an energy-efficient alternative for Li^+ separation due to their high porosity, uniform pore sizes, and rich host-guest chemistry, which are advantages for selective separation over competing ions in membrane-based processes. This work critically summarizes the MOF-based composite membranes characterized into thin film composite (TFC), mixed matrix membrane (MMM), and polycrystalline membrane (PCM), highlighting their mechanism and performance for Li^+ selectivity. Recent advancements include the development of lithium-selective membranes using UiO-66, ZIF-8, and HKUST-1 MOFs, which demonstrated impressive selectivity ratios against competing ions such as Mg^{2+}, Na^+, and K^+. These MOFs composites in membranes, including ZIF-8@MLDH, 2D Zr-BTB/PSS, PSS@HKUST-1 show excellent selectivity of 31.9, 37.8, and 1815, respectively, over Mg^{+2}, 15.8, 11, and 35, respectively, with respect to Na^+ and against K^+ of 10.7, 16.5, and 67, respectively. Similarly, the Li^+ selectivity of HSO_3-UiO-66, UiO-66(Zr/Ti)–NH_2, PEI@UiO-66-NH_2-TMC, and defect-free UiO-66-NH_2 over Mg^{+2} was 4.2, 11.2, 13.2, and 60, respectively. Additionally, these MOF-based membranes also enhanced Li^+ permeability compared to traditional membranes. This review aims to provide a comprehensive understanding of the potential of MOF-based membranes for selective Li^+ transport to address the growing lithium demand while contributing to a sustainable society, and further modification and observation have to be needed to increase the selectivity and permeability of Li^+.

Keywords: Ion Selective Membranes, Li-Ion Selectivity, MOFs-Based Membranes, Permeability, Sustainable Technology

Mg-Al-Layered Double Hydroxide: A Multi Anionic Dye Adsorbent

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Abstract

This work demonstrates the effectiveness of quintinite, an Mg–Al Layered Double Hydroxide (LDH) with an Mg/Al ratio of ~2, as a highly efficient adsorbent for the removal of toxic anionic dyes, particularly Amido Black 10B. Synthesized through a simple and scalable process, quintinite features a layered metal hydroxide structure balanced by anions, resulting in a net positive charge in an aqueous environment. This positive surface charge, coupled with a mesoporous structure, facilitates rapid and high-capacity dye adsorption, achieving ~99 % dye removal in just two minutes for low dye concentrations and a maximum adsorption capacity of 207 mg/g at higher concentrations. These adsorption results are among the highest ever reported for any pristine Mg–Al-LDH synthesized below 100 °C, underscoring quintinite's exceptional capability for dye capture without any foreign modifications or secondary alterations.

To mirror real-world conditions, eight different anionic dyes including reactive, azo, and acid dyes were blended to simulate typical wastewater effluents. Remarkably, quintinite demonstrated ~100 % dye removal for both individual and mixed dye solutions within two minutes. Structural (XRD, BET) and zeta potential analyses confirmed phase-pure, mesoporous LDH formation with a stable positive surface charge, which supports fast and efficient dye adsorption. The adsorption mechanism, dominated by chemisorption through electrostatic interaction and ion-exchange reactions, was validated by XRD and FTIR analyses, revealing interactions between Al3+ ions and amine or sulfate groups from dye molecules. Quintinite's superior performance in diverse pH ranges and in the presence of co-existing anions emphasizes its potential for environmental remediation. This work highlights that pristine Mg–Al-LDH, without modifications, can achieve maximal adsorption efficiency with proper synthesis, offering a sustainable, recyclable, and cost-effective solution for large-scale toxic dye removal from water.

Keywords: Dye Adsorption, Environmental Remediation, Mesoporous: Intercalation, Ion Exchange

A Review on Poly(Tetrafluoroethylene) Membrane Fabrication: Structure, Properties and Applications

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Abstract

Polymeric membranes are playing vital role for number of industrial applications including food packaging, medical, gas separation, water purification, protein purification etc. The different types of polymeric membrane such as cellulose-based membranes, polyamide membranes, polyimide membranes, polyvinylidene fluoride membranes, polyether sulfone membranes, polyetherimide membranes, polypropylene membranes etc. are used for different applications. In the past decade, poly(tetrafluoroethylene) (PTFE) is extensively used in a wide range of membrane applications like liquid/air separation, biomedical and new energy applications because of its exceptional qualities. In this review, an overview of PTFE material including its structure, qualities, production methods, recycling, and various applications are discussed. Additionally, the latest developments in the preparation process of PTFE porous membranes are highlighted. Moreover, comprehensive details are provided for the functionalization of PTFE porous membranes as well as the methods for controlling the membrane pore structure. The primary issues and limitations related to real-world usage of PTFE porous membranes are also emphasized. At the end of this article, a concise conclusion and outlook on PTFE porous membranes for its subsequent research are compiled and discussed. The precise description of this review is intended to familiarize the importance of PTFE materials and providing the basic knowledge about PTFE to the readers for selecting the best PTFE membrane synthesize method for a wide range of practical applications. The information provided in this article may also provide useful information for development of novel PTFE-based membrane technologies in the future.

Keywords: Applications, Fabrication, Poly(Tetrafluoroethylene), PTFE, Porous Membrane

Comparison of Pre-Treatment Methods for Swine Wastewater: Optimization of Electrocoagulation for Improved Effluent Quality and Residue Utilization in Brick Manufacturing

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Abstract

This study evaluates and compares three pre-treatment methods—plain sedimentation, coagulation-flocculation, and electrocoagulation—to remove suspended solids from swine wastewater, with a focus on optimizing solid-liquid separation and subsequent residue utilization. Electrocoagulation achieved the highest suspended solids removal efficiency (99.85%) within a 30-minute settling time, outperforming coagulation-flocculation (99.7%) and plain sedimentation (45%). Additionally, electrocoagulation produced less sludge than coagulation-flocculation, enhancing its feasibility for practical applications. Optimum conditions for electrocoagulation were identified as a current density of 50 mA/cm², reaction time of 40 minutes, initial pH of 6.5, and Al-Al electrodes. The resulting effluent quality was superior, with pH 7.56, electrical conductivity (EC) 2.18 mS/cm, turbidity 4 NTU, total solids (TS) 72 mg/L, total suspended solids (TSS) 18 mg/L, total dissolved solids (TDS) 54 mg/L, and total chemical oxygen demand (tCOD) 97 mg/L.

Following treatment, X-ray diffraction (XRD) analysis of the residue identified minerals such as struvite ($MgNH_4PO_4 \cdot 6H_2O$), quartz (SiO_2), calcium carbonate ($CaCO_3$), and potassium chloride (KCl), indicating potential for nutrient recovery and sustainable waste management. The treated residue (SWTR) was further utilized in brick manufacturing by mixing with laterite soil in proportions of 10-70%. Bricks incorporating up to 60% SWTR met Indian standards for dimensional tolerance and compressive strength (10-18 MPa), qualifying them for structural applications. However, SWTR content above 50% reduced compressive strength due to decreased clay content, with bricks incorporating over 70% SWTR exhibiting cracks that compromised structural integrity. These findings demonstrate electrocoagulation as an effective pre-treatment for swine wastewater, enhancing effluent quality while enabling residue reuse in sustainable construction materials.

Keywords: Brick Manufacturing, Electrocoagulation, Pre-Treatment, Swine Wastewater, X-Ray Diffraction

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Decanoic Acid-Based Nades for Enhanced Extraction of Aegeline from *Aegle Marmelos*: Optimization and Recovery Analysis

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Abstract

The extraction and separation of phytocompounds commonly rely on organic solvents such as ethanol, methanol, and chloroform. However, these solvents possess limitations, including carcinogenicity, neurotoxicity, and volatility, leading to potential health risks from residual solvents in final products. To overcome the limitations of conventional solvents, developing novel solvents that are safe, eco-friendly, and selective is essential. Deep eutectic solvents (DES), ionic liquids, and supercritical fluids are emerging as promising alternatives. Among these, natural deep eutectic solvents (NADES) offer a green and tunable option for phytochemical extraction. Challenges in solvent recovery and high viscosity often hinder their application. This study introduces and evaluates a safe and hydrophobic NADES, AD12 (acetic acid and n-decanoic acid in the molar ratio 1:2), whose polarity closely resembles chloroform. Molecular dynamics simulations and experimental studies confirmed that AD12 is more suitable than ethanol for Aegeline extraction. Therefore, AD12, as the extraction solvent, was selected to perform ultrasound-assisted extraction of Aegeline from *Aegle marmelos*. Extraction and recovery parameters were optimized using response surface methodology with central composite design (RSM-CCD). The optimal parameters identified for phytochemical extraction were 13 W ultrasonic power, 8-minute extraction time, and a solid-to-solvent ratio of 0.1 g/ml, focusing on maximizing total alkaloids, total phenolics, and yield. Solvent recovery was achieved through a three-stage ultrasonication process incorporating deionized water (DI) to filtrate. The optimized filtrate-to-DI ratio and ultrasonic time for each stage were 0.05 ml/ml filtrate-to-DI ratio and 10 minutes, respectively. Further, multiple reuse and reconstitution of AD12 were assessed to estimate the recovery efficiency. This study presents a recoverable and reusable NADES solvent optimized for extracting Aegeline from *Aegle marmelos*. Additionally, investigating the mechanisms underlying the increased efficiency of reused AD12 will provide valuable insights into their long-term performance and stability. Expanding the range of NADES with varying compositions and properties may also lead to developing more versatile and effective extraction protocols in phytoextraction.

Keywords: Aegeline, Decanoic Acid, NADES Recovery, Phytoextraction

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Process Modelling and Validation of Vacuum Membrane Distillation Process for Concentration and Crystallization

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Abstract

Vacuum Membrane Distillation (VMD) has the significant potential in recovery of valuables and treating higher concentrated solution without reduction in performance of the membrane unlike any pressure driven process. Membrane Distillation process combines both thermal distillation and separation through a porous hydrophobic membrane which allows only pure vapor. This becomes advantageous for separating the solute from solution in the purest form. Competing RO in terms of energy consumption is far ahead, but the limitations of energy consumption can be mitigated by recovering the latent heat from this process. In this study, a 1-Dimensional mathematical model was developed based on mass, heat and momentum balance to study its performance and optimize the operating variables. Further, the developed model was validated with the actual experimental conditions and thereby estimated the parameters through calibration. The relative error has been reduced by less than 1% to ensure the robustness of the model. The entire developed system was tested for reject stream of Reverse Osmosis (RO) process having the salt concentration close to 65-75g/L. Evaluation of pure water flux upon varying the operating variable such as feed temperature, flowrate and vacuum pressure were systematically studied to determine the best operating conditions. Results reveals that pure water flux of 10L/h upon operating the feed temperature at 70^0C and under vacuum pressure of 710mmHg were determined. The concentration of the permeate stream reported to be less than 5mg/L. Upon further concentrating the reject stream a critical nucleate formation concentration was found in the theoretical study which favors crystallization in the developed process. The energy consumption in the overall system was attempted to reduce by integrating with energy device like Thermo Electric Heat Pump (THEP).

Keywords: Crystallization, Energy Consumption, Modelling, Membrane Distillation, Separation, Optimization

Ultrafiltration of Treated Petroleum Refinery Wastewater Using a Novel Extruded Tubular Ceramic Membrane Developed from Pyrophyllite and Coconut Shell-Derived Activated Carbon

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Abstract

Petroleum refinery wastewater (PRW), a byproduct of the oil refining process, contains a complex mixture of contaminants, including hydrocarbons, heavy metals, sulfides, and organic compounds, making its treatment essential for environmental protection and regulatory compliance. The treatment of PRW has been successfully achieved through biodegradation using a mixed culture consortium of bacteria. In this study, a cost-effective tubular ceramic ultrafiltration membrane was developed via the extrusion method, using a blend of pyrophyllite, kaolin, feldspar, and coconut shell-derived activated carbon (AC), followed by sintering. The ceramic mixture, combined with carboxymethylcellulose sodium salt as a binder, was extruded to create a porous tubular membrane. The incorporation of AC aimed to mitigate membrane fouling and enhance organic removal efficiency. The sintered membrane demonstrated a uniform, crack-free surface with excellent corrosion resistance in both acidic and basic environments. Field emission scanning electron microscopy (FESEM) analysis revealed that increasing the sintering temperature reduced pore size and pore count, with an average pore size range of 0.15 to 0.5 μm, confirming its suitability for ultrafiltration. Additionally, the flexural strength of the membrane increased significantly from 6 MPa to 21 MPa as the sintering temperature was raised from 850 °C to 1100 °C. The fabricated membrane exhibited promising potential for ultrafiltration applications in the treatment of PRW, specifically in the filtration of treated oily wastewater. The developed ceramic membrane shows strong potential for practical application in industrial wastewater treatment, offering a sustainable solution for PRW management. With the optimized composition and fabrication conditions, future studies could explore scale-up processes and long-term performance evaluations to support industrial applications.

Keywords: Activated Carbon, Ceramic Membrane, Oily Wastewater, Pyrophyllite, Tubular Membrane

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Comparative Studies on Tetracycline and Ciprofloxacin Degradation Under Ambient Conditions in Presence of Microporous Ammonium Phosphomolybdate as A Catalyst

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Abstract

The persistence of antibiotics in aquatic environments poses significant ecological and public health challenges. This study presents a comparative analysis of the oxidative degradation of two widely used antibiotics, tetracycline (TC) and ciprofloxacin (CIP), using microporous ammonium phosphomolybdate (APM) as a catalyst under ambient and dark conditions. The efficacy of APM in catalyzing the degradation of these two antibiotics is systematically evaluated in pond water and real wastewater matrices. For CIP, over 99% degradation was achieved within 35 minutes at pH 6.6, demonstrating the remarkable efficiency and stability of the catalyst, with minimal leaching and recyclability up to eight cycles. Similarly, APM facilitated the effective breakdown of TC also under similar conditions. The mechanistic insights into its degradation pathways reveal the involvement of hydroxyl radicals ($^{\bullet}OH$) and singlet oxygen ($^1O_2$). Key factors influencing degradation, which include solution pH, APM dosage, and the presence of interfering ions, are examined, highlighting optimal conditions for maximum efficiency. The comparative degradation kinetics indicate that CIP degradation exhibits a higher rate constant, which is likely due to the differences in molecular structure. This work underscores the potential of APM as a sustainable and cost-effective catalyst for mitigating antibiotic pollution. The study provides a robust framework for employing advanced catalytic materials in real-world wastewater treatment, offering critical insights for scaling up processes to combat emerging contaminants effectively.

Keywords: Ammonium Phosphomolybdate, Ciprofloxacin, Oxidative Degradation, Tetracycline, Wastewater

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Sustainable Polymers for Pharmaceutical Removal

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Abstract

Emerging pollutants such as pharmaceutical compounds (PCs) are known to cause detrimental effect on the environment. Presence of such compounds in water bodies at high concentrations due to inappropriate treatment of hospitals and industry effluents and increase usage of drugs have raised serious concerns for the environment and public health. Because of the complex structure and existence in low concentration makes them difficult in removal by the conventional methods using conventional adsorbent. Biopolymers also referred as green adsorbents are becoming more and more popular among the researchers because of their remarkable removal capacities and capability for multiple cycle regeneration and reuse. Natural polysaccharides like cellulose, chitosan, Polyvinyl alcohol(PVA), alginate etc. which are abundantly available are effective adsorbents for removal of pharmaceuticals from water bodies.

Here, we will focus on the research progress of natural polymers including remarkable properties, modification methods and applications in removal of pharmaceuticals and other environmental pollutants. The effect of cross likers and the structural changes on the adsorption capacities will be elaborated. The review also highlights the mechanism for the adsorption along with the supporting characterization. The various parameters such as influence of temperature and P^H will be thoroughly discussed. Further various remediation techniques using functionalized biopolymers will be illustrated.

Keywords: Cellulose, Chitosan, Polyvinyl Alcohol, Alginate, Emerging Pollutants, Pharmaceutical Compounds, Natural Polymer

Theme: AIML

AI and ML in Environmental Sciences

Oral Presentations

Environment 2024
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Estimation of Solubility of Albendazole in Binary Solvent of Water and Ethanol by Thermodynamic Models

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Abstract

Prediction of solubility of active pharmaceuticals ingredients (API) has become important step in the pharmaceutical industries. With the knowledge of solubility of API, one can have the control over the meta stable zone width in the anti-solvent crystallization of API and thereby the control over particle size and shape of the precipitated drug particles. Now a days, prediction of solubility of API through various thermodynamic model such as NRTL, UNIQUAC, UNIFAC etc. has gained attention. In the present paper, the API molecule is considered as a unique entity for modelling approach and, therefore, API solubility is predicted as a function of temperature and composition of the solvent mixture. The solubility of albendazole a API in a binary system of C_2H_5OH (Ethanol) & H_2O (Water) system was evaluated by comparing actual and predicted solubility data obtained by modelling the non-random two-liquid (NRTL), Buchowski-Ksiazczak, and ideal models throughout a temperature range of (288.95 to 317.25) K. The NRTL model was found to be the most accurate and precise method for calculating albendazole's solubility in the binary solvent of Ethanol and Water system. Additionally, the average relative deviation (ARD) and coefficient of determination R-Square were used to determine the discrepancy between the estimated solubility data from the NRTL model, the λh model, and the ideal thermodynamic model and the experimental solubility. The NRTL activity coefficient model was shown to be the most efficient, with the lowest average relative deviation and the highest R-Square coefficient of determination. The ARD and R-Square of NRTL were determined to be less than 0.016 and larger than 0.9992, respectively.

Keywords: Binary Solvent, Solubility prediction, Thermodynamic Models

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AI for Ocean: A Sustainable Path to Save Biodiversity from Climate Crisis

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Abstract

To save our 30% life on land it is mandatory Duty for 8 billion brains to concern about 70% ocean health. To secure lives from the disaster of the next 50 years we need to take immediate action of sustainable planning and proper execution for Ocean health, this extra work will become our global duty. Ocean is our asset; we know for increasing sea level rise we are losing mangroves which is the key asset of absorbing carbon emissions. We are losing more than 75% of coral reefs for heavy bleaching effects and the pollution level which is increasing at the ocean. To save the biodiversity of the ocean and to save the Earth we need to go on advanced technology. We need large amounts of data to fight climate effects. AI's ability to process vast amounts of data and provide insights is transforming our approach to addressing climate challenges. AI is proving invaluable in monitoring environmental changes, from tracking deforestation to analyzing ice sheet dynamics. Machine learning models can predict extreme weather events, helping communities prepare and adapt, reducing potential damage and loss of life. AI-driven systems are also optimizing energy use, from smarter grids that reduce wastage to renewable energy forecasts that ensure efficient deployment of resources like solar and wind power. 90 % of ocean data still unrevealed, climate justice is required to team work on the technology and green to save Kolkata to Jakarta, which is at present one of the most Vulnerable. If we need to plant mangroves then we have to. AI will give the data for ideal space and proper mapping to save the city and the condition of the river bed. 1.2°C has already reached & we are going to lose 70% coral reefs from Earth. Australia has already started the process to secure the Ocean Doctor. Using artificial intelligence and robotics, we can manufacture 10,000 skeletons a day. Coral reefs are considered to be the most biodiverse ecosystems on the planet. We will lose 95% by 2050 from extreme heatwaves and an unhealthy ocean. Coral Reefs provide a $400 Billion ecosystem per year but we are in trouble. Healthy mangroves ecosystems are nature's multitaskers, and they are essential to address the climate crisis. These coastal forests absorb and store significant amounts of carbon dioxide and protect coastal communities and infrastructure from storm surge and erosion. But these unique ecosystems are under threat from increased temperatures, changing rainfall, sea level rise, and other effects of climate change. To effectively conserve these coastal forests for the future, we need to learn how mangroves and the services they provide are affected by these threats and adapt our conservation strategies accordingly. AI is being used to optimize reforestation and restoration efforts. AI-powered tools can identify suitable areas for reforestation, select the most appropriate tree species for specific sites, and monitor reforestation progress. This information can help to ensure that reforestation efforts are effective and sustainable.

Keywords: AI, Climate Change, Ocean Safety, Mangroves, Carbon Emissions, Sustainable Policies

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Assessing the Impact of Traffic Composition on Prediction of Vehicular Emission Accuracy Using Machine Learning Approach

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Abstract

Estimating vehicular emission concentration is the first step to estimate the commuter's exposure to air pollution. This task is challenging due to the diverse traffic conditions in India and the dynamic traffic flow that causes temporal variability in exposure levels. The impact of fleet composition in Indian traffic conditions is unexplored, and hence this study tries to assess the influence of traffic composition on the prediction accuracy of emission concentrations. For this objective, two models were developed. Model 1: categorizes vehicle types into two-wheelers as 2W, cars as CAR, autorickshaws as 3W, and buses and trucks as HCV. Model 2: categorizes two-wheelers as 2W, cars and auto-rickshaws as LMV, and buses and trucks as HCV. The necessary data on traffic volume and roadside pollution concentrations was collected from videographic recordings and a stationary monitoring apparatus. Both models were trained using machine learning methods such as Support Vector Regression (SVR) and Random Forest (RF) to estimate emission concentration and, consequently, the accuracy of the predictions. Better prediction performance was obtained for model 2 when analyzed over SVR and RF. The model 2 provided a higher coefficient of determination ($R^2>0.8$) and lower MAE and RMSE. Thus, classifying the vehicles according to this study contributes to accurately predicting the pollutant concentration and thereby the exposure levels in daily commuters and road-side residents. This study supports environmental research and urban planners in effectively assessing the commuter's health impact due to traffic emissions.

Keywords: Fleet Composition, Forecasting Concentrations, RF, SVR, Traffic Emission

Theme: AC

Atmospheric Chemistry

Oral Presentations

Gourd-level Ozone and Air Quality from a Road-Side Ambient Air

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Abstract

This study explores the O_3 pollution levels and air quality impacts from traffic emitted air pollutants at Kharagpur, India. Kharagpur is an urban area where we investigated the level of O_3 pollution resulting from the road traffic of National Highway-16 (NH-16). On-site measurements were conducted for O_3, NOx ($NO+NO_2$), CO, and VOC from 01-05 April 2024, during 07:00 - 19:00 of each day by using a USEPA-approved Serinus 10 ozone analyzer, Serinus 40 NO_x analyzer along with Aeroqual S500 VOC and CO monitor. A portable weather station (Kestrel 5500) was also engaged to receive the real-time weather data. We observed a strong positive relationship between O_3 and temperature (r = 0.82) along with a strong negative relationship between O_3 and RH (r = -0.82), O3 and NO (r = -0.73). The study reveals that NO_2 was positively influencing (r = 0.25) whereas VOC was negatively influencing (r = -0.24) the O_3 formation but almost at same rate. However, NO_2 tended to increase slightly during the decline of O_3 levels due to O_3 formation inhibition by high levels of NO_2 through titration. The initial rise in VOC levels supported photochemical reactions and contributed to rise in O_3 levels during mid-day. As VOC are consumed in reactions, O_3 levels begin to decline. The peak CO levels were observed during 09:00-10:00 and showed an inverse relation with O_3 throughout the entire day. WS acted as a poorly influencer (r = 0.039) but CO emerged as a negative influencer (r = -0.27) for O_3 formation. The 8-h O_3 levels (122.72 ± 33.69 µg m^{-3}) surpassed the air quality standards notified by NAAQS 2009 and Kharagpur area is falling under Moderately Polluted (AQI 133) region. The findings suggest the necessity of comprehensive assessments of O_3 levels along national highways in India and formulation of targeted policies to address the increasing level of O_3 pollution.

Keywords: Ozone, AQI, Correlation, NH-16, Pollution

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Statistical Analysis of Parameters Influencing the Air Quality in Lucknow City

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Abstract

Air pollution is one of the most pressing issues affecting human health today, especially in many nations. In India, air pollution has seen a sharp increase due to rapid industrialization, population growth, the rise in the number of vehicles, widespread use of fossil fuels, inadequate transportation infrastructure, and, most critically, weak environmental regulations. With the accelerating pace of industrialization, particularly in developing countries, environmental issues have also intensified. Population growth and economic expansion have led to a substantial rise in air pollution sources. In addition to exacerbating respiratory difficulties, air pollution worsens pre-existing respiratory and cardiovascular diseases.

The present study aims to provide a detailed analysis of air quality in two prominent locations in Lucknow - Lalbagh and Talkatora - by examining the monthly average concentrations of four key air pollutants: particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3). The data spans a three-year period from 2019 to 2021, offering insights into trends over time. These pollutants were chosen because they are critical indicators of air quality and are directly linked to public health risks. The primary objectives are to understand the limitations of publicly available data and its effectiveness in identifying pollution sources in these two areas of Lucknow. Data on air pollutants, collected by the Central Pollution Control Board (CPCB), cover different zones including residential, commercial, and industrial areas. The analysis includes using box plots to visually display the distribution and variability of pollutants ($PM_{2.5}$, NO_2, SO_2, and O_3) at both locations, helping us identify trends and outliers. Additionally, the ratios $PM_{2.5}/NO_2$ and $PM_{2.5}/SO_2$ were calculated to explore the relationships between particulate matter and gaseous pollutants. By plotting these ratios over time, we aim to detect patterns that could indicate specific sources of pollution. These findings would help in explaining the factors contributing to rising pollution levels in Lucknow city.

Keywords: Air Pollution, Lucknow, Box-Plot, Pollutant Ratios

Theme: CCS

Carbon Capture and Sequestration

Oral Presentations

Assessing the Role of Macrophytes in Carbon Sequestration: Evidence from Keibul Lamjao National Park of Manipur, Northeast India

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Abstract

Understanding the potential of an ecosystem to sequester carbon dioxide is very important in comprehending its role in mitigating climate change. Although wetlands account for only 7-8% of the Earth's total geographical area, they are considered one of the most biologically diverse ecosystems. Wetlands have a unique habitat, making them an excellent ecosystem to sequester carbon dioxide, effectively storing it in vegetation, sediments, and phytoplankton. The macrophytes capture carbon dioxide from the atmosphere via photosynthesis. Keibul Lamjao National Park (KLNP) is located in the Southern part of Loktak Lake of Manipur, a Ramsar Site, and is home to the critically endangered Brow-Antlered deer, *Rucervus eldii eldii*, locally known by Sangai. The study was conducted in KLNP to determine the carbon content in the macrophytes and its role in mitigating climate change. Sampling was done for one year, from February 2022 to January 2023, using the short-term harvest method. The Above-ground biomass and Below-ground biomass were estimated separately. Carbon stock was obtained from the total biomass with a conversion factor of 0.5, considering 50% of the plant biomass as carbon. The total vegetation carbon stock in vegetation was recorded to be 10.72 kg C m^2 y^{-1}. The carbon stock showed seasonal variation, with the highest levels recorded during the monsoon season. This study emphasizes the role of wetland macrophytes and aquatic vegetation in carbon sequestration. Macrophytes in wetlands are vital in capturing carbon dioxide from the atmosphere. The growth of the macrophytes above the *phumdi* may directly or indirectly be affected by the hydrology of the Park. Regular monitoring and stringent regulations are required to maintain the overall well-being of the water quality and the Park.

Keywords: Carbon Sequestration, Keibul Lamjao National Park, Macrophytes, Wetland, Climate Change

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Assessment of Carbon Storage in a Community-Protected Grassland of Ukhrul, Manipur

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Abstract

Vegetative carbon stocks and soil organic carbon in a community-protected grassland of Ukhrul, Manipur, were assessed. A short-term harvest method was employed to determine the biomass of the vegetation. Carbon stocks (g C m^{-2}) were calculated from the biomass using a conversion factor of 0.5, assuming that 50% of plant biomass is carbon. Soil organic carbon (0-30 cm) was determined by employing the Walkley-Black method. Aboveground carbon stocks ranged from 341.60±52.28 g C m^{-2} to 979.60±25.46 g C m^{-2}, and belowground carbon stocks ranged from 495.28±78.96 g C m^{-2} to 1241.56±175.64 g C m^{-2}. The total vegetative carbon stocks were recorded highest in March (1765.31 g C m^{-2}) and lowest in June (1141.18 g C m^{-2}). The root and shoot ratio was very low, at 1.06. Pearson correlation analysis revealed that the aboveground carbon stocks had a significant positive correlation with mean air temperature and relative humidity and a negative correlation with belowground carbon and soil moisture. Soil organic carbon during the study period ranged from 6.46-11.16 %. The distribution pattern of soil organic carbon across different soil layers indicated that 43% was concentrated in the surface layer (0-10 cm), 33% in the 10-20 cm layer, and 24% in the 20-30 cm layer. SOC was negatively correlated with climatic factors. Thus, the study reveals that climate change has a negative impact on soil carbon storage. Overall, the study highlights the significant role of grasslands in mitigating climate change by sequestering a considerable amount of carbon in vegetation and soil.

Keywords: Biomass, Carbon Sequestration, Climate Change, Grassland, Soil Organic Carbon, Vegetative Carbon Stock

An EFG Based Numerical and Experimental Studies of Mechanical Properties of Reservoir Rock and Caprock Specimens Under Brine Saturation

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Abstract

The element-free Galerkin (EFG) meshfree method is presented to study the mechanical properties of reservoir rock and caprock specimens under brine saturation. Experimental results from the literature show that for the application of carbon dioxide (CO_2) injection and sequestration of CO_2 in the deep saline aquifer (reservoir rock) at different brine saturation level leads to reduction in mechanical strength properties such as fracture toughness, Young's modulus and Poisson ratio. After validating the developed EFG model with the help of the experimental mechanical properties at different brine saturation in uniaxial stress environment and a mesoscale model is developed for future prediction of mechanical properties of reservoir rock and caprock strength. In this mesoscale modelling, the representative volume element (RVE) is used to create the constitutive model with the help of homogenization process. The RVE used to in the EFG method to create macroscopic modelling to obtain stress and strain energy of the system. Finally, quasi-static analysis is performed to obtain the crack path of the pre-existing fracture/fault in the system using different fracture criteria.

This study also aims to investigate the mechanical properties, such as fracture toughness (K_{IC}) and Young's modulus (E) of Silchar sandstone saturated under the influence of different salinity level (0 % NaCl to 30 % NaCl). For this purpose, the experiments are performed in Three-Point Bending (TPB) fracture tests using Single-Edge Notched Beam (SENB) configuration. These experimental results are numerically validated using Element Free Galarkin (EFG) model. This model simulates the obtained TPB experimental results, that is load versus displacement plot, and its rock macro parameters, that is E and K_{IC}. The study also incorporated X-ray Diffraction (XRD) analyses of dry and brine saturated sandstones to obtain detailed mineralogical and microscopic information. Based on the experimental and numerical results, it is concluded that water and brine saturation have a significant effect on the mechanical strength parameters of the rock. The developed EFG model could easily be extended for developing crack path modelling and multiscale modelling for studying the integrity of caprock and reservoir rock in CO_2 storage application in the deep saline aquifers.

Keywords: *Carbon* Sequestration, Caprocks, Aquifer, Mechanical Properties, Element-Free Galerkin (EFG) Meshfree Method, Mesoscale Model, Fracture Toughness

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Climate Change Mitigation in Dry Tropics: Impact of Urban Tree Plantations on Soil Organic Carbon Fractions

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Abstract

Climate change, driven by greenhouse gases (GHGs) like CO_2, is a global challenge, especially in urban land use change (ULUC), intensifying global warming and affecting ecosystem and socioeconomic aspects. Tree plantation is a sustainable and efficient restoration strategy to improve soil quality by increasing soil organic carbon (SOC) through carbon sequestration and mitigating global warming. Limited studies have been conducted to assess how urban vegetation influences the SOC dynamics in urban degraded land, to reduce the GHGs, especially in dry tropics. Therefore, the present study was designed to investigate the SOC in terms of major labile (LCFs) and stable carbon fractions (SCFs) as well as soil carbon indices i.e., carbon pool management index (CPMI) in response to three economically important tree plantations viz., *Terminalia arjuna* (TAP), *Eucalyptus citriodora* (ECP), and *Tectona grandis* (TGP) and agroecosystem (AG) grown on urban degraded grassland (DG) for climate change mitigation in dry tropics. Each land use types (LUTs) was located in a radius of 2.5 km within the campus of Banaras Hindu University, Varanasi, India. Soil samples were collected from each LUTs from three soil depths i.e., upper (0-30 cm), middle (30-60 cm), and lower (60-90 cm) to measure SOC content and its LCFs viz., microbial biomass carbon (MBC), permanganate oxidizable carbon (POX-C), water extractable organic carbon (WEOC), and SCFs like fulvic acid (FA) and humic acid (HA). Additionally, soil carbon indices (CPMI) were calculated as indicators of SOC dynamics. In upper soil depth, across all the LUTs, the SOC content and LCFs viz., POX-C, WEOC, and MBC as well as the SCFs i.e. HA, and FA were highest in TAP, followed in decreasing order by ECP, TGP, DG, and lowest in AG. In the middle and lower depths, SOC and SCFs showed a similar pattern to that of the upper depth. However, MBC and WEOC were higher in TGP than in ECP. SOC and all carbon fractions decreased with soil depth, and LCFs were more sensitive to LUTs, while the SCFs to soil depth. Soil carbon indices followed a similar trend to that of SOC across the LUTs and soil depths i.e., TAG>ECP>TGP>DG>AG. LUT had a greater influence on CPMI than soil depths. The variation in carbon fractions and their carbon indices was attributed to the differences in carbon inputs through tree dimension, litter quality, and root biomass of different LUTs. Higher CPMI in tree plantations especially TAP, indicated the restoration potential of trees and lower CPMI in AG suggested a stage of degradation. Thus, *Terminalia* plantation may be recommended for inclusion in the long-term sustainable restoration strategies of DG. These findings are crucial for understanding SOC dynamics and can be valuable for reducing GHGs through carbon sequestration efforts in dry tropics.

Keywords: Carbon Pool Management Index, Labile Carbon Fractions, Stable Carbon Fractions, Soil Organic Carbon, Urban Degraded Land

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Role of Medicinal Trees in Urban Planning in Dry Tropics: Strategies for Climate Mitigation through Soil Carbon Dynamics

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Abstract

Urban green spaces enhance human health, promote biodiversity, support community stability, and improve ecosystem functions amid climate change and urbanization. Evaluating urban ecosystem health is crucial for sustainable soil management, aligning with Sustainable Development Goals 13 and 15. Understanding soil organic carbon (SOC) dynamics is essential for effective management of urban ecosystems. Soil microbial biomass (SMB) serves as an early indicator of SOC changes, significantly influencing decomposition and formation processes. By enhancing carbon sequestration and improving soil health, variations in SMB can inform strategies to reduce greenhouse gas emissions through SOC storage. This study aims to assess the effect of different medicinal tree species of young and mature age groups on carbon dynamics in term of SOC, total nitrogen (TN), microbial biomass-C (MBC) and microbial biomass-N (MBN) and microbial quotient (MQ) across the soil depth in urban ecosystem. This study was performed in the botanical garden and ayurvedic garden, BHU campus, Varanasi, India, involving six different medicinally important trees viz *Terminalia arjuna* (TA), *Azadirachta indica* (AI), *Emblica Officinalis* (EO), *Crateva nurvala* (CN), *Mimusops elengi* (ME), and *Saraca asoca* (SA) of two age groups i.e. young (<10 year-A) and mature (>10 year-B) and control (CO) site. SOC, TN, MBC and MBN were analysed by dichromate oxidation back titration method, Kjeldahl method and modified chloroform fumigation - extraction method respectively. The trends for SOC and TN were TA>AI> ME> EO > CN >SA>CO across both the soil depths. Similar trends were observed in case of the level of MBC and MBN. The content of SOC and TN and levels of MBC and MBN were higher in mature trees as compared to younger trees except ME and SA. Soil C/N ratio were higher as compared to control site. TA had higher MQ-C, N and microbial C/N ratio as compared to other tree species over control site. On the basis of this study tree species TA, AI, ME, and EO were found to be over time capable of improving soil quality by accumulating more carbon. Specifically, ME and SA were effective in storing carbon at a younger age, making them beneficial for early soil quality improvements. Tree based strategies are therefore essential for land restoration, enhancing soil quality, sequestering carbon to combat climate change, promoting sustainable resource use, and supporting local communities. This study emphasizes the importance of native medicinal tree species in increasing carbon storage within dry tropical urban ecosystem. By harnessing the distinctive characteristics of these species, urban planners and environmentalists can develop more sustainable environments that significantly aid in climate change mitigation efforts.

Keywords: Medicinal Plant, Climate Mitigation, Soil Organic Carbon, Microbial Biomass, Carbon Sequestration

Phase Separation Evaluation, Absorption-Desorption Performance, Regeneration Heat Duty and Speciation Analysis for Post-Combustion CO_2 Capture into Triethylenetetramine/ Tetramethyl-Ethylenediamine Blend

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Abstract

Biphasic solvents show significant promise for CO_2 capture due to their potential to lower energy consumption. However, challenges such as poor regeneration performance, high energy usage, and issues related to the high viscosity of the CO_2-rich phase can affect flow resistance, heat transfer efficiency, and phase separation stability, hindering long-term cyclic performance. This study introduces a novel biphasic aqueous solvent composed of triethylenetetramine (TETA) and tetramethyl ethylenediamine (TMEDA). The effects of the TETA: TMEDA molar ratio on absorption loading, density, viscosity, and phase separation behaviour were analysed at three temperatures and compared with 5M mono-ethanolamine (MEA). Increased temperature enhanced phase separation, and varying TETA concentration tuned CO_2 capture performance. The optimal absorption was observed with a 1.5 M TETA: 2.5 M TMEDA solvent at 40 °C, achieving a CO_2 capture capacity of 0.72 mol CO_2/mol total amine. The lower phase, comprising 60% of the total volume, captured 84% of the total CO_2 within 10 minutes. Desorption studies were carried at 80, 85, and 90 °C. The optimum desorption CO_2 loading of 0.43 mol CO_2/L was observed at 90 °C, resulting in a cyclic capacity of 2.45 mol CO_2/L, 62% higher than that of 5M MEA. The regeneration energy for the biphasic solvent was 2.77 GJ/t CO_2, 22% lower than that of 5M MEA. Qualitative and quantitative ^{13}C NMR analyses were conducted on fresh, CO_2-loaded, and regenerated solvents to understand the reaction mechanism and phase separation behaviour. Ten absorption-desorption cycles were performed to examine operational stability.

Keywords: Biphasic TETA and TMEDA Solvent, CO_2 Capture, Phase Separation, ^{13}C NMR Speciation Analysis, Reaction Mechanism

Theme: EB

Environmental Biotechnology

Oral Presentations

Synergistic Bacterial Consortium in Treatment of Pharmaceutical Contaminants: A Sustainable Environmental Clean-up Approach

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Abstract

The growing prevalence of antibiotic contamination in water bodies, especially from pharmaceuticals, agricultural runoff, and wastewater treatment plants, has raised significant environmental and public health concerns. Among these, tetracycline antibiotics are commonly detected due to their extensive use in both human and veterinary medicine. Conventional wastewater treatment methods are often insufficient in removing these persistent contaminants. Environmental biotechnology is gaining important as integrated technology in wastewater treatment. Bioremediation, utilizing microbial consortia, presents a promising and sustainable solution. This study focuses on the use of a synergistic bacterial consortium for the degradation of tetracycline antibiotics in wastewater. The consortium comprises a blend of bacterial strains with complementary metabolic capabilities, which were selectively enriched and optimized for tetracycline biodegradation. The enrichment process included an initial concentration of 50 mg/L and gradually increasing up to 400 mg/L. These bacteria possess specific enzymes enabling them to break down the complex molecular structure of tetracycline into simpler, less harmful metabolites. The consortium was applied in batch bioreactors under controlled conditions, where the pH, temperature, and dissolved oxygen levels were optimized to enhance microbial activity and antibiotic removal efficiency. In batch experiments, the bacterial consortium achieved a degradation efficiency of up to 90% within 72 hours at an initial tetracycline concentration of 50 mg/L. Kinetic studies revealed that the degradation followed first-order kinetics, with a half-life of approximately 24 hours. The biotransformation of tetracycline drugs was confirmed using High Performance Liquid Chromatography. This study concludes that synergistic bacterial consortia offer an efficient, eco-friendly approach for mitigating antibiotic pollution in wastewater. The findings provide valuable insights into the potential for up scaling bioreactor designs for industrial applications and highlight the importance of microbial synergy in enhancing biodegradation rates. Further research into genetic and metabolic pathways could lead to the development of more robust bacterial consortia tailored to specific environmental conditions.

Keywords: Bioremediation, Degradation, Environmental Biotechnology, Tetracycline, Wastewater

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Remediation of Arsenic ions from Drinking Water by Utilizing Biomass of a Purple Non-Sulfur Bacteria

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Abstract

Permissible limit of total arsenic content in drinking water as prescribed by the United States Environmental Protection Agency is 10µg/L, any amount beyond this permissible limit is detrimental to human health. In our study we utilized 10, 20 and 40mg biomass of a Purple Non-Sulfur bacteria and found that 40mg biomass was significant in reducing different concentrations of [As (V)] and [As (III)] ranging from 30 µg/L- 120 µg/L to 10µg/L. The physical parameters like pH was fluctuated to study the optimum pH required for efficient [As(V)] and [As(III)] removal. Hydride Generator-Atomic Absorption Spectroscopy was used to detect the initial and final concentration of [As(V)] and [As(III)]. First order kinetics model depicted the rate of reaction (K)for [As(V)] removal to be 0.0551 whereas for [As(III)] removal the value of (K) was found to be 0.0350 at 28±2ºC temperature and 6.7 pH. Adsorption capacity for 40mg biomass of Purple Non-Sulfur Bacteria was 100 mg/g and 114 mg/g for [As(V)] and [As(III)] respectively. Adsorption mechanism favoured non linear Langmuir model with R^2 = 98% for [As(V)] removal and R^2 = 99% for [As(III)] removal. Under alkaline conditions the rate of reaction for [As(V)] and [As(III)] removal were 0.0202 and 0.0076. With the aid of FTIR characterization studies and SEM-EDAX analysis the mechanism of [As(V)] and [As(III)] removal by 40mg biomass of Purple Non-Sulfur Bacteria was examined. Also, an investigation of the 40 mg biomass's reusability was conducted to find out the number of cycles the biomass could be re-utilised for arsenic ions removal.

Keywords: Adsorption capacity, Arsenic ion removal, Hydride Generator-Atomic Absorption Spectroscopy, Non linear Langmuir model, Purple Non-Sulfur Bacteria

Value-added Products from Carbon Monoxide Bioconversion using *Clostridium carboxidivorans*: Effect of Different Trace Metals and Optimization Employing Taguchi Experimental Design

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Abstract

Global energy consumption has increased substantially over the last century and is expected to double by 2030. Oil refineries remain the primary source for producing fuels and a variety of chemicals. However, environmental challenges posed by fossil fuel use and increasing energy costs are driving the global shift toward reducing the dependence on conventional energy sources. In this regard, anaerobic bacteria, specifically Clostridial strains, are a promising for carbon monoxide (CO) conversion to ethanol and other value-added products via the Wood-Ljungdahl pathway. This study evaluated the effect of different trace metals (Cu, Co, Mo, Se, W) and optimization of their compounds for enhanced production of C2 - C6 compounds by *Clostridium carboxidivorans* employing Taguchi orthogonal array design of experiments comprising of 18 experimental runs with three different levels of the trace metals. At optimum concentrations of these trace metals, significant increase in acetic acid (167.4 mg/L), propionic acid (348.5 mg/L), lactate (32.7 mg/L), butyrate (634.86 mg/L), isovaleric acid (13.75 mg/L), and ethanol (1458 mg/L) were produced from initial concentration of CO 42 mmol/L. These values were of 6.2 - 48% higher when compared to the value obtained under unoptimized conditions. Selenium and molybdenum positively influenced the ethanol production, whereas a low molybdenum concentration promoted the cell growth and overall metabolite synthesis. These findings highlight the importance of trace metals in green synthesis of value-added products from CO. Biokinetic parameters involved in cell growth and metabolites production by *C. carboxidivorans* were estimated by using modified Gompertz and Logistic models, which revealed very good potential of the anaerobic bioconversion process in obtaining value-added products from CO-rich syngas. Further studies aimed at intensifying the anaerobic bioconversion of CO for enhanced production of the C2-C6 compounds are currently underway.

Keywords: Carbon Monoxide Bioconversion, *Clostridium Carboxidivorans*, Kinetic Modeling, Taguchi Design of Experiment, Trace Metals

Production of Poly(3-hydroxybutyrate) Bioplastic by *Bacillus Subtilis* utilizing Waste Biomass

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Abstract

The progression of industrialization leads to rising demand for plastic products globally, resulting in pollution caused by the accumulation of plastic waste. Poly(3-hydroxybutyrate) (PHB)as bioplastic is attracting the attention of researchers as an alternative to conventional plastics which degrade the environment quality. Studies suggest that 40-60% of the production cost of bioplastic is related to the type of raw material used. Various waste materials have been sightseen as substrates or feedstock for microbes to produce PHB. This work focuses on producing PHB from waste materials as a sole carbon source. Litchi shell is utilized as a low-cost feedstock by *Bacillus subtilis* to produce intracellular PHB. Herein extraction of PHB is carried out by sonication replacing sodium hypochlorite. Further, the functional groups were analyzed by FTIR, NMR, and Raman spectroscopy. Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC) analyzed the polymer for its thermal stability and properties. Moreover, their morphological analysis was performed by FE-SEM. This work demonstrates a cost-effective and sustainable way of PHB production.

Keywords: Bacillus Subtilis, Bioplastic, Litchi Shell, Poly(3-hydroxybutyrate), Waste Biomass

Biodegradation of Polyethylene Film by *Brucella intermedia* MR-B1

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Abstract

Polyethylene (PE), due to its widespread and imprudent use over time, along with its resilience to degradation, poses serious environmental challenges. This study investigates the polyethylene-degrading potential of *Brucella intermedia* MR-B1, isolated from the Mithi River, which is significantly impacted by xenobiotic contamination and accumulation of plastic debris. The biodegradation of polyethylene film was evidenced by a weight loss of 4.6% ± 1.3 over 60 days, alongside the formation of additional ─OH and ─C═C─ unsaturated group in polymer backbone, as demonstrated by Attenuated total reflectance- Fourier transform infrared (ATR-FTIR) analysis. A reduction in water contact angle (WAC) in comparison to control further indicates deterioration of polyethylene film's surface property. Moreover, a dense biofilm layer of *Brucella intermedia* MR-B1 on the polyethylene surface, visualized by scanning electron microscopy (SEM), suggests bacterial growth utilizing polyethylene polymer. The PE surface exhibits sign of damage post incubation characterized by the presence of pits and cracks. The biodegradation process was further validated through Gas chromatography mass spectroscopy (GC-MS), which detects short-chain hydrocarbons, alcohol, and alkenes as degradation products. Additionally, a differential protein expression analysis of *Brucella intermedia* MR-B1, was conducted using polyacrylamide gel electrophoresis (PAGE). This analysis revealed distinct protein bands, highlighting both upregulated and downregulated proteins, suggesting involvement of specific metabolic pathways in degradation of polyethylene.

These findings highlight the potential of *Brucella intermedia* as a biological agent for polyethylene degradation, indicating that this genus could be instrumental in bioremediation efforts aimed at combating plastic pollution. This research opens up new possibilities for innovative strategies to address the environmental issues associated with synthetic materials, showcasing the role of microbial solutions in mitigating ecological challenges.

Keywords: Brucella Intermedia, Mithi River, Polyethylene Biodegradation, Protein Expression, Sustainable Solution

Optimization of Biohydrogen Production from Food Waste and its Process Intensification

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Abstract

Hydrogen is the cleanest fuel, and its production from sustainable resources has been investigated with zest by the global scientific community. This study has reported insight into optimization of process parameters and ultrasound-assisted enhancement in biohydrogen production from food waste hydrolysate fermentation using metabolic flux analysis (MFA). *Clostridium pasteurianum* is used as microbial culture in the fermentation process. Analysis of statistical experimental data using an artificial neural network coupled with genetic algorithm (ANN-GA) resulted in biohydrogen yield of 1108 mL/L (or 1.73 mol/mol hexose sugar) for the parameter set: pH = 6.7, temperature = 36.8 °C, TRS concentration = 10.85 g/L. In the fermentation carried out at ANN-GA-predicted conditions, the metabolic intermediates (acetic acid, butyric acid, succinic acid and lactic acid) had a greater shift towards the acetic acid/ butyric acid pathway that resulted in higher H_2 production. A pseudo-steady-state metabolic flux network model was constructed and analyzed using experimentally measured hexose sugar or glucose uptake rate and fluxes of four metabolites, viz. lactate, butyrate, succinate, and Acetate. Glucose consumption (~ 55%) and biohydrogen yield (~ 22%) increased by the application of ultrasound. Acetate and butyrate were major by-products of hexose sugar fermentation. Sonication had a significant influence on carbon fluxes of Acetyl-CoA node. MFA results revealed enhanced flux towards butyrate under sonication, which was manifested in a higher acetate to butyrate ratio in products and greater hydrogen generation. Biohydrogen production was also a microbial growth-associated process. Finally, two theoretical alternatives for further enhancement of biohydrogen were assessed with flux analysis, viz. enhancement of hexose sugar uptake rate and blocking of particular metabolite pathway.

Keywords: BioH_2, Dark Fermentation, Food Waste Hydrolysate Ultrasound, Metabolic Flux Analysis

Production and Characterization of Autochthonous *Bacillus*-Derived Biosurfactant and Biopolymer from Assam Oil Reservoirs for Application in Microbial Enhanced Oil Recovery

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Abstract

As energy consumption rises and industrialization intensifies, the demand for petroleum continues to escalate, leading to unsustainable extraction rates. This situation not only threatens energy security but also exacerbates environmental concerns, highlighting the urgent need for a transition toward alternative energy sources and sustainable practices. The crude oil production can be improved by implementation of enhanced oil recovery processes. Microbial enhanced oil recovery is one of the mechanisms for corporations looking for innovative ways to boost the returns on their previous investments. Biological preparations comprising many symbiotic microbial isolates are significant due to their superior biotechnological properties and improved efficacy over monobacterial formulations. The isolation of possible biosurfactant, biopolymer producing, and crude oil-degrading strains from various oil collecting unit of Assam (in Eastern India) oil field production facilities has thoroughly been described in the current work. Various strains were isolated from the oil field samples, and the growth of these strains was assessed using crude oil-enriched Bushnell Haas agar. Based on the surface-active characteristics and growth profile, strains SN1, FD3, ED1, ED5 and MD1 were selected for further investigation. Selected isolates have the ability to lower the surface tension as low as 30 – 32 mN/m and interfacial tension to 0.2 – 1 mN/m in the presence of 1 % crude oil as the substrate. The isolates were all identified as gram-positive bacteria of *Bacillus* species, with ability to produce biosurfactant in concentration range of 1.19 – 3.84 g/L. Additionally, the ability of each strain to emulsify oil, produce biopolymer, and biosurfactant was assessed both individually and as a consortium. Isolated strain ED1 showed emulsification index of approximately 62.5 % but had 67.25% EI when grown along as a consortium. Based on various spectroscopic techniques (FTIR, ^{1}H-NMR, MALDI-ToF, HRMS), the biosurfactant produced were found to belong to the lipopeptide class (i.e., surfactin). Isolate FD3 and ED5 also showed biopolymer production of 0.52 and 0.42 g/L respectively which were identified as glycoprotein using FTIR. The suitability of the microbial consortia for microbial enhanced oil recovery was determined using various analytical techniques.

Keywords: Biopolymer, Biosurfactant, Consortium, Strain Isolation, Surface Active Properties

The Screening for the Sustainable Substrate in the Production of Biosurfactants and its Application in Microbial Enhanced Oil Recovery

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Abstract

Microbial biosurfactants are the substitutes for traditional chemical-enhanced oil recovery (EOR). Microbial surfactants, often known as biosurfactants, are amphiphilic, surface-active chemicals produced by microorganisms such as yeast, bacteria, and unicellular fungi. Biosurfactants exhibit eco-friendly qualities as they have total biodegradability, low eco-toxicity, and generation from bio-renewable sources. Moreover, improved surface properties can be attained by biosurfactants in several ways, including by lowering surface tension and interfacial tension, improvement in mobility by increasing emulsification capacity, decreasing critical micelle concentration (CMC), and changing wettability (contact angle). Microbial-enhanced oil recovery (MEOR) is being implemented to eliminate the restrictions of other EOR methods. However, the amount of biosurfactants produced by the microbes is found to be inadequate to use in the reservoir field which eventually turns the whole process expansive. The objective of this study is to explore agro-industrial waste as a substrate for the production and enhancement of biosurfactants for the application of microbial EOR. Different waste substrates as nutrient sources, such as waste cooking oil (WCO), waste engine oil (WEO), molasses, and corn steep liquor (CSL), compared with the biosurfactants production from commercial carbon sources such as mustard oil, paraffin oil light, paraffin oil heavy, and glycerol using two isolated bacterial strains RSL-2 Bacillus subtilis RSL-2 and Pseudomonas aeruginosa P7815 from the oil-contaminated site. The production was optimized with substrate concentration 1-4 % (w/v) (one factor at a time) with the batch parameter (temperature 37 °C, pH 7, RPM 180, inoculum size 5 % (v/v). The isolated strains Bacillus subtilis RSL-2 were found to have potential results regarding biosurfactant production by utilizing substrates like corn steep liquor with 3% (w/v). The result was effective with surface-active properties such as surface tension 28.52±0.058 mN/m, interfacial tension 0.92±0.5 mN/m, emulsification index 59±1 %, CMC 150±15ppm, and biosurfactant yield 1.3 ± 0.3 g/L. The produced biosurfactants were characterized with FTIR, MALDI, and NMR and found to be lipopeptides. The lipopeptides were also found suitable for antimicrobial activity against Staphylococcus aureus and Escherichia coli with Minimum inhibitory concentration (MIC) values of 4 ± 0.21 mg/mL and 5 ± 0.1 mg/mL, respectively. This selective substrate based on the surface-active properties could be optimized further with fermentation parameters to enhance the production yield.

Keywords: Corn Steep Liquor, Lipopeptides, Molasses, Minimum Inhibitory Concentration (MIC), Optimization

Theme: ELEM

Environmental Law, Economics and Management

Oral Presentations

Legislative Developments in E-waste Management in India

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Abstract

The world is moving towards a consumption-based economy where production and consumption are among the major growth pillars in the present economy. Since 2010, the growth of e-waste generation has been outpacing formal collection and recycling by almost a factor of 5 in 2022.In 2022, a record 62 billion kg of e-waste was generated globally, which is equivalent to an average of 7.8 kg per capita per year. Only 22.3 percent of this e-waste mass was documented as formally collected and recycled in an environmentally sound manner. In India, in the year 2023-24, a total of 17,51,236.0 tonnes of E-waste was generated and 7,60,663.0 tonnes of e –waste was recycled, which is 43.43 percent (approx) of total e-waste generated. Various countries have adopted various legislative measures to protect the environment; however, with growing complexities in managing waste, there is a need for comprehensive laws and amendments to enforce proper environmental protection and put in place a policy framework for environmentally sound waste management.

In India, the Ministry of Environment, Forest and Climate Change (MoEF&CC) has notified the E-Waste (Management) Rules, 2022, effective from 1st April, 2023. These new rules are intended to manage e-waste generated in India in an environmentally sound manner and thus have put in place an improved Extended Producer Responsibility (EPR) regime for e-waste recycling. The new provisions would also facilitate and channelize the informal sector to the formal sector for doing business and ensure recycling of E-waste in an environmentally sound manner. Overall, these new amended rules promote Circular Economy through EPR regime and scientific recycling/disposal of e-waste. This paper also reflects on the E-Waste (Management) Rules, 2022, and provides a comparative analysis with the E-Waste (Management) Rules, 2016. This paper attempts to bring about an analysis of the newly notified Rules, the key provisions introduced and possible challenges. This paper uses primary data from Government and official sources to analyze the current E-waste situation in India. This paper also includes suggestions/amendments to existing law on E-waste in India to improve the existing legislative framework in the Indian E-waste scenario.

Keywords: E-Waste, E-Waste Legislation, E-Waste (Management) Rules, 2022, Extended Producer Responsibility (EPR) Regime, Recycling, Sustainable Waste Management

An Overview of Existing Industrial Effluent Collection/Conveyance System of CETPs in Gujarat

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Abstract

The treatment and conveyance of effluent from industrial Common Effluent Treatment Plants (CETPs) is a complex challenge, particularly when managing effluent from a diverse range of 100 to over 1,000 industries across various sectors. This research focuses on industrial effluent collection systems utilized by CETPs. Literature reports indicate that a well-controlled and efficient effluent conveyance system enhances the effectiveness of treatment at CETPs. Effluent can be transported via different systems, including tankers, open channels, or pipelines (either aboveground or underground). During the study, it was observed that strict adherence to CETP inlet norms often leads to the failure of specific effluent collection systems. This can result in an unsteady flow rate and inconsistent parameters such as pH, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), and Chemical Oxygen Demand (COD) at the CETP inlet, ultimately causing non-compliance issues for the CETPs. The research compares the advantages and disadvantages of effluent collection via tankers and pipelines. Brief documentation of all 34 functional CETPs in Gujarat, which together have a treatment capacity of 755 MLD, is provided. However, the study focuses on three CETPs with distinctly different effluent collection systems for a more in-depth comparison. Additionally, the research emphasizes the importance of automatic sampling systems and the integration of Supervisory Control and Data Acquisition (SCADA) with Programmable Logic Controllers (PLC) to monitor effluent quality from each member industry and at various points in the conveyance system. The study also suggests that composite samples should be collected throughout the day to allow for accurate analysis and assessment. In conclusion, the result suggests that for effective wastewater treatment, the management of wastewater collection system plays a pivotal role.

Keywords: Efficient Conveyance of Wastewater, Industrial Wastewater, Wastewater Collection, Wastewater Management, Wastewater Treatment

Integrated Floodplain Management: Balancing Flood Risk Mitigation and Ecosystem Conservation

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Abstract

The degradation and loss of riverine floodplains, largely driven by rapid urbanization and population growth, pose significant threats to environmental health, public safety, and economic stability. As floodplains are increasingly developed for residential, commercial, and industrial purposes, the risk of flooding and its associated hazards grow. These hazards include economic losses from property damage, rising disaster relief and recovery costs, and the ongoing degradation of water resources and floodplain ecosystems. The functional integrity of floodplains, which is essential for regulating flood risks, is heavily influenced by land-use practices in river catchment and valley areas. These practices directly affect the frequency, scale, and impact of flood events. Climate change, with its increasing occurrence of extreme weather events, further complicates flood management. While preventing floods entirely is unfeasible, adaptive management of floodplains can significantly reduce risks. Historically, flood management has relied on structural interventions such as dams, levees, and floodwalls. However, the rising financial losses from flooding, despite these interventions, raise concerns about their long-term economic sustainability. Additionally, floodplains provide crucial ecological and socio-economic services, including biodiversity support, food security, livelihood opportunities, carbon sequestration, and natural water retention. These services have often been overlooked in traditional policy frameworks.

Achieving the twin objectives of flood risk reduction and floodplain conservation requires designating floodplains as no-construction zones to prevent encroachment. This can be achieved through strict land-use regulations, zoning ordinances, and the removal of economic incentives that promote development in flood-prone areas. Several efforts have been made to define floodplains through judicial rulings, notifications by the National Mission for Clean Ganga (NMCG) Authority, Central Water Commission (CWC) technical guidelines, and various state acts and notifications. However, regulating land use in floodplains presents significant governance challenges. This paper advocates for the development of a comprehensive national framework to coordinate floodplain management across different levels of government and private stakeholders. It highlights innovative strategies such as implementing a "river rent," applying the "polluter pays" principle, and integrating various programs like green construction, the Govardhan scheme, and the National Project on Organic Farming (NPOF). These coordinated policy actions are essential to prevent floodplain encroachment and ensure sustainable land use.

Keywords: Flood, Flood Plain, Zoning, Policy, Interventions

Establishing a Holistic Water Quality Index for Real-Time Identification of Unsafe Water Parameters

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Abstract

Considering the growing concerns over water quality stemming from industrialization, urbanization, and agricultural practices, there is an imperative demand for a sophisticated water quality index (WQI) that comprehensively represents water health and identifies significant contamination thresholds. The existing WQIs frequently fail to encapsulate the intricacies of water quality because of the restricted range of parameters evaluated and the absence of detail for particular parameter exceedances. This research introduces an innovative Water Quality Index (WQI) incorporating 16 critical water quality criteria, encompassing physical, chemical, and biological indicators, providing a more comprehensive evaluation of water quality. This index distinctly identifies parameters beyond allowable limits, offering prompt, actionable information for water resource managers, legislators, and the public. The suggested WQI identifies out-of-bounds characteristics, enabling focused interventions and prioritizing remedial efforts. Case studies utilizing real-world datasets will showcase the index's improved diagnostic efficacy across diverse water sources, highlighting its potential as a significant resource for regulatory bodies, water managers, and public health authorities. This innovative index offers a detailed perspective on water quality and specific pollutant issues, enhancing monitoring precision, facilitating proactive environmental management, and safeguarding human health and aquatic ecosystems. This improved WQI framework seeks to create a more sophisticated method for monitoring water quality, assuring safer water management methods.

Keywords: Contaminants, Index, Parameters, Water Quality, WQI

Theme: EN

Environmental Nanotechnology

Oral Presentations

Tuning of Photocatalytic Ability of Sm Doped Cu-Ni Spinel Ferrite Nanoparticles and its Use in Wastewater Treatment

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Abstract

In this decade, wastewater treatment has become a major challenge worldwide to protect the natural resources of water. Due to the turbulent growth of numerous industries especially in developing countries for managing human needs, wastewater treatment has actively drawn the attention of researchers. Elimination of harmful contaminants from wastewater is extremely necessary due to their long-term terrible impacts on the environment. The photocatalysis process using nanosized catalysts is preferred extensively for degrading toxic pollutants. This work explored the versatility of nanocrystalline Sm-doped Cu-Ni spinel ferrites in different applications, with special emphasis on hyperthermia and photocatalytic activities. The samarium doped Cu-Ni spinel ferrite nanoparticles with varying Sm content have been prepared synthesized via the conventional co-precipitation method. Careful examination of the registered powder x-ray diffractograms (XRD) ensured the presence of pure spinel cubic crystal structure. Determination of average crystallite size together with developed microstrain for all the samples was done by using the Williamson-Hall technique. Both the coercive field and saturation magnetization were observed to decrease gradually as noticed in M(H) loops. The superparamagnetic phenomenon has been aroused at room temperature for higher Sm ions content ferrite samples which favored the magnetic controlled hyperthermia through induction heating. Bare Sm doped Cu-Ni ferrite samples showed excellent induction heating obeying clinical safety limits. Photon-mediated degradation of ciprofloxacin (CIP) antibiotic was conducted using as-prepared samples and it was found that 15 % Sm doped Cu-Ni ferrite sample was sufficient to remove 95.8 % of the CIP from the solution in 60 minutes. Hence, Sm doped Cu-Ni spinel ferrites are indeed versatile material and can be used in hyperthermia and photocatalytic applications.

Keywords: Antibiotic Degradation, Spinel Ferrites, Magnetization, Magnetic Nanoparticles, Hyperthermia

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A Comparative Study of Green Synthesized Nanoparticles in Decolourization of Tannery Effluent

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Abstract

Water pollution from tanning and leather industries presents a significant environmental and public health issue due to the large volumes of highly contaminated wastewater they produce, containing heavy metals like chromium, organic dyes, suspended solids and other toxic chemicals. These contaminants degrade water quality, disrupt ecosystems, and pose a serious risk to human health. The conventional methods for treating tannery wastewater, such as coagulation, precipitation, and filtration, are inefficient, costly, and result in secondary pollution through toxic sludge generation. To address these limitations, this study focuses on the green synthesis of iron (Fe), zinc (Zn), and magnesium (Mg) nanoparticles (NPs) using *Punica granatum* (pomegranate) peel extract, a sustainable and eco-friendly resource. The synthesized NPs were characterized using various analytical techniques, including UV-Visible spectrophotometry to monitor NPs formation, Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray (EDX) for morphological and elemental analysis, Fourier Transform Infrared (FT-IR) spectroscopy to identify functional groups, and X-Ray Diffraction (XRD) to confirm their crystalline structures. These characterizations confirmed the successful synthesis of Fe, Zn, and Mg NPs with unique surface properties and high reactivity. The efficacy of these green-synthesized NPs was tested in tannery wastewater treatment, where they exhibited excellent decolourization and adsorption capabilities, effectively removing chromium, dyes, and organic matter. The photocatalytic activity of NPs achieved decolourization efficiencies of 57%, 60%, and 76% for Fe, Zn, and Mg NPs in sunlight, and 52%, 58%, and 70% decolourization efficiencies in dark condition, respectively. These results suggest that Fe, Zn, and Mg NPs synthesized from pomegranate peel extract are highly efficient in mitigating tannery wastewater pollution, offering a sustainable and cost-effective alternative to conventional treatment methods.

Keywords: Decolourization, Green Synthesis, Nanoparticles, Photocatalytic Activity, Tannery Wastewater

Photocatalytic Degradation of Synthetic Dyes from Wastewater Using Biogenically Synthesized Silver Ferrite Nanocomposites

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Abstract

The contamination of water bodies by synthetic dyes from industrial effluents poses a significant environmental challenge due to their toxicity and resistance to degradation. In this study, silver ferrite nanocomposites ($AgFeO_2$) were synthesized using a biogenic approach, employing plant extracts as reducing and stabilizing agents, which offers a green and sustainable method for nanoparticle production. The nanocomposites were characterized using various analytical techniques. X-ray diffraction (XRD) confirmed the crystalline structure, while scanning electron microscopy (SEM) revealed the nanoscale morphology and size distribution of the particles. Fourier-transform infrared spectroscopy (FTIR) identified the functional groups from the plant extract that facilitated the stabilization of the nanocomposite, and UV-Vis spectroscopy demonstrated its optical properties. The photocatalytic activity of the synthesized silver ferrite nanocomposite was investigated for the degradation of synthetic dyes under visible light irradiation. Photocatalytic experiments revealed a substantial reduction in dye concentration, which was monitored using UV-Vis spectrophotometry, indicating efficient dye breakdown. The generation of reactive oxygen species (ROS) during the photocatalytic process played a crucial role in oxidizing the dye molecules into less toxic compounds. Additionally, the magnetic properties of the composite facilitated easy separation and recovery, enhancing its practical utility. This study underscores the potential of biogenically synthesized silver ferrite nanocomposites as highly effective and reusable photocatalysts for the removal of hazardous dyes from wastewater, offering a sustainable solution for environmental pollution control.

Keywords: Biogenic Synthesis, Dye Degradation, Environmental Remediation, Methylene Blue, Photocatalysis, Silver Ferrite Nanocomposite

$^1O_2$ Radical Accelerated C doped $MnFe_2O_4$ for Thermal Oxidative Activation of Peroxymonosulfate Towards Degradation of Textile RO Reject

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Abstract

Thermal oxidative activation of peroxymonosulfate via C doped $MnFe_2O_4$ (C-MnF) was experimented for the degradation of methyl orange (MO) dye from textile reverse osmosis (RO) reject. The as-prepared C-MnF was characterized for SEM, XRD, and FTIR for exploring the physico-chemical properties of the catalyst. Thermal oxidative degradation of MO dye from RO reject (MO + Na_2SO_4) conducted at 200 mg/L C-MnF, 400 mg/L PMS, 20 mg/L initial MO concentration, 1000 mg/L Na_2SO_4 concentration, 90°C temperature and 7.8 solution pH, showed 100% color reduction and >60% TOC reduction within 25 min reaction time. Parametric studies were conducted for C-MnF (50 – 300 mg/L), PMS dose (100 – 500 mg/L), initial MO concentration (10 – 50 mg/L), Na_2SO_4 concentration (125 – 5000 mg/L), temperature (60 – 90°C), and initial pH (3 – 11). $^1O_2$ radical and •OH were the dominant reactive species confirmed by scavenging study. C-MnF showed >80% degradation efficiency and >50% TOC reduction after 5 recyclability cycles; structural and chemical morphology detected by XRD and FTIR of reused C-MnF. Finally, LC-MS analysis detected the degradation pathway of MO dye from RO reject of textile effluent system.

Keywords: Peroxymonosulfate Activation, C doped $MnFe_2O_4$, Reverse Osmosis Reject, Thermal Oxidative Activation

Magnetically Actuated µ-RH@Bots: A Biocompatible and Cost-Efficient Approach for Targeted Micro-Nanoplastic Removal from Aqueous Environments

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Abstract

Micro-nanoplastic pollution is one of the most insidious environmental threats, infiltrating ecosystems and posing serious risks to both marine life and human health. Plastics, which are synthetic polymers composed of organic monomers linked by strong covalent bonds, degrade into micro-nanoplastics (MNPs) under external stimuli like erosion and fragmentation. These MNPs vary in size, with microplastics ranging from 1 µm to 5 mm and nanoplastics being smaller than 1000 nm. The pervasive threat of microplastic pollution has emerged as one of the most pressing environmental crises, posing serious risks to marine ecosystems and human health through contamination of the food chain. Therefore, it is of great urgency to find a cost-efficient and biocompatible material to remove microplastics from the environment. In this context, drawing inspiration from the coordinate bonds found in nature, we present a simple and affordable method for producing µ-RH@Bots. The surface of rice husk is functionalized by the strong coordination bond between surface phenolic groups of tannic acid and Ferric ions (Fe^{3+}). Fe^{3+} facilitates surface complexation. The synthesized µ-RH@Bots, which are externally triggered by the transversal rotating magnetic field, have the capacity to clear away the targeted Micro Nano Plastics (MNPs) due to their strong hydrophobic, electrostatic, and hydrogen bonding interaction characteristics. With the µ-RH@Bots, the microplastics can be navigated along an arbitrarily predefined path by a rotating field and removed using a directional magnetic field. Such functionalized µ-RH@Bots are envisioned to be used in swarms to remove microplastics from aqueous environments. This biocompatible, scalable approach has the potential to transform microplastic remediation strategies, offering a promising tool for large-scale environmental clean-up efforts.

Keywords: Microplastics, Nanoplastics, Micro/ Nano Robots, Pollutant Removal, Magnetic Micromotors

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Advancement, and Multifaceted Characteristics of Shikakai (*Acacia concinna*) Seed Oil (SSO) Pickering Nanoemulsion for Potential Pharmaceutical Applications

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Abstract

Acacia concinna is becoming popular for its multifaceted characteristics including phytochemical, antibacterial, antifungal and bio-reducing agents in different sectors such as composite materials, food, drug delivery and various biological-related potential applications. Shikakai crude extracts determined the presence of flavonoids, alkaloids, phenols, saponins, terpenoids, tannins and steroids. Besides, the Fourier-transform infrared spectroscopy (FTIR) result showed the bio-reducing functional groups like carboxyl, phenols and carbonyl were present in Shikakai crude extract. Additionally, Shikakai seed is the potential source of Carbon Quantum Dots for containing various phytochemicals including ascorbic acid, lupeol, sugar, acacia acid, tartaric acid, spinasterol, succinic acid, lactone, alkaloids and citric acid. Shikakai seed oil was extracted through Soxhlet device and using hexane as a solvent for the extraction process. The physical properties of SSO have been studied including refractive index (IR), viscosity (μ), pH, color and density (ρ). The density (ρ) of SSO was determined up to 0.72g/ml, pH range was 6.7 to 6.8 and color was yellowish by visually checking. The Refractive Index (IR) of SSO was determined at a temperature of 25°C in the spectral range of 0.41μm to 0.67μm. In this study, the value of refractive-index decreased monotonically by increasing the value of wavelength. The Mathematical models have been accommodated to experimental data. The chemical analysis of SSO has been determined including peroxide value, free fatty acids (FFA), soluble vitamins, qualitative and quantitative phenols and fatty acids. Synthesis of cellulose nanocrystals (CNCs) has been successfully done from coconut starch. The characterization of CNCs including average particle size, zeta (ζ)-potential and scanning electron microspore (SEM) has been presented in the result and discussion. The preparation of pickering nanoemulsion has been described as mixing SSO and CNCs by using the ultrasonic homogenizer. The characterization of emulsion including microstructure, stability, lipid oxidation measurement, UV light stability, antioxidant stability and bioaccessbility has been determined as described in the result section. Consequently, SSO pickering nanoemulsion may offer to take the place of major implications for advanced drug delivery, control release and loading. By channeling the efficiency of enhanced drug-delivery and the interfacial properties, this study may lead to rational design of SSO pickering nanoemulsion for potential pharmaceutical applications.

Keywords: Bioaccessbility, Cellulose Nanocrystals (CNCs), Pickering Nanoemulsion, *Shikakai* Seed Oil (SSO), Potential Drug Delivery System

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Development of Dot Assay Based Colorimetric Aptasensor for Highly Selective and Sensitive Detection of Acetamiprid

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Abstract

A novel colorimetric biosensor utilizing a single-stranded DNA (ssDNA) aptamer and a high-throughput dot assay was developed for the specific detection of acetamiprid, a widely used and hazardous insecticide known for its environmental and health risks. Aptamers, which are short, single-stranded nucleic acids that can specifically bind to target molecules, offer a promising alternative to traditional antibodies due to their high specificity, stability, and ease of synthesis. To identify an aptamer specific to acetamiprid, we employed a non-immobilized graphene oxide-based systematic evolution of ligands by exponential enrichment (SELEX). After 15 SELEX cycles, we isolated a 79-mer aptamer (Apt-SS5) with high specificity for acetamiprid. The binding affinity of Apt-SS5 was evaluated using a novel colorimetric dot assay, revealing a linear DNA folding with a melting temperature (Tm) of 53°C and a Gibbs free energy (ΔG) of -7.24 kcal/mol at 37°C. The aptamer's binding pocket, formed by bases C-16 to T-32, demonstrates a strong interaction with acetamiprid, particularly through bases C-10, C-16, G-25, A-26, G-27, G-28, and A-29. Apt-SS5 exhibited exceptional affinity for acetamiprid, with a limit of detection (LOD) of 0.039 ppb. The efficacy of the developed colorimetric assay was validated by testing with water samples spiked with various concentrations of acetamiprid, demonstrating its practical application for environmental monitoring and safety assessment.

Keywords: ssDNA, Acetamiprid, Biosensor, SELEX, Aptamer, Colorimetric Assay

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Plant-based Phytochemicalsfor the Synthesis of p-n Junction CuO/CdS Heterostructures for Photocatalytic CO_2 Reduction to Ethanol and Carbon Monoxide

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Abstract

The rising energy demand due to industrialization and improved living standards is projected to increase global energy consumption by 28% by 2040. This demand is primarily met by burning non-renewable fossil fuels, risking their depletion and driving greenhouse gas emissions. CO_2, the major contributor, accounts for 76% of emissions, exceeding 36 billion tons annually, with atmospheric concentrations at 425.5 ppm. Developing sustainable energy solutions is essential to meet demand and mitigate these effects. Various technologies, including biological, catalytic, thermochemical, electrocatalytic, photocatalytic, and photoelectrocatalytic methods, address CO_2 emissions. Among these, photocatalytic reduction stands out for its ability to utilize abundant solar energy and water to produce value-added chemicals like methanol, ethanol, formic acid, methane, and carbon monoxide through an environmentally friendly process. Mimicking natural photosynthesis, this approach tackles both energy and environmental challenges.

Bio-based methods for synthesizing semiconductor nanoparticles (NPs)/quantum dots (QDs) offer numerous advantages over traditional chemical-based approaches, including environmental friendliness, cost-effectiveness, one-step synthesis, and the abundant availability of biomaterial sources. Employing green pathways for NPs/QDs synthesis and incorporating them into CO_2 photo-reduction processes could be a promising strategy to curb industrial CO_2 emissions. The Northeastern states of India, with their rich diversity of tropical and subtropical plants, could serve as a source of environmentally friendly phytochemicals. These phytochemicals could act as potential agents for reducing and capping semiconductor nanomaterials efficiently. In this research study, we present the synthesis of CdS QDs using phytochemicals derived from *Aegle marmelos*. The CdS QDs were further modified to reduce oxidative photo-corrosion and minimize the recombination of electron-hole pairs. A bio-based route was employed to incorporate CuO into the CdS QDs, forming a p-n junction heterostructure that enhances charge carrier separation and transportation and CO_2 adsorption while reducing electron-hole recombination and photo-corrosion. The resulting catalyst was evaluated for its ability to catalyze the reduction of CO_2 under visible light, producing ethanol and carbon monoxide as the primary products. Additionally, stability and reusability studies were performed.

Keywords: Bio-Based Heterostructure, Photocatalytic CO_2 Reduction, Ethanol, Carbon Monoxide, P-N Junction

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Development of Bio-inspired $CuInS_2$ for Photocatalytic CO_2 Reduction to Value-Added Products

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Abstract

The enormous combustion of fossil fuels largely for industrial development in the past involves generation of billions of metric tons of CO_2, instigating climate change, global warming, and health issues. As a result, the earth's surface temperature rises by 0.2°C per decade. To mitigate these problems, electro-, photo-, electro-photo-, and photo-thermo-catalytic technologies have been tested in a greater extent for CO_2 reduction to value-added products. Among them, photocatalytic CO_2 reduction technique is highly warranted due to its simplicity, effectiveness, and high conversion efficiency. Nanomaterials-based catalysts such as CdS, CuS, MoS, ZnO, and AgNPs are commonly applied for photocatalytic CO_2 reduction to formic acid, methanol, ethanol, etc. Among them, metal sulfide nanostructures in particular own lower bandgap and suitable band-edge potential for visible light driven photocatalytic CO_2 reduction to value-added products. However, single metal sulfide nanostructures suffer from satisfactory conversion efficiency of CO_2 reduction due to high recombination rate and photo corrosion. However, bimetallic $CuInS_2$ nanostructures exhibit enhanced conversion efficiency of CO_2 reduction with appropriate bandgap for visible light absorption and effective band edge potential to generate electron-hole pairs. Moreover, it could adsorb crucial intermediates through tuning of bimetallic active sites for selective formation of specific products in the CO_2 photo-reduction process. Nevertheless, most of the reported methodologies for the synthesis of metal sulfide nanostructures involve environmentally aggressive chemicals.

Herein, we have reported a greener approach involving bio-analytes for the synthesis of $CuInS_2$ nanostructures using *Phyllenthus embelica* leaves extract. The phytochemicals present in the bio-extract were primarily gallic, ascorbic acid, and lesser amounts of flavonoids, alkaloids, tannins, and saponins which was exploited for the formation of stable $CuInS_2$ nanoparticles. The morphological analyses of as-prepared $CuInS_2$ nanostructures were done by Field emissions scanning electron microscopy (FESEM) and Field emission transmission electron microscopy (FETEM). The synthesized $CuInS_2$ nanostructures was tested for photocatalytic reduction of CO_2 to value-added products.

Keywords: Bio-inspired Synthesis, Energy Crises, Environmental Pollution, Global Warming, Photocatalytic CO_2 Reduction

Synthesis of Bio-based Gadolinium Doped Magnetic Fe_3O_4 Nanoparticles for Photocatalytic Treatment of Wastewater

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Abstract

The supply of safe drinking water is a need for the survival of mankind. However, water pollution is a major concern largely arising from rapid industrial growth, urbanization, and excessive use of synthetic chemicals, namely, dyeing agents, pesticides, pharmaceutically active ingredients (APIs), etc. Antibiotics are remarkably used APIs. Intake of antibiotics traces present in the environment through drinking water may cause gradual damage to the human intestinal microbiome and could lead to the development of resistance against antibiotics. Furthermore, it is toxically deposited on targeted organs, causing immune and metabolic diseases. Therefore, wastewater containing antibiotics must be removed and degraded before they are discarded into the environment. To treat wastewater containing antibiotics, different technologies such as membrane technology, activated carbon, membrane distillation, ozone/hydrogen peroxide treatment, ultrasound irradiation, electrochemical oxidation, and photocatalysis are in practice. In particular, the photocatalytic process is popular among the scientific communities for enhanced degradation of APIs.

Photocatalysts such as TiO_2 and ZnO are commonly used to treat organic and inorganic contaminants present in water because of their abundance, non-toxicity, and strong photocatalytic activity. Both these semiconducting materials suffer from low visible light activity, having a high bandgap. Further, catalyst recovery is a serious challenge to make the process sustainable. The treated water containing photocatalyst traces is also unsuitable for drinking applications. Whereas magnetic catalysts such as Fe_3O_4, Co_3O_4, and NiO are easily recoverable by applying a magnetic field. They exhibit high stability, notable adsorption capacity, and easy regeneration and reusability for bulk applications. However, one of the major setbacks of magnetic photocatalysts is that when coupled with nonmagnetic material, their magnetic saturation value decreases. This work reports on the development of doped magnetic photocatalysts to overcome this problem.

Bio-based photocatalyst preparation is an environmentally friendly and economical approach. In this study, cost-effective, environmentally friendly, and reusable Gd-doped iron oxide (Gd-Fe_3O_4) nanoparticles were synthesized by co-precipitation in combination with bio-extract prepared using *Mimosa pudica* leaves. This extract is a source of bio-analytes such as flavonoids, saponins, alkaloids, terpenoids, tannins, phenols, etc., and could act as both reducing and stabilizing agents. The synthesized catalyst was used for photocatalytic degradation of ciprofloxacin (antibiotics) under visible light irradiation.

Keywords: Bio-based Doping, Catalyst Recovery, Magnetic Photocatalyst, Photocatalytic Degradation

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Efficacy of Green Synthesized Silver Nanoparticles for the Elimination of Drug-Resistant *Pseudomonas aeruginosa* Isolates from Wastewater

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Abstract

The current study investigates silver nanoparticles, which are known for their exceptional disinfectant properties. This knowledge has a long history, and the utilization of silver in nanoparticle form enhances its effectiveness significantly. It is also important to address the synthesis process associated with these nanoparticles. Currently, in this study, silver nanoparticles were synthesized from $AgNO_3$ by utilizing the plant extract *Phyllanthus acidus* leaves. After using different proportions, it was found that 1:4 (leaves extract: $AgNO_3$) is most effective. This conclusion was made based on the absorption of the obtained solution in a UV-visible spectrometer, the absorbance observed was found in the surface plasma resonance of silver in the range of 420 to 450 nm. Further, the analysis using X-ray diffraction (XRD) confirmed that the synthesized nanoparticles exhibited a crystalline structure. Additionally, Scanning Electron microscopy (SEM) images revealed that the nanoparticles had a small size of approximately 25 nm. *Pseudomonas aeruginosa* was isolated from the wastewater sample and its presence was confirmed through biochemical tests and 16S rRNA sequencing. It was found that these *pseudomonas species* exhibited multiple drug-resistant characteristics upon conducting antibiotic susceptibility testing using fluoroquinolones, β-lactams, macrolides, aminoglycoside, glycopeptide, and penicillin class of antibiotics. From the Zone of Inhibition studies, we can confirm that synthesized silver nanoparticles exhibited higher efficiency in eliminating *Pseudomonas aeruginosa* from wastewater.

Keywords: Silver Nanoparticles, Green Synthesis, *Pseudomonas Aeruginosa*, Antibiotic-Resistant Bacteria

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Synthesis of Rice Husk Derived Silica Nanoparticles Through Chemical Method

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Abstract

Rice husk, a common agricultural waste, can be used to create silica nanoparticles, which is an economical and sustainable way to create useful nanomaterials. This study investigates the production and enhancement of the yield of silica nanoparticles from rice husk, a commonly accessible agricultural waste, using hydrochloric acid. In order to optimize the extraction conditions and obtain the maximum silica production, the first stage is pretreatment of rice husk to eliminate both organic and inorganic contaminants. The treated rice husk undergoes a hydrochloric acid leaching procedure, producing a silica-rich solution that is then refined by washing, filtering, and drying. After the silica sample is purified, it is calcined to generate high-purity amorphous silica powder. Stabilization temperature and acid concentration are important variables that must be carefully adjusted to maximize the yield and quality of silica nanoparticles. The findings show that adjusting the synthesis parameters greatly increases the quantity and quality of silica nanoparticles. This process not only provides an economical and environmentally friendly way to turn rice husk waste into useful nanomaterials, but it is also scalable and appropriate for use in industrial settings. The findings support waste valorisation and sustainable development by highlighting the potential of agricultural by-products as feasible sources for the manufacturing of value-added materials. This process not only supports sustainable waste management but also contributes to the advancement of green nanotechnology by leveraging agricultural waste. The silica nanoparticles were amorphous in nature having 99% purity.

Keywords: Acid Leaching, Chemical Method, Rice Husk, Silica Nanoparticles, Waste Valorisation

Synthesis of Carbon Quantum Dots (CQDs) from Renewable Sources and Its Catalytic Applications for Organic Synthesis

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Abstract

Carbon Quantum Dots (CQDs) have emerged as one of the most versatile and ignited domains balancing the fundamental as well as applied research on a single podium. We have synthesized CQDs from bio-mass waste *i.e.* banana peels and human hairs, with the deep imprint of sustainable development and waste utilization. Both these B-CQDs and H-CQDs have been comparatively scrutinized in order to set up a relation between the CQDs properties and the choice of precursor for their synthesis according to their application requirement. Characterizations including UV-Vis, ATR-IR, P-XRD, DLS, HR-TEM, EDX, SAED, AFM etc were performed to decipher the individual properties and behaviors from the gamut specialties of CQDs. Various microstructural parameters have been estimated from the results of different characterizations and plausible lattice specifications and measurements for CQDs have been explored. The verification and justification of these parameters from micrograph image calculations *i.e.* HR-TEM was done to evidently present the results. Amino-acid functionalization of CQDs was failed but the intervening reason explained about the formation of macromolecular synthon-tecton cluster cavity formations which can encapsulate CQDs and quench their fluorescence properties. Amine based functionalization of CQDs has also been performed and the direct catalytic applicability of the H-CQDs and f-B-CQDs in α-β unsaturated compound synthesis from alkynes organic compounds has also been reported. The organic products so formed in the application part was analyzed and identified from TLC and Nuclear Magnetic Resonance spectroscopy.

Keywords: Carbon Quantum Dots, Cauchy-Lorentz Function, Dislocation Density, Synthons, Tecton

Theme: GC

Green Chemistry

Oral Presentations

Active Packaging: Biopolymeric Film Based on Chitosan-Polyvinyl Alcohol (PVA) and Mango (*Mangifera Indica*) Seed Kernel Extract with High Antioxidant Activity

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Abstract

Food waste and spoilage are becoming a greater concern in a world of growing population with constant need of increasing food supply. Usage of Active packaging biodegradable films not only target to free the world from plastic pollution but these biopolymer-based materials are also excellent medium for combining antioxidant and antimicrobial agents which will preserve and increase the shelf life of the food. That's why the development and application of these films have received a lot of attention. The present study focused on synthesis of PVA (Polyvinyl alcohol)-Chitosan biopolymeric films with phytochemicals extracted from mango seed kernel (*Mangifera indica*) as natural antioxidant. Characterization such as SEM (Scanning Electron Microscopy) was performed which showed the smooth surface morphology. The water absorbency was measured by calculating the swelling index and water vapor permeability was also checked. To measure hydrophobicity of the film surface water contact angle testing was performed and mechanical properties of the film was also checked using Universal Tensile Testing machine. The presence of PVA in the film helped in achieving great mechanical strength. On the other hand, addition of chitosan made the films hydrophobic in nature. Mango seed kernel is a great source of various polyphenols and flavonoids such as Gallic acid, Mangiferin, Catechin, p-Coumaric acid, Quercetin etc. These bio actives show great antioxidant activity which was measured by DPPH scavenging activity. Finally, the real-life application of this active film on sliced apple was performed to test how much it can increase the shelf life of the apple slices by protecting the food from oxidation. The study revealed that this active packaging increased the shelf life of sliced apple by four days which is very promising.

Keywords: Antioxidant activity, Biodegradable Packaging, Chitosan, Food Preservation, Polyvinyl Alcohol

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Green Nanopesticides for Fungal Control: Synthesis and Comparative Analysis

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Abstract

The persistent use of chemical insecticides has resulted in toxicity to non-target organisms, the development of pest resistance, and widespread environmental pollution globally. Zein, derived from corn protein, was chosen for its appealing physiochemical characteristics and combined with essential oils; neem and eucalyptus. Neem and eucalyptus are known for their high pest toxicity owing to their primary ingredients, azadirachtin, and 1,8-cineole, respectively. Based on this foundation, the synthesis aims to create integrated Eucalyptus oils and Neem oils Zein-based nanopesticides. These formulations will be evaluated for their efficacy against individual oil-based nanopesticides, Eucalyptus oil Zein-based nanopesticides, and Neem oil Zein-based nanopesticides in combating the common coconut mold. The study seeks to harness the antifungal attributes of both oils and optimize the formulation to enhance its overall performance. Utilizing these components, nanopesticides were synthesized and evaluated for their antifungal properties against fungi. Through the antisolvent method, three unique nanopesticides were developed using zein-based formulations integrating neem oil, eucalyptus oil, and a blend of both. The nanopesticides exhibited diverse hydrodynamic mean diameters: 7 ± 3 nm for neem oil, 12 ± 5 nm for eucalyptus oil, and 54 ± 12 nm for the combined neem-eucalyptus oil variants, as revealed by Dynamic Light Scattering (DLS). These formulations were evaluated for their antifungal efficacy against naturally occurring common coconut mold in controlled Petri dish assays, resulting in efficient inhibition of fungal growth. Notably, the combined neem-eucalyptus oil zein-based nanopesticides displayed exceptional efficiency, recording approximately 80% inhibition, surpassing the eucalyptus oil zein-based (54.32%) and neem oil zein-based nanopesticides (16.53%). This highlights how combining these oils makes them work better against fungus, and it suggests looking into how they affect pests that harm crops. Embracing a green synthesis methodology, these formulations leverage the combined properties of essential oils to achieve mutual enhancement of antifungal properties, while maintaining an eco-friendly profile.

In conclusion, the experiment demonstrates the effective formulation of essential oil zein-based nanopesticides through environmentally friendly methods. These alternatives aim to eliminate the toxic impact of conventional pesticides, offering superior efficacy with reduced toxicity towards non-target species. The green synthesis approach ensures minimal environmental harm, harnessing the combined properties of essential oils to mutually enhance the antifungal effectiveness of the nanopesticides while maintaining an environmentally friendly nature.

Keywords: Agriculture, Antifungal, Essential Oils, Green Synthesis, Nanopesticides

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Loading of Tin Based Dichalcogenide Over Metal Organic Framework Z-Scheme Heterojunction Asisted with Peroxymonosulfate for Boosting Visible-Light Photocatalytic Degradation of Antibiotics

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Abstract

In recent decades, public concern has escalated concerns the prevalence of drugs in aquatic ecosystems. These residues originate from multiple sources, including hospitals, domestic wastewater, and pharmaceutical production, encompassing both voided and surplus drugs. Antibiotics, a category of pharmaceutical agents employed for the treatment and prevention of bacterial infections, are widely used in medicine, livestock husbandry, and aquaculture. Merely 30% of antibiotics ingested by people and animals are assimilated, with the remainder being expelled via feces and urine, subsequently contaminating the environment. Multiple research studies have provided empirical evidence demonstrating that wastewater treatment plants do not completely eliminate pharmaceutical chemicals due to the low biodegradability and high hydrophilicity of these substances. Consequently, the advancement of efficient technology for its eradication is essential.

This research encompassed the synthesis of metal-organic framework, Tin based dichalcogenide, and their composites. Experiments on the degradation of antibiotics such as Norfloxacin (NOR), Sulfamethazine (SMT), Tetracycline-Hydrochloride (TC), and Ciprofloxacin (CIP) utilizing developed heterojunction composite were conducted in 300 mL cylindrical flasks, fitted with 250-watt mercury lamps and magnetic stirrers, operating at a speed of 550 rpm under ambient conditions. Comprehensive investigations utilizing techniques such as FESEM, EDX, XRD, Raman, FTIR, BET, and XPS have been performed, validating the effective synthesis of the photocatalysts. The optical characteristics of the synthesized sample were assessed using UV-VIS diffuse reflectance spectroscopy (DRS), indicating a band gap conducive to effective visible light absorption. The semiconductor type was determined, charge transfer kinetics were investigated, and charge separation and transfer within 'on and off' zones were examined using Mott-Schottky plots, Electrochemical Impedance Spectroscopy (EIS) analysis, and photocurrent investigations, respectively. The degradation of antibiotics was conducted in an appropriate photochemical reactor, and the reaction rate constant was determined. After 60 minutes under optimum conditions, the residual antibiotics concentration decreased to undetectable levels. A Box-Behnken experimental design was employed to optimize various operating parameters, including dose, pH, and beginning concentration. Additionally, the mechanism and degradation pathway were established.

Keywords: Emerging Pollutant, Metal Dichalcogenide, Metal-Organic-Framework, Reactive Oxygen Species (ROS), Visible-Light Degradation

Synthesis of Nanocellulose from Biomass Cellulose using A Synergistic Action of Recombinant Cellulases and its Application as Hydrogel

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Abstract

Nanocellulose, a sustainable and eco-friendly nanomaterial, has emerged as a leading green material with numerous applications. However, current production methods physical, chemical, and physicochemical face challenges, including high energy consumption, lengthy processing times, and low yields. This study explores an enzymatic approach to overcome these limitations by combining two recombinant enzymes, β-(1,4) endoglucanase (*At*GH9C-CBM3A-CBM3B) and cellobiohydrolase (*At*CBH5A) from *Acetivibrio thermocellus*. These enzymes collaboratively facilitate cellulose fibrillation through restricted hydrolysis to produce cellulose nanofibers (CNF). The study focuses on two biomass sources: pretreated rice straw (RS) and cellulose derived from sugarcane bagasse (SCB) and elephant grass (EG). RS was chemically pretreated with sodium chloride before enzymatic hydrolysis and defibrillation via sonication. SCB and EG cellulose underwent enzymatic hydrolysis for CNF production. Thin-layer chromatography (TLC) revealed the synergistic action of the enzymes at different ratios, and Fourier-transform infrared (FTIR) spectroscopy confirmed functional groups remained intact during enzymatic treatment. Enzyme-treated biomass exhibited increased functional groups (-COC and -OH), indicating effective hydrolysis. Crystallinity index analysis via X-ray diffraction showed that enzyme-treated biomass had higher crystallinity compared to untreated samples, signifying a reduction in amorphous cellulose. For comparison, CNF was also produced chemically using TEMPO-mediated oxidation. TEMPO-treated samples yielded larger fiber diameters, suggesting lower efficiency compared to enzymatic processes. Physical and chemical characterizations, including field emission scanning electron microscopy (FESEM) and energy-dispersive X-ray analysis (EDX), evaluated the physiochemical properties of the nanocellulose. The enzymatically derived CNF was blended with carboxymethyl cellulose sodium salt (CMC-Na) to create a hydrogel. The hydrogel, comprising a 40% CMC-Na blend, was produced via chemical methods and evaluated for potential applications in de-inking and drug delivery. The study highlights the advantages of enzymatic methods in nanocellulose production, emphasizing their potential to enhance sustainability and efficiency while maintaining the material's functional integrity.

Keywords: Antioxidant Activity, Biodegradable Packaging, Chitosan, Food Preservation, Polyvinyl Alcohol

Theme: OET

Other Environmental Topics

Oral Presentations

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Breaking Down PFAS: Advanced Degradation through Adsorptive Photocatalysis

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Abstract

PFAS are a vast family of more than 10,000 manufactured organic chemicals known for their versatility in being used as surfactants and repellents. India's rapid industrialization and urbanization raise concerns about the potential widespread use of PFAS in various sectors like textiles, personal care products, non-stick cookware, electronics, and firefighting foams/gear. PFAS have been ubiquitously detected in air, water/wastewater/effluents, soil, human blood, hair and breastmilk, biota, and found bioaccumulating into the food chain/environment due to their widespread use and resistance to degradation. Consequently, PFAS-contaminated water can enter drinking water supplies, posing potential health risks to millions of people.

The increasing prevalence of PFAS contamination necessitates a comprehensive strategy that includes preventative measures and solutions for existing contamination. Given the recalcitrant nature of PFAS and the limitations of existing conventional water treatment technologies, there is an urgent need to develop and implement innovative approaches to address this emerging challenge. Such technologies must be capable of effectively removing PFAS from water sources while also being economically feasible and environmentally sustainable. As the environmental concentrations of PFAS are in the range of nanogram to microgram per liter, the direct application of the destruction/degradation process may not prove effective. Concentration and destruction techniques are gaining wide attention for the remediation of PFAS-contaminated waters as this technique may be advantageous in terms of treatment effectiveness for trace-level concentrations, volume to be treated, and energy efficiency. These hybrid treatments, combining concentration and destruction technologies, are significantly more effective than traditional treatments. Of these, adsorption and photocatalysis are both easily integrable technologies that can concentrate the PFAS and also destroy it at the same time. This integrated strategy leverages the pollutant-concentrating ability of adsorption to maintain a high concentration of contaminants at the catalyst surface, facilitating efficient degradation by photogenerated reactive species under light irradiation. This circumvents the need for separate regeneration processes and potentially enhances degradation efficiency through improved pollutant-catalyst contact.

Keywords: Adsorptive-Photocatalysis, Hybrid Treatment, PFAS, Separation And Concentration, Water Treatment

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Green Finance as a Catalyst for Viksit Bharat: Insights from Coimbatore's Banking Sector

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Abstract

Green finance has emerged as a critical instrument for advancing sustainable development, particularly in regions like Coimbatore, which plays a key role in India's economic growth. This study examines the role of green finance in promoting the Viksit Bharat 2047 vision by focusing on Coimbatore's banking sector. Through a comparative analysis of public and private sector banks, the research evaluates the drivers, challenges, and opportunities for green energy investments. The study highlights how both public and private banks contribute to financing renewable energy projects, with public sector banks leading large-scale projects due to government mandates, while private banks adopt more strategic, market-driven approaches. Coimbatore's industrial prominence and favorable climatic conditions make it an ideal candidate for green energy projects, especially solar and wind energy. This study examines the city's progress in renewable energy initiatives, emphasizing the banking sector's crucial role in financing these efforts. The analysis identifies key factors influencing banks' decisions to fund green projects, such as profitability, risk management, and regulatory support. Additionally, the study explores the barriers that banks face, including high initial costs, regulatory complexities, and the need for specialized expertise. Recommendations are made for enhancing the role of banks in green finance, such as promoting innovative financing models, improving regulatory frameworks, and fostering public-private partnerships. By addressing these challenges, Coimbatore's banking sector can significantly contribute to India's sustainable development goals. This research is valuable for policymakers, financial institutions, and industries looking to integrate sustainability into their operations and investments, ultimately fostering a more resilient and green economy in India.

Keywords: Banking Sector, Coimbatore, Green Finance, Sustainable Development, Viksit Bharat

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Phytoremediation of Acid Mine Drainage: Comparative Analysis of Constructed Wetlands for the Removal of Cu, Mn, Al and Cd

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Abstract

Acid mine drainage (AMD) poses a significant environmental threat due to its high concentrations of heavy metals and low pH, which can severely impact aquatic ecosystems. This study investigates the efficiency of two constructed wetland systems—CW-I (unplanted) and CW-II (planted)—in treating synthetic AMD containing Copper (Cu), Manganese (Mn), Aluminum (Al), and Cadmium (Cd). The experiment was conducted over 12 months, focusing on the influence of hydraulic retention times (HRTs) of 24, 48, and 72 hours on the removal of these metals. CW-II incorporated *Alocasia odora* and *Spirodela polyrhiza* to enhance metal removal through biological uptake, while CW-I relied solely on physical and chemical processes. Results showed that CW-II consistently outperformed CW-I across all metals, with the most substantial improvements observed at the 72-hour HRT. Time series analyses revealed that CW-II maintained lower metal concentrations over time, with significant reductions in Cu, Al, and Cd. The box plot analysis confirmed CW-II's more stable and predictable performance, especially at longer retention times, while CW-I demonstrated greater variability and plateaued after the initial 24 hours. Two-way ANOVA results indicated that both system type and HRT had significant impacts on metal removal efficiencies, with strong interaction effects showing that the combination of longer retention times and vegetation maximized the removal potential in CW-II. Tukey's post hoc analysis further supported these findings, highlighting statistically significant differences between the two systems, particularly at the 72-hour retention time. This study demonstrates the potential of planted constructed wetlands for AMD treatment, with CW-II proving to be more effective due to its combination of physical filtration and biological uptake. The findings suggest that integrating vegetation into wetland systems can significantly enhance the removal of heavy metals from contaminated water, making them a viable, nature-based solution for addressing AMD pollution. However, the synthetic nature of the AMD used in this study, along with the small-scale experimental setup, may limit direct application to real-world scenarios. Further research is needed to explore the long-term sustainability, scalability, and adaptability of such systems in diverse environmental conditions.

Keywords: Acid Mine Drainage, Constructed Wetlands, Heavy Metal Removal, Hydraulic Retention Time, Phytoremediation

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Balancing Charging Demand and Emissions: A Grey Wolf Optimization Model for EV Charging Station Location

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Abstract

The transportation sector is one of the largest producers of greenhouse gases. It is therefore imperative that sustainability in the transportation sector must be carefully researched. In line with this, electric vehicles (EV) have come to the forefront as a sustainable option, being a zero-emission tank-to-wheel vehicle. Although two wheeled and three wheeled EV has penetrated significantly into the transportation system, the four wheeled EV finds limited takers due to problems such as range anxiety, charge anxiety and high upfront cost. Uptake of 4W-EV can gain impetus with adequate number of fast charging stations to overcome charge anxiety. There are many factors that influence the location of charging stations in an urban network. Few of these factors are driving distance to charging station, capacity of charging station, congestion and waiting time along with charging rates at charging stations. Fast chargers are usually deployed at charging stations to enable rapid charging to 80% of State of Charge (SoC). These chargers are high capacity chargers, usually above 30kW in rating.
This work aims to optimize electric vehicle charging station locations within an urban area, to mitigate the total driving distance from point of charging demand to nearest charging station. For analysis purpose, a base case scenario has been created in an urban area of 10km x 10 km. The location of charging stations has been randomly generated to meet the charging demand. The objective function of the optimization is to minimize the total emissions by correlating it to the reduction achieved in total driving distance. Constraints have been placed on location coordinates of the charging station, state of charge of battery when the charging demand arises and state of charge of EV battery when the charging is completed. The Grey Wolf Optimization (GWO) technique is a population-based metaheuristic optimization algorithm inspired by the social hierarchy within a pack of Grey Wolves, i.e. alpha (α), beta (β), delta (δ), and omega (ω), and their hunting behaviour. GWO mimics how grey wolves encircle and attack their prey. The simulations have been caried out in MATLAB environment. Cost to users, based on a mathematical model (containing variables of SoC, travel distance between point of charging demand to nearest charging station, etc.) and the optimal location obtained from GWO, will then be compared with the base case scenario to yield the best-case solution to meet the charging demand and mitigate total emission.

Keywords: Contact Angle, CTAB, Interfacial Tension, SDS

Collection and Evaluation of Different Germplasm of Pomegranate

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Abstract

A field study was carried out to collect and evaluate the different germplasm of pomegranate during different years (2019-20, 2020-21 and 2021-22). Seven cultivars of pomegranate collected from different institutions were evaluated (Ganesh, Mridula, Bhagwa, Jalore Seedless, Basein Seedless, Kandhari and Jodhpur Red). The results of the study revealed a significant increase in number of fruits/plant, yield (kg/plant), fruit skin colour, fruit girth (cm), TSS (^{0}Brix), acidity (%) and juice (%) of pomegranate. During 2019-20, maximum number of fruits/plant (112.0), fruit yield (27.7 kg/plant) and fruit girth (21.1 cm) were recorded in cv. Bhagwa and maximum TSS (14.1^{0}Brix), minimum acidity (1.13 %) and juice content (35.9 %) were recorded in Mridula. Whereas during 2020-21, maximum number of fruits/plant (125.7), fruit yield (30.0 kg/plant) and fruit girth (20.7 cm) were also recorded in cv. Bhagwa and maximum TSS (14.1^{0}Brix), minimum acidity (1.11%) and juice content (34.7 %) were recorded in Mridula. Similarly, during 2021-22, maximum number of fruits/plant (112.3), fruit yield (27.7 kg/plant) and fruit girth (20.3 cm) were recorded in cv. Bhagwa and maximum TSS (14.3^{0}Brix), minimum acidity (1.10%) and juice content (32.0 %) were recorded in Mridula. The challenges faced during the research work was extreme variations in day and night temperatures.

Keywords: Acidity, Pomegranate, Skin Colour, TSS, Yield

Impact of Silicate and Iron Oxide Mineral Weathering Sequence on the Fate and Transport of Emerging Contaminant (Nanoplastics) in the Environment

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Abstract

The novel emerging contaminants, i.e., nanoplastics (NPs), are omnipresent and currently a critical topic of discussion considering their ecological consequences. It is imperative to advance our knowledge of NPs environmental fate and how it is linked with existing abundant minerals and varying geochemical conditions. Rock and minerals undergo continuous weathering in aquatic and subsurface environments, releasing colloidal mineral particles. Their transformation of mineral particles over time defines mineral weathering sequence and may further impact the fate and transport of NPs. Keeping this in mind, we investigated the interaction of NPs with typical weathering sequences of silicate and iron oxide minerals under varying geochemical conditions (ionic strength, pH, humic acid, and natural aqueous matrix). Experimental data modeling using non-linear kinetic and isotherm models was performed to enhance the understanding of minerals-plastic interaction. Adsorption isotherm results revealed that silicate-weathered minerals (gibbsite) and primary iron oxide (magnetite) exhibit maximum sorption of NPs due to their smaller size, higher positive surface charge, and surface hydroxyl functionality. In contrast, the continuous adsorption-desorption and limited sorption capacity of feldspar, kaolinite, maghemite, and hematite can be attributed to their limited surface reactive functional groups, larger size, and physical sorption. The achievement of a point of zero charge in gibbsite-NPs and magnetite-NPs bimodal system suggests the coagulation and sedimentation of NPs in the presence of gibbsite and magnetite.

In a natural environment, surfaces of granular media are frequently coated with different minerals. Column transport experiments were performed to mimic the subsurface media and delineate the role of mineral-coated sand on the NPs transport behavior using breakthrough curves (BTCs) with varying pore water chemistry. Results revealed higher NPs retention in mineral-coated sand than in bare quartz sand. Also, maximum NPs retention (> 85%) in magnetite and gibbsite-coated quartz sand columns suggested a limited risk of NPs mobility in the subsurface media. Overall, this study provides insightful details on the role of typical weathering mineral sequence on the transport of NPs in aqueous and subsurface environments, highlighting the NPs fate in rivers and groundwater.

Keywords: Adsorption, Minerals, Nanoplastics, Transport, Weathering

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Synergetic Effect of Biosurfactant and Surfactant with Alkali for MEOR Application

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Abstract

The capillary number, primarily influenced by interfacial tension (IFT) and contact angle, is a critical factor affecting oil recovery. The use of saline water combined with biochemical agents such as rhamnolipid and alkali is emerging as an advanced technique in enhanced oil recovery (EOR). Nowadays, synergetic effect of biosurfactants and chemical surfactants (cationic and anionic) has become an extraordinary option for EOR. In this regard, the present work examines the collaborative impact of the rhamnolipid-salts system with chemical surfactant on IFT and wettability alternation (W.A). The stability of the rhamnolipid-salt system with chemical surfactant was evaluated by measuring the zeta potential of the system. The efficacy of chemical surfactants in a rhamnolipid-salt system to modify the wettability of oil-wet sandstone and limestone was assessed by measuring contact angle (CA) values.

The IFT of crude oil with rhamnolipid, rhamnolipid-salts system, and rhamnolipid+ salt+ CTAB was measured. The IFT between crude oil-rhamnolipid at critical micelle concentration (CMC), crude-oil rhamnolipid (60 ppm), and crude oil – rhamnolipid (60 ppm) + 5% (w/v) NaCl were found to be 5.80 mN/m, 6.73 mN/m and 1.81 mN/m, respectively. Furthermore, The IFT between crude oil and CTAB (CMC), SDS (CMC), and rhamnolipid (60 ppm) -CTAB (CMC), were found to be 0.135 mN/m, 1.641 mN/m, and 0.046 mN/m, respectively. Additionally, the introduction of 5% (w/v) NaCl to the rhamnolipid-CTAB system resulted in the maximum reduction of IFT observed at a concentration of rhamnolipid (100 ppm) combined with CTAB (200 ppm), yielding a value of 1.5×10-3 mN/m. These values indicate the effectiveness of the rhamnolipid-salts system in reducing IFT, which is a key factor in enhanced oil recovery. The primary mechanisms identified for enhancing oil recovery include the alteration of wettability towards a water-wet state, reducing IFT, and improved mobility ratio.

Keywords: Contact Angle, CTAB, Interfacial Tension, SDS

In-cabin Particulate Matter Exposure of Heavy Earth Moving Machinery operators in a Highly-Mechanized Opencast Coal Mine

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Abstract

The rising environmental concerns surrounding the discharge of synthetic surfactants and builders into Heavy earth-moving machinery (HEMM) operators are frequently exposed to various air pollutants, as a part of their occupational environment. Airborne particulate matter (PM) is the most prevalent air pollutant. This study investigates the PM exposure levels of HEMM operators in highly mechanized opencast coal mines in India, focusing on various HEMM types such as dumper, shovel, and drill. The in-cabin PM concentrations were evaluated for various activities associated with HEMM: the dumper during loading, unloading, and traveling; the shovel during crowding, digging, and loading; and the drill during marching and drilling. In this study, how the HEMM cabin type impacts in-cabin PM concentration level is also explored. The PM_{10} concentration inside the drill machine cabin was significantly higher than that of the dumper and shovel. The PM_1, $PM_{2.5}$, and PM_{10} concentrations inside the drill machine were 2300 µg m^{-3}, 510 µg m^{-3}, 305 µg m^{-3}. The operator's exposure to PM followed the trend: drill > shovel > dumper. The particle mass exposure was calculated for all the HEMM operators. The corresponding respiratory quotient (RQ) for all the HEMM operators was assessed and their associated health risk was determined. Currently, limited research exists on the particulate matter exposure to HEMM operators within the in-cabin environments, hence this study will help mine management and regulatory authorities to look for effective PM control strategies.

Keywords: HEMM, Particulate Matter, Respiratory Quotient, Operators, Opencast Coal Mine

Integrated Riverfront Revitalization and Urban Redevelopment in Howrah Municipal Corporation Area: Issues and Challenges

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Abstract

The Howrah Municipal Corporation (HMC) area, situated along the western banks of the river Hooghly, epitomizes the complex relationship between industrial encroachment, urbanization, and environmental decline. The underutilized land of the riverfront, combined with socio-economic disparities and environmental degradation from prolonged industrial activity, presents a multifarious challenge. This study, delves into the challenges and issues surrounding the riverfront revitalization and urban redevelopment within the area. Howrah riverfront being historically dominated by industries faces severe environmental degradation, including limited green space, pollution, diminishing biodiversity from decades of unchecked industrial activities. Social challenges further worsen these problems, as economically disadvantaged communities living near the riverfront face poor infrastructure and limited public amenities. Economically, the area suffers from stagnant land use, and dilapidated industrial structures, which limit growth and development opportunities.

Drawing from international and national case studies, this study assesses best practices in the revitalization of urban riverfront. The methodology integrates participatory approaches, environmental planning, and spatial design, customized to Howrah's unique socio-economic and industrial context.

Key focus areas include reducing pollution, improving and expanding public accessibility by developing pedestrian-friendly pathways, and promoting green, open spaces that reconnect the community to the riverfront. This research provides valuable insights into the sustainable redevelopment of industrialized riverfronts. Emphasizing the need for environmental planning frameworks that consider both ecological and social needs.

The study also examines the alignment of these strategies with the United Nations' Sustainable Development Goals, and the key Indian schemes, policies and acts such as Water (prevention and control of pollution) Act, Environment (Protection) Act, National Green Tribunal Act, Namami Gange program, National River Conservation Plan, Smart Cities mission, and AMRUT.

Keywords: Community Engagement, Ecological Restoration, Inclusive Planning, Riverfront Revitalization, Sustainable Urban Development

Expanding the Genetic Code: Site-Specific Incorporation of Triazolyl Unnatural Amino Acids into Super Folder GFP

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Abstract

The genetic code expansion (GCE) technique for incorporating unnatural amino acids (uAAs) allows the precise modifications to different kinds of proteins, adding novel functionalities for desired advanced applications. Recent reports suggest that different classes and types of unnatural amino acids have been incorporated using the GCE method. However, the incorporation of triazolyl amino acids with tuned properties has never been previously reported. Click chemistry derived-triazolyl amino acids are reported to possess several beneficial properties such as better stability against enzymatic degradation, higher biocompatibility, better tuneability and enhanced photophysical properties. Therefore, towards this end, we represent a simple methodology for the site-specific incorporation of fluorescent unnatural triazolyl amino acids (FTUAAs) into modified super folder green fluorescent protein (sfGFP), using the method pioneered by Peter G. Schultz. By the introduction of a UAG stop codon (amber stop codon) at the 150th codon position of the sfGFP gene, we are able to site-specifically incorporate an FTUAA into the reporter protein.

Our approach starts with designing the reporter gene (here sfGFP), towards inserting a UAG stop codon at an ectopic position. Then, an engineered orthogonal tRNA/aminoacyl-tRNA synthetase (aaRS) pair, validated by molecular docking studies, is utilized to site-specifically incorporate the FTUAA in the reporter protein. The pair is also checked for its orthogonality against standard amino acids. Furthermore, the expression of the modified sfGFP protein is optimized in an E. coli-based expression system, where the expression conditions are fine-tuned for balancing the protein yield and efficiency of the FTUAA incorporation.

The successful incorporation of the FTUAAs have been validated by fluorescent microscopic analysis and spectroscopic analyses. Our process of incorporating FTUAAs into desired protein sequences opens up a gateway of incorporating a new class of uAAs establishing a versatile platform for engineering proteins with newer functionalities.

Keywords: Amber stop codon, Fluorescent Triazolyl Unnatural Amino Acids (FTUAAs) Genetic Code Expansion (GCE), Orthogonal Aminoacyl tRNA Synthetase (o-aaRS), Super Folder Green Fluorescent Protein (sfGFP)

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Re-Refining of Waste Engine Oil: A Review

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Abstract

During year 2021, total consumption of petroleum product in our country was 194.30 MMT and 2.1% of the total accounts for the lubes and greases. HPCL at Mumbai have the largest lube refinery of the country with the capacity of 428 TMTPA. Out of this, almost 60% accounts for automotive and the rest of 40% for industrial lubricants. Used lubricant oil constitutes a major feedstock for the recycling spent oil sector (Used/Waste Oil). Lubricating oils are used in all core industrial sectors including defence, railways, marine and transport with the lube oil growth potential for 2015-2021 was >5%. Current demand of lube oils may be increased due to raise in number of vehicles on the road. Lubricants have important applications in internal combustion engine, vacuum pump, turbine, diesel engine, etc. These lube oils were known to reduce the friction, prevent corrosion, act as heat absorber, increase mileage etc. Among such lubricant, engine oil is one of the most used lubricant oils. After certain period of time these engine oils tends to lose its property and get contaminated with pollutants and chemicals changes. Thus, it needs to be changed at regular interval to protect the internal parts of the engine. The used oil or waste oil contains iron, copper, lead, zinc, sulphur, burned carbon residue, and ash produced during the lubrication process.

Huge amount of waste engine oils (WEO) were produced annually and generally disposed to both soil or water environment and creating severe environmental problems. One litre of waste engine oil has the capacity to contaminate 106 litres of water. It was reported that more than 30 billion litres of WEO have been accumulated in the environment, mostly produced by automobile and industrial engines. Engine oils were used to protect the engine parts from wear-tear, reduce friction, prevent corrosion and have cooling property. During operation, the engine oil gets contaminated with iron, copper, lead, zinc, sulphur, burned carbon residue, and ash produced during the lubrication process. Regeneration or re-refining of WEO may be one of the suitable processes for pollution control. Moreover, process may provide basic oil for the engine oils. In India, the capacity of recycling waste oil in 2010 was 1.339 MMT (257 refining units, of which 46 % were dedicated for WEO refining process. All units of the re-refining process used clay-treatment followed by vacuum distillation, and very limited reports were available on the technological upgrade due to the complication in the process. It is also reported that less than 50% of the WEO is being recycled. Using this oil in furnace resulted to toxic gas emission in the environment. The present study reviewed the available process of purification & refining of waste/used lubricating oil for its recovery of base lube oil. The recovering and refining of lubricating oil may leads to circular economy from the waste materials along with pollution abatement of pollution due these hard to degrade lube oil.

Keywords: Adsorption, Acid Treatment, Clay Treatment, Vacuum Distillation, Waste/Used Engine Oil

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Understanding Soil Nutrient Changes Following Insecticide Treatment: Insights from a 120-day Mesocosm Study

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Abstract

The use of agrochemicals such as pesticides and fertilizers has become imperative for the production of crops and the sustenance of the global population. With the growing popularity of these agrochemicals, their use has been increasing rapidly. In 2020, the total pesticide uses in agriculture totally accounted for 2.7 million tonnes of active ingredients. By 2027, the global agricultural consumption of pesticides is forecasted to increase at around 4.41 million metric tonnes. On the other hand, pesticides have undesirable properties such as resistance, bioaccumulation, non-target toxicity and specificity, which renders them harmful to the soil ecosystem and environment. As such, the impacts of the application of these pesticides on the soil and their interactions with the soil ecosystem need to be elucidated. This study aims at understanding the effects of pesticides on the nutrient quality and health of the soil. A mesocosm study was conducted in a greenhouse pot setup. Soil from a virgin plot was collected and artificially spiked with commercially available insecticide - Roket (a.i. Cypermethrin and Profenofos). Two different dosages of the insecticide were applied, one at standard dose and the other at double the recommended dose, to also see the effects of different dosages on the soil. The study was conducted for 120 days, and samples were analyzed every 15 days. Results revealed a more significant reduction or loss of nutrients such as Nitrogen, Potassium, and Phosphorus from the treatment with a double dose of the applied insecticide as compared to that of soil alone along with time. Other influencing parameters such as Soil Organic Matter, pH, Bulk Density, and Water holding capacity showed variable changes when compared to soil alone and the one treated with the spiked insecticide. The prominent decrease in nutrient content and other parameters can be seen prominently till the 60th day after which the decrease trend was almost stabilized. The percentage decrease in the nutrient content in pesticide-applied soil is a reason for concern in terms of supporting the health of the soil for future and further sustainable agriculture.

Keywords: Agriculture, Mesocosm, Nutrient Quality, Pesticides, Soil Health

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Sustainable Biosurfactant Production from *Bacillus subtilis* IS5 for Detergent Applications

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Abstract

The rising environmental concerns surrounding the discharge of synthetic surfactants and builders into water bodies highlight the urgent need for sustainable alternatives. The high levels of phosphate-based builders commonly found in commercial detergents contribute to eutrophication in aquatic systems, leading to harmful algal blooms. This study aims to produce biosurfactants (BS) that can replace synthetic surfactants and explore non-phosphate builders in replacement with phosphate. A bacterium isolated from marine water produced BS efficiently and was identified as *Bacillus subtilis* IS5. A one-factor-at-a-time (OFAT) approach was used to enhance the productivity of BS by optimizing pH, temperature, carbon source, and incubation time, which were found to be 8, 40 ºC, glycerol, and five days, respectively. The determining factors of the optimization study were growth measurement via dry cell weight (DCW), BS production via emulsification index (E_{24}), and oil displacement assays. Further, various characterization studies, including FTIR, HRMS, NMR, surface tension (ST), and contact angle measurement, were performed for the produced BS. The characterization analysis revealed the lipopeptide nature of the BS with a m/z value of 1035 g/mol (resembling Surfactin). At optimized conditions, the bacteria produced BS with a yield of 9.78 ± 0.34 g/L and reduced the ST of hard water from 72.15 ± 0.8 mN/m to 35.23 ± 0.73 mN/m. Moreover, the efficiency of produced BS in detergent applications was measured by testing various compositions that included BS, builders, and fillers in varying ratios. Interestingly, BS, when added in a 1:1 ratio with commercial detergent, could further reduce the ST of water to 27.12 ± 0.25 mN/m. Assays like gravimetric analysis, oil extraction, and calorimetric tests were performed to validate the efficiency of the designed detergent formulations. This research demonstrates the potential of BS derived from *B. subtilis* as a sustainable solution for detergent applications.

Keywords: Contact Angle, CTAB, Interfacial Tension, SDS

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Bioremediation of As(III) Using Biowaste-Derived Cellulosic Aerogel

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Abstract

In this study, cellulosic aerogel was prepared using cellulose extracted from waste biomass. Cellulosic aerogel are sustainable, biodegradable, and ultra-light porous materials characterized by three-dimensional networks with high specific surface area. Cellulose extracted from banana stem waste was used as the precursor materials to prepare biowaste-based cellulosic aerogel. Cellulose was extracted from banana stem using NaOH and Na_2O_2 treatment. Furthermore, the synthesis of cellulosic aerogels includes four primary steps: mixing in solvent, gelation, solvent exchange, and drying. In first step, NaOH/urea solution was used as the solvent for cellulose dissolution followed by sonication for proper mixing of cellulose solution and then solidified in deep freezer. Afterwards, the freezed cellulose solution was thawed at room temperature to obtain gel like substance. Subsequently, the gel was dipped in 99% ethanol and solvent exchange was allowed. Then the gel was washed with in distilled water to obtain hydrogel. Subsequently, hydrogel was dried using freeze-drying method using a lyophilizer and was hydrophobically modified using trimithyloxymethylsilane (MTMS) to obtain the cellulosic aerogel. Scanning electron microsopic (SEM) image shows that cellulosic aerogel are fibrous network structure composed of cellulose microfibers. It further illustrates the intricate, irregular, and interconnected porous structure within the cellulosic aerogel. Additionally, fourier transform infrared spectroscopy analysis of cellulosic aerogel sample showed presence of O–H stretching vibrations of phenols, alcohols and carboxylic acid, C–H stretching vibrations of methylene group, C–H, C–O, C=C, C-Si and C-O-Si bonds. Moreover, BET total surface area was found to be almost 6 m^2/g. Thermogravimetric analysis (TGA) of cellulosic aerogel showed that it was thermally stable and 50% weight loss was noted when heated upto temperature of 371 ^oC. Removal of almost 81%, 68% and 60% As(III) concentration was observed for adsorbent doses of 1, 3 and 5 g/L respectively for initial As(III) concentration of 250 µg/L and temperature was maintained at 30 ^oC.

Keywords: As(III), Banana stem, Cellulose, Cellulosic aerogel, Removal

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A Review on Phytoremediation of Contaminated Soils by using *Chromolaena Odorata*, an Invasive Terrestrial Weed

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Abstract

The increase in anthropogenic activities like mining, industries, use of fertilizers and pesticides etc. produces lots of toxins due to heavy metals and polycyclic aromatic hydrocarbons (PAHs) in the soil. It affects the overall environment and human health drastically. Phytoremediation, an eco-friendly green technology is one of the best methods to remediate the contaminated soils. This paper attempts to review the use of *Chromolaena odorata* (Siam weed), an invasive perennial weed which can grow in extreme environment for phytoremediation of heavy metals and PAHs. Higher biomass, high tolerance and high accumulation of heavy metals make the weed a good alternative for phytoremediation in contaminated sites. Bioaccumulation factor and translocation factor of the plant provides a significant role in analyzing the decontamination of soils. The weed survives normally up to a lead concentration of 100000 mg/kg^{-1} at a lead contaminated nutrient media. Bioaccumulation coefficient reaches more than 1000 to the weeds grown in the contaminated sites. Decontamination efficiency of the weed showed in the order Cd > Pb > Zn while showing a bioaccumulation factor of 4.5 high in Cd. Use of surfactants in the soil contaminated by PAHs and Cd enhanced the phytoaccumulation of cd and Phyto-simulation by the weed. However, Phytoremediation depends mainly on the degree of contamination and the presence of bioavailable forms of heavy metals. The tedious process of remediation, limiting bioavailable forms and complexity in the disposal of weed biomass are some of the hindrances to be considered while adopting the process.

Keywords: Bioaccumulation Factor, *Chromolaena Odorata*, Phytoremediation, Toxic Metals, Translocation Factor

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Nitrate Removal from Wastewater Using Copper

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Abstract

In wastewater treatment plants the major focus is given on the reduction of the COD levels. The discharge of wastewater without proper treatment for high levels of nitrate is a major reason for eutrophication of lakes. Many times, this released wastewater ends up contaminating the ground water is a major cause of death in children due to methemoglobinemia Some common methods for reduction of nitrate from waste water are biological reduction, electrochemical reduction, ion-exchange and adsorption.

Our study aimed for reduction of nitrate by combing the biological denitrifiers with the copper which act as the electron doner to speed up the process of denitrification. For this, a low-cost reactor was developed creating anoxic conditions. During the experiment, the effect of temperature on Solid Retention Time (SRT) and on the concentration of nitrate in effluent wastewater was determined. To carry out the denitrification anoxic conditions were developed in a container made of HDPE (High-Density polyethylene). The results demonstrated that with the increase in the temperature, the required Solid Retention Time (SRT) decreased. It was also seen that with the increasing temperature, effluent nitrate concentration decreased which could be related to an increase in the reaction kinetics of denitrifiers. Throughout the study environmental factors were based on Indian conditions and at a temperature of 20℃ an optimum retention period of 2 days was achieved. The experiment concluded a reduction in nitrate from an initial value of 160 mg/l to 5.5 mg/l. It was also observed that the COD reduced from 450.4 mg/l to 10.7 mg/l.

Keywords: Denitrification, Nitrate Removal, Solid Retention Time, Temperature, Wastewater Treatment

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Structural Insights into ASL-1/ATF-1 in Fungal Pathogenicity

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Abstract

The basic leucine zipper (bZIP) transcription factor Sko1, also known as ATF/CREB, plays essential roles in stress responses in both yeast and mammals. Due to its significant functions, it has become a valuable target in antifungal drug development. In *Neurospora crassa*, the homolog ASL-1 has been renamed Activating Transcription Factor-1 (ATF-1) because of its functional similarity to mammalian transcription factors. ATF-1 regulates responses to osmotic and oxidative stress, positioning it as a candidate for antifungal targeting. This study focuses on the structural prediction and validation of ASL-1 using computational modeling. A preliminary 3D model was generated through homology modeling and assessed for stability with molecular dynamics simulations, offering insights into its conformational characteristics and potential regulatory motifs. These findings establish a structural framework for ASL-1, allowing detailed interaction studies to advance antifungal therapeutic strategies.

Keywords: Activating Transcription Factor-1 (ATF-1), Antifungal Drug, *Neurospora Crassa*, Stress Response

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Metal-responsive Fluorophore and Amikacin Conjugated Heparin for Bacterial Cell Imaging and Antibacterial Applications

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Abstract

The escalating prevalence of bacterial infections presents a formidable challenge to the current global healthcare systems. Rapid identification and quantification of bacterial pathogens with anticipated sensitivity and selectivity are crucial for targeted therapeutic interventions to mitigate disease burden, drug resistance and further transmission. Concurrently, there is a pressing need to innovate novel approaches to combat infections and counter antibiotic resistance. Herein, we demonstrated the development of heparin (HP) conjugates modified with a Zn^{2+}-induced 'Turn-on' fluorophore, 2-(pyridin-2-yl)-1H-benzo[d]imidazole (PBI) that interacts with bacterial cells via specific binding with the surface-exposed heparin-binding proteins (HPBs), thereby inducing fluorescence signals for rapid and selective sensing of whole bacterial cells. Additionally, amikacin (Amk) antibiotic was integrated into the modified heparin polymer (HP-PBI-Amk) to augment its antibacterial efficacy via reactive oxygen species (ROS) generation. Despite the nephrotoxicity of only amikacin, its inclusion in the biopolymer retains its antibacterial properties while providing biocompatibility. The outcome of this study demonstrates the development of HP-PBI and HP-PBI-Amk as promising strategies for bacterial detection and eradication, respectively, offering potential avenues for future research and clinical applications.

Keywords: Antibacterial Activity, Antibacterial Resistance, Antibiofilm Activity, Heparin Conjugates, Selective Bacterial Cell Imaging, Zn(II) Ion-Sensitive 'Turn-On' Fluorescence

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Development of Light Weight Porous Alumina-Ceramic Foam Structure for Effective De-Fluoridation of Industrial Wastewater Treatment

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Abstract

Industrial wastewater contains large amounts of particulate matter along with heavy metals like fluoride, phosphorous, lead, mercury, cadmium, chromium, arsenic, selenium, etc., depending on the type of industry. Several methods, such as biological, membrane, and filtration processes, have been used for wastewater treatment. The filtration process has often suffered from clogging because of particulate aggregations with the coagulant in the wastewater. Foaming material has been an alternative filtration process to avoid clogging of the filter media. Foam is a highly porous and permeable structure. It exists in a range of densities and pore sizes. This makes it useful for high filtration processes. The foaming agent method of preparation yields two types of foam: alumina foam (AF), which is foam made directly from alumina without activation, and activated alumina foam (AAF), which is foam made after sulphuric acid activation of fresh alumina. H2SO4 acid is well known for its strongest oxidizing property, which increases the adsorption capacity of an adsorbent. Hydrogen peroxide is used as foaming agent and poly vinyl alcohol as binding agent were used. Alumina, alumina foam and activated alumina foam are characterized by EDS analysis, FESEM, XRD analysis. The effect of AF and AAF structure on fluoride ion removal has been studied; removal efficiencies for activated alumina foam are 86% and for alumina foam are 62.3%. The concentration fluoride ions removed by the foam were analyzed by the ion-selective electrode (Orion 720A+, Thermo Electron Corporation, Beverly, USA) after a specific time interval.

Keywords: Alumina Foam, Porus Material, Waste Water Treatment

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Brick Kilns and Air Quality: Cutting-Edge Technologies, Pollution Battles, and Environmental Impact

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Abstract

Brick kilns are a significant source of air pollution in many Indian cities, particularly those still relying on outdated technologies like the Fixed Chimney Bull Trench Kiln (FCBTK). These traditional kilns release large quantities of pollutants, including soot and fine particulate matter, which heavily impact local air quality. This study explores the environmental impact of brick kilns located near Guwahati and Nagaon, examining their role in the region's air pollution challenges. Through a detailed comparison, we analyzed the emissions and economic feasibility of FCBTK kilns against newer, more efficient Zigzag kiln technology. This assessment considers emission concentration, pollutant dispersion characteristics, and cost-effectiveness. Our research focused on 20 brick kilns around Guwahati and Nagaon, which collectively produce 55.5 million bricks per season, consuming 2,794 tonnes of coal and 765 tonnes of wood as fuel. Our findings indicate that these kilns produce significant pollution, releasing 65.3 tonnes of PM_{10}, 43.53 tonnes of $PM_{2.5}$, 12.51 tonnes of NO_x, and 25,697 tonnes of CO_2. The results demonstrate the potential of Zigzag kilns to reduce emissions, offering an environmentally viable alternative to conventional kiln technology. This study provides a valuable resource for policymakers, highlighting Zigzag kilns as a path to reducing pollution and advancing sustainable development initiatives in northeast India.

Keywords: Air Pollution, AERMOD, Brick Kiln, Emission, Environmental Impact, Sustainable Technology

Theme: RSEM

Remote Sensing and Environmental Monitoring

Oral Presentations

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Polycyclic Aromatic Hydrocarbons (PAHs) in Urban Road Dust of Guwahati, Assam: Distribution, Sources, and Human Health Risk Assessment

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Abstract

Urban road dust serves as a vector for polycyclic aromatic hydrocarbons (PAHs), a significant source of pollution for several environmental groups, and a means of PAH exposure for urban populations. We assessed the prevalence, compositional patterns, and origins of several PAHs in fifteen urban road dust samples and five land use zones (<75µm) from Guwahati, Assam. The mean concentrations were greatest in Highways and lowest in Residential areas, indicating the effects of commercialization and industrialization in the study region. Fluoranthene, Pyrene, Benzo[a]anthracene, and Benzo[b]fluoranthene were the predominant individual polycyclic aromatic hydrocarbons (PAHs). The composition of PAHs was mostly characterized by 4-5-ring PAHs, which accounted for about 71% of the total PAHs. The incremental lifetime cancer risk (ILCR) associated with exposure to urban road dust-bound PAHs ranged from 10^{-4} to 10^{-6}, indicating a significant cancer risk for people of Guwahati. Principal Component Analysis (PCA)was used for the source apportionment study, which identified vehicular abrasion, industrial operations, tailpipe emissions, and coal combustion as the primary sources of PAHs in Guwahati.

Keywords: Carcinogenic Risk, Guwahati, PCA, Polycyclic Aromatic Hydrocarbons, Ring Profile

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Evaluating Land Use and Land Cover Data in WRF Simulation over NCR, India

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Abstract

Recently, researchers have successfully used the Weather Research and Forecasting (WRF) model to achieve reliable simulation results due to improvements in various parameters such as static geographical data; and incorporation of urban and climate-related parameters. Accurate land use and land cover (LULC) representation, incorporated into static geographic data, plays a vital role as it encompasses the physical properties of the area, which influences the meteorological parameters such as temperature, wind speed etc. Thus, as the preliminary step, WRF simulations would be influenced by the different LULC data. In this study, 4 LULC maps obtained from USGS, MODIS, ISRO and Google Earth Engine (GEE) based LULC data are used to represent the area of NCR, India. The results obtained were statistically compared for 2m air-temperature (T2) and IMDAA reanalysis data for 10m wind speed components (U10 and V10) over the areas of Anand Vihar, Nehru Nagar, Najafgarh and Sector-125, Noida. It was observed that the GEE-based LULC data performed better in T2 simulation compared to other LULC data with lower RMSE values, for all the locations whereas MODIS LULC has performed relatively better in U10 and V10 simulations.

Keywords: Land Use Land Cover, MODIS, Satellite Data, WRF Model

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Impact of Dust Storms on Particulate Matter (PM_{10} &$PM_{2.5}$) over Indo Gangetic Plain India

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Abstract

Air quality is a significant global concern, posing serious risks to both human health and the environment. The impact of dust storms on the coarse and fine particulate matter is studied over during April 2024-June 2024. This paper studied the impact of dust storms on air quality and aerosol properties (Aerosol Optical Depth, AOD) for Indo Gangetic Plain (Delhi, Haryana and Uttar Pradesh) using data from ground stations, remote sensing-based satellite observations. Three major sites were selected—DTU CPCB, NSIT Dwarka, and ITO CPCB (Delhi); Sirsa, Narnaul, and Kurukshetra (CPCB Haryana); and Agra, Jhansi, and Lucknow (CPCB Uttar Pradesh)—as representative for each state. Satellite observations (AOD at 550µm, etc.), climate model reanalysis products (dust column mass density DCMD $PM_{2.5}$) from the NASA Giovanni web portal were epmloyed. The IGP experienced a sequence of dust storms, which occurred on 10-11 and 15–16 May 2024 and 06-07 June 2024. Hourly concentrations of PM_{10} and $PM_{2.5}$ for the study area, downloaded from the data portal of CPCB, lied in the range 100-900 µg/m^3 and 30-600 µg/m^3 respectively for all sites. The highest value of PM_{10} and $PM_{2.5}$ concentration were observed during storm events for almost all sites (10,11 May 2024 and 6, 7 June 2024). It has been observed that the daily average AOD was significantly higher than 1 during the dust storm event which revealed the high abundance of PM_{10} and $PM_{2.5}$ in the ambient atmosphere. The dust density in the fine ($PM_{2.5}$) component was found to be significantly elevated i.e., a high aerosol column burden was present over the region during the dust storm event. The 72-hour backward trajectories generated using the NOAA HYSPLIT model revealed that dust-laden air masses originating from the originated from Pakistan and travelled through Punjab and Haryana. Long-range transport of air masses from Afghanistan, Iran (western) and Bangladesh (eastern) region resulted in a widespread dust storm affecting Haryana, Delhi, and Uttar Pradesh. The surface concentrations of fine particulate matter ($PM_{2.5}$) were computed using MERRA-2 and found in the range of 5-30 µg/m^3 for all sites which is much less than the ground hourly $PM_{2.5}$ concentration (30-600 µg/m^3). This finding needs further investigation for surface $PM_{2.5}$ concentration as MERRA-2 underestimates compared to ground-based measurements. High levels of particulate matter and AOD during dust storms indicated that meteorology and dust also play important role in pollution levels over IGP in addition to the anthropogenic activities.

Keywords: Aerosol Optical Depth, Dust Column Mass Density, Dust storm, $PM_{2.5}$, PM_{10}

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Assessing the Spatio-Temporal Changes in Kabartal Wetland (Ramsar Site) using Field and Geospatial Analysis

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Abstract

This study examined the temporal changes in land use land cover (LULC) and water quality within the Kabartal wetland from 1989 to 2023. Landsat data was utilised to analyse the wetland zone of 26.02 km². A time series analysis was conducted for the wetland, and relative changes over time were observed. Geospatial techniques, such as the Normalised Difference Vegetation Index (NDVI), Modified Normalised Difference Water Index (MNDWI), and LULC classification, were employed to assess changes in vegetation and water bodies. High annual precipitation recorded in 1989 and 2000 corresponded with increased MNDWI values in the Core wetland area. Additionally, a physicochemical analysis of soil and water was conducted. Key findings include a decline in vegetation and water areas in the wetland zone, driven primarily by agricultural expansion and urbanisation. Soil analysis revealed elevated levels of Ca, Mg, K, Fe, and Cu. While water quality parameters were within permissible limits, strong correlations between nitrate, phosphate, and electrical conductivity suggest agricultural runoff as a significant pollutant source. The wetland shows a decline in vegetation, water quality, and quantity. This research highlights the urgent need for conservation strategies to address the identified driving forces and mitigate the ongoing degradation of the wetland ecosystem.

Keywords: LULC, NDVI, MNDWI, Buffer Zone, Electrical Conductivity

Defining the Invisible: Why Quality Assurance Matters in Microplastic Research

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Abstract

Microplastic pollution has become a major environmental concern, affecting ecosystems, human health, and water quality on a global scale. However, accurately identifying and quantifying microplastics in environmental systems presents significant challenges due to their small size, varied polymer compositions, and susceptibility to external contamination. These challenges underscore the need for stringent quality assurance (QA) and quality control (QC) measures to ensure reliable and reproducible results in microplastic analysis. This study examines the critical role of QA/QC in minimizing errors during sampling, processing, and detection of microplastics. The lack of standardized methods often leads to inconsistencies between studies, emphasizing the need for harmonized protocols in microplastic research.

Our study found notable inconsistencies in particle abundance, shape, size, color, and chemical composition across seemingly identical samples. Samples analyzed using our QA/QC protocols showed fewer contaminant particles compared to those without. Each sample contained between 2 to 10 particles, with cellulose consistently present in all samples. While particle shapes varied, most samples contained both fibers and fragments, and even particles of the same polymer exhibited size variability. Some contaminants, such as polypropylene fragments from bottle lids and fibers from lab coats, could be traced back to laboratory sources, though for many particles, the origin remained unknown.

These results highlight the persistent issue of contamination in microplastic analysis and emphasize the importance of rigorous QA/QC protocols. Without robust QA measures, microplastic research data can become unreliable, undermining efforts to assess environmental risks. Therefore, establishing standardized QA/QC guidelines is essential for advancing microplastic research, improving study comparability, and informing policies to reduce microplastic pollution.

Keywords: Fibers, Microplastics, Polypropylene, Quality Assurance and Control

Phyto-Analytic Development of V_2O_5 Nanostructures for Ultra-Selective Electrochemical Detection of Phenylbutazone

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Abstract

The pollutants of emerging nature are a significant concern to the environmental scientist due to their largely unknown long-term health and environmental effects. A huge amount of synthetic pharmaceuticals are applied to boost medical outcomes and address global health challenges. The remnant pollutant residues pose a rising hazard to ecosystems and human health. The abundance of pharmaceuticals in the environment increases gradually over the period due to increased production, improper disposal practices, accidental releases, and various biotic and abiotic factors. Regulatory authorities are actively working to implement stricter laws and regulations to curb pollution arising from the discharge of contaminants of emerging nature. However, the very first step towards the preventive measure to control environmental pollution is the development of a highly efficient and low-cost device for pharmaceutical determination at their source, irrespective of the geographical location. Therefore, the development of a highly efficient in-situ system for the sensing and quantification of environmental contaminants is highly warranted to control environmental pollution globally.

Electrochemical sensors have shown great promise for in-situ sensing and quantification of targeted analytes such as pharmaceuticals, heavy metals, pesticides and their intermediates, etc. They are merited with low cost, high sensitivity, selectivity, and low detection limit towards the target analytes. Moreover, modifying the working electrode surface with nanostructured-based catalysts such as V_2O_5, ZnO, $BiVO_4$, Bi_2S_3, ZnO, AgNPs, etc., using a binding agent (Nafion, epoxy resins, and polyethylene glycol) could further improve the performance of electrochemical sensors in a great extent by enhancing effective surface area, catalyst active sites, and unimpeded charge transfer characteristics. The binding agent provides structural support to the nanostructures on the surface of the functioning electrode and prevents the rapid catalyst delamination from the support electrode, boosting the sensor's performance in terms of stability, selectivity, and reproducibility. Furthermore, the binding agent simplifies the processing and fabrication of functioning electrodes, promoting a uniform distribution of active nanostructures, leading to the more reliable and reproducible detection of pharmaceuticals. However, conventionally, nanomaterials synthesis is carried out in chemical-intensive processes and employs many environmentally hazardous chemicals and reagents.

Herein, we report the synthesis of V_2O_5 nanostructures in a phyto-analytic route by employing the phytochemicals present in plant and their organs. The phytochemicals present in the plant extract will be exploited to form stable nanostructures. Subsequently, V_2O_5 nanostructures immobilized on the surface of the functioning electrode using the binding agent for electrocatalytic sensing of phenylbutazone.

Keywords: Electrochemical Sensing, Phyto-Analytic Development, Square Wave Voltammetry, V_2O_5 Nanostructures

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LULC Change Analysis of Umiam Catchment in Meghalaya using High-Resolution Satellite Imagery

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Abstract

Umiam Reservoir, located in Ri-Bhoi district, is one of three critical wetlands in Meghalaya and the only wetland identified by the Indian government under the National Wetlands Conservation Programme for the state. Its catchment area spans approximately 221.52 sq. km and is 15 km north of Shillong. Being 65 years old, it is the first hydroelectric project in the North-Eastern region, it provides ecological, domestic, aquaculture, and cultural services, that are now threatened by anthropogenic activities from its catchment area. With the aid of Remote Sensing (R.S.) and Geographical Information System (G.I.S.), this study uses high-resolution multispectral data from the IRS ResourceSat-2 satellite's LISS-IV sensor, to monitor changes in the land use land cover (LULC) pattern in the Umiam catchment for a study period ranging from the pre-monsoon of 2013-2018. This study has classified the catchment into six LULC classes namely – Agricultural land, Built-up, Forest, Grassland, Wastelands, and Waterbodies at Level 1; and eleven and fifteen sub-classes at Level 2 and Level 3 respectively as classified by the ISRO's NRSC classification system for the Land Use/Land Cover Classification for 2nd cycle of NRC LULC mapping for a scale of 1:50000. Visual interpretation method for LULC changes aim to compare the satellite imagery of the study period for identifying the changing pattern within the LULC classes as an aid for vestigating the zone of influence for degradation in the catchment area.

Keywords: IRS ResourceSat-2, LISS-IV, LULC Change Analysis, NRSC Classification, Umiam Catchment

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Spatiotemporal Variability of Key Parameters in A River System with Non-Point Industrial Pollution Sources

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Abstract

Adequate spatiotemporal water quality monitoring in rivers is crucial, especially in a region where high fluctuations in water quality are observed due to climatic and topographical features. Discharges from industrial areas often contribute to river pollution, especially during monsoon seasons, as they drain runoff and increase the pollution load. The present study is conducted on the Digaru River in Assam, also known as Umtrew in Meghalaya. This river is a tributary of the Brahmaputra, originating in Meghalaya, and the geographical coordinates of the river basin range from 25°35′15″ to 26°14′18″ N. The Digaru River supports a diverse array of aquatic species and serves as an essential livelihood resource for the communities living along its banks. However, the river faces contamination from both point and non-point sources of pollution, including industrial effluents and municipal sewage discharges from the urbanized Byrnihat industrial clusters (BIC), which is located upstream along the river banks (PCBA, 2020). A brief report of the key spatiotemporal physicochemical water quality parameters is highlighted from selected sampling sites where monitoring was conducted for one year. Sharp seasonal variation, mostly high in monsoon months, is observed on critical parameters, including turbidity, whose maximum value observed is 512 NTU with a mean of 76.97±104.87, COD, and BOD, while other parameters, such as DO, have concentrations within the BIS permissible limit, except in some cases. Compared to other seasons, higher values of EC and TDS are observed in the pre-monsoon months. Along the river stretch, a gradually slight increment of TDS is observed, signifying that not much removal or remediation of contaminants has taken place during the flow, indicating the river's poor self-replenishing capability. An increase in COD concentration is observed from the initial point of the BIC in all months, and a sharp spike in concentration is observed in monsoon samples, suggesting significant contributions from surface runoffs within the BIC regions. This study provides an overview of the spatiotemporal variations of the water quality of the Digaru River and its pollution loads from different non-point sources. It also provides a database for the concerned authorities to take up appropriate rejuvenation or conservation strategies in future.

Keywords: Industrial Pollution, Physicochemical, River Monitoring, Spatiotemporal, Water Quality

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Capturing Channel Bar Dynamics in the Mid Brahmaputra Using Long Term Sequential Data

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Abstract

River bars are large sediment deposits reflecting architecture of river planform, flow dynamics and sediment flux of a river channel. Inter alia, stable river bars are viable land resources supporting human population and economy; with the provision of settlement ground and livelihood, and also creating diverse habitats for plants and animals. In this study, 33 consecutive satellite imageries spanning from 1987 to 2019 were used to understand the dynamism of a transitory environment, and to overcome the information lacunae on bar dynamism as a result of extant intermittent data. In a dynamic environment where aggradation and erosion are a regular phenomenon, an uninterrupted and continuous dataset is essential for data quality that decreases the risk of inaccurate results and enhances its resemblance to reality. A quantified account of change in rate and magnitude of erosion and accretion based on long-term data is desirable for accurate reconstruction of land loss or gain for the bar landscapes. The mean gleaned from long-term sequential data can be an efficient and realistic reference for the assessment of river bar dynamism. For a transitory environment that in inhabited by a population and relies on for economy and livelihood, changes and dynamism of the landscape is crucial in terms of resource availability, livelihood strategies, and community resilience.

The area under study is situated in the mid Brahmaputra River (BR) channel bounded by 26º40′48″N to 26˚48′8″N latitude and 93˚36′E to 93˚55′12″E longitude. Eight river bars in mid BR were selected which are merited by its inherently transitory environment. Analysis of annual gain and loss in land area in select bars of the mid-Brahmaputra River channel migration zone from 1987-2019 shows both accretion and erosion occurring as a natural phenomenon. This chorology is in conformity with braided rivers like the BR and the location of the bars within the channels of the river. Thus, for the select river bars the mean rates of accretion and erosion are estimated as 505.93 ha/year and 489.92 ha/year respectively. Though no significant trend is prominent, the positive mean/year (+16.01 ha) indicates accretion dominance in the select bars pertaining to an increase in area.

Capturing erosion and deposition though is a straightforward research scope, but is invaluable considering the lacunae and significance of river bars. Besides being a reference for future studies, the quantification derived from long-term sequential data is a potential and dynamic resource for river managers, geomorphologists, hydrologists and other stakeholders.

Keywords: Brahmaputra River, Erosion-Deposition, River Bars, Riverine Environment

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Groundwater Quality Mapping of Parts of UBVZ of Assam

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Abstract

Assessing groundwater quality is critical to ensure its safety and sustainable use, especially amid challenges posed by the spatial variability of contaminants and the range of indicators particularly the important micronutrients that need to be evaluated. This study presents groundwater quality assessment for parts of UBVZ, Assam, utilizing Geographic Information Systems (GIS) to create a clear and actionable map of such water quality parameters that aids in informed policy decisions. The GIS-based approach synthesizes diverse data sources, providing policymakers with a holistic view of regional groundwater quality. The study's methodology included geo-referencing the entire study area, establishing a systematic grid for representative sample collection, and employing GPS-based sampling to ensure spatial accuracy. Key water quality parameters examined were pH, iron (Fe), copper (Cu), zinc (Zn), and manganese (Mn). The pH analysis indicated levels mostly within the permissible range (6.42 to 6.92), though a subset showed mild alkalinity. More concerning were the Fe and Mn concentrations, which significantly exceeded Bureau of Indian Standards (BIS) limits, reaching 10.70 to 158.49 mg/L for Fe and 3.89 to 37.7 mg/L for Mn, thereby raising substantial health concerns. Copper levels in groundwater varied from 0.28 to 10.47 mg/L, with the majority of the area falling within the safer range of 0.28 to 2.7 mg/L. Zinc concentrations spanned from 0.27 to 0.94 mg/L, predominantly in the range of 0.60 to 0.65 mg/L. Spatial analysis of these parameters uncovered distinct zones of water quality concerns, allowing for targeted mapping of contamination hotspots across the study area. The resulting groundwater quality map offers critical insights into the region's water quality issues, emphasizing the necessity for prioritized interventions to safeguard groundwater resources and public health. This GIS-driven study underscores the importance of spatially informed management approaches, advocating for periodic monitoring and mitigation strategies to maintain safe groundwater quality in the parts of UBVZ of Assam.

Keywords: Groundwater, GIS, Mapping, Iron, Zinc, UBVZ

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Assessing the Urban Spatial Pattern and Urban Heat Island Effects to Anticipate Potential Risks in Noida City

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Abstract

Urban heat island is a critical ecological issue that has intensified due to rapid urbanization and human activities in the National Capital Region of India, including Noida. The urban heat island effect, characterized by higher temperatures in built-up areas compared to surrounding rural areas, significantly impacts the quality of life and sustainability of urban environments. In Noida, the urban heat island effect is particularly pronounced due to rapid development and the proliferation of built-up areas. Mapping and modeling of urban heat islands in Noida using satellite data explores the use of geospatial technologies in assessing heat islands and thermal comfort. The surface urban heat island intensity in Noida exhibits distinct diurnal and seasonal patterns, with high intensity during the day and night, and between summer and winter. This can be attributed to factors such as the density and materials of the built environment, vegetation cover, and human activities. The urban heat island in Noida is exacerbated by dense commercial and residential areas, where the built infrastructure acts as a heat trap, leading to heat stress and deterioration of residents' quality of life. The findings underscore the urgent need for climate-sensitive urban planning and design interventions to mitigate the adverse effects of urban heat islands in Noida and other rapidly urbanizing regions of the National Capital Region. Key risks associated with the urban heat island effect in Noida include increased energy consumption, elevated air pollution, water pollution, heat-related illnesses, and biodiversity loss. A comprehensive approach is required to address these challenges, which should involve enhancing urban greenery through the integration of increased vegetation, trees, and green spaces, promoting sustainable building practices that incorporate reflective and insulating materials, expanding the deployment of cool roofs and pavements, and implementing advanced monitoring and modeling techniques to inform urban planning and design decisions.

Keywords: Biodiversity Loss, Built Environment, Climate Change, Energy Consumption, Water and Air Pollution

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Spatial Distribution of Drinking Water Quality Parameters in Barak Valley Region, North-east India

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Abstract

This study focuses on the development of a spatial map of drinking water quality using secondary data obtained from the India-Water Resources Information System (I-WRIS), which was created by the Ministry of Jal Shakti (MoJS), to be a repository of nation-wide water resources data as a part of the National Hydrology Project. The objective is to evaluate the status of drinking water quality in the Barak Valley region, considering critical parameters such as pH, total hardness, electrical conductivity, total dissolved solids, magnesium, calcium, and sulphate. The study progressed by extracting and compiling groundwater quality data from the India-Water Resources Information System (I-WRIS) database of 22 stations across the valley, which collect samples from sources of various types, such as tube-wells, borewells, and handpumps, from agencies including the Central Ground Water Body (CGWB), the Central Pollution Control Board (CPCB), and state agencies. Geographic Information System (GIS) tools were utilized to visualize the data spatially, incorporating interpolation techniques allowing for identification of regions that meet or exceed safety standards established by the Bureau of Indian Standards (BIS) for drinking water, available in the database of I-WRIS. pH and sulphate (SO_4) are observed to be in limit with mean of 7.5 and 32 mg/l whereas total hardness, total dissolved solids, Magnesium (Mg) and Calcium (Ca) exceeded the limit with mean 184.5 mg/l, 307.9 mg/l, 24.5 mg/l, and 60.3 mg/l respectively.

Spatial maps of water type, which were determined using the weighted arithmetic index-based WQI model whose concept was first introduced by Horton in 1965, later modified and established by Brown et al. (1970), and all individual parameters, are prepared for 22 stations that have been considered for the study, among which 32% are in the poor category, 23% are in the very poor category, 41% are in the good category.

Keywords: Groundwater, Geographic Information System (GIS), Spatial Map, Water Quality Index (WQI)

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Estimating Rice Biophysical Parameters and Soil Moisture from Agricultural Fields by using Optical and SAR data in Conjunction with In-situ Data

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Abstract

The present study is focused on estimating the Rabi Rice Crop Biophysical Parameters, Above-Ground Biomass (AGB), Plant Height and Soil Moisture during its growth stages by combining Optical, SAR and In-situ data. The crop biophysical parameters are widely used for determining crop growth and yield prediction and is used as input in many crop growth models. The Surface soil moisture acts as a key soil health parameter for accessing water availability for crop growth and aids in regulating the agricultural productivity. Thus, the potential of the radar parameter and vegetation indices were investigated for estimating the key agronomic parameters Above Ground Biomass, Plant Height and Soil Moisture. The In-situ study was conducted in the mid Brahmaputra valley at Kurukani Village of Sonitpur District for three Months-January, March and May. In-situ biomass and soil samples were collected from field using random sampling from 30 different plot placing 0.5 m X 0.5 m quadrant and brought to laboratory for estimating fresh and dry weight of the biomass along with the plant height and soil moisture estimation.

The sentinel 1 GRD and sentinel 2 L2A data were obtained in concurrent to the field sampling data and were processed using SNAP for obtaining three radar parameters namely vertically transmit and vertically received backscattering (σ0VV), vertically transmitted and horizontally received backscattering (σ0VH), (σ0VHVV) obtained by addition of VV and VH backscattering and two optical vegetation indices- Normalized Difference Vegetation Index (NDVI) and Soil Adjusted Vegetation Index (SAVI). To this end, machine learning algorithm Random Forest was performed to estimate the AGB, Plant Height and Soil Moisture from the sentinel1, sentinel2 data. From the feature importance it was inferred that sentinel1 VH parameter has higher efficiency for predicting AGB with MAE: 0.001, RMSE: 0.0010, R^2: 0.65 and Plant Height with MAE: 12.44, RMSE: 12.57, R^2: 0.6542605255658498 along with NDVI with MAE: 6.07, RMSE: 8.73, R^2: 0.83 for Plant Height, VV with MAE: 5.13, RMSE: 6.75, R^2: 0.87 has higher efficiency for predicting Soil Moisture. An integration of sentinel1 (VH, VV, VHVV) and sentinel 2 (NDVI, SAVI) parameters was done to improve the efficiency for predicting AGB, Plant Height, Soil Moisture. VHVV_SAVI improved the perdition of AGB, Plant Height and Soil Moisture with MAE: 0.0005, RMSE: 0.0007, R^2: 0.83, MAE: 6.07, RMSE: 8.73, R^2: 0.83, MAE: 8.52, RMSE: 9.43, R^2: 0.76 respectively. Thus this study infers that random forest can be used for prediction of AGB, Plant Height and Soil Moisture estimation with limited dataset. VH, NDVI was more efficient in estimating crop biophysical parameter while VV was more efficient in predicting Soil Moisture.

Keywords: Above Ground Biomass, Radar Indices, Rice Crop, Soil Moisture, Vegetation Indices

Theme: RACC

Resilience and Adaptation to Climate Change

Oral Presentations

Moringa Oleifera: A Superfood with Nutritional and Antioxidant Potential for Functional Foods

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Abstract

Moringa oleifera, also known as the drumstick or horseradish tree, is a perennial deciduous tropical & subtropical, fast-growing, drought-resistant tree native to northern India. It has gained recognition as a climate-smart plant with significant potential for enhancing nutritional security. The various parts of the tree (leaves, flowers, seeds, and roots), have been used in traditional medicine for generations. M. oleifera is a rich source of phenolics, but its content and profile may vary according to environmental conditions, harvest season, and plant tissue. This study explores the multifaceted attributes of M. oleifera, focusing on its nutritional composition, bioactive compounds, and adaptability to diverse climatic conditions. The moringa leaves and seeds were collected from different locations of India. The analysis revealed that that M. oleifera samples were rich in protein content, ranging from 8.43-33.81%, and low in fat, from (3.2-10.8%) and sugar (3.46-8.56 mg/g DW). The vitamin C content of fresh M. oleifera leaves ranged from 170.96–269.68 mg/100 g, calcium ranged from 250.7-311.79 ppm, phosphorous ranged from 0.152–0.304 g/100 g, and potassium ranged from 131.8-276.92 ppm and sodium ranged from 40.79-79.84 ppm. In vitro antioxidant activity of extracts were evaluated using DPPH, ABTS and FRAP methods which showed high antioxidant capacity which is directly related to the increased content of phenolic compounds. The phenolics identified (UPLC) were around fifteen corresponding to chlorogenic acid, gallic acid, catechol, vanillin, taxifolin, trans-p coumaric acid, trans-sinapicacid, rutinhydrate, trans-cinnamic acid, quercetin dehydrate, apigenin, kaempferol, Naringenin, ellagic acid, syringic acid. The findings suggest that Moringa oleifera has the potential to be used as a functional ingredient for human food which can offer health benefits such as improved antioxidant status, reduced inflammation, and enhanced nutritional intake. Incorporating moringa into dietary interventions could address micronutrient deficiencies and promote overall health, particularly in regions where nutritional challenges are prevalent.

Keywords: Antioxidant, Functional Food, Moringa, Nutrition, Phenolics

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A Preliminary Work on the Population Study of Earthworms in different land-use of Thoubal district, Manipur

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Abstract

Earthworms are the most significant soil creatures as they make up a large portion of the total biomass of invertebrates present in the soil. They are the members of the class Oligochaeta under the Phylum Annelida, constitutes more than 80% of total soil invertebrates biomass in subtropical, tropical and temperate regions. They are classified into three primary ecological categories- Epigeic, Anecic and Endogeic(Fraposo and Lavelle,1995).The physic-chemical and biological characteristics of soil ecosystem is considered good when all the three primary ecological categories of earthworms are inhabiting (Dewi and Senge,2015).The aimed of present study is to investigate the distribution and abundance of earthworms under three different land use patterns-Horticulture farm ,Vegetable farm and Agroforestry and their influence on the soil physico-chemical properties of the soil. Earthworms were sampled from four plots each from the three different study sites. From each sites twelve plots and total of thirtysix plots from the three sites. Tropical soil biology and fertility methodology was used in sample collection at monthly interval. Altogether the number of earthworms/m^2 for July 2024 is 77/m^2(Horticulture farm-47/m^2, Vegetable farm-27/m^2 and Agroforestry-3/m^2) and that of August is 83/m^2(Horticulture farm-60/m^2, Vegetable farm-19/m^2 and Agroforestry-4/m^2). The four basic soil parameters i.e, Soil temperature, Soil porosity, Soil moisture content and Bulk density were also recorded. For Soil temperature highest average value is recorded in Vegetable farm -29.67^{O}C at first layer (0-10cm) and lowest is recorded in Horticulture farm-19^{O}C at second layer (10-20). For Soil porosity highest average value is recorded in Agroforestry-59.25g/$cm^3$and lowest is also in the same study site i.e, Agroforestry-50.38g/cm^3. The highest as well as lowest average Soil moisture content is also recorded in the Agroforestry with the value of 41.77% and 17.72% respectively. For bulk density the highest average value is recorded in Horticulture farm-1.56g/cm^3 and lowest is in Agroforestry with the value of 0.73g/cm^3. It is concluded that among the three different study sites, the number of earthworms/m^2 is highest in the Horticulture farm and than Vegetable farm and the least is recorded in Agroforestry. It might be due to their adaptability in the changing environment as well as undisturbed by humans.

Keywords: Earthworm, Population, Horticulture, Agroforestry, Climate Change, Land-Use, Adaptability

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Navigating sustainability: A Transboundary Socio-Ecological Study of the Brahmaputra River Basin

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Abstract

After the recent COP-26 emphasizing green energy transitions, carbon-heavy industries like transportation are shifting to greener modes and clean fuels. The industry is increasingly adopting waterways transportation due to its lower carbon emissions and cost-effectiveness. Economies with untapped waterway potential, such as the Brahmaputra River Basin, are witnessing a surge in inland waterway utilization for green transportation. India and Bangladesh, sharing the Brahmaputra River, have bilateral trade and transportation ties. However, this shift toward sustainability must account for impacts on the river's health, aquatic biodiversity, and dependent human communities. Inland water transportation activities disturb river ecosystems, overexploit aquatic biodiversity like endangered river dolphins, and can compromise the safety and privacy of local inhabitants. Field visits by the authors reveal that these initiatives must integrate the perspectives of local communities and stakeholders for equitable development.

This study seeks to evaluate if Inland Water Transportation in the transboundary Brahmaputra River represents a truly sustainable decision by balancing economic, social, and environmental imperatives. Using qualitative content analysis, the study will identify key actors and explore how environmental and socio-economic considerations are integrated into regional inland water and climate adaptation policies. It anticipates transformative changes in the Brahmaputra River Basin between Assam and Bangladesh by incorporating social and environmental inclusion into decision-making processes for industry development.

Additionally, the study aligns with SDG 6, target 6.6, aiming to restore the Brahmaputra River and its biodiversity while advancing sustainable inland water transportation. Collaborative efforts that consider social, economic, and environmental priorities will position the industry as technologically advanced, inclusive, and equitable. Such a transformation would establish inland water transport as a livelihood source along the Brahmaputra River while ensuring the long-term preservation of invaluable biodiversity and community well-being.

Keywords: Brahmaputra River Basin, Inland Water Transportation, Inclusivity, Sustainability, Transformation

Assessing the Impact of Future Climate Change on the Distribution of Tea (*Camellia Sinensis L.)* Growing Areas in the Eastern Himalayan Region of India

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Abstract

Tea, prepared from the leaves and leaf buds of *Camellia sinensis* plant, belonging to the family Theaceae, is one of the highly consumed non-alcoholic beverages around the world contributing significantly to the economy of the producing nations. As the second-largest tea producer globally, India needs a clear understanding of tea's potential distribution and habitat preferences under current and future climate conditions to develop effective adaptive strategies against climate change. This study models the climate suitability for tea cultivation in the Eastern Himalayan region, encompassing Arunachal Pradesh, Bhutan, Sikkim, and Darjeeling, Jalpaiguri, and Kalimpong districts of West Bengal. We evaluated current climatically suitable areas for *C. sinensis* and projected changes for the year -2050 and 2100- using a general circulation model (HadGEM3-GC31-LL) under two Shared Socioeconomic Pathway (SSP) scenarios i.e., ssp126 and ssp585.

To construct the climatic niche of *C. sinensis*, maximum entropy (MaxEnt) modeling with 19 bioclimatic variables and altitude was used, to predict the suitable areas under the present and future conditions. Our findings indicate that highly suitable areas for tea cultivation under projected future climate scenarios are expected reduce significantly compared to the baseline scenario. The model also reveals a notable shift in habitat suitability toward higher altitudes in the Eastern Himalayan Region. Notably, Arunachal Pradesh shows a higher percentage of habitat suitability for projected future plantation activities. This study demonstrates the utility of ecological niche modeling (ENM) for assessing habitat suitability, forecasting future distribution shifts, and identifying resilient areas to support sustainable tea agriculture in the face of climate change.

Keywords: Climate Change, Ecological Niche Modeling, Forecasting, Sustainable Agriculture, Tea

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Role of Biochar as a Sustainable Soil Management Strategy for Climate-Resilient Agriculture in Dry Tropics

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Abstract

Agro-ecology and sustainable farming practices are essential approaches that prioritize environmental health, social equity, and economic viability in agriculture. To improve soil health, reduced reliance on chemical inputs can ultimately contribute to resilient agricultural systems. In South Asia, the dominant rice-wheat cropping system depletes soil nutrients and generates rice straw (RS), which is frequently burned, exacerbating climate change, pollution, and soil degradation by reducing organic matter and harming beneficial microorganisms. Maintenance of soil organic carbon (SOC) is considered to be essential for long term sustainability of agroecosystem especially in dry tropics. To enhance SOC sequestration and to reduce greenhouse gas emission while ensuring crop productivity climate resilient agriculture practices has been widely advocated. Conversion of RS to biochar is one such strategy that can provide a sustainable solution that enhances soil quality. Existing studies have focused on individual management practices, without exploring the synergistic effects of combining multiple climate-resilient practices on SOC and soil health especially in dry tropics. Present study was therefore designed with an objective to analyse the impact of addition of exogenous soil amendments like chemical fertilizer (CF), rice straw (RS), RS biochar (RSB), RSB combined with chemical fertilizer (RSB+CF), nitrogen enriched RSB (NE-RSB) and control (CO) (no inputs) on SOC, Bulk Density (BD), Porosity and Microbial biomass carbon (MBC), Microbial biomass nitrogen (MBN). This experiment was performed at the experimental plots of Department of Botany, Banaras Hindu University, Varanasi involving a rice-wheat crop sequence where an equivalent amount of nitrogen (80 kg N /ha) was provided in the form of chemical fertilizer and all other organic inputs. SOC was estimated by Dichromate oxidation and titration method, BD by Core sampling method, Soil porosity (%) is inverse of BD and soil MBC and MBN were estimated by Chloroform Fumigation Extraction method. Considerable changes in the SOC, BD, POR of soil at the end of the annual cycle were found, the trend in the level of SOC was NE-RSB > RSB+CF >RS>RSB> CF > CO whereas that of soil BD was: NE-RSB< RSB+CF< RS< RSB <CF< CO and porosity followed the reverse trend of BD. MBC followed the trend as NE-RSB>RSB+CF> RS> RSB >CF>CO whereas MBN followed NE-RSB>RSB+CF> RSB> RS>CF>CO. On the basis of this study treatment NE-RSB was found to significantly improve soil properties like SOC, BD, POR, MBC, MBN compared to sole RSB or chemical fertilizer making it a promising practice for long term sustainability of agroecosystems in dry tropics. The implications of the study would help in devising agro-management practices that would eventually lead to a climate resilient agriculture.

Keywords: Biochar, Climate Change, Climate-Resilience, Dry Tropics, Sustainable Agriculture

Theme: SWSDS

Safe Water Storage and Distribution Systems

Oral Presentations

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Assessing the Health Risks Associated with Exposure to Chlorinated By-products in Indian Drinking Water

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Abstract

The formation of disinfection by-products, often known as DBPs, occurs when chlorine reacts with organic materials present in water. Among the several DBPs that are found in drinking water, trihalomethanes (THMs) are the most common. These THMs are also recognized as human carcinogens. For the purpose of this investigation, five drinking water treatment plants located in Guwahati, India were chosen, and the levels of total THMs in the water that was treated at these plants were measured. Variability in THMs concentrations was observed across all of the treatment plants, with values ranging from 235.92 to 260.42 parts per billion (ppb). These values were much higher than the suggested limit of 80 ppb set by the United States Environmental Protection Agency (USEPA). Trichloromethane (TCM) was the most abundant contaminant among all of the THMs, followed by bromodichloromethane (BDCM) and dibromochloromethane (DBCM) as the compounds that were found in the highest concentrations. There was no sign of bromoform ever found. Ingestion, skin absorption, and inhalation were the three methods that were used to evaluate the chronic intake of THMs. The non-cancer hazard index and the lifetime cancer risk were also evaluated. Ingestion was associated with a higher incidence of cancer in individuals compared to the other two exposures. After doing an analysis of the average lifetime risk of cancer, it was shown that children were more susceptible to the risk than adults. The risk of non-cancerous health effects was greatly enhanced by oral consumption, but the risk of skin exposure was much lower. According to the findings of the sensitivity analysis using Monte Carlo Simulations, the key factor that contributed to the development of cancer was the presence of TCM in water. Subsequently, the body weight and the frequency of exposure to THM were further relevant variables.

Keywords: Cancer Risk, Drinking Water, Monte Carlo Simulation, Sensitivity Analysis, Trihalomethanes

Theme: SWM

Solid Waste Management

Oral Presentations

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Evaluation Phytotoxicity and Ecological Risks of Biomined Good Earth product as a Soil Nutrient: Dhapa Landfill

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Abstract

One of the sustainable options to reclaim legacy waste is biomining, which encompasses clearing landfill space for incoming waste and recovering valuables from legacy waste. "Good earth", a soil-like material (< 6 mm fraction) constitutes a major portion of the legacy waste. The present study examines the recycling potential of good earth fraction for potential application as a soil nutrient. Legacy waste is excavated from Dhapa dumpsite located in Kolkata, India, and the < 4 mm fraction (finer fraction of good earth) is collected and tested for essential compost parameters like pH, electrical conductivity, total organic carbon, primary nutrients, total heavy metals, leachable heavy metals, and salts. Further, the impact of good earth on plant growth is studied using phytotoxicity and vegetation test. Total Organic carbon is found to be 4.39–5.22 % whereas in the control i.e. background agricultural field soil, it is observed to be 0.77–1.18 %. Total soluble solids are found to be in the range of 18000−27200 mg/kg, several times higher than that of background soils (3200−4800 mg/kg). The intensity of yellow-brown colour in the water extract obtained from good earth is observed to be 212.54–375.12 PCU while in the water extract of local soils it was found to be 94.71–115.45 PCU, highlighting the potential for release of coloured leachate from good earth. Though total heavy metals in good earth exceeded the municipal compost standard limits for arsenic, chromium, copper, nickel, lead, and zinc except cadmium but leachable heavy metals are not alarmingly high in good earth. Concentration ratios of the metals in good earth indicate that iron and lead are 10–15 times higher in leachate extract compared to soils. Zinc is found to exhibit high concentration ratio i.e. 7.8 whereas cadmium was not elevated in good earth in comparison to the background soils. The potential ecological risk index reveals that the good earth is contaminated with heavy metals with moderate environmental and ecological risk. Therefore, adoption of precautionary measures are essential to reduce the high dissolved solids, higher organic content, and undesired colour from the good earth. The germination index of rice seeds (Oryza sativa) for the aged good earth extract (> 25 years old) is more than that of the control group i.e., background soil. In vegetation test on Napier grass (Pennisetum purpureum) for the 60% mix ratio of good earth and background control soil, the highest biomass growth was observed with 100% increase in biomass compared to that of control on both wet and dry basis. Various possible uses e.g. as fertilizer, soil enrichment, or substrate have been identified as a part of remedial measures based on the characteristics of the finer fraction, with the most appropriate usage varying on case-to-case basis.

Keywords: Ecotoxicity, Good Earth, Heavy Metals, Nutrient Recovery, Phytotoxicity

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Analysis of the Sustainability of the Existing Solid Waste Management System of Newtown, a Smart City

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Abstract

Controlling greenhouse gas emission (GHG) plays a crucial role for developing sustainable municipal solid waste management (MSWM) system. Newtown, a smart city in Kolkata, has implemented a biomethanation plant to convert organic waste into energy after performing central segregation. However, it lacks a disposal facility, so mixed and non-recyclable waste is disposed of at Dhapa landfill. This study examines the present MSWM scenario of Newtown in the context of GHG emission to help policy makers to develop economically affordable waste management (WM) plan for smart urban development. For physiochemical characterisation of waste, ASTM standard methodology was used for determining moisture content (MC), ash content, volatile matter, fixed carbon, and calorific value in the context of revealing generation of significant heat and landfill gases, which cause spontaneous fires due to biological and chemical reactions within landfill. The study tested 50 g waste samples in a muffle furnace under 3oC/min to determine ignition temperature and smouldering point, using an IR-based handheld thermometer. A sensor-based air quality monitoring equipment assessed PM emissions from waste segregation stations and biomethanation plants. Data for PMs were collected from each location, monitoring 30 minutes for six days a week. The LandGEM (3.02) model was used to anticipate GHG emissions from the landfill site Considering two hypothetical scenarios—(i) all waste was disposed of without any treatment and (ii) only mixed waste was disposed of after treatment of organic portion in biomethanation plant The compositional analysis of MSW, reveals that the fresh waste had the highest organic portion (48.79%), followed by food, paper, plastics, textiles, garden trimming, inert, rubber, leather, and unidentified waste. Organic waste has an average MC of 77.57%, while mixed waste has 69.04%. Higher MC indicates compostable waste material. Ash content was 6.21% for organic and 6.64% for mixed waste. Volatile matter and fixed carbon varied among waste types. Organic waste had lower calorific values (1086.29kcalg^{-1}) due to high MC. Ignition temperature of organic waste and mixed waste were obtained 297 °C and 210 °C respectively. Average of PM_s (PM_{10}, $PM_{2.5}$, PM_1) in segregation and biomethanation plant were 89 µg/m^3, 74.5 µg/m^3, 67.5 µg/m^3 and 124 µg/m^3, 106 µg/m^3, 74 µg/m^3 respectively. Using geometric increase method for population forecasting, the per capita waste generation rate was predicted 0.807 gd^{-1}. Annual waste generation is projected from 2011 to 2026, with daily waste generation of 563.10 tons in 2023. CH_4 and CO_2 values derived from the LandGEM model are 231153.52 tons, 84246.82 tons respectively in 1st scenario and 226768.5 tons and 82648.65 tons respectively in 2nd scenario. The study reveals the necessity of development of sustainable integrated MSWM plan for controlling particulate matter and GHG emissions during MSWM.

Keyword: Characterization, Land GEM, Municipal Solid Waste Management, Pollution Control, Smart City

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Reuse of Carbon Dust (Waste/by Product) Generated from Selected Industries as Toner Component - Profitable Solution of Waste to Wealth

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Abstract

The increased Industrialization and urbanization produces large quantity of different Industrial byproducts. Wide range of industries generates different quality and quantity of industrial byproducts. There is a need to ensure that the waste generated from one industry should be used as raw material in another industry to achieve sustainable development and to reduce fresh raw material. This industrial ecology not only finds solution to waste handling problems, but also reduces the environmental burden of fresh resources produced by the nature. Carbon dust is one of such general industrial waste that is produced in almost all industrial processes varying in its quality and quantity from one industry to the other. Very large quantity of carbon dust is generated from Aluminum industry, Tyre (manufacturing/ vulcanizing) industry and paper recycling industry. The quality & quantity of carbon dust generated varies with specific possessing specific manufacturing processes. The carbon dust so generated as by product of specific industry, poses great challenge for managing without casing pollution in the surrounding environment. As it is of very fine particles, it poses air pollution and if it is disposed on the soil, there are chances of leaching into the ground water causing ground water pollution. Generally, the carbon dust is dumped in landfills without any precaution. The transportation and handling of the carbon dust is also problematic. Due to large generation rate, its nature and the fine particle size, the carbon dust has potential reuse as toner component. An attempt is made to find an environmental friendly alternate solution for treatment & disposal of Carbon dust, generated from selected industries, to use as toner material. The toner is used in photocopiers and laser printers and is a powder mixture. The text is printed as an image due to this powder. This environmental alternate solution can also serve as a potential source of employment opportunity for the young entrepreneurs.

The Carbon dust from the various industries needs to be collected and identified. As these carbon dust are collected from different industrial operations, for attaining uniformity, the modifications of the nature of the carbon dust have to be carried out. The preparation of the toner powder may be carried out after the Characterization of the modified carbon dust. Production of this product (Toner Powder) will help the carbon dust generating industry to have environmentally sound technology for carbon waste problem and to get rid of its carbon dust efficiently and economically. This may also open up job opportunity of toner powder generation to be used in printers. The aim of this project is to collect Carbon dust in its various forms from different industries, modify its properties to achieve uniformity, characterize the modified Carbon dust, use it to prepare a printing toner powder, and perform quality checks and life span and economic analysis on the same to convert as business model.

Keywords: Carbon Dust, Carbon Black, Toner, Particle Size, Industry, Industrial Byproduct

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Insight on Pollution and Energy Recovery Potential of Leachate from Landfill Sites of Northern India

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Abstract

Leachate is an extremely digested by-product of waste degradation process which originates from municipal landfills. It has high pollution potential and therefore warrants treatment before disposal. Environmentally sustainable technology like microbial fuel cells (MFCs) is becoming a novel choice as it treats as well as produces energy from leachate. Nevertheless, the suitability of energy (biogas) recovery depends upon the leachate characteristics. The leachate from three landfill sites of Ghazipur, Okhla and Bhalswa in Delhi was characterized. The findings revealed that the organic strength of leachate in terms of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) do not support biogas production. Further, high concentrations of NH_3-N and chloride may exert inhibitory effects on biomethanation. Heavy metals such as Fe, Cr and Ni create a positive effect, whereas Zn and Cu inhibit the leachate to biogas conversion. Leachate Pollution Index (LPI) values for Ghazipur, Okhla and Bhalswa were 24.77, 26.28 and 24.64, respectively. Since the LPI is greater than 15, leachates need to be treated. When pollution potential was assessed using sub-indices, the comparative leachate pollution for organics is Okhla > Bhalsawa > Ghazipur, for inorganic pollutants Ghazipur > Okhla > Bhalwsa, and for heavy metals, the order follows Okhla > Bhalswa > Ghazipur. Further, the Principal Component Analysis (PCA) of these three landfills shows that the leachate from Ghazipur and Bhalswa are rich in organic content. For Okhla, the leachate characteristics are mostly determined by inert waste material contributed largely by construction and demolition (C and D) waste. Thus, Gahzipur and Bhalswa landfills may better support leachate-gas production over the Okhla landfill.

Keywords: Biogas, Landfill Leachate, Leachate Pollution Index, Principle Component Analysis, Waste-To-Energy

Characterization and Determination of Pollution Risks caused by Landfill-Derived Soil from Four Different Cities

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Abstract

Landfill mining addresses the issue of legacy waste at municipal solid waste (MSW) dump sites in developing nations like India. The soil-like material or fine fraction is one of the four principal residues of landfill mining. This MSW fine fraction makes up approximately 45-80% of the total landfill-mined residues, hence its utilization is of the utmost significance. This study examines fine fraction from landfill mining obtained from four different dump sites in India- namely Boragaon in Guwahati, Ghazipur and Bhalswa in New Delhi and Bandhwari in Haryana. It will also address the treatment of fine fraction and its potential off-site applications. The characterization includes physicochemical characterization, heavy metal analysis, pollution indices, and instrumental characterization to compare and ascertain the extent of pollution risks caused by the fine fraction. The results concluded that fine fraction obtained from all the sites had similar physicochemical characteristics and the organic matter ranged from 13%-17%. Fine fraction from all the dumpsites contained total organic carbon, total potassium, and total nitrogen content comparable to those of city compost except total phosphorus. Fine fraction from all the dumping sites exhibited elevated measures of total heavy metals. However, Zn in Boragaon and Bhalswa, Cr in Ghazipur, and Fe in Bandhwari had the highest potential to enter the food chain and impact biodiversity, based on the bioavailability of heavy metals. Based on the contamination factor, all the heavy metals posed moderate to high contamination risk for fine fraction obtained from all the four dumping sites. Based on the pollution load index, fine fraction from all the dumping sites carried a pollution load greater than unity. Fine fraction from Boragaon dump site was ascertained to have the highest pollution load, followed by Ghazipur, Bhalswa, and Bandhwari sites. Considering the evident ability of the fine fraction from all the sites to cause pollution within the geoenvironment, appropriate treatment and utilization methods have been suggested.

Keywords: Contamination Factor, Fine Fraction, Heavy Metals, Landfill Mining, Pollution Load Index

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Surface Modification-A Promising and Sustainable Solution to use Bio-medical Plastic Waste in Concrete

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Abstract

The use of plastics in hospitals is unavoidable due to its convenience and ease of use. Bio-medical plastic waste (BMPW) pollution pose a significant threat to the environment due to its heavy demand and disposal issues. At the same time, the huge extraction of natural layers for concrete aggregates adversely affects the environment. Thus, the use of BMPW as concrete aggregates is a promising solution to balance the demand of coarse aggregates as well as the waste management. However, the strength of plastic concrete is a challenge due to weak bonding between the plastic surface and the concrete matrix due to the hydrophobicity nation of plastic. To address the issue, surface modification of the plastic aggregates may offer a possible solution to bonding between the plastic and the concrete matrix and hence the concrete strength.

In this work, surface modifications of the non-contagious BMPW aggregates have been done through molding plastic wastes into different shapes, dimensions and sand embedment and then compressive strength of concrete were investigated and compared with the non-modified plastic aggregates concrete. Different shapes such as spherical, cylindrical, cuboidal and trigonal and different sizes of the best shape with L/D ratio ranging from 0.5 to 2.0 have been considered for the investigation. The surface modification of the above aggregates through sand embedment has been carried out to find the effect of such modification on compressive strength characteristics of concrete. M30 grade of concrete with 10% replacement level of coarse aggregates replacement with by modified plastic aggregates was considered cast the different types of BMPW concrete. The compressive strength was observed at the of 7- and 28-days water curing period and compared with reference concrete.

The findings indicate that I. The molded plastic aggregates concrete offers better compressive strength compared to the concrete made with cut plastics. II. The cylindrical shape aggregates concrete displayed better compressive strength compared to other shapes. III. Among the cylindrical shaped aggregates, the aggregates with L/D ratio 1.5 demonstrates enhanced compressive strength. IV. Sand embedment to the aggregates surface offer significant improvement in compressive strength. Thus, the sand embedment technique of surface modification of plastic aggregates is a promising and sustainable solution to overcome the challenges of lower compressive strength of plastic concrete

Keywords: Aggregates dimension, Aggregates shape, Bio-medical plastic waste, Plastic concrete, Surface modification

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Current State and Pathways for Sustainable Solid Waste Management in Kohima

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Abstract

Unplanned urbanization in hilly areas presents numerous challenges, one of the most significant being sustainable municipal solid waste management (MSWM). The increasing volume of waste generation, with open dumping as the primary disposal method, has become a severe concern for the MSWM system in Kohima, the capital city of Nagaland. This study aims to delve into the current status of waste management in Kohima and identify strategic pathways toward a sustainable solid waste management system. The study was based entirely on data from secondary sources. The existing waste management practice in Kohima comprises the collection of unsegregated waste, its transportation to the dumping site, and final disposal. The waste composition includes a significant portion of biodegradable waste (> 50%) followed by recyclables (>20%). Limited focus was given to waste treatment, recycling, and recovery, primarily due to the absence of waste segregation. The current practices pose a significant threat to the environment and human health due to leakages from waste that contaminate air, soil, and water. Some challenges faced in Kohima are limited waste collection coverage, inadequate waste collection frequency, inadequate infrastructure, less manpower, lack of funds, and low public awareness. The critical pathways identified and recommended were implementing Integrated Solid waste management (ISWM) focusing on the 3Rs (Reduce, Reuse, and Recycle), community-based solid waste management, decentralized waste management, capacity building, extensive awareness programs, and enforcing stricter policy and regulations. The study also explores the implementation of emerging technologies such as Artificial Intelligence (AI) and Machine Learning (ML) in waste management.

Keywords: Capacity Building, Community, Decentralized, Hilly Area, Waste Segregation

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GIS-Based Evaluation of Municipal Solid Waste Management in Dimapur District, Nagaland: A Case Study

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Abstract

Effective Municipal Solid Waste (MSW) management poses a significant challenge for urban areas globally. Rapid urbanization, increasing population and rapid economic growth have changed the living standards in many aspects that accelerate the waste generation rate of MSW in Indian cities including Dimapur District, in the northeastern state of Nagaland. The city's reliance on open dumping and the absence of modern waste treatment facilities have led to severe environmental and health impacts, particularly in communities near the dumpsite. The primary objective of this study to evaluate the current Solid Waste Management (SWM) system in Dimapur using Geographic Information System (GIS) tools, providing an in-depth spatial analysis of waste generation, collection efficiency, and disposal practices. Additionally, the study aims to identify high-impact waste generation areas, assess the efficiency of waste collection and optimize waste collection and transportation routes. The methodology used in the study includes data collection which focused on waste generation points, collection routes, population density, environmental factors, and disposal sites. These data were integrated into a GIS platform to ensure accuracy and spatial compatibility, enabling the creation of thematic maps that visualize waste generation hotspots, collection route coverage, and the locations of disposal sites. Spatial analysis tools were applied to assess the proximity of waste generation points to collection infrastructure and to identify areas with high waste accumulation. GIS-based optimization techniques were used to refine waste collection routes, minimizing travel time, fuel consumption, and emissions while maximizing service coverage. The study reveals critical inefficiencies in Dimapur's existing SWM system, particularly the reliance on open dumping and limited waste segregation at source. The findings highlight the potential of GIS to improve the planning and operational efficiency of SWM in medium-sized cities and offer recommendations for sustainable waste management practices, including route optimization, enhanced waste segregation, and better public participation.

Keywords: Geographic Information Systems (GIS), Municipal Solid Waste, Route Optimization, Spatial Analyst, Waste Coll08ction

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Innovations and Challenges in Solid Waste Management: Towards Sustainable and Efficient Solutions

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Abstract

Rapid urbanization, population increase, and changing consumer behavior have made solid waste management (SWM) a more pressing issue on a global scale. The technical, financial, and environmental difficulties of managing multiple waste streams in a range of geographical and socioeconomic contexts are examined in this study, which delves into the intricacies of contemporary SWM. The volume and complexity of today's trash are beyond the capacity of traditional waste collection, treatment, and disposal systems, which negatively impact the ecosystem through pollution, greenhouse gas emissions, and biodiversity loss. This study addresses by highlighting significant advances that are transforming SWM, such as advanced recycling techniques, waste-to-energy technologies, bioengineering solutions, and digital transformations driven by artificial intelligence (AI) and the Internet of Things (IoT). These developments offer encouraging avenues for a more effective and sustainable SWM system when paired with policy-driven strategies like circular economy frameworks and Extended Producer Responsibility (EPR). This study highlights the significance of increasing resource recovery, fostering public participation, and tailoring technology and policies to local conditions through a comparative study of effective SWM models in developed and developing nations. The discussion concludes by pointing out new developments and fields of research in SWM that could help with international sustainability initiatives. Ultimately, efficient and sustainable waste management necessitates teamwork incorporating community involvement, legislative support, and technology advancement.

Keywords: Solid Waste Management (SWM), Sustainability, Waste-to-Energy, Circular Economy, Resource Recovery

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Assessment of Waste Tire Fibre Mixed Black Cotton Clay Engineering Performance Inundated by Various Heavy Metal Concentrations

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Abstract

In this study, naturally occurring black cotton clay (BCC) was used as a landfill liner material instead of India's hardly available and economical bentonites and bentonite-sand mixtures. On the other hand, BCC causes cracks or swells as a result of excessive drying or wetting processes, respectively. Specifically, cracks induced by the shrinkage phenomena deteriorate the liner material stability, rendering it ineffective and eventually leading to groundwater pollution. In general, fibre reinforcement regulates the cracking behavior of liner material. The development of large amounts of waste tire content is increasing these days due to the higher demand for vehicles as a result of population growth and urbanization. Illegal dumping and burning of waste tires have major consequences for the environment (water, soil, and air) and pose a hazard to human life. Hence, it is important to recycle and reuse this waste tire content in order to benefit both the environment and society. Recycled tire waste is obtainable in many forms like chips, fibres, powders, crumbs etc. Therefore, in this work, waste tire fibres (WTFs) were mixed by 0, 5, and 10% by BCC's dry weight. Conversely, there is an additional issue that is becoming increasingly prevalent: the impact of leachates on the stability of barrier materials. Especially, the rising of heavy metal content has been becoming more prevalent in landfill leachates. For this purpose, two prominent heavy metals, lead nitrate and potassium dichromate, were employed as heavy metal saturating liquids at two concentrations (100 and 1000 ppm) to simulate the impact of leachate. The test results exhibited a significant reduction in swelling properties such as swelling heights, swelling potentials, and swelling pressures for the addition of WTFs. These swelling properties were further dropped with heavy metal permeants compared to distilled water. However, this reduction in swelling properties was more prominent for potassium dichromate permeants than lead nitrate. Finally, permeability values of BCC were increased proportionally with tire fibre content up to 10%. Higher permeability values were observed with hexavalent chromium permeants compared to lead nitrate permeants.

Keywords: Black Cotton Clay, Heavy Metal Concentrations, Permeability, Swelling Pressure, Waste Tire Fibres

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Catalyst-Free Polyethylene Terephthalate (PET) Waste Degradation at Room Temperature for High-Value Metal Organic Frameworks (MOFs): A Waste to Wealth Approach

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Abstract

Synthetic polymers or Plastics unlike any other previous useful materials (wood, ceramics, glass, bronze and steel) on the course of human civilization, possess something that is new. Its intrinsic nature and ability to transform, having an easy and simple mode of malleability and the flexible mechanical suitability to adapt various means of industrial utility and as well as in everyday life, made them a substance of surprise. Within the next few decades after the invention of Bakelite in 1907, the first synthetic Polymer, the usage of plastics has become so ubiquitous in our society that the production of various synthetic polymers increased from 2 million metric tons per year in 1950 to an estimated gigantic number of 381 million Mt/year. As a result of its imperious usage and unsustainable management of plastics, nature has to endure the agony of something that is not sustainable in its chemical essence. It is evaluated that on average 19 to 23 million Mt of waste ends up in the aquatic environment annually.

In this work, Polyethylene Terephthalate(PET) waste has been degraded at room temperature environment via alkaline hydrolysis pathway. In doing so, effect of co-solvent has been taken into account in lowering the energy input cost. Around 98% PET waste degradation has been achieved within a period of 3 hr, without using any kind of catalysts. Major reaction product Terephthalic Acid has been separated and utilized to synthesis various Metal Organic Framework (MOFs) for waste upcycling purposes.

Keywords: MOFs, PET, SDG, Upcycling, Waste

Kinetics Governing Colloidal Gas Aphrons Generation and Stability: The Foundation for Sustainable Aerated Concrete

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Abstract

Colloidal Gas Aphrons (CGAs) offer a groundbreaking approach to sustainable aerated concrete production, merging precise control over air void formation with the innovative reuse of waste materials. The kinetics of CGAs generation are critical in the design of lightweight and durable aerated concrete, as they influence parameters such as microbubbles stability, generation rates, and successful integration into cementitious systems. This study examines the dynamic formation of CGAs across various surfactant types—anionic, cationic, and nonionic—evaluating their effects on air holdup and CGAs stability. By understanding these kinetic processes, optimal conditions for producing stable CGAs were established, enabling their incorporation into wet aerated slurry with densities ranging from 400 to 800 kg/m^3. These stable CGAs provided uniform size distribution, improving material properties such as tensile strength and water absorption. Furthermore, incorporating single-used polyethylene bag-cuts, up to 1.5% of the total solids, significantly reduced the environmental impact by repurposing lightweight, high-littering solid waste into sustainable building materials. This research highlights the essential role of CGAs generation kinetics in developing eco-friendly, high-performance building materials, while addressing global challenges like resource efficiency and waste management.

Keywords: Colloidal Gas Aphrons (CGAs), Aerated Concrete, Polyethylene Bag Cuts, Kinetics, Air Holdup, Stability

Theme: SPD

Sustainable Processes Development

Oral Presentations

Revolutionizing Industrial Wastewater Treatment: Harnessing Ultrasound-Enhanced Laccase Immobilization on Magnetic Fe_3O_4 Nanoparticles for Superior Efficiency and Optimization

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Abstract

In developed countries, water pollution caused by industrial discharge has emerged as a significant environmental concern over the past decades. However, despite ongoing efforts, a fully effective and sustainable remediation strategy has yet to be identified. This paper describes how enzymatic and sonochemical treatments have demonstrated great promise in degrading bio-refractory pollutants. Mainly, a compelling area of interest lies in the combined technique of sono-enzymatic treatment, which has exhibited a synergistic enhancement effect surpassing that of the individual techniques. This study employed the covalent attachment method to immobilize Laccase from *Trametes versicolor* onto amino-functionalized magnetic Fe_3O_4 nanoparticles. To comprehensively characterize the synthesized free nanoparticles and the laccase-immobilized nanoparticles, various techniques such as X-ray diffraction (XRD), FT-IR, scanning electron microscope (SEM), vibrating sample magnetometer (VSM), and surface area through BET were employed. The size of immobilized Fe_3O_4@Laccase was found to be 60 nm, and the maximum loading of laccase was found to be 24 mg/g of nanoparticle. An investigation was conducted to study the effect of various process parameters, such as immobilized Fe_3O_4@Laccase dose, temperature, and pH, on the % COD removal as a response. The statistical design pinpointed the optimum conditions (immobilized Fe_3O_4@Laccase dose = 1.46 g/L, pH = 4.5, and Temperature = 66 ^oC), resulting in a remarkable 65.58% COD removal within 60 minutes. An even more significant improvement (90.31% COD removal) was achieved with ultrasound-assisted enzymatic reaction utilizing a 10% duty cycle. The investigation of various kinetic models for free and immobilized laccase, such as the Haldane, Yano, and Koga, and Michaelis-Menten, showed that ultrasound application impacted the kinetic parameters V_{max} and K_m. Specifically, V_{max} values for free and immobilized laccase were found to be 0.021 mg/L min and 0.045 mg/L min, respectively, while K_m values were 147.2 mg/L for free laccase and 136.46 mg/L for immobilized laccase. The lower K_m and higher V_{max} for immobilized laccase indicate its enhanced affinity towards the substrate, likely due to ultrasound-induced alterations in the enzyme's confirmation and increased exposure of active sites, leading to more efficient degradation. Furthermore, the toxicity and LC-MS analysis revealed that after the treatment process, the wastewater exhibited 70% less toxicity than before treatment, with over 25 compounds degrading by more than 75%. At last, the prepared immobilized laccase had excellent recyclability, retaining 70% activity up to 6 consecutive cycles. A straightforward manufacturing strategy and outstanding performance make the recyclable magnetic immobilized Laccase (Fe_3O_4@Laccase) an up-and-coming option for various environmental applications, particularly in water pollution control and treatment.

Keywords: Laccase, LC-MS, Immobilized laccase, RSM, Toxicity

Sequential Extraction of Mangiferin and Pectin from Waste Mango Peel using Ionic Liquid in the Presence of Microwave Radiation

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Abstract

A large consumption of mango fruits leads to the generation of a huge amount of waste (~420 kg per ton of fruit), creating an environmental concern. Around 15% of this waste corresponds to the peels of the mango fruits. A sustainable solution for the judicious utilization of mango waste has been proposed by employing microwave radiation. A simultaneous extraction process has been developed using ionic liquids for the recovery of mangiferin and pectin from the mango peels, thereby reducing the number of steps in processing and, hence, beneficial in terms of energy and environment. In the present investigation, dicationic ionic liquids, namely, N, N,N,N',N',N'-hexaethyl-ethane-1,2-diammonium dibromide (1a), N,N,N,N',N',N'-hexaethyl-propane-1,3-diammoniumdibromide (1b), N,N,N,N',N',N'-hexaethyl-butane-1,4 diammonium dibromide (1c) were used for the concurrent extraction of mangiferin and pectin at various operating conditions. Percentage extraction of pectin was strongly affected by the alkaline nature of dicationic ionic liquid (1c > 1b >1a). The parametric study employing extraction time, temperature and solid loading has been performed to assess the effect of various parameters and achieve the optimum conditions. Dicationic ionic liquid 1c has provided the highest yield of pectin (31.5 %) with ~77 % degree of esterification and mangiferin (4.63 mg/g) at temperature of 80 oC, extraction time 15 min, solvent loading of 10 %, solid to liquid ratio of 1:30 g/mL and microwave power of 80 W. Further, the ionic liquid 1c extract exhibited 79.38 % and 96.43 % DPPH and ABTS scavenging activity, respectively under the optimal circumstances. A simultaneous extraction of useful compounds has resulted in reduced numbers of processing steps leading to increased productivity, reduced resource requirement in terms of solvents and utility, improved energy efficiency and reduced carbon footprint.

Keywords: Dicationic Ionic Liquids, Mangiferin, Microwave, Mango Peels, Pectin

FTIR Analysis of Sustainable Green Concrete Incorporating Copper Mine Tailings

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Abstract

Cement is the primary material used as a binder in concrete and the most consumed building material in the construction industry. However, the manufacturing of cement is associated with the release of enormous amounts of carbon dioxide, having a severe impact on the environment. Approximately, 8% of carbon emissions come from the building sector. At the same time, a lot of solid and liquid waste is generated from various industries. These industries are facing the problem of waste disposal and as of now the waste from these industries is dumped in a dumping dam or even on open barrel land creating several problems for the residents and the environment. This study focuses on sustainable, green, and durable concrete, a growing concern today. Copper mine tailings, an industrial waste is used as an alternative for replacing cement in concrete, considering environmental sustainability. The experimental program was comprised of analyzing five different concrete composites. For various mix designs with cement replacement from 0 – 20% with copper tailings, an in-depth analysis was commenced using the Fourier Transformation Infrared Ray (FTIR) analyzer test. FTIR analysis is a non-destructive technique that detects the combinations of different elements and the formation of any specific compound(s) in the specimens. The test was conducted on 28 and 84-day mature samples. A shift in the spectral band was noticed when standard results were compared with the frequencies found in FTIR spectra. The outcomes demonstrated that in contrast to the controlled concrete mix, greater absorption of C-S-H gel occurs at 10% replacement of copper mine tailings.

Keywords: Concrete, Copper Mine Tailings, FTIR, Industrial Waste, Sustainability

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Sustainable Leather Processing: Biopolymer Retanning Agents for Environmental Impact Reduction

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Abstract

The leather industry faces significant environmental challenges due to the extensive use of petroleum-based synthetic tanning agents, which contribute to increased pollution load and introduce free formaldehyde into leather products. This study presents the development of a sustainable retanning process utilizing biopolymers as alternative retanning agents. Derived from renewable sources, these biopolymers are designed to replace conventional syntans, offering a greener approach to leather processing with a reduced environmental footprint. This study aims to develop an eco-friendly biopolymeric retanning agent using carrageenan as a sustainable alternative to petroleum-derived resins used in conventional synthetic tanning agents. Experimental results demonstrate that biopolymer-based retanning agents substantially lower the pollution load in effluents compared to traditional syntans. Furthermore, since formaldehyde is a key component in many syntans, the use of biopolymer agents significantly reduces the free formaldehyde content in the leather without compromising its mechanical properties, such as tensile strength, elongation, and tear resistance. The performance of the biopolymer agents meets or exceeds that of conventional syntans, highlighting their efficacy as a sustainable alternative.

This research underscores the potential of biopolymer retanning agents to advance the leather industry's shift towards environmentally sustainable practices. The findings contribute to the growing body of knowledge advocating for the replacement of hazardous chemicals with bio-based alternatives, aligning with global environmental standards and sustainability goals. Importantly, these bio-based agents maintain the functional qualities of leather, ensuring that performance and durability are not compromised. This study highlights the significance of integrating sustainable materials into leather processing, paving the way for a more responsible and eco-friendly industry.

Keywords: Biopolymers, Carrageenan, Eco-Friendly, Retanning Agent, Seaweed

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Millets as a Catalyst for Sustainable Environmental Development: Integrating Animal Studies

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Abstract

Millets, a diverse group of small-seeded grains such as pearl millet (*P. glaucum*), finger millet (*E. coracana*), and foxtail millet (*S. italica*), are emerging as a key component of sustainable agricultural practices due to their climate suppleness, low input requirements, and high nutritional value. Traditionally cultivated in arid and semi-arid regions of Asia and Africa, millets are now gaining global attention for their role in addressing food security, environmental sustainability, and animal health. In addition to their benefits for human nutrition and environmental conservation, recent research highlights the positive impact of millet-based diets in animal husbandry. Millets, rich in fiber, essential amino acids, and micronutrients like calcium, iron, and magnesium, are not only beneficial for man consumption but also serve as an excellent alternative to conventional animal feeds. Studies show that millet grains, by-products like millet bran, and stover (stalks and leaves after harvest) can be used as nutrient-dense animal feed, particularly for cattle, poultry, and small ruminants. Research from the *Indian Veterinary Research Institute* (IVRI) indicates that feeding millet-based diets to livestock can improve animal health and productivity. In cattle, millet bran has been shown to enhance milk yield and quality due to its high fiber content and digestibility. A study published in *Animal Feed Science and Technology* demonstrated that millet grains could replace up to 40% of conventional maize-based feed in poultry diets, leading to improved weight gain, feed conversion efficiency, and meat quality, while reducing feed costs. Moreover, millet stover, a by-product of millet cultivation, is a valuable source of roughage for ruminants like goats and sheep. Research conducted by the *International Livestock Research Institute* (ILRI) revealed that millet stover has higher protein content compared to other cereal residues, making it an ideal feed for livestock in drought-prone regions. This not only supports animal health but also contributes to sustainable livestock management by reducing the reliance on commercial feed and minimizing environmental degradation associated with overgrazing. From an environmental perspective, integrating millet cultivation with animal husbandry offers a sustainable solution to the growing demand for feed resources. Millets, being drought-tolerant and requiring minimal water and chemical inputs, reduce the ecological footprint of feed production. Additionally, millet-based agro-pastoral systems can enhance biodiversity and restore degraded landscapes, aligning with the goals of sustainable land use (SDG 15: Life on Land) and climate resilience (SDG 13: Climate Action). In conclusion, the inclusion of millets in both human and animal diets provides a holistic approach to sustainable development. The use of millets as an alternative feed source not only improves livestock health and productivity but also contributes to environmental sustainability by reducing water usage, promoting soil health, and supporting resilient agricultural systems.

Keywords: Millets, Agriculture, Animal, Feed, Conservation

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Environment Assessment Impact Model for Enzyme Induced Calcite Precipitation in Soil

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Abstract

Enzyme Induced Calcite Precipitation (EICP) is a promising bio-geotechnical method of stabilization of soil. It involves a combined utilization of urea, calcium chloride, and urease enzyme with additional organic stabilizer to produce calcite which cements the soil particles thereby increasing the soil strength. However, not much research on the integrated assessment of the components/chemical considered in EICP methodology of soil treatment is addressed, from the environmental perspective. Thus, this paper conducts a life cycle assessment (LCA) study along with the detailed experiments of EICP process emissions while stabilizing the soil with EICP treatment of bio-cementation. The process of LCA is designed to identify potential unintentional consequences associated with the EICP process and to strategically analyze both the environmental benefits and its adverse effects. Four environmental impact indicators considered for this study are viz. global warming, eutrophication, energy use and freshwater ecotoxicity potentials. The results revealed that the ammonium by-products of EICP process account for 91% and 95% for with and without non-fat milk powder for eutrophication and 83% for freshwater ecotoxicity potentials. Urea is responsible for 70% and 71% of energy use for with and without non-fat milk powder respectively. The comparison analysis of EICP with and without non-fat milk powder revealed that there is a significant increase of global gas emissions (111%) when non-fat milk powder is used in the EICP treatment of soil. The analysis suggested that EICP is potentially a better environmental option, in terms of its carbon footprint, at lower compressive strength of the treated soils. The authors feel that these results will be essential for directing future investigations to address important environmental factors in the EICP life cycle, as it incorporates the sustainability goals when defining a suitable ground improvement technique.

Keywords: EICP, LCA, Soil, Ground Improvement, Sustainability

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Environmental Impact Assessment of Biodiesel production from *Croton macrostachyus* Leaves Oil

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Abstract

This study presents a comprehensive Life Cycle Assessment (LCA) of biodiesel production from Croton macrostachyus (CM) leaves oil, highlighting its potential as an environmentally sustainable, non-edible biofuel feedstock. The LCA encompasses the entire production cycle, from biomass acquisition including cultivation, collection, and transportation to fuel production and utilization phases. Employing a cradle-to-grave LCA boundary, the assessment evaluates the inputs, outputs, and emissions at each stage of the process. Under optimized conditions, the production yielded 96.375% biodiesel, demonstrating substantial reductions in carbon emissions and dependence on fossil fuels and other conventional liquid fuels. The findings underscore the environmental advantages of CM leaves as a biodiesel feedstock, aligning with ASTM D6751 standards while significantly minimizing ecological impacts. The LCA reinforces the viability of CM leaves oil for sustainable biofuel production and promotes its broader adoption as a renewable energy source. The results offer valuable insights for policymakers seeking to design strategies aimed at reducing carbon emissions and fostering sustainable energy transitions. This study contributes to the fulfillment of key Sustainable Development Goals (SDGs), particularly climate action and affordable clean energy, and promotes the principles of the circular economy by utilizing non-edible biomass in fuel production.

Keywords: Biodiesel, Croton Macrostachyus (CM) Leaves Oil, Circular Economy, Life Cycle Assessment (LCA), Sustainable Development Goals (SDGs)

Quinoxaline-Probe embedded Injectable Fluorogenic Hydrogels from Guar Gum and i-Carrageenan for Sensitive Volatile Organic Compound Detection

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Abstract

The innovation of novel chemosensor probes for the recognition of trace volatile organic compounds is critical due to their hazardous effect on the environment and human health. A nitro-group integrated quinoxaline probe with a profound discriminative fluorescence 'turn-on' response to mesitylene was fabricated into guar gum and i-carrageenan, two biopolymer-based hydrogel matrices, to develop compact, portable fluorogenic hydrogel sensors and assess their fluorescence properties. A comparative characterization-based analysis was investigated to ascertain the overall compatibility of the hydrogel-based sensors for use as a smart rapid detection tool. Fluorescence spectroscopic investigations yielded promising results of 0.15 ppm limit of detection (LOD) in guar gum and 0.29 ppm LOD in i-carrageenan hydrogels respectively. The practical feasibility of the chemosensor in hydrogel form for mesitylene detection in the vapor phase was also explored. This approach of incorporating chemosensors into biobased hydrogel networks has the potential to broaden its opportunities in the field of chemical, biomedical, and environmental sensing sectors.

Keywords: Carrageenan, Guar Gum, Hydrogel, Mesitylene, Quinoxaline

Impact of Pyrolysis Temperature and Duration on the Adsorption of Drug Pollutants: A Study of Biochar Derived from *Dillenia indica*

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Abstract

This study focused on removing emerging contaminants such as chloroquine, used extensively during the COVID-19 pandemic, and antibiotics (ampicillin, AP; ciprofloxacin, CPX; amoxicillin, AX; and tetracycline, TCL). These drug pollutants cause irreparable harm to our environment. The study reports on the high-yield preparation of biochar (BC) from the waste of *Dillenia indica* (DI) fruit by pyrolysis. The impact of temperature and residence time on the BC yield and properties is reported. This DI biochar (DBC) represents an affordable and sustainable biosorbent for treating drug pollutants. The Freundlich isotherm model confirms that the adsorbate forms a multilayer on the DBC surface, and the pseudo-second-order kinetic model confirms the chemisorption. Notably, the adsorption of drug pollutants reaches equilibrium quickly (in 60 minutes). The maximum adsorption capacity for CP, CQ, and TC was found to be 91 mg g^{-1}, 99.9 mg g^{-1}, and 94 mg g^{-1}, respectively. DBC demonstrates outstanding removal efficiency and excellent recyclability. In conclusion, DBC can be further utilized for other emerging pollutants, as it has proven to be capable of removing antibiotics and antivirals from wastewater.

Keywords: Dillenia Indica, Biochar, Adsorption, Water Treatment, Antibiotics, COVID-19 Antiviral

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Biochar Derivation from Biomass: A Sustainable Approach for the Carbon Sequestration and Soil Enrichment

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Abstract

Biochar is a carbon rich material produced by the process, namely Pyrolysis organic matter. It consists the process of thermally broken down of biomass in a low-oxygen environment to produce biochar, which is a stable form of carbon. This presentation led to a scientific approach for production of Biochar, which summarizes an analysis of chemical and physical properties through a different method characterization. The Strategic application contributes in soil amendment because of its porous structure, ability to store nutrients, and capability to carbon sequestration and pollution mitigation. It offers a sustainable way to utilize the derived biomass while contributing to the climate change mitigation.

Keyword: Carbon Sequestration, Climate Change Mitigation, Pyrolysis

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Adsorption and Interfacial Phenomena of Natural Surfactants for Environmentally Sustainable Process of Oil Recovery

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Abstract

The loss of surfactants during Enhanced Oil Recovery (EOR) due to adsorption onto reservoir rock surfaces is a significant challenge, often leading to increased operational costs and environmental concerns. In line with the principles of green chemistry, this study investigates the adsorption behavior of natural, eco-friendly surfactants on sand and sandstone rock particles under varying conditions, aiming to optimize EOR processes while minimizing environmental impact. In this work, *Acacia concinna* (Shikakai), a non-ionic natural surfactant, was used due to its biodegradability and cost-effectiveness. The adsorption of the surfactant onto sand and sandstone particles was studied using X-ray diffraction (XRD) and Field Emission Scanning Electron Microscopy (FESEM). These analyses provided insights into the mineralogical composition and morphology of the adsorbent, which are critical for understanding surfactant behavior in porous media. Brunauer–Emmett–Teller (BET) analysis was also conducted to quantify the available surface area of the particles. In addition to adsorption studies, Interfacial Tension (IFT) measurements were carried out to assess the surfactant's ability to reduce the oil-water interfacial tension, a key factor in mobilizing trapped oil during EOR. The rheological properties of the surfactant solution were also evaluated to understand its flow behavior through porous media, which directly impacts the efficiency of oil displacement. These additional analyses contribute to a deeper understanding of the surfactant's performance under varying reservoir conditions. The adsorption experiments were conducted at varying temperatures and time intervals to assess the impact of thermal conditions on surfactant efficiency. Solutions of the natural surfactant at concentrations ranging from 0.5 wt.% to 1.5 wt.% were mixed with sand and sandstone particles, and adsorption data were collected at room temperature and elevated temperatures over a series of time points. The results indicate a clear relationship between temperature, surface adsorption, IFT reduction, and surfactant effectiveness. At room temperature, the surfactant exhibited stable adsorption behavior, while higher temperatures showed increased adsorption efficiency and improved IFT reduction, potentially due to enhanced molecular interactions at the surface. The findings demonstrate the potential of using natural surfactants in EOR as a more sustainable alternative to conventional chemical surfactants, significantly reducing the environmental footprint. The incorporation of IFT and rheology studies further underscores the potential for optimizing the surfactant formulation for field applications, paving the way for more green and efficient EOR technologies.

Keywords: *Acacia Concinna*, Enhanced Oil Recovery, Green Chemistry, Interfacial Tension (IFT), Rheology, Surfactant Adsorption

Environment 2024
International Conference on Environmental Challenges, Opportunities and Sustainable Solutions

Challenges and Promises in Revival of Tramways: A Case of Kolkata

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Abstract

The success of urban mobility lies, among others, in the promotion of sustainable and inclusive transit systems. Tramways is distinctive among such modes of transit for it being electrically operated and low in running cost, which makes it an eco-friendly and affordable modal alternative. Additionally, trams hold cultural significance, being operational in Kolkata, the only city in India where they continue to run. Trams also have a high carrying capacity which is the most viable option for crowded cities like Kolkata. However, since the 21st century, the tramways in Kolkata have been gradually diminishing, with several routes either temporarily or permanently discontinued. This study aims to investigate the reasons behind the termination of tram routes and explore future prospects for reviving trams in Kolkata, considering their benefits for sustainable and affordable mobility. The research follows a two-step methodology. The first step involves examining successful cases of tram adoption globally. A critical literature review reveals that the advent of motorized vehicles and personal cars led to the decline of tramways in many countries during the 1950s. However, from the 1970s onwards, many countries reintroduced tramways, transforming them into Light Rail Transit (LRT) systems with technological enhancements to coexist with other urban transportation modes. Various strategies, such as extending tramlines in France and Australia, integrating metro and tramways in Germany, and other approaches in Europe, London, Hong Kong, and Turkey, have successfully revived tram usage and achieved significant ridership. The paper also looks into the failure stories to understand the challenges in rejuvenation of tramways.

The second step focuses on the analysis of the city characteristics and mobility patterns of our case city, Kolkata, through the lens of lessons learned from global scenarios to understand the challenges and opportunities for reviving tramways in Kolkata. To investigate this, reconnaissance survey, tram-user and non-user surveys were conducted across the three operational routes of Kolkata in 2023. The analysis revealed that the majority of respondents in Kolkata favored the resurgence of the tram system, provided it undergoes technological upgrades. The hindrances are identified and strategies are also recommended to overcome those like extension of tram routes in the outskirts of Kolkata or tramways acting as a feeder to other modes, thereby creating a cohesive public transportation network within the city. Addressing these challenges can not only rejuvenate the tramways but also contribute significantly to the goals of the 'National Urban Transport Policy' 2014, promoting urban growth along a low-carbon path. By leveraging the insights gained from international examples and adapting them to the unique context of Kolkata, transport planners and policymakers can create a more efficient, eco-friendly, and inclusive mobility solution for other Indian cities.

Keywords: Developing Country, Inclusive Planning, Sustainable Mobility, Tram Systems, Transit

Assessing the Role of Litter Dynamics of Different Economically Important Trees: Implications for Sustainable Land Management in Dry Tropics

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Abstract

Land use changes due to rapid urbanization has been considered as a major contributor for degradation of urban soil. Integrating economically important tree species along with managing its leaf litter as a natural resource, may serve as an efficient and sustainable approach for restoration of degraded soils. However, there is a notable lack of research on these strategies within urban ecosystems, highlighting the need to address these gaps to develop effective restoration methods for degraded soils. This study elucidates the litter dynamics including decomposition rate both *in- situ* and *ex-situ*, the initial leaf acquisition traits (LAT) and leaf morphological traits (LMT) of four economically important tree species viz. *T. arjuna* (TA), *T. grandis* (TG), *E. citriodora* (EC) and *P. guajava* (PG) with the major objective of restoration of degraded urban ecosystems in dry tropics. The study was conducted at Banaras Hindu University, Varanasi, India. Leaf litter was collected, air-dried, cleaned, and then used for chemical analysis while the rate of decomposition was determined using the litter bag technique. The carbon, cellulose, and lignin content of the initial leaf litter were estimated using the loss on ignition method and by measuring weight reduction due to acid treatment, respectively. Total phosphorus was determined colorimetrically, while total extractable polyphenols and total nitrogen were analyzed by Folin-Denis method and micro-Kjeldahl method, respectively. LMTs i.e., specific leaf area followed the trend: TG> TA> PG>EC, whereas leaf mass per area followed the reverse trend. In TA, LATs involving carbon, nitrogen and cellulose was highest but C/N and lignin/N ratios were lowest, whereas lignin, polyphenol, C/N and lignin/N ratios were highest in PG. In the leaf litter bag experiment decomposition rate followed the trend: TA >TG >EC >PG. *In- situ* and *ex-situ* rate of decomposition of all the four leaf litters were found to be similar. LATs especially lignin/N, N and C/N ratio rather than LMTs were found to be better predictor of the litter decomposition rate. Litter decomposition dynamics are better explained by LATs than by LMTs. The lack of significant differences in decomposition rates between *in-situ* and *ex-situ* conditions suggests that both methods are equally effective for restoring degraded urban land. The comparable edaphic and climatic factors at both sites, aside from variations in tree canopy, floor litter mass, and root biomass, suggest that these elements may not significantly influence decomposition rates. This allows for strategic collection and use of plant litter for off-site restoration without significantly altering decomposition patterns. Additionally, TA which shows a higher decomposition rate, may be recommended for inclusion in restoration strategies. Overall, these observations highlight the significance of integrating leaf litter as a natural resource into restoration strategies of urban degraded soil.

Keywords: Dry Tropics, Leaf Acquisition Traits, Leaf Morphological Traits, Litter Decomposition Rate, Soil Restoration

Development of Green Corrosion Inhibitor using *Duranta Erecta* Leaves

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Abstract

Metals and their alloy are most commonly used as structural material in several industries, such as construction, automotive, aerospace, manufacturing, petrochemicals, food, and pharmaceutical industries, due to their strength, durability, and versatility. These structures are degraded with time primarily due to corrosion. Corrosion is the process of metal degradation due to chemical or electrochemical reactions with its surrounding medium. Corrosion can lead to significant structural and economic challenges across many industries, especially where metal structures are exposed to harsh environmental conditions. Several preventive approaches have been applied to protect the various metals from numerous corrosive environments, including coating, cathodic protection, anodic protection, use of inhibitors, and environmental control. Among all these corrosion control techniques, inhibitors are regarded as one of the most suitable methods for protecting metals in acidic environments due to their advantages: inexpensive, non-toxic, environment friendly, and easily applicable for both regular and irregular shapes of metal bodies. In this study, a novel green corrosion inhibitor was developed using Duranta erecta leaves, and its inhibiting effect was investigated using weight loss and potentiodynamic polarization methods in the acidic medium. Results showed that Duranta erecta leaves extract significantly reduced the metal corrosion as compared to the blank system. Furthermore, the adsorption behavior was studied using Langmuir, Temkin, and Frumkin adsorption isotherms, and the best fit was found for the Langmuir adsorption model. The effect of Duranta erecta leaves extract on the microstructure of metal has been scrutinized through several surface analysis approaches, for instance, Field emission scanning electron microscopy (FESEM), Energy-dispersive X-ray (EDX), and X-ray diffraction (XRD).

Keywords: Adsorption Studies, Corrosion, Green Corrosion Inhibitor, Potentiodynamic Polarization, Surface Analyses

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Evaluating The Potential of Biosurfactant Treated Wastewater for the Removal of Diclofenac Along with A Conventional Treatment Option

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Abstract

The increasing per capita water consumption, driven by more luxurious lifestyles, has led to higher volumes of sewage generation, contributing to the rise of emerging pollutants and increasing the load on sewage treatment plants (STPs). This study aims to treat Diclofenac using biosurfactant along with regular parameters like BOD, COD and Nitrates-N from the real time samples. Experiments have been conducted to produce biosurfactant using Pseudomonas aeruginosa and used for the production of biosurfactant using crude engine oil as an substrate. Screening experiments were conducted to confirm the presence and better yield of biomass production. Results revealed that 70 to 80% removal of Diclofenac was achieved along with removal efficiency for BOD (65.07%) and a COD removal efficiency of (60.12%). pH of the influent and effluent observed was 7.96 and 7.76 respectively. The concentration of Nitrates-N increased from 0.64 mg/L to 5.4 mg/L, likely due to the conversion of ammonia-N to nitrate-N during aeration. Further comparison with biosurfactant-treated wastewater offers insights into alternative treatment approaches for emerging pollutants, paving the way for more efficient and environmentally friendly wastewater management systems. The findings suggest that with slight modifications to the treatment system, the treated effluent from STP could meet the required standards for agricultural irrigation, contributing to a circular economy.

Keywords: Biosurfactants, BOD, COD, Diclofenac, Nitrates-N, *Pseudomonas Aeruginosa*

Slope Stability Analysis and Performance Evaluation of Lithomargic Clay with Phosphorous Slag as Additive- A Review

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Abstract

In South-western coast of India has various deposits of highly problematic soil normally referred to as lithomargic clay in. This problematic silty soil is characterized by its high sensitivity to moisture content with high erosion potential and low shear strength. This study attempts to solve this problem by chemical stabilization of lithomargic clay using Sisal fiber and Ferro-phosphorous slag. Disposing of huge quantities of phosphorous slag (PS) poses a severe impact on the environment. Phosphorous slag has high pozzolanic activity, and utilizing it for the stabilization of soils would be a sustainable and eco-friendly solution. To optimize PS contents for achieving better geotechnical properties of the stabilized soil and to understand the mechanism governing the improvement, a series of laboratory experiments were performed on lithomargic clay by stabilizing it with different amounts and FPS. Optimum Phosphorous slag contents obtained from the laboratory experiments are 10% and 20%, respectively. A significant increase in strength was achieved with this optimized mix. The improvement in strength was justified through the microstructural changes observed due to the formation of cementitious compounds.

Keywords: PS, Lithomargic Clay, Slope Stability

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Feasibility Studies on Biomass Briquettes Production from Organic Solid Waste Feedstocks in Bule Hora Town, West Guji, Ethiopia

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Abstract

Biomass briquettes are a sustainable alternative to traditional biomass fuels like firewood and charcoal in Ethiopia, addressing energy demands and reducing environmental impact. This study examined the production and characterization of biomass briquettes using coffee husks, sawdust, maize cobs, and leaf litter as feedstocks in Bule Hora city, Ethiopia. Waste paper was utilized as a binder at a constant proportion of 25%. Both non-carbonized and carbonized briquettes were evaluated for physical and combustion properties using thermogravimetric analysis. Key parameters analyzed included density, porosity index, shatter resistance, volatile matter, ash content, fixed carbon, and calorific value. The effects of binder ratio, compaction pressure, and dwell time on briquette energy properties were also investigated using SPSS, regression, and ANOVA. Raw feedstocks revealed high volatile matter (80.2±0.45%) and moisture content (11.47±0.15%) in leaf litter, while maize cobs exhibited the highest fixed carbon (16.03±0.22%) and calorific value (1820.54±0.37 kcal/kg). Non-carbonized briquettes (NCB9) showed the highest density (0.56±0.18 g/cm^3), shatter resistance (97.84±0.13%), and compression strength (66.40±0.12 kg/cm^2) with the lowest porosity index (38.97±0.11%). Carbonized briquettes (CB4) exhibited the highest density (0.61±0.13 g/cm^3), shatter resistance (96.35±0.10%), and compression strength (69.43±0.15 kg/cm^2) with a porosity index of 33.92±0.11%. Combustion properties showed NCB9 had the highest fixed carbon (19.26±0.18%) and calorific value (2463.98±0.16 kcal/kg), with the lowest volatile matter (71.98±0.78%), ash content (3.81±0.12%), and moisture content (7.86±0.27%). Carbonized briquettes (CB4) demonstrated superior fixed carbon (82.71±0.24%) and calorific value (4670.92±0.1 kcal/kg), with reduced volatile matter (13.49±0.13%), ash content (1.13±0.25%), and moisture content (2.65±0.58%). ANOVA results confirmed significant differences in physical and combustion properties (p=0.000). Optimal briquette performance was achieved with a binder ratio of 40-50%, compaction pressure of 40-55 bars, and dwell time of 6-8 minutes. These findings underscore the viability of biomass briquettes as a renewable, cost-effective, and environmentally friendly energy source to support Ethiopia's transition to cleaner energy systems. The study provides a framework for scaling up briquette production to reduce deforestation and reliance on traditional fuels.

Keywords: Biomass Briquettes, Combustion Properties, Organic Feedstocks, Physical Properties, Thermo-Gravimetric Analysis

ENVIRONMENT 2024

POSTER PRESENTATIONS

DAY 1 : SESSION I

Date: 09-12-2024 & Time: 12:45 - 14:30

Venue: Core 5 (Venue: Foyer)

Sl. No.	Abstract ID	Name	Title
1	ASPT04	Bhojaraja Mohan	*Advances in Multi-Component Treatment of Organics and Heavy Metals by Adsorption in Industrial and Municipal Wastewater: A review*
2	ASPT18	Shivangi Yadav, Mirtunjay Kumar	*Extraction of Phenolic Compounds from Corn Silk (Stigma Maydis)*
3	AIML02	Nikita Nepal	*An Approach to Achieve Higher Accuracy in Landslide Hazard Zoning (LHZ) through AHP Empowered by Inventory and Statistics*
4	AIML06	Rohit Kumar	*A Data-Driven Approach for the Real-Time Prediction of PM10 and PM2.5*
5	AIML07	Saptarshijyoti Gogoi	*Leveraging Machine Learning to Predict Cadmium Bioaccumulation in Earthworms*
6	AC02	Shruti	*Exploring Aerosol Influence on Indian Monsoon and Rainfall Variability*
7	CCS06	Arjun Singh	*Embodied Carbon in Buildings: A Review of Recent Developments*
8	CCS12	Rishikesh K	*ZIF-8 Synthesis in Deep Eutectic Solvents: Potential for CO2 Capture*
9	EB01	Umesh	*Recent Progress in Pretreatment Technologies for Waste Biomass Conversion to Bioethanol*
10	EB02	Diya Sircar	*Cooling Tower Wastewater Treatment Utilizing Live Algae Navicula species and its Biochar for Producing Value-added Products*
11	EB07	Barkha Chhipa	*Investigation of Physiological Traits in Wheat (Triticum aestivum L.) under Terminal Heat Stress Conditions.*

12	EB12	Akshita Kanwar	*Chimeric Cellulase (AtGH1-L1-AtGH8) of β-glucosidase (AtGH1) and β-1,4-endoglucanase (AtGH8) from Thermophilic Bacterium Acetivibrio thermocellus ATCC 27405 for its Comparative Analysis of Glucose Production with the Individual Enzymes*
13	EB20	Pragya Dadhich	*Determination of Zinc Concentration in the Selected Water Bodies of Udaipur District and Its Remediation by Cyanobacteria*

DAY 1 : SESSION II			
Date: 09-12-2024 & Time: 12:45 - 14:30			
Venue: Core 5 (Venue: Foyer)			
Sl. No.	**Abstract ID**	**Name**	**Title**
14	EN02	Pallabi Paul	*Synthesis of Protein Derived Carbon Dots as a Dual Sensor for Detection of Hg+2 and Tetracycline in Aqueous Medium*
15	EN09	Swagata Pal	*Development of Biochar–Integrated Magnetic Nanoparticles Derived from Mushroom Waste for Enhanced Rhodamine B Dye Removal: A Comprehensive Study on Water Remediation and Phytotoxicity Assessment in Vigna Radiata*
16	EN10	Jatin Sharma	*The Impact of Titanium Dioxide Nanoparticles on Concrete Properties: A Review*
17	EN15	Neeharika Baruah	*Unveiling Hetero Atom Containing Fluorescent Carbon Dots from Indigenous Soil Bacterial Metabolites for Toxic Cr (VI) Ion Detection*
18	SWM08	Lourembam Nongdren	*A Survey-based Approach to Exploring Attitudes, Behaviours, and Beliefs Regarding Cigarette Butt Littering in Aizawl City*
19	SWM11	Souvik Pal	*Improving Waste Reduction and Bioconversion Efficiency Through BSFL Composting: A Sustainable Approach to Waste Management in India*
20	SWM19	Tchummegne Kouam Ida	*Pharmaceutical Removal from Wastewater using Microbial Fuel Cell and Their Impact on Current Production and Microbial Community: State of Art and Future perspective*
21	SWM29	Prangan Duarah	*Optimizing Hydrothermal Carbonization of Factory Tea Waste for Enhanced Fuel Properties and Adsorptive Performance of Activated Hydrochar*

22	SWM33	Onkar Chowkekar	*TGA Based Kinetic Study of Simulated Red Category Bio-Medical Waste*
23	RACC06	Anukriti Srivastava	*In-Silico Approach to EST Marker Design: Co-Relation with Physio-morphological and Agronomic Traits of Wheat (Triticum aestivum L.) under High Temperature and Humidity*
24	RACC07	Taruna Sharma	*Screening of Heat Tolerant Genotypes in Bread Wheat (Triticum aestivum L.) under Terminal Heat Stress Using Heat Susceptibility Index*
25	ELEM06	Prakash Chaturvedi	*Opportunities and Challenges for India as a Green Economy*

DAY 2 : SESSION III			
Date: 10-12-2024 & Time: 13:00 - 14:30			
Venue: Core 5 (Venue: Foyer)			
Sl. No.	**Abstract ID**	**Name**	**Title**
26	RSEM01	Barasha Rani Konwar	*Integrating Plant Functional Traits and Remote Sensing for Comprehensive Macrophytic Health Monitoring in Wetlands*
27	RSEM02	Himanshu Gupta	*Quantifying Silt Load and Emission Rates from Road Dust in Silchar: Trace Element Analysis and Source Identification*
28	RSEM06	Boria Anya	*Delineation of Groundwater Potential Zones in The Noa-Dihing River Basin, Arunachal Pradesh – An Approach Using Geomorphometry, AHP and Multiple Criteria Decision-Making*
29	RSEM08	Dhananjay Tripathi	*Evaluating Human Exposure to Microplastics in Atmospheric Fallout: Health Risk Considerations*
30	RSEM12	Shreya Sharma	*Identification of Water Hyacinth in The River/Lake System Using Advanced Remote Sensing Technique: A Review*
31	OET03	Dhriti Kalita	*Occurrence of Bacterial Pathogens after Yearly Flooding Episodes in the Water Sources over a Riverine Settlement of Mid-Brahmaputra Valley, India*
32	OET04	Nidhi Pandey	*Sustainable Economic Development of India through Ecological Strategies of Festive Marketing*
33	OET07	Rajib Das	*Modeling the Contribution of Two-wheelers to Urban Road Traffic Noise using SoundPLAN*

34	OET08	Rahul Kumar	*Microkinetic Modelling on Ni(111) for Methane Cracking and Experimental Insights to Dry Reforming of Methane using Ni/Al2O3 Catalyst*
35	OET11	Paras Krishna Kothari	*A Review on Modification of Properties of Cement Mortar and Concrete with Addition of Reduced Graphene Oxide*
36	OET14	Golla Sreekanth Yadav	*Review of Current Approaches towards Recycling of Spent Lead Acid Batteries: Ecological and Human Health Risks Associated with Metals*
37	OET19	Biplab Sarmah	*Calibration and Validation of SWAT Hydrological Model using Remote Sensing Data: A Review*
38	OET21	Ashutosh Singh	*Degradation Kinetics of 4-Nitrophenol and its Control by Ozone Bubble with and without Nanocatalyst in an Ozone Bubble Column Reactor*
39	OET29	Gyanaranjan Jena	*Potential of Jamun Pulp as Natural Coagulant for Effective Removal of Surfactant in Wastewater*
40	OET30	Hemanshu	*Isolation, Characterisation, and Diesel Degradation Potential Study by a New MDR strain of P. aeruginosa Sourced from Hospital Effluent*

DAY 2 : SESSION IV			
Date: 10-12-2024 & Time: 13:00 - 14:30			
Venue: Core 5 (Venue: Foyer)			
Sl. No.	**Abstract ID**	**Name**	**Title**
41	SPD03	Prasath V L	*Keratin Extraction from Tannery Animal Hair Waste: A Comparative Study of [BMIM]Cl Dissolution Method using Conventional and Acoustic Cavitation-Assisted Technique for Sustainable Process*
42	SPD11	Munshi Izaz Refaz	*Transforming Waste to Energy: Sustainable Composite Fuel Consists of RDF Obtained from Landfill Biomining for Cement Production in India*
43	SPD14	Silinbou Newmai	*Development of a High-Performance Portable Solar Dryer*
44	SPD19	Dinesh Ahongshangbam	*Sustainable Stabilization of Expansive Soils Using RHA-Based Geopolymer*
45	SPD21	Sushmita Konwar	*Earthworm Casts and Ecosystem Resilience Towards Sustainable Soil Health in Assam*

46	SPD23	Akshit Kaundal	*A review on synergistic effect of addition of different types of nano clays on cement-based composites*
47	SPD25	Nayan Jyoti Khound	*Breakthrough Curve Analysis and Fixed Bed Dynamic Modelling of Bio-sorption of Pb (II) from Aqueous Medium*
48	SPD36	Jumi Kalita	*Advances in Natural Hydrogels through Composite Fabrication for Various Environmental Applications*
49	SPD41	Niladri Sekhar Roy	*Post-Harvest Storage Solution for Small and Marginal Farmers Employing Visible Light – An Alternative of Cold Storages*
50	GC01	Mankaran Singh	*Chlorophyllase from Microalgal Fermentation and Induction Using Chlorella Species and Its Application for Pigments Removal in Edible Oil*
51	GC02	Satwika Das	*Bioconversion of Mixed Food Waste to Citramalic Acid using Engineered Pichia Pastoris for the Development of a Sustainable Biorefinery*
52	GC05	Chandukishore.T	*Engineering of Yarrowia Lipolytica for D-Lactic Acid Production using Food Waste*

Theme: ASPT

Advanced Separation and Purification Techniques

Poster Presentations

Advances in Multi-Component Treatment of Organics and Heavy Metals by Adsorption in Industrial and Municipal Wastewater: A review

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Abstract

Heavy metals and organic compounds in industrial wastewater are common problems. Usually, both pollutants exist together, further complicating their treatment since different remediation methods are required for each contaminant to be effectively removed. This coexistence poses great environmental and health hazards because of the toxicity and persistence of heavy metals and organic pollutants. This study aims to achieve the complete removal of both heavy metals and organic pollutants from contaminated water at the same time. Adsorption is an effective treatment option for industrial wastewater containing organics, and heavy metals since the adsorbent material can be customized to remove multiple types of contaminants simultaneously. This process could achieve high removal efficiency, it is possible to regenerate the adsorbent cost-effectively, it is scalable for large-scale applications, and since this process would effectively decrease the concentration of the pollutants, the waste became less toxic. Moreover, adsorption could be used in combination with other processes to remove all contaminants from industrial wastewater. The individual removal of organic and inorganic pollutants by any treatment method is feasible, however, their simultaneous existence in industrial or municipal wastewater poses many difficulties for complete removal. Such a scenario has been focused on in this manuscript by sustainable treatment methods through adsorption for the simultaneous removal of these pollutants. This manuscript critically summarized the advantages, performance and impact of various activated carbon adsorbents on the simultaneous removal of integrated organic and inorganic pollutants from either industrial or municipal wastewater.

Keywords: Adsorption, Heavy Metals, Mechanism, Organic Pollutants, Wastewater

Extraction of Phenolic Compounds from Corn Silk (Stigma Maydis)

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Abstract

Corn silk typically regarded as waste and it is thrown during the production of baby corn and highly sweet corn products on the other hand Corn silk has been exploited as an herbal remedy in traditional medicine by native Americans, Chinese and various cultures, phytochemicals in corn silk exhibits antioxidant properties and health benefits. Corn Silk can be used as supplement and it can provide various health benefits while using as daily dietary source. In the present study, ultrasound-assisted extraction of polyphenols from corn silk was investigated and optimized. Response surface methodology (RSM) based on a five-level four-factor central composite surface design (CCD) was employed to obtain the optimal extraction conditions by simultaneous maximization of extraction yield, TPC yield and TFC yield. The effects of various extraction parameters such as extraction temperature (30-70 °C), extraction time (15-75 min), ethanol concentration (10-90% (v/v)) and solvent-to-solid ratio (10–50 mL/g) on the extraction yield, TPC yield and TFC yield were studied. All experiments were performed according to statistical designs in presence of fixed ultrasonic power of 100 W. The analysis of variance (ANOVA) was performed to validate the developed quadratic models. The optimum extraction conditions (59.9°C, 43.5 min, 53.2 % ethanol concentration, and 40 mL/g) produced an extract with 32.6% extraction yield, 68.8 mg GAE/g d.e. TPC yield and 27.4 mg QE/g d.e. TFC yield with significant antioxidant activity (DPPH). The statistical analysis revealed that the extraction yield, TPC yield and TFC yield were significantly affected by the linear and quadratic effect of L/S ratio, ethanol concentration and temperature ($p<0.0001$). Eigenvalue analysis revealed that all the eigenvalues of Hessian matrix constructed from overall desirability function were negative at the optimal conditions, indicating the condition of maximum. The HPLC analysis of corn silk extract revealed the presence of gallic acid, ellagic acid, caffeic acid, catechin and p coumaric acid. The present study demonstrated that the aqueous ethanolic extract of corn silk could be used as a potential source of phenolic compounds.

Keywords: Analysis of Variance, Corn Silk, Polyphenols, Response Surface Methodology, Ultrasonic Assisted Extraction

Theme: AIML

AI and ML in Environmental Sciences

Poster Presentations

Environment 2024
International Conference on Environmental Challenges, Opportunities and Sustainable Solutions

An Approach to Achieve Higher Accuracy in Landslide Hazard Zoning (LHZ) through AHP Empowered by Inventory and Statistics

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Abstract

Landslide hazard zoning (LHZ) is carried out to demarcate zones with different degree of susceptibility to landslide. With the advancement of science and technology, numerous modern and sophisticated techniques have been emerged and evolved for assessment of landslide susceptibility and delineation of landslide prone zones. However, despite the high chance of bias and subjectivity, the Analytic Hierarchic Process (AHP) is still one of the most widely used techniques for LHZ. In this study, LHZ has been carried out for the Gangtok and Pakyong districts of Sikkim, India which suffer severely due to frequent landslides. The AHP technique was employed for the LHZ with the help of three experts having experience in landslide research. The results depicting landslide-susceptibility of different zones obtained through the AHP and experts' opinions are found to be different. This is due to the difference in understanding, experience and personal bias of the experts in determining the factor-influence on landslide. Thus, the study has pointed out the inherent subjectivity involved in the AHP technique. Without the knowledge of the landslide inventory of the concerned area, the experts' opinions are dependent entirely on their individual concept that differs widely regarding the weights of different factors that govern the occurrence of landslides. Further, the study has demonstrated how landslide inventory and frequency ratio (FR) can be used to improve the AHP based LHZ to achieve higher accuracy and efficiency. The LHZ map thus produced has delineated five zones in the Gangtok and Pakyong districts of Sikkim corresponding to very low, low, moderate, high, and very high risk for landslide.

Keywords: AHP, Inventory, Landslides, LHZ, Risk, Sikkim

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A Data-Driven Approach for the Real-Time Prediction of PM_{10} and $PM_{2.5}$

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Abstract

In the past few decades, air pollution has become a major environmental and health hazard in growing cities like Guwahati. Rapid Urbanization and the growth of the vehicular population cause detrimental consequences on health and environment. Alteration of the quality of air is one of the major outcomes. A machine-learning based model is a vital approach for the prediction of pollutant concentration. The alternate machine-learning-based model incorporated variations in data size which included real-time pollution data, vehicular population data and meteorological data. This presentation applied alternate machine learning-based models such as Random Forest (RF) and Extreme Gradient Boosting (XGB), Decision Tree (DT), Multilayer Perceptron (MLP), Support Vector Regression (SVR) and K nearest neighbour (KNN). The models were assessed in terms of important measures such as the coefficient of determination (R^2), mean absolute error (MAE), and root mean square error (RMSE). These findings highlight the efficacy of machine learning models for their ability and effectiveness to estimate air quality. Thereby, such studies can provide better foresight for the policy makers for safeguarding the air quality and mitigating its impact on social well-being.

Keywords: Data Analysis, Machine Learning, Meteorological Parameters, Particulate Matter, Prediction. Vehicle Count

Leveraging Machine Learning to Predict Cadmium Bioaccumulation in Earthworms

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Abstract

Artificial Intelligence (AI) and Machine Learning (ML) have become indispensable in environmental science, enhancing data interpretation and predicting complex ecological patterns. With their robust predictive modelling, these technologies help to uncover complex relationships in vast datasets and address challenges posed by environmental variability. Among various ML approaches, the random forest method has gained traction for its accuracy and interpretability in ecological data analysis. As a key bioindicator, Earthworms play a critical role in ecosystem health and soil remediation, yet they are vulnerable to metal contaminants like cadmium, which affect their physiological and ecological functions. By leveraging random forest, an ensemble learning algorithm known for its high accuracy and ability to handle large datasets with minimal assumptions, we generated a predictive model for cadmium bioaccumulation with a strong correlation to observed data. The model's performance was evaluated using R-squared and mean absolute error metrics, demonstrating strong predictive capabilities. These findings not only provide insights into the role of soil properties in Cd uptake but also contribute to improving soil contamination assessment methods. Our findings underscore the potential of ML techniques like random forest in enhancing the understanding of bioaccumulation processes, providing a predictive framework for assessing heavy metal risks in soil ecosystems. This approach supports environmental risk assessments, facilitating better resource management and targeted remediation strategies. As ML continues to evolve, its application in ecological science promises substantial advancements in monitoring, prediction, and mitigation, contributing to sustainable ecosystem management and conservation.

Keywords: Cadmium Bioaccumulation, Earthworm Bioindicators, Machine Learning, Random Forest Model, Soil Contamination Assessment

Theme: AC

Atmospheric Chemistry

Poster Presentations

Exploring Aerosol Influence on Indian Monsoon and Rainfall Variability

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Abstract

The study investigates the relationship between aerosol loadings and rainfall anomalies over the Indian subcontinent from 1982 to 2023. Aerosol Optical Depth (AOD) data were retrieved from the NCEI Global Ocean Aerosol Optical Thickness Climate Data Record, using AVHRR sensors, while rainfall data were sourced from the ERA-5 reanalysis dataset. The Indian subcontinent, a region heavily influenced by monsoonal circulations, exhibits average AOD values exceeding 0.4 throughout the study period. This elevated aerosol loading suggests a significant alteration in atmospheric dynamics, which can have cascading effects on regional precipitation patterns, particularly during the monsoon season. Our analysis of monthly AOD and rainfall data reveals that higher aerosol concentrations coincide with notable disruptions in monsoonal rainfall distribution. Increased atmospheric aerosol loading likely causes cooling by reflecting incoming solar radiation, interfering with the thermodynamic processes that drive monsoon circulation. This cooling effect can alter the land-sea temperature gradient, a critical driver of monsoon dynamics, leading to anomalies in rainfall intensity and spatial distribution. The study shows a clear correlation between elevated AOD values and observed rainfall anomalies, with enhanced aerosol presence contributing to reductions or shifts in precipitation patterns during critical periods of the monsoon season. These disruptions underscore the important role of aerosols in modulating the regional climate, particularly through their influence on monsoonal processes. The results highlight the need for further research to quantify the precise mechanisms through which aerosols impact monsoon dynamics. The findings suggest that mitigating aerosol emissions is crucial to reducing the potential climate risks of altered monsoon patterns. Understanding the aerosol-monsoon relationship will be vital for devising climate adaptation strategies in the Indian subcontinent, which is highly vulnerable to monsoonal variability.

Keywords: Aerosols, Climate Variability, Monsoon Dynamics, Rainfall Anomalies

Theme: CCS

Carbon Capture and Sequestration

Poster Presentations

Embodied Carbon in Buildings: A Review of Recent Developments

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Abstract

The building and construction sectors are by far the largest emitter of greenhouse gases, accounting for global emissions. The building and construction industry accounts for nearly 37% of global carbon emissions. Embodied carbon refers to the greenhouse gas (GHG) emissions associated with the entire lifecycle of building materials, from extraction to manufacturing, transportation, installation, maintenance, and eventual disposal, contributing greatly to carbon emissions. Quantitative assessments of embodied carbon emissions in a building can play a crucial role in providing environmentally sustainable solutions in the building sector. Planning must begin during the planning and design stage of a project to reduce embodied carbon, calculating the share of materials selected in terms of their corresponding carbon footprint. Through qualitative evaluation of relevant literature, this paper presents a synthesized review of design strategies and methodologies for reducing embodied carbon in structural systems. It investigates the extent of embodied carbon emissions from buildings, examining their role in climate change and the efficacy of current strategies to reduce embodied carbon in Buildings. Comprehending these impacts is essential for developing sustainable practices and reducing the carbon footprint of the built environment.

Keywords: Embodied Carbon, Greenhouse Gas, Sustainability, Planning, Climate Change

ZIF-8 Synthesis in Deep Eutectic Solvents: Potential for CO_2 Capture

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Abstract

Controlling anthropogenic CO_2 emissions is the most important task in scientific challenges for sustainable development and global economy. Carbon capture technologies are mandatory to reach the climate goals and MOFs are turning out to be a potential solid adsorbent that is highly efficient for CO_2 capture. Typically, solvothermal/hydrothermal, microwave, electrochemical, mechanical, sonochemical, slow evaporation, and diffusion techniques define the synthesis of Metal-Organic Frameworks (MOFs). Although the solvothermal method is frequently employed, it often demands high temperatures and pressures, which makes it time-consuming, energy-intensive, and maybe dangerous given the great volatility and toxicity of ordinary organic solvents. Because their hydrophilic character reduces gas collection, these solvents can also adversely affect adsorption efficacy. Current physical adsorbents limit their efficiency in uses including CO_2 collection by lacking ideal properties like high absorption capacity, selectivity, quick kinetics, low regeneration energy, and lifetime. In this regard, deep eutectic solvents (DES) offer a green substitute for conventional organic solvents that seems interesting. Offering remarkable thermal and chemical stability, tunability, and environmental friendliness, DES are created via hydrogen bonding interactions between a hydrogen bond acceptor (HBA) and a hydrogen bond donor (HBD). This work investigates the production of ZIF-8, a MOF distinguished for gas adsorption properties, under DES as a solvent. With this work, we seek to improve adsorption selectivity and stability by using DES, hence lowering energy requirements and minimising the use of hazardous solvents. Various characterization studies including FTIR, XRD, FESEM, and adsorption isotherms support the study's conclusion. Advancing the realm of gas capture technologies, this method may open the path for more sustainable, efficient, and better-performance MOF adsorbents.

Keywords: Carbon Capture, MOFs, ZIF-8, Deep Eutectic Solvents (DESs), Adsorption

Theme: EB

Environmental Biotechnology

Poster Presentations

Recent Progress in Pretreatment Technologies for Waste Biomass Conversion to Bioethanol

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Abstract

The increasing focus on addressing the problem of energy demand and environmental concerns has led to exploration of eco-friendly pretreatment methods for bioethanol production. Bioethanol biofuel is promising as an alternative bioenergy source to fossil fuels, like gasoline, because it has a carbon neutral emission profile. The major challenge faced is improving the bioethanol fermentation efficiency of lignocellulosic biomass (LCB) is due to the presence of lignin in LCB. Pretreatment methods imply the process of breaking down the crystalline structure of lignocelluloses by effectively removing lignin and separating cellulosic and hemicellulosic components. These polysaccharide components, specifically cellulose and hemicellulose, can be broken down into pentose and hexose sugars through hydrolysis. After that, these pentose and hexose sugars can be converted into bioethanol by fermentation process. As a result of which the bioethanol fermentation of LCB becomes more efficient. Nowadays, various recent advancements in the pretreatment methods have been established for the pretreatment of LCB.

This review article provides a comprehensive overview of the new methods and chemicals employed in the physical, chemical, biological and thermal pretreatment of LCB to improve the process of bioethanol fermentation. Furthermore, the mechanism, applications, benefits, drawbacks, and limitations of each form of pretreatment have also been discovered. Ultimately, this review will offer novel concepts for the advancement of pretreatment methodologies.

Keywords: Bioethanol, Cellulosic, Fermentation, Pretreatment, Lignocellulosic Biomass

Cooling Tower Wastewater Treatment Utilizing Live Algae *Navicula* species and its Biochar for Producing Value-added Products

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Abstract

Cooling tower blowdown presents significant environmental challenges due to high concentration of contaminants that severely impact aquatic ecosystems and water quality. To address these harmful effects, the cultivation of diatoms offers an innovative and critical advancement in sustainable water treatment strategies. Diatoms are known for their intricate silica-based outer shell known as frustule, which is pivotal in promoting carbon fixation, biomagnification, and nutrient recycling, hence naturally purifying water bodies. Diatoms also yield value-added products like biofuels, pharmaceuticals, and nanotechnology materials. This study investigates the cultivation of diatoms of *Navicula* species using WC medium for inoculum preparation which was used for two primary objectives: cooling tower blowdown treatment using live *Navicula* species and its biochar along with production of value-added products. *Navicula* species stands out for its adaptability and potential in treating polluted water bodies due to its robustness in such environments. The cultivation process involves assessing the efficiency of *Navicula* species in removing heavy metals and silica from the cooling tower blowdown to reduce scaling in towers and freshwater utilization. The diatom concentration is a valuable resource for extracting high lipid content, essential for biofuel production and other value-added products. This method aims to maximize diatom growth and its capacity for bio-utilization of nutrients efficiently. The 15 days fermentation time played a crucial role in understanding the nutrient consumption in live cultures. The cultures were grown in the BOD Incubator, with and without orbital shaking, with specific growth rates of 0.12 and 0.15 per day, respectively, and at ambient room temperature outside the BOD incubator shaker with a specific growth rate of 0.10 per day. Over this period, 76%, 70% and 85% nitrate and 46%, 40% and 53% phosphate were consumed for three set of culture conditions with shaking, without shaking and at the ambient room temperature without shaking respectively. The uptake of silica was faster in the outside culture than in the shaker set-up and least in the BOD incubator without orbital shaking set-up. Lipid yield over biomass produced varies from 9-28% w/w of *Navicula* species produced in presence of residual nitrate. Diatom biochar showed a specific removal rate per minute per mg of biochar as 0.06% and 0.045% for Pb^{2+} and Cu^{2+} respectively, suggesting fast bioremediation by *Navicula* species. The findings from this research contribute to understanding *Navicula* species' effectiveness in eco-friendly wastewater treatment without producing toxic waste and exploring the production of valuable resources from diatom biomass. The present research also contributes to UN-SDG 6 aiming for clean water and sanitation also UN-SDG 13 of climate action.

Keywords: Biochar, Biosorbent, Diatom, Lipid, Wastewater Treatment

Investigation of Physiological Traits in Wheat (*Triticum aestivum* L.) under Terminal Heat Stress Conditions.

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Abstract

High temperatures affect various morpho-physiological and agronomical traits in wheat crops. To investigate the impact of heat stress on different physiological traits during the crop seasons of 2022-2024, twelve bread wheat genotypes were sown in three replicated trials under timely-sown (TS) and late-sown (LS) field conditions at Krishi Vigyan Kendra, Banasthali Vidyapith, Rajasthan. Heat stress during the reproductive stage of the wheat crop results in the sterility of pollen grains and reduced yield. It is important to identify genotypes with higher pollen viability, as they are most sensitive to extreme temperatures. Pollen viability was examined using the iodine-potassium iodide (IKI) method. Wheat grain yields also highly depend upon the number of spike-bearing tillers produced per plant. The heat susceptibility index (HSI) was used as a screening criterion to determine heat-sensitive and heat-tolerant genotypes.

The findings showed that heat stress significantly reduced the number of productive tillers and the number of viable pollen grains. Heat susceptibility index (HSI) values recorded for pollen viability and productive tillers ranged from -0.79 to 3.59 with a mean value of 0.98 and -0.61 to 1.87 with a mean value of 0.86, respectively. Five genotypes, namely GW 513, MACS 6222, HD2932, PBW771, and HP 1744, were heat-tolerant (HSI < 1) for both the traits. SSR (simple sequence repeats) markers were also utilised to indicate the existence of polymorphism between genotypes.

Keywords: HSI (Heat Susceptibility Index), Pollen Viability, Productive Tillers, SSR (Simple Sequence Repeats) Markers, Terminal Heat Stress

Chimeric Cellulase (*At*GH1-L1-*At*GH8) of β-glucosidase (*At*GH1) and β-1,4-endoglucanase (*At*GH8) from Thermophilic Bacterium *Acetivibrio thermocellus* ATCC 27405 for its Comparative Analysis of Glucose Production with the Individual Enzymes

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Abstract

It becomes imperative to make the conversion process of biomass to bioethanol commercially and economically effective by adapting technologies which include less expensive pre-treatment technologies and using cellulases with high efficacy for biomass saccharification. Cellulases are Glycoside hydrolases that constitute several enzymes acting together to carry out the hydrolysis of cellulose into shorter-chain polysaccharides like cellodextrin, cellobiose or glucose. In the present study, a bi-functional cellulosic chimera was constructed. The genes encoding β-glucosidase from GH family 1 (AtGH1) and endoglucanase from GH family 8 (AtGH8) were fused by using a natural linker from the cellulosomal gene celH from Acetivibrio thermocellus. The chimera, AtGH1-L1-AtGH8 showed maximum endoglucanase activity (5900 µmol min-1µmol of protein-1) using 1%, w/v CMC-Na at 72ºC and pH 5.8 (50 mM citrate phosphate buffer). AtGH1-L1-AtGH8 showed maximum β-glucosidase activity (4800 µmol min-1 µmol of protein-1) using 1 mM p-Nitrophenyl glucopyranoside at 68ºC, pH 5.8 (50 mM citrate phosphate buffer). The biomass sugarcane bagasse was subjected to the alkali followed by the acid pre-treatment. The enzymatic hydrolysis of the pretreated biomass using the chimeric enzyme yielded 85 mg/g of glucose, while the enzyme mixture containing the individual enzymes AtGH1 and AtGH8 yielded 55 mg/g of glucose. Furthermore, the MALDI-TOF analysis of the hydrolyzed products of biomass saccharification by chimera AtGH1-L1-AtGH8 and individual enzymes AtGH1 and AtGH8 showed various oligosaccharides. Linear positive mode MALDI-TOF mass spectra of cello-oligosaccharides released by incubating chimera with pretreated biomass for 36 h displayed glucose peak [M+Na+] at m/z 203, in addition to peaks corresponding to pre-dominantly cellotriose [M+2Na+] and cellotetraose [M+Na+] at m/z 550 and 689.5, respectively. Similar results were found when the biomass was incubated with the enzyme mixture AtGH1+AtGH8, however with much lower intensities. Linear positive mode MALDI TOF mass spectra of oligosaccharides released by only endoglucanase AtGH8 with pretreated biomass for 36 h displayed cellobiose [M+Na+], cellotriose [M+Na+], cellotetraose [M+K+], cellopentaose [M] and cellohexaose [M+K+] at m/z values 365, 527, 728.5, 828.7 and 1013 respectively but no glucose. Hence, the endoglucanase, AtGH8 can hydrolyze the cellulosic chain in the pretreated biomass to give higher oligosaccharides, but the chimeric enzyme has the ability to synergistically generate the cello-oligosaccharides and further hydrolyze them to release glucose as the final product.

Keywords: *Acetivibrio thermocellus*, Bioethanol, Chimera, Glucose, Glycoside Hydrolase

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Determination of Zinc Concentration in the Selected Water Bodies of Udaipur District and Its Remediation by Cyanobacteria

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Abstract

Monitoring zinc concentrations in water bodies is crucial, as contamination can severely impact both aquatic ecosystems and public health by compromising water quality. Despite its importance, there is a noticeable gap in research on zinc pollution in the water bodies of Udaipur district, Rajasthan. This study aims to fill that gap by investigating the zinc levels across various water bodies in the region, evaluating the extent of pollution and its potential effects on the environment and human health. Water samples were collected seasonally from five locations—Lake Pichola, Lake Fateh Sagar, Ayad River, Sukha Naka, and Dabok Pond—during the 2023-2024 period. The results showed that zinc concentrations in Lake Pichola and Lake Fateh Sagar remained consistently below detectable levels (<0.01 mg/l) throughout the year, suggesting minimal contamination. In contrast, Ayad River and Sukha Naka showed slightly elevated zinc levels during the summer months. Dabok Pond, however, exhibited consistently measurable zinc concentrations, pointing to a persistent source of contamination. The study underscores the urgent need for ongoing monitoring and proactive management of water quality in Udaipur.

The second part of the study will look forward to determine the potential of cyanobacteria to remediate zinc from waste water. Results of the studies from the world have demonstrated that cyanobacteria can significantly reduce zinc concentrations in wastewater. This biological approach not only provides a cost-effective and environmentally friendly solution but also reduces the need for harsh chemicals traditionally used in metal removal. Cyanobacteria-based bioremediation thus offers a sustainable alternative with promising implications for wastewater treatment, contributing to both environmental protection and resource recovery.

In conclusion, the findings of the study hopefully will be applied in offering an eco-friendly and sustainable approach to address metal pollution in aquatic ecosystems. Incorporating such biological solutions could compliment traditional water management strategies, contributing to the preservation of water quality and the overall health of aquatic environments.

Keywords: Bioremediation, Cyanobacteria, Udaipur, Water bodies, Zinc

Theme: ELEM

Environmental Law, Economics and Management

Poster Presentations

Opportunities and Challenges for India as a Green Economy

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Abstract

As global economic activities evolve, their environmental impacts have become increasingly significant, prompting a shift towards green economic practices. This trend has catalyzed the development of innovative public policies aimed at fostering a green economy and promoting sustainable growth. Recent international commitments, including India's ratification of the Paris Agreement and its dedication to the 2030 Global Development Agenda, underscore the urgency of this transition. The concept of a green economy gained traction during the late 2000s economic crisis, recognized as a strategy to stimulate recovery through the creation of green jobs and investments. South Korea's pioneering approach of "Low Carbon Green Growth" in 2008 has inspired similar initiatives globally. Despite India's impressive economic growth, which has significantly reduced poverty, environmental degradation and resource scarcity pose substantial challenges. The Study will explore the complex interplay between economic development and environmental sustainability in India, highlighting the opportunities for advancing a green economy and the critical issues that need addressing toachieve a balanced and inclusive growth model.

Keywords: 2030 Global Development Agenda, Green Economic Practices, Green Jobs, Low Carbon Green Growth (2008), Paris Agreement, Sustainability

Theme: EN

Environmental Nanotechnology

Poster Presentations

Synthesis of Protein Derived Carbon Dots as a Dual Sensor for Detection of Hg^{+2} and Tetracycline in Aqueous Medium

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Abstract

Antibiotics and heavy metals are two major contaminants that possess sever health risk towards health and eco system. Effective remediation requires monitoring contaminant levels in the environment. Traditional detection methods like high-performance liquid chromatography (HPLC), electrochemical techniques, liquid chromatography-mass spectrometry (LC-MS), and capillary electrophoresis have been employed, but fluorescence-based approaches offer a simpler and more straightforward alternative. Therefore, we have prepared protein biopolymer derived carbon dots to monitor environmental contaminants, particularly antibiotics (such as tetracyclines) and heavy metals (like mercury). CDs has exhibited a remarkable quantum yield of 36% without incorporation of foreign element, can effectively detected tetracyclines such as tetracycline (TC), chlortetracycline (ClTC), and doxycycline (DTC) and Hg^{2+} in aqueous mediums. The nano sensor exhibited high fluorescence quenching (up to 99% for antibiotics and 86% for Hg^{2+}) and excellent sensitivity, with detection limits in the nanomolar range. The sensor also demonstrated fast response times (less than 10 seconds) and high selectivity in real samples like serum, urine, milk, and cigarette extract. CDs coated paper strip experiment has exhibited up to nanomolar detection for both the analytes, making the sensor applicable as portable system. The quenching mechanism was thoroughly investigated, and the sensor's application shows promise for environmental protection and ecosystem safety.

Keywords: Carbon Dots, Mercury Detection, Nanosensor, Paper Strip Detection, Tetracycline Detection

Development of Biochar–Integrated Magnetic Nanoparticles Derived from Mushroom Waste for Enhanced Rhodamine B Dye Removal: A Comprehensive Study on Water Remediation and Phytotoxicity Assessment in *Vigna Radiata*

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Abstract

The release of Rhodamine B dye into aquatic ecosystems poses significant environmental challenges, underscoring the urgent need for innovative and sustainable remediation strategies. This study explores the development and characterization of biochar-integrated magnetic nanomaterials synthesized from mushroom waste, aimed at effectively adsorbing and removing Rhodamine B dye. The engineered nanomaterials demonstrated an excellent adsorption efficiency of 95% under optimized conditions, highlighting their potential as a practical solution for dye pollution. A systematic investigation of key operational parameters, including pH, temperature, and contact time, was conducted to evaluate their effects on adsorption kinetics and equilibrium behavior. Characterization studies show increased surface area and various functional groups within the nanomaterials, enhancing their capacity for dye adsorption. A phytotoxicity test was conducted using the *Vigna radiata* plant (green gram) to test the ecological safety of the treated effluent. The results indicated that no adverse effects on seed germination or biomass production, confirming the non-toxic nature of the treated water. These findings suggest that utilizing mushroom waste-derived magnetic nanomaterials represents a novel and sustainable approach to effectively mitigate Rhodamine B dye contamination in water bodies. The synergy between biochar and magnetic nanoparticles further optimizes the interaction with dye molecules, facilitating a more effective adsorption mechanism. The approach also aligns with green chemistry principles, promoting waste valorization and resource recovery. This research not only addresses the critical issue of dye pollution but also contributes to the circular economy by valorizing agricultural waste, thereby advancing sustainable wastewater treatment practices. Hence, the current study emphasizes the potential of mushroom biochar-based nanomaterials in improving water quality and their application in the field of water remediation.

Keywords: Biochar, Nanomaterials, Phytotoxicity, Rhodamine B, Water Remediation

The Impact of Titanium Dioxide Nanoparticles on Concrete Properties: A Review

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Abstract

Concrete is one of the most utilized and most important construction materials. To design a good strength structure, it is a must to design a good strength concrete. However, the cement used in concrete is brittle, having low tension strength, formation of cracks due to small size particles at younger stages. These properties of cement are modified using supplementary elements called nanoparticles which have particle size much lesser than that of cement particles approximately about in the range of 1 to 100 nanometers. Titanium dioxide is very useful in industry due to its chemical inertness, low cost, and availability. Recent developments concentrate on the extent to which alterations to the surface characteristics of titanium dioxide either enhance or inhibit its reactivity. It is beneficial due to its twin function to behave as each a semiconductor and light scatterer. Understanding how titanium dioxide impacts these industries is therefore relevant to its optical performance. Recent developments focus on the extent to which modifications to the surface characteristics of titanium dioxide either enhance or impede its reactivity. Recent concerns about titanium dioxide's toxicity have arisen due to its potential classification as a human carcinogen. These controversies are explored by highlighting the inconsistencies between experimental toxicity protocols and their results. It is important to review the latest advancements in fast-growing industries where titanium dioxide is broadly used, while keeping in mind insights into its disputed toxicity.

Natural titanium dioxide (TiO_2) found in three different polymorphs (rutile, anatase, and brookite). TiO_2 is utilized in diverse industries due to its remarkable properties (structural, optical, electrical, chemical, non-toxic, etc.). The utilization of TiO_2 is influenced by its size, surface, morphology, and crystal phase. TiO_2 as a photocatalyst is used in energy and eco-friendly applications which involve water purification, hydrogen production, phenol degradation, etc. This paper covers the recently reported methods that are used to synthesize TiO_2 nanoparticles, such as sol-gel, hydrothermal, precipitation, etc. The different properties of TiO_2 are also provided in this paper. This paper involves the review of use of titanium dioxide as a nanoparticle and its effect on the strength, early characteristics, mechanical properties and the durability of concrete. Use of nanoparticles affects many properties of cement concrete like tensile strength, flexure strength, compressive strength, water permeability, abrasion resistance pore structure of concrete. This study may provide a better insight on the role of titanium dioxide in concrete compounds to improve their overall properties.

Keywords: Abrasion Resistance, Durability, Nanoparticles, Strength, Titanium Dioxide

Unveiling Hetero Atom Containing Fluorescent Carbon Dots from Indigenous Soil Bacterial Metabolites for Toxic Cr (VI) Ion Detection

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Abstract

Bacteria and their metabolites can be a promising source for the synthesis of fluorescent Carbon dots. The liquid containing the metabolites (organic acids, fatty acids, proteinaceous substances) produced by microbial growth and remaining nutrients is called the cell-free supernatant. In this work, we have explored the potential of indigenous soil bacteria for the synthesis of carbon dots and their application in heavy metal detection in water. We have isolated a bacterial strain, and successfully synthesized fluorescent carbon dots through hydrothermal treatment of the cell free supernatant of the bacterial culture. The formation of carbon dots was characterized by fluorescence spectroscopy, uv-vis spectroscopy, FTIR, FETEM, zeta potential, etc. The synthesized carbon dots exhibited strong fluorescence and exceptional stability under various conditions. They unveiled the presence of hetero atoms like Nitrogen and Sulphur on their surface. The carbon dots acted as a potential nanosensor for the detection of Cr (VI) even in real water samples demonstrating strong fluorescence quenching in seconds with a limit of detection of about 30 nM. The carbon dots were screened through several plausible coexisting analytes that exhibited impressive selectivity towards Cr (VI).

Keywords: Carbon Dots, Fluorescence, Nanosensor, Selectivity, Soil Bacteria

Theme: GC

Green Chemistry

Poster Presentations

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Chlorophyllase from Microalgal Fermentation and Induction Using Chlorella Species and Its Application for Pigments Removal in Edible Oil

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Abstract

Food waste and spoilage are becoming a greater concern in a world of growing population with constant Chlorophyll absorbs light energy and transfers it to respective reaction sites. Photoautotrophic organisms regulate the biosynthesis and metabolism of chlorophyll to sustain growth because chlorophyll degradation is crucial for plant ageing and fruit ripening. An enzyme of the class hydrolase involved in the sequential pathway of chlorophyll degradation is chlorophyllase (E.C.3.1.1.14) which catalyses the hydrolysis of chlorophyll, removes the phytol side chain and produces chlorophyllide. Environmental stressors such as high exposure to sunlight, less availability of nutrients and water, affect these processes. Chlorophyllase has been found in most plants as localised in the thylakoid membrane of chloroplasts and being produced in-vitro by green algae and recombinant species. High concentration of pigments in edible oils, resulting generally due to premature seeds, is a bottleneck for oil processing refineries and have harmful effects when consumed directly by humans. Chlorophyll increases the photosensitivity which reduces shelf life of untreated oils and green products. Therefore, it becomes essential to remove chlorophyll from the edible oils. Conventionally, chlorophyll concentration is reduced from the oils by methods such as degumming by phosphoric acid, physical absorption and oxidation. Phosphoric acid in even trace amounts is toxic for the environment and unsafe for human consumption, later processes require high cost and machinery. However, using immobilised chlorophyllase enzyme for pigment removal from oils will be more environment friendly and cost effective. This paper is focusing on producing chlorophyllase as a secondary metabolite during submerged fermentation of microalgae *Chlorella* species induced by chlorophyll-A as a substrate. *Chlorella* is a freshwater, green algae, having high concentrations of chlorophyll and effective growth profile in submerged fermentation. Submerged fermentations are performed in photoautotrophic batch keeping operational conditions as temperature 30°C, pH 9.2 in modified Zarrouk's medium. The enzyme exhibits maximum activity at pH 7.5 and temperature 40°C. Understanding of the activity and mechanism of chlorophyllase's biological role in growth of photoautotrophic microalgae and its potential applications in oil for alleviating pigments, is further explored in this research.

Keywords: *Chlorella* Sp., Chlorophyllase Enzyme, Chlorophyll Pigment, Submerged Fermentation, Sustainable Pigment Removal

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Bioconversion of Mixed Food Waste to Citramalic Acid using Engineered Pichia Pastoris for the Development of a Sustainable Biorefinery

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Abstract

The persistent use of chemical insecticides has resulted in toxicity to non-target organisms, the development of pest resistance, and widespread environmental pollution globally. Zein, derived from corn protein, was chosen for its appealing physiochemical characteristics and combined with essential oils; neem and eucalyptus. Neem and eucalyptus are known for their high pest toxicity owing to their primary ingredients, azadirachtin, and 1,8-cineole, respectively. Based on this foundation, the synthesis aims to create integrated Eucalyptus oils and Neem oils Zein-based nanopesticides. These formulations will be evaluated for their efficacy against individual oil-based nanopesticides, Eucalyptus oil Zein-based nanopesticides, and Neem oil Zein-based nanopesticides in combating the common coconut mold. The study seeks to harness the antifungal attributes of both oils and optimize the formulation to enhance its overall performance. Utilizing these components, nanopesticides were synthesized and evaluated for their antifungal properties against fungi. Through the antisolvent method, three unique nanopesticides were developed using zein-based formulations integrating neem oil, eucalyptus oil, and a blend of both. The nanopesticides exhibited diverse hydrodynamic mean diameters: 7 ± 3 nm for neem oil, 12 ± 5 nm for eucalyptus oil, and 54 ± 12 nm for the combined neem-eucalyptus oil variants, as revealed by Dynamic Light Scattering (DLS). These formulations were evaluated for their antifungal efficacy against naturally occurring common coconut mold in controlled Petri dish assays, resulting in efficient inhibition of fungal growth. Notably, the combined neem-eucalyptus oil zein-based nanopesticides displayed exceptional efficiency, recording approximately 80% inhibition, surpassing the eucalyptus oil zein-based (54.32%) and neem oil zein-based nanopesticides (16.53%). This highlights how combining these oils makes them work better against fungus, and it suggests looking into how they affect pests that harm crops. Embracing a green synthesis methodology, these formulations leverage the combined properties of essential oils to achieve mutual enhancement of antifungal properties, while maintaining an eco-friendly profile.

In conclusion, the experiment demonstrates the effective formulation of essential oil zein-based nanopesticides through environmentally friendly methods. These alternatives aim to eliminate the toxic impact of conventional pesticides, offering superior efficacy with reduced toxicity towards non-target species. The green synthesis approach ensures minimal environmental harm, harnessing the combined properties of essential oils to mutually enhance the antifungal effectiveness of the nanopesticides while maintaining an environmentally friendly nature.

Keywords: Agriculture, Antifungal, Essential Oils, Green Synthesis, Nanopesticides

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Engineering of *Yarrowia Lipolytica* for D-Lactic Acid Production using Food Waste

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Abstract

With the drastic increase in the population growth and fast depletion in fossil fuels need for sustainable production of bioproducts is need of the hour. The awareness on adverse effects of plastic non-biodegradability and increase in demand for bioplastic there is tremendous global research undergoing in finding economical route for bioplastic production. Lactic acid is the important platform chemical for the production of Polylactic acid (PLA) a bioplastic. In recent times PLA stands as second most used bioplastic and as numerous applications from food industry to biomedical uses. Yeast cell factories are attractive option to counter the challenges posed by the lactic acid bacteria such as low acid tolerance and high cost media requirements for lactic acid fermentation. *Yarrowia lipolytica* is a GRAS organism was engineered for codon optimised *ldhA* gene from *K.pneumoniae* and for improved acetic acid tolerance acetyl CoA synthase (*Acs*) gene from *Saccharomyces cerevisiae (S28CC)* was overexpressed in *ldhA* integrated strain to improve the lactic acid productivity. Further food waste hydrolysate produced from the in-house produced fungal enzymes through isolated *Aspergillus terreus* in solid state fermentation. This hydrolysate was used as carbon source to produce D-lactic acid from double amplified gene (*ldhA-Acs*). Initially with *ldhA* gene integration the *Y.lipolytica* strain (YDldh) was able to produce D-lacticacid at a yield of (0.45g/g) of glucose. Further through *Acs* gene integration, shake flask and batch bioreactor optimization studies final *Yarrowia lipolytica* strain (YDAcs) was able to produce D-lactic acid at and yield of (0.71g/g) of glucose. This is the first attempt of *Yarrowia lipolytica (PO1d)* engineered for D-lactic acid gene. Additionally, with the fed batch studies and purification strategies this approach could be an added improvement strategy for lactic acid production through biorefinery approach.

Keywords: Bioplastic, Fungus, Food Waste, Polylactic Acid, *Yarrowia Lipolytica*

Theme: OET

Other Environmental Topics

Poster Presentations

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Occurrence of Bacterial Pathogens after Yearly Flooding Episodes in the Water Sources over a Riverine Settlement of Mid-Brahmaputra Valley, India

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Abstract

River floods are one of the major factors that can influence the distribution and abundance of the bacterial pathogens in water systems in a region. This work examines the presence of bacterial pathogens in the major water sources for human consumption (surface water and groundwater) over a flood-affected riverine settlement in the mid-Brahmaputra valley in Assam, India; which has been carried out in an attempt to provide a baseline understanding of the flood induced microbial contamination associated with pathogens, resulting in public health risks. Water samples of both surface water and groundwater were collected from ten selected sites across the study area during both pre-flood and post-flood periods and were examined for bacterial pathogens following standard methods. Surface water samples were collected from the river, and groundwater sources included open wells and tubewells. Collection and analysis of riverine sediments were also carried out to examine the seasonal prevalence of pathogens in the same. The quantification of pathogens was expressed in terms of Colony Forming Units (CFU/mL) and identification of the bacterial pathogens was done based on 16S rRNA.

During the pre-flood period, the growth of bacterial pathogens was observed only in the sediments, whereas in the post-flood season both the water and sediment samples had shown pathogenic growth. The CFU/mL count for the sediment ranges from $(32\text{-}87)\times10^2$ in the pre-flood period. The range of the same for river water, groundwater, and sediment in the post-flood period were $(31\text{-}125)\times10^2$, $(33\text{-}41)\times10^2$, and $(38\text{-}93)\times10^2$ respectively, highlighting the influence of floods as a source of bacterial pathogens in the water systems and depletion of the availability of safe water for human consumption. Bacterial genera isolated and identified in the pre-flood season are *Aeromonas veroni*, *Aeromonas hydrophila* and *Pseudomonas aeruginosa*; whereas *Escherichia coli*, *Salmonella enterica*, *Pseudomonas aeruginosa*, *Aeromonas cavie* and *Ralstonia pickettii* in the post-flood period, indicating the presence of infection-causing organism in the water sources after flooding episodes. Out of the total isolates, the quantity of *Pseudomonas aeruginosa* is found to be the highest $(15\text{-}63)\times10^2$ CFU/mL during the pre-flooding season. For the post-flooding period the isolates of *Salmonella enterica* $(51\text{-}96)\times10^2$ CFU/mL and *Escherichia coli* $(27\text{-}93)\times10^2$ CFU/mL are present in the highest quantity in the river water and sediment samples respectively. The findings form a novel cardinal database of bacterial pathogens associated with flooding in the concerned region, useful for periodic monitoring and remediation to maintain water quality and public health in riverine settlement areas.

Keywords: Floods, Bacterial pathogens, Groundwater, Riverine settlements, Contamination

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Sustainable Economic Development of India through Ecological Strategies of Festive Marketing

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Abstract

Festivals are celebrated with great enthusiasm in India. They are lives and souls not only for Indians, but also for the economic development of nation. Festivals have a significant influence on the Indian market. Festive marketing is the process by which businesses step up their efforts to draw in customers with the goal to increase profit by giving them worthwhile offers. Companies touch the emotional reminiscence of consumers and boost their sales. They use many innovative strategies to attract the customers during festivals, one of them is by 'Going Green'. When Green Marketing is applied with Festive Marketing, then festival consumptions and investments are undertaken with social responsibilities. Sahara rolled out electric vehicle "Sahara Evols" during festive season as means of green transport. Indian Railway introduced ecofriendly disposable hand towels and pillow covers to meet the increasing demand of passengers during festivals. In last festive season, Ultratech announced its ground breaking plan of producing green cement from industrial wastes. The council of Scientific and Industrial Research Institute introduced green crackers named SWAS, SAFAL and STAR in India which lacks the barium component responsible for air and noise pollution. Various platforms like "Amazon Karigar" and "Flipkart Samarth" are promoting local eco-friendly vendors to make the festive experience fantastic. These companies are taking alternate, sustainable, and eco-friendly initiatives. In the National Geographic Society's Greendex research, India came in first place for the fourth consecutive year. India's market for green products is predicted to develop at a 32.90% annual growth rate, from USD 12.93 million in 2021 to USD 74.05 million in 2027.The main contribution is during festive season. This is a win-win situation and benefits-firstly, the consumers, who get green goods in discounts and offers with a satisfaction that they are not degrading the environment, secondly, the companies, who earn huge profits with fulfilment of social responsibilities, thirdly, the nation, which achieves economic growth in sustainable way and finally, the environment, our "mother nature." Today industries are responsible for a major part of pollution, so it is their moral duty to accept ecological way of marketing as their norm. But many wrong tactics are also being followed by the companies in the name of 'green' during festivals like green spinning, green selling, and green washing. This is not only breaking the consumers' trust but such acts have also been considered as the 'Dark Patters' of sales, which is a punishable offence in India. The purpose of the research is to educate the customers about the dark patterns and to inform the companies about the green need and choices of the consumers. This will help the companies to follow a healthy marketing tool at the time of festivals which can be innovative and sustainable. This will boost the sales of companies in a greener way, working towards sustainable economic development of nation.

Keywords: Ecological Strategies, Festive Marketing, Festive Season, Green Marketing, Sustainable, Economic Development

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Modeling the Contribution of Two-wheelers to Urban Road Traffic Noise using SoundPLAN

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Abstract

This paper mainly focuses on the roadside traffic noise contribution of two-wheelers in urban traffic corridors. Traffic is the primary source of noise in cities. Its long-term effects are harmful. People using traffic corridors are exposed to unprecedented high noise levels and are subjected to severe health hazards. In traffic corridors, noise levels are often exceeding the national ambient noise standards, and honking could be the cause. This increases the exposure of people causing annoyance. The hourly equivalent noise levels follow the traffic-flow patterns and are mainly influenced by two-wheelers. The noise exposure in urban, suburban areas may remain high until the person moves out of the noise control region. The number of vehicles crossing the survey location along the direction of measurements and in the opposite direction was determined as per the standard format of the Indian Road Congress (IRC). The real-time videotaped traffic was studied in the lab to determine various characteristics such as speed and composition. It has been observed from the field study that about 50-51% of the total traffic was comprised of two-wheelers. The day-night total noise emission level contributed by road traffic noise was found to be 81 dB(A), which exceeded the noise level CPCB standards. Noise calculations for the urban traffic corridor were performed as per the TNM2.5 FHWA standards for equivalent noise levels. Traffic data were entered in the form of the histogram and annual daily traffic (ADT) of the hourly fractions, and traffic average speed data for each type of vehicle. The predicted noise level obtained from SoundPLAN for two-wheelers was 72 dB(A) and its contribution was about 22%.

Keywords: Traffic Noise, Urban Traffic, SoundPLAN, Two-Wheeler, Noise Pollution

Microkinetic Modelling on Ni(111) for Methane Cracking and Experimental Insights to Dry Reforming of Methane using Ni/Al_2O_3 Catalyst

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Abstract

Microkinetic modelling and simulation underscores the importance of revealing intrinsic reaction kinetics and mechanism at the interface of catalyst active site and fixed bed reactor. In the present study, methane cracking reaction using Ni/Al_2O_3 catalyst is probed via microkinetic modeling followed by experimental validation, whereby initial methane conversion is calculated and determined to correlate with initial activity for dry reforming of methane (DRM). As cracking of methane is kinetically fundamental to DRM, so it is vital to ascertain key insights on methane activation and conversion to hydrogen and solid carbon. A simple microkinetic model is formulated to examine the surface coverage of the reaction intermediates, solid carbon, and vacant sites on Ni(111). The model is studied by assuming a plug flow reactor with a series of zero-dimensional reactors to represent catalytic fixed bed and employing continuity and species balance equation to calculate initial methane conversion. The calculated percentage methane conversion (X_{CH4}) is validated experimentally in a tubular quartz reactor by considering identical values of catalyst contact time (0.2, 0.4, and 0.6 g_{cat} .h $gmol_{CH4}^{-1}$) and temperature (723, 823, 923 K). The results indicate that rate of dissociation is faster at higher temperatures with a concomitant increase in carbon deposition. An early trend is being observed with initial methane conversion in cracking reaction and DRM. Further studies are underway to obtain a logical trend between simulated conversion with the experimental one for both cracking and DRM reactions. The effect of reaction temperature and catalyst contact time studied under the umbrella of microkinetic modeling and experimental validation can unlock identifying key operating regime along with a concept proof of the developed microkientic model.

Keywords: Microkinetic Modeling, Initial CH_4 Conversion, CH_4 Cracking, Dry Reforming of CH_4, Ni/Al_2O_3

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A Review on Modification of Properties of Cement Mortar and Concrete with Addition of Reduced Graphene Oxide

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Abstract

Graphene-based nanomaterial such as reduced graphene oxide (rGO), is an appropriate material for utilization with cement-based materials. It has exceptional properties and improved mechanical behavior due to its chemical reduction from graphene oxide (GO). The functional groups present in graphene oxide undergo reduction to form rGO which modifies the microstructure and partly restores the physical strength making it an effective reinforcing agent in concrete. The presence of oxygen groups in rGO provides additional nucleation sites for hydration of cement thus increasing the production rate of hydration products. Therefore, even in very low dosages, rGO can be used as an additive to improve a wide range of properties of cement-based composites and concrete. Some of these properties include improvement of the microstructure of the concrete, reduction in pore size, reduction in shrinkage, improvement in strength, thermal properties, durability, and electromagnetic properties of cement composites. This characteristic improvement in properties is also due to the densification of the material's microstructure resulting from the addition of rGO.

It has been observed that very little work has been currently conducted in summarizing the benefits of using rGO for the modification of properties of concrete as compared to other popular graphene-based nanomaterials such as graphene oxide (GO) and pristine graphene (G). Therefore, this review article summarizes the effect of the addition of rGO on the properties of Cement-based composites and concrete as reported in various studies conducted in the past. The addition of reduced graphene oxide into concrete provides an effective way to enhance the material's characteristics, with the potential to enable the development of sustainable building materials with excellent performance. for different conditions. Identification of by-products shows that the main step involved in degradation was decarboxylation.

Keywords: Graphene Oxide (GO), Microstructure, Mechanical Properties, Reduced Graphene oxide (rGO), Sustainable material

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Review of Current Approaches towards Recycling of Spent Lead Acid Batteries: Ecological and Human Health Risks Associated with Metals

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Abstract

Lead-acid battery (LAB) is widely used across the automotive sector, solar power systems, electric vehicles, and telecommunications industries. According to an IMARC survey, the Indian lead-acid battery market was valued at US$ 4.17 billion in 2023 and is projected to reach US$ 6.52 billion by 2032, with a compound annual growth rate of 4.70% during 2024–2032. In addition to the increase of LABs, the generation of spent batteries are also increased due to the low life span (2-2.5 years). One of the primary benefits of spent LABs is the recyclability of lead, which can be almost entirely recovered through smelting. About 60% of total lead demand is fulfilled with recycling of spent LABs, significantly reducing the need for primary lead mining. Formal lead recycling facilities in India have expanded significantly, from 355 units in 2010 to 672 units in 2024 as reported by the Central Pollution Control Board, India. However, informal recycling practices remain prevalent, posing environmental and health risks. In addition to informal recycling, secondary lead smelting plants (SLSP) generate wastewater characterized by high lead and sulfate concentrations, and low pH due to the usage of sulfuric acid as electrolyte. This wastewater is typically treated via chemical precipitation using quick lime and slaked lime. Furthermore, flue gas emitted from SLSP contains lead and sulfur oxides, posing risks to air, soil, and water quality. Therefore, this review provides a comprehensive assessment of current practices in recycling spent lead acid batteries and treatment of SLSP wastewater, while also summarizing methodologies developed to evaluate the potential environmental and health risks associated with SLSP operations.

Keywords: Chemical Precipitation, Comprehensive Assessment, Flue Gas, India, Soil Contamination

Calibration and Validation of SWAT Hydrological Model using Remote Sensing Data: A Review

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Abstract

The soil and water assessment tool (SWAT) is a semi-distributed, physically based, continuous hydrological modeling tool that has been applied for various hydrological simulations. The SWAT hydrological model requires precise calibration and validation in order to simulate reliable outputs. Calibration and validation often involve conventional techniques using ground-based observable data such as discharge, sediment, etc. However, the lack of data in data-scarce regions necessitates the development of unconventional techniques using remote sensing-derived data. Although conventional techniques remain widely used, the application of remotely sensed data has grown significantly in recent years.

This review explores existing research on the diverse sources of remotely sensed Actual Evapotranspiration (AET) data and evaluates their effectiveness and reliability in enhancing model predictions during both calibration and validation stages. Besides, it explores how different data sources contribute to improving model predictions. By accessing the strengths and weaknesses of the remote sensing-derived data, this review highlights whether their application provides a reliable and robust methodology for calibration and validation. It examines the effectiveness of the AET data in improving model accuracy and reducing uncertainty in this process. Further, this study investigates different uncertainty analysis algorithms integrated with the SWAT model with the objective of how different algorithms exhibit varying levels of efficiency when calibrating with remotely sensed AET data. The findings highlight the feasibility and convenience of the open accessed satellite-based AET data for SWAT model calibration. In addition, this review seeks to determine whether the unconventional approaches offer a reliable method for calibrating and validating the model.

Keywords: Actual Evapotranspiration, Calibration, Remote Sensing Data, SWAT, Validation

Degradation Kinetics of 4-Nitrophenol and its Control by Ozone Bubble with and without Nanocatalyst in an Ozone Bubble Column Reactor

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Abstract

Extensive use and inappropriate disposal of phenolic over several decades have led to significant surface and drinking water pollution. Numerous types of phenolic and their metabolites are exposed to the aquatic environment due to which they have been found in drinking water above their permissible limits (ranging from ng L^1 to g L^1). Various types of phenolic such as phenol, cresols, tannins, guaiacol, and nitrophenol have been detected in surface water. Discharge of untreated industrial effluents, domestic wastewater disposal, and human excretions are some of the major reasons for the existence of phenolics in drinking and surface water. Conventional wastewater treatment plants are inefficient in removing such phenolic from potable water due to the lack of effective treatments and resistance toward the existing methods, which adversely affects human health. Prolonged consumption of contaminated water can cause human health problems even though the concentration of phenolic in surface water is very low. Hence, it is essential to develop an effective treatment process, which is specially designed for the removal of the phenolic.

Ozonation has been found to be significantly effective for the removal of phenolic. Ozone has a high oxidizing capacity and it generates hydroxyl radicals, which have more oxidizing power than ozone itself. In some European countries, ozone treatment of drinking water has been practiced for the last several years due to the regulations on chlorine by-products. However, sometimes metabolites formed during the degradation processes can have a more adverse effect than the parent compound. It has been reported that the by-product formed during the chlorination of bisphenol was more toxic than the bisphenol itself. Therefore, a high degree of mineralization is necessary to eliminate the adverse effects of the oxidation by-products.

In the present study, a combination of ozonated fine bubbles and metal oxide catalyst ZnO was used for effective removal of 4NP. For ozone supply of 0.60 mg s^{-1}, the 4NP was removed below the detection limit within 5 min of reaction. Addition of ZnO enhanced the degradation process effectively, due to the generation of hydroxyl radical, which possess the high oxidation potential. Effect of ozone supply rate and pH of reaction system were also studied. Alkaline medium accelerates degradation process due to more hydroxyl radical generation than acidic medium. Ozone supply to reactor also has the prominent effect on reaction time. For 0.40 mg s^{-1} ozone supply, removal was found 30-75 % in 100 min whereas for 0.60 mg s^{-1}, it was 99% within 5 min of reaction. Pseudo-first-order rate constant was also calculated for different conditions. Identification of by-products shows that the main step involved in degradation was decarboxylation.

Keywords: Phenolic Pollutants, Ozonation, Degradation, Kinetics

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Potential of Jamun Pulp as Natural Coagulant for Effective Removal of Surfactant in Wastewater

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Abstract

Surfactants are emerging contaminants commonly found in greywater systems, including wastewater from showers and washing machines. These chemical compounds are widely used in laundry detergents and soaps for washing. Due to their surface-active properties, surfactants can affect water quality, disrupt natural ecosystems, and potentially bioaccumulate organisms. Therefore, it becomes crucial to implement effective treatment methods to remove surfactants in wastewater before their release into the environment. The present study tested the coagulation ability of Jamun pulp (JP) powder for surfactant removal from simulated wastewater. The experiment was performed in a six-paddle jar test apparatus, and the operational conditions were pH 8, coagulant dose 3 g/L, fast mixing with 140 RPM, slow mixing with 40 RPM, and 1 h settling time. The turbidity and surfactant removal efficiency was 77.08% and 68.25%, respectively. Various analyses were conducted to characterize the natural coagulant. XRD was used to examine the crystalline structure, and the observed diffractogram peaks between 15 to 40 degrees indicated the presence of proteins, lipids, and carbohydrates. Total carbohydrate and protein content analysis revealed concentrations of 600 µg/g and 97.14 µg/g in JP, highlighting the presence of the bioactive compounds. SEM revealed a distribution of forty irregularly sized structures on the coagulant's surface. At the same time, EDX analysis showed that JP primarily consists of carbonaceous materials (60.5%) along with trace amounts of inorganic elements, including Ca, K, S, Mg, and Na. Zeta potential measurements determined the surface charge at different pH levels. Results showed a zeta potential of -5.17 mV for JP and 3.48 mV for the surfactant at pH 6, -13.5 mV for JP, and 2.94 mV for the surfactant at pH 8, and -6.8 mV for JP and -11.2 mV for the surfactant at pH 10. Using FTIR, the study confirmed the presence of functional groups in the coagulant, identifying free hydroxyl groups (3600–2800 cm^{-1}), stretching bonds related to alkanes and carboxylic acids (2926 cm^{-1}), C-O stretching vibrations associated with alkanes or carboxylic acids (2353 cm^{-1}), polymeric compounds like proteins, polysaccharides, and esters (1600–959 cm^{-1}), COO– symmetric stretching (1438 cm^{-1}), and halogen compounds, C-Cl (500–730 cm^{-1}). The current study demonstrates that JP powder is an excellent coagulant for wastewater treatment due to its notable cost-effectiveness and environmental benefits. This natural coagulant showcases the immense potential for the efficient and effective removal of surfactant from wastewater, significantly contributing to preserving and restoring the precious environment.

Keywords: Coagulation- Flocculation, Emerging contaminant, Natural Coagulant, Surfactant, Wastewater

Isolation, Characterisation, and Diesel Degradation Potential Study by a New MDR strain of *P. aeruginosa* Sourced from Hospital Effluent

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Abstract

The growing concern over multidrug-resistant (MDR) bacteria has become a critical global health issue, primarily fuelled by the widespread, indiscriminate use of antibiotics in medical and agricultural practices. This overuse has enabled bacteria to rapidly adapt and evolve, developing mechanisms that neutralize the efficacy of antibiotics. Among the most concerning MDR pathogens is *Pseudomonas aeruginosa*, a versatile and opportunistic bacterium commonly associated with infections in immunocompromised individuals. Known for its resilience and adaptability, *P. aeruginosa* can acquire resistance to a broad spectrum of antibiotics, often through horizontal gene transfer, mutations, and biofilm formation. Hospital effluents, which often contain high concentrations of antibiotics and other antimicrobial agents, are hotspots for the emergence and spread of such MDR strains, creating reservoirs of resistant organisms that pose significant risks to public health and environmental safety. In this study, we report the isolation and characterization of a novel MDR strain of *P. aeruginosa*, designated as GSSB 2301, sourced from hospital effluent. This strain demonstrates resistance to several commonly used antibiotics, including ampicillin, chloramphenicol, kanamycin, tetracycline, streptomycin, and spectinomycin, highlighting its adaptability and survival potential in antibiotic-rich environments. Further genetic analysis using 16S rRNA gene sequencing has confirmed its close relation to other *P. aeruginosa* strains, though with distinct resistance patterns. Beyond its antibiotic resistance profile, this strain tested for diesel oil degradation, as it likely to thrive in polluted environments making it a potential candidate for bioremediation. This strain disintegrates diesel's complex organic compounds, converting them into less toxic forms and potentially aiding in the natural detoxification of contaminated environments. However, not all *P. aeruginosa* strains exhibit significant diesel degradation capabilities, and thus, identifying and characterizing new strains with this potential is essential for developing effective bioremediation strategies. This dual functionality of this *P. aeruginosa* strain as both an MDR pathogen and a potential bioremediatory offers promising applications for environmental cleanup efforts, particularly in controlled remediation of diesel contaminated sites. The study's findings not only underscore the environmental risks posed by MDR bacteria in hospital effluents but also suggest a new avenue for leveraging these resilient organisms for biotechnological applications in pollution management.

Keywords: 16S rRNA Gene Sequencing, Bioremediation, Hospital Effluent, Multidrug-Resistant (MDR), *Pseudomonas Aeruginosa*

Theme: RSEM

Remote Sensing and Environmental Monitoring

Poster Presentations

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Integrating Plant Functional Traits and Remote Sensing for Comprehensive Macrophytic Health Monitoring in Wetlands

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Abstract

Aquatic plants are an essential component of wetlands, one of the world's most significant ecosystems in terms of biodiversity and ecological services. As dominant vegetation, macrophytes are considered critical bioindicators of wetland health as their presence, abundance, and composition reflect the ecological status of wetland systems. Functional traits, indicating plant growth, reproduction, and survival strategies, are key indicators of ecological processes and environmental conditions, aiding in understanding macrophytes' responses to environmental stressors. Functional traits provide insights into plant adaptive strategies in varying conditions and have become a focus in predicting plant responses to climate change and other anthropogenic pressures. These traits are increasingly used in ecological assessments to link plant community composition with ecosystem functioning, enhancing the capacity to monitor wetland health. Remarkably, remote sensing technology has become a critical tool for wetland monitoring, offering distinct advantages over conventional field-based methods, particularly in terms of spatial coverage in regions that are difficult to access. While conventional techniques remain widely used, the application of remote sensing has grown significantly in recent decades due to its ability to provide large-scale, repeatable observations and cost-effectiveness. Global research on wetlands covers a diverse range of topics, including biodiversity conservation, climate change, water quality assessment, and invasive species management. However, despite extensive research in wetland science, studies integrating plant functional traits with remote sensing technologies are limited and have received less attention. Although wetlands, macrophytes, plant functional traits, and remote sensing have been studied individually, there remains a lack of comprehensive studies in research that connects these disciplines into a unified approach for wetland monitoring. Despite the global significance, few studies have examined the integration of macrophyte functional traits and remote sensing for the purpose of monitoring wetland ecosystems.

This study scrutinizes existing research on the use of wetland macrophytes for monitoring purposes, with an emphasis on plant functional traits as reliable indicators of overall wetland health. The review explores how these traits can be effectively correlated with remote sensing technologies to enhance wetland monitoring efforts. It specifically analyzes whether the integration of field-collected data on macrophyte functional traits and remotely sensed data can provide a comprehensive and viable approach for monitoring wetland ecosystems. By evaluating the strengths and limitations of both in-field and remote sensing methodologies, this review seeks to determine whether their combined application offers a robust framework for assessing wetland health and ecological processes.

Keywords: Macrophytes, Plant Functional Traits, Remote Sensing, Wetland, Wetland Monitoring

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Quantifying Silt Load and Emission Rates from Road Dust in Silchar: Trace Element Analysis and Source Identification

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Abstract

Road dust is the most dominating source in the contribution of particulate matter (PM) which poses a significant risk to human health and the environment. Road dust samples were meticulously gathered from four distinct land use zones in Silchar, encompassing highways, residential areas, commercial and industrial areas. The collected dust samples were fractioned through a 75 µm sieve. Silt load and PM emission rate were quantified for eight distinct sampling sites in Silchar. Silt loads were observed highest near the highway sampling sites (S6= 24.28g/m^2). Similarly, $PM_{2.5}$ and PM_{10} emission rates were also observed maximum near the highway sites ($PM_{2.5}$ =6.12 g/VKT and PM_{10} = 25.32 g/VKT) and minimum near residential sites ($PM_{2.5}$ =1.56 g/VKT and PM_{10} = 6.47 g/VKT). Furthermore, the chemical characterization of road dust samples was done and trace elements like Al, Ca, Mg, Cr, Cu, Zn, Mn, K, Na, Ni, Pb, Cd, and Fe were analyzed using inductively coupled plasma spectrometry. Higher concentrations of Al, Ca, Mg, Fe, and Na were observed at all the sampling sites due to abundance in the earth's crust whereas, Cu, Ni, Zn, Ni, and Pb concentrations were higher near highways and commercial areas due to heavy traffic density. Cd exhibited the highest value for ecological risk (ER) and contamination factor (Cf) when compared to other analyzed trace elements indicating its significant contribution to environmental contamination and potential ecological hazards. Principal component analysis (PCA) identified vehicular abrasion, crustal matter, and biomass combustion as the major sources of PM-bound trace elements in Silchar.

Keywords: Emission Factors, Road Dust, Silchar, Silt Load, Trace Elements

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Delineation of Groundwater Potential Zones in The Noa-Dihing River Basin, Arunachal Pradesh – An Approach Using Geomorphometry, AHP and Multiple Criteria Decision-Making

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Abstract

Water is the most essential resource for survival of life on the earth. Groundwater is the main source of freshwater that supports domestic, agricultural, and industrial needs. With the galloping rise in population, demand for groundwater is escalating continuously all over the world. Therefore, delineation of groundwater potential zones is important for extraction of this most essential natural resource. This, however, is a challenging task since groundwater occurs in variable amount in the subsurface geological formations called aquifers, and its accumulation, movement, replenishment, and yield are governed by numerous hydrogeological, topographical, and meteorological factors, which again vary across space and time. The task is even more daunting in the mountainous regions due to frequent variation in topography, lack of comprehensive datasets on hydrogeological factors, and difficulty in conducting traditional geophysical survey. In this study, an effort has been made to demarcate groundwater potential zones in the Noa-Dihing River basin in Arunachal Pradesh using the analytical hierarchical process (AHP) and multi-criteria decision-making (MCDM) technique. The novelty of the present approach is that beside the commonly used parameters such as soil, lithology, fracture density, and land use land-cover (LULC), the geomorphometric and hydro-morphometric parameters such as slope, aspect, drainage density, curvature, topographic wetness index (TWI) etc. have been used in the demarcation of groundwater recharge-potential zones. In the conventional practices, the geomorphometric parameters are mostly overlooked. Appropriate weights have been assigned to these different parameters (factors) using AHP and MCDM through pair-wise comparison and consistency index (CI) verification. Thematic layers (maps) were generated using GIS technology and the groundwater potential of the study area was evaluated through integration of the weighted thematic layers. The integrated layer (map) was reclassified into five categories representing zones having very low, low, medium, high, and very high groundwater potential. The groundwater recharge potential zoning map thus generated will provide an insight into the spatial distribution and variation of groundwater resources and replenishment in the Noa-Dihing Basin.

Keywords: AHP; Geomorphometry, Groundwater Potential Zone, Multi-Criteria Decision-Making, Noa-Dihing Basin

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Evaluating Human Exposure to Microplastics in Atmospheric Fallout: Health Risk Considerations

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Abstract

Microplastics (MPs) have become pervasive contaminants, not only in aquatic and terrestrial environments but also in the atmosphere, posing potential risks to human health. This study focuses on assessing human exposure to airborne microplastics (AMPs) and evaluating the associated health risks. Ambient air samples were collected from industrial, and urban residential areas to quantify the presence of MPs, followed by characterization of their size, polymer composition and potential sources. Using analytical techniques such as Fourier-transform infrared (FTIR) spectroscopy we identified a wide range of polymer types, including polyethylene (PE), polypropylene (PP), and polystyrene (PS), with particle sizes ranging from 10 µm to 1000 µm. Results revealed significant differences in microplastic concentrations across sampling locations, with urban areas showing the highest levels (average concentration: 30.5 particles/m^2/day) compared to residential (50.3 particles/m^2/day) and industrial zones (45.7 particles/m^2/day). Fibers were the most commonly detected particle type (60%), followed by fragments (30%) and films (10%). Potential sources of AMPs include tire wear, synthetic textiles, and plastic waste degradation.

Health risk assessments were conducted based on estimated inhalation exposure, suggesting that prolonged exposure to elevated concentrations of AMPs could increase the risk of respiratory issues, particularly for vulnerable populations such as children and the elderly. The presence of toxic additives and adsorbed pollutants on MPs may further exacerbate health risks, potentially leading to oxidative stress, inflammation, and long-term pulmonary effects. This study highlights the growing concern of airborne microplastics as an emerging environmental health threat and underscores the need for stricter regulations and mitigation strategies to reduce human exposure. Further research is required to fully understand the toxicological impacts of AMPs and their role in human respiratory diseases.

Keywords: Atmospheric fallout, FTIR, Health implication, Microplastic

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Identification of Water Hyacinth in The River/Lake System Using Advanced Remote Sensing Technique: A Review

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Abstract

In recent decades, humanity has grappled with four interrelated global challenges: water, food, energy, and the environment. Of these, water is particularly critical as it underpins the other three. Water is essential for food production and energy generation, making its availability and management central to addressing these issues. Moreover, critical environmental challenges, such as ensuring water quality and mitigating water-related damages, are directly tied to the global water crisis. Therefore, effective solutions to water problems are crucial for sustainable development in all sectors. Water hyacinth negatively impacts species diversity by reducing light penetration, altering turbidity and dissolved oxygen levels, depleting nutrients, and disrupting the aquatic food web. The dense mats formed by the weed provide a habitat for pathogenic microorganisms, pests, and insect larvae, contributing to the spread of common diseases such as dengue, chikungunya, and malaria. These mats also obstruct waterways, hindering boat traffic and damaging propellers while impeding fishing activities, making casting nets challenging. Increasing urbanization and eutrophication of inland and coastal water bodies suggest that these problems will intensify.

Effectively addressing the issue of water hyacinth requires accurate and timely monitoring of habitats susceptible to infestation within aquatic ecosystems. Traditionally, water hyacinth monitoring has relied on field surveys with limited spatial coverage, which are time-consuming and labor-intensive. With advancements in space-borne satellite remote sensing, water hyacinth large-scale detection and periodic monitoring have proven cost-effective. Synthetic Aperture Radar (SAR) remote sensing offers significant advantages in all-weather, day-and-night monitoring and detecting surface roughness and moisture variations, making it particularly useful for continuously tracking water hyacinth growth. Conversely, optical remote sensing provides more detailed spectral information and higher spatial resolution. In India, Assam provides an ideal region of tropical areas where water hyacinth thrives in slow-moving or stagnant freshwater bodies like lakes, rivers, and reservoirs. This state presents a distinctive and advantageous location for water hyacinth detection via remote sensing, attributed to its extensive water bodies, high infestation levels, complex climatic conditions, and significant socio-economic impact. The region's unique hydrological and environmental challenges necessitate advanced geospatial technologies, which offer crucial insights into local ecological dynamics and contribute to strategies for managing invasive species.

Keywords: Remote Sensing, SAR, Water Hyacinth

Theme: RACC

Resilience and Adaptation to Climate Change

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In-Silico Approach to EST Marker Design: Co-Relation with Physio-morphological and Agronomic Traits of Wheat (*Triticum aestivum* L.) under High Temperature and Humidity

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Abstract

Terminal heat stress is one of the most important abiotic stresses to affect wheat production. There is a considerable loss of yield due to heat stress even though plants have developed mechanisms to cope up with it. ESTs or expressed sequence tags can be used to study processes underlying such mechanisms and can give a prediction of the behavior of plant under conditions of terminal heat stress. These ESTs link to those genes that play a vital role in triggering plant's reaction toward heat stress.

For In-Silico designing of EST markers, we have retrieved existing EST sequences of wheat endosperm tissue from NCBI and used the bioinformatics tool to design the markers by setting different parameters of marker designing i.e. (higher GC%). In our study, we sowed different genotypes under two distinct conditions: timely sown (mid-November) and late sown (mid-December) over the crop seasons from 2022 to 2024, conducted at the Krishi Vigyan Kendra, Banasthali Vidyapith, Tonk, Rajasthan; India. We systematically recorded a range of physiological, morphological, and agronomic traits under varying temperature and humidity conditions to evaluate the effects of terminal heat stress. To further understand the relationship between the In-Silico designed markers and the observed traits, we have calculated the HSI (Heat susceptibility index) of wheat genotypes with respect to different traits and have co-related with the EST markers by comparing phenotypic variations between different wheat genotypes. For example- wheat genotype- DBW90 (0.69), DBW107 (0.93) and DBW222 (0.3) are heat tolerant where as HD2177 (1.04), GW190 (1.26) and HD2501 (1.06) are observed as heat sensitive on the basis of HSI with respect to wheat tillers. Several other traits have also been co-related with the EST markers. After co-relation, phenotypic variations have been calculated and according to the phenotypic variation percentage, these markers will be used as putative marker for terminal heat tolerance in wheat for future prospects like plant breeding programme.

Keywords: EST Markers, HSI (Heat susceptibility index), NCBI (National Centre for Biotechnology Information), Terminal heat stress, Wheat

Screening of Heat Tolerant Genotypes in Bread Wheat (*Triticum aestivum L.*) under Terminal Heat Stress Using Heat Susceptibility Index

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Abstract

Productive tillers are significantly reduced by terminal heat stress, hence identifying genotypes that are heat tolerant is crucial to wheat breeding programs. The present study was conducted at Krishi Vigyan Kendra, Banasthali vidyapith, Niwai, Rajasthan during 2022-2023 & 2023-2024 rabi (crop) season to evaluate fourteen bread wheat genotypes GW451, PBW-550, GW499, DBW173, HI1634, NIAW3170, HD3293, CG1029, HD3043, PBW658, NW2036, NIAW1994, HUW234 & WH1105 under timely sown and late sown condition, the experiment set up as a randomized complete block design with three replications. Results revealed that late sowing (terminal heat stress) had a significant adverse impact on agronomic trait like differences in tiller per plant (dTPP) . Based on the Heat Susceptibility Index (HSI) values obtained from two years of crop season data, the following conclusions can be drawn regarding the heat tolerance of various wheat genotypes: Genotypes with HSI values ≥ 1, such as HD3293, NIAW1994, and GW499, can be classified as heat-tolerant. These genotypes exhibit a relatively lower reduction in grain yield under heat stress conditions, indicating enhanced thermos tolerance and adaptability to elevated temperatures during critical growth stages. Genotypes with HSI values between 0 and 1, including HD3043, WH1105, CG1029, and HI1634, are classified as heat-sensitive. These genotypes display a more pronounced yield reduction under heat stress, suggesting increased susceptibility to high-temperature conditions and lower adaptability to thermal stress. Further goal is to determine the correlation between SSR marker alleles and HSI values, which could indicate genetic loci associated with heat tolerance.

Keywords: HSI, Late Sown, Productive Tillers, Timely Sown, Terminal Heat Stress, Wheat

Theme: SWM

Solid Waste Management

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A Survey-based Approach to Exploring Attitudes, Behaviours, and Beliefs Regarding Cigarette Butt Littering in Aizawl City

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Abstract

Cigarette butt (CB) littering is a widespread environmental concern that has gained significant attention in recent years. Despite constituting a small fraction of overall waste, cigarette butts are the most frequently littered item globally, with trillions finding their way into landfills, streets, and water bodies annually. Their widespread presence presents considerable ecological and health risks. Given the significant environmental impact of cigarette butt waste, understanding community perceptions and actions is crucial for developing effective waste management strategies.

The objective of this study is to analyse cigarette butt disposal behaviour through a survey-based questionnaire for people residing in Aizawl City, which is often named the cancer capital of India. A total of 808 responses were collected to examine their place attachment, perceptions, littering behaviour and environmental attitudes that influence improper cigarette butt disposal. According to the findings, about 48.5% of respondents have no idea or think that cigarette butts are made of cotton or paper. Owing to its small size, most people don't consider cigarette butts as litter and toxic. The main reported reason behind littering was a lack of awareness regarding proper disposal methods. Fewer than two-thirds indicated that they dispose of cigarette butts either on the ground or in a sewer/drain, while 43.44% expressed the belief that discarding smoked cigarette butts in a dustbin could cause a fire. Most respondents suggested that creating designated smoking areas and installing more receptacles would be the most effective way to minimize cigarette butt litter.

The survey revealed a notable gap between awareness and action, highlighting the need for effective public education campaigns and improved waste management strategies. The findings underscore the importance of community engagement and emphasise the necessity for various infrastructure interventions to mitigate cigarette butt littering and promote responsible disposal practices. This enhances our understanding of public perceptions regarding cigarette butt littering, offering important insights for policymakers and environmental advocates.

Keywords: Attitudes, Cigarette Butt, Disposal Behaviour, Litter, Receptacles

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Improving Waste Reduction and Bioconversion Efficiency through BSFL Composting: A Sustainable Approach to Waste Management in India

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Abstract

According to the United Nations Food Waste Index Report, around 78.2 million tons of food waste are generated in India annually, 25-30% of the total food production. A maximum portion of this waste is treated by windrow composting and vermicomposting, a small portion by biogas, and the rest ends in landfills. Despite source segregation, cooked food and raw vegetable waste come under the same category; this mixed waste is then sent for composting. Many kinds of waste, like oily and high-fat content food, citrus fruit, onion, garlic, meat, dairy, etc, are harmful to the worms and make vermicomposting inefficient. For that, an innovative composting process with black soldier fly larvae (BSFL) has been explored in this paper. This study deals with both cooked food waste (FW) and vegetable waste (VW) collected from the Nilgiri Mess of IIT Madras in different ratios for BSFL bioconversion: S1 (100% FW), S2 (70% FW + 30% VW), S3 (50% FW + 50% VW), S4 (30% FW + 70% VW), S5 (100% VW). The effect of the Waste Reduction (WR), Waste Bioconversion Ratio (BCR), Feed Conversion Ratio (FCR), larval growth, weight, and compost quality were examined and tried to find the best combination. Waste Reduction is higher for S2 (65-70%) followed by S3, S1, S4, and S5. The BCR found in S3 is 13.67%, followed by S4 (11.49%), S2 (10.24%), S5(10.09%), and lastly S1 (7.73%). The properties of S3 made the feed easily consumable for the BSFL. Apart from S1 (1.5-2 cm), there were no significant changes in the length of the larvae i.e. 2-2.5 cm. However, the total weight of segregated larvae was different; for S3, the larvae growth was very high, and the least growth was in S1. These waste types have not substantially altered the composition of the compost. The portion of Carbon ranges from 27-32%, Nitrogen 2.5-4%, Hydrogen 4.5-4.8%, and Sulphur 0.5-0.7% of the dry weight of compost. Our findings indicate that BSFL composting can be used for the mixture of FW and VW, which gives it more benefits than vermicomposting or windrow composting. However, in bioconversion, S1 became the slurry type, and S5 became sticky and lumpy, but the combined feed performed well. From these outcomes, it can be concluded that BSFL composting performs well in mixed waste. If waste reduction is the only criterion, then the ratio of S2 can be used as feed, but overall, S3 performed well in waste reduction, BCR, FCR, and larval growth. Almost the same amount of FW and VW were produced in households, messes, and canteens. Thus, BSFL composting became the most suitable composting process for this mixed kind of waste, which not only deals with waste management but also provides a sustainable alternative protein source for livestock and many more value-added products.

Keywords: Bioconversion, BSFL, Feed Conversion, Mixed Food Waste, Waste Reduction

Pharmaceutical Removal from Wastewater using Microbial Fuel Cell and Their Impact on Current Production and Microbial Community: State of Art and Future Perspective

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Abstract

The exponential occurrence of pharmaceuticals residues in the ecosystem is becoming an enormous environmental challenge since they can easily find their way in natural water. Adequate commercial techniques are not available for the pretreatment of pharmaceuticals residues in water. Subsequently, they find their way in municipal wastewater treatment plant. Besides extensive usage of various class of pharmaceutical such antibiotics, non-steroidal anti-inflammatory drug, analgesic and antipyretic, etc. and the increase of their anthropogenic activities are responsible of the increase concentration of pharmaceutical in the environment. The use of appropriate techniques is fundamental for the efficient removal of leftover pharmaceutical from water. Conventional methods used for the treatment of wastewater involve coagulation process, membrane filtration process, Fenton process, etc. however, microbial fuel cells are promising bio-electrochemical method whose usage is gradually more recurrent. But operation cost and the high energy required during the process remain and issue. The efficiency of the technique relies on many parameters that can be related to many fields like microbiology, organic chemistry, electrochemistry material science and environmental science. In this review, we summarize study reporting the removal of pharmaceutical from wastewater paper using microbial fuel cells system putting emphases on its performance through the influence of many factor such as the pharmaceutical class, their concentration, the electrode design and the microbial response. The integration of other techniques is also discussed and outlook in view of improving the technique as well.

Keywords: Extracellular Electron Transfer, Microbial Community, Microbial Fuel Cell, Pharmaceutical Degradation

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Optimizing Hydrothermal Carbonization of Factory Tea Waste for Enhanced Fuel Properties and Adsorptive Performance of Activated Hydrochar

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Abstract

This study presents a comprehensive investigation into the hydrothermal carbonization (HTC) of factory tea waste, aiming to valorize this abundant agro-industrial byproduct as a renewable solid fuel and an efficient adsorbent. Utilizing a central composite design within a response surface methodology framework, the study examines the effects of temperature (180–220 °C) and reaction time (0–240 min) on key fuel properties, including hydrochar yield, higher heating value, and energy yield. Optimized conditions yielded a hydrochar with fuel properties comparable to traditional solid fuels. Structural and combustion characteristics of the hydrochar were analyzed through thermogravimetric analysis and FTIR spectroscopy, providing insights into its fuel potential. Additionally, Fenton oxidation was applied to activate the hydrochar (F-HC), significantly enhancing its surface area. The adsorption performance of F-HC was systematically assessed across multiple dyes, with equilibrium best described by Freundlich and Redlich-Peterson isotherms and chemisorption identified as the primary mechanism. F-HC demonstrated high adsorption efficiency in real wastewater treatment, underscoring its practical applicability for environmental remediation. This study illustrates the dual potential of factory tea waste-derived hydrochar as a fuel and a versatile adsorbent, offering sustainable solutions for waste valorization and environmental management.

Keywords: Tea Waste, Fuel Kinetics, Hydrochar, Adsorption, Water Treatment

TGA Based Kinetic Study of Simulated Red Category Bio-Medical Waste

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Abstract

With the increase in population and advancements in technology and society, there is a rise in the number of individuals seeking medical care, resulting in an increase in medical waste generation. Pyrolysis is an emerging method that is currently being researched for medical waste management. In this work, five commonly used red category bio-medical waste items were selected and mixed in a uniform ratio of 20 percent each to prepare a mixture. This mixture is assumed to represent red category biomedical waste segregated in medical organizations in real life scenario. Thermal degradation profiles of raw materials as well as the mixture were studied by thermogravimetric analysis (TGA) at four different heating rates namely 10,20,30 and 50°C from 20°C to 1000°C in nitrogen atmosphere with a constant flow rate of 20 mL/min. The data obtained from thermogravimetric analysis was utilized to deduce the kinetic triplets, activation energy (E_α), pre- exponential factor(A_α) and reaction model ($f(\alpha)$) of thermal decomposition process of individual components of the medical waste as well as the mixture. Iso-conversional methods like Friedman and Flynn wall Ozawa methods were used to determine activation energy. The degradation mechanisms were deduced using Criado master plot. Understanding of pyrolysis process kinetics can help establishing the experimental parameters for the conversion of red category bio-medical waste into value added products.

Keywords: Activation Energy, Kinetics, Pyrolysis, Red Category Bio-Medical Waste, Thermogravimetric Analysis

Theme: SPD

Sustainable Processes Development

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Keratin Extraction from Tannery Animal Hair Waste: A Comparative Study of [BMIM]Cl Dissolution Method using Conventional and Acoustic Cavitation-Assisted Technique for Sustainable Process

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Abstract

Animal hair waste, generated from livestock, presents significant environmental disposal challenges. The Indian tanning industry generates approximately 40,000 tons of hair waste annually, most of which is discarded. However, this waste can serve as a valuable source for keratin recovery. This study focuses on extracting keratin in its native form using environmentally friendly solvents (ionic liquids) and optimized process techniques to minimize hair disposal issues. Keratin, a major protein, exhibits excellent biocompatibility and physical properties, making it an attractive material for polymeric composite materials and biomedical applications. In this study, ionic liquid (IL) was employed to dissolute hair, comparing conventional methods with acoustic cavitation-assisted (ACA) techniques. Key operating parameters, such as solid-liquid ratio (hair: IL), process time, regeneration, and recovery processes were optimized. The conventional method yielded 64.3% keratin, whereas the ACA technique achieved 70% yield with a significant reduction in dissolution process time ($1/24^{th}$). Characterization using ATR-FTIR, solid-state ^{13}C NMR, XRD, DSC and SEM analysis confirmed the presence of secondary structures (α-helix and β-sheet), crystallinity, thermal stability and morphology, indicating that the extracted keratin retained in its native form. The ionic liquid (IL) in the effluent was recovered up to 93% (conventional) and 77% (ACA). The ^{1}H and ^{13}C NMR analysis of the recovered IL revealed that the number and position of protons and carbons in the recovered IL remained unchanged to that of reference (i.e. pure IL), confirming its purity and demonstrating potential for solvent recycling and reuse. This study has significant implications for waste reduction and value-added product development in the leather industry.

Keywords: Acoustic Cavitation, Dissolution, Ionic Liquids, Keratin, Tannery Animal Hair

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Transforming Waste to Energy: Sustainable Composite Fuel Consists of RDF Obtained from Landfill Biomining for Cement Production in India

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Abstract

In India, the increasing challenge of landfill capacity has highlighted the urgent need for effective waste management strategies. One promising approach is landfill biomining, which has been mandated by the Government of India for implementation across all municipal landfills. This process yields key products such as Refuse Derived Fuel (RDF), Soil Like Material (SLM), and inert materials which are required to be managed properly for the sustainability of the biomining process. On the other hand, India stands as the world's second-largest cement producer, with an increasing demand every year. The cement production sector is expected to continue to grow due to recent government initiatives, comes mainly from housing, infrastructure, construction and the industrial sector. As fossil fuel resources, particularly coal, face depletion, there is a compelling opportunity to explore alternative fuels for cement production. The objective of this study is therefore to develop a sustainable alternative fuel blending RDF obtained from biomining process with other waste products like wood dust, rice bran, and bagasse. To do that, RDF samples were collected from the Sankarpur Dumpsite in Durgapur, while the remaining waste materials were collected from the local market. The RDF from Sankarpur Dumpsite primarily consists of 54.47% plastic material, with other components including textile, coconut husk, and miscellaneous materials. The RDF has a moisture content of 12%, an ash content of 8.8%, and a calorific value of 4376.38 kcal/kg, classifying it as RDF Grade-II according to the Ministry of Housing and Urban Affairs (MoHUA, 2018). Different proportions of materials were examined in triplicate and the optimum mix created consisted of 50% RDF, 20% wood dust, 20% bagasse, and 10% rice bran. The calorific value of the composite fuel was determined using a bomb calorimeter, yielding an average value of 4,100 Kcal/kg, exceeding the 3,000 Kcal/kg minimum requirement set by the Ministry of Housing and Urban Affairs, (MoHUA, 2018) for generating sufficient thermal energy in cement production. To evaluate the environmental impact of the alternative fuel, a Life Cycle Analysis was conducted using the Ecoinvent database and the IPCC GWP 100a indicator. The analysis revealed that using refused derived fuel (RDF) as fuel resulted in a 30.96% reduction in global warming potential (GWP, measured in CO_2 equivalent) when replacing 100 kg of traditional coal. Additionally, there was an 8.86% further reduction in GWP when using this composite fuel instead of traditional coal. These results highlight the significant environmental benefits of this composite fuel in the cement industry, supporting more sustainable waste management and energy solutions in India. Ultimately, this innovative approach not only addresses waste management challenges but also contributes to a greener and more sustainable future for the cement industry, aligning with India's broader goals of reducing carbon emissions and promoting circular economic practices.

Keywords: Biomining, Cement Industry, Composite Fuel, Global Warming Potential, LCA

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Development of a High-Performance Portable Solar Dryer

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Abstract

Solar drying is cost efficient and environmentally friendly technique for drying food, crops, and other products using the power of the sun. Solar dryers use a combination of heat, air circulation, and solar radiation to remove moisture from products, which can help to increase their shelf life, reduce waste, and improve their quality. This work shows the experimental investigation on drying turmeric (*Curcuma* longa) and ginger (*Zingiber officinale)*, at three different modes under the climatic condition of Imphal, India: Open Sun Drying (OSD), Solar Drying Without Thermal Storage (SDW-OTS), and Solar Drying with Thermal Storage (SDW-TS). Pebbles is used as Sensible Heat Storage Materials (SHSM) for the study. A 12V DC fan is used as a blower and 5.5 W PV panel to facilitate the blower. Comparative analysis of sensible heat storage materials including sand, soil, rocks and pebbles aiming to identify the most efficient thermal performance. To determine the effectiveness of dehydrating the samples, a comparison was done between OSD, SDW-OTS, and SDW-TS. Pebles has found to have the most efficient thermal performance. Curcuma longa moisture content was reduced from 90% (w.b.) to 14% (w.b.) in 30 hours, a 56 hour improvement over open sun drying, with a thermal efficiency of 10%. Zingiber officinale moisture content went from 90% (w.b.) to 16% (w.b.) in 27 hours, 30 hours faster than open sun drying, with a thermal efficiency of 9%. From a sustainable energy engineering perspective, solar drying with thermal storage (SDW-TS) emerges as a promising sustainable and cost-effective alternative to conventional drying methods, leveraging solar energy for efficient dehydration.

Keywords: Drying Efficiency, Moisture Content, Solar Drying, Thermal Storage

Sustainable Stabilization of Expansive Soils Using RHA-Based Geopolymer

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Abstract

Expansive soils are prone to volumetric changes due to its clay mineral constituents. The swelling and shrinkage characteristics of expansive soils compromise the durability and functionality of civil engineering structures like roads, embankments, and buildings, rendering them unsuitable for direct use in their natural state. Traditional soil stabilization methods using binders like lime or cement have been commonly used as a stabilizing material to strengthen the soil. Although these materials are effective, their production generates high carbon emissions, which harms the environment by contributing to pollution and climate change. In response to this, the present study utilize an environmentally friendly binder derived from agricultural waste i.e., rice husk ash (RHA), which is a byproduct of rice processing. RHA serves as a pozzolanic material activated using sodium hydroxide (NaOH) as an alkaline activator to form an RHA-based geopolymer, aimed at enhancing the geotechnical properties of expansive soils. This present study evaluates the impact of RHA-based geopolymer stabilization on key geotechnical parameters, including unconfined compressive strength (UCS), consolidation characteristics, Free Swell Index (FSI), and linear shrinkage. The result of the study observed that a noticeable increase in strength was observed with the addition of RHA as a binder, along with changes in the molarity of the alkaline activator and curing period. An increase in pH was observed with an increase in molarity. Moreover, the free swelling index of RHA-based geopolymer decreases compared to that of untreated expansive soil. Further, a significant decrease in linear shrinkage is observed for RHA-based geopolymers in expansive soil compared to untreated expansive soil. The findings suggest that RHA-based geopolymer binder improves the geotechnical properties of expansive soils and offers a sustainable solution by recycling agricultural waste and reducing the environmental impact associated with traditional binder.

Keywords: Expansive Soil, Geopolymer, Rice Husk Ash (RHA), Soil Stabilization, Sustainability

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Earthworm Casts and Ecosystem Resilience Towards Sustainable Soil Health in Assam

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Abstract

A study was conducted to study the impact of earthworm casts on soil properties across diverse land-use types in Assam, India, with a focus on their sustainable contribution to soil health and ecosystem resilience. Earthworm casts occur in two primary forms—Turret Casts (TC) and Mass Casts (MC)—and were evaluated in seven distinct land-use settings namely Agricultural Land (Kharif), Agricultural Land (Vegetables), Agricultural Land (Double Cropped), Agricultural Plantation (Horticultural Orchard), Agricultural Plantations (Tea Garden), Forest (Moist Mixed Deciduous Dense), and Forest (Moist Mixed Deciduous Open).. Through comprehensive physico-chemical and biological analyses, the study assessed the Soil Quality Index (SQI) of casted soils versus non-casted soils. Results revealed that both TC and MC significantly improved soil characteristics, showing higher silt and clay content, water stable aggregates (WSA), and mean weight diameter (MWD), alongside elevated levels of moisture, pH, electrical conductivity (EC), organic carbon (OC), cation exchange capacity (CEC), and essential nutrients (N, P, K). Earthworm casts also had enhanced levels of exchangeable calcium (Ca) and magnesium (Mg), microbial biomass carbon (MBC), dehydrogenase activity, and total bacterial count, underscoring their role in boosting soil structure, nutrient availability, and microbial activity. Notably, forest ecosystems exhibited more favorable soil properties compared to agricultural lands, where intensive cropping was associated with higher heavy metal concentrations, raising concerns about soil contamination and sustainability. The SQI analysis further highlighted that TC had higher values than MC, suggesting that TC more effectively enhances soil quality. These findings underscore the potential of earthworm-based sustainable soil management approach. By fostering improved soil properties and supporting ecosystem services, earthworms contribute to enhanced environmental resilience and agricultural productivity. Integrating earthworm-based solutions into land management could provide a viable path toward mitigating soil degradation and promoting sustainable agriculture and forestry systems in Assam.

Keywords: Earthworm Casts, Soil Quality Index, Land Use, Sustainable Soil Management, Environmental Biotechnology

A review on synergistic effect of addition of different types of nano clays on cement-based composites

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Abstract

Concrete possesses various flaws due to its brittle nature, therefore researchers have been working on new methods to modify the properties of concrete using suitable nanomaterials and the need for new types of materials enticed much attention to their discovery because the existing materials are either not enough for the usage and applications of the mankind, or more advanced materials with new properties are needed to overcome the shortcomings of the existing materials.

Keeping the above point in view several materials are being tested for their compatibility with concrete. One such material that has gained popularity in past is nano clay which is easily available in nature and is cost effective. Nanoclay can be found in many forms due to the presence different ions and each types shows different properties with concrete. The effects of different types of nanoclay on different type of concrete revealed an increase in workability, compressive and flexural strength and splitting tensile strength as well as durability aspect such as decrease water penetration and increase electrical resistivity while simultaneously decreasing porosity permeability and capillary water absorption. With constant development, construction materials are becoming sparse and it is hard to find alternatives which can provide same properties and are copious. So, considering these effects of nano clay we can see that it can be further researched and used as a replacement. It has been found that there is a lack of work summarizing the effects of nano clay on the properties of concrete thus an effort has been made to summaries the forementioned. This review paper emphasis on influence of nano clay, as a cement substitute and supplement on the performance of conventional and Self Compacting Concrete (SCC).

Keywords: Self Compacting Concrete

Breakthrough Curve Analysis and Fixed Bed Dynamic Modelling of Bio-sorption of Pb (II) from Aqueous Medium

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Abstract

Sandalwood leaf powder (SLP) prepared from mature, dried Indian Sandalwood (Santalum Album) leaves was investigated to assess its ability to remove the Pb(II) cations from aqueous medium in a dynamic fixed bed borosil glass column of internal diameter 1.5 cm and length of 35 cm. The design parameters such as column bed height, flow rate of Pb(II) solution into the column and initial concentration of Pb(II) solution have been investigated to analyze the effect of these parameters on the bed performance and breakthrough curves. The adsorption capacities at 90% breakthrough of the SLP column were found to decreases from 115.0 mg/g (flow rate of 2.5 mL/min) to 65.0 mg/g (flow rate 12.5 mL/min). The breakthrough volume for 90% removal showed an increase from 715 mL for bed depth of 2.5 cm to 1220 mL for 3.5 cm. The maximum bed capacities at 50, 100 and 150 mg/L Pb(II) concentrations were calculated as 70, 72 and 75 mg/g respectively at 90% breakthrough point. The desorption cycle acquired 30 min for complete exhaustion and the maximum concentration of Pb(II) was obtained at an eluent volume of 50 mL in 10 min. The results indicated that the column packed with SLP could be used as an efficient tool to treat Pb(II) enriched wastewater.

Keywords: Fixed Bed Column, Bio-Sorption, Breakthrough Curve, SLP, Pb(II) Cation

Advances in Natural Hydrogels through Composite Fabrication for Various Environmental Applications

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Abstract

Gel composites are advanced materials created by integrating two or more polymers or embedding inorganic molecules within a gel matrix. This combination enhances the composite's physical, mechanical, and chemical stability, biodegradation resistance, and adsorption capabilities, making it more functional than individual gels. The properties of gel composites are influenced by the blend type, component ratios, and cross-linking agent concentration. Composite formation can follow an organic approach, where gels are integrated with enzymes, carbon nanotubes, or additional polymers, or an inorganic approach, combining gels with minerals like metals, metal oxides, or nanoparticles. The synergy between these components ensures structural stability, even under significant water absorption and swelling. Examples of composite types include polymer blends like Ecovio®, which combines polylactic acid and biodegradable PBAT, and interpenetrating polymer networks (IPNs) where cross-linked polymer networks form interlocking structures with enhanced mechanical and functional properties. Various natural based hydrogels and their composites were synthesized and tested for pollutant removal from wastewater by different researchers. By utilizing innovative composite preparation techniques and synthesis methods, these hydrogels are poised for removal of pollutants like heavy metals, dyes, microplastics and even pharmaceutical residues from wastewater, demonstrating high adsorption capacities and potential for reuse through regeneration processes. Thus, this review explores the advantages of gel composites, emphasizing their role in overcoming conventional hydrogel limitations to expand environmental applications. Ultimately, these advancements showcase the transformative potential of natural hydrogels, offering sustainable alternatives with customizable properties tailored to diverse practical needs.

Keywords: Adsorption, Composite, Hydrogel

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Post-Harvest Storage Solution for Small and Marginal Farmers Employing Visible Light – An Alternative of Cold Storages

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Abstract

It is perceived that owing to financial burden of the ever increasing cold storage charges to small and marginal farmers, newer ways of food storages should come up. Thus, in this direction we propose an alternative pathway to the existing usage of cold storages for storing vegetables and grains employing Photodynamic Inactivation (PDI) of microbes. The storage of agricultural goods post-harvest is a considerable difficulty owing to insufficient facilities and escalating expenses. The endeavour seeks to create a portable kit using a non-toxic Vitamin B2 spray solution as a photosensitizer, coupled with a flash visible light source for the photodynamic inactivation of bacteria in food products and packaged food components. This method eradicates pathogens, guaranteeing their total elimination from food and surfaces while inhibiting their proliferation. An automated system kit using eco-friendly photosensitizers and visible light at wavelengths of 455 and 476 nm for effective visual disinfection and sterilization is under development. This technology integrates chemical and optical illumination, guaranteeing human safety and IoT interoperability, while enhancing energy efficiency, decision-making support, responsive service, user experience, and product customization. It demonstrates significant promise for the post-harvest management system.

Keywords: Visible Light Catalysis, Post Harvest Food Management, PDI, Cold Storages

Environmental Hackathon 2024

Event highlights

- *Multi-disciplinary solutions to critical environmental challenges*
- ***Workshop** on environmental technologies and sustainable practices*
- ***Hackathon** session to identify real-world environmental problems and propose innovative solutions.*

Key themes

- *Climate Mitigation*
- *Water and Wastewater Treatment*
- *Solid Waste Management*
- *Carbon Capture and Storage*
- *Sustainable Development*
- *Air Pollution Control*
- *Green Chemistry*
- *Environmental Laws, Economics, and Management*
- *Environmental Biotechnology*
- *Environmental Nanotechnology*

Event details

- ***Date:** 11/12/2024*
- ***Venue:** Core 5, IIT Guwahati*
- ***Deadline:** 5/12/2024*

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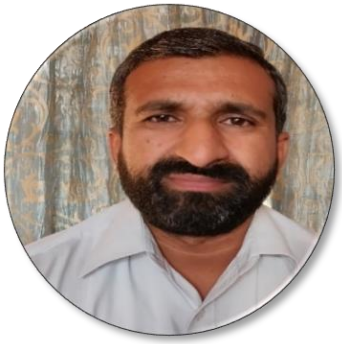

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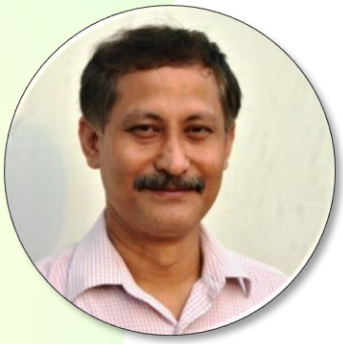

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