ACMS

2nd International Conference on ADVANCES IN CHEMICAL AND MATERIALS SCIENCES

12-14th April, 2026

Organized by

Centre for Education Innovation and Entrepreneurship (CEIE), Kolkata

In association with

Anusandhan National Research Foundation | CSIR-INDIA | CIPET | Indian Chemical Society ESTD. 1924 | CEST Anna University | MIT Muzaffarpur | Bidhan Chandra College Asansol

Springer | WILEY Publishers Since 1807

Certificate

This is to certify that Prof./Dr./Mr./Ms./Mrs.

SOURAV KUNDU

Institute of Engineering & Management (IEM), School of University of Engineering and Management (UEM), Kolkata

has presented a paper (Oral/Poster) in ACMS-2026, held at Indian Institute of Chemical Engineers, Kolkata, during 12– 14 April 2026.

Title : Generative AI for Environmental Equity: Synthesizing Urban to Rural Pollution Gradients via Multi Modal GANs

Co-authored by : DWAIPAYAN DE, APARAJITA MUKHERJEE, SOURAV KUNDU, SOUMYA BANERJEE

Abstract ID : OP-653 (Oral Presentation)

Prof. M. K. Jha	Dr. Goutam Kumar Dalapati	Dr. Avijit Ghosh
Principal, MIT Muzaffarpur & DG, IIChE-TI	Founder Hydgen Innovation Technologies Pte, Singapore & Co-Chairman, ACMS 2026	Organizing Secretary, ACMS-2026

CONTENT

Abstract ID: OP-648

Abstract

The ever-increasing amount of fruit and vegetable waste in households, markets, and processing plants makes it imperative to have proper waste management and sustainable energy technology. Dumping organic waste in landfills contributes to environmental degradation and inefficient use of organic resources. The purpose of this research is to evaluate the viability of using fruit and vegetable waste as a substrate for biogas production through anaerobic digestion, facilitated by process simulation using the DWSIM software. Fruit and vegetable waste have high organic matter, high moisture content, and high biodegradability rates, making them ideal for microbial fermentation and subsequent biogas production.

The aims are to assess the feasibility of biogas production, methane content, and overall process effectiveness while simultaneously considering waste reduction. Apart from the production of biogas, the anaerobic digestion process also produces a stabilized digestate that can be used as an organic soil conditioner, thus promoting sustainable agriculture. A steadystate simulation model of the anaerobic digestion process was developed in DWSIM to simulate material and energy balances in the biogas plant. The simulation model allows the assessment of gas composition, rate of conversion, and process performance for different feedstock, providing critical information for performance evaluation and optimization.

The coupling of simulation modeling with waste-to-energy analysis improves process understanding within the boundaries of experimental investigation. Organic waste can be harnessed for the production of renewable energy with a reduced environmental impact. Conclusion: The treatment of organic waste and simulation modeling is a viable, efficient, and environmentally sound method for biogas production.

Keywords: Fruit and vegetable waste; Biogas production; Anaerobic digestion; DWSIM simulation; Waste-to-energy;

Generative AI for Environmental Equity: Synthesizing Urban to Rural Pollution Gradients via Multi Modal GANs

Dwaipayan De[1], Aparajita Mukherjee[2], Sourav Kundu[3*], Soumya Banerjee[4]
[1234]Mechanical Engineering Department, Institute of Engineering & Management (IEM), School of University of Engineering and Management (UEM), Kolkata
*Corresponding Author: Sourav Kundu, iem.sourav2005@gmail.com, 7810887602

Abstract ID: OP-653

Abstract

Infrastructure gaps in air quality monitoring systems result in critical data deserts in rural areas, making it difficult to implement public health policies on an equal footing. The present work proposes a software intensive approach to synthesize high resolution maps of ground level air pollution in areas lacking physical sensors. The researchers employs a Multi Modal Generative Adversarial Network (GAN), more specifically a Pix2Pix model, to accomplish

spatial super resolution. The proposed approach utilizes the Google Earth Engine (GEE) platform to combine multi spectral satellite data from Sentinel-5P (CO, SO_2, NO_2) with high resolution meteorological data from the ERA-5 dataset (wind vectors and temperature). By training the GAN on urban areas such as Kolkata, the GAN learns complex non-linear relationships between atmospheric column density and ground-level concentrations. The main result of this work is a synthesized high resolution continuous pollution map for rural areas lacking air quality monitoring systems. Experimental results show that the GAN successfully reconstructs localized pollution patterns with a Structural Similarity Index (SSIM > 0.82), clearly outperforming traditional interpolation and regression approaches. By simulating virtual sensors in data scarce areas, this work contributes to the development of a scalable software intensive solution for environmental monitoring, promoting data equity and informing targeted policy interventions in areas where physical infrastructure is economically unfeasible.

Keywords: GANs, GEE, Sentinel-5P, ERA-5, Data Deserts, Environmental Equity

Preparation and Evaluation of Peanut Shell-Derived Activated Carbon Pellets and Membranes for Pollutant Removal

Vidur Sosa[1], Dr.K.Suresh [2]

[1]Department of Chemical Engineering, Maulana Azad National Institute Technology Bhopal Madhya Pradesh, India 462003

[2]Professor, Department of Chemical Engineering, Maulana Azad National Institute Technology Bhopal Madhya Pradesh, India 462003

*Corresponding Author: Dr.K.Suresh; ksuresh@manit.ac.in; +917013955615

Abstract ID:PP-674

Abstract

This research investigates the efficiency of peanut shell (PS) derived activated carbon in two forms—pellets and membranes—for removing industrial pollutants. Peanut shells were converted to activated carbon via chemical activation and fabricated into pellets and, consecutively, incorporated into filtration membranes. The adsorbents were characterized using SEM and BET methods, demonstrating a high surface area suitable for adsorption of heavy metals (e.g., Pb, Cr, Cd) and industrial dyes. Batch adsorption studies indicated that the activated carbon followed pseudo-second-order kinetic models and Langmuir isotherm, indicating monolayer adsorption on a homogeneous surface. The membrane, made from activated carbon and a polymer binder, was tested for the filtration of wastewater, exhibiting excellent removal rates for both, particulate and dissolved toxic pollutants, due to enhanced pore structure and surface functional groups. This approach offers a sustainable, cost-effective alternative to commercial activated carbon for wastewater remediation.

Keywords: At least three key words separated by; Peanut shells (agricultural waste); Drying; Pyrolysis; pellets and membranes; Removal of contaminants; sustainability (circular economy)

Sustainable Waste Valorization of Fish Scales into Activated Carbon for Efficient Removal of Acidic (Congo Red) and Basic (Methylene Blue) Dyes from Aqueous Solutions

Yogesh Dangoliya[1], Nabendu Paul[2], Rupak Kishor[2*]
[1]Department of Chemical Engineering, MANIT Bhopal, India, 462003;
[2,2*]Assistant Professor, Department of Chemical Engineering MANIT Bhopal, India, 462003
*Corresponding Author: Rupak Kishor, Email: rupak.k@manit.ac.in, Phone. +91 97070 59721,
Abstract ID: OP-676

Abstract

Acidic dye Congo red and basic dye methylene blue are synthetic dyes extensively used in textile and printing industries. However, owing to their rich aromatic structures, these dyes exhibit strong resistance to biological degradation. Their high solubility in aqueous media enables prolonged persistence in aquatic environments, posing significant risks to aquatic life, as their degradation by-products are often carcinogenic in nature. In this study, a high surface area activated carbon was synthesized from waste fish scales via KOH activation and investigated for the efficient adsorptive removal of congo red and methylene blue from aqueous solutions. BET analysis showed that the prepared adsorbent has a high specific surface area of 913.81 m^2/g, while FTIR analysis confirmed that its surface is rich in oxygen-containing functional groups. The adsorption process was systematically studied and optimized with respect to key operational parameters, including solution pH, adsorbent dosage, adsorption isotherms, and thermodynamic behaviour. The prepared active carbon shows the optimum performance for both the dye is at pH 7.0 and 1 g/L of adsorbent. The prepared fish scale derived activated carbon demonstrated excellent adsorption performance toward both acidic and basic dyes, achieving removal efficiencies of approximately 99% at an initial dye concentration of 100 ppm. The results indicate favourable adsorption characteristics and strong affinity of the adsorbent toward both dye types.

Overall, this work highlights the potential of waste fish scale derived activated carbon as a low-cost, sustainable, and highly effective adsorbent for the treatment of dye-contaminated effluents from textile and related industries.

Keywords: Activated carbon; Adsorption; Solid waste management; Wastewater treatment,

Structure–Performance Relationship of Graphene-Reinforced Ceramic Membranes for Wastewater Treatment Applications

Abhik Dey[1], Akash Kumar Das[2], Nilay Sarkar[3,] Aditi Sinha[4*]
[1,2,3,4*] *Department of Chemical Engineering, Haldia Institute of Technology, Hatiberia, ICARE Complex, Haldia -721657, West Bengal, India*
Corresponding author email: Aditi.sinhachemicalengg@gmail.com
Abstract ID: PP-701

Abstract

Graphene-reinforced ceramic membranes represent a promising class of advanced filtration materials capable of overcoming the limitations of traditional ceramic and polymeric membranes in wastewater treatment. This work presents a comprehensive understanding of the structure–performance relationship that governs the behavior of these hybrid membranes,

highlighting the role of graphene in tailoring membrane morphology and transport properties. The integration of graphene-based materials into ceramic matrices leads to the formation of hierarchical pore structures with a regulated pore size distribution, enhanced surface hydrophilicity, and well-defined nanochannel networks. These structural modifications collectively govern water permeability, solute selectivity, and fouling resistance by facilitating preferential water transport while restricting contaminant passage. Key structural factors, including graphene loading, dispersion homogeneity, interfacial bonding, pore connectivity, and nanochannel continuity, are identified as decisive parameters affecting membrane performance. In addition to improving mass transport, graphene imparts antimicrobial activity and enhanced chemical stability, enabling membranes to withstand harsh wastewater environments and repetitive chemical or physical cleaning cycles. The relationship between membrane microstructure and functional performance is critically evaluated across various wastewater treatment applications, such as dye removal, heavy-metal separation, oil–water separation, and biofouling control. By systematically linking pore architecture and nanochannel characteristics with separation outcomes, this work emphasizes the importance of rational material engineering in developing high-performance graphene-reinforced ceramic membranes. The insights provided offer guidance for future research and highlight challenges related to scalability and long-term operation, paving the way for practical implementation in advanced wastewater treatment systems.

Keywords: Graphene-based ceramic membranes; Hybrid membrane materials; Wastewater treatment; Fouling-resistant membranes

Selective Bromine Removal from Non-Metallic Fraction of Crushed Printed Circuit Boards Using Aqueous Sodium Carbonate

Saanz Wanjari[a], Muhmmad Abdul Kadir[a], Gireesh Kumar Shroti[b], Parthasarathi R.R.[a], Diwakar Z Shende[b] , Sam David Swaminathan[*a]
a-SRM institute of science and technology, Chennai; b-VNIT, Nagpur
*Dr Sam David, Associate Professor, samdavis@srmist.edu.in, 9894400940
Abstract ID: OP-719

Abstract
Printed circuit board waste contains brominated flame retardants that make recycling and reuse highly unsafe. In this work, crushed PCB was first segregated into metallic and non-metallic fractions using a gas–solid fluidized bed followed by magnetic separation. The non-metallic fraction was treated with low-concentration aqueous sodium carbonate to selectively leach bromine. The effects of alkali concentration, liquid-to-solid ratio, sonication time, particle size, and segregation condition were systematically studied. Bromine removal was quantified and the stability of metallic elements was also verified. The optimized sodium carbonate system achieved high bromine leaching efficiency without dissolving valuable metals. This study demonstrates a safe and low-cost route for detoxifying PCB non-metallic fractions prior to reuse or further processing

Keywords: E-waste; printed circuit boards; brominated flame retardants; sodium carbonate leaching; non-metallic fraction; detoxification

Waste-to-energy technologies: A sustainable Pathway for Resource Recovery and Materials Management

Mayuri Hon[1], Dr. Utkarsh Maheshwari[2], Dr. Shailesh Ghodke [3*]
Undergraduate Student, DY Patil International University,Pune; Associate Professor, DY Patil international University, Pune ; Head of Department, DY Patil International University,
*Mayuri Hon,mayurihon2005@gmail.com, 9623702128,
Abstract ID: OP-727

Abstract
The rapid increase in municipal solid waste generation and escalating energy demand have intensified environmental and resource challenges worldwide. Advanced Waste-to-Energy(WtE) technologies provide a promising pathway for sustainable energy recovery and circular economy integration. There are various techniques that are helpful in dealing with problems of municipal solid waste generation and those are Advanced thermal technologies like Gasification for converting carbonaceous materials like municipal waste into combustible, clean burning gas , pyrolysis to convert organic materials into valuable products, Advanced biochemical technologies like Anaerobic Digestion for converting waste into methane rich gas, Landfilling & landfilling gas recovery etc., Advanced chemical technologies like transesterification, Hydrothermal carbonization. Criteria for evaluating the efficiency of Advanced Waste-to-Energy Technologies includes Energy efficiency, waste reduction, etc. This paper also reviews challenges and future perspectives to put systems in place for implementations of Waste-to-Energy Technologies. Waste-to-Energy Technologies convert waste to energy, supporting a circular economy.

Keywords: circular economy; thermal technologies ; sustainable energy; municipal solid waste;Waste-to-Energy Technologies

Organic source of biomass for synthesizing magnetic nano catalyst for biofuel production from industrial waste: characterization & Optimization, Kinetic studies.

Gengadevi R[1], Kowsalya M[2], Vijaya Kumar B[3*]
[1]Assistant Professor; Department of Petrochemical Technology, RVS College of Engineering and Technology, Coimbatore, Tamil Nadu
[2]Assistant Professor; Department of Petrochemical Technology, RVS College of Engineering and Technology, Coimbatore, Tamil Nadu
[3] Professor: Department of Petrochemical Technology, RVS College of Engineering and Technology, Coimbatore, Tamil Nadu
Gengadevi R, gengadevir@rvscet.ac.in, 9500663664,
Abstract ID: OP-736

Abstract
Currently, around the globe energy utilization is depends on petroleum derivatives, which declines due to the continuous exploitation of fossil fuels. Thus, globally improvement in the future energy source relies on alternative fuel, which should be ecofriendly & provides a

sustainable environment with zero emission of pollutants. Thus, many research is focused on looking forward for producing biodiesel, which is the best alternative source of energy. The biomass was produced from peel of jackfruit which is synthesized through co-precipitation for deriving the nano magnetic catalyst. The synthesized catalyst was characterized through different analytical instruments for the identifying the morphological behavior as well as the physical and chemical properties. The activity of the catalyst was investigated through transesterification techniques. The optimization studies were carried out by analyzing the various process parameters such as methanol to oil ratio, catalyst concentration, reaction temperature and reaction time. The obtained yield of biodiesel was 97.8 wt%, which was examined by optimizing the process parameters. The kinetic study reveals that transesterification reaction follows pseudo first order with providing maximum activation energy. Thus, the reusability of nanocatalyst shows stable activity for seven cycles providing excellent yield upto 95% by using different solvents for better recovery of nanocatalyst. The produced biodiesel was characterized and various properties were analyzed and compared with that of ASTM D6751 standard.

Keywords: Biodiesel, Transesterification, Jackfruit, co-precipitation.

Microalgae Cultivation in Domestic Wastewater as a Sustainable Strategy for Biodiesel Production and Nutrient Remediation

Sonali Biswas[a], Muruganandam L[b], Ganesh Moorthy I[b]*

[a] School of Bio-Sciences and Technology, Vellore Institute of Technology, Tamilnadu, Vellore 632014, India

[b] School of Chemical Engineering, Vellore Institute of Technology, Tamilnadu, Vellore 632014, India.

*Corresponding Author's Address**:**Dr. Ganesh Moorthy I,Associate Professor Senior, School of Chemical Engineering,Vellore Institute of Technology, Vellore 632014, India.

E-mail ID**:** ganeshmoorthy.i@vit.ac.in

Abstract ID: OP-737

Abstract

Growing demand for sustainable energy has intensified interest in microalgae as a promising feedstock for biodiesel production. Compared to conventional oilseed crops, microalgae exhibit rapid growth rates, high lipid accumulation, and the ability to thrive on non-arable land using non-potable water. Cultivating microalgae in wastewater further enhances sustainability by supplying essential nutrients such as nitrogen and phosphorus, thereby reducing reliance on synthetic fertilizers while simultaneously lowering production costs and enabling wastewater remediation. Wastewater-tolerant microalgal strains cultivated under optimized conditions can achieve enhanced biomass productivity and lipid yields. The utilization of nutrient-rich municipal and industrial effluents allows simultaneous biofuel generation and pollutant removal, addressing both energy and environmental challenges. This study evaluates the influence of wastewater composition on microalgal growth, lipid accumulation, and biochemical characteristics, along with optimization of key culture parameters including light intensity, pH, and hydraulic retention time to maximize lipid productivity within shorter cultivation periods. In addition, biodiesel production is supported by the use of a reusable heterogeneous catalyst derived from waste shells, offering an environmentally benign and

cost-effective alternative to conventional homogeneous catalysts during the transesterification process. The application of shell-based catalysts enhances catalyst recovery, reusability, and overall process economics. The findings indicate that wastewater-grown microalgae, coupled with sustainable heterogeneous catalysis, provide a viable and economically attractive route for biodiesel production while promoting resource recovery and circular bioeconomy principles.

Keywords: Microalgae; Biodiesel; Wastewater treatment; Transesterification; Lipid production; Biofuels

Next-Generation Biodegradable Ternary BiOI/TiO_2/PPy Heterojunction Hydrogel for Efficient Photocatalytic Tetracycline Degradation

Hritankhi Tripathy[1], Ratnakar Sahoo[2], Arvind Kumar[3*]

[1] Ph.D Research Scholar, Environmental Pollution Abatement Laboratory, Department of Chemical Engineering, National Institute of Technology Rourkela, Odisha, 769 008, India

[2] B.Tech M.Tech Dual Degree, Department of Chemical Engineering, National Institute of Technology
Rourkela, Odisha, 769 008, India

[3] Associate Professor, Environmental Pollution Abatement Laboratory, Department of Chemical Engineering, National Institute of Technology Rourkela, Odisha, 769 008, India

*Arvind Kumar, arvindkumar@nitrkl.ac.in,

Abstract ID: OP-755

Abstract

This study investigates the photocatalytic degradation of tetracycline (TC) using BiOI/TiO_2/PPy (BTPY) hydrogels, highlighting their efficiency and applicability for wastewater treatment. BTPY was synthesized via hydrothermal method followed by polymeric interaction with carboxymethyl cellulose and crosslinked with $FeCl_3$ to enhance stability and reusability. The photocatalytic performance was evaluated under visible light, achieving up to 91% degradation efficiency under optimized conditions. The process involved the activation of peroxymonosulfate (PMS), which facilitated the generation of reactive oxygen species (ROS) such as sulfate (SO_4•$^-$) and hydroxyl (•OH) radicals, identified as key contributors to TC degradation. Experimental parameters, including BTPY dosage, PMS concentration, pH, and water matrix composition, were systematically analyzed to optimize degradation efficiency. Scavenger studies confirmed the predominance of sulfate and hydroxyl radicals in the degradation pathway, with sulfate radicals having the most significant impact. While BTPY showed high efficiency in distilled and drinking water, its performance was reduced in complex matrices like lake water due to natural organic matter interference. These findings underscore the potential of BTPY hydrogels as cost-effective photocatalysts for environmental remediation. Future work should explore scalability, application in diverse water matrices, and integration into solar-assisted systems to advance sustainable water purification technologies.

Keywords - Bismuth Oxyiodide; Tetracycline; Photocatalysis; Heterojunction; Wastewater Treatment.

Process Simulation and Sustainability Assessment of Pine-Cone-Derived Biochar for Multicomponent Azo Dye Removal from Textile Wastewater

Anwesha Mukherjee[1], Ankita Bhowmik[2], Bikash Kumar Mondal[3]*
[1]National Institute of Technology, Durgapur; Ph. D. Scholar
[2]National Institute of Technology, Mizoram; Post-Doc Fellow
[3]National Institute of Technology, Durgapur; Assistant Professor
*Corresponding Author: Dr. Bikash Kumar Mondal, bkmondal.che@nitdgp.ac.in
+91-9434789037
Abstract ID: OP-756

Abstract

Textile effluents containing azo dyes, when discarded into waterways, pose a significant environmental challenge due to their high colour intensity, consequential toxicity, and resistance to biodegradation. Conventional biological treatment processes typically achieve less than 30– 40% colour removal, making advanced physicochemical treatment necessary. Although adsorption using commercial activated carbon is effective, its high production energy requirement (6–10 kWh kg^{-1}) and cost limit application in developing regions. In this study, a process design and simulation framework was developed to evaluate pine-cone-derived biochar, an abundant forest litter biomass, as a low-cost adsorbent for the removal of multicomponent azo dyes from wastewater.

The Indian subcontinent has an abundance of pine, which has led to accumulation and significant forest fire events in the past few years. To combat this, the Uttarakhand government has launched the 'Pirul Lao-Paise Pao' campaign to contain the raging forest fires in the state.

Pine cones composed of lignocellulosic biomass were considered for slow pyrolysis at 400–500 °C to produce porous biochar containing oxygenated functional groups (–OH, –COOH). Reported adsorption capacities for lignocellulosic biochars (80–180 mg g^{-1} for common azo dyes such as Congo Red and Reactive Black) were used as input parameters for modelling. A fixed-bed adsorption column was simulated for continuous treatment conditions. Equilibrium behaviour was described using the Langmuir isotherm. Bed-Depth Service-Time (BDST) modelling indicated that a bed height of 0.6–1.0 m at a flow rate of 5–10 L min^{-1} could achieve 80–90% colour removal for an inlet dye concentration of 50–100 mg L^{-1}, corresponding to regulatory discharge compliance.

A comparative cradle-to-gate Life Cycle Assessment was conducted using a functional unit of 1 m^3 of treated textile wastewater. Using the Indian grid emission factor (0.82 kg CO_2 kWh^{-1}), pinecone biochar production was estimated to reduce carbon emissions by approximately 55–70% compared to coal-based activated carbon, due to its lower activation temperature and the avoidance of raw material extraction. The results demonstrate that pine-cone-derived biochar can provide an environmentally sustainable and economically viable adsorption system suitable for decentralised textile wastewater treatment. The study highlights a circular approach linking wastewater remediation with forest biomass management and resource recovery.

Keywords: Pine cone biochar, multicomponent adsorption, fixed-bed adsorption column, azo dye removal, Life Cycle Assessment (LCA)

Waste-Derived Catalyst for Sustainable Biodiesel Production

Shrestha Mondal[1], Anand V P Gurumoorthy[2], Ganesh Moorthy I[3*]
[1]School of Bio Science and Technology, Vellore Institute of Technology, Vellore-632014, Tamil Nadu, India
[2] Professor, School of Chemical Engineering, Vellore Institute of Technology, Vellore-632014, Tamil Nadu, India
[3]Associate Professor, School of Chemical Engineering, Vellore Institute of Technology, Vellore-632014, Tamil Nadu, India
*Corresponding author at: School of Chemical Engineering, Vellore Institute of Technology, Tamil Nadu, India. E-mail address: ganeshmoorthy.i@vit.ac.in. Phone. No. 9894746710
Abstract ID: OP-757

Abstract
This research advances the circular economy by integrating two distinct waste streams—nonedible seed oils and agricultural residues—into a streamlined, eco-friendly biodiesel production process. By employing a non-edible feedstock, the study bypasses the "food versus fuel" debate, instead focusing on the chemical conversion of underexploited biomass using a customengineered, waste-derived heterogeneous catalyst. This solid catalyst, synthesized through controlled thermal activation and characterized by its high basicity and crystalline stability, offers a sustainable alternative to traditional liquid catalysts due to its easy recovery and multi-cycle reusability. Under optimized transesterification conditions involving precise methanol ratios and temperature controls, the process achieved high-purity fatty acid methyl esters (FAME) that meet international fuel specifications for energy content and viscosity. Ultimately, this integrated approach minimizes industrial wastewater, reduces refining costs, and provides a scalable model for converting agricultural by-products into high-value renewable energy.

Keywords: Biodiesel; Non-edible feedstock; Catalyst; Fatty acid methyl esters (FAME

Dual Z-Scheme $Cu_2(OH)PO_4$/g-C_3N_4/r-GO Ternary Heterostructure for Efficient Cr(VI) Reduction and Methylene Blue Degradation under Visible Light

Garima Pal[1], Lovjeet Singh[1*], Satyendra Prasad Chaurasia[1], Pawan Rekha[2]
[1]Department of Chemical Engineering, Malaviya Institute of Technology, Jaipur, Rajasthan-302017
2Department of Chemistry, Malaviya Institute of Technology, Jaipur, Rajasthan-302017
*Corresponding author. E-mail: lovjeet.chem@mnit.ac.in, Tel: +919549652527
Abstract ID: OP-763

Abstract

This study presents the design and fabrication of copper hydroxy phosphate- and reduced graphene oxide-embedded graphitic carbon nitride ($Cu_2(OH)PO_4$/r-GO/gC_3N_4) nanocomposites through a one-step hydrothermal method for visible-light-induced photocatalytic dye degradation and toxic metal reduction applications. The synthesized nanocomposites, containing varying weight percentages of $Cu_2(OH)PO_4$, were systematically characterized for their structural, optical, morphological, and electrochemical properties using XRD, FTIR, Raman, XPS, UV-vis DRS, FE-SEM, TEM, and EIS techniques to understand the relationship between structure and performance. EIS spectra of the nanocomposite indicated effective separation and transfer of photo-induced charge carriers. The optimized nanocomposite CCG 361 shows the excellent photocatalytic activity, 99.98% reduction efficiency for Cr (VI) and 99.93% degradation efficiency for methylene blue (MB), more than binary composites (CHP/CN, CN/r-GO) and bare g-C_3N_4. The effect of several parameters such as pH, catalyst dose and initial pollutant concentration has also been recorded to find the optimum conditions. Scavenger tests revealed that $Cu_2(OH)PO_4$/r- GO/gC_3N_4 nanocomposites effectively produce superoxide anions and hydroxyl radicals for dye degradation and heavy-metal reduction. The material maintained ~100% efficiency over five cycles, showed strong pH-dependent photoreduction and stable dye degradation, making it promising for treating multi-pollutant wastewater.

Keywords: Graphene Oxide; Graphitic carbon nitride; Copper Hydroxy Phosphate, Hexavalent Chromium (Cr (VI)) photoreduction; Photocatalytic dye degradation; Methylene Blue.

Domestic Solid Waste in a Rural Area and the Challenges Aheadin Waste Management

Atanu Pal[1*], Ananta Kumar Das[2],Brojendra Nath Dey[3] , Tapan Kumar Parya[4]
[1*]Scholar, Department of Renewable Energy Engineering, MaulanaAbulKalam Azad University of Technology, West Bengal, India. Email ID: atanu.pal92@gmail.com
[2] Professor, Department of Renewable Energy Engineering, MaulanaAbulKalam Azad University of Technology, WB, India. Email ID:ananta_das59@yahoo.co.in
[3]Assistant Professor, Department of Basic Science & Humanities, MCKV Institute of Engineering,Howrah, West Bengal, India. Email ID:brojendranathdey@gmail.com
[4] Ex-Professor, Department of Renewable Energy Engineering, Maulana Abul Kalam Azad University of Technology, West Bengal, India. Email ID: tapankumar.parya@makautwb.ac.in
* Corresponding author's email ID: anantadas.akd@gmail.com M. - 834892887
Abstract ID: OP-766

Abstract

Earlier years, rural waste was mostly biodegradable and could be composted or naturally decomposed. With increased access to manufactured goods, plastics, electronics, and chemical products, the nature of household waste in rural areas has shifted toward materials that are more toxic and difficult to manage safely. The load of plastic &hazardous waste in rural areas has shifted from small quantity in earlier years to ample quantity in recent years because of technological development. As the wastes are scattered in households, the collection and treatment are more complex and expensive. The traditional rural waste practices are to feed

leftover organic matters to livestock as there is absence of non-biodegradable materials. But due to the fast growth of packaged& synthetic products, and hazardous wastes the natural waste management systems become disrupted, leading most of the communities to rely on open dumping, backyard burning, or burial. Such methods release toxic gases causing air pollution, contaminate soil, and pollute groundwater, directly affecting productivity of agricultural land and the quality of drinking water. Rural communities often struggle to address these impacts due to limited technical expertise and financial resources. Although many countries now introduced strict Rules &Regulations for waste management, the rural panchayat in India are still facing challenges because of inadequate monitoring and infrastructure. In spite of adoption of recent technology like improved biological, chemical, thermal treatment, and decentralized waste-processing models which are accessible and efficient, the rural waste management systems are at stake due to lack of awareness, policy support, and community-based management. In this paper, the challenges being faced by a rural panchayat having waste management systems has been discussed.

Keywords: Rural domestic waste; Environmental pollution; Waste Management; Alternative Technologies; Challenges

Vertical Flow Constructed Wetlands for Efficient Nitrogen and Organic Matter Removal from Institutional Wastewater

Amandeep Singh[1], Moumita Dikshit[2], Dr. Kapil Kumar[3*]

[1]Laboratory of Environmental Sustainability and Energy Research (LESER), National Institute of Technology Delhi, New Delhi, 110036 India; Research Scholar

[2]Laboratory of Environmental Sustainability and Energy Research (LESER), National Institute of Technology Delhi, New Delhi, 110036 India; Research Scholar

[3]Laboratory of Environmental Sustainability and Energy Research (LESER), National Institute of Technology Delhi, New Delhi, 110036 India; Assistant Professor

[*]**Corresponding author:** Dr. Kapil Kumar, kapilkumar@nitdelhi.ac.in, 8755604422

Abstract ID:OP-787

Abstract

Institutional wastewater often exhibits variable nitrogen and organic loadings, posing challenges for decentralized treatment systems. Conventional wastewater treatment plants (WWTPs) and natural treatment systems such as constructed wetlands (CWs) are widely utilized to treat municipal and institutional wastewater with diverse contaminant loads. Among these, CWs have emerged as an eco-sustainable, low-cost, and easy-to-operate technology, making them particularly suitable for decentralized wastewater management. In this study, the performance of vertical flow constructed wetlands (VF-CWs) operated at the National Institute of Technology Delhi was evaluated for the removal of nitrogen and organic matter from institutional wastewater. Six subsurface flow (vertical flow) wetland units with varying bed configurations—comprising sand, gravel, and sand–gravel mixed combinations—were investigated under controlled hydraulic conditions. The systems were planted with Canna indica and Typha species, while sand and stone chips served as the primary substrate media to support filtration and microbial activity. The experimental results demonstrated substantial pollutant removal efficiencies: BOD_5 (70–90%), COD (60–85%),

phosphate (20–60%), nitrate (50–80%), and total nitrogen (30–70%). The enhanced nitrogen removal observed in the final stages of the coupled wetland system was attributed to the release of organic carbon from decomposing macrophytes, which stimulated denitrification processes and improved nutrient uptake through plant roots. Additionally, the alternating aerobic–anaerobic zones within the vertical flow beds facilitated simultaneous nitrification–denitrification mechanisms. Overall, the study highlights the potential of VF-CWs as a sustainable, low-cost, and efficient treatment option for institutional wastewater management, contributing to nutrient pollution control and the broader goals of environmental sustainability.

Keywords: Vertical flow constructed wetlands; Wastewater treatment and reuse; Nutrient and organic pollutant removal;

Anaerobic Baffled Reactors as Sustainable Alternatives to Conventional Treatment Systems: A Critical Review

Lipane Vaibhav[1], Bombale Dnyandeep[2], Rakhade Rajshri[3], Kute Shraddha[4], Vikas S Hakke[5*]
[1]Pravara Rural Engineering College, Loni, Ahilyanagar Maharashtra, India; Student and,
[2]Pravara Rural Engineering College, Loni, Ahilyanagar Maharashtra, India; Student and
[3]Pravara Rural Engineering College, Loni, Ahilyanagar Maharashtra, India; Student and,
[4]Pravara Rural Engineering College, Loni, Ahilyanagar Maharashtra, India; Student, and,
[5]Pravara Rural Engineering College, Loni, Ahilyanagar Maharashtra, India; Assistant Professor, Chemical Engineering Department
*Corresponding Author: Dr. Vikas S Hakke, hakke.vikas@gmail.com, 9890499781,
Abstract ID:OP-797

Abstract
Sustainable remediation on global issue of wastewater is significantly hot and focused. In this concern the intensification of wastewater treatment with the Anerobic baffled reaction (ABR) utilization plays a crucial role. One of the most important strengths of ABR is its ability to naturally separate the different biological phases developed during. the anaerobic digestion along with the length of reactor. The combination of hydrolysis and acidogenesis is dominant in front section of reactor whereas, acetogenesis and methanogenic conversion was observed in the tail section of reactor. The spatial phases separation enhances process stability and protects sensitive methanogenic bacteria from sudden organic or toxic shocks. This leads performance enhancement of ABR towards the fluctuation in hydraulic retention time (HRT), initial organic loading rate (OLR) and complex nature of industrial effluent. These quality of ABR makes it a robust, low cost and energy efficient technology for sustainable wastewater treatment. The present review article provides the deep learning of the ABS working principles, demonstrated effective treatment performance analysis across diverse wastewater streams. The applications to the streams such as domestic sewage, distillery effluent, agro-industry and textile dye effluent.

Keywords: Sustainable approach; Wastewater treatment; Anaerobic baffled reactor; hydraulic retention time (HRT); organic loading rate (OLR).

Environmental Impact Assessment of Hydrothermal Carbonisation of Mixed Sewage Sludge for Energy Recovery

Suhina Bhaduri[1], Vikranth Volli[2*]
Anant School for Climate Action, Anant National University, India.
*Corresponding Author, Email: vikranth.volli@anu.edu.in, Phone number: +91 6379862729
Abstract ID: OP-803

Abstract
Sewage sludge management is a major environmental concern due to increasing wastewater treatment and the high moisture and organic content of sludge. This study performs a comparative cradle-to-grave life cycle assessment (LCA) of hydrothermal carbonisation (HTC) of mixed sewage sludge using SimaPro software and the ReCiPe 2018 midpoint impact assessment method. The functional unit was defined as the treatment of 1 tonne of wet, mixed (primary and secondary) sewage sludge. Two treatment pathways were assessed: conventional anaerobic digestion (AD) and an integrated HTC+AD system. The system boundary includes sludge treatment, biogas production, gas cleaning, combustion for energy recovery, and hydrochar utilisation. The results indicate a total climate change impact of 93.3 kg CO_2-equivalent per tonne of sludge treated in the HTC+AD system. Terrestrial acidification was 0.0685 kg SO_2-eq, while freshwater eutrophication reached 0.0677 kg P-eq, reflecting nutrient transfer to the aqueous phase. Energy recovery resulted in avoided fossil resource use of −40.2 kg oil-eq and a net water balance of −0.487 m^3. The findings show that HTC redistributes environmental burdens across impact categories while enabling resource recovery from sewage sludge. In future work, we will emphasise End Point analysis, grouping environmental impacts into human health, ecosystem, and resource damage categories.

***Keywords*:** Hydrothermal carbonisation; Sewage sludge; Life cycle assessment, Anaerobic digestion

Assessment and Mitigation of Indoor Air Pollution with Prototype Development

Subhadeep Mondal[1], Mr. Manjur Rahaman[1], Prof. (Dr.) Swami Vedajnananda[1*]
[1]Department of Chemical Engineering, Heritage Institute of Technology, Kolkata, West Bengal, India;
* swami.vedajnananda@heritageit.edu, +919831569865
Abstract ID:OP-823

Abstract
The rapid deterioration of ambient air quality in Indian cities has intensified concerns regarding occupational and public exposure in semi-enclosed micro-environments such as petrol filling stations. These locations experience continuous emissions from fuel evaporation, vehicular exhaust, and resuspension of settled particulates, yet remain inadequately characterized in conventional air quality monitoring frameworks. In the present study, a systematic assessment of indoor and near-field air pollution was carried out at four petrol pumps-two located in urban settings (Pump A and Pump B) and two in rural settings (Pump C and Pump D)-to quantify spatial and operational variability in pollutant concentrations.
Key pollutants, namely formaldehyde (HCHO), total volatile organic compounds (TVOC), and particulate matter fractions ($PM_{1.0}$, $PM_{2.5}$, and PM_{10}), were monitored using calibrated

portable sensors alongside meteorological parameters such as temperature and relative humidity. Observations indicate that urban petrol pumps experience substantially elevated pollutant levels during peak operational hours, with TVOC concentrations reaching **2.5-3.8 mg·m^{-3},** $PM_{2.5}$ levels in the range of **85-140 µg·m^{-3},** and PM_{10} exceeding **200 µg·m^{-3}**, particularly under high crowd density conditions. In contrast, rural petrol pumps exhibited comparatively lower baseline concentrations; however, episodic peaks were observed during refuelling rush hours, highlighting the role of activity intensity and limited dispersion even in low-traffic regions.

The study further demonstrates that crowd density, fuel handling frequency, and local ventilation conditions exert a stronger influence on pollutant accumulation than geographic location alone. **The novelty of this work lies in its integrated comparison of urban and rural petrol pump micro-environments combined with the development of a low-cost prototype-based mitigation framework**, offering a scalable approach for real-time monitoring and exposure reduction in occupational settings. The findings provide actionable insights for environmental management, policy formulation, and the design of targeted mitigation strategies to safeguard workers and commuters alike.

Keywords: Indoor air pollution; Petrol pump emissions; VOCs; Formaldehyde; Particulate matter; Urban-rural comparison; Air quality monitoring; Environmental mitigation.

Pharmaceutical Wastewater Treatment by ZLD an Advanced Wastewater Treatment: A Review

Santosh. S. Sable[1*], Nilesh Cholke[1], Gaurav Dale[1]

[1]Chemical Engineering Department, Pravara Rural engineering College, Loni, 413-736.

*Corresponding Santosh. S. Sable[1], Email: sablesantosh199@gmail.com, Phone number: 9970951344,

Abstract ID: OP-830

Abstract

For eliminating liquid effluent discharge from industrial premises Zero Liquid Discharge is an advanced wastewater treatment approach. Indian, where high-strength wastewater and strict environmental regulations prevail, ZLD systems have become increasingly relevant for pharmaceutical industry waste water treatment. Zero Liquid Discharge treatment system utilizes advanced technological water treatment processes are environmentally friendly and highly reliable. For situations where scarcity of water demands water recovery (recycle/reuse) ZLD technologies help you achieve environmental compliance, reduce your carbon which eliminates liquid waste by converting it into disposable dry solids and recover around 95% of your liquid waste for reuse. Zero Liquid Discharge treatment process can adopted as advanced waste water treatment constituents to by-products that are more readily biodegradable and reducing overall toxicity, pH, COD, TDS, SS, BOD parameters. Zero Liquid Discharge system producing a clean stream suitable for use elsewhere in the plant processes and minimize the volume of liquid waste that requires treatment Zero Liquid Discharge capable to reduce the all types of waste water and make it reusable and recyclable further for different applications.

Keywords: Zero Liquid Discharge; Pharmaceutical Wastewater; Evaporation, RO; WWT.

Other Areas in Science, Engineering and Technology (OSET)

Oxygen Rich Technology In Secondary Steel Making Process

Dr Shivaji Biswas, Propreitor , Dscube Energy And Enviro Consultants

Abstract ID:OP-147

Abstract

In the secondary steel project the witnessed a slow change of fuel type .Coal was transformations from the pre independence to the present abundantly used in the British era till in secondary steel making process .At that time most of furnaces were semi continuous , the fuel slowly was changed to liquid like furnace oil /low sulphur heavy stock etc ---- steady price rise of fuel oil made them to rethink about fuel change over .Natural gas resource was opened ,pipeline was laid from source to use points like HBJ pipeline , along with producer gas . But producer gas has tar related problem .Now a days gas fired furnaces are in operation . In a bid to go for more productive . Here next productive solution is to use 0xygen rich gas ,in place of air as secondary air .,objective was to eliminate “nitrogen” . The technology Dilute oxygen combustion technology helps to provide rolling mill process with higher productivity without high capital and operating cost .This process lower specific energy to heat steel and promote uniform temperature and heat transfer with lower specific energy to heat steel ,waste gas also contains lower heat content . Dilute oxygen combustion technology uses separate high velocity fuel and oxygen jets to generate strong in furnace gas recirculation ,these low NO x ,oxy fuel burners have been developed and commercially demonstrated in steel reheating furnace .The design of burner meets industry needs for increased productivity and reduced operating cost . .the sketch of oxy fuel burner in a reahting furnace is presented in figure In addition to typical oxy gen/fuel advantage ,fuel and oxtgen are injected through separate ports rather than a single burner .the reactants mix up with hot furnace gases before reacting with each other .This dilation effect prevents the high peak temperature .

Biomass-Derived Granular Activated Carbon (GAC), Analysis and its Applications in Wastewater Treatment: A Study of Removal of Emerging Pollutants

Shiv Nandan[1], Vinod Kumar Meena[2*], Himadri Roy Ghatak[3]

[1]Sant Longowal Institute of Technology, Longowal, Sangrur, Punjab, 148106, India; [2]Assistant Professor, Sant Longowal Institute of Technology, Longowal, Sangrur, Punjab, 148106, India; [3]Professor, Sant Longowal Institute of Technology, Longowal, Sangrur, Punjab, 148106, India.

* Vinod Kumar Meena, vkbamnawat@yahoo.com; vinod_chemical@sliet.ac.in, +91 1672-253718

Abstract ID: PP-220

Abstract

The presence of emerging pollutants (EPs) such as pharmaceuticals, personal care products, endocrine-disrupting compounds, and industrial chemicals in wastewater poses significant environmental and public health concerns due to their persistence and bioaccumulation potential. Conventional wastewater treatment processes often fail to effectively remove these contaminants. Biomass-derived granular activated carbon (GAC) has gained attention as a

sustainable and efficient adsorbent for EP removal, offering a low-cost and environmentally friendly alternative to commercial activated carbon. This review provides a comprehensive study of different biomass precursors, GAC synthesis methods, physicochemical characterization, and adsorption mechanisms of GAC synthesized from various biomass sources including agricultural residues, forestry by-products, and industrial wastes. Key parameters influencing GAC performance, such as surface area, pore size distribution, surface chemistry, and activation methods (physical and chemical), and operational conditions are critically analyzed. Furthermore, the review highlights recent advances in the application of biomass-derived GAC for the adsorption of specific classes of EPs, techno-economic feasibility of GAC in real-world wastewater treatment and addresses regeneration strategies, challenges, and future research directions. The findings emphasize the potential of biomass-based GAC as a viable material for advanced wastewater treatment technologies targeting emerging contaminants.

Keywords: Biomass; Precursors; Granular Activated Carbon; Emerging pollutants; Wastewater; Adsorption.

A Life Cycle Assessment of the Production of Important Polymers

Shashwata Ghosh[1,2*], Joseph A. Fallurin[3], Meghan Peltier[3], Joule Bergerson[4]
[1]Department of Chemical Engineering, Indian Institute of Technology Dharwad 580011, Karnataka, India
[2]Department of Chemical and Petroleum Engineering, University of Calgary, Calgary, AB T2N 1N4, Alberta, Canada
[3]RMI (formerly Rocky Mountain Institute), 17 State Street, 25th Floor, Unit 2500, New York, New York, 10004, United States of America
[4]Department of Chemical and Biomolecular Engineering, University of Notre Dame, Notre Dame, IN 46556, United States of America
*Corresponding author: Shashwata Ghosh, Email: shashwata.ghosh@iitdh.ac.in
Abstract ID: OP-395

Abstract
Worldwide, the production of some of the widely used polymers has grown by more than double in the past couple of decades. About 18% of the annual global CO_2 emissions result from the chemical industrial sector, a majority of which is owing to production of major chemicals like ethylene, propylene, ammonia, methanol, benzene, toluene and xylenes. Most of these are important feedstocks of the polymer industry. Analysing the emissions is important to identify measures for reduction of emissions for a more sustainable polymer industry compliant with stricter emission standards and helping in our progress towards achieving net-zero emissions. Except for a small amount of polymers (less than 10%) produced by recycling, the entire industry is reliant on oil and natural gas as the feedstock for production of polymers. This work uses a combination of process simulation and statistical analysis to analyse the variation in greenhouse gas emissions resulting from various factors in the processes like oil and gas extraction, cracking of hydrocarbons to produce some of the

monomers required to produce several important polymers. It has been found that these processes have significant stakes in the total emissions of greenhouse gases in the life cycle of the polymers. Additionally, one type of polymer may be produced by multiple routes, resulting in widely different emissions for each route depending on variables e.g. process operating conditions, diverse sources of oil and gas, transportation, refinery configurations, etc. This again results in a large range of emissions associated with the production of any polymer.

Keywords: Life cycle assessment; polymers; emissions; analysis

Development of Centralized Control Strategies for Laboratory Scale OC-OTEC Plant

Siva Rasme SankarRam[1*], Sutha Subbian[2], Venkatesan Govindarajulu[3]
[1]Department of Instrumentation Engineering, MIT Campus, Anna University, Chennai;
[2]Professor, Department of Instrumentation Engineering, MIT Campus, Anna University, Chennai;
[3]Scientist-G, Department of Energy and Freshwater, National Institute of Ocean Technology, Chennai.
*Siva Rasme SankarRam, sivarasme2008@gmail.com, 8056453201
Abstract ID: OP-458

Abstract
Open-Cycle Ocean Thermal Energy Conversion (OC-OTEC) is a dual sustainable energy technology capable of simultaneously producing power and freshwater from seawater based on temperature gradient for meeting the growing demands of remote island communities. One of the major challenges in operating an open-loop OC-OTEC system is the fluctuation in sea surface temperature, which adversely affects overall plant performance and reliability. Furthermore, the OC-OTEC system is highly interacting and highly sensitive to temperature variations. Hence, identifying a suitable control strategy is essential for automating the OC-OTEC process. In this paper, various centralized Proportional Integral (PI)-based control strategies were developed, and their performances and stability were compared to determine the most suitable approach for realtime application. Experimental data was collected from the laboratory-scale OC-OTEC plant, and a data-driven model was developed using system identification techniques. PI-based control strategies using the Davison Method, Decoupler Design Method, and Internal Model Control (IMC)-based Tuning Method were implemented, and their performances were evaluated under both servo and regulatory operations. The results demonstrate that the closed-loop response of the centralized IMC-PI controller outperforms the other techniques, providing improved tracking, superior disturbance rejection, and enhanced stability. Hence, the IMC-based controller can be recommended for automating the real-time OC-OTEC plant.

Keywords: OC-OTEC; Temperature gradient; Centralized controller; IMC-PI; Stability.

Radio-Tolerant Novel Bacterial Consortium for the Biodegradation of Hexamine

Sk Wasim Ahmed[1] & Shaon Ray Chaudhuri[2*]
Microbial Technology Laboratory, Department of Microbiology, Tripura University, Suryamaninagar, Tripura West -799022, India
*Shaon Ray Chaudhuri, Shaonraychaudhuri@tripurauniv.ac.in, +918910432280.
Abstract ID: OP-595

Abstract
A rapidly growing nation faces increasing demand for water, resulting in generation of a matching volume of wastewater, demanding efficient and rapid wastewater management technologies. Such technologies impact global challenges like water scarcity, pollution abatement, and the Sustainable Development Goals (SDGs). Biofilm-based bioremediation of emerging organic pollutants on a large industrial scale is an economically viable and sustainable technology for prolonged use for wastewater treatment. It starts with development of microbial formulation at laboratory scale, its performance optimization, validation at pilot scale before moving to industrial operation. The problem becomes compounded under radioactive environment as seen in the sewage treatment plants of nuclear medicine centre. Tailor-made, strong biofilm-forming bacterial consortium was developed using six well-characterized bacterial isolates from the hexamine and formaldehyde-containing industrial effluent with ability of hexamine, formaldehyde and COD removal upon low doses of ^{60}Co g irradiation in a biofilm setup, revealing the consortium to be radio-tolerant recovering their efficiency within 96 hours post irradiation. The immobilized system, showed 94.6%, 86% and 52.5% reduction in hexamine, formaldehyde and COD after 3.75Gy of ^{60}Co g irradiation and 92.2%, 84.2% and 52.57% reduction in hexamine, formaldehyde and COD after 5.25 Gy of ^{60}Co g irradiation, when starting with an initial 51.6 mg/L hexamine, 39.1 mg/L formaldehyde and COD 13359 mg/L. In this study we report the hexamine removing ability of *Brucella pseudintermedia* and *Ochrobactrum sp.* A rapid and sensitive paper sensor was developed for the detection of formaldehyde in aqueous solution. The sensor could detect 1 mg/L, 5 mg/L, 10 mg/L 100 mg/L formaldehyde at ambient room temperature.

Keywords: Hexamine, Bioremediation, Paper sensor

Energy Harvesting from Waste Heat and Vibrations: Turning Lost Energy into Useful Power

Sharwari Paulkar[1], Shruti Vind[2], Mrs. Minal Patil[3]
[1] and [2] 3rd year student of Chemical,Engineering, PCE, Nagpur,
[3] Assistant professor, PCE, Nagpur
*Mrs. Minal Patil, minalgpatil17@gmail.com, +91 9096347134
Abstract ID: PP-605

Abstract
A large amount of energy produced in industries, vehicles, and machines is wasted in the form of heat and mechanical vibrations. Energy harvesting is an effective method to capture this unused energy and convert it into useful electrical power. This poster focuses on energy harvesting from waste heat and vibrations, explaining its basic principles, methods, and applications.

Waste heat energy harvesting mainly uses thermoelectric generators based on the Seebeck effect, where a temperature difference between two surfaces produces electricity. These systems can be used in industrial furnaces, power plants, and automobile exhaust systems. Vibration energy harvesting converts mechanical vibrations into electrical energy using piezoelectric and electromagnetic materials. Such systems are suitable for low-power applications like wireless sensors and Internet of Things (IoT) devices.
Energy harvesting helps in reducing energy loss, improving energy efficiency, and supporting sustainable development. It also allows the operation of self-powered devices with low maintenance requirements. However, challenges such as low efficiency, limited power output, and high material costs still exist. Ongoing research in advanced materials and hybrid energy harvesting systems aims to overcome these limitations. Overall, energy harvesting from waste heat and vibrations is a promising technology for future renewable energy and smart engineering applications.

Keywords: Energy harvesting; Waste heat recovery; Thermoelectric generator; Piezoelectric materials; Vibration energy

Towards On-Site Detection: Advancing Wastewater Management with Optical Sensors for Toxic Pollutants

Debasmita Paul[1], Bandita Datta[2*]

[1]Student, Department of Chemistry, Amity Institute of Applied Sciences, Amity University Kolkata, Major Arterial Road (South-East), A. A. II, Rajarhat, Kolkata, West Bengal, 700135, India

[2]Assistant Professor, Department of Chemistry, Amity Institute of Applied Sciences, Amity University Kolkata, Major Arterial Road (South-East), A. A. II, Rajarhat, Kolkata, West Bengal, 700135, India

*Corresponding Author: Name: Dr Bandita Datta, Email: bdatta@kol.amity.edu, Phone number: +919593631077

Abstract ID:OP-680

Abstract

The increasing discharge of industrial, agricultural, and domestic effluents has led to severe contamination of water resources, necessitating the development of efficient and real-time wastewater monitoring systems. This work focuses on the development of a sensitive and reliable sensor for the detection of pollutants in wastewater. The proposed sensor is designed to monitor key contaminants such as heavy metals, organic pollutants, and toxic ions that pose significant risks to environmental and human health. By integrating advanced sensing materials with optimized transduction mechanisms, the sensor demonstrates high sensitivity, selectivity, and rapid response under complex wastewater conditions. The probe enables continuous, on-site monitoring, reducing reliance on labor-intensive laboratory-based analyses. Emphasis is placed on improving detection limits, operational stability, and cost-effectiveness to facilitate large-scale deployment in wastewater treatment facilities and environmental monitoring stations. Experimental validation shows that the sensor provides accurate and reproducible measurements over a wide range of pollutant concentrations, even in the presence of interfering species. The developed sensor holds strong potential for early detection of pollution events, regulatory compliance, and sustainable water resource management. Overall, this study

contributes toward the advancement of smart sensing technologies for real-time wastewater quality assessment and environmental protection.

Keywords: Environmental sensor; Smart sensing technology; Pollution detection; Wastewater monitoring; Water quality assessment.

Generative AI in Chemical Engineering Education: Case study of using Gen AI in Heat Transfer Course

Janani Priyadharshini V., Kaviya J, Poorani T, Naren P R*
School of Chemical & Biotechnology
SASTRA Deemed University, Thanjavur, Tamil Nadu 613401 INDIA
*Naren P R, prnaren@scbt.sastra.ac.in, +91 9445658211
Abstract ID: OP-712

Abstract
Analytical reasoning is often underemphasized in foundational chemical engineering problem-solving, particularly in Heat Transfer, where conventional digital tools frequently prioritize direct solution delivery over conceptual understanding. This work presents a structured, AI-assisted framework designed to support stepwise reasoning and improve conceptual clarity in Heat Transfer. The approach adopts a prompt-based methodology inspired by Socratic enquiry, in which guided questioning leads users through governing equations, assumptions, and physical interpretations rather than revealing immediate numerical answers. The system is enhanced by a Reverse Tutoring mode where users must identify and correct conceptual fallacies presented by the AI to reinforce mastery. The framework utilizes adaptive scaffolding to dynamically adjust inquiry depth based on real-time user proficiency. Operating within a single interface, it offers adjustable interaction levels to accommodate various expertise degrees. Artificial intelligence serves as a reasoning support mechanism rather than a solution-generation tool. By prioritizing analytical progression over rote formula recall, the framework enhances independent problem-solving and deepens mastery of fundamental Heat Transfer principles. The proposed approach demonstrates how AI-assisted reasoning tools can be integrated into Chemical Engineering subjects while maintaining fundamental engineering rigor and highlights the potential role of structured AI support in chemical engineering training and technical skill development within advanced Chemical Engineering applications.

Keywords: Heat Transfer; GenAI; Chemical Engineering Education

Microbial Bioreactors for Emerging Contaminants: Mechanisms, Limitations, and Research Priorities

Marco Masabuda[1], Zainab Hussein[1][0009-0008-5787-9219], Salma Nagy Fathy[1][0009-0001-3144-0792], *Dr. Nageswara Rao Lakkimsetty[1][0000-0002-5042-515X] & G. Kavitha[0000-0002-8188-1481]

[1*]Department of Chemical and Petroleum Engineering, American University of Ras Al Khaimah (AURAK), Ras al Khaimah, United Arab Emirates
[2]Department of Chemical Engineering, RVR&JC College of Engineering (A), Guntur, A.P,
*Corresponding Author: lakkimsetty.rao@aurak.ac.ae
Abstract ID: OP-758

Abstract

Microbial bioreactors are the backbone of biological wastewater treatment across municipal and industrial sectors, increasingly tasked with removing nutrients, refractory organics, and emerging contaminants while enabling safe water reuse. This review critically evaluates the performance of conventional activated sludge, biofilm systems (MBBR/IFAS), anaerobic bioreactors, and hybrid membrane bioreactors (MBRs), integrating pollutant complexity, microbial ecology, fouling mechanistic, and energy–quality trade-offs. Removal pathways for key contaminant classes are systematically examined, highlighting persistent uncertainties associated with transformation products, particularly for pharmaceuticals and endocrine-disrupting compounds. Major operational and knowledge gaps are identified, including EPS and SMP-induced fouling in MBRs, process resilience under salinity, temperature, and toxic shock conditions, stability of mainstream shortcut nitrogen removal pathways, and treatment limitations for high-salinity industrial wastewaters. In addition, the lack of standardized fouling characterization methods and lifecycle economic assessments linked to reuse objectives is discussed. The review concludes by proposing a structured decision framework and research priorities to guide reactor selection, process control, and system intensification, supporting the development of resilient, energy-efficient, and risk-aware biological wastewater treatment technologies.

Keywords: Microbial bioreactors; emerging contaminants; wastewater treatment; membrane bioreactors; biofilm processes; water reuse

Advances in Oxovanadium Complexes as Biofunctional Materials: From Molecular Design to Biomedical Applications

Tapan Kumar Si*
*Department of Chemistry, Bidhan Chandra College, Asansol-713304, West Bengal, India.
Email: tapan@bccollegeasansol.ac.in
Abstract ID:OP-868

Abstract

Oxovanadium complexes have gained significant attention as biofunctional materials due to their versatile redox behavior, structural tunability, and notable biological activities. Advances in ligand design have enabled precise control over their stability and reactivity, enhancing their ability to mimic enzyme functions such as haloperoxidase activity and insulin-like behavior. These properties make them promising candidates for applications in diabetes management, antimicrobial therapy, and anticancer strategies. Mechanistically, their biological effects are largely attributed to redox modulation, generation of reactive oxygen species, and interactions with biomolecular targets including DNA and proteins. Despite encouraging progress,

challenges related to toxicity, bioavailability, and long-term stability must be addressed for clinical translation. This review highlights recent developments in molecular design, mechanistic understanding, and biomedical applications of oxovanadium complexes, emphasizing their future potential as multifunctional therapeutic agents.