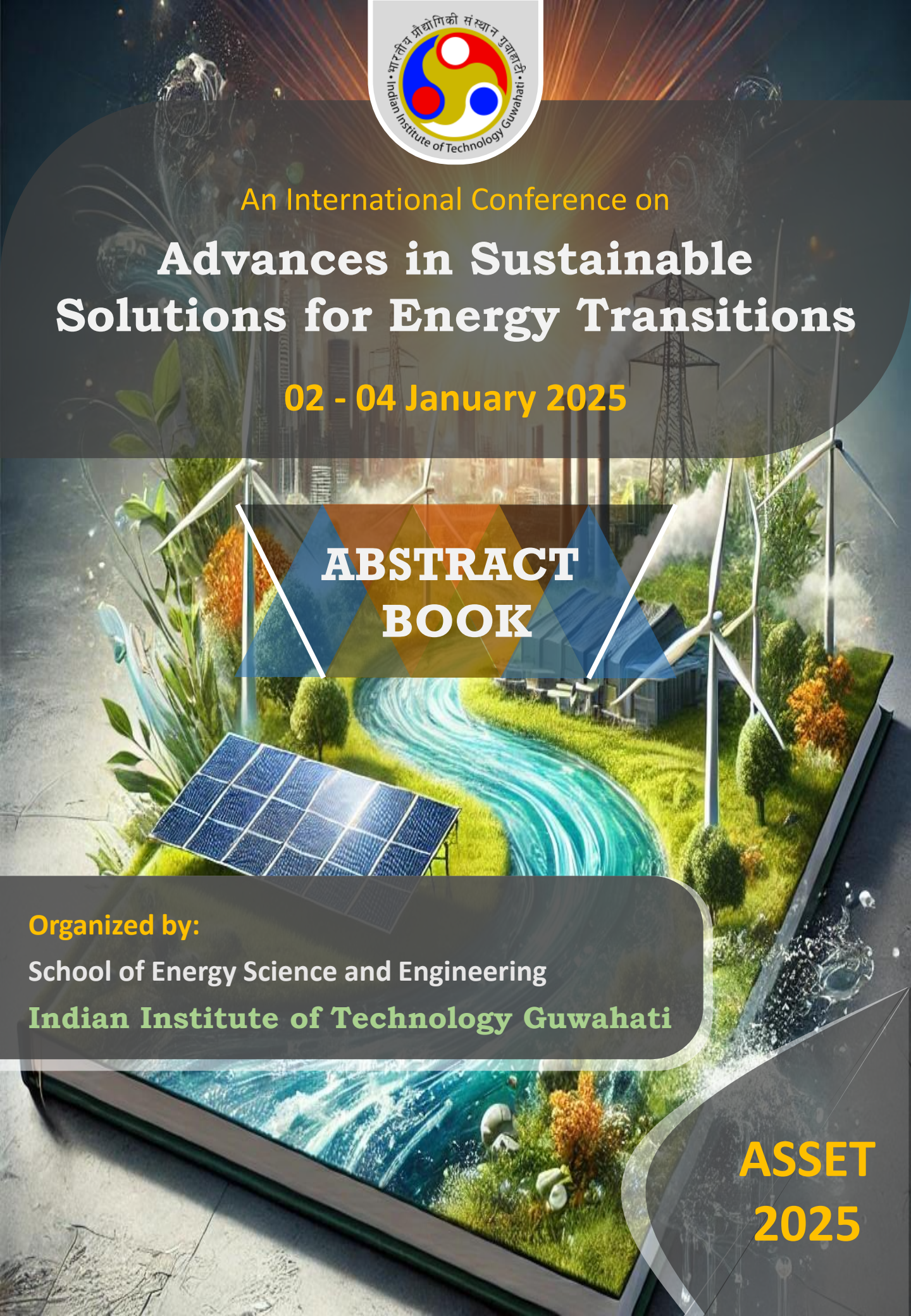
An International Conference on

Advances in Sustainable Solutions for Energy Transitions

02 - 04 January 2025



ABSTRACT BOOK

Organized by:

School of Energy Science and Engineering

Indian Institute of Technology Guwahati

ASSET 2025

ASSET - 2025

Advances in Sustainable Solutions for Energy Transitions

An International Conference on

Advances in Sustainable Solutions for Energy Transitions

(2 – 4 January 2025)

Abstract Book

Organized by

School of Energy Science and Engineering
Indian Institute of Technology Guwahati
Guwahati – 781039, Assam, India

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 National Institutional Ranking Framework (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 School of Energy Science and Engineering

School of Energy Science and Engineering (formerly Centre for Energy) at IIT Guwahati was established in May 2004 to promote multidisciplinary activities focused on various facets of energy technology and systems in the form of research, teaching, and consultancy. Being located in Guwahati, the gateway to North-East India, it envisions catering to the energy needs of the entire region academically, technologically, and intellectually. Currently, the School is focusing on (i) Energy generation (through thermochemical route, biochemical route, biofuel, fuel cell, solar, catalyst development, and solar-wind hybrid), (ii) Energy storage (Li-ion Battery, compressed air and metal hydride) (iii) Energy transmission (nano-fluid, metamaterials) and (iv) development of integrated systems and innovative products. The research activities in the School are in the form of funded projects from various national and international funding agencies. The School currently has 5 dedicated faculty members from various educational and research backgrounds. Additionally, faculty members from various departments of the institute, such as Biosciences and Bioengineering, Chemical Engineering, Civil Engineering, Design, Electronics and Electrical Engineering, Mechanical Engineering, and Physics, are associated with the School for the promotion of interdisciplinary research for sustainable energy. The school offers three academic programs viz. Bachelor of Technology (B.Tech.) in Energy Engineering, Master of Science by Research (MS-R), and Doctor of Philosophy (PhD). The School is actively participating in Unnat Bharat Abhiyan, Rashtriya Avishkar Abhiyan, and Uchhatar Avishkar Abhiyan and aims to significantly contribute to Make in India, Skill India, Imprint India, Solar Mission, GIAN, and other complementary initiatives of the Govt. of India. The School foresees developing itself as an energy hub with advanced state-of-the-art facilities in cutting-edge research for generating human resources and laboratory-to-field technology. The facilities available at the School have been a great support for the students working in different areas at IITG as well as for the students of various academic and research institutions of the North East.

About Conference

International Conference on Advances in Sustainable Solutions for Energy Transitions (ASSET 2025), scheduled for January 2-4, 2025 at the esteemed School of Energy Science and Engineering, IIT Guwahati aims to stand as a cornerstone event in the quest for sustainable energy solutions. This conference, which will bring together top specialists, scholars, decision-makers, and business representatives from around the globe and promises to be a turning point in the conversation around energy sustainability. Keynote addresses, panel discussions, paper presentations, and workshops on a variety of subjects, including renewable energy integration, energy storage, smart grid systems, and policy frameworks for sustainable development, will be included in the conference. Participants will get the chance to participate in multidisciplinary discussions that promote cooperation and knowledge sharing across the government, business, and academic sectors.

Outcomes and impacts of the conference

- Generation of new knowledge, insights, and innovations through research presentations, case studies, and technical sessions, contributing to the advancement of sustainable energy solutions
- Identification of policy gaps, barriers, and opportunities for promoting sustainable energy transitions, leading to informed policy recommendations and advocacy initiatives.
- Facilitation of technology transfer, commercialization, and deployment of sustainable energy technologies through industry-academia collaborations and partnerships.
- Empowerment of researchers, students, and professionals through capacity-building learning in the field of sustainable energy.
- Establishment of network of stakeholders, fostering collaborations, partnerships, and knowledge exchange to address common challenges and accelerate the transition towards sustainable energy systems.

Broad Thematic areas

I. Biomass, Biofuels, Biorefinery & Waste Management
II. Solar, Wind, Hydro, Hydrogen & Fuel Cells
III. Energy - Materials, Storage, Transmission, Distribution & Policies, e-Mobility

Conference Schedule

ASSET-2025

International Conference on Advances in Sustainable Solutions for Energy Transitions

January 2-4, 2025

Venue: Conference Center, Indian Institute of Technology Guwahati

Day 1 | 2nd January 2025		
08:00 - 09:30	Registration and Breakfast	
09:30 - 10:00	Inauguration	
Plenary Lectures		**Venue: Conference Hall-2**
10:00 - 10:30	**PL - 1**	***Prof. Ganapati D. Yadav*** National Science Chair (ANRF/GOI), Emeritus Professor of Eminence Former Vice Chancellor, Institute of Chemical Technology, Mumbai, India *Net-negative goals and clean energy transition: the role of green hydrogen in CO_2 refineries and biomass valorization*
10:30 - 11:00	**PL - 2**	***Prof. P. Mahanta*** Director, NIT Meghalaya Professor, Department of Mechanical Engg., IIT Guwahati *Technology intervention in climate change perspective*
11:00 - 11:20	**High Tea & Coffee**	
Keynote Lectures		**Venue: Conference Hall-2**
11:25 – 11:47	**KL - 1**	***Prof. Amar K. Mohanty, University of Guelph, Canada*** Improved Utilization of Co-products from Biofuel Production: New Industrial Uses for a Sustainable Bio-refinery
11:47 – 12:09	**KL - 2**	***Prof. Ajay K. Dalai, University of Saskatchewan, Canada*** Extraction, Characterization, Blending, and Hydrotreating of Bio-crude oil from Hydrothermal Liquefaction of Agricultural Biomass

Technical Sessions (3 Parallel Sessions)

A : Theme I (Biomass, Biofuel, Biorefinery and Waste Management held)
B : Theme II (Solar, Wind, Hydro, Hydrogen & Fuel Cells)
C : Theme III (Energy - Materials, Storage, Transmission, Distribution & Policies, e-Mobility)

Technical Session		Venue: Hall-1
Session 1A: Theme I		
12:15 – 12:32	IL - 1	***Dr. Surajit Das, NIT Rourkela*** Sustainable approaches for waste management involving bacterial biofilms in biodegradation of recalcitrant environmental pollutants
12:32 – 12:49	IL - 2	***Dr. Pranjal Kalita, CIT Kokrajhar*** Sustainable Catalyst: Biofuel Production and Biofuel Precursor
13:00 – 14:00	Lunch	
Session 1A : Theme I (contd.)		
14:00 – 16:00	Oral Presentations (10 Papers)	
16:00 – 16:20	Tea/Coffee Break	
Technical Session		**Venue: Hall-2**
Session 1B: Theme II		
12:15 – 12:32	IL - 3	***Dr. Sisir Nayak, IIT Guwahati*** MPP Estimation a PV Array under different environmental conditions
12:32 – 12:49	IL - 4	***Dr. Satya Sekhar Bhogilla, IIT Jammu*** Design and development of solar-driven hydrogen energy systems
13:00 – 14:00	Lunch	
Session 1B: Theme II (contd.)		
14:00 – 16:00	Oral Presentations (10 Papers)	
16:00 – 16:20	Tea/Coffee Break	
Technical Session		**Venue: Hall-3**
Session 1C: Theme III		
12:15 – 12:32	IL - 5	***Dr. K. Ravi Kumar, IIT Delhi*** Cascade latent heat storage system for solar thermal applications
12:32 – 12:49	IL - 6	***Prof. N R Peela, IIT Guwahati*** Hydrogen production and energy storage
13:00 – 14:00	Lunch	
Session 1C: Theme III (contd.)		
14:00 – 16:00	Oral Presentations (10 Papers)	
16:00 – 16:20	Tea/Coffee Break	

Special Talk	Venue: Conference Hall-2
16:25 – 17:15	Talk on Publishing a Research Paper by ***Prof. U K Saha, IIT Guwahati*** The Complete Workflow
17:15 – 18:30	**Poster Presentation and Evaluation**
19:45 – 21:30	**Dinner**

Day 2 | 3rd January 2025		
08:00 - 09:15	Registration and Breakfast	
Keynote Lectures		**Venue: Conference Hall-2**
09:15 - 09:37	**KL - 3**	***Prof. Santanu Bandopadhyay, IIT Bombay, India*** Industrial decarbonization for energy transitions
09:37 - 09:59	**KL - 4**	***Prof. Manjusri Misra, University of Guelph, Canada*** Advanced biocarbons from sustainable resources and their lightweight and flame retardant polymer composite materials for EV parts to boost decarbonization and a move for net zero transition
Technical Session		**Venue: Hall-1**
Session 2A: Theme I		
10:05 – 10:22	**IL - 7**	***Dr. Kalpana Maheria, SVNIT Surat, India*** Synthesis and characterization of micro-mesoporous zeolite H-BEA for eco-friendly biomass conversion to value-added chemicals
10:22 – 10:39	**IL - 8**	***Dr. Garima Srivastava, Banasthali Vidyapith, Banasthal, India*** Renovating food waste into clean energy: A sustainable biogas production initiative for universities
10:39 – 10:56	**IL - 9**	***Dr. S.P. Chaurasia, MNIT Jaipur, India*** Effect of synthesis parameters on fabrication of PVDF-Co-PTFE membranes for ethanol-water separation using vacuum membrane distillation
10:56 – 11:10	**Tea/Coffee Break**	

Session 2A: Theme I (contd.)	
11:15 – 12:51	Oral Presentations (8 Papers)
13:00 – 14:00	**Lunch**

Technical Session		Venue: Hall-2
Session 2B: Theme II		
10:05 – 10:22	**IL - 10**	***Dr. Pranab Goswami, IIT Guwahati*** Photosynthetic microbial fuel cell: A bio-inspired system for generating green energy and developing sensors
10:22 – 10:39	**IL - 11**	***Dr. Shilpi Shital, RSERC, Technology Innovation Institute, UAE*** PV deployment to match summer demand in hotter climates
10:39 – 10:56	**IL - 12**	***Dr. Niranjan Sahoo, IIT Guwahati*** Harnessing wind power for sustainable energy generation: a vertical axis wind turbine perspective
10:56 – 11:10	**Tea/Coffee Break**	
Session 2B: Theme II (contd.)		
11:15 – 12:51	Oral Presentations (8 Papers)	
13:00 – 14:00	**Lunch**	
Technical Session		**Venue: Hall-3**
Session 2C: Theme III		
10:05 – 10:22	**IL - 13**	***Dr. Swati Sharma, IIT Mandi*** Laser-patterned carbon for flexible energy generation and storage devices
10:22 – 10:39	**IL - 14**	***Prof. Karuna Kalita*** Introduction to Electric Vehicles
10:39 – 10:56	**IL - 15**	***Dr. Gaurleen Kaur*** Harvesting Light: The AgriPV Evolution
10:56 – 11:10	**Tea/Coffee Break**	
Session 2C: Theme III (contd.)		
11:15 – 12:39	Oral Presentations (7 Papers)	
13:00 – 14:00	**Lunch**	

Keynote Lectures		Venue: Conference Hall-2
14:00 – 14:22	**KL - 5**	***Prof. Satya Narayan Naik, IIT Delhi, India*** Extraction of high-value compounds from Kappaphycus alvarezii utilising supercritical CO2 and subcritical water

14:22 – 14:44	KL - 6	*Dr. Tumpa Sarker, Bangladesh Agricultural University, Bangladesh* Hydrothermal liquefaction: A holistic approach to produce transport fuel
Technical Session		**Venue: Hall-1**
Session 3A: Theme I		
14:50 – 16:26	Oral Presentations (8 Papers)	
16:30 – 17:00	**Tea/Coffee Break**	
17:00 – 18:30	Poster Presentation and Evaluation	
19:45 – 21:30	**Gala Dinner**	
Technical Session		**Venue: Hall-2**
Session 3B: Theme II		
14:50 – 16:02	Oral Presentations (6 Papers)	
16:30 – 17:00	**Tea/Coffee Break**	
17:00 – 18:30	Poster Presentation and Evaluation	
19:45 – 21:30	**Gala Dinner**	
Technical Session		**Venue: Hall-3**
Session 3C: Theme III		
14:50 – 15:50	Oral Presentations (5 Papers)	
16:30 – 17:00	**Tea/Coffee Break**	
17:00 – 18:30	Poster Presentation and Evaluation	
19:45 – 21:30	**Gala Dinner**	

Day 3 | 4th January 2025		
08:30 - 09:15	Breakfast	
Keynote Lecture		**Venue: Conference Hall-2**
09:15 - 09:37	KL - 7	*Prof. Janusz A. Koziński, Lakehead University, Canada* Blockchain Principles: A Sustainable Biofuture Perspective
09:37 – 09:59	KL - 8	*Dr. Ritesh Mittal, Engineers India Limited, Gurugram, India* Novel Biomass based Catalytic Processes for Green Hydrogen Generation: A Review

Technical Session	Venue: Hall-1
Session 4A: Theme I	
10:05 – 10:22	**IL - 16** ***Prof. Rupam Kataki, Tezpur University, India*** Leveraging Biochar for Sustainable Environmental Solutions
10:22 – 12:10	Oral Presentations (9 Papers)
12:05 – 12:15	**Tea/Coffee Break**
Technical Session	**Venue: Hall-3**
Session 4B: Theme II	
10:05 – 11:41	Oral Presentations (8 Papers)
12:05 – 12:15	**Tea/Coffee Break**
12:15 – 13:00	**Valedictory Session and Closure of the Programme and Vote of Thanks (Hall 2)**
13:00 – 14:00	**Lunch**
14:00 – 14:30	**Distribution of Certificates and Receipts (Registration desk)**

Plenary Lectures

Prof. Ganapati D. Yadav
National Science Chair (ANRF/GOI)
Emeritus Professor of Eminence, Former Vice Chancellor
Institute of Chemical Technology, Mumbai, India

Net-Negative Goals and Clean Energy Transition: The Role of Green Hydrogen in CO_2 Refineries and Biomass Valorization

Abstract

The quest for sustainability and climate resilience demands transformative approaches to energy and resource management. By 2050, global energy demand is projected to reach 49,000 TWh, with 73% from renewables and hydrogen contributing 25% of the energy mix. CO_2 refineries emerge as revolutionary solutions, transforming emissions into valuable products like hydrocarbons, methanol, and dimethyl ether (DME), leveraging solar, wind, and hydrogen energy. At ICT, Mumbai, pioneering innovations such as the thermochemical copper-chlorine cycle for water splitting (TRL 6+) have achieved breakthroughs in green hydrogen production, reducing costs to USD 1 per kilogram for a 100 TPD capacity. This makes hydrogen economically viable for large-scale deployment, accelerating its integration into CO_2 refineries for net-negative processes.

ICT has also advanced CO_2 methanation and valorization, demonstrating the conversion of emissions into clean substitutes for natural gas, methanol, ethanol, and DME—fuels compatible with existing infrastructure. Additionally, high-value chemicals like formic acid, a promising hydrogen carrier, offer diverse industrial applications. These innovations create pathways to decarbonize transportation, energy, and chemical sectors, shifting the focus from carbon sequestration to carbon utilization. India's National Green Hydrogen Mission further strengthens this vision, targeting 5 MMT of green hydrogen annually by 2030, enabling the conversion of over 50 million tonnes of CO_2 into valuable products.

CO_2 refineries represent a cornerstone of the global clean energy transition, simultaneously addressing emissions and fostering sustainable growth. ICT's innovations demonstrate the feasibility and economic potential of transforming emissions into assets, with methanation and hydrogen production at the forefront. As policies incentivize carbon utilization and public-private partnerships drive investments, India is poised to lead the global decarbonization agenda. CO_2 refineries, supported by renewable energy and hydrogen infrastructure, will be pivotal in achieving net-negative emissions and building a resilient, inclusive, and sustainable future.

Keywords: Green hydrogen, CO_2 refineries, Global clean energy transition, Net-negative emissions, Sustainable future

Prof. Pinakeswar Mahanta
Director, National Institute of Technology, Meghalaya
Former Professor in the Department of Mechanical Engineering
IIT Guwahati

Technology Intervention in Climate Change Perspective

Abstract

The global energy sector remains predominantly reliant on conventional fossil fuels, contributing significantly to greenhouse gas (GHG) emissions and climate change. India exemplifies this challenge, with coal and crude oil forming the bulk of its primary energy supply. However, the rising environmental and economic costs of fossil fuels have spurred efforts toward renewable energy adoption. Since 2014, India's renewable energy capacity has seen remarkable growth, with solar capacity increasing nearly 29-fold and wind capacity doubling. Despite this progress, India's greenhouse gas emissions continue to rise, highlighting the urgent need for cleaner energy technologies. This study emphasizes the transformative role of Industry 4.0 technologies, such as artificial intelligence, machine learning, and digital twins, in revolutionizing energy generation. These tools enable predictive maintenance, improve operational efficiency, and reduce emissions in both renewable and conventional power systems. Specific applications include optimizing wind energy systems, enhancing solar power reliability, and integrating biomass with coal-fired plants. Key advancements, such as battery storage systems, further enhance renewable energy reliability, especially for off-grid and remote locations. To ensure a sustainable energy future, significant policy reforms and international cooperation are essential. Shifting subsidies from fossil fuels to renewables, streamlining regulatory processes, and fostering technology transfer will accelerate the global energy transition. India, with its commitment to achieving 50% renewable energy reliance by 2030 and net-zero emissions by 2070, exemplifies a pathway for balancing economic growth with environmental stewardship. However, achieving these targets requires substantial investment, robust supply chains, and public-private partnerships.

Keywords: Fossil fuels, Greenhouse gas, Renewable energy

Keynote Lectures

Theme: Biomass, Biofuels, Biorefinery & Waste Management

Prof. Janusz A. Koziński
Department of Chemical Engineering,
Lakehead University, Canada

Blockchain Principles: A Sustainable Biofuture Perspective

Abstract

There is a growing suspicion that the current worldview driving our actions, locally and internationally, is one which supports resource exploitation, the accumulation of profit, and infinite growth. This worldview continues to ignore that we live on a finite planet with limited resources and permeates the global socio-politico-economic system under which we live. As such, it will never be effective to address the sustainability challenges we face. There is an urgent need to conceptualize a new path forward that goes beyond ineffective so-called 'green' planning and reconnects humans, nonhumans, and nature. This can only be done by acknowledging planetary boundaries which can lead to successful ecosystem governance. What we are proposing is a radical transformation of how we conceive of ourselves and the world we live in. This presentation endeavors to initiate a radical transformation in our worldviews to remodel our current so-called development into what should be sustainability for all beings, not only humans. We will bring system thinking to a new level: reconnecting sustainable biorefining technology with nature, while applying the principles of the blockchain concept. Our goal is to challenge existing paradigms that guide our decision-making by adopting novel and unique directions emerging from a transdisciplinary dialogue.

Some of the fundamental questions we need to address are: Does Technology Make Us More Human? What's Beyond Sustainability in the Post-Humanist World?

Technological advancements have improved the quality of life for humans but created environmental disasters. It is eminent that oil-derived chemicals and energy carriers have become an inseparable part of human life but also the primary contributors to the environmental challenges. The current belief in our capacity to ultimately devise technological and scientific tools that can fix any problem is equally damaging. However, there are a few exceptions. For example, biorefining is considered as an environmentally friendly manufacturing platform for generating sustainable biomaterial and bioenergy. Through biorefining, the forestry and agro-based sectors are poised to become pivotal in the manufacturing process to replace oil-derived products with clean, sustainable, biobased alternatives used in many sectors, including cosmetics, food, medicine, and energy/automotive/aerospace. In this presentation, we claim that there is a need for a fundamental overhaul of our modes of thinking about ourselves and our natural world. What we are aiming at is nothing less than a paradigm shift away from an outdated understanding of sustainability toward a system-thinking-model of sustainability akin to recently developed post-humanist theories.

Keywords: Blockchain, Socio-politico-economic system, Biorefining technology, Sustainability

Theme: Energy - Materials, Storage, Transmission, Distribution & Policies, e-Mobility

Prof. Santanu Bandopadhyay
Department of Energy Science and Engineering
Indian Institute of Technology, Bombay
Powai, Mumbai, 400076, India

Industrial Decarbonization for Energy Transitions

Abstract

One of the essential steps for transitioning energy systems to a sustainable energy system is decarbonizing the energy sector. The word "decarbonization" literally means the reduction of carbon dioxide emissions. Decarbonization is converting to an economic system to reduce and compensate for carbon dioxide (CO_2) emissions and other greenhouse gases. Energy transition helps achieve this long-term goal of a CO_2-free energy system. The industrial sector, in general, contributes significantly to the emission of atmospheric greenhouse gases. Industrial decarbonization represents the phasing out of carbon dioxide emissions from all aspects of industry without compromising competitiveness and prosperity. In this talk, techno-economic analysis related to industrial decarbonization will be discussed, and some examples from hard-to-abate Indian industries will also be presented.

Keywords: Decarbonization, Carbon dioxide, Greenhouse gases

Theme: Energy - Materials, Storage, Transmission, Distribution & Policies, e-Mobility

Prof. Manjusri Misra

[1]School of Engineering
College of Physical and Engineering Science
University of Guelph, Guelph, ON, Canada
[2]Bioproducts Discovery & Development Centre
Plant Agriculture, Ontario Agricultural College
University of Guelph, Guelph, ON, Canada

Advanced Biocarbons from Sustainable Resources and their Lightweight and Flame Retardant Polymer Composite Materials for EV Parts to Boost Decarbonization and a Move for Net Zero Transition

Abstract

Lightweight green composites from renewable resources are gaining significant attention in advanced manufacturing sectors as industries prioritize decarbonization and the transition to net-zero emissions. The push for weight reduction in automotive parts, without compromising strength and durability, is driven by the need to improve fuel economy, particularly in electric vehicles. To enhance the renewable content in materials, we employ thermo-chemical conversion (pyrolysis) of biomass, agri-food, forestry resources and waste feedstock. This approach addresses key challenges associated with traditional natural fibres in melt-processed biocomposites. Biocarbons, with their high thermal stability, expand the potential for use as a reinforcing filler in a range of plastics – from traditional thermoplastics like polypropylene to engineering thermoplastics such as polyamide and polyphthalamide (PPA). In addition, biocarbons have been successfully integrated into composites made with waste plastics. Overall, biocarbon composites represent a promising strategy for creating sustainable materials, advancing decarbonization efforts, and accelerating the transition to a net-zero future.

Keywords: Decarbonization, biocomposites, Polymer, EV parts, Net-zero emissions

Theme: Biomass, Biofuels, Biorefinery & Waste Management

Prof. Ajay K. Dalai
Department of Chemical and Biological Engineering
University of Saskatchewan
Saskatoon, Canada

Extraction, Characterization, Blending, and Hydrotreating of Bio-crude oil from Hydrothermal Liquefaction of Agricultural Biomass

Abstract

Biofuels, which are gaining attention as renewable energy sources, can be produced from a wide variety of renewable feedstocks and biogenic wastes through thermochemical, biological and hybrid conversion technologies. This presentation will highlight the current Canadian and global scenario and strategy on pollution control, and candidacy of a variety of bioprocessing technologies for a wide range of waste feedstocks such as lignocellulosic biomass to produce clean sustainable energy production. This with will focus on some notable research studies conducted in the Catalysis and Chemical Reaction Engineering Laboratories (CCREL) over the past 25+ years at the University of Saskatchewan, especially on biomass-to-liquid (BTL) conversion technology using supercritical water liquefaction process to produce synthetic transportation fuels and carbon-rich solid products and on pollution control strategies from conventional thermal power plants. The current progress, challenges and knowledge gaps in the R&D of these technologies for the production of synthetic hydrocarbon fuels from waste resources as well as their global opportunities for bio-economy will be presented.

Keywords: Hydrotreating, Bio-curde oil, Biomass, Biomass-to-liquid, Bioprocessing technologies

Theme: Biomass, Biofuels, Biorefinery & Waste Management

Prof. Amar K. Mohanty
Bioproducts Discovery and Development Center
School of Engineering and Department of Plant Agriculture
University of Guelph, Canada

Improved Utilization of Co-products from Biofuel Production: New Industrial Uses for a Sustainable Bio-refinery

Abstract

Use of residues and undervalued co-products from biofuel industries as the raw materials for new industrial products is a path forward in sustainable solutions for energy transitions. “Bio-fuel and co-product” are two sides of the same coin. This presentation will highlight the recent developments in value-added industrial products from first, second and third generation of biofuels. Lignin, hemicellulose, crude glycerol, micro-algae from biofuel production will find value-added uses in green manufacturing. The production of 2G biofuel from lingo-celluloses produces ethanol, lignin and carbon dioxide in 1:1:1 ratio. The increased production of bioethanol from lignocelluloses can accumulate a huge amount of co-products like lignin that needs value-added uses for a sustainable biorefinery. Hybrid lignin and biomass on reinforcement with bioplastics show promise in engineering sustainable green composites. Lignin based flexible materials shows potential uses in substituting petro-based elastomers for industrial uses. We could innovate microalgae (a 3G co-product) plasticized with crude glycerol co-product and a biodegradable plastic to manufacture green composites for sustainable packaging uses. A group of researchers at the Bioproducts Discovery and Development Centre are working on developing cost-competitive green and biocomposites for uses in eco-friendly auto-parts, consumer products, and compostable packaging. This presentation will highlight the research on waste valorization and how innovation through a unique circular approach, can be made possible from University-Industry-Government collaborations.

Keywords: 2G biofuel, Lingo-celluloses, Green composites, Biorefinery

Theme: Biomass, Biofuels, Biorefinery & Waste Management

Prof. Satya Narayan Naik
Supercritical Fluid Extraction Laboratory
Centre for Rural Development and Technology
Indian Institute of Technology Delhi, New Delhi, 110016

Extraction of High-Value Compounds from Kappaphycus Alvarezii utilising Supercritical CO_2 and Subcritical Water

Abstract

Kappaphycus alvarezii procured from Indian coastline was valorised by extracting value added compounds using two emerging green technologies i.e., supercritical fluid extraction (SFE) and subcritical water (SCW) extraction techniques. SFE extracted solvent-free lipids high in health-beneficial polyunsaturated fatty acids, such as eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), arachidonic acid (AA), and γ-linolenic acid (GLA), from biomass, which can be directly used to improve the nutritional value of food. The SFE residual biomass was found to be rich in sulphated polysaccharide κ-carrageenan and protein. The ultrasound assisted approach yielded the most κ-carrageenan with the highest sulphate content, the largest concentration of galactose and 3,6-anhydrogalactose sugars, and the best rheological characteristic, which may be beneficial to the nutraceutical and pharmaceutical industries. SCW hydrolysis efficiently hydrolysed SFE residual biomass to recover the maximum protein which can be used as an active ingredient in functional food. In addition, the κ-carrageenan effectively inhibits the main protease of SARS-CoV-2, which may be useful in combating COVID-19. Consequently, the present work reveals a feasible strategy for valorising biomass by extracting high-value products utilising environmentally friendly technology for numerous industrial operations.

Keywords: Supercritical fluid, Kappaphycus alvarezii, Hydrolysis

Theme: Solar, Wind, Hydro, Hydrogen & Fuel Cells

Dr. Ritesh Mittal
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Novel Biomass based Catalytic Processes for Green Hydrogen Generation: A Review

Abstract

Strategizing carbon neutral technologies is critical driver to promulgate futuristic clean advanced bio-fuels like Renewable Green Hydrogen. Hydrogen contributes considerably to refining industry and is utmost costly molecule requiring costly naphtha to produce via steam reforming (SR). Ligno-cellulosic-biomass derived Pyrolysis bio-oil as second generation bio-fuel offers advantages over first generation bio-fuels due to sustainability without invoking food vs. fuel debate. Owing to economic challenges in direct Hydrolysis of cellulose and hemi-cellulosic components of Ligno-cellulosic biomass, Bio-oil Reforming, Biomass gasification and direct use of bio-oil due to high oxygen content & viscosity, prudent area of focus globally is alternate bio-oil utilization route by development of robust catalyst and viable catalytic technologies to produce Green Hydrogen. Analysis of Coking minimisation by coke precursor gasification & steam activation, use of Noble and non-noble catalysts with support modifiers like magnesium, lanthanum, cobalt and chromium that enhances steam adsorption to facilitate partial oxidation/gasification of coke precursors and enhancers like cobalt and chromium that slows coking surface reactions due to cracking and de-oxygenation are elaborated. For Green Hydrogen Generation, Accelerated Water Gas Shift (WGS) reaction and depressed Methanation, Boudouard & Reverse Water-Gas Shift (RWGS) as a function of catalyst are analyzed with predictions of futuristic tailored heterogeneous active catalyst formulations for the economic viability of catalytic processes. For enhanced insight, Novel bio-oil catalytic techniques for Green Hydrogen production like catalytic electrochemical, spouted bed, auto thermal and molecular beam mass spectrometer-interfaced processes are elaborated. Innovative modifications in conventional fixed and fluidized catalytic bed reactors with modified feeding systems for overcoming challenges like bio-oil polymerization, high viscosity, poor fluidity are argued in Green Hydrogen production from Biomass. Study of these technologies aims to establish that tailored novel catalytic bio-oil processes can be promising pathway for producing Green Hydrogen using renewable ligno-cellulosic biomass. In Comparison, Economic Feasibility overweighs Societal, Climatic and generation costs of Blue, Grey and Pink Hydrogen. Green Hydrogen is technically emerging area globally for use of second generation bio-fuel sources by mitigating challenges of Grey hydrogen in refining industry with in-situ integration of this carbon neutral perspective of Bio-Refinery based Renewable Green Hydrogen. Hope this compilation will create lots of interest amongst researcher and practicing engineers active in bio-fuels, Industrialist and environmentalist towards meeting Net Zero goal 2070 and to promulgate National Green Hydrogen Mission (NGHM) - 2023.

Keywords: Green hydrogen, Bio-fuels

Theme: Biomass, Biofuel & Waste Management

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Hydrothermal Liquefaction: A Holistic Approach to produce Transport Fuel

Abstract

Being abundant, eco-friendly, and sustainable, Lignocellulose shows great potential as a replacement for fossil fuels. Hydrothermal liquefaction is a highly effective method for converting biomass into liquid fuels and valuable chemicals. This study provides a comprehensive overview of the reaction mechanisms, key influencing factors, and production applications associated with hydrothermal liquefaction. It emphasizes the reaction mechanisms of lignocellulose's structural components: cellulose, hemicellulose, and lignin. Additionally, it discusses in detail the factors affecting the process, such as the types of feedstock, temperature, heating rate, retention time, pressure, solid-to-liquid ratio, and catalysts. Furthermore, the upgradation techniques for upgrading biocrude to various valuable biofuels and platform chemicals were extensively explored. The study also addresses the current limitations and prospects of hydrothermal liquefaction of lignocellulose, offering valuable insights for enhancing the process and developing advanced lignocellulose-based products. The techno-economic and life cycle assessments indicate that commercializing HTL technology is still a long way off, with necessary advancements needed in product yield, quality, and process energy efficiency. This study provides a deeper understanding of HTL technology and helps identify new valuable opportunities for advancing biocrude production.

Keywords: Hydrothermal liquefaction, Biofuels, Platform chemicals, Upgradation, Technoeconomic analysis

Invited Lectures

Theme: Biomass, Biofuels, Biorefinery & Waste Management

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Effect of Synthesis Parameters on Fabrication of PVDF-Co-PTFE Membranes for Ethanol-Water Separation Using Vacuum Membrane Distillation

Abstract

Present work is focused on synthesizing ethanol selective polyvinylidene fluoride (PVDF), and polyvinylidene fluoride (PVDF)-polytetrafluoroethylene (PTFE) hybrid flat sheet membranes using N,N-Dimethyl Acetamide (DMAc), and Dimethylformamide (DMF) for ethanol-water separation via vacuum membrane distillation(VMD). This type of membranes can be further useful in developing Memberane Bioreactor for Ethanol production. Effect of parameters have also been studied for the synthesis of hybrid membranes (PVDF-PTFE membranes) using DMAc and DMF as a solvent and ethanol-water mixture as non-solvent in a coagulation bath. The use of copolymer (PTFE) has shown positive effect on membrane characteristics such as contact angle (C.A.), porosity and pore size of the synthesized membranes. Five important synthesis parameters, such as polymer concentration (A), copolymer concentration (B), Coagulation Bath Temperature (CBT) (C), ethanol concentration in the coagulation bath (D), and evaporation time (E), have been studied for the membrane synthesis. The pore size, porosity, and contact angle for the synthesized membranes were obtained in the range of 0.18-0.24µm, 51.68-74.21%, and 98.26-139.52°, respectively for the effect of different synthesis parameters such as bath temperature (30-60 °C), the effect of evaporation time (10-30 seconds), ethanol concentration of coagulation bath (5-50 vol. %). The morphology of synthesized membranes was investigated using a high-resolution Field Emission Scanning Electron Microscope (FESEM). Atomic Force Microscopy (AFM) was used to measure the roughness of the membrane surface. Shape analyzer was used to assess the contact angle of manufactured membranes to determine their hydrophobicity. The VMD performances were measured in terms of ethanol flux and separation factor were 12.72 Kgm-2h-1, 7.39 and 7.88 Kgm-2h-1, 17.78 for DMAc and DMF-membranes, respectively.

Keywords: Membranes, morphology, contact angle, ethanol flux, separation factor

Theme: Solar, Wind, Hydro, Hydrogen Energy & Fuel Cell

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Photosynthetic Microbial Fuel Cell: A Bio-inspired System for Generating Green Energy and Developing Sensors

Abstract

Cyanobacteria are emerging as new-generation biocatalysts for generating power in fuel cells. The advantages of using these bacteria in the fuel cell system are enormous, among which their flexible growth conditions (phototrophic, heterotrophic, and mixotrophic modes) and tolerance to high salt and organic contaminants are noteworthy. These traits are suitable for applications of cyanobacteria-based photosynthetic microbial fuel cells (PMFC) for wastewater treatment and developing biosensors. Currently, the major impediment in using these cells is the lack of a rational strategy to channel the metabolic electrons to the electrode and to perform their prolonged operation to harvest power. Herein, cyanobacterial biofilm on the electrode surface has been investigated as a prerequisite strategy to create close contact between the cells and electrode material for harvesting electrons. Biocompatible polymers such as silk-fibroin have been identified as biofilm-inducing materials. A novel nano-biocomposite matrix containing CdTe quantum dots and conductive nanomaterials was employed to establish FRET-guided surging of cyanobacterial photosystem to improve power production under low light conditions in a PMFC. The study also extended to multispecies cyanobacterial biofilm as an anodic catalyst under extended dark-depended operation to stabilize and improve the power production in a PMFC. The critical findings unveiled through this study advance our understanding of the resilience of phototroph-based anodic catalysts for developing biophotovoltaic devices for long-term operations, degradation of toxic dyes, and developing biosensors.

Keywords: Cyanobacteria, Biofilm, Biosensors

Theme: Solar, Wind, Hydro, Hydrogen Energy & Fuel Cell

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MPP Estimation a PV Array under different Environmental Conditions

Abstract

This work presents a novel approach for the conversion of an implicit current-voltage (I-V) expression of a double diode model (DDM) photovoltaic (PV) module to an explicit expression of current in terms of voltage. A new method is proposed for the estimation of maximum power point (MPP) of a DDM PV module using the explicit I-V expression of a PV module under uniform irradiance condition. Further, a new mathematical model of a partially shaded PV array is developed using the proposed explicit expression. Since the explicit I-V expression is used for the estimation of MPP of a DDM PV module under uniform and nonuniform irradiance conditions, the estimation of MPP is simple, accurate, and efficient. The accuracy of the explicit expression is verified considering three different PV modules. A comparison of MPP of a DDM PV module extracted using the proposed method with different existing methods under different environmental conditions (DECs) is presented. The results obtained using the proposed method are validated with the experimental results under DEC. Also, the accuracy of the estimated global MPP of a PV array under partial shading conditions is verified.

Keywords: Double diode model, Photovoltaic, PV modules

Theme: Solar, Wind, Hydro, Hydrogen & Fuel Cells

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Harnessing Wind Power for Sustainable Energy Generation: A Vertical Axis Wind Turbine Perspective

Abstract

Rapid inflation in population growth, the standard of living and industrialization have led to a growing demand for electricity, and it is surely not expected to decrease any time soon. Traditionally, the requirement for electricity is satisfied by primary sources (fossil fuels). With the diminution of fossil fuels and the increase in environmental problems such as unusual weather changes, global warming, and high emission rates of carbon dioxide, the world realizes that alternative energy sources are desirable to ensure sustainability and the conservation of the environment. These factors have popularized the use of various sources of renewable energy (solar, wind, hydro, geothermal, and biomass). Among these, wind energy is plentiful, inexhaustible, clean, cheap, pollution-free, and has been used by humankind over centuries. The wind machines have turbine or rotor, that is a used for harnessing wind energy (Fig. 1). They are broadly classified as, vertical axis wind turbine (VAWT) and horizontal axis wind turbine (HWAT). The VAWTs have been growing in interest due to their omnidirectional ability, low costs, low noise, and robustness, mainly in urban and off-shore applications. The Darrieus type straight-bladed vertical axis wind turbine (SB-VAWT) is a wind rotor that seems to be suitable for low wind speed conditions. These wind rotors have several applications: electricity generation, purifying and desalinating water by reverse osmosis, pumping water, heating water by fluid turbulence, heating and cooling using vapor compression heat pumps, mixing and aerating water bodies, etc. These wind rotors suffer less performance than horizontal axis wind turbines, even if these are more advantageous than other VAWTs. The theme wind turbine research for harnessing wind power spreads in various research domains. It will share a new perspective on the state-of-the-art wind energy by exploring the opportunity and the possibility for harnessing the wind power in multi-disciplinary thrust areas for the commercial viability.

Keywords: Wind turbine, Sustainable energy, Vertical axis turbine

Theme: Biomass, Biofuels, Biorefinery & Waste Management

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Leveraging Biochar for Sustainable Environmental Solutions

Abstract

Waste to Energy (WtE) technologies is an effective alternative that aid to reduce the space requirement and other inherent management, and disposal related problems associated with various biowastes including MSW. Pyrolysis is a thermochemical conversion process that converts any biowastes in absence of oxygen at an elevated temperature (300 to 1000 °C), into biochar (solid product), liquid product consisting of an aqueous fraction (termed as wood vinegar, WV) and a thick fraction termed as bio-oil. Pyrolysis offers a sustainable alternative to current biowaste practices, turning organic materials into carbon-negative biochar and is being considered as a Negative Emission Technology (NET). Biochar has emerged as a prime focus of multifaceted research due to its unique features, broad-spectrum applications in diverse fields, and promising development prospects including soil amelioration, carbon sequestration, mitigation of contaminants, etc. Socio-economic and environmental awareness have redirected the basic and applied research using biochar applications including energy, environment, and agriculture sectors to address the issues of energy shortage, environmental pollution, and food security. Biochar or its activated form provides a noble platform to maximize its targeted applications. The current work aims to discuss the potential applications of biochar in numerous environmental matrices. Additionally, pyrolysis and its by-products could be used to meet future bio-economy challenges by generating energetically feasible and economically viable value-added products.

Keywords: Biowastes, Biochar, Pyrolysis, Environmental applications, Bioeconomy

Theme: Energy - Materials, Storage, Transmission, Distribution & Policies, e-Mobility

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Introduction to Electric Vehicles

Abstract

The electrification of the automobile can be a significant step towards avoiding the consequences of climate change and at the same time, a significant step towards the future competitiveness of our automotive industry. Electrical vehicles (EVs) are already very popular in Western countries. Countries with large cities and high population density have started to consider electrical vehicles as a solution for air quality problems in their major cities. China has been a forerunner in electrifying two-wheelers, four-wheelers and heavy-duty vehicles that are used in large cities. Similarly, EVs have also entered into Indian cities but slowly. Many cities have adopted electric bus as replacements for their IC engine buses. Electrification of electric vehicles will have profound impact in the smart cities planned in India. This talk will discuss the electrical vehicle design including the design of the vehicle components, system level design and optimization as well as the infrastructure design. This talk will also discuss the basic principles and trends of smart mobility, impact of smart mobility on existing sectors, drive cycle analysis, vehicle power plant requirement, electric motors for EV and HEV applications.

Keywords: Electric vehicles, Optimization, Design

Theme: Biomass, Biofuels, Biorefinery & Waste Management

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Sustainable Approaches for Waste Management Involving Bacterial Biofilms in Biodegradation of Recalcitrant Environmental Pollutants

Abstract

Rapid industrialization and urbanization have led to a surge in environmental pollution, necessitating bioremediation approaches. Bacterial biofilms offer a promising solution for the degradation of recalcitrant pollutants achieving the Sustainable Development Goals (SDGs), particularly SDG 6 (Clean Water and Sanitation) and SDG 14 (Life below water). Bacterial biofilms are an intricate assemblage of cells embedded within an extracellular matrix, composed of extracellular polymeric substances (EPS) like polysaccharides, proteins, lipids, enzymes, and nucleic acids. With a higher surface area, the biofilm matrix supports diverse metabolic pathways and facilitates active binding, solubilization, and emulsification of pollutants, thereby enhancing the efficiency of pollutant remediation. Bacteria within biofilm facilitate the degradation of organic pollutants, such as polycyclic aromatic hydrocarbons (PAHs), employing oxygen as an auxiliary oxidation substrate in aerobic environments, while in low-oxygen environments, biofilms rely on reductive reactions to degrade PAHs. In rubber wastewater, ureolytic bacterial biofilm facilitates adsorption of inorganic nitrates and phosphates through enzymatic activity, further reducing biological oxygen demand (BOD), chemical oxygen demand (COD), and total dissolved solids (TDS) levels. These biofilms also neutralize treated wastewater by producing calcium carbonate from excess Ca^{2+} ions. In addition, specific functional groups of the EPS interact with heavy metals through complexation, resulting in their adsorption to the biofilm matrix. Recently, an innovative strategy of immobilizing EPS within polymer-based biosorbents has been found to be more efficient in metal sequestration. The resilience of bacterial biofilm against organic and inorganic pollutants makes them valuable tools for sustainable bioremediation, waste management, pollution control, and environmental restoration.

Keywords: Biofilm, Pollutant, Bioremediation

Theme: Biomass, Biofuels, Biorefinery & Waste Management

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Green Hydrogen Production and Purification/Storage

Abstract

The generation of green hydrogen from solar energy via photocatalytic overall water splitting reaction is a Holy grail in the research community. If we develop this process with high efficiency, then we can replace the existing "photo-voltaic solar to electrical energy conversion followed by water electrolysis" with this new technology, which directly converts the solar energy to chemical energy (i.e., hydrogen). Optofluidic microreactors are highly promising for this process. In this presentation, I would like to give an overview of the research work going on in our laboratory in this area. In brief, we developed various strategies for the photocatalytic overall water splitting reaction. The photocatalysts, such as metal doped and co-catalyst loaded photocatalysts (Ag/TiO_2, Pt/TiO_2, IrO_2/TiO_2 and $Pt/IrO_2/TiO_2$), binary (CdS/MnOx-BiVO4 and $CdS/g\text{-}C_3N_4$) and ternary heterojunctions ($Ag/g\text{-}C_3N_4/g\text{-}C_3N_4$), and facet-selective ($MnOx\text{-}BiVO_4$), were developed for the photocatalytic water-splitting to produce hydrogen and oxygen simultaneously. Various optofluidic microreactor configurations, such as planar, serpentine, corrugated and micropillared, were designed, fabricated in-house and tested for photocatalytic water-splitting to produce hydrogen and oxygen. The insights obtained from the materials and optofluidic device testing studies will be discussed in the presentation. Moreover, the metal hydride-based purification-cum-storage system is integrated to the hydrogen production line using methanol steam reforming. This resulted in the production of highly pure hydrogen (nearly 99% purity) using low-grade heat input (50 – 60°C), for an impurity range of up to 40%.

Keywords: Fossil fuels, Greenhouse gas, Renewable energy

Theme: Solar, Wind, Hydro, Hydrogen & Fuel Cells

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Cascade Latent Heat Storage System for Solar Thermal Applications

Abstract

The huge dependency on conventional energy sources and ongoing concern over the depletion of the living environment on the earth has triggered efforts to find ways to utilize renewable energy resources effectively and efficiently. In this context, solar thermal energy technologies are gaining interest across the globe due to the abundant existence of solar energy. Solar thermal energy is being utilized for various applications at different operating temperature ranges. For high-temperature applications, solar thermal energy is being utilized for electricity generation using concentrated solar thermal power plants. In contrast, various low and medium-temperature applications of solar thermal energy can be found in cooking, drying, desalination, space heating/cooling, industrial process heating, etc. The challenge of intermittent availability of solar energy needs to be addressed in order to utilize solar heat in various applications efficiently. Integrating an appropriate thermal energy storage system improves the dispatchability of solar energy systems, enhances overall efficiency, and makes them cost-competitive with other renewable energy technologies. The high energy density and easy operation make latent heat storage systems an attractive choice of storage for various applications of all temperature ranges. In recent years, solid-liquid phase transition-based latent heat storage has been recognized for appreciable energy storage capabilities. Despite better storage capabilities, the significantly poor thermal conductivity of phase change materials (PCMs), which results in poor heat transfer between the heat transfer fluid (coming from the heat source) and the storage media (PCM), limits their utilization in diverse applications. Utilizing multiple PCMs (cascade latent heat storage (CLHS)) instead of a single PCM significantly augments the heat transfer rate in the latent heat storage systems. It is observed in a numerical investigation that the cascading of the $NaNO_3$ and $NaNO_2$ PCMs in single storage can reduce the charging time by 35.23% and 10.52%, respectively, as compared to the storage having single PCM $NaNO_3$ and $NaNO_2$. During experimental investigation performed on the state-of-the-art CLHS system developed at Indian Institute of Technology Delhi in integration with the cooking system, it was observed that the CLHS system could also satisfy the variable temperature end-use energy demand of cooking processes. The developed cascade latent heat storage system maintains the stable end-use temperature of 473 K, 452 K, and 373 K, respectively, at the cooking plate, frying pan, and cooking vessel for baking, frying, and boiling food products. Cooking time for baking a chapati (60 g), frying potato chips (80 g), and boiling potatoes (500 g) is observed as 4 minutes, 4 minutes, and 13 minutes, respectively.

Keywords: Thermal Energy Storage, Cascade Latent Heat Storage, Solar Thermal Applications

Theme: Biomass, Biofuels, Biorefinery & Waste Management

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Synthesis and Characterization of Micro-Mesoporous Zeolite H-BEA for Eco-Friendly Biomass Conversion to Value-Added Chemicals

Abstract

Global warming, exacerbated by the extensive use of non-renewable fossil fuels, has intensified the need for sustainable solutions, particularly the transformation of renewable biomass into valuable materials, fuels, and chemicals. Porous materials, known for their high surface area and tunable functionalities, have gained prominence due to their applications in catalysis, medicine, and electronics. Among these, zeolites stand out as microporous crystalline aluminosilicates with uniform pore structures, high acidity, and excellent thermal stability, making them ideal solid acid catalysts for key organic transformations such as esterification, condensation, and cracking. This study explores the synthesis of micro-mesoporous zeolite H-BEA with bimodal porosity via a sol-gel approach, utilizing alkali-treated zeolite BEA precursors and surfactants such as CTAB and DTAB. Synthesized zeolites were characterized through advanced techniques, including XRD, 29Si and 27Al MAS-NMR, FT-IR, TGA, and BET surface area analysis, to confirm their structural and chemical properties. The catalytic activity of micro-meso H-BEA was evaluated for the esterification of levulinic acid with n-butanol to synthesize n-butyl levulinate, a bio-based chemical with significant industrial relevance. Reaction parameters, catalyst reusability and performance comparisons with existing catalysts were systematically studied. The results highlight the potential of these materials in sustainable biomass conversion into value-added chemicals, emphasizing their broader applicability in green and eco-friendly organic transformations. This work contributes to the advancement of sustainable technologies for a more environmentally friendly future.

Keywords: Micro-mesoporous composite of zeolite, Solid acid catalyzed levulinic acid esterification, Biomass derived value-added chemicals

Theme: Solar, Wind, Hydro, Hydrogen & Fuel Cells

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Design & Development of Solar-driven Hydrogen Energy Systems

Abstract

Global energy demand has been rising, intensified by the coronavirus pandemic. This increasing energy consumption has led to heightened greenhouse gas emissions, contributing significantly to global warming and climate change. Addressing this issue requires a transition to cleaner and more sustainable energy sources. Hydrogen has the capability of transforming our mobility and power generation sector, as it can be locally produced unlike gasoline and diesel which are usually imported by most countries.

These problems have motivated scientists all around the world to work and develop technologies which help us achieve self-sustainability. Hydrogen Energy Systems (HES) offers a comprehensive approach to addressing global energy, economic, and environmental challenges. Hydrogen, produced from renewable sources such as solar or wind through electrolysis, can be stored in metal hydride tanks for later use in fuel cells, which helps in balancing supply and demand. Fuel cells produce efficient power and significant waste heat, which can be used for combined cooling, heating, and power generation (CCHP) to boost overall efficiency. Produced hydrogen can be compressed with metal hydride compressors for use at refueling stations, underscoring the need for a hydrogen infrastructure. This study explores renewable energy storage systems, focusing on HES. It examines thermodynamics, performance, and energy and exergy analyses across two modes: electrolyzer and fuel cell. This paper presents an innovative integration of a beam down solar based thermal plant with the CuCl hydrogen production cycle, emphasizing the effective utilization of thermal energy generated from the solar thermal plant.

Keywords: Solar, Hydrogen, Energy Storage

Theme: Biomass, Biofuels, Biorefinery & Waste Management

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Sustainable Catalyst: Biofuel Production and Biofuel Precursor

Abstract

In the present scenery, the synthesis of sustainable catalyst is the burning research area for production of biofuel and biofuel precursor with respect to the global warming in the environment. To overcome the drawback of the reported catalysts, researchers are devoting their time on non-hazardous materials as well as feedstock for production of biofuel and biofuel precursor. In this context, we have developed agro-waste materials & composite materials as sustainable heterogeneous catalyst for production of biodiesel and 5-hydroxymethylfurfural (HMF) that acts as fuel precursor. Interestingly, prepared sustainable catalyst showed superior catalytic activity for the desired product. The characterization of catalyst and analysis of the products confirm the heterogeneity of the catalyst and the reaction. The detail work will be discussed during presentation.

Keywords: Agro-waste, Sustainable heterogeneous catalyst, Composite, Biofuel

Theme: Solar, Wind, Hydro, Hydrogen & Fuel Cells

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PV Deployment to Match Summer Demand in Hotter Climates

Abstract

Photovoltaic (PV) systems are a cause of grid instability. However, in hotter regions, PV generation can align well with peak cooling demands, as higher PV generation typically coincides with periods of high cooling load. In countries like India and UAE a significant portion of electricity consumption is dedicated to space cooling, which leads to energy imports and load shedding in summer. To minimise that, our work examines PV deployment optimisation to support grid stability across various regions in India and the UAE.

We optimize the tilt and azimuth angles for three distinct scenarios - maximizing annual yield, maximizing summer yield, and achieving alignment with local demand curves – for the UAE and India use cases, respectively. PV yield was calculated using the PVlib python library, while the scipy library was used for optimization. Key findings indicate that in both countries optimal tilt angles for summer months are significantly lower than those for annual yield, and the PV tilt angles for best demand match are close to the PV tilt values for optimum summer yield.

This study emphasises the need for integrated approaches – combining optimised PV deployment with demand-side management and energy storage solutions – to address gaps between PV output and demand. Policymakers and grid planners are encouraged to adopt region-specific PV optimization strategies, considering current and projected demand patterns. These strategies would significantly accelerate renewable energy integration, reduce dependency on fossil fuels, and enhance grid reliability under growing electricity demands.

Keywords: Summer Demand, Photovoltaic tilt optimization, Grid stability

Theme: Energy - Materials, Storage, Transmission, Distribution & Policies, e-Mobility

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Laser-patterned Carbon for Flexible Energy Generation and Storage Devices

Abstract

Carbon's utility in the field of advanced energy technology needs no introduction. In parallel to exploring the potential carbon nanomaterials such as graphene in energy storage and generation devices, the current trend is to investigate inexpensive and commercially viable forms of carbon without compromising on their performance.

Laser-patterned carbon is one such material that satisfies all the next-generation manufacturing requirements, along with an excellent performance in various energy devices. In our reassert group we have investigated the electrocatalytic activity of laser-patterned carbon and found it to have several advantages over metals including an inherent activity, excellent stability and environment friendly processing. The same material has also shown a good supercapacitor performance, which can be further improved by modifying the laser-carbon layer with carbon quantum dots. Numerous modification possibilities render laser-carbon an excellent choice for a base material in flexible energy electronics.

In this talk, the aim is to describe the fabrication of flexible supercapacitors and electrocatalysts devices using laser-patterned carbon. A detailed discussion on the formation mechanism and properties of the material itself, in comparison to other carbon forms will also be presented. The possibilities of digital manufacturing, recyclability and overall sustainability will also be touched upon.

Keywords: Laser-patterned carbon, Electrocatalyst, Carbon quantum dots, Supercapacitor, Flexible electronics

Theme: Solar, Wind, Hydro, Hydrogen & Fuel Cells

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Harvesting Light: The AgriPV Evolution

Abstract

Agrivoltaics, the integration of solar energy systems with agricultural practices, offers a compelling solution for countries facing land scarcity, while simultaneously addressing the global need for clean energy and sustainable food production. In this talk, we will explore the origins of agrivoltaics and its evolution into a viable strategy for land optimization, focusing on its potential to meet the dual challenges of food security and renewable energy generation. Through a review of global best practices and real-world case studies, we will highlight the proven benefits of agrivoltaics in various regions. The session will also delve into how this approach can be particularly beneficial for countries with limited land resources, offering a way to maximize the use of existing agricultural land without compromising food production.

A central theme of the discussion will be understanding agrivoltaics from the perspectives of keystakeholders—industry leaders, government bodies, policymakers, engineers, and farmers in India. Tailored recommendations will be presented for each group, focusing on overcoming regulatory hurdles, technical integration, and socio-economic considerations.

The session aims to provide valuable insights into how agrivoltaics can be effectively implemented and scaled, fostering collaboration among stakeholders to shape a sustainable and resilient future. By understanding its potential and aligning innovation with policy, agrivoltaics can become a cornerstone of future strategies for nations looking to balance energy needs with agricultural sustainability.

Keywords: Agrivoltaics, Food security, Agricultural sustainability, Renewable energy

List of Selected Papers (Theme Wise)

Theme I: Biomass, Biofuels, Biorefinery & Waste Management

Abstract ID	Authors Name	Title
ABS-005	Trisnehi Pradhan	*Redifining waste management approaches using marine bacterial consortium for heavy metal bioremediation*
ABS-012	Sharmily Chakraborty	*Mitigation of lead induced soil toxicity and plant growth promotion by phosphate solubilizing bacterium Enterobacter hormaechei KR2215*
ABS-013	Faizan Hussain	*Ocimum distilled biomass waste for the production of biofuel precursors via biopolymer isolation and enzymatic deploymerization*
ABS-019	Dr. Prasant Kumar Rout	*Isolation of cellulose from Mentha distilled waste and production of hydroxymethylfurfural A Biofuel precursor*
ABS-023	Akanksha Rai	*High performance polyhexahydrotriazine (PHT) thermoset for the synthesis of furanics*
ABS-025	Manisha Pandey	*Selective Catalytic Hydrogenation of methyl oleate over Pd supported on V2O5 an extension to soyabean oil and microalgal lipid (D salina) esters*
ABS-036	Dr. Praveen Kumar	*Catalyst effect on kinetics and reaction mechanisms of biomass pyrolysis*
ABS-037	Vikas Patel	*In situ immobilization of heavy metals using single step hydrothermal gasification of hyperaccumulator biomass for hydrogen production*
ABS-038	Deepti Dubey	*Volumetric reduction of simulated solid waste using graphite plasma arc technology and conceptual design of the system for trapping radioactive elements*
ABS-039	Moirangthem Dingku Singh	*Geopolymerization An approach towards utilization of toxic biomedical waste ash a construction material*
ABS-043	Divyanshi Sharma	*Fabrication and Characterization of Insulation Panel made by using waste from Foot Wear Industry and Rubber Tyre*
ABS-045 (I)	Dr. Udaya Bhaskar Reddy Ragula	*Synergistic Effect of Solgel Synthesized NickelCobalt Catalyst under Dry Reformation Conditions for Enhanced Conversion of Biogas to Biohydrogen*
ABS-045 (II)	Dr. Udaya Bhaskar Reddy Ragula	*Effect of Temperature on Product Profiles of Pyrolysis of Nerium Oleander*
ABS-046	Bhavesh Thakur	*From Waste to Wearable Converting Polyester Bottles into High Performance Nanofibre Face Masks for Sustainable Waste Management*
ABS-047 (I)	Kalpana Kawathekar	*Assessing Academic Campus Solid Waste Management in the Light of Sustainable Practices to Lower Green House Gas Emissions*

ABS-057 (I)	Umesh Umesh	*Deciphering Interaction of Phytochemical molecules with Carboxymethyl Cellulase (CMCase) Using Computational Approach*
ABS-057 (II)	Umesh Umesh	*Life Cycle Assement (LCA) and Environmental Aspects of Bioethanol Synthesis for Bioenergy A Critical Review*
ABS-058	Poorvika Kulshrestha	*A novel Multi Copper Oxidase from Micrococcus sp IITD 107 useful for Polypropylene and Polyethylene degradation*
ABS-059	Archana V	*Isolation and characterization of microorganisms capable of polyethylene and polypropylene degradation*
ABS-075	Aasma Tadvi	*A Novel Approach to Pretreat Lignocellulosic Materials Using Surfactant Foam*
ABS-078 (I)	Dr. Goutam Khankari	*Development and Utilization of NonTorrefied Biomass Pellets with Mill Rejects in the Existing Ball & Tube Mill Based Coal Power Plants A Novel Approach towards Circular Economy*
ABS-080	Nijara Das	*Effective Conversion of Biomass Derived 5Hydroxymethylfurfural to Highly Value Added Chemicals*
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ABS-087	Dr. Nikhil GN	*Anaerobic biorefinery for valorization of food waste and environmental sustainability*
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ABS-094	Dr. Md Modassir Khan	*Production of Hydrogen By The Application of Biomass A Review*
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Theme II: Solar, Wind, Hydro, Hydrogen & Fuel Cells

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	Nagal	*Buffer layer in Bifacial Perovskite Solar Cells*
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Theme III: Energy - Materials, Storage, Transmission, Distribution & Policies, e-Mobility

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ABS-115	Divya Singh	*Synthesis of WSe2@PANI nanocomposite for Asymmetric Supercapacitor Device Application*
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ABS-252	Fatma Parween	*Zn(II) Coordination Polymer-Based Hetero-Composites for Asymmetric Supercapacitor Applications*

THEME

Biomass, Biofuels, Biorefinery & Waste Management

Abstract ID: ABS - 005

Redefining Waste Management Approaches Using Marine Bacterial Consortium for Heavy Metal Bioremediation

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Keywords

Bioremediation
Heavy metals
Consortium
Extracellula
Polymeric substances

Abstract

Marine ecosystems are prone to heavy metal contamination from various anthropogenic sources which necessitate innovative waste management strategies. Biofilm forming marine bacteria have the ability to sequester metal ions in their extracellular polymeric substances (EPS), thereby serving as promising bioremediating agents. The present study investigates the metal remediation potential of consortium formed by biofilm-forming marine bacterial isolates *Pseudomonas aeruginosa* CSA06P and *Kurthia gibsonii* PLW09P tolerating high concentration of Pb(II), Cr(VI), and Hg(II). Confocal laser scanning microscopy confirmed interaction of biofilm with metals, showing reduced biofilm thickness. The results of metal sequestration studies indicated that the consortium showed higher removal efficiency of 97.66 % for 100 ppm Pb(II) , 41.8 % for 100 ppm Cr(VI), and 51.92 % for 15 ppm Hg(II). The biofilm mode exhibited enhanced metal removal compared to planktonic mode; hence, the interaction between EPS and metal ions was further studied. Field Emission SEM-Energy Dispersive X-ray Spectroscopy (FESEM-EDX) revealed that globule size increased post-treatment with multimetal which confirmed metal sequestration by EPS. Fourier transformed infrared spectroscopy (FTIR) revealed the interaction between metal ions and EPS associated functional groups (O-H, –C≡C and H–C=O). Proton nuclear magnetic resonance (^{1}H NMR) showed that the intensity of peaks in proton ring region of carbohydrates in EPS has significantly decreased with slight peak shift (from 3.65 ppm to 3.47 ppm). The interactions strongly indicate that EPS of the consortium play a pivotal role in metal sequestration. This bioremediation strategy holds significant potential for mitigating heavy metal contamination, offering a sustainable solution for environmental waste management.

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Abstract ID: ABS - 012

Mitigation of Lead-Induced Soil Toxicity and Plant Growth Promotion by Phosphate-Solubilizing Bacterium *Enterobacter Hormaechei* KR2215

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Keywords

Phosphate-solubilizig bacteria
Biofilm
Lead
Antioxidant activity

Abstract

Lead (Pb) contamination in soil, primarily caused by mining and agricultural practices, poses significant environmental challenges due to its toxicity and persistence. Phosphate-solubilizing bacteria (PSB) adsorb Pb through anionic groups present on their cell walls, thereby improving soil health, and enhancing nutrient availability to plants. This study explored the role of PSB in Pb remediation and chickpea (*Cicer arietinum*) growth under lead stress. The bacterium *Enterobacter hormaechei* KR2215, isolated from the Bhitarkanika mangrove ecosystem, demonstrated exceptional Pb-removal efficiency with a tolerance of 1900 ppm while promoting plant growth. ICP-OES analysis revealed that the bacterial activity significantly reduced Pb concentration in biofilm mode compared to the planktonic mode. ATR-FTIR and ^{1}H NMR spectroscopy analyses revealed shifts in functional groups in the biofilm-EPS treated with Pb. FESEM-EDX spectra confirmed Pb adsorption peaks on the treated EPS, with approximately 39.73 atomic wt.%. The phosphate solubilization activity peaked upto 931.96 mg/ml on the 4th day, accompanied by a decrease in pH. An upregulation of the phosphate solubilizing genes (*phoR* and *pqqE*) was observed till the 4th day, while gene responsible for lead uptake (*zntA*) showed increased expression up to 5th day. The chickpea plants exhibited an increased height and vigor index under Pb stress when inoculated with *E. hormaechei* KR2215. Additionally, antioxidant activity increased significantly, with a 49.23% rise in superoxide dismutase and 61.85% in catalase, aiding plant survival under Pb stress. Therefore, this bacterium offers a promising biological solution for improving soil health and crop productivity in lead-polluted environments.

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Abstract ID: ABS - 013

Ocimum Distilled Biomass Waste for The Production of Biofuel Precursors Via Biopolymer Isolation and Enzymatic Depolymerisation

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Keywords

Ocimum basilicum
Cellulose
Glucose
Methyl levulinate

Abstract

Steady rise in annual consumption of Ocimum essential oil contributes to exponential production of Ocimum distillate biomass. CSIR-CIMAP promoted *Ocimum basilicum* such as *Soumya*, *CIM-Shishir*, *CIM-Suvaas* varieties at the farmer's field. These varieties contained 0.5-0.8% of essential oil, which is isolated through hydro-/steam distillation method at the farmer's field. After distillation, the unspent biomass is treated as waste. Ocimum biomass is collected from the farmer's field, and screened for potential chemical entities and structural biopolymers. A novel greener process has been developed for isolation lignin, and hemicellulose using imidazole-p-toluene sulfonic acid, and imidazole-NH_3 solvent systems, respectively. Biopolymers such as, Cellulose (37%), hemicellulose (26%) and lignin (12%) were isolated using a laboratory fabricated 2 L double jacketed reactor and the process was optimized via statistical and mathematical modelling. Further, isolated cellulose was enzymatically saccharified to glucose (492 mg/g) with 10 FPU/g loading of *Trichoderma reesei* enzyme (67 FPU/ml) at 50 °C for 48 h. This glucose solution was transformed to methyl levulinate (74%) under aqueous-methanol (5:1) solvent system for 2 h at 160 °C using $La(OTf)_3.H_2O$ catalyst. This study provides an effective solution utilizing the Ocimum biomass to liquid biofuel.

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Abstract ID: ABS - 019

Isolation of Cellulose from Mentha Distilled Waste and Production of Hydroxymethylfurfural: A Biofuel Precursor

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Keywords

Biofuel
Hydroxymethyl furfural
Bio-polymer

Abstract

Cornmint (*Mentha arvensis*) is cultivated to produce essential oil, which consists of about 75% of menthol. Fresh biomass is hydrodistilled for ~5 h to obtain essential oil (1%), and the rest of the pre-treated biomass (99%) is generated as waste. India produces more than 40,000 tons of mint oil with World share of nearly 70%. In this process of distillation, more than 8.0 million tons per annum of aromatic spent biomass generated. A novel, green and economical two-step process has been developed using a mixture of imidazole (IM)-p-toluene sulfonic acid (pTSA), and IM-20%NH_3 for the separation of lignin and hemicellulose, respectively. The lignin and hemicellulose were isolated from the respective solution by precipitation, and final undissolved solid residue was obtained as cellulose. This process was scaled-up, recovering cellulose (38%), hemicellulose (27%), and lignin (14%) using 7 L double jacketed reactor. The present invention relates to the development of green process for preparation of hydroxymethyl furfural (HMF) from cellulose isolated from aromatic spent biomass. The present process relates to the preparation of HMF from cellulose using solid Indion catalysts and zeolite-phosphomolybdic acid catalysts. HMF is an intermediate molecule with potential application as bio-polymer and biofuel.

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Abstract ID: ABS - 023

High Performance Polyhexahydrotriazine (PHT) Thermoset for the Synthesis of Furanics

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Keywords

Biomass
Biofuel
Degradablepolymer
Hydroxymethylfurfural
Polyhexahydrotriazine.

Abstract

Highly active, environmentally friendly thermosets, polyhexahydrotriazines (PHTs) were prepared through the condensation of aromatic diamines and paraformaldehyde. The sulfonic acid-derived PHT possesses that both Brønsted base and acidic sites have been realized as a potential material in the dehydration of biomass (glucose/fructose) to 5-hydroxymethylfurfural (HMF) at low temperature. This thermoset is degradable at high temperatures (> 80 °C) in the presence of aqueous solution of glucose/fructose with the generation of oxidized products of HMF and consequently produced furan-amine adducts. Moreover, the highly active PHT can be separated at lower temperatures (< 80 °C) with recyclability and found that its activity is declining after each cycle. This thermoset material can be used as an alternative to plastic material which is not degradable even thermally. This may be an alternative degradable polymer in the presence of biomass, which can solve the environmental problems. In addition, PHTs were characterized successfully by various techniques such as PXRD, FT-IR, SEM, BET, and TGA analysis.

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Abstract ID: ABS - 025

Selective Catalytic Hydrogenation of Methyl Oleate Over Pd Supported On V_2O_5: An Extension to Soybean Oil and Microalgal Lipid (*Dunaliella Salina*) Esters

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Keywords

Biodiesel
FAMEs
Micro algae
Lipid

Abstract

For the oxidative stability of FAMEs (biodiesel), the catalytic hydrogenation had performed by Pd doped V_2O_5. The synthesized pristine V_2O_5 and modified one characterized by different characterization technique as PXRD, FTIR, XPS, TEM-EDX, BET and hydrogenation of methyl oleate, methyl linoleate, methyl erucate and FAMEs of olive oil, soyabean oil as well as lipid extract of microalgae *D. salina* as a source of third generation biofuel feedstock, had been done with optimized reaction condition at 70 ^oC, for 5.5 hours in hexane. The analysis of hydrogenated product had done by ^1H and ^{13}C NMR and isolation of product done by low temperature crystallization method, further *cis-trans* analysis has been done by FTIR study of pure methyl oleate and hydrogenated product. The mild reaction condition is one the important factor of controlling the trans isomer as it is not of use because of its cold flow property.

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Abstract ID: ABS - 036

Catalyst Effect On Kinetics and Reaction Mechanisms of Biomass Pyrolysis

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Keywords

Biomass
Coats-Redfern
Master plots
Pyrolysis
Reaction mechanism

Abstract

In the study, the pyrolysis behavior and kinetics of lumber industry biomass waste was studied by Coats Redfern and validated using master plots. Thermogravimetric analysis was performed with and without catalyst to identify the reaction mechanism using non-isothermal integral model of Coats-Redfern. The results showed that the accuracy of the kinetics computation was validated by the activation energies estimated using coat-Redfern techniques. After the catalyst was added, the activation energy of the biomass waste from the lumber industry, which was previously predicted to be between 127.8 - 150.03 kJ mol-1, is significantly decreased to 92.12 - 113.95 kJ mol-1. The results from Coats-Redfern method showed that the pyrolysis of all the samples were controlled by the diffusion mechanism for a conversion $0< \alpha <0.7$. For conversion $0.7< \alpha <0.8$, where complex organic compound breakdown occurs, follow the chemical reaction mechanism of order 2 – 3. Further, the conversion $\alpha > 0.8$ pyrolysis process follows the nucleation mechanism. With the addition of the catalyst, up to conversion $0 < \alpha < 0.6$ follows a diffusion mechanism and for $0.6 < \alpha < 0.8$, follows chemical reaction mechanism of order 2 – 3. Master plot method also confirms that the pyrolysis process follows multiple reaction mechanism including nucleation and diffusion, where nucleation mechanism is predominant towards the last stage of the pyrolysis process. The study provides critical insights in to the reaction mechanism of biomass waste pyrolysis with and without a catalyst that could be used for the pyrolysis reactor design.

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Abstract ID: ABS - 037

In-Situ Immobilization Kinetics of Heavy Metal Using Single-Step Hydrothermal Gasification of Hyperaccumulator Biomass for H_2 Production

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Keywords

Cauliflower
Heavy Metals
Hydrogen
Nano-metal
Carbon-Composite
Adsorption Kinetic Model

Abstract

Supercritical water gasification (SCWG) is an evolving technology that directly converts wet organic waste to produce a higher hydrogen yield and recover HMs from the wastewater in a single step. The lignocellulosic feedstocks can produce fuel gases, which can be further utilized to synthesize chemical requirements or used as a replacement for fossil fuels. Cauliflower, one of the highest waste production rates among all vegetables, is abundantly available in India as the second largest producer in the world. Heavy metals (HMs) enriched wastewater from electroplating industries was used as the gasification medium for experiments. This research employed a novel methodology to examine the impact of multiple variables, including temperature, residence time, and mass transfer effect. At 600 °C temperature and a 50 min residence time, the outmost total gas yield (TGY) (31.7 mol/kg) and the maximum H2 yield (26.2 mol/kg) were obtained. The treated aqueous fractions are subjected to total organic carbon (TOC) and Microwave Plasma Atomic Electron Spectroscopy (MP-AES) analysis to measure organic carbon and metal concentration in the treated effluent. FE-SEM, XRD, and XPS analysis confirm the immobilization of the heavy metals, with an average size of 37.2 nm, from wastewater to produce biochar during the SCW gasification process. The maximum specific surface area (73.43 m2/g) and the pore volume (0.12 cc/g) were obtained at 600 °C, and the residence time was 60 min. The experimental data was further analyzed through the kinetic study of the adsorption of HMs into carbon matrix, and it was observed that physical adsorption more inherently takes place during the SCWG process, with the highest adsorption capacitance of 33.11 mg/g of biomass.

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Abstract ID: ABS - 038

Volumetric Reduction of Simulated Solid Waste Using Graphite Plasma Arc Technology and Conceptual Design of System for Trapping of Radioactive Elements

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Keywords

Low-level radioactive waste
Simulated waste
Nuclear reactor
Solid waste
Plasma pyrolysis graphite arc
Fusion reactor
ITER
DEM
JET

Abstract

Disposal of low-level radioactive waste (LLRW) generated from nuclear reactor operations poses significant environmental challenges, particularly due to the substantial volume it occupies. Traditional incineration methods can produce harmful by-products, such as dioxins, furans, and polyaromatic hydrocarbons, which are recognized carcinogens. To address these concerns, this study explores the use of an innovative thermal plasma-based technology for the environmentally safe disposal of LLRW. Specifically, we used IPR's patented Graphite Arc Plasma Pyrolysis (GAPP) technology, which utilizes high-energy plasma arcs to disintegrate waste materials, significantly reducing their volume while simultaneously encapsulating hazardous components. In our investigation, we focus on Dry Solid Compactable Waste (DSCW) originating from fusion facilities, specifically targeting cellulose and plastic waste. Drawing on data from the JET soft-housekeeping waste assessment, we model the simulated waste composition as 30% cellulose and 70% plastics. Notably, the experimental waste we created is devoid of any radioactive components, allowing us to safely analyse the process. Preliminary results indicate that when the system operates in gasification mode, the off-gas produced contains notable levels of hydrogen and traces of carbon monoxide, alongside other gaseous products. The waste processing framework comprises two main stages: the GAPP treatment system for waste processing and volume reduction, and an off-gas purification system utilizing getter bed technology to handle radioactive exhaust gases effectively. This study presents experimental data on the gas composition emitted from the primary chamber and the calculated volume reduction of the treated waste, which is then compared to the available data from the JET facility, providing insights relevant to waste management for ITER-like machines. This highlights the promise of advanced plasma technology as a safer and more efficient solution for waste management.

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Abstract ID: ABS - 039

Geopolymerization: An Approach Towards Utilization of Toxic Biomedical Waste Ash as Construction Material

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Keywords

Biomedical waste ash
Concrete
Geopolymerization
Heavy-metals Stabilization

Abstract

The global emphasis on the proper management of biomedical waste (BMW) has continuously increased with the increase in hospitalization rate, which is further exacerbated by medical crises like the COVID-19 pandemic. Of all the BMW treatment techniques, incineration is regarded as the most effective because it eradicates pathogens and lowers waste mass and volume. Despite its huge advantages, incineration leads to the production of hazardous ash that requires proper care and disposal. Moreover, a significant amount of CaO, SiO_2, and Al_2O_3 are present in the chemical composition of the incinerated biomedical waste (IBMW) ash, along with high concentrations of heavy metals. These concerns relate to the advantages and disadvantages of using this ash. Only a few studies on the safe and efficient management of this hazardous waste ash and its application in the concrete industries have been reported to date. IBMW ash can partially substitute 5-10% of cement in concrete production. For the first time, this review effort highlights the explicit great potential of IBMW ash as a precursor material for geopolymer building material. Geopolymerization will significantly enhance the effective utilization of IBMW ash, resulting in the production of durable and sustainable construction materials. Critical findings are presented at the end of the review in the form of research gaps and potential directions for future investigation. The results contribute to sustainable waste management and public health solutions by addressing the pressing need for better management strategies for hazardous IBMW ash, in addition to revealing potential engineered applications.

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Abstract ID: ABS - 043

Fabrication and Characterization of Insulation Panel Made by Using Waste from Foot Wear Industry and Rubber Tyre

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Keywords

Insulation Panel
Leather Waste
Footwear Waste
Insulation
Sustainable Product

Abstract

Recent study examines the creation and characterisation of environmentally sustainable insulating panels utilizing waste materials from the leather and footwear sectors. The present study sought to develop sustainable panels by integrating leather scraps with footwear scraps, crumb rubber, and polyurethane (PU) modified with methylene diphenyl diisocyanate (MDI), thereby minimizing industrial waste. Six unique sample formulations were created, using different ratios of leather scrap, footwear scrap, and crumb rubber. The compositions changed from DIP-01 to DIP-06, maintaining leather scrap at 100%, while footwear scrap fluctuated between 20% and 40%, crumb rubber from 0% to 20%, and PU/MDI was consistently set at 50% of the leather scrap weight. The mechanical, thermal, and acoustic characteristics of these panels were methodically assessed. Mechanical assessments quantified compressive strength, flexural strength, and tensile strength, demonstrating enhanced structural integrity and resilience, especially with the use of crumb rubber. Thermal conductivity experiments were conducted to evaluate the insulation effectiveness of the panels, illustrating their efficacy in reducing heat transmission. Furthermore, the acoustic performance was assessed by examining the panels' noise absorption and sound attenuation properties. The findings validated that the incorporation of footwear waste and crumb rubber into the panels did not detract from thermal or acoustic performance, but markedly improved mechanical qualities. These findings underscore the possibility of using waste from the leather and footwear industries in construction materials, therefore advancing sustainable building techniques. The use of industrial waste provides a cost-efficient option while simultaneously supporting environmental objectives by minimizing waste and fostering the circular economy. The present research highlights the feasibility of converting industrial by-products into high-performance, sustainable insulating materials, providing significant insights for the building sector.

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Effect of Temperature On Product Profiles of Pyrolysis of *Nerium Oleander*

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Keywords

Syngas
Nerium
Oleander
Pyrolysis
Zeolite-5A
Product Profiles

Abstract

Increase in demand for energy in the developing countries provided opportunities to explore new and renewable energy sources including biomass. Biomass may be converted to useful energy via pyrolysis, gasification and liquefaction. The primary factors that affect the distribution of product profiles during the pyrolysis are temperature, heating rate, catalyst, residence time, and volatile matter to fixed carbon ratio. In this work, the pyrolysis of leaves and stem of *Nerium oleander* was carried out in a laboratory scale fixed-bed reactor in the temperature range of 250 to 650 °C for the particle size 125-1000 microns, at atmospheric pressure with and without Zeolite-5A as catalyst. The pyrolysis products were measured in three different phases, namely, gas, liquid/tar and char. The yield of liquid varies from 1.39% to 41.3% for both non-catalytic and catalytic pyrolysis of *Nerium oleander* stem for three different particle sizes at the heating rate of 10 °C /min. The optimal temperature for higher liquid product yield was observed to be in the range of 370-450 °C. We concluded that, higher volatile matter to fixed carbon ratio as well higher hemicellulose results in higher liquid product yield during pyrolysis. Further, the liquid product yield is at least 1.5 times higher for catalytic pyrolysis using Zeolite-5A catalyst when compared to non-catalytic pyrolysis. The liquid product yield during the catalytic pyrolysis with Zeolite-5A was found to be much higher when compared to other zeolite catalysts. Therefore, Zeolite-5A may be used as catalyst for biomass pyrolysis with reduced char production.

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Abstract ID: ABS – 045 (II)

Synergistic Effect of Sol-Gel Synthesized Nickel-Cobalt Catalyst Under Dry Reformation Conditions for Enhanced Conversion of Biogas to Biohydrogen

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Keywords

Biogas
Dry Methane Reformation
Sol-gel Synthesis
Nickel-Cobalt Catalyst

Abstract

Hydrogen has emerged as a versatile carrier with the growing demand for cleaner energy to significantly reduce carbon emissions and reliance on fossil fuels. Biogas, primarily sourced from agricultural and cattle waste, is a rich and renewable feedstock for hydrogen production. Utilizing biogas not only addresses waste management issues but also mitigates both methane and carbon dioxide, which are significant contributors to greenhouse emissions. Dry reformation converts methane and carbon dioxide into syngas, utilizing the inherent carbon dioxide in biogas for sustainable energy production. This study investigates the dry reforming of methane for hydrogen production over Ni/Alumina and bimetallic Ni-Co/Alumina catalysts, synthesized via Sol-gel technique. The synthesized catalysts were evaluated in a quartz-packed bed reactor between 600 and 700 °C and at atmospheric pressure, with gas hourly space velocities from 20,000 to 30,000 ml/(g_{cat}·hr) and a methane to carbon dioxide ratio of 1 and 1.5. The bimetallic Ni-Co/Alumina catalyst achieved an impressive CH_4 and CO_2 conversion and a H_2/CO ratio > 2, outperforming the Ni/Alumina catalyst. This enhanced performance is linked to improved metal-support interactions that promote better active site dispersion and reactivity. Additionally, a lower amount of coke was deposited over the bimetallic catalyst due to balanced acidic and basic active sites. Therefore, we propose Ni-Co/alumina catalysts synthesized using sol-gel catalyst as replacement for conventional catalysts for dry reformation for sustainable fuel production from biogas.

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Abstract ID: ABS - 046

From Waste to Wearable: Converting Polyester Bottles into High-Performance Nanofibre Face Masks for Sustainable Waste Management

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Keywords

Recycling
Air pollution
Nanofibre Electrospinning
Antibacterial

Abstract

The widespread use of polyester bottles presents both environmental and social challenges, primarily due to their non-biodegradable nature, contribution to landfill overflow, and generation of microplastic pollutants. Addressing these issues requires solutions that reduce microplastic production and alleviate landfill strain. Simultaneously, particulate matter (PM) pollution is a growing health concern, and while high-efficiency face masks provide protection, they often suffer from increased breathing resistance, making them uncomfortable for long-term use. In our study, we successfully converted discarded polyester bottles into ultrafine nanofibres with an average diameter of around 70 nm. We developed both pristine and silver quantum dot (QD)-embedded polyester nanofibre matrices for air filtration. By sandwiching these nanofibres between spunbonded nonwoven fabrics, we significantly improved particle filtration efficiency, from a modest 10% to over 99%. Remarkably, we achieved this while keeping the pressure drop low, at just 12-13 Pa. The silver-QD embedded nanofibres also imparted antibacterial properties to the filter media, offering 99.78% protection against E. coli and 99.92% protection against S. aureus, making them ideal for personal protective equipment (PPE). In conclusion, our research presents a simple yet effective approach to repurposing waste polyester bottles into high-efficiency filtration media, contributing to sustainable waste management and improved public health.

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Abstract ID: ABS – 047 (I)

Assessing Academic Campus' Solid Waste Management in the Light of Sustainable Practices to Lower GHG Emissions

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Keywords

Solid Waste Generation
3R's of sustainability
SW Management
GHG Emissions
Sustainable Practices

Abstract

Solid Waste Management (SWM) includes collecting, treating, and disposing of waste material. Improper disposal of waste creates unsanitary conditions, leading to environmental pollution. Urbanization makes controlling waste more critical. It increases the burden and challenges of SWM for sustainability. Institutional campuses have a confined boundary, making SWM easier. This paper is an attempt to evaluate the SWM practiced in an academic campus, demonstrating the greenhouse gas emissions (GHG) due to solid waste management activity on a campus under its scopes 1, 2, and 3 in a methodical manner. It describes the existence of sustainable practices under SWM, including regular cleaning of buildings, roads, landscaped areas, and other open spaces; reducing the waste generation by optimizing its use; reusing waste papers, drawing sheets, models, and its base materials; selling the e-waste for its recycling; collecting and converting biowaste to compost; biogas generation and its use for steamed cooking in mess; reusing waste food for animals; and burning waste and reusing its ash. Most of these practices are appreciable, but a few, viz., biogas production, need maintenance to make the practice effective for reducing GHG emissions. The burning of waste should have an alternative sustainable solution for reducing emissions. It also states that scope 1 emissions are controlled but need further improvement; scope 2 and scope 3 emissions have not been evaluated as the institute has no control over these. The detailed study of scope 2 and scope 3 emissions is recommended for sustainable development with solid waste management.

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Abstract ID: ABS – 057 (I)

Deciphering Interaction of Phytochemical Molecules with Carboxymethyl Cellulase (CMCase) Using Computational Approach

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Keywords

CMCase
Molecular docking
MD simulations
Binding affinity

Abstract

Carboxymethyl cellulase (CMCase) from *Bacillus amyloliquefaciens SS35*, catalyzed the hydrolysis of the internal β-(1→4) glycosidic bonds of the cellulose molecule. The CMCase previously recognized for its crucial function in producing altered glycosides and does not currently have identified the 3-dimensional protein structure. The 3D protein structure and biological function prediction was done from their amino acid sequence using the I-Tasser server. After the structure prediction, the molecular docking study and molecular dynamics (MD) simulations and MM-PBSA study was performed. Molecular docking shows the binding affinity of various substrates such as Apigenin (-7.71 Kcal/mol), Luteolin (-7.45 Kcal/mol), Chlorogenic acid (-6.96 Kcal/mol), Caffeic acid (-5.28 Kcal/mol), Cellobiose (-4.87 Kcal/mol), Sinapic acid (-4.4 kcal/mol), Furfural (-3.97 kcal/mol), 3-caboxyfuran (-3.7 Kcal/mol), and HMF (-3.59 Kcal/mol) with the CMCase. It also shows the interaction between the substrate molecules with the amino acid residues of the CMCase. Afterwards, MD Simulations of the top four highest binding affinity complex and apoprotein were performed for 100 ns duration. These MD simulations predicted stability, fluctuation of amino acids, compactness in terms of RMSD, RMSF, Rg, and intermolecular Hydrogen bonding. Post MD simulations, MM-PBSA was performed for free binding energy calculation. Above finding of MD simulations and MM-PBSA suggested that the Luteolin complex has the most stable among all complex.

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Abstract ID: ABS – 057 (II)

Life Cycle Assessment (LCA) and Environmental Aspects of Bioethanol Synthesis for Bioenergy: A Critical Review

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Keywords

Biofuels
Bioethanol
Life cycle assessments (LCA)
Environmental Impact
Feedstock

Abstract

Air pollution has been a significant problem from many years, causing about 6 million deaths annually worldwide. Biofuels are presently seen as sophisticated alternatives that guarantee energy security by diminishing air pollution and decreasing the dependence on fossil fuels. This review article gives an overview and critical analysis of LCA and environmental aspects. Considerable efforts have been made to performing life cycle assessments (LCA) of the production of bioethanol. The environmental impacts of bioethanol synthesis have been studied from a lot of different viewpoints in many different works. This review article study reviewed at previous LCA studies on production of bioethanol from different types of lignocellulosic biomasses feedstock by studying the impacts of biomass feedstock, technical pathways and its operational mechanisms on the outcomes of LCA studies. The review article evaluated the number of articles published from 2014 to 2024, specifically focusing on studies that covered a comprehensive range of environmental aspects. However, it has been very challenging to compare the results of the LCA, because there has been lack of the harmony among the research articles. Review article reviewed that the LCA operational mechanism, such as functional units, system boundary, and others, influenced the outcome of the investigations. Mostly reviewed papers were demonstrated the decrease in the potential for the global warming. On the other hand, opposite findings have been discovered regarding the influence of rising the acidification, eutrophication, and photochemical oxidant production as outcome of the provision of biomass feedstock. When it comes to the details, the review showed that most of the articles saying pre-treatment as an important part of bioconversion processes.

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Abstract ID: ABS – 058

A Novel Multi Copper Oxidase from Micrococcus Sp. IITD107 Useful for Polypropylene and Polyethylene Biodegradation

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Keywords

Microbial breakdown
Polypropylene
Polyethylene
Value-added products
Bioaccumulate

Abstract

Every day, vast amounts of plastic are produced and continue to accumulate, creating a significant global, environmental and social crisis. The exponential rise in plastic production poses severe ecological risks and health hazards. Not only do plastics bioaccumulate and magnify toxicity in ecosystems, but their breakdown products are also harmful to both human health and the environment. Polyethylene and polypropylene, two of the most widely used plastics, are particularly resistant to degradation, making their microbial breakdown a challenge. This study reports the cloning and expression of a multi-copper oxidase enzyme from *Micrococcus* sp. IITD107, which was able to show a 6.8% and 0.5% reduction in weight of polypropylene and polyethylene strip, respectively, within 7 days of incubation using crude lysate. SEM analysis revealed that the strips' surfaces became rough and uneven at the edges. NMR and FTIR analyses confirmed C-H bond stretching and carbonyl bond attack due to enzymatic activity. GC-MS identified degradation products such as alkanes, aldehydes, carboxylic acids, and ketones, with carbon chains ranging from C3 to C15. Based on these findings, a possible degradation pathway for polyethylene has been proposed. This research aims to improve enzymatic or microbial biodegradation processes for more efficient plastic breakdown and the generation of value-added products.

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Abstract ID: ABS – 059

Isolation and Characterization of Microorganisms Capable of Polyethylene and Polypropylene Degradation

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Keywords

Microbial plastic degradation Polyethylene Polypropylene Plastic dumped soil Enrichment

Abstract

Plastic has found application in every field due to its durability, low cost, and high resistance. Fossil fuel-derived plastics are accumulating at a rate much higher than that of their degradation in the natural environment. Therefore, it is necessary to accelerate the degradation rate of plastics. The biological degradation of plastics has proven to be safe and eco-friendly compared to physical and chemical degradation. In the case of microbial degradation, polyethylene and polypropylene are very difficult to degrade due to their high molecular weight and hydrophobicity. There are only a few reports on microbial degradation of these plastics. The microbes that degrade polyethylene and polypropylene can be isolated from areas rich in these plastic wastes using the principle of enrichment. Soil samples dumped with plastic waste were collected from different regions of Delhi. These samples were inoculated in the medium where only polyethylene and polypropylene serve as carbon source. The microbes which grow in this medium are able to use them as carbon and energy sources for their growth and metabolism. A few such microbes are isolated and the degradation efficiency of these microbes are tested. These microbial strains were characterized in detail, and the genes and pathways will be described.

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Abstract ID: ABS – 075

A Novel Approach to Pretreat Lignocellulosic Materials Using Surfactant Foam

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Keywords

Surfactant foam
Solid state fermentation
Lignocellulosic materials

Abstract

An essential first step in converting biomass into useful chemicals is pretreatment of lignocellulosic materials. There are numerous pretreatment techniques available in the literature, each with advantages and disadvantages of its own. The lignocellulosic materials in this investigation were pretreated using surfactant foam. These lignocellulosic materials should be processed to boost the enzymatic action, enlarging the substrate's pores and increasing its surface area, before being fed to a solid-state fermenter. Maximum lignin removal can be achieved with minimal effort by using surfactant foam. Comparative analysis between solid state fermentation in a surfactant foam bed and other traditional methods was performed to check the protein content and porosity of the pre-treated material using SEM. The results of study have been explained on the basis of protein content and porosity of the material obtained after the respective treatment.

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Abstract ID: ABS – 078 (I)

Development and Utilization of Non-Torrefied Biomass Pellets With Mill Rejects in The Existing Ball and Tube Mill Based Coal Power Plants: A Novel Approach Towards Circular Economy

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Keywords

Biomass pellet
CO_2
Grass; Mill rejects
Paddy straw
TGA

Abstract

The present work proposes an experimental study on the formation of non-torrefied biomass pellets from colony dry grasses and paddy straw with a mixing ratio of 25:75 and the combustion behaviours study of the developed biomass pellets, coal and mill rejects individually and in blend form for re-use in the coal fired steam power plants running with Ball and Tube mill. The GCV and VM values of the developed pellets are in the range of about 4326 kCal/kg and 71.19 %, respectively. For re-utilizing the mill rejects in the existing power plant, the optimum blending values of fuel mixture is found about 91.25 % (coal) , 5 %(biomass pellet), and 3.75 % (mill reject), respectively. Combustion parameter indices of the blend sample are well matched with coal except intensity index which is slightly lower than the coal. The parametric performance study of the power plant using developed biomass pellets and mill rejects as co-firing with coal are studied through modelling in Cycle-Tempo modelling software. Result shows that there is an improvement in energy and exergy efficiency by about 3.45 % point and 3.05 % points, respectively by considering coal as the only input. Implementation of the proposed system can reduce the annual CO_2 emission of about 2.70 Lacs Metric Tons (LMT). Economic analysis discloses that making cost of pellet is about INR 5.03 / kg.

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Effective Conversion of Biomass-Derived 5-Hydroxymethylfurfural to Highly Value-Added Chemicals

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Keywords

Biomass
Value-added chemicals
Platform chemicals
Bio-based fuels
5-Hydroxymethylfurfural

Abstract

The catalytic conversion of chemicals derived from biomass to value-added products has gained a lot of attention in recent years since it resolves environmental and energy-related problems. Value-added chemicals produced from biomass-derived platform chemicals will reduce the existing reliance on carbon resources provided via fossil reserves. Non-edible lignocellulosic biomass has been identified as the most potential renewable resource for producing high-value bio-chemicals. One of the most significant groups of intermediates in the process of converting non-edible lignocellulosic biomass into bio-based fuels and chemicals is furan. Currently, the cellulose and hemicellulose fractions of biomass are typically used to produce bio-furan derivatives by dehydrating their respective C6–C5 sugars under the influence of an acid catalyst, which can subsequently be used to produce an extensive range of products. 5-hydroxymethylfurfural (HMF), with simple molecular structure including a hydroxyl group, an aldehyde group, and a furan ring, is a very significant and platform chemical synthesised from renewable biomass. HMF is ranked among the top 10 bio-based chemicals by the USA Department of Energy and surely one of the most favoured furan-based feedstocks since its chemical structure enables the synthesis of numerous high-value-added compounds, such as 5-ethoxymethylfurfural (EMF), 2,5-dimethylfuran (DMF), 2,5-diformylfuran (DFF), furan-2,5-dicarboxylicacid (FDCA), etc. Levulinic acid (LA) is produced as a key byproduct on the profitable scale of HMF production, which is a potential organic bio-platform chemical. This review mainly focuses on the conversion of biomass-derived HMF into value-added chemicals through catalytic processes.

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Abstract ID: ABS – 081

Acid/Alkali Leaching of Torrefied Rice Husk for Improvement of Fuel Properties

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Keywords

Acid leaching
Alkali leaching
Torrefied rice husk
Ash content
Calorific value
Enriched biomass

Abstract

The transition of the global energy mix towards affordable and cleaner energy has boosted the utilization of biomass feedstock. Among the various technologies for biomass conversion, torrefaction is a very modern thermo-chemical process utilized to improve its fuel properties, thereby, making it suitable for gasification and power generation applications. Although the process of torrefaction enhances the carbon content and heating value, it also increases the ash content of the product. The higher ash content in the fuel reduces combustion efficiency and contributes towards slag formation within the reactor due to ash melting. Hence, in this experimental investigation, acid/alkali leaching of the torrefied rice husk (TRH) has been performed to reduce its ash content, thereby improving its overall fuel properties. The torrefied rice husk prepared in an inert atmosphere under suitable operating conditions was treated using HCl as well as NaOH at different concentrations and residence times. The treated samples were washed thoroughly and dried for successive analysis. Several characterization techniques, such as proximate analysis, CHNSO analysis, gross calorific value, FTIR, XRD, fibre analysis, FESEM, etc. were performed to investigate the optimum leaching conditions. From the analysis, it has been witnessed that acid leaching was sufficient to remove the majority of the ash content. Hence, to reduce the severity of the treatment condition and cost, acid leaching of TRH using 0.1N HCl for 30 min residence time is suggested as the optimum treatment condition for ash removal for its successive utilization in various thermal processes.

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Abstract ID: ABS – 084

Development of Chemically Durable Borosilicate Glass Wasteform for Immobilisation of High-Level Waste

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Keywords

Borosilicate Glass
Strontium
Immobilisation
High-level waste

Abstract

The short-lived radionuclides such as strontium, cesium etc. needs to be vitrified before permanent disposal in geological site. The borosilicate glass matrices have been synthesised with conventional method and investigated for their chemical durability. The glass containing SiO_2, B_2O_3, Na_2O, BaO, CaO, Al_2O_3, TiO_2 loaded with varying content of SrO (from 10 to 25 mol%) have been prepared. The X-ray diffraction patterns of all the glass prepared matrices confirm their amorphous nature. The band position in Raman spectra indicates good quality glass formation. The elemental mapping has confirmed the uniform distribution of elements in the glass matrix. The chemical durability of glass matrices was investigated with PCT test at 90 ± 1°C for 30 leaching days. The leaching rate of strontium (LR_{Sr}) was found below detection limit of ICP-OES instrument. The leaching of Si (LR_{Si}), B (LR_B), Ba (LR_{Ba}), Ti (LR_{Ti}) was obtained in the order of 10^{-8}, 10^{-8}, 10^{-12} and 10^{-9} $g.m^{-2}.\ day^{-1}$, respectively. The inferences drawn from above results provides fruitful inputs for the immobilization of short-lived radioactive wastes in borosilicate glass wasteform.

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Abstract ID: ABS – 087

Anaerobic Biorefinery for Valorization of Food Waste and Environmental Sustainability

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Keywords

Biomass
Biogas
Closed-loop
Fermentation
Waste management

Abstract

Global food waste generation is set to reach ~1 billion tonnes annually, with developing countries experiencing a rapid increase. Improper waste management can lead to greenhouse gas emissions, pathogenic organism breeding, and landfill life-shortening. Anaerobic digestion is a process that not only treats but also degrades it to valuable products like VFAs, hydrogen, methane, etc. For this, three different mixed consortiums were considered: cow dung (R_1), sewage sludge (R_2), and a mixture of cow dung and sewage sludge (R_3). It was observed that the mixed consortia (R_3) produced maximum biogas (310 mL) as well as efficient removal of sCOD in R_3 (66%), R1 (34%), and R_2 (32%). The stable operation of AD with FW was optimized using two widely used optimization methods: Response Surface Methodology with Box-Behnken Design (RSM-BBD) and Taguchi orthogonal array L9. The optimum condition of RSM-BBD shows higher biogas production, i.e., 850 mL, and VS_r was 41%. Apart from biogas, other bio-refinery approaches, such as the anaerobic digestion of food waste and VFA production with nanoparticle augmentation, have also been studied. The goal of sustainability is further enhanced by treating VFAs-rich effluent by culturing Microalgae (*Chlorella vulgaris*) in different modes of nutrition, and the mixotrophic mode in acidogenic effluent of the AD system generated maximum biomass of 0.580 g/L and a maximum total lipid content of 21.1% w/w. Further optimization can increase microalgal biomass and lipid content.

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Abstract ID: ABS – 093

Characterization Biomass Combustion Using Single Pellet Experiments and Mitigation of Ash Related-Challenges

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Keywords

Biomass
Bioenergy
Pellet
Combustion
Additives
Kaolin

Abstract

As the world seeks to reduce our dependence on fossil fuels, biomass stands out as a cleaner, and renewable option for generating electricity. In India, with an annual availability of 750 million metric tons (MMT) and a surplus of 230 MMT as of 2021, biomass presents a cost-effective and environment-friendly alternative to coal. This study investigates the characterization and optimization of Indian biomass agro-residues for combustion, with a focus on pelletization, single pellet combustion experiments of biomass and coal-biomass blends, and additives to mitigate ash-related challenges. Single pellets made from coriander, soya, coal and coal-biomass blends were combusted, and the salient aspects like biomass burning rate, carbon conversion efficiency and gaseous emissions were evaluated. The ash-related metrics like slag viscosity and fouling index, base to acid ratio and potential for corrosion were determined using the detailed characterization of the solid residue post-combustion. To overcome the ash-related issues, an additive, kaolin (aluminum silicate- $Al_2Si_2O_5(OH)_4$), was mixed with biomass at 3% and 5% by weight. This helps to neutralize the alkali metals like potassium that tends to form low-melting chlorides and sulfates by creating more stable like high melting point potassium aluminum-silicate ($KAlSi_3O_8$:1080^oC). Using kaolin in single pellet combustion reduced the ash deposition and slag viscosity by more than 50% for the biomass and biomass-coal blends. More interesting results on the mechanism of action of additive will be discussed during the presentation.

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Abstract ID: ABS – 094

Production of Hydrogen by The Application of Biomass – A Review

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Keywords

Biomass
Hydrogen
Catalyst

Abstract

The combustion of fossil fuels has been one of the major reasons behind the detrimental environmental problems around the world. The present petroleum reserves trigger a sense of global energy insecurity. So, fresh research in inevitable in the domain of clean emissive, alternate and renewable fuels. In this regard, hydrogen energy gathers the attention of the researchers and industrialists, worldwide. Hydrogen, as fuel, offers numerous advantages over conventional fossil fuels. Among many sources, the origin of hydrogen energy lies in biomass, which are renewable in nature. Although the calorific value of hydrogen is very high, yet its combustion renders clean emission with complete absence of CO, CO2, NOx and other Green House Gas emissions. Therefore, with significant benefits of hydrogen energy, this review paper was drafted with core focus at production of hydrogen by the utilization of biomass. The purpose of this work was to investigate the various methods employed till date to produce from biomass. The intensive literature survey showed that thermo-catalytic process proved to be a promising method for the generation of hydrogen from biomass. Moreover, the present work articulates the conversion of organic domestic wastes to hydrogen which reflects the waste to wealth energy conversion concept. The role of catalyst in the thermo-catalytic breakdown of biomass is investigated deeply. Besides, the article outlines the challenges faced by the researchers and the way forward in the effective conversion of biomass into hydrogen fuel.

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Abstract ID: ABS – 103

Response Surface Methodology (RSM) Approach Towards Environmentally Benign Biodiesel Production from Waste Frying Oil (WFO) Using Sro@Zno Heterogeneous Nanocatalyst

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Keywords

Biodiesel
Waste frying oil
Transesterification
Response surface methodology

Abstract

Biodiesel is one of the most promising renewable energy sources with minimal environmental effects on the environment. In our study, a novel catalyst SrO@ZnO (SZO) was designed to evaluate its catalytic activity and stability as a heterogeneous catalyst in biodiesel production from waste frying oil (WFO). The physicochemical characterizations of the synthesized catalysts were performed using various analytical techniques like TGA, XRD, FT-IR, BET isotherm, HR-SEM, HR-TEM, and XPS. The synthesized biodiesel was quantified using ^{1}H-NMR analysis. The box-Behnken Design (BBD) approach was used to optimize various reaction parameters for the transesterification reaction of biodiesel production through the Response surface methodology (RSM). The biodiesel conversion of 97.1 % was obtained under optimized transesterification reaction conditions of 2.5 wt% catalyst concentration at 50^{o}C reaction temperature with 12:1 methanol to oil molar ratio for the reaction time of 60 min. The synthesized SZO catalyst is recyclable up to five times suggesting high catalytic activity and stability throughout the reaction course. Kinetic and thermodynamic studies revealed that the transesterification process of biodiesel production using SZO catalyst follows an endothermic non-spontaneous pathway. Obtaining high turnover frequency and low E-factor values signified that the process is clean, efficient, and environmentally friendly. The mechanistic investigation was executed based on previously reported literature. Moreover, various fuel properties like kinematic viscosity, cetane number, calorific value, cloud point, fire point, etc. are consistent with ASTM D-6751 and EN-14214 international standards. Thus, the proposed catalyst shows excellent catalytic efficiency as a heterogeneous catalyst in biodiesel production from WFO with great potential for industrial-scale biodiesel production.

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Abstract ID: ABS – 106

Arsenic (As) Adsorption Studies on Functionalized Cellulose Through Molecular Dynamic Simulation (MDS)

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Keywords

Arsenic
Cellulose
Molecular dynamic simulation

Abstract

Although the adverse effects of arsenic (As) are a matter of great concern, exposure to this notorious metalloid is inevitable. In order to develop an efficient, cheap, and eco-friendly adsorbent to remove As from water, molecular dynamic simulation using Material Studio 2017 software is performed to understand the behaviour of cellulose as an adsorbent. Modification of cellulose with different functional groups like –OH, -COOH, -NH2, etc via complexation, Ion exchange, electrostatic interaction, or Van der Waals attraction, etc. has a great role in the adsorption phenomenon.are studied, and calculations of adsorption energy and density functional theory (DFT) are performed. Various electronic properties like charge density, binding energy, radial distribution function, total energy, as well as energy convergence, have been calculated to find out the most efficient structure for adsorption of As. Amongst all the modifications, i.e., –SH, –COOH, CH3COO-, –NH2, cellulose functionalized with –SH shows an optimum result in terms of energy (highest occupied molecular orbital energy (HOMO), -4.817 eV), surface area (470.29Å^2), lowest unoccupied molecular orbital energy (LUMO), -0.934 eV , Chemical potential (μ), -2.875, Hardness (η), 0.97075, Electrophilicity (ω), 4.25882, Global Softness (S), 0.515065, Maximum electronic charge (ΔN), 2.962142, Electronegativity (χ),2.8755 and surface volume (490.37Å^3) which gives a strong inference of using cellulose material and its –SH modified structure as a suitable and potential biosorbent for As removal. With this computational study we found that the adsorption behavior of cellulose molecules changes with its modification.

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Abstract ID: ABS – 108

Hydrothermal Disposal of Tetra Pak Waste Using Metal Effluents to Produce Biofuels

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Keywords

Liquefaction
Bio-oil
Tetra Pak
Catalyst.

Abstract

The rising global population presents two pressing challenges: an ever-growing demand for energy and an escalating accumulation of solid waste. In 2019 alone, approximately 9.4 million tons of plastic waste were produced, with the food packaging industry identified as the predominant contributor to this surge. A notable example is Tetra Pak waste, where around 190 billion Tetra Pak cartons were sold across more than 160 countries that same year, underscoring the magnitude of this issue. Due to the low recycling rate and the lack of infrastructure, this waste either ends up in the incineration plants or in the landfills. This study proposes a novel hydrothermal technique for the disposal of Tetra Pak waste to produce highly valuable biofuel and metallic carbon nanocomposites (MCN). Four metal effluents (Fe, Cu, Ni, and Zn) of known concentrations were replaced with traditional deionized water in the hydrothermal liquefaction and the experiments were carried out at 320 °C, 30 minutes, and a substrate-to-solvent ratio of 1:10. The trends of the total bio-oil yields were found to be in the following order: Zn (22.54 wt.%) < Ni (30.09 wt.%) < Fe (53.19 wt.%) < Cu (55.85 wt.%). The presence of various in-situ generated active metal ions promoted the enhanced breakdown of the feedstock and improved the bio-oil yields. Different analyses of the bio-oil confirm the presence of various organic species (alcohols, esters, ketones, ethers, aromatics, and acids). The FESEM and TEM analysis also shows the formation of Metal-alumina nanoparticles with potential catalytic applications

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Abstract ID: ABS – 110

Biohydrogen Synthesis from Food Waste Hydrolysate: Optimization Using Statistical Design of Experiments (Doe) and Artificial Neural Network (ANN)

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Keywords

Biohydrogen
Food waste hydrolysate
Response Surface Methodology
Central Composite Design
Artificial Neural Network (ANN-GA)
Dark Fermentation

Abstract

Hydrogen is emerging as a clean next-generation fuel. An eco-friendly route for hydrogen synthesis is dark fermentation using Clostridial cultures. The present study has addressed the matter of valorization of food waste to biohydrogen through dark fermentation using Clostridium pasteurianum. Initially, statistical optimization of fermentation parameters (pH, temperature and total reducing sugar (TRS) concentration in food waste hydrolysate) was done using response surface methodology (RSM) with central composite design (CCD) of experiments. The RSM-CCD analysis resulted in biohydrogen yield = 1039 mL/L (1.58 mol/mol hexose sugars) for the parameter set: pH = 6.5, temperature = 36 □C, TRS concentration = 10 g/L. 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 H2 production. These results clearly demonstrate superiority of ANN-GA technique for simulating and predicting behavior of a non-linear system like the metabolic pathway of C. pasteurianum. The biohydrogen production profiles were analysed using modified Gompertz model, which revealed higher H2 production potential using ANN-GA technique as compared to statistical design of experiments (RSM-CCD method).

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Abstract ID: ABS – 124

Assessment and Comparison of Various Microalgae for Bio-Oil Production

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Keywords

Bio-oil
Microalgae
Macromolecular components
Hydrothermal liquefaction (HTL)

Abstract

Bio-oil is the liquid fraction of the hydrothermal liquefaction fraction that could be used in place of petro-crude. Among all thermochemical processes, hydrothermal liquefaction (HTL) appears to be the most cost-effective approach for producing bio-oil. In this study, microalgae such as Chlorella vulgaris and Nostoc muscorum were evaluated for bio-oil production. Biochemical examination of microalgal species found that Nostoc muscorum had a higher protein (49%) and carbohydrate (31%), compared to Chlorella vulgaris, which had 44% protein and 20% carbohydrate. Chlorella vulgaris was found to have a higher lipid content (13%) than Nostoc muscorum (4%). Chlorella vulgaris and Nostoc muscorum biomass yields were determined to be 0.78gL-1 and 0.70gL-1, respectively. HTL was carried out at three different temperatures (220°C, 270°C, and 320°C) for 30 minutes at 110 and 220 bar pressure, respectively. During HTL, organic acids such as acetic acid (CH3COOH) were utilized as a catalyst. Bio-oil yield in Chlorella vulgaris and Nostoc muscorum was reported to be 20%, 23%, 27% and 15%, 18%, 23% at 220°C, 270°C, and 320°C, respectively, at 110 bar pressure for 30 minutes. At 220 bar pressure for 30 minutes, bio-crude yield in Chlorella vulgaris and Nostoc muscorum was found to be 24%, 30%, 39% and 17%, 22%, 30% at 220°C, 270°C, and 320°C, respectively, indicating that pressure and temperature influence bio-oil yield.

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Abstract ID: ABS – 130

Thermodynamic and Life Cycle Assessment of Thermodynamic Cycles for Waste Heat Recovery from Flue Gases

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Keywords

Thermodynamic performance
Environmental impacts
Energy efficiency
ASPEN Plus
COP

Abstract

Energy demand has surged in the past decade, with the industrial sector consuming 38% (~169 EJ) of global energy in 2021, and this is expected to rise. This energy is sourced from fossil fuels, biomass combustion, or electricity, but thermodynamic constraints lead to significant heat loss to the stack. Thermodynamics offers an effective method to improving the efficiency by recycling the heat in exhaust gases to electricity or streams for heating/cooling. This study investigates a heat recovery strategy using thermodynamic cycles — Organic Rankine Cycle (ORC), heat pumps, and absorption chillers, simulated in ASPEN Plus using flue gas as the heat source. The performance of the cycles as an alternative waste heat recovery (WHR) configuration was carried out using a sensitivity analysis, first and second law assessment. The results showed that despite operating at low pressure and using water as a refrigerant, absorption chillers had a lower COP than heat pumps (COP of 3) and ORC (16% thermal efficiency). An environmental feasibility using life cycle assessment (LCA) quantified the damage from each cycle, focusing on ecosystem impact and emissions. The normalized global warming potential, acidification potential, and cumulative energy demand of the cycles were compared using SimaPro. The results showed that absorption chillers offered lower environmental impacts at 0.281 kg CO2 eq/1000 m3 of chilled water and 0.471 kg SO2 eq/1000 m3 of chilled water. This study highlighted ORC as the most efficient for WHR, while absorption chillers offered lower environmental impact. These findings help industries solve the dual problem of energy and environment simultaneously.

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Abstract ID: ABS – 132

Areca Nut Husk: A Green and an Efficient Catalyst in The Fuel Sector

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Keywords

Areca nut husk
Agro-waste
5-hydroxymethylfurfural
Biofuel

Abstract

The vast quantity of waste created by the agriculture sector poses a threat to global health and food security. Due to the potential applications of agro-residues in a variety of industries, including food processing, chemicals, agriculture, and pharmaceuticals, the synthesis of these biograins has been the focus of much research in recent years. It is noticed that several groups of researchers have already been discussed on different types of agricultural wastes. The present article has been specially focused on development of areca nut husk wastes as green and an efficient catalyst and their various applications in biofuel and fuel precursor of 5-hydroxymethylfurfural (HMF). Currently, biofuel is a very hot topic in the field of catalysis, which has already been reported with good amount of yield using the materials obtained from agricultural waste. This article also discussed the current status and future prospects of development of areca nut husk as a sustainable heterogeneous catalyst in various fields beyond the fuel sector. Different characterization techniques have been discussed for identification of properties and structures of areca nut husk. Recycled study also discussed to proof heterogeneity nature of areca nut husk.This review provides a new scope for areca nut husk in R&D sector.

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Abstract ID: ABS – 137

Pyrolysis of Sewage Sludge with Potassium Acetate to Improve Phosphorus Recovery

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Keywords

Biochar
Sewage sludge
Phosphorus
Pyrolysis

Abstract

Phosphorus (P) is an essential nutrient element for plants without any substitute. The only source of P is phosphate rocks, which are non-renewable and depleting with time. Therefore, recovery of P from waste sources is vital. Sewage sludge (SS) is a byproduct of treatment of municipal wastewater and is rich in P. Pyrolysis is one of the treatments for SS, which produces nutrient-rich biochar. Sewage sludge was dried and ground before pyrolysis. Pyrolysis was done at 600 °C with heating rate of 5 °C/min and retention time of 2 h in a muffle furnace. The total phosphorus (TP) content of the sewage sludge biochar (SSB) was 24.48 mg/g. Available P (AP) was determined by extracting in 2% formic acid which was 8.2% lesser in SSB than SS. Pyrolysis of SS enriched the P content in biochar but reduced the amount of AP. Doping of SS was done with potassium (K) as potassium acetate (K-acetate) before pyrolysis. K-acetate was added as 1%, 2% and 5% K in sludge on a dry basis. The AP content in 5% K doped biochar increased by 38% as compared to undoped biochar. The percentage water extractable of total P increased by 148 times in SSB with 5% K addition compared to undoped biochar. SS doping with K increased the extractability of P in biochar and can be used as P fertilizer in agriculture.

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Abstract ID: ABS – 146

Biogas Upgradation Through Fixed Bed Adsorption Column Using Sugarcane Baggage-Based Biochar

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Keywords

Biogas upgradation
Biochar
CO_2 adsorption
Porosity

Abstract

Biogas, primarily composed of methane (CH_4), carbon dioxide (CO_2), and trace gases such as hydrogen sulfide (H_2S), requires upgrading to enhance its energy content and calorific value for applications like electricity generation and direct heat production. This study presents the development of a cost-effective fixed-bed adsorbent column purification system using biochar derived from sugarcane bagasse. The biochar was produced at a heating rate of 10°C/min with a residence time of 1 hour at three different pyrolysis temperatures: 550°C, 450°C, and 350°C using a pyrolyser. Results indicated that biochar prepared at higher pyrolysis temperatures demonstrated higher adsorption capacities for CO_2 and H_2S, with a CO_2 removal efficiency of 49.65% at 550°C, compared to 37.90% for biochar produced at 350°C. The enhanced adsorption is attributed to the porous structure of biochar, which provides an extensive active surface area for CO_2 capture. Brunauer-Emmett-Teller analysis confirmed higher specific surface area, pore diameter, and pore volume of biochar produced at elevated temperatures. Low hydrogen-to-carbon and oxygen-to-carbon ratios indicated a high degree of aromaticity and carbon fixation, further favouring CO_2 capture. The presence of surface functional groups and alkaline and alkaline earth elements in the biochar also contributed to significant conditions for the biogas purification process. This study highlights the potential of using biochar derived from sugarcane bagasse as an effective adsorbent for biogas upgrading.

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Abstract ID: ABS – 154

Pyrolytic Biochar From Rubber Wood: A Sustainable Approach to Improve Soil Water Retention in Indian Agriculture

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Keywords

Rubber Wood biochar
Water Holding Capacity
Pyrolysis
Sustainable Agriculture

Abstract

This research investigates the potential of pyrolytic biochar derived from rubber wood as a sustainable solution for improving soil water retention in Indian agriculture with special focus to N.E. Soils. With the rise of world population and increasing agricultural requirements comes an increasing need of fresh water. It is important to know that while India is home to almost 18% of global population of world population, it has only 4% of fresh water resources. And according to Indian Central Water Commission, India is using 78% of his fresh water to the agriculture. Rapid climate changes have been threating the sustainable development of agriculture sector around the country. And it is causing prolonged drought which gives negative effects on productivity and quality of agricultural products. For solving these emerging challenges there have been many solution on improving soil health in order to increase the tolerance of soil and plant to weather condition. The study examines the physicochemical properties of rubber wood biochar proposed as one of the solutions to water stressed agricultural regions produced through pyrolysis and its effects on soil hydrology. Experiments were conducted by mixing definite proportions of pyrolyzed rubber wood biochar with soil. Results indicate that rubber wood biochar significantly enhances soil water holding capacity, with increases of up to 25% observed in sandy loam soils. The biochar's high porosity and surface area contribute to improved soil structure and increased water holding capacity. The long-term stability of biochar in soil suggests its potential for carbon sequestration, with an estimated carbon storage capacity of 0.5-1 ton per hectare annually. This research demonstrates that rubber wood biochar offers a promising, locally-sourced solution for sustainable agriculture in North East Indian agriculture, particularly in water-stressed areas, while also contributing to waste management and climate change mitigation efforts.

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Abstract ID: ABS – 167 (I)

Biomass-Based Cogeneration System for Rural Grid Extension and Post-Harvest Drying: A Case Study

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Keywords

Cogeneration
Rural electrification
Organic rankine cycle
Agriculture residue
Crop drying
Efficiency

Abstract

The increasing demand for electricity in rural regions, in addition to need for efficient post-harvest crop management, demands sustainable and localized energy solutions. However, in a number of villages in the agriculturally wealthy regions of Punjab, Haryana, and Uttar Pradesh in India, there is an ongoing shortage of electricity and a large amount of grain wastage as a result of the dependence on sunlight for drying after harvesting. This research describes a biomass-based cogeneration system that combines a drier system (DS) for post-harvest grain drying with an Organic Rankine Cycle (ORC) for electricity generation. In this detailed study, five villages are chosen with 1000 households, where predominant crops are sugarcane, wheat, and paddy. The thermal energy is produced by the combustion of the post-harvest agricultural residues like straw, husk, and bagasse. This heat is captured by the ORC to produce electricity, and the leftover heat is effectively recovered to be used in the drying process of two crops paddy and wheat for safe storage. The study also concentrates on improving the ORC's working fluid in order to boost system effectiveness. Findings show that the heat produce after the combustion of the residues is estimated as 751 kW which run this cogeneration system. It successfully satisfies the communities' needs for drying and electricity, producing 154.3 kW of electricity with a power plant efficiency of 23.48 % and 71.25 % of dryer efficiency. This sustainable technique highlights the potential of agricultural residues as a useful energy source for post-harvest dehydration and rural electricity.

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Abstract ID: ABS – 171

Valorizing Agro-Industrial Waste: Bioethanol Production from Delignified Spent Passion Fruit Rind Residue

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Keywords

Bioethanol
Delignification
Fermentation
NaOH
Passion fruit rind

Abstract

Lignin removal is a critical step in bioethanol production from lignocellulosic biomass, as its recalcitrant nature hinders enzymatic hydrolysis, and its elimination enhances cellulose accessibility for subsequent fermentation. This study investigates the complete valorization of industrial waste, particularly passion fruit rind (PFR), using a two-step process of delignification and fermentation to produce bioethanol. Post-ultrasound-assisted extraction, the PFR residue contained ~20% cellulose, 21% hemicellulose, and 10% lignin. The PUH-PFR (residue obtained post-ultrasound-assisted extraction and sulfuric acid treatment) was subjected to delignification using NaOH to enhance cellulose accessibility. The delignification process was optimized using statistical methods, varying the independent parameters, including solid loading, NaOH concentration, and treatment duration, to achieve maximum cellulose recovery. The delignified cellulose was hydrolyzed using commercial cellulase, followed by fermentation, yielding bioethanol with an efficiency of 87.88%. The improved procedure effectively removed the lignin, increasing the cellulose available for enzymatic hydrolysis. This work highlights the potential of agro-industrial waste valorization in manufacturing sustainable bioethanol. The approach is consistent with the concepts of the circular bio-economy, as it helps to reduce waste production and enhance resource efficiency. The study offers insightful information on turning agro-industrial residue into high-value biofuels, supporting sustainable waste management techniques and more environmentally friendly energy options.

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Abstract ID: ABS – 174

Biodiesel Production using Green Synthesized Nanocatalyst

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Keywords

Waste Cooking Oil
Goat Fecal Matter
Nanoparticles
Transesterification
Biodiesel

Abstract

The rise in fuel prices and increasing environmental concerns have led to a pressing need for renewable energy sources that are cost-effective and have a low carbon footprint. Since the transportation sector is a major energy consumer, biofuels like biodiesel and bioethanol can significantly reduce the dependence on fossil fuels. Biodiesel can be produced through methods such as pyrolysis, direct blending, microemulsion, and transesterification, with transesterification being the most used process. This project uses waste cooking oil as feedstock for producing biodiesel, which is an eco-friendly approach and helps in the production of renewable energy. The catalyst plays an important role in the transesterification process, as it increases the rate of reaction and improves yield. ZnO nanoparticles, which were synthesized using Goat Fecal Matter (GFM) extract, served as a reducing agent for zinc sulfate. Here, the ZnO NPs are a heterogenous catalyst that offers easier separation and reusability than homogenous catalysts. The optimal biodiesel conversion was achieved at 65°C and 9:1 methanol-to-oil ratio, with ZnO nanocatalyst maintaining efficient catalytic properties over two cycles. ZnO NPs were analysed using UV-visible spectroscopy, Fourier transform infrared spectroscopy (FTIR), X-ray Diffraction (XRD), Energy Dispersive X-ray (EDX), Transmission Electron Microscopy (TEM) and scanning electron microscopy (SEM). XRD and SEM were utilized to determine the average crystallite size, structure, and shape of ZnONPs. FTIR examination offers information about the sample's composition, purity, and the synthesis of ZnONPs. Biodiesel synthesis was confirmed using Proton Nuclear Magnetic Resonance (1H) and GCMS techniques.

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Abstract ID: ABS – 176

Experimental Evaluation of the Combined Effects of Coffee Husk and its Biochar in Composting

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Keywords

Additives
Biochar
Coffee husk
Composting
Food and Kitchen Waste
In-vessel Composting

Abstract

A major fraction of Municipal Solid Waste (MSW) consists of food and kitchen waste. Tropical countries like India effectively convert this biodegradable fraction to soil amendment through composting. This process can be enhanced by incorporating additives from various biomasses, including agricultural waste. Coffee husk, an agricultural waste in the country, can be effectively utilized for composting. The combined effect of coffee husk and its biochar in food and kitchen waste composting is the prime focus of this study. It is significant because the combined effect of coffee husk and its biochar is expected to vary from their individual effect in composting. In this study, an additive mix is added to the substrate (food and kitchen waste) at varying proportions (1%, 3%, 5%, and 7% weight/weight). This additive mix contains coffee husk and its biochar at predefined ratios (1:1, 1:2, 1:3, 2:1, and 3:1). The biochar is prepared by slow pyrolysis at 350 °C. A 40-day aerobic in-vessel composting is done with the substrate-additive mix. During the composting process, parameters such as temperature, pH, conductivity, moisture content, microbial population, etc. are monitored. Compost obtained after the specified period is tested for its quality as per the regulations. This study also evaluates the suitability of coffee husk and its biochar in composting based on their properties. A control compost is also made without any additives, and its parameters are compared with the enhanced treatments. A suitable amount of bulking agent (sawdust) is added to the substrate to maintain the moisture content at an optimal level. In summary, this study broadens the scope for effective and localized disposal of coffee husk.

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Abstract ID: ABS – 180

Alkali Naoh Pretreatment of Mixed Lignocellulosic Biomass for Efficient Delignification

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Keywords

Mixed lignocellulosic biomass
Bioethanol
Delignification

Abstract

The pretreatment of lignocellulosic biomass (LCBs) is a key process to break down the linkage among its different components namely cellulose, hemicelluloses and lignin, which makes enzymatic hydrolysis easier. The pretreatmentmodifies the cellulosic components present in the cell walls of LCBs by reducing crystallinity and polymerization, removing the lignin and other inhibitors and increasing porosity and surface area. Mixed lignocellulosic biomass (MLB) approach utilizes two or more different feedstocks to be used together, which helps in alleviating the dependency on single biomass. Morover, by using multiple feedstocks instead of a single can lead to higher ethanol production, lowering the cost and also benefiting the environment. In this study three LCBs, rice straw (RS), kans grass (KG) and napier grass (NG) as mixed lignocellulosic biomass (MLB) were used. Several different class of pretreatments namely organic acid (acetic acid, oxalic acid), dilute acid (sulfuric acid, H2SO4, phosphoric acid, H3PO4and nitric acid, HNO3), alkali (sodium hydroxide, NaOH and alkaline hydrogen peroxide, AHP), deep eutectic solvent (choline chloride:acetic acid(1:2),choline chloride:oxalic acid(1:1)) and physico-chemical (hydrogen peroxide, H2O2) pretreatment were screened. Amongst these, alkali NaOH pretreatment was found to be more efficient in terms of delignification (89.8%), holocellulose recovery (83.9%) and crystallinity index(41.9%). For efficient pretreatment, other parameters such as the concentration of alkali NaOH, the temperature and the time were optimized using RSM-CCD model. The final validated parameters for efficient pretreatment was found to be at NaOH concentration of 3.49%(w/v), 118.71 C for 67 minutes.

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Abstract ID: ABS – 182

Exploring the Scalability of Biogenic Magnetized Nanocatalyst Towards Biodiesel Production

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Keywords

Waste oil
Transesterification
Biodiesel
Fe_3O_4 nanocatalyst
Magnetic catalyst
Citrus limetta

Abstract

This study explores the effective use of a magnetic nanocatalyst derived from waste Citrus limetta peel ash (CLPA@Fe_3O_4) for biodiesel production from waste oil (WO), demonstrating a significant innovation in waste utilization and biodiesel synthesis. The magnetic nanocatalyst, analyzed via SEM, TEM, EDAX, XRD, XPS, VSM, and FTIR, features a core-shell structure that maintains its morphology and enhances surface properties, contributing to high catalytic stability. Under optimized conditions (6 wt% catalyst, 30 wt% methanol concentration, 60 °C, and 3 hours), a high biodiesel yield of 97.92% was achieved. The thermodynamic study confirmed the transesterification reaction as endothermic and non-spontaneous, consistent with controlled energy input for optimal yield. Kinetic analysis showed pseudo-first-order kinetics with an activation energy of 33.138 kJ/mol, suggesting moderate energy demands. Additionally, with a magnetization strength of 31.56 emu/g, the catalyst could be effectively separated from the reaction mixture using an external magnet, supporting reusability up to 80% over six cycles. The turnover frequency (TOF) of 0.011 mol/g-1h-1 indicates the catalyst's capability in biodiesel synthesis, and FTIR and GC-MS confirmed the conversion of WO to biodiesel, which met ASTM D6751 fuel standards, ensuring quality and suitability for industrial applications. The life cycle cost analysis indicated economical feasibility, with a catalyst cost of $0.533/kg and biodiesel production at $1.005/L, making it competitive for commercial adoption.

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Abstract ID: ABS – 191

The influence of microbial communities on electrical power generation within a double-chambered microbial fuel cell

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Keywords

Renewable energy
Microbial fuel cell
Mixed bacterial communities
DGGE

Abstract

Microbial fuel cells (MFCs) have emerged as a promising technology within the realm of renewable energy. These devices deploy microorganisms to generate electricity from organic matter via its oxidation and reduction reactions. Recent advancements in various aspects of MFC technology have yielded valuable insights into renewable energy applications. Compost samples represent a distinctive microbial ecosystem characterized by significant diversity and elevated biomass concentration. The mixed bacterial communities present in the compost samples are generally regarded as the source of power generation as these microbes adhere to the anode surface in the MFC. Consequently, acquiring deeper insights into the microbial composition is crucial for clarifying their biological functions and the intricate interactions amongst these microbial communities. This in turn would provide a better understanding for the improvement of MFCs design and operation. The present work emphasizes the effectiveness of different bacterial communities in electricity generation which were sourced from various environmental locations. These mixed cultures were subjected to MFC experiments, wherein the highest voltage and current outputs were recorded for the respective samples. The fuel cell setup constituted carbon cloth as electrodes in both the anodic and cathodic chambers, partitioned by Nafion which acted as the proton exchange membrane (PEM). Further, molecular fingerprinting method i.e. Denaturing Gradient Gel Electrophoresis (DGGE) was also performed to analyze the molecular profiles of the complex ecosystem communities.

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Abstract ID: ABS – 199

Preparation and Characterization of TiO_2-Immobilized Biochar for Treatment Of Single and Binary Mixture Of Dyes

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Keywords

Adsorption
TiO_2-immobilized biochar
Dye removal
Biomass

Abstract

Water pollution is a critical issue, leading to resource contamination and the spread of diseases. Wastewater, a major source of pollution, impacts ecosystems through effects such as water discoloration, reduced dissolved oxygen, and aquatic habitat destruction. Such contamination limits sunlight penetration in water bodies, diminishing photosynthesis rates, and harming aquatic life. Additionally, toxic compounds from polluted water can enter food chains, raising severe health concerns for both humans and wildlife. Effective removal of hazardous substances, including dyes and heavy metals, from wastewater is essential to protect ecological systems and promote human health. Adsorbents derived from biomass have proven to be effective in removing contaminants from wastewater. In this study, TiO2-immobilized biochar was prepared using carrot grass, an abundant weed. The biochar was characterized using FTIR, SEM-EDX, BET, XRD, and other analytical techniques. TiO2-immobilized biochar was employed for the removal of single dyes and binary dye mixtures (Eriochrome Black T and Azure A dye). Dyes were removed through both adsorption in dark conditions and photocatalysis under sunlight exposure, using TiO2-immobilized biochar. Testing under various conditions, including dye dosage, concentration, and contact time, demonstrated the effectiveness of the biochar. The performance of biochar was validated with real industrial wastewater, measuring chemical oxygen demand and dissolved oxygen levels, and the material was further evaluated for antibacterial properties. The findings suggest that TiO2-immobilized biochar is a highly effective adsorbent for the removal of dyes from wastewater, making it a promising solution for addressing real-world water pollution challenges.

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Abstract ID: ABS - 201

Techno-Economic Analysis of Hydrodynamic Cavitation Intensified Cleaner Production of Catalytic Fatty Acid Methyl Ester (Biodiesel) From Thumba Seed Oil (*Citrullus Colocyntis*)

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Keywords

Techno-economic analysis
Process integration
Fatty acid methyl ester
TiO_2
Thumba oil
Hydrodynamic Cavitation

Abstract

The Thumba seed oil, a source of non-edible oil abundantly available in tropical climate, was utilized for the production of fatty acid methyl esters (FAME or biodiesel) through two methods; conventional transesterification and intensified transesterification. In this study, techno-economic analysis (TEA) and environmental impact assessment of the Thumba oil FAME production were investigated for the two biorefinery approaches: conventional transesterification and intensified hydrodynamic cavitation integrated transesterification approach. Aspen plus simulation software was used to simulate the process and investigate its techno-economic analysis and greenhouse gas (GHG) emissions. A plant processing Thumba seeds 100 metric tonnes per day was the basis for its conversion to the FAME trough ultrasonic oil pre-treatment followed by TiO_2 catalyzed integrated hydrodynamic cavitation transesterification. According to the experimental results, maximum FAME yield of 71.8 wt% was achieved using 3×2 mm orifice as cavitation device under the pressure drop of 5 bar within 1 h cavitation process time. The specific energy analysis shows that the highest energy consumption of cavitation process was 16 kWh m^{-3}, which was much less than the conventional process consuming energy at the rate of ~500 kWh m^{-3}. Furthermore, the Aspen energy analyzer was used to estimate the energy savings through the process integration approach. Aspen Process Economic Analyzer was used for estimating the cost of equipment and the minimum selling price of the FAME product using breakeven point analysis for conventional and integrated process. Also the GHG emissions performance was estimated to assess the environmental impact of the undertaken cleaner process.

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Abstract ID: ABS – 207

Effect of Magnetic Field on Low-cost Flexible 3D Porous Aerogel Electrodes for Microbial Electrosynthesis

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Keywords

Microbial electrosynthesis
Volatile fatty acids
Carbon capture and utilization
Biofilms
Magnetic field
CO_2 valorisation

Abstract

To achieve a stable and sustainable atmospheric environment, it is critical to prevent the current irreversible rise in atmospheric carbon dioxide (CO_2) concentrations. Microbial electrosynthesis (MES) is a carbon capture and utilization (CCU) technique that involves the conversion of CO_2 into usable complex compounds such as volatile fatty acids (VFAs) and biopolymers through the use of microbes and electrochemistry. A cathode with a high specific surface area and electrode-microbe electron transfer is necessary to promote biofilm development on the cathode and, as a result, the rates of valorised product production. To achieve the same, 3D porous aerogel electrodes will be fabricated using Polydimethylsiloxane (PDMS), a polymer known for its biocompatibility with graphene nanoparticles as the conductive filler. Sugar will be added to the mixture while curing and sonicated in water resulting in a porous textured electrode. Apart from optimum microbe-surface interactions, studies have reported that external magnetic field having additive effects on electrotrophic growth and synergistic stimulating effects on the release of extracellular polymeric substances (EPS), the circuital current had a greater impact on the amount of EPS. In this study, magnetite nanoparticles will be added to the electrode fabrication material, to understand the synergetic effects of magnetic field and magnetite nanoparticles on VFA production. The amount of VFAs produced will be compared in the presence and absence of magnetic fields, followed by electrochemical characterisation of the electrodes.

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Abstract ID: ABS – 214

Utilizing Symbiosis to Scavenge Oxygen in the Anodic Chamber of a Photosynthetic Microbial Fuel Cell for Generation of Electricity

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Keywords

Photo MFC
Symbiotic association
Electrogenic properties

Abstract

Photosynthetic organisms, such as plants, algae, and cyanobacteria, have the remarkable ability to capture solar energy through photosynthesis. While traditionally associated with the production of biomass and biofuels, recent advancements have explored their potential to directly generate electricity. Photosynthetic organisms can utilize the natural electron transfer pathways in photosynthesis to produce electrical current, offering a potential renewable energy source. Besides bioelectricity generation, an additional benefit of photoMFCs is that carbon dioxide is removed from the atmosphere by the integrated photosynthetic process. Cyanobacteria are promising sustainable hosts for biofuels and power production because of high solar energy conversion efficiency, high CO_2 tolerance, rapid growth rate, low demand for arable land and fresh water and more amendable to genetic engineering than eukaryotic microalgae. There has been limited study on the use of cyanobacteria in microbial fuel cells, both in anode and cathode for power generation. The main advantage of using cyanobacteria in a MFC is that apart from having exoelectrogenic properties, they are photosynthetic and are the only known oxygenic photosynthetic bacteria and hence they are self-sustaining. The major limitation of using cyanobacteria is the oxygen generated during photosynthesis in the anode of the MFC proves to be a hindrance to electricity production. To overcome such limitations, a symbiotic association of cyanobacteria with heterotrophic bacteria might prove beneficial.

In the current study, cyanobacteria along with two other heterotrophic bacteria supposedly associated with it in nature were isolated from a local water body. The exoelectrogenic properties of each of the isolates were studied and the consortia was applied to the anodic chamber of a photosynthetic MFC which was developed indigenously and operated in alternating light and dark cycles of 12 hours each with 2500 lux at 25°C using graphite as the electrodes. Biofilm formation was observed when the anodic chamber was inoculated with the isolated cyanobacteria along with generation of electricity of 50mV and current of 5µA for a period of 8 days after which the voltage dropped to 35mV. It was observed that along with the increase in cyanobacterial biomass, there was an increase in the dissolved oxygen levels in the anodic chamber reaching up to 9.00mg/L by day 8 which probably hindered the electricity production. The addition of the 2 heterotrophic electrogenic bacterial isolates to the anodic chamber of the MFC helped in scavenging the oxygen thus contributing to the power output of the MFC. The MFC with the isolated microbial consortia were able to generate a voltage of 150mV and a corresponding current of 15 µA for well over 20 days.

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Abstract ID: ABS – 217

A Review on Hydrothermal Liquefaction Process of Biomass

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Keywords

Hydrothermal liquefaction
Biomass

Abstract

Hydrothermal liquefaction (HTL) is a thermochemical process that can convert biomass into valuable biofuels and chemicals, commonly using water as a solvent at high temperatures and pressures. This process mimics the formation of fossil fuels but at a much more accelerated rate. The type of feedstocks for HTL may include algae, agricultural residues, and lignocellulosic biomass. HTL takes place under very high temperatures between 250°C – 400°C and pressures of between 5 and 25 MPa to convert the organic material into liquid bio-oil. Bio-oil as mentioned is a complex solution of hydrocarbons that can be upgraded to convert to transportation fuel or for other purposes. HTL has some advantages over direct biomass conversion methods such as it does not require the pre-treatment drying of biomass and has flexible feedstock choice. Additionally, the process creates a secondary stream, which is composed of aqueous phase and, there will also be solid residues, which can be used for other applications or energy generation. Published work also indicated that HTL technology can have high carbon efficiency and reduce the formation of undesired products for biofuel application making it sustainable. Obstacles persist in determining the best conditions for the process parameters, improving the quality of bio-oil, and commercializing the technology. However, for HTL to serve as an effective route to transition from the conventional fossil fuel economy and towards renewable energy, it can be seen as a more sustainable and circular economy solution.

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Abstract ID: ABS - 222

Techno-Economic Analysis of Syngas Production from Sanitary Waste through CO_2 Co-Gasification

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Keywords

Syngas
Gasification
Techno-economic
Waste Management
Sanitary Waste

Abstract

The utilisation of the sanitary product is increasing day by day due to its importance in the daily life. It is necessary to find the novel approaches towards the management of the sanitary waste. The CO_2 assisted gasification of the sanitary waste is a promising waste-to-energy solution. CO_2 gasification is a substitute for traditional air or steam gasification. It uses carbon dioxide as a gasifying agent to raise the calorific value of the syngas generated, hence possibly lowering CO_2 emissions and raising syngas yield. This work presents a complete techno-economic assessment of syngas production from sanitary waste via CO_2 assisted gasification system. Examined were mostly the gasification temperature, CO_2 to waste input ratio, and reactor pressure. These variables were optimized to increase the quality and production of syngas. Capital expenditures, operational costs, and return on investment were computed to assess the economic feasibility of this procedure for industrial and small-scale implementations. Research demonstrates that the co-gasification of CO_2 with sanitary waste is economically viable, especially when included into current waste management frameworks, yielding favorable syngas outputs predominantly consisting of CO and H_2. The study suggests that syngas production using CO_2 assisted gasification not only enhances the value of sanitary waste but also promotes sustainable energy generation with less environmental impact. This analysis establishes CO_2 assisted gasification as a cost- effective and efficient technology for sustainable waste management and renewable energy production, rendering it appropriate for large-scale applications in urban and industrial contexts.

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Abstract ID: ABS - 224

Biomass Briquetting: A Brief Review of Current Status and SWOT Analysis

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Keywords

Briquettes
Biomass
Bioenergy

Abstract

Densification of biomass by compacting to form biomass briquettes is a practice widely followed around the globe. These briquettes can be used for combustion in furnaces, stoves, etc. or may be utilized as feed for biomass gasification. This current work reviews the global status of biomass briquetting in the 21st century with special focus on the Indian context. The review analyses the various techniques, biomasses and binders that have been used by researchers to produce different variety of pellets or briquettes. Literatures also indicate addition of catalysts, coal, etc. to enhance briquette quality. The review also gives an overview of the various parameters that are utilized to assess quality of produced briquettes. Finally, Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis is carried out on this briquetting technology. This analysis shows that in spite of weakness like logistics issues or threats like advent of newer technologies, biomass briquetting is still a viable option of bioenergy, especially in a developing and biomass-rich country like India. As per Negi et al., the current yearly surplus of agricultural biomass availability is approximately 230 million metric tonnes. Bioenergy being a carbon neutral technology, a substantial contribution can be made via biomass briquetting or bioenergy in India's ambitious target of achieving net zero carbon emissions by 2070.

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Abstract ID: ABS - 227

A Comprehensive Study on Mesoporous Materials for Biofuel Applications

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Keywords

Biofuel
Mesoporous materials
sustainable energy
Catalyst and carbon emissions

Abstract

The rising demand for biofuels is driven by the need for sustainable energy sources that reduce dependence on fossil fuels and help lower carbon emissions. Fossil fuels are depleting quickly and contribute to environmental damage, making the shift to renewable energy, like biofuels, essential for a sustainable future. Mesoporous materials, with their unique properties such as large surface area, tunable pore sizes, and high thermal stability, play a crucial role in biofuel production. These materials act as highly efficient catalysts in various processes, including biomass conversion, transesterification for biodiesel production, and upgrading of bio-oil. By speeding up reactions, reducing energy use, and helping turn biomass into fuel more effectively, mesoporous materials can improve the efficiency of biofuel production. They offer a promising solution for creating cleaner, more sustainable energy systems, and can play a key role in reducing the carbon footprint, making biofuels a more viable alternative to traditional fossil fuels.

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Abstract ID: ABS - 251

Dye Adsorption from Industrial Waste Water Over Carbon Nano Onions (Cnos)@Tio$_2$ Composites

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Keywords

Waste water
Adsorption
Composites

Abstract

The interesting characteristic properties of carbon nano-derivatives, in recent decades they all have been explored more and more. At present, with the uniqueness and special features, one of the derivatives of carbon well known as carbon nano-onions (multi-layered fullerenes) have gained focus of attention all over the world for their multiple applications such as in lithium ion batteries, super capacitor electrodes, removal of contaminants from industrial waste water etc. A single solvent-induced one-step solvothermal method was applied for the synthesis of nanocomposites composed of carbon nano-onions (CNOs) and TiO_2 possessing very good adsorption capability and the composite materials were prepared by making variation in percentage of CNOs in the composites without disturbing any other factor or reaction conditions. The composites were characterized by several techniques such as X-ray diffraction (XRD), Raman shifts, Fourier-transform infrared spectroscopy (FTIR) and BET surface area analysis. In addition, the as-prepared nanomaterials with different composition of CNOs and TiO_2 were investigated for the decoloration of aqueous solution of methylene blue dye and they all showed enhanced dye-adsorption efficiencies. However, the optimum result was observed by taking the composite with 10 % CNOs (adsorbent concentration = 0.16 g/L, methylene blue concentration = 0.02 g/L). The experimental result was comparatively much more greater than that in case of prepared bare TiO_2 and also higher than the adsorption capacity of other composite materials and the reason may be possibly associated with the improved surface properties during the solvothermal route of hybrid formation. Furthermore, the adsorption performance is greatly influenced by the obtained specific surface area values and it can be said that adsorption properties of as-synthesized nanomaterials towards methylene blue removal are found to be directly related to their specific surface area. The effect of various parameters and kinetics were also investigated.

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Abstract ID: ABS - 261

Numerical Modelling of Co-Combustion of Segun Leaves and Segun Leaves Char with High Ash Indian Coal

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Keywords

Numerical modelling
CFD
Segun leaves
DTF
Char combustion rate

Abstract

The present study investigates the combustion behavior of high ash Indian coal (HAIC) blended with segun leaves (SG) and segun leaves char (SGC) under both air-fuel and oxy-fuel conditions in a down-fired drop tube furnace (DTF). The numerical results reveal the effects of replacing air with a CO_2-rich environment and adjusting O_2 concentrations during oxy-fuel combustion. Three different blending ratios of HAIC with SG and SGC were analyzed. Findings show that increasing the SG biomass fraction from 10% to 50% raises the temperature from 1292K to 1310K in 21% O_2/79% N_2, 1286K to 1315K in 21% O_2/79% CO_2, and 1295K to 1330K in 35% O_2/65% CO_2. The devolatilization rate rises from 1.88×10^{-12} kg/s to 5.01×10^{-12} kg/s as biomass content increases from 10% to 50% in 21% O_2/79% N_2. Char combustion was completed earlier in the furnace (0.59 m from the inlet for 50% SG compared to 0.67 m for 10% SG) under 21% O_2/79% N_2. Similar trends, with minor differences, were observed for HAIC-SGC blends. These results demonstrate that incorporating biomass and biochar significantly enhances HAIC combustion in the DTF across various atmospheric conditions, with higher O_2 concentrations further optimizing combustion performance.

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Abstract ID: ABS - 297

Valorising Rice Husk Waste into Activated Carbon: Influence of Loading Ratios via Acetic Acid Activation and Double Crucible Method

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Keywords

Activated Carbon
Double Crucible Method
Rice husk
Waste management

Abstract

Rice husk, a major byproduct of rice milling, is produced in enormous quantities globally and is often discarded through environmentally detrimental practices such as open burning and landfilling. These disposal methods exacerbate air pollution, greenhouse gas emissions, and soil contamination, posing significant ecological and health risks. However, the high silica and carbon content of rice husk make it an ideal candidate for conversion into value-added materials such as silica nanoparticles and activated carbon. This study focuses on the sustainable valorisation of rice husk through the synthesis of activated carbon using an innovative double crucible method with acetic acid activation. The impact of varying loading ratios (1:5, 1:10 and 1:20) on the yield and quality of activated carbon was systematically analysed. Characterization techniques including FESEM, BET, XRD, and FTIR were employed to assess the microstructural, morphological, and surface properties of the synthesized materials. Results highlight the efficacy of this approach in producing high-performance activated carbon with enhanced properties, underscoring its potential for applications in environmental remediation and energy storage. This study demonstrates a scalable and eco-friendly pathway for converting rice husk waste into high-value products, contributing to sustainable waste management and circular economy initiatives.

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Abstract ID: ABS - 300

Sustainable Catalyst: Biofuel Production and Biofuel Precursor

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Keywords

Agro-waste
Sustainable heterogeneous catalyst composite
Biofuel

Abstract

In the present scenery, the synthesis of sustainable catalyst is the burning research area for production of biofuel and biofuel precursor with respect to the global warming in the environment. To overcome the drawback of the reported catalysts, researchers are devoting their time on non-hazardous materials as well as feedstock for production of biofuel and biofuel precursor. In this context, we have developed agro-waste materials & composite materials as sustainable heterogeneous catalyst for production of biodiesel and 5-hydroxymethylfurfural (HMF) that acts as fuel precursor. Interestingly, prepared sustainable catalyst showed superior catalytic activity for the desired product. The characterization of catalyst and analysis of the products confirm the heterogeneity of the catalyst and the reaction. The detail work will be discussed during presentation.

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Abstract ID: ABS - 308

Sustainable Approaches for Waste Management involving Bacterial Biofilms in Biodegradation of Recalcitrant Environmental Pollutants

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Keywords

Biofilm
Pollutant
Bioremediation

Abstract

Rapid industrialization and urbanization have led to a surge in environmental pollution, necessitating bioremediation approaches. Bacterial biofilms offer a promising solution for the degradation of recalcitrant pollutants achieving the Sustainable Development Goals (SDGs), particularly SDG 6 (Clean Water and Sanitation) and SDG 14 (Life below water). Bacterial biofilms are an intricate assemblage of cells embedded within an extracellular matrix, composed of extracellular polymeric substances (EPS) like polysaccharides, proteins, lipids, enzymes, and nucleic acids. With a higher surface area, the biofilm matrix supports diverse metabolic pathways and facilitates active binding, solubilization, and emulsification of pollutants, thereby enhancing the efficiency of pollutant remediation. Bacteria within biofilm facilitate the degradation of organic pollutants, such as polycyclic aromatic hydrocarbons (PAHs), employing oxygen as an auxiliary oxidation substrate in aerobic environments, while in low-oxygen environments, biofilms rely on reductive reactions to degrade PAHs. In rubber wastewater, ureolytic bacterial biofilm facilitates adsorption of inorganic nitrates and phosphates through enzymatic activity, further reducing biological oxygen demand (BOD), chemical oxygen demand (COD), and total dissolved solids (TDS) levels. These biofilms also neutralize treated wastewater by producing calcium carbonate from excess Ca^{2+} ions. In addition, specific functional groups of the EPS interact with heavy metals through complexation, resulting in their adsorption to the biofilm matrix. Recently, an innovative strategy of immobilizing EPS within polymer-based biosorbents has been found to be more efficient in metal sequestration. The resilience of bacterial biofilm against organic and inorganic pollutants makes them valuable tools for sustainable bioremediation, waste management, pollution control, and environmental restoration.

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Abstract ID: ABS - 309

Biomethane Production from Food Waste: A Sustainable Approach to Waste Valorisation and Renewable Energy Generation

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Keywords

Anaerobic digestion
Food waste
Biofuel
Volatile solid
Total solid

Abstract

The amount of waste generated globally is rising along with the growth of the population. The accumulation of increasingly generated food waste (FW) is a heavy burden on the environment. As a prime example of waste-to-energy technology, waste-to-biogas conversion offers a simple approach to simultaneously address the issue of the rising demand for renewable energy sources. Anaerobic digestion (AD) of FW produces biofuel, bioenergy, and bio-fertilizers. In this study, we use anaerobic digestion to utilize food waste in batch reactor. The regular monitoring of batch reactor was done for analysing impact of process parameter on biogas production. The pH, total solids (TS), volatile solids (VS), and moisture content were analyzed from the influent and effluent samples. The high amount of VS and TS was analysed and moisture content 51.11%. The biogas volume obtained for biogas 250 -300ml in 10 days from FW. Anaerobic digestion approach appears promising in generating biogas in the context of the growing energy demand using renewable energy sources and contributing to waste minimization.

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Abstract ID: ABS - 310

Nanomaterial as a Future Approach: Biofuel/Bioenergy Production

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Keywords

Bioenergy
Nanomaterial
Biofuel
Algae
Renewable Technology

Abstract

Bioenergy, a growing part of the global energy system, is being explored as an alternative to fossil fuels. Among the renewable energy technologies, bioenergy from biomass has its unique advantages such as feedstock availability, easy processing and high energy content. The advanced introduction of nanomaterial to optimize and improve the production of bioenergy from lignocellulose, microalgae, and wastewater is now in high demand. The current inclusion specifically explores the principles of nanomaterials, their distinctive characteristics, and their importance in enhancing the efficiency of enzymes, microbial fuel cells, biofuels and biodiesel. We also discuss the continued challenges in developing biofuel technologies using natural nanomaterials. Along with outlining future directions for study and advancement in this exciting field, it also draws attention to the dearth of creative solutions to current constraints. Subsequently, future trends and research needs are highlighted based on the current literatures. Pilot-scale research is necessary to examine the viability of incorporating nanoparticles on a large-scale bioenergy production basis.

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Abstract ID: ABS - 311

Perennial Grass-Based Activated Biochar for Dual Removal of Arsenic and Fluoride from Contaminated Water: Synthesis, Adsorption Behavior, and Air Filtration Potential

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Keywords

Perennial grass
Activated biochar
Arsenic
Fluoride
Air filter

Abstract

The present study investigates the synthesis and application of activated biochar derived from perennial grass (A. donax) for arsenic (As) and fluoride (F^-) removal from aqueous solutions. The experimental findings revealed that the biochar exhibited a high removal efficiency for arsenic (79.1%) and a moderate efficiency for fluoride (55.5%) under optimal conditions. Adsorption data were well described by the Langmuir isotherm model for both contaminants, while kinetic analysis indicated conformity with the pseudo-second-order model. These results highlight the potential of A. donax-based activated biochar as a low-cost, environmentally friendly adsorbent for water purification. Additionally, the biochar demonstrated promising efficacy in air filtration applications. This dual utility underscores the versatility of biomass-derived activated biochar as a sustainable solution for addressing environmental pollution. The findings provide insights into its practical application for mitigating arsenic and fluoride contamination in water and enhancing air quality.

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THEME

Solar, Wind, Hydro, Hydrogen & Fuel Cells

Abstract ID: ABS - 014

Design, Simulation and Fabrication of Solar Refrigerator using Peltier Module

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Keywords

Solar refrigerator
Photovoltaic cell
Peltier-module

Abstract

The need for renewable energy sources increases with rising demand of energy over the past decades. To fulfill such demand, other sustainable energy sources are utilized, out of which solar energy is most widely used. However, the temperature rise due to climate change escalates the cooling demand specially in remote areas, where there is scarcity of electricity. Such demand can be fulfilled by solar refrigerators, which runs on solar energy, using photovoltaic cell. Therefore, the present work focuses on developing a solar refrigerator, where the electricity produced from solar panel is supplied to a Peltier module, which produces cooling effect by Thermo-electric conversion process. The cooling effect produced by Peltier-based module eliminates the need for compressor and refrigerant, which has potential for small to medium-scale cooling applications in remote or off-grid locations. In the present work, firstly a Peltier-based solar refrigerator is designed and the transient thermal analysis is performed in Ansys workbench. Finally, the solar energy driven refrigerator using Peltier module is fabricated and testing of the experimental model is done to check for the required cooling effect. The numerical experimentation in Ansys results in a COP of 2.89, where temperature inside the refrigerator drops to 5.06º C by assuming room temperature to be at 30º C. However, from the experimental results, it is obtained that the solar refrigerator is able to attain a COP of 2.75, which is higher than that of a commercial refrigerator of same size.

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Abstract ID: ABS - 027

Variable-Pitch Vertical-Axis Wind Turbine Torque Improvement with Predefined Pitch Angle at Low Tip Speed Ratio

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Keywords

Predetermined pitch angle
Variable-pitch vertical-axis Wind turbine (VAWT)
CFD

Abstract

The growing emphasis on the extraction of renewable energy and urban sustainability has gained a renaissance in popularity on vertical-axis wind turbine as a feasible source of sustainable energy. Recent research has focused on the variable-pitch vertical-axis wind turbine in an effort to enhance the wind turbine's aerodynamic performance and ability to self-start. The concept of predetermined pitch angle for variable-pitch turbine is used to increase the wind turbine performance at lower tip speed ratio. Aiming to this, the present study offers a 2-D numerical simulation on pre-set pitch angle-based variable-pitch turbine at various amplitudes for a specific tip speed ratio of 0.1. The predefined pitch angle for each blade is decided based on their azimuthal position, which follows the sinusoidal variation. A computational study of 2-D transient flow surrounding the turbine is carried out with amplitudes ranging from 5° to 30°. In order to simulate the turbulent flow around the turbine rotor, the nonlinear Unsteady Reynolds Average Navier-Stokes (URANS) equations and the SST k-ω turbulence model are used. To solve the sinusoidal pitching motion of turbine, equations are implemented in cell zone conditions. The current results are compared with the same of conventional variable-pitch vertical axis turbine at the same tip speed ratio. An improvement of 38.27% on total torque coefficient is achieved at amplitude of 10° with this concept. The findings confirm that using a predetermined pitch angle for a variable-pitch turbine can increase torque of a standard vertical-axis turbine.

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Abstract ID: ABS - 028

A Targeted Approach to Fabricate and Test PEM Electrolyzer for Enhanced Efficiency

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Keywords

Hydrogen
PEM Electrolyzer
Renewable energy resources

Abstract

Hydrogen is a crucial energy carrier for the future green energy economy, but currently, it is produced from carbon-based compounds. Currently, 96% of global hydrogen production comes from carbon-based compounds through reformation processes, while only 4% comes from water electrolysis, which can be powered by renewable energy sources like wind and solar to produce green hydrogen. Polymer electrolyte membrane water electrolysis (PEMWE) is a promising technology to generate hydrogen using electricity from renewable energy sources. PEM electrolyzers show the most promise due to their high power, efficiency, and durability. However, their high cost, largely due to expensive catalysts like platinum (Pt) and iridium (Ir), remains a significant challenge. We will develop in-house testing of PEM electrolyzers by integrating high-precision fabrication techniques such as doctor blade and slot-die coating with the roll-to-roll (R2R) method to develop scalable, low-loading anodes for PEM electrolyzers. Additionally, variations in the ionomer and catalyst loading will be studied to optimize the performance of the PEM electrolyzer. The manufactured electrodes will be tested in 25 cm^2 electrolyzer hardware and the performance will be evaluated using electrochemical techniques such as electrochemical impedance spectroscopy, cyclic voltammetry, linear sweep voltammetry, and polarization behavior of electrodes to understand the microscale and macroscale behavior of the electrodes.

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Abstract ID: ABS - 030

Hour Ahead Multivariate Forecasting of Global Horizontal Irradiance using Advanced Deep Learning Techniques

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Keywords

Global Horizontal Irradiance
Deep Learning
Long Short-Term Memory
Convolutional Neural Network
U-net

Abstract

The hour-ahead forecasting of global horizontal irradiance (GHI) is essential for integrating the electrical energy produced from solar photovoltaic (SPV) plants into electrical grids. Solar energy is highly intermittent and diurnal in nature. The produced electrical energy from (SPV) plants cannot be directly integrated into the electrical grid since it causes grid instability. In order to alleviate this issue, GHI forecasting is critical. In this study, advanced deep learning techniques such as Long Short - Term Memory (LSTM), Convolutional Neural Networks (CNN), Gated Recurrent Unit (GRU), Bidirectional Long Short - Term Memory (BiLSTM), along with conventional machine learning techniques such as U-net, Extreme Gradient Boosting (XG Boost) and Gaussian Processing Regression (GPR) are used to forecast the hour ahead Global Horizontal Irradiance. The weather parameters for this study are obtained from Solcast®. The models used were hyper-tuned to determine the optimal configuration of the architecture. Root mean square error (RMSE), mean absolute error (MAE), coefficient of determination (R^2) and forecast skill are used to assess the model's performance. A smart persistence model is used as a baseline model for comparison. The values of RMSE for XG Boost, LSTM, CNN, GRU, BiLSTM, BiLSTM-CNN, U-net are 66.34 W/m^2, 43 W/m^2, and 0.9487, 67.11 W/m^2, 42.84 W/m^2, and 0.9485, 58.41 W/m^2, 63.34 W/m^2, 64.75 W/m^2, 64.62 W/m^2, 63.28 W/m^2, and 58.99 W/m^2 respectively. It is concluded from the results, the proposed models such as multi-layer LSTM and U-net, almost yields the same accuracy as compared to other standalone and hybrid models.

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Abstract ID: ABS - 031

Quantification of Energy Efficiency from Vortex-Induced Vibration of Two Circular Cylinders Mounted on a Cantilever Beam

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Keywords

Water tunnel
VIV
Bluff body
Energy extraction efficiency
Cantilever beam

Abstract

The energy extraction from Vortex-Induced Vibration (VIV) of circular cylinders is a clean and renewable energy source. VIV is a type of fluid-structure interaction phenomenon in which the alternating vortices generated in the wake of the bluff body cause periodic oscillations. This study presents the quantification of energy efficiency from the VIV of two circular cylinders mounted on a cantilever beam in side by side arrangement. Quantification of energy efficiency of the VIV system can be done by applying the variable external damping to the system. The damping system consists of an eddy current damping mechanism comprising a permanent magnet and an aluminium plate. The variable damping can be achieved by varying distance between the plate and magnet with the help of a stepper motor with an accuracy of 0.02 mm. The experimental studies have been done in an open surface recirculating water tunnel having a flow speed range of 0.04 m/s to 0.6 m/s on the VIV of two carbon fibre circular cylinders of diameter 10 mm and length 345 mm, mounted on a cantilever beam. The experimental setup was validated with the experimental data. The distance between the circular cylinders is kept as 5 D, where D is the diameter of the circular cylinder. The damping mechanism was validated by comparing the gap vs damping ratios with the experimental data. The VIV experiments were conducted by varying the flow speeds while keeping the cylinder's natural frequency and diameter constant. The maximum energy extraction efficiency is around 20%.

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Abstract ID: ABS - 034

A Comprehensive Review of Solar Agri-Food Dryers integrated with Thermal Energy Storage

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Keywords

Solar drying
Thermal energy storage
Food preservation
Sustainability
Energy efficiency

Abstract

The increasing demand for food preservation and sustainability in agriculture has led to the development of innovative drying technologies. Solar drying is an effective method, utilizing renewable energy to reduce food spoilage and significantly reduce the carbon footprint. However, its performance can be limited by weather conditions. By integrating thermal energy storage, these systems can store excess solar energy for use during cloudy days or at night, ensuring consistent drying performance. The paper examines various designs and technologies used in solar agri-food dryers, highlighting their benefits and challenges. It also discusses the role of thermal energy storage in improving the efficiency and reliability of these drying systems. It highlights key innovations, challenges, and future opportunities in improving drying performance, energy efficiency, and cost-effectiveness. Ultimately, this review contributes to the understanding commercially and economically viable Agri-food products preservation solutions through energy efficient Solar Dryers. The findings aim to provide possible solutions with the noble objective of addressing food supply chain challenges.

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Abstract ID: ABS - 040

Effect of Exposed Area on Dye sensitized Solar Cell (DSSC) Performance

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Keywords

Current density(Jsc)
Open circuit voltage (Voc)
Power conversion efficiency (PCE)

Abstract

Solar energy is the most easily available green energy and treated as a source of renewable energy. Dye sensitized solar cell (DSSC) is one of the type of third generation solar cell that are easy fabrication, cost effective, efficient and environment friendly. DSSC efficiency is often reported with very little or no consideration of the cell area for which they are reported. Although the correct measurement of power conversion efficiency (PCE) and subsequently current density (Jsc), open circuit voltage (Voc) of DSSC should be conducted with masking as per the standard protocol, masking should be used carefully, especially for small area devices. In this work, we demonstrate that the cell area and the nature of masking also affect the reported efficiency. Two different kinds of cells have been fabricated in this work: large-area cells where the performance metrics are obtained by masking. Other kinds of cells are also produced in various active areas. A comparison of these two kinds of cells demonstrates that heavy cell masking should be avoided while reporting the cell efficiency and only edge masking is desirable. Overall, a 60 mm^2 or above cell must be used to avoid large uncertainty and area dependence on the reported efficiency. The best PCE obtained for 4 mm^2 aperture area based DSSC and 25 mm^2 active area based DSSC were 10.47% and 6.05% respectively. These results not only throw light on the correct estimation of PCE but also pave the way for the large area fabrication of devices.

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Abstract ID: ABS - 050

A Study on Land Suitability for Solar Power Plants in Jorhat District, Assam, India using GIS, AHP, and Multi-Criteria Decision Technique

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Keywords

Analytical Hierarchy Process
Multi-Criteria Evaluation
Weighted Overlay Analysis
Solar Power Plant
Jorhat District

Abstract

The global pursuit of renewable energy has gained urgency as fossil fuel reserves diminish and their role in exacerbating climate change becomes increasingly evident. Solar energy, one of the most abundant and eco-friendly renewable sources, offers substantial potential for growth due to its minimal technological demands and low environmental impact. This study focuses on identifying suitable locations for solar power plant installations in Jorhat District, Assam, India, utilizing a combination of Geographic Information System (GIS), Analytical Hierarchy Process (AHP), and Multi-Criteria Evaluation (MCE) techniques. Various parameters such as slope, elevation, solar radiation, proximity to power transmission lines, roads, buildings, water bodies, and earth surface temperature were assigned weights using the Weighted Overlay Analysis (WOA) in ArcGIS. The resultant land suitability map categorized the study area into four classes: unsuitable, less suitable, moderately suitable, and highly suitable for solar power plant development. The analysis indicated that 346.63 km² (18.88%) of the area is highly suitable for solar farm development, whereas 57.76 km² (3.15%) was deemed unsuitable. Among all parameters, solar radiation and proximity to power transmission lines emerged as the most influential. This research highlights the immense potential for solar energy expansion in Assam, providing valuable insights for government bodies, urban planners, and stakeholders in sustainable energy development. The study's outcomes offer strategic guidance for solar power plant placements, thus playing a crucial role in reducing carbon emissions and fostering a cleaner, more reliable energy supply for the region's population.

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Abstract ID: ABS - 052

Designing Fuel Cell Flow Path for Improved Power Performance

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Keywords

Power efficiency
Equipartition
Serpentine flow path
High-temperature fuel cell

Abstract

This study proposes a modified flow field arrangement of the fuel and oxidizer streams within a fuel cell stack to improve its energy efficiency at a fixed overall system size and fuel utilization. Different flow architectures for fuel cell stacks have been proposed in the literature to improve fuel distribution and liquid water removal. Here, we focus on controlling the electrochemical reactions to minimize exergy destruction through thermodynamic equipartitioning. The ideal equipartitioned operation of a fuel cell distributes current density optimally over the electrode area to minimize the overall entropy generation rate under constraints of fixed total system size, and current production. The condition for equipartition simplifies maintaining a uniform current density if the local resistance is approximately constant, or to a constant dissipation rate over the area if the local resistance is not a strong function of local current density. A modified two-pass flow field (serpentine) design is proposed to redistribute fuel and oxidizer to the neighbouring fuel cell before exiting the stack. This design results in a nearly uniform local current density distribution, even when operated under a fixed electric potential difference between the end electrodes. Considering high-temperature fuel cells, the proposed flow path design can achieve power enhancement of up to 90% of the theoretical enhancement possible under the equipartition limit. The power efficiency is improved by 4-10% compared to single pass design operated at constant voltage, with higher improvement at lower average current density.

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Abstract ID: ABS - 064

Performance and Degradation Analysis of 1.1 MWp Solar Photovoltaic Plant after 10 Years of Operation under Real Outdoor Conditions

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Keywords

Solar energy
Solar Power Plant
Photovoltaics
PV Syst
Sustainability
UNSDG

Abstract

The solar power generation has received a major thrust in recent years to achieve the targets of the United Nations Sustainable Development Goal-Energy for All (SDG-7). The Solar Photovoltaic (PV) technology has now become the most reliable and cost-competitive for electricity generation worldwide. It is important to analyze the performance of installed PV power plants at different locations to assess the performance, energy production, sustainability, and degradation of the technology. With this objective, performance analysis of 1.1MWp PV power plant operational for the last 10 years has been done in the present study using PV Syst. software using 10 years of real-time data. The degradation analysis of the solar power plant is carried out considering the state of PV modules, string inverters, cables, junction boxes, and the O&M methodology followed. The grid connected solar power plant was installed in 2012 as a captive power generation plant for the New Secretariat Building in Naya Raipur city of Chhattisgarh State, India. A total 4180 numbers of PV modules of 265Wp capacity each have been installed with 55 string inverters of 20KW capacity each. The study of power generation with seasonal variations reveals that customized systems design, selection of equipment, layout of the cables, synchronization of power plant with grid, and regular O&M activities reduce the effects of degradation of PV modules and other equipment, thus saving considerable conventional energy and government exchequer. Follow-up research areas have also been identified along with policy recommendations.

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Abstract ID: ABS - 072

Next-Generation Photovoltaics: Transparent Top Electrodes and Buffer Layer in Bifacial Perovskite Solar Cells

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Keywords

Bifacial perovskite solar cells
Transparent conductive electrode
Buffer layer

Abstract

Since the discovery of metal halide perovskites in 2009, researchers have achieved up to 25% efficiency in perovskite solar cells. These organic/inorganic metal halide perovskites are highly valued for next-generation photovoltaic technologies due to their potential for low cost, high performance, and ease of fabrication. Solar energy, with its promise of abundant, affordable power, benefits significantly from advancements in device architecture. One such innovation is bifacial perovskite solar cells (BPSCs), which capture light from both sides to enhance efficiency, utilizing a transparent top electrode. In our study, we employed Indium tin oxide (ITO) sputtered onto a meticulously controlled device structure (Glass/ITO/SnO_2/$MA_{0.9}AA_{0.1}PbI_3$/Li-Spiro/ITO/Au). This setup serves as an efficient transparent top-electrode for BPSCs, where the ITO layer provides over 90% transparency and low sheet resistance (68 ohm/sq). We explored suitable buffer layers, such as Au or MoOx, to minimize damage to the absorber layer from the sputtering process. The champion device achieved a power conversion efficiency of over 16%, with a short-circuit current density (J_{sc}) of 25 mA/cm² and an open-circuit voltage (V_{oc}) of 1.0 V. However, a low fill factor (FF) suggests that sputtering might damage the interface of underlying layers. Additionally, our BPSCs offer cost advantages over traditional monofacial PSCs. The same transparent electrode technology is being applied to the fabrication of tandem solar cells and flexible, stainless-steel-based solar cells. This research not only advances BPSCs but also has broad implications for the development of future photovoltaics.

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Abstract ID: ABS – 078 (II)

An Opportunity for Harnessing Hydro-Electric Power from Condenser Cooing Water System using Surface Hydro-Kinetic Turbine with/ without Adjustable Blade in a Thermal Power Plant

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Keywords

Power Plant
Mini-Hydro Turbine
Cooling Water System
CO2
Economic

Abstract

The current document suggests a possibility to generate hydro-electric power by combining a low head hydro turbine with an existing coal-based thermal power plant. A comparative analysis is conducted by comparing scenarios with and without adjustable moving blades on the hydro turbine. The findings demonstrate that incorporating a surface hydro-kinetic turbine system into the cooling water system of a 500 MW power plant can produce approximately 170 kWh of clean energy with a cooling water flow rate of around 16.7 m^3/s and a gross head of about 1.5 meter between the cooling tower (CT) and the cooling water (CW) basin. The efficiency of the hydro power plant with fixed moving blades is lower than that of the adjustable blades due to the reduced turbine efficiency at low flow velocities. This proposed system is expected to reduce the CO_2 emissions of the primary plant by approximately 3.34 /day. The power generation cost and the simple payback period for the proposed mini hydro project at full capacity are approximately INR 2.1/kWh and about 6 years, respectively.

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Abstract ID: ABS - 085

Application and Advantage of Novel Hybrid Technology in Manufacturing of Small Hydro Turbine

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Keywords

Hydro Turbine
Computational fluid dynamics (CFD)
Efficiency
Novel hybrid technology
3D printing

Abstract

Geometrical accuracy of the hydro turbine runners is one of the most critical contributors to the turbine performance, reliability and eventually to the capacity utilisation over the service life. However, achieving high degree of accuracy in runners of small hydro plants is challenging by conventional methods, due to their size limitations. This paper investigates the impact of manufacturing of runner of small hydro plants through conventional casting methods on its performance. To overcome the limitation posed by the conventional method, application of novel hybrid technology is explored employing both additive and casting technology. The impact of both the conventional and the proposed hybrid technologies are compared through Computational Fluid Dynamics (CFD) analysis and experimental study.

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Abstract ID: ABS - 089

Performance Analysis of Single PEM Fuel Cell with MEA of 5 cm²

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Keywords

PEMFC
MEA
Gas Diffusion Layer
Micro Porous Layer
Bipolar Plates

Abstract

Testing of single Proton Exchange Membrane Fuel Cell (PEMFC) gives promising future for the assembly of stack. Fabrication of PEMFC and its characterization indicates the moderate performance of a single fuel cell, based on which fuel cells' stack can be built up. Fabrication process of Membrane Electrode Assembly (MEA) is achieved by Hot Press Method and ensures the successful running and working of Fuel Cell. Effective Area of MEA of Fuel Cell is 5cm2, catalyst used is 20% Pt/C with Vulcan XC 72 carbon black. GDL allows transportation of the reactants onto the catalytic surface and also helps in removal of water at the Cathode. Gas Diffusion Layer with Micro Porous Layer paper is used as electrode substrate to deposit the Catalyst. Whereas, Nafion 212 is used as Proton Exchange Membrane and is sandwiched between GDLs. To provide the structural support to a single fuel cell, 10mm thick Graphite bipolar plates are used together with single serpentine flow channel for efficient gas distribution. For optimum functioning of fuel cell, flow rates of reactants; Hydrogen (H_2) and Oxygen (O_2) are carefully controlled at Anode and Cathode respectively. Current PEMFC is intended to manufacture and run small and compact units in near future by enhancing its performance. OCV is found to be 0.88 Volts, while Current Density is 0.0672 A/cm^2 and Power Density is 0.0403 W/cm^2 after conducting the trial for 5 hours period. Commercial viability of existing PEMFC will improve over a period of time and thus will result in its better performance after execution of further runs.

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Abstract ID: ABS – 096 (I)

Savonius Turbines with Endplates- A Review

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Keywords

Savonius
Endplates
Power coefficient

Abstract

Savonius turbines fall into the category of drag type turbines which uses the drag force for the rotation of blades. It is a kind of kinetic turbines that extracts energy from the free stream of wind or water into power. This is contrary to the others like Darrieus and axial, which works based on the principle of lift. The savonius turbines have less performance than lift based ones. But it comprises in its simple construction and cost effectiveness that makes it suitable for low-speed applications. The traditional savonius lacking endplates suffers from turbulence and causes less energy extraction. In the recent years the addition of endplates has proven to increase in the overall performance by overcoming the turbulence losses and increasing torque extracted. However, the variety of studies done on the endplates are significantly low comparing to other studies in savonius turbines. Hence, this literature review provides a comprehensive overview of the research conducted on Savonius turbines with end plates. Several studies on the design parametres such as shape and size of endplates are discussed. The detailed analysis indicates that a well-designed endplate can improve the efficiency and power output. This review paper highlights the potential of end plates to improve the performance and efficiency of Savonius turbines in wind and water applications.

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Abstract ID: ABS – 096 (II)

Savonius Hydrokinetic to Harness Energy from Marine Currents

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Keywords

Renewable energy
Tidal energy
Savonius turbine
Numerical analysis
Performance parameters

Abstract

This article presents the numerical investigation of the Savonius hydrokinetic turbine (SHKT). The literature has shown the effectiveness of SHKT for harnessing hydrokinetic energy. The various design parameters of the SHKT blade are presented experimentally. However, understanding the turbine's detailed transient performance and flow characteristics through experimentation requires more effort. The numerical model developed from the experimental study discusses this study's detailed transient performance and fluid flow analysis. A two-dimensional numerical model was studied using computational fluid dynamic software ANSYS Fluent 2019 R3. Pressure and velocity distribution are more uniform at higher rotational angles, resulting in minimum torque fluctuations. The turbine showed a maximum power coefficient of 0.283 at a 0.9 tip speed ratio.

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Abstract ID: ABS - 101

Design, Development and Thermal Testing of Inhouse Fabricated Mixed-mode Active Type Solar Dryer

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Keywords

Drying
Grapes
Moisture content
No-load performance index (NLPI)
Solar dryer

Abstract

Solar dryers are available in different sizes and designs to dry various products. Testing a solar dryer is essential to assess its performance comparatively with other dryers. The result obtained provides quite significant information for designers and users. An in-house constructed mixed-mode active-type solar dryer with two double pass solar air collectors connected in series, a dryer chamber with a tray, a 0.5 hp blower, and a 1.25 kVA solar off-grid combination is designed for this study. A general approach has been followed for thermal testing of an in-house fabricated mixed-mode active-type solar dryer under no-load conditions. Applying the heat balance concept of a solar dryer without load, a nondimensional parameter called the no-load performance index (NLPI) is computed. The results reveal that for a given particular airflow condition, the proposed parameter NLPI is more or less independent of absorbed thermal energy from solar radiations and the ambient air temperature and hence can be used for comparing different types of solar dryers. The average value of NLPI was 2.21, which is relatively higher than the NLPI values reported in the literature for other dryers. In addition, the dryer has been tested for drying seedless grapes. The moisture content of seedless grapes was reduced from 74% (w.b.) to 13.44% (w.b.) in just 31 hours in a solar dryer compared to 40.67% (w.b.) by open sun drying in the same duration of time. The proposed dryer will be suitable for small-scale farmers, and it can be scaled up to any size.

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Abstract ID: ABS - 104

A Self-Powered Voltage Booster for Enhancing the Voltage Output of Sediment Microbial Fuel Cells

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Keywords

Sediment Microbial fuel cells (SMFCs)
Power Management System (PMS)
Charge pump
Boost converter

Abstract

Sediment Microbial fuel cells (SMFCs) receive significant research interest for their excellent bioremediation and energy conversion processes. Moreover, uninterrupted energy production and bioremediation ability of SMFCs make them most sustainable in terms of energy recovery, cost efficacy, and also these systems require minimal maintenance. However, the energy conversion efficiency of these sustainable energy source requires substantial improvement for their usability in commercial applications. An efficient Power Management System (PMS) can assist these renewable energy sources to achieve real world applicability. The basic configuration of a PMS comprises a boost converter or a charge pump and a supercapacitor. The boost converter increases the voltage of the SMFC to a desired level and then stores the charge in a supercapacior, which is then fed to a load. The conventional boost converters are not efficient due to low power output of the SMFCs and hence require external power source for their operation. This study presents a novel approach to boost the voltage output from the SMFCs. The proposed boost converter is a self-powered boost converter constructed with ICL7660 charge pump ICs. A series of voltage-doubler configuration of the charge pump was utilized to increase the voltage output of the SMFCs by 4 fold with 95±2% efficiency. The ICL7660 is a charge pump IC that requires minimum input voltage of 1.5V to operate, and that was obtained by connecting two SMFCs in series. The voltage conversion ability of the booster circuit was tested for 30 days by intermittently charging and discharging a 0.47F supercapacitor.

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Abstract ID: ABS - 112

Analysis of Capacitance-Voltage Measurements for Majority carrier Depth Profiling of Phosphorus-doped Si nanowire

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Keywords

Differential capacitance-voltage
Spin-on-doping
Effective doping depth
Interstitial airgaps
Majority carrier concentration

Abstract

Doping depth profile measurement for Si is essential for determining junction depth, leakage current, threshold current, and overall device parameters. However, the widely used sophisticated approaches such as secondary ion mass spectroscopy and electrochemical capacitance-voltage (ECV) measurement are destructive techniques. Further, these techniques are not preferred for doping measurement of Si nanostructures, especially Si nanowires (SiNWs), due to complex multidimensional depth profiling. The work utilizes non-destructive majority-carrier depth profile analysis of the SiNW array using dry capacitance-voltage (CV) measurement and addresses the oxide layer and air-gap issues. A boron-doped p-type SiNW array was fabricated by pre-optimized metal-assisted chemical etching. SiNW array was doped with P by spin-on-doping (spin-coating of P-containing phosphosilicate glass sol-gel followed by annealing), varying the P-concentration. P-concentration was varied in the sol-gel by varying the P2O5 concentration as 1.25 mM, 2.5 mM, 5.0 mM, and 7.5 mM. The Hall effect measurement estimates the surface carrier concentration as a reference for the differential CV measurement. The analysis estimates an effective doping depth and corresponding majority carrier concentration for the SiNW arrays with different doping concentrations. Due to the interstitial air gap formed by the SiNWs and the metal electrode, differential CV analysis overestimates the doping concentration and underestimates the doping depth. The differential CV analysis estimates the majority carrier concentration as 7.7 × 1026 cm-3 with an effective doping depth of 5.4 nm for the SiNW array doped with a P_2O_5 concentration of 5 mM.

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Abstract ID: ABS - 125

p-Block-based NRR Electrocatalyst for Highly Selective Ammonia Synthesis

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Keywords

Ammonia
Electrocatalyst
Nitrogen reduction reaction
p-block elements

Abstract

Electrochemical nitrogen reduction reaction (ENRR) is a sustainable and renewable approach to ammonia production. It is regarded as a promising alternative to the conventional Haber-Bosch process, which operates under extreme temperature and pressure conditions and requires large amounts of energy to convert nitrogen to ammonia. Despite its potential, NRR faces a significant challenge of extremely low activity and selectivity due to issues in nitrogen adsorption and activation on the catalyst surface. The activation can be achieved by electron donation and back-donation between the unoccupied orbitals of the active catalyst material and the nitrogen π*-orbitals. The choice of the electrocatalyst is also critical to minimize side reactions such as hydrogen reduction reaction (HER) and hydrazine formation. While noble metals are costly, transition metals struggle with HER selectivity due to the d-orbital coupling with H s-orbital which compromises the NRR selectivity. p-block elements have an intrinsically poor binding ability to hydrogen, bringing them to the forefront as low-cost catalysts with an inherent ability to inhibit HER and thus improve NRR selectivity effectively. The current work focuses on exploring p-block based materials as a potential NRR electrocatalyst to improve nitrogen reduction to ammonia while limiting competitive HER. The work investigates the electrochemical performance of the prepared catalyst while quantifying the results in terms of ammonia yield and faradaic efficiency.

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Abstract ID: ABS - 129

Enabling the Formation of Active NiOOH Species by in-situ Electrochemical Activation of Urea Electro-Oxidation Pre-catalysts

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Keywords

Urea electrolysis
Pre-catalyst
Activation
In-situ spectroscopy
NiOOH
Complexes

Abstract

Urea electrooxidation reaction (UOR) has gained immense attention as a promising anodic process to complement the electrolytic hydrogen evolution reaction, offering a cost-effective method for hydrogen production. Despite extensive exploration of Ni-based catalysts for UOR, the potential of nickel coordination complexes remains unexplored, primarily due to their poor conductivity and instability in alkaline conditions. Interestingly, this instability facilitates the rapid transformation of these pre-catalysts into catalytically active species under applied anodic potentials. In this study, we introduce nickel hydrazine complexes as pre-catalysts for UOR, which, upon electrochemical activation, yield ultrapure NiOOH species—the true active species for UOR. To overcome the problem of poor conductivity, these complexes are incorporated into a multi-walled carbon nanotube (MWCNT) framework, significantly enhancing charge transfer characteristics and thereby boosting electrocatalytic performance. The activated catalysts demonstrate exceptional UOR activity, achieving a high current density of 120 mA/cm², a low Tafel slope of 22 mV/dec, increased electrochemically accessible surface area, high turnover frequency, and remarkable durability over 40 hours of continuous electrolysis. Employing in-situ X-ray Absorption Spectroscopy (XAS) and Raman Spectroscopy, we probe the electrochemical activation behaviour, identify the dynamic nature of the active species, and elucidate the operating electrocatalytic mechanisms. Post-activation and post-stability characterizations provide insights into the chemical transformation and fate of the active species formed. This work provides a comprehensive account of Ni-based coordination complexes as pre-catalysts, emphasizing their capability to in-situ generate catalytically active species with enhanced activity and stability, thereby advancing the field of UOR catalyst design and sustainable hydrogen production.

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Abstract ID: ABS – 131 (I)

Environmental-Safe Mobile Solar-Distillation Unit for Extraction of Essential Oil from Aromatic Crops: A Sustainable Technology

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Keywords

Essential oils
Distillation
Solar Energy
Aromatic Crops
Green House Gases
Environmental Sustainability

Abstract

Valuable essential oils are extracted from aromatic plants using several distillation methods, including hydro distillation, steam distillation, and conventional hydro-distillation. The conventional distillation method requires massive wood for steam production, leading to oil charring from uncontrolled heating and thus adversely affecting the environment by emitting greenhouse gases into the atmosphere. To address this environmental challenge and satisfy the existing energy requirements for distillation, a newly designed Mobile Solar Distillation Unit (MSDU) has been developed, utilizing renewable solar energy. This unit facilitates the extraction of essential oils from Mentha, Lemongrass, and Tulsi through steam generation at various locations, while minimizing operational costs and avoiding carbon emissions. The system comprises a hydraulic movable trolley, 21 solar panels (12.6 kW), a distillation unit, four heating elements (3 kW), a packed column, a condenser, and a newly designed oil receiver with a glass tube for enhanced visibility of the oil for farmers. The utilization of MSDU is significantly more effective than WDU, as it reduces the agricultural sector's dependency on fossil fuels and mitigates deforestation, hence protecting the ecosystem and reducing pollution. The yield of essential oil extracted from MSDU is of superior quality, as evaluated by GC-FID and GC-MS studies.

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Abstract ID: ABS – 131 (II)

Integrating Renewable Energy Solutions for Effective CO_2 Reduction: Pathways to a Sustainable Future

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Keywords

Aromatic Plants
Distillation
Low Carbon Emission
Technological Advancement
Renewable energy

Abstract

As atmospheric carbon dioxide (CO_2) levels continue to rise due to the burning of fossil fuels and industrial activities, the urgency to adopt sustainable solutions for CO_2 reduction becomes critical. This paper presents a comprehensive analysis of integrating renewable solar energy systems as a key approach to reduce the direct burning of wood in aromatic crops distillation operation strategy to address this CO2 challenge. Focusing on renewable energy transitions- such as the adoption of solar and advancement with conventional technology it highlights how these innovations can significantly curb CO_2 emissions. Additionally, the research explores complementary approaches including energy-efficient infrastructure, reforestation, carbon capture and sustainable agricultural practices. These solutions, combined with the promotion of circular economy models and policy-driven incentives like carbon pricing, represent a multifaceted approach to mitigating the impact of greenhouse gases. The paper underscores the role of education and public engagement in driving behavioral changes that support CO_2 reduction. Grounded in reports from leading global climate bodies such as the IPCC and IEA, this study offers a forward-looking framework for the integration of renewable energy solutions, aiming to chart a clear pathway towards a sustainable, low-carbon future.

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Abstract ID: ABS - 133

Flow and Heat Transfer Analyses in a U-Tube for Tubular Receiver Design

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Keywords

Tubular receiver
U-tube
Nusselt number
Secondary flow

Abstract

Solar energy is increasingly recognized as a key solution to global energy needs. Among solar thermal technologies, tubular receivers stand out for their potential in high-temperature applications, such as power generation. A key example is the cavity receiver, which utilizes a curved conduit in which fluid flow and heat transfer are similar to a U-tube. In U-tube configurations, fluid flow, and heat transfer are complex due to secondary flows caused by the imbalance between centrifugal forces and radial pressure gradients. These secondary flows enhance heat transfer by improving fluid mixing. Additionally, gravity plays a significant role in shaping the flow field, affecting temperature distribution and overall heat transfer performance. This study presents a numerical analysis of fluid flow and heat transfer in a U-tube, which is critical to the performance of heat exchangers and solar thermal systems. Simulations were performed with and without gravitational effects across a range of Reynolds numbers (Re) from 100 to 2000, comparing two working fluids: water and Therminol-66. Results show that for Therminol-66 at Re = 100, the average Nusselt number increases by 21% when gravitational forces are considered. However, at higher Reynolds numbers (Re $\geq$ 500), the influence of gravity on heat transfer becomes negligible. The study also highlights that fluids with higher Prandtl numbers exhibit more effective thermal mixing, especially in the curved sections of the U-tube, further enhancing heat transfer. These findings provide valuable insights for optimizing and the need for local Nusselt number correlation for U-tube designs in tubular receivers and other engineering applications where efficient heat transfer is essential.

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Abstract ID: ABS - 138

Energy Harvesting from Fluid Flow via Rotary Conversion of Flexible Foil-Induced Fluttering

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Keywords

Flexible foil
Energy harvesting
Wind

Abstract

Over the years, wind energy technology has seen remarkable progress, from conventional horizontal axis wind turbines to unconventional bladeless designs. The present research introduces a novel approach to energy extraction from fluid flow for electricity generation. In the experiment, we placed the flexible foil in the flowing fluid with its leading edge attached onto a circular cylinder, the trailing edge started to flutter. This fluttering motion was converted into rotary motion with the help of connecting rod and crank to generate electricity by attaching a generator. Experiments were conducted in a 40cm×30cm cross-section low-speed wind tunnel. Flexible foils with varying flexural rigidities were tested at various Reynolds numbers. Our investigation revealed that the trajectory of the trailing edge forms a distorted figure eight ('8'), similar to previous findings. To ensure smooth power generation, a part of the energy from the power stroke is stored in a flywheel and used in the idle stroke. The experimental results revealed that each foil has a specific range of Reynolds numbers within which sustained crank rotation is possible. To examine this phenomenon, smoke flow visualisation was conducted. The ongoing research aims to fully understand the fluid-structure interaction and the parameters that influence system optimisation for maximum energy harvesting potential.

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Abstract ID: ABS - 141

Insights into the Piezoresistive Behaviour of Woven Gas Diffusion Layers under Uniaxial Compression

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Keywords

Fuel Cell
Gas Diffusion Layer
Piezoresistivity

Abstract

Proton Exchange Membrane Fuel Cells (PEMFCs) rely on gas diffusion layers (GDLs) for efficient operation, facilitating gas diffusion, electron transfer, and water management. GDLs are composed of carbon fibres and are available in two forms: woven (carbon cloth) and nonwoven (carbon paper). Woven GDLs have a compact, uniform structure that makes them suitable for compact fuel cell assemblies and enhances catalyst deposition. Under compression, typically ranging from 40–60% strain, GDLs exhibit piezoresistive behaviour, where their electrical resistance decreases. However, this compression also reduces porosity, which can hinder gas diffusion. Thus, optimizing both electrical resistance and porosity is crucial for the efficient performance and longevity of fuel cells. This study examines the compression-induced piezoresistive behaviour of woven GDLs using X-ray micro-computed tomography (microCT) to analyse their 3D microstructure. Structural data from microCT scans was employed to develop a multiscale analytical model that predicts changes in electrical resistance across the GDL thickness under varying compression levels. The model treats yarns as parallel fibre bundles and considers changes in fibre volume fraction due to compression to estimate changes in fibre-fibre contacts at yarn interlacement points, which influences electrical resistance. Validation with commercially available woven GDL samples showed good agreement between the predicted and measured resistance changes. Consequently, this study elucidates the relationship between the 3D microstructure and the piezoresistive behaviour of woven GDLs, offering insights that can help optimize GDL design for improved PEMFC performance.

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Abstract ID: ABS - 142

Solar Radiation Forecasting using Optimized Extreme Gradient Boosting Algorithm

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Keywords

Grid stability
XGBoost
Ensemble model
Hyperparameter tuning

Abstract

Accurate solar radiation forecasting is essential for optimizing the efficiency and reliability of solar energy systems, enhancing grid stability, and minimizing operational costs. Despite advancements in this domain, several key research gaps persist. Many studies employing the XGBoost algorithm, an ensemble model, fail to fully explore its potential for performance enhancement through comprehensive hyperparameter tuning. Additionally, further evaluation is required to assess XGBoost's ability to manage complex, non-linear relationships and minimize overfitting. This study presents a machine learning approach to forecast hourly Global Horizontal Irradiance (GHI) for the cities of Gangtok and Jaipur in India using the XGBoost algorithm, recognized for its high predictive accuracy and capability to handle large datasets. Key features such as Solar Zenith Angle, Clearsky GHI, and Clear Sky Index, among others, were selected through Pearson correlation to improve prediction accuracy. The historical data utilized in this study was sourced from the National Renewable Energy Laboratory (NREL), encompassing the period from 2005 to 2014. The dataset was partitioned such that the years 2005 to 2012 were designated for training, 2013 for validation, and 2014 for testing purposes. The results achieved R^2 scores of 84% for Gangtok and 88% for Jaipur, with RMSE values of 100.10 W/m² and 82.10 W/m², respectively. This study underscores the potential of XGBoost in GHI prediction while highlighting opportunities for performance improvement through advanced decomposition techniques, pointing to the need for further research into model optimization for enhanced solar radiation forecasting.

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Abstract ID: ABS - 143

Numerical Simulation of Vortex-Induced Vibration of Two Rigidly Coupled Elliptical Cylinders in an Inline Arrangement

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Keywords

Vortex induced vibration
Inline elliptical cylinders
Effect of spacing
Energy extraction
Numerical simulation

Abstract

Renewable and clean energy sources are a prominent need to fulfil the energy requirements of the present world. Energy extraction from vortex-induced vibration of the bluff body is one such energy source. The power output from multiple bluff bodies in the fluid flow is better than a single bluff body due to wake-induced vibration. Still, two or more independently moving bodies will create complexity in the energy extraction system. In the present work, we are performing the numerical simulations to analyse the maximum amplitude of vibration and the width of lock-in region of two rigidly coupled identical elliptic cylinders (Aspect Ratio = minor axis/major axis = 0.4) arranged in inline arrangement, undergoing transverse (one-degree-of-freedom) vortex-induced vibration at low Reynolds number for a mass ratio 10 by employing a wide range of reduced velocities $2 \leq U_r \leq 11$ and spacing ratios $1.5 \leq L/D \leq 5$ at an interval of 0.5. The flow field Dimensionless incompressible Navier–Stokes equations are solved using the moving mesh method in the OpenFOAM® library. The maximum amplitude of vibration of the elliptical cylinders in the inline arrangement at a $L/D \geq 2$ is more in comparison to the single elliptical cylinder. The energy extraction from two elliptical cylinders is more than twice that from a single cylinder.

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Abstract ID: ABS - 148

Heat Flux Enhancement in Metal Halide Solar Simulators via Secondary Reflector based on Optical Arc Source Model

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Keywords

HFSS
Solar Thermal
Ray tracing
ANSYS SPEOS

Abstract

We present the optical modeling, design, and construction of a 6-kW metal halide lamp-based high-flux solar simulator module, developed for high-temperature applications such as thermochemical processes, including solar gasification of biomass and coal, and solar thermal material processing. Optical modeling was performed using ANSYS SPEOS 2021 software, exploring two arc source geometries: an elliptical arc source with a major diameter of 23 mm and a minor diameter of 10 mm, and a cylindrical arc source with hemispherical ends, featuring a 10 mm diameter and a 23 mm arc length. Radiation heat fluxes were calculated at a 60 mm diameter target plane. The arc source dimensions were optimized based on the optical model and validated through experimental measurements using a Medtherm heat flux transducer. The results showed a strong agreement between experimental and numerical peak heat fluxes, with deviations of less than 10% for both sources. Experimentally, the 6-kW lamp module achieved a peak heat flux of 255 kW/m², while simulations yielded peak heat fluxes of 271 kW/m² for the elliptical source and 238 kW/m² for the cylindrical source. Both numerical and experimental results identified the peak radiation heat flux at 150 mm above the secondary focal plane with the lamp vertically positioned. A conical secondary reflector was designed to enhance the heat flux, resulting in peak and average flux values of 2181 kW/m² and 793 kW/m², respectively, at the 60 mm target plane.

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Abstract ID: ABS - 151

Optimization of Helical Hydrokinetic Turbine via Supervised Learning Technique

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Keywords

Renewable energy
Helical turbine
Optimization
Numerical analysis
Artificial intelligence

Abstract

The increasing demand for renewable energy has prompted extensive research into optimizing hydrokinetic turbines, particularly those with helical designs. This paper presents a comprehensive study on optimizing helical hydrokinetic turbines using artificial intelligence (AI). The numerical investigation is done by solving the Unsteady-state Reynolds Averaged Navier-Stokes (URANS) equations to capture the transient fluid flow characteristics around the turbine. The base turbine, with a maximum power coefficient of 0.36, is the benchmark for this study. The optimization employs AI techniques to enhance the turbine's performance metrics, explicitly leveraging a neural network model. A detailed comparison between the base and optimized models will be presented, focusing on the fluid flow characteristics, including velocity fields, pressure distribution as predicted by the URANS solutions. The optimization is anticipated to reduce adverse flow phenomena such as separation and wake formation, thereby enhancing energy conversion efficiency. Moreover, the optimized model's performance will be assessed under varying operational conditions, such as changes in flow velocity and rotational speed, to evaluate its robustness and efficiency across different scenarios. This comparison will emphasize the intriguing improvements in fluid-structure interaction, a key technical advancement, and the overall increase in power extraction efficiency, demonstrating the potential of AI-driven optimization techniques in advancing the design of hydrokinetic turbines and contributing to the development of more efficient renewable energy systems.

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Abstract ID: ABS – 152 (I)

Techno-Economic and Environmental Analysis of Hybrid Energy Systems for Rural Areas: A Case Study in Sudan

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Keywords

Sustainability
Hybrid energy systems
Techno-economic analysis
Unelectrified site
HOMER
Sudan

Abstract

Hybrid energy systems provide a cost-effective and sustainable solution for remote communities when grid expansion is not economically viable. This study comprehensively evaluates the techno-economic and environmental performance of hybrid energy systems (HESs) in the unelectrified Diri and Umm Kardus villages in South Darfur, Sudan. Using HOMER Pro software, six systems designs were evaluated, combining conventional resources, particularly diesel, with renewable energy sources, such as solar and wind, alongside a battery storage solution. The hybrid system comprising a diesel generator, solar photovoltaic panels, wind turbine, and battery storage exhibited optimal cost-effectiveness at both locations, with a total net present cost (NPC) of 1.33 million and 3 million US dollars and a levelized cost of energy (LCOE) of 13.7 and 12.7 ¢/kWh. Additionally, it yielded the second lowest levels of unutilized energy at 26% and 25.1%, with annual CO2 emissions of 34.29 and 65.5 tons, respectively. The wind battery storage configuration was identified as the costliest arrangement, exhibiting an NPC of 2.63 and 6 million US dollars and an LCOE of 27.2 and 25.3 ¢/kWh while maintaining zero greenhouse gas emissions. The sensitivity analysis illustrates the effect of uncertainties in techno-economic parameters on the levelized cost of energy and the net present cost. The LCOE for utility diesel generators in Sudan is estimated at 22 cents per kilowatt-hour, indicating that hybrid systems with a lower LCOE may yield profitability. The findings may assist investors and policymakers in developing and implementing tailored energy solutions for unelectrified communities.

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Abstract ID: ABS - 156

Effects of Flow rate, Rotational speed and Load on the Power Output of Archimedes Screw Turbines for Ultra-Low Head Remote Power Generation

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Keywords

Hydropower
Archimedes screw turbine
Renewable energy
Ultra-low head
Clean energy

Abstract

The increasing global demand for renewable energy has driven significant interest in technologies capable of utilizing untapped hydropower resources, particularly at low-head sites. Within this context, the Archimedes screw turbine (AST) presents a promising solution, characterized by its simplicity, high efficiency in low-head conditions, and minimal environmental impact. The AST is ideally suited for low-head applications, typically ranging from 1 to 10 meters, and moderate flow rates. Its ability to operate efficiently under such conditions enhances its potential for decentralized, small-scale hydropower projects, providing a sustainable energy source. Furthermore, the turbine's low noise production and fish-friendly design underscore its environmental compatibility. This study focuses on the experimental investigation of AST performance, examining the effects of varying flow rates, rotational speeds, and applied loads on the turbine's power output. A series of full-scale experiments were conducted to optimize performance under different hydraulic conditions, with flow rates ranging from 3 to 15 litres per second, at a 35º installation angle and a 2-meter head. The fixed parameters include a diameter ratio of 0.47, a pitch of 0.295 meters, three blades, and a turbine length of 2 meters. Maximum power output of 255.54 watts was achieved at a flow rate of 15 litres per second, 142.3 RPM, and a load of 394.36 N. This research provides valuable insights into the potential of AST to contribute to global renewable energy objectives by enabling efficient, eco-friendly power generation at low-head sites.

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Abstract ID: ABS - 158

Design and Experimental Study on a Dual Stage Metal Hydride-Based Hydrogen Compressor Targeting Pressure up to 300 Bar

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Keywords

Hydrogen compression
Metal hydride
Thermal compressor

Abstract

This study presents the design, development, and experimental evaluation of an industrial-scale metal hydride-based hydrogen compression system. Operating in two stages, the system compresses hydrogen from 40 to 300 bar within a temperature range of 20–90°C, processing approximately 6200 L of hydrogen. The reactors, designed to withstand pressures up to 300 bar at 200 °C, utilize 19 SS316 seamless tubes, each facilitating the storage of 350 g of hydrogen. Two alloys, La0.5Ce0.5Ni4Fe and Ti0.8Zr0.2CrMn0.3Fe0.6Ni0.1, were selected for the two-stage compression process. During testing, hydrogen was compressed from 40 to 300 bar over 140 minutes. Stage 1 absorbed 300 g of hydrogen at 40 bar and 20°C, reaching 104 bar after heating to 90°C. Stage 2 absorbed hydrogen from Stage 1 at 5°C, with 275.1 g absorbed in 40.3 min. Upon heating to 92°C, the hydrogen was compressed to 300 bar. The compressed hydrogen was successfully transferred into Type-1 commercial cylinders, demonstrating the system's effectiveness for hydrogen refuelling applications. A single cylinder was refilled within 34.34 min, transferring 466.07 g of hydrogen. Energy analysis revealed that the system consumed only 3 MWh of thermal energy, all below 100°C, making it suitable for solar thermal integration. The system has been successfully commissioned at NTPC NETRA, Greater Noida, highlighting its practical application.

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Abstract ID: ABS - 162

A Statistical and Experimental Approach to Optimize the Parameters of an Undershot Water Wheel through Artificial Neural Network and Response Surface Methodology

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Keywords

Undershot water wheels
Renewable energy
Ultra-low head hydropower
Curved blades
Artificial neural network
Response surface method

Abstract

Undershot water wheels are best suited to install in the channels built alongside the perennial rivers. The water wheel utilises the kinetic energy of the flowing water and converts it in to shaft power, even at low water velocity. Thus makes it suitable for remote power generation applications, where installation of conventional grid powered supply lines are economical not feasible. The main focus of this study is to retrofit the existing water wheel to improve its performance by changing the design and number of blades. In this study, the performance of the undershot water wheels are evaluated using the scaled models of the existing water wheel and three new water wheels having 24, 36 and 48 numbers of curved profile blades for the variables such as the water flowrate and the number of blades. The lab scale experimental studies on these scaled models have revealed that irregular blade profile of the existing water wheel has significant effect on the performance of the water wheel. Also, the increase in the number of blades and flowrate suggests that the performance of the undershot water wheel detoriates after certain point, due the less space available for the flow and the induced drag in the wheel due to high flow rates. Statistical techniques such as response surface methodology and ANN are used to determine the optimum power point of the water wheel for the variable such as flowrate and the number of blades, resulting the blade numbers in the range of 41 to 42 and the water flowrate from 10.5 to 12.5 liters per second resulting optimum power between 3700- 3800 mW.

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Abstract ID: ABS - 165

Molecular Doping Approach Towards the Photoabsorption Enhancement of g-C_3N_4 analogues for Efficient Photocatalytic Water Splitting to Produce Clean H_2

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Keywords

g-C3N4
Hydrogen
Molecular Doping
Photocatalysis
Water Splitting

Abstract

With the swift depletion of non-renewable energy sources like fossil fuels, the race to meet the global demand for clean and sustainable energy sources present a staggering concern to the researcher fraternity all across the globe. Humans have tried to harness the solar power since a long time: the solar cell is one such device which can engross the solar energy for converting it into electrical energy. Moreover, researchers across the globe also intend to translate solar energy into chemical energy form like hydrogen, from photocatalytic splitting of water which has high calorific value as fuel and is clean by nature as well. Recently, Graphitic carbon nitride (g-C3N4) has stood up as a highly potent photocatalyst for artificial photosynthesis, primarily due to its high chemical and thermal stability, low toxicity, cost-effectiveness, visible light absorption capacity and ingeniously tunable synthetic routes as compared to other semiconductor platforms. Nevertheless, lower specific surface area, lesser electrical conductivity, fast recombination of photo triggered excitons and narrow visible light absorption window hinder the application of this catalytic material for practical photocatalytic utilization. To address the aforementioned issues and to modulate the photochemical and photophysical properties of g-C3N4, elemental as well as molecular doping has been a widely employed strategy. Pristine carbon nitride suffers from radiative recombination losses and the drawbacks related to the radiative recombination of pristine g-C3N4 can be mitigated by disrupting the regular triazine and heptazine repeat units, by introducing disordered zones in the framework by the use of carefully chosen non triazine based molecular precursors, or by using heteroatomic dopants.

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Abstract ID: ABS – 167 (I)

Sustainable Solar Based Cogeneration System for Rural Communities: Electrification and Cold Storage Solutions

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Keywords

Solar
Cogeneration
Rural Electrification
Organic Rankine Cycle
Cold Storage
COP
Efficiency

Abstract

Sustainable and locally relevant energy solutions are required due to the growing demand for electricity in rural regions and the need for effective post-harvest crop management. However, a number of villages in India's agriculturally wealthy regions experience ongoing power outages, and a large amount of vegetables are wasted because they must be preserved in open air or a hall. This study describes a solar-powered cogeneration system that combines the production of electricity through the Organic Rankine Cycle (ORC) with the cold storage of post-harvest vegetables using a vapour absorption system (VAS). For this detailed study, five villages with 1000 households have been chosen with adequate solar availability and a predominance of potato and tomato farming. Through the parabolic trough collector, thermal energy is utilized for electricity production via the Organic Rankine cycle, while the residual heat is efficiently recovered for use in the cold storage process. In order to achieve the required input heat of 914 kW, the solar trough collectors have been arranged in a rectangular array (8×2). The study also concentrates on improving the ORC's working fluid in order to boost system effectiveness. Findings show that the cogeneration system successfully provides the communities with the electricity and cooling they require, generating 148 kW of electricity with a power plant efficiency of 23.4% and a cooling system coefficient of performance (COP) of 0.54 with 64.57 kW cooling load. This environmentally friendly method emphasizes how solar energy may be a useful resource for post-harvest vegetable storage and rural electrification.

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Abstract ID: ABS – 170 (I)

Green Hydrogen Production through PEM Electrolyzer Integrated with a Polygeneration Cycle: A Life-Cycle Perspective

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Keywords

Green hydrogen
Polygeneration
LCA
PEM electrolyzer

Abstract

As the world transitions toward sustainable energy, green hydrogen emerges as a critical energy carrier due to its environmental benefits and compatibility with renewable energy sources. This study presents a Life-Cycle Assessment (LCA) of green hydrogen production using water splitting technology integrated with a polygeneration cycle, which enables simultaneous production of hydrogen and other utilities. By using solar energy to power Proton Exchange Membrane (PEM) electrolyzer, the study assesses both the environmental impact and energy efficiency of the proposed setup. Emphasis is placed on the Global Warming Potential (GWP) and Cumulative Energy Demand (CED), which offer insight into carbon emissions and the overall energy footprint across the life cycle stages. The integration of the polygeneration cycle with water splitting technology is analyzed to determine its potential in reducing environmental impact and enhancing resource utilization efficiency. Results suggest that this approach could significantly lower GWP while optimizing energy input, making it a viable path toward more sustainable hydrogen production. The findings hold promise for advancing green hydrogen production technology in alignment with global decarbonization goal.

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Abstract ID: ABS – 170 (II)

Techno Economic Analysis of Green Hydrogen Production towards a Net Zero University Campus

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Keywords

Green hydrogen
Techno economic analysis
Solar energy
Net zero campus

Abstract

As the world transitions towards cleaner energy sources, green hydrogen is poised to play a central role in reducing greenhouse gas emissions, with one of its key applications being fuel for hydrogen fuel cell vehicles (HFCVs). With an already established solar infrastructure, Aligarh Muslim University has played a leading role in the education sector of embracing and implementing clean sources of energy. This research aims to utilize the university's 3.2 MW solar farm and exploit excess solar energy to produce green hydrogen for the university campus, on the path of achieving net-zero campus. With erratic solar irradiation and varying consumption of electricity in the campus, there is a part of solar electricity which can be utilised exclusively to produce green hydrogen for powering official campus vehicles. This research aims to conduct a detailed techno economic analysis for the various green hydrogen production technologies comparing different types of fuel cells for the implementation on the university campus scale. Studying the consumption of hydrogen for official campus vehicles is also done, and the amount of carbon emissions abated in the process, is calculated. The study estimates that supporting the campus's official vehicle fleet with a PEM electrolyzer-based hydrogen infrastructure will require the production of 12.4 kg of H_2/day. To meet this demand, the university would need to install an electrolyzer with a capacity of 26.44 kW, involving an investment of approximately $50,000 to establish the green hydrogen infrastructure, which would lead to the abatement of approximately 3720 kg of carbon dioxide annually.

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Abstract ID: ABS - 172

Design and Simulation of a Metal Hydride Reactor for Providing Constant Flow of Hydrogen Required for the Fuel Cell

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Keywords

Metal hydride
Hydrogen
Hydrogen storage
Fuel cell

Abstract

Fuel cells are the emerging technology to be employed for future power generation, and hydrogen is the most well-known clean fuel of tomorrow. Hydrogen supply and storage are essential for the fuel cell's efficient operation. The present study focuses primarily on the design and simulation of a metal hydride reactor capable of providing a steady flow of hydrogen as a fuel for the fuel cell using COMSOL Multiphysics. This study investigated metal hydride reactor with and without fins. The reactor is filled with 20 kg of low-pressure LaNi5 metal hydride alloy. For investigating the reactor's hydrogen absorption performance, an absorption temperature of 25°C and a pressure of 20 bar is maintained. The desorption temperature is varied in the range of 25°C to 60°C, with 25°C representing room temperature and 60°C being the operating temperature of the PEM-fuel cell. In order to meet the hydrogen requirements of a 1 kW, 2 kW, and 3 kW fuel cell, the study's constant hydrogen flow rates were 13 lpm, 26 lpm, and 39 lpm. Under the identical desorption conditions, the reactor with fins desorbed more hydrogen than the reactor without fins. Increasing the desorption temperature allowed continuous hydrogen supply for a longer duration. Additionally, it was found that the reactor with fins could supply hydrogen at a constant flow rate for a longer period of time than the reactor without fins.

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Abstract ID: ABS - 196

Synthesis, Structural Characterization and Application of ZnS/GO Heterostructures for Photochemical, Electrochemical and Photoelectrochemical Hydrogen Evolution

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Keywords

Hydrogen Energy
Photochemical
Electrochemical
Heterojunction

Abstract

Proposing advancement in the applicability of ZnS/GO (ZG) heterogeneous nanostructures which were synthesized through simple hydrothermal and Hummers' methods as a cost-effective alternative to conventional noble metal-based catalytic systems, that are often prohibitively expensive. The investigation revealed that the ZnS/GO nanostructure outperformed pure ZnS in both structural integrity and catalytic efficiency. To broaden the application potential for sustainable hydrogen fuel, the ZG heterostructures were evaluated in photochemical, electrochemical, and photo-electrochemical water-splitting experiments. The concentration of ZnS on GO was varied across 5%, 10%, 20%, and 30% by weight, with 20 wt% ZnS/GO achieving the highest photocatalytic performance in H_2 production, as well as showing enhanced photo-current in PEC assessments. Electrochemical studies further underscored ZG's suitability as a hydrogen evolution reaction (HER) catalyst, demonstrating higher cathodic current density at lower potentials. The improved catalytic performance of the ZG heterostructures was attributed to the synergistic interaction between ZnS and GO, which facilitated the separation and movement of photo-induced charge carriers and reduced overpotential, ultimately accelerating the kinetics of H_2 evolution.

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Abstract ID: ABS - 209

Sensorless Field-Oriented Control of Variable-Speed Wind Turbine Generators Using Sliding-Mode Observer for Maximum Power Tracking

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Keywords

Field-Oriented Control (FOC)
Maximum Power Point Tracking (MPPT)
Renewable Energy Systems
Sensorless Control
Sliding-Mode Observer (SMO)
Variable-Speed Wind Turbine Generators

Abstract

In modern wind energy conversion system (WECS), variable-speed control is crucial for maximizing power capture under fluctuating wind conditions. This paper presents a sensorless field-oriented control (FOC) strategy for variable-speed wind turbine generators to enhance efficiency and reliability while reducing dependence on mechanical sensors. The proposed sensorless FOC strategy employs a sliding-mode observer (SMO) to estimate the rotor position in real time even under noisy and low-speed scenarios, enhancing the controller's reliability and accuracy. Furthermore, the sensorless FOC is cascaded with a speed controller, enabling adaptive control of the generator's operating point to track the maximum power point (MPP) in response to changing wind speeds. Additionally, the integrated maximum power point tracking (MPPT) algorithm adjusts the generator speed dynamically, ensuring optimal energy capture across a wide range of wind conditions. Simulation and experimental results validate the performance of the proposed sensorless FOC strategy, demonstrating fast transient response, precise MPP tracking, and efficient power output. Furthermore, simulation and experimental results revealed that the proposed sensorless FOC strategy offers a resilient, cost-effective solution for wind turbine applications by eliminating mechanical sensors, reducing maintenance needs, and providing stable operation across varying wind conditions. Moreover, the findings highlight the suitability of the proposed sensorless FOC for advanced wind energy systems that prioritize both performance and reliability.

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Abstract ID: ABS - 210

Performance Assessment of Forecasting Models for Renewable Energy and Demand Prediction

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Keywords

Energy Demand Forecasting
Forecasting Models
Predictive Accuracy
Solar Energy Forecasting
Statistical Models
Wind Energy Forecasting

Abstract

Forecasting energy demand and renewable energy generation is essential for efficient power system planning and grid stability, especially as renewable sources like wind and solar power continue to grow in penetration. This study presents a performance assessment of various forecasting models for predicting energy demand, wind energy, and solar energy outputs. The proposed analysis includes traditional statistical models and machine learning techniques such as Monte Carlo Simulation, Quasi Monte Carlo Simulation, linear regression, auto regressive integrated moving average (ARIMA), and seasonal auto regressive integrated moving average (SARIMA). Additionally, these forecasting models are evaluated for predictive accuracy, computational efficiency, and applicability across short-, medium-, and long-term forecasting. Results from this study reveal the strengths and limitations of each forecasting model/approach, offering guidance on model selection based on criteria such as forecast accuracy, computational demands, and data availability. Furthermore, this study identifies optimal strategies for each energy source through detailed case studies and performance metrics, thereby enhancing grid reliability and supporting informed decision-making for grid operators and energy planners. Moreover, these insights highlight the necessity for tailored forecasting approaches that address the uncertainty characteristics and challenges of renewable energy integration and demand variability.

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Abstract ID: ABS - 211

Insight of Multi Modular Microbial Fuel Cell Operated in Continuous mode using Cow Dung enriched Exoelectrogens

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Keywords

Microbial Fuel Cell(MFC)
Continuous mode
Hydraulic retention time (HRT)

Abstract

Sustainable energy production and wastewater treatments are the top priority in the developing global community. All the conventional wastewater treatment is usually the most energy-intensive unit process and required a mass amount of energy. Some of this energy can be recovered by using Microbial Fuel Cell (MFC) as a source of sustainable energy using either of low or negative economic value such as wastewater. Microbial fuel cells (MFCs) represent a new method for treating wastewaters and simultaneously producing electricity (renewable energy (bioelectricity)) as innovative technologies. In the present study, a litre-scale multi-modular microbial fuel cell was operated using exo-electrogenic inoculum enriched from cow-dung to produce bioelectricity. The reactor was operated in continuous mode under ambient condition at different hydraulic retention time (HRT). The maximum open circuit voltage (OCV) observed was 597 mV in module 5 at HRT of 5 mL/min, while an average of 510 mV voltage was observed for all the six modules. Additionally, 72% COD removal and 7.4% columbic efficiency was observed for the MFC under given set of operating conditions. From the LSV data, a maximum power density of 474.6 mW m-2 was derived at the current density of 2562.5 mA m-2 in module 2 at HRT of 5 mL/min. The electrochemical investigations of the MM-MFC suggested that the electrochemical metabolic rate was highest at low HRT while internal resistance was minimum, which resulted in maximum power generation.

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Abstract ID: ABS - 212

Phase Change Materials in Solar PV Thermal Management: A Systematic Review of Applications and Performance

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Keywords

Photovoltaic
Cooling Technologies
Phase Change Materials
Electrical Efficiency

Abstract

The growing global energy demand and environmental issues associated with fossil fuel usage have driven the adoption of renewable energy sources, predominantly solar energy. However, the operating temperature of photovoltaic (PV) cells has a considerable impact on the efficiency of solar PV systems. This paper provides a detailed overview of the various cooling techniques used to improve the performance of PV systems, with an emphasis on the use of phase change materials (PCMs). The working principle of PV cells and effect of temperature on their performance are discussed. The study categorizes cooling technologies into active and passive methods, providing a detailed analysis of each approach. The study emphasizes the potential of PCMs in PV thermal management due to their high latent heat capacity and ability to maintain a constant temperature during phase transition. The classification, selection criteria, and thermophysical properties of commonly used PCMs are presented. Furthermore, the study reviews the application of PCMs in PV thermal management, discussing numerical and experimental investigations conducted by researchers. The effects of PCM properties, ambient conditions, and PCM container design on PV-PCM system performance are highlighted. The integration of PCMs has been shown to reduce PV cell temperature by up to 72.4% at peak heat flux and improve electrical efficiency by up to 20%. The study also explores the use of fins, metallic foams, and nanoparticles to enhance heat transfer within PCM containers. Finally, the research indicates that a combined use of passive and active cooling technologies may successfully control PV cell temperature while improving overall system performance.

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Abstract ID: ABS - 216

Performance Evaluation of Droop Control and Virtual Synchronous Machine Control for Grid-Forming Converters in Renewable-Dominated Microgrids

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Keywords

Droop control
Grid-forming converters
Inertia emulation
Microgrids/power systems
Renewable energy integration
Virtual synchronous machine (VSM)

Abstract

The increasing penetration of renewable energy sources (RES) in modern power grids introduces significant challenges for grid stability and control. Unlike conventional synchronous generators, RESs are interfaced through power electronics that lack inherent inertia, which can lead to frequency instability, especially under high RES penetration scenarios. Grid-forming controllers have emerged as a potential solution, providing grid-supportive functionalities by mimicking synchronous generator characteristics. This paper evaluates the performance of two widely used grid-forming control methods: droop control and virtual synchronous machine (VSM) control. Droop control adjusts the power output based on frequency deviations, emulating the frequency droop behaviour of traditional synchronous machines, while the VSM control emulates the dynamics of a synchronous machine by providing virtual inertia and damping to the system. In this paper, a comparative analysis of both droop and VSM control strategies is conducted in a MATLAB/SIMULINK environment under various test scenarios including changes in power reference, grid voltage, frequency, phase, and faults. Key performance metrics such as active power, reactive power, output voltage, and output currents of grid-forming converter are evaluated to determine the suitability of each control method for maintaining grid stability. Furthermore, the results indicate that the droop control provides effective frequency support in steady-state conditions, while the VSM control offers superior transient stability due to its inertia-like behaviour. Moreover, this work provides insights into the optimal application scenarios for droop and VSM controls, contributing to the design of robust grid-forming inverters for future renewable-dominated microgrids and power systems.

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Abstract ID: ABS - 219

Exploring Liquid Ammonia as a Carbon-Neutral Fuel: Combustion Characteristics, Challenges, and Future Directions in Engine Applications

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Keywords

Carbon-neutral fuel
Liquid Ammonia combustion
Internal combustion engines
Ammonia Slip
Decarbonization
Emissions

Abstract

Liquid ammonia has now come out to be a carbon-neutral fuel, at the top of the urgent requirement for decarbonizing the global energy sector. This paper reviews comprehensively the present state of knowledge on combustion of liquid ammonia in SI, CI, and marine engines. It brings in the intrinsic combustion attributes of ammonia with regard to the energy density, flammability limits, ignition, and emissions profile in relation to the conventional fossil-based fuels. The paper discusses deeper aspects of special characteristics in the combustion of ammonia with its low reactivity, toxicity, corrosive behaviour, and specially developed engines, including safety factors associated with them. We discuss these challenges along with their impact on engine performance, efficiency, and emission levels, but with greater focus on SI, CI, and marine applications. Another direction of emerging solutions that have been investigated and suggested as future research directions toward overcoming these challenges include using dual-fuel strategies and ammonia cracking, with advanced ignition systems. Our review attempts to detail the technical and strategic work that needs to be built so that ammonia can be more fully released as carbon-neutral fuel towards supporting decarbonization in the world's energy mix.

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Abstract ID: ABS - 220

Effect of Injector Hole Variation on the Performance of Hydrogen-Powered Single-Cylinder Engines Using Numerical Simulation

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Keywords

Injector modification
Hole number variation
Hydrogen
Spray atomization
Emissions reduction

Abstract

To enhance combustion and emission outcomes in hydrogen-powered engines, injector designs have been modified by varying the number of injector holes. This study employs numerical simulations on a single-cylinder engine model to assess how these variations impact combustion behavior and spray characteristics. Changes in the number of holes significantly influence spray atomization, fuel-air mixing efficiency, and flame spread, all of which are essential for improving combustion performance and reducing emissions. Simulation results indicate that increasing the hole number enhances atomization and reduces spray penetration depth, enabling faster and more uniform fuel-air mixing. This improved mixing contributes to a more stable combustion process, potentially reducing NOx emissions and increasing thermal efficiency. The study provides valuable insights into how different hole configurations affect spray penetration, droplet size distribution, and combustion temperature fields within a single-cylinder environment. These findings emphasize the role of injector design in achieving cleaner and more efficient hydrogen combustion, underscoring hydrogen's potential as a sustainable fuel. This work contributes to advancing high-efficiency, low-emission engine technology by optimizing injector configurations.

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Abstract ID: ABS - 225

Modelling and Optimizing Machine Tool Operations for Sustainable Manufacturing: A Petri Net Approach to Carbon Emission Reduction

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Keywords

Sustainability
Carbon emission
Petri net

Abstract

This research presents a novel methodology for enhancing the sustainability of machine tool operations through the application of Petri nets. Leveraging the mathematical modelling capabilities of Petri nets, the study systematically analyses the dynamic behaviour of machine tool systems, identifying bottlenecks, inefficiencies, and areas of high carbon emissions. Carbon emission factors are integrated into the Petri net model, allowing for a quantitative assessment of the environmental impact associated with each process. Simulation results provide insights into the efficiency of the system, enabling the formulation of optimization strategies to minimize carbon emissions. The study demonstrates how the Petri net model serves as a powerful tool for ongoing monitoring, reporting, and the quantification of achieved reductions in carbon emissions. The proposed approach offers a systematic and adaptable framework for decision-makers in manufacturing to enhance sustainability while maintaining operational efficiency.

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Abstract ID: ABS - 231

A Correlation between the Interfacial Charge Transfer and Reusability of a $MoSe_2$/Activated Biocarbon Heterostructure for Wastewater Treatment

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Keywords

Molybdenum diselenide ($MoSe_2$)
Activated biocarbon
Heterostructured photocatalyst
Photocatalytic dye degradation
Wastewater treatment

Abstract

Surface and interface engineering has been proven to be an essential strategy for designing more advanced photocatalysts with enhanced photocatalytic activity. Activated biocarbon derived from sugarcane bagasse (SB-C) was used as a supporting substrate with Molybdenum diselenide ($MoSe_2$) to design the heterostructure photocatalyst to improve charge separation and interface charge transfer. Compared to individual MoSe2 and SB-C components, the SB-C/$MoSe_2$ heterojunctions demonstrated a significantly enhanced ability to degrade organic pollutants under visible light irradiation, achieving a rate of 97.17% under 20 min of visible light irradiation. This remarkable capability is driven by efficient interfacial charge transfer, a larger electrochemical surface area of 5402.85 cm^2, a lower band gap energy of 2.38 eV, and a reduced recombination rate of electron-hole pairs. A first-order kinetic model sufficiently elucidates the photodegradation mechanism, as revealed by a kinetic study. Moreover, the photocatalytic activity of the SB-C/$MoSe_2$ heterostructure remained consistently effective even after undergoing four cycles of use, indicating its excellent stability. In addition, the experiments on radical trapping showcased the significant involvement of major active species, such as O_2•- and •OH, in the photocatalytic process. These results suggested the potential for developing a highly effective heterostructure photocatalyst suitable for treating industrial wastewater by harnessing visible-light-driven photocatalytic activity.

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Abstract ID: ABS - 235

Boosting Performance of Inverted A-FAPI Perovskite Solar Cells from Redissolution of Pure Phase Bulk Crystal Powder

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Keywords

Inverted PSCs
Interface quality
Perovskite crystal powder

Abstract

In the realm of perovskite solar cells, formamidinium lead iodide (FAPbI3) is a promising photoactive material due to its optimal bandgap and good thermal stability. The n-i-p (regular) configuration has seen efficiencies over 25%, but the p-i-n (inverted) configuration, despite its advantages like scalability and flexibility, has struggled to exceed 23% efficiency. Inverted p–i–n PSCs have potential applications in tandems, and excellent stability against moisture, however, their performance is still low because of the hole transport layer and unfavourable interface contacts in the p-i-n configuration. Improving these aspects could help bridge the efficiency gap between the two configurations. Herein, the HTL/FAPI interface quality is improved by stabilizing $\boldsymbol{\alpha}$-phase FAPbI3 using bulk crystal powder which serve as the high-purity precursor to fabricate perovskite films. This strategy facilitates direct $\boldsymbol{\alpha}$-phase formation and inhibits the complex intermediate phases. The resulting crystal powder-based perovskite film exhibited large grain size and minimal defects, leading to PSCs with an impressive power conversion efficiency (PCE) of 17.5 %, an open-circuit voltage of 0.97 V, and the fill-factor of 76%. Encouragingly, the crystal powder-based PSCs demonstrated enhanced reproducibility and storage stability.

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Abstract ID: ABS - 258

Machine Learning and Organic Solar Cell: A Growing Synergy

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Keywords

Organic solar cell
Machine learning
RDKit descriptors

Abstract

Recent development of novel conjugated polymer donor and non-fullerene acceptor (NFA) materials with promising properties have led to an unprecedented rise in the power conversion efficiency (PCE) of organic solar cells (OSCs) by more than 19%. However, in this era of artificial intelligence, identifying the highly potential combinations of such donor and acceptor materials using the current trial-and-error experimental approaches is certainly not feasible. Herein, we effectively predicted and screened the performance of OSCs based on various polymer: NFA combinations by employing a data-driven machine learning (ML) approach and successively validated this predictivity by fabricating a set of highly efficient devices with a PCE up to 15.23%. A dataset of 1242 experimentally verified donor:acceptor (D/A) combinations was constructed, and the corresponding material descriptors were generated to train and test five different supervised ML models. Using a unique combination of both frontier molecular orbital (FMO) and RDKit descriptors as input features, the random forest ML model performed best for predicting the PCE with a Person's coefficient (r) of 0.791 and a mean absolute percentage error of 2.004. On the other hand, the gradient-boosting ML model showed a substantially improved performance for the prediction of both J_SC and V_OC with high r values of 0.842 and 0.862, respectively. Furthermore, the importance of critical RDKit descriptors along with FMO descriptors in such performance predictions was realized by SHapley Additive exPlanations (SHAP) analyses. Therefore, the proposed ML framework guided by these new descriptors will be indeed fruitful for designing new molecules and screening and predicting suitable D/A combinations, to accelerate the development of highly efficient OSCs.

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Abstract ID: ABS - 262

Optimizing Charge Transfer in Ternary Organic Solar Cells for Low Energy Loss and High Efficiency

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Keywords

Ternary blend
Charge transfer
Energy loss

Abstract

The structural disorder and aggregation of the third acceptor with the host active layer are critical in the light absorption, film morphology, and charge carrier mechanism of their photovoltaic blends to achieve highly efficient organic solar cells (OSCs). However, an effective third component needs to be introduced in the host binary blend as a combination of ternary blend, which can improve the absorption profile, film morphology, and charge dynamics. In this work, non-fullerene acceptor DRCTF is incorporated as a third component in host PM6:Y6 binary blend. Compared to host blend, the ternary blend improves charge transfer processes, which evident by steady-state photoluminescence and time-resolved photoluminescence measurements. It is found that when addition of 20% DRCTF into host binary blend results in facilitating charge dissociation with reducing recombination and voltage loss. All these characteristics contributed to an improved power conversion efficiency of 14.45% in the PM6:Y6:DRCTF ternary OSCs (T-OSCs), compared to PM6:Y6 (12.46 %) in open-air fabrication conditions. Consequently, this study elucidated the impact of third components on the charge transfer mechanism in T-OSCs. These findings suggested, T-OSCs with a perfectly chosen third component in the host binary blend achieve a comprehensive absorption profile, smooth film morphology, efficient charge dynamics, and reduced voltage loss.

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Abstract ID: ABS - 263

Electrical Behaviour of Ni/NiO Core Shell Nanoparticle Dispersed in PVA Matrix

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Keywords

Conductance
Ni/NiO
Dielectric properties

Abstract

This study investigates the electrical properties and morphology of Ni/NiO core cell nano-particles. In this work, we synthesized Nickel-nickel oxide (Ni/NiO) core-shell nanoparticles by a bottom-up approach via the sol-gel method, followed by annealing under ambient conditions. The material was simply dispersed in polyvinyl alcohol (PVA) solution, with one sample dried at room temperature under a static magnetic and another without magnetic field. Thermal gravimetric analyses (TGA) show thermal stability up to 600℃, while UV-Vis analysis revealed the optical bandgap. The observed behavior of electronic conductivities of the sample is increasing with temperature. This work compares the electrical behaviour of the material in different mediums and emphasizes the importance of understanding the relationship between morphology and electrical properties to optimize the material's performance in various technological applications.

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Abstract ID: ABS - 273

Catalyst Design and Optimization for Methane-to-Hydrogen Conversion Using $FeCo/Al_2O_3$

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Keywords

Catalytic decomposition of methane
Hydrogen
$FeCo/Al_2O_3$ catalyst

Abstract

Catalytic decomposition of methane is a promising route for producing hydrogen and carbon nanotubes (CNT). This study is focused on optimizing CNT yield using an iron-cobalt supported on alumina catalyst ($Fe\text{-}Co/Al_2O_3$). We investigated the effects of methane partial pressure, reaction temperature, and Fe-Co bimetallic composition on hydrogen and CNT production. A quadratic polynomial model was developed using Design Expert software to predict the optimal conditions for methane cracking, maximizing hydrogen yield. Response surface methodology was employed to conduct a series of experiments, resulting in the identification of the ideal reaction parameters for achieving the highest hydrogen production. It was found that Fe-Co metal ratio of 90:10 yielded the highest hydrogen production at 710°C and 0.7 atm CH4. Characterization techniques (XRD, BET, Raman, HRTEM, FESEM-EDX) revealed the formation of various CNT structures under optimal conditions. These findings offer valuable insights for the development of more efficient catalysts for sustainable methane cracking processes to produce hydrogen and CNT.

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Abstract ID: ABS - 305

Nickel based Single Atom Electrocatalyst For Catalysing Water Splitting Reaction To Produce Green Hydrogen

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Keywords

Electrocatalyst
Green hydrogen
Electrolysis

Abstract

One solution to the problem of global warming can be the use of hydrogen gas as an energy source because hydrogen is a fascinating energy carrier. Hydrogen, the most common chemical element, does not exist on planet in free form. Therefore, numerous methods have been devised to derive this efficient energy carrier. Hydrogen, derived by any technique, is the cleanest source of energy but either its production method itself need some energy input and also evolve some sort of polluting footprints such as carbon dioxide, or the sources, from which hydrogen is derived are not sustainable meaning that even if hydrogen is used as sole energy source it can no longer be a solution to the problem of global warming. One way to address this issue is to use water electrolysis technique for hydrogen production in which water dissociates into H_2 and O_2 with help of applied voltage and electrocatalyst. Owing to the use of input voltage and electrocatalyst, the water electrolysis technique becomes less cost competitive as compared to other methods of hydrogen production. So, the researchers of energy terrain are working at their level best to improve the overall performance of electrolysis. Here, we are producing hydrogen by the methods of electrolysis in which, an electrolyser with two electrodes immersed in electrolyte solution, acts as hydrogen producing unit. The energy input to catalyse the water splitting for hydrogen production is provided through solar energy. The only factor left for adding high cost to the hydrogen production is electrocatalysts, for which we have fabricated Ni based single atom electrocatalysts and the resulted catalysts is capable of producing hydrogen at lower voltage as compared to other reported catalysts. It has also demonstrated significantly low overpotential to achieve high current densities.

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THEME

Energy - Materials, Storage, Transmission, Distribution & Policies, e-Mobility

Abstract ID: ABS - 016

Techno-Economic Feasibility of Solar and Wind Hybrid Adiabatic Compressed Air Energy Storage System for 20% of the Electricity Demand of 2030 in India

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Keywords

Adiabatic compressed air energy storage system
Electricity demand
Net present value
Solar generation
Unmet demand
Wind generation

Abstract

India needs to enhance its electricity grid to support the integration of 500 GW of solar and wind generators by 2030. A hybrid grid-scale energy storage system will therefore, be essential for balancing the increasing electricity demand while maintaining grid stability. Thus, the primary aim of this manuscript is to determine the optimal over-generation capacity, minimum net present value and unit-dispatch schedule necessary to develop a grid-scale solar and wind hybrid adiabatic compressed air energy storage system (ACAESS) in India, which would meet 20% of the country's electricity demand from 2028 to 2030. The paper's novelty lies in its methodology, which uses the criteria that the total unmet demand has to be less than or equal to 100 GW. The required data set for electricity demand of 2028-2030 is acquired by compounding annually the demand data of 2021-2023 at 7.18% through 2026-28 and then by 5.79% till 2028-2030. The solar and wind generation dataset is obtained by compounding the 2021-2023 data annually at 20% till 2028-2030. The generation cost in 2028-2030 is assumed to be 5 INR/kWh. The results show that a minimum over-generation of 50.82% and a minimum cost of 11.26 INR/kWh is required if a 5000 GWh ACAESS is integrated with India's solar and wind energy generation for satisfying 20% of India’s electricity demand of 2028-2030 which would have a net present value of 9079.80 bn INR. This research can assist policymakers for shaping energy policies in India and worldwide for supporting net-zero emission goals of the future.

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Abstract ID: ABS - 022

Pumped Thermal Energy Storage System for Clean Energy Applications

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Keywords

PTES
Waste Energy Source
Round Trip efficiency
COP

Abstract

In the current scenario of the world, due to the severe issue of global warming and greenhouse emissions, researchers are focusing on renewable sources of energy for power production, but large-scale storage of energy is required to ensure the balance between supply and demand. However, due to the intermittency in availability of the renewable sources (solar, wind, etc.) of energy, the storage of produced energy become the most important issue to ensure the balance between energy supply and demand. In the current world, mostly applied large-scale electricity storage technologies consist of pumped hydro energy storage (PHES), liquid air energy storage (LAES), compressed air energy storage (CAES), and electrochemical energy storage systems such as lithium-ion battery. But the above systems having limitations due to geographical and material availability. A pumped thermal electricity storage (PTES) system is one of the most promising large-scale energy storage systems with high energy density and low cost per unit storage, however independent of the geographical and cost limitations such as with pumped hydro energy, compressed air, liquid air, and thermochemical (battery) storage. This analysis presents the comparative results from a numerical evaluation of an Organic Rankine cycle base-pumped thermal energy storage and thermally integrated pumped thermal energy storage system. The numerical results of the thermally integrated PTES system showed a better round-trip efficiency of 69.4% compared to the PTES without thermal integration at a storage temperature of 130°C.

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Abstract ID: ABS - 026

PVDF-BCZT Composite Film-Based Self-Charging Flexible Symmetric Piezoelectric-Supercapacitor for Wearable Electronics

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Keywords

Self-charging
Energy harvesting
Energy storing
Wearable electronics

Abstract

Designing and fabrication of environment-friendly, compact, and wearable devices that synchronously harvest and store energy, in-situ, is highly desirable to design modern electronics. Here, we report the fabrication of PVDF-BCZT composite film-based self-charging flexible symmetric piezoelectric-supercapacitor (SCPSC) using MoS2-carbon black (CB) as electrodes and PVA-KOH as gel-electrolyte. Poly-vinylidene fluoride-0.5Ba (Zr0.2 Ti0.8) O3-0.5 (Ba0.7Ca0.3) TiO3 (PVDF-BCT-BZT) porous piezoelectric composite separator was used for converting mechanical energy to electrical energy which is subsequently used to charge the supercapacitor. Cyclic voltammetry, galvanostatic charge-discharge, and electrochemical impedance measurements were employed to characterize the present SCPSC. The self-charging capability of the device was demonstrated by mechanical deformation under finger tapping. The present SCPSC was charged up to 1.8 V with finger tapping. The stability of the device was shown under continuous charge-discharge for up to 200 cycles under a dynamic compressive force.

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Abstract ID: ABS – 047 (II)

Significance of E-rickshaw as Intermittent Public Transport Supporting Major Public Transport Accessibility in Nagpur Metropolitan City

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Keywords

Public Transport
Accessibility
PT Catchment Area
E Mobility
E Rickshaw
Sustainable Development

Abstract

E-mobility is a sustainable alternative solution to provide accessibility to commuters. Nagpur metropolitan city in central India has older bus and newer metro public transport networks that connect the city areas. Both of these are complemented by intermittent public transports like taxis, auto rickshaws, and e-rickshaws. The rickshaw, commonly called Maxi, is an intermittent non-motorized public transport vehicle increasing its count hurriedly and catering to the socio-environmental and economic necessities of the urban settlements. This paper attempts to identify the provisions for e-rickshaw mobility, its charging, and parking points to equip Nagpur maha-metro riders' movement. The study of seven metro station catchment areas was done for evaluating the E-rickshaw infrastructure provisions to add to public transport accessibility and increase E mobility for low-income, elderly, and children users in Nagpur. The physical study observes no or little provisions. The users' survey marked the need for provisions of pickup and drop-up points with safety and security to give them confidence in crowds and congested zones. On interviewing the metro and urban local authorities, it was noticed that the thought for e-rickshaw infrastructure provisions throughout the city area was not considered, and metro planners concentrated on the station area only. The study was concluded with an understanding of the significant role of e-rickshaws in public transport accessibility to users and making recommendations for e-rickshaw facilities promoting economic and environmental solutions and provisioning spaces for its infrastructure development, thereby increasing e-rickshaw usage towards sustainable development.

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Abstract ID: ABS - 051

The Critical Role of Al_2O_3, $BaTiO_3$ and ZrO_2 Nanoceramic Fillers in PVDF-HFP based Composite Polymer Electrolytes for High Performance Lithium-Metal Batteries

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Keywords

Composite polymer electrolytes
Lithium-metal batteries
Inorganic fillers
Dendrite growth
Ionic conductivity
Surface charge

Abstract

Lithium metal batteries (LMBs) are at the forefront of energy storage research, offering significantly higher energy density than traditional lithium-ion batteries. Lithium metal, with its high theoretical capacity (3860 mAh/g) and lowest electrochemical potential (-3.04 V vs. SHE), is considered as the ultimate anode material for future battery technologies. However, the commercialization of LMBs faces several challenges, such as lithium dendrite growth, low cycle life, and safety concerns, primarily due to the limitations of traditional liquid electrolytes. To address these issues, the development of composite polymer electrolytes (CPEs) has emerged as a promising approach. In this study, Al_2O_3, $BaTiO_3$, and ZrO_2-based CPEs are developed by an easy-to-scale-up solution casting method. The optimized concentrations of inorganic ceramic fillers are incorporated into PVDF-HFP/LiTFSI matrix to enhance the ionic conductivity, mechanical stability, and electrochemical performance. The room temperature ionic conductivities of the CPEs are found to be 0.29×10-4 Scm-1 for Al2O3, 0.23×10-4 Scm-1 for BaTiO3, 0.93×10-4 Scm-1 for ZrO2 and 0.09×10-4 Scm-1 without ceramics. Extensive electrochemical studies reveal that CPEs with inorganic fillers exhibited stable lithium stripping-plating behaviour for over 500 hours. Notably, the ZrO_2-based CPE showed the lowest polarization loss, higher Li+ transport number, and excellent full cell performance. The overall performances of CPEs may be attributed to the nature of deposition of the ceramic nanoparticles on the polymer matrix and their mutual interaction, which is influenced by their surface charges and Lewis acid-base characteristics. Thus, this study offers a promising pathway for developing robust and safe CPEs for next-generation solid-state LMBs.

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Abstract ID: ABS - 065

Experimental Assessment of Cost Effective Highly Reliable Phase Change Material for Low Temperature Applications

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Keywords

Phase Change Material (PCM)
Thermal Energy Storage (TES)
Temperature
Reliability

Abstract

Thermal energy storage (TES) has become a pivotal technique for enhancing the efficiency of solar thermal systems. Solar thermal technologies rely on sunshine, Thermal energy storage technique retains surplus heat and cold for the continuous application of energy generated from renewable sources. Integrating thermal energy storage with solar thermal systems enhances their operational efficiency by guaranteeing heat availability across a broad temperature spectrum. There are three distinct categories of thermal energy storage technologies: sensible, latent, and thermochemical. Fundamental characteristics, including melting and solidification temperatures, heat storage capacity, non-corrosiveness, cost-effectiveness, and little volumetric change during phase transitions, are critical for selecting the optimal material for thermal storage. Nonetheless, successive thermal cycles (heating and cooling) will result in thermal and physical deterioration of the PCM, affecting the efficacy of the TES system. The objective of the study is to create phase change material characterized by excellent thermal stability, substantial heat storage capacity, thermal reliability, and cost-effectiveness for low-temperature (30-50°C) thermal energy storage applications. This study examines the thermal reliability of paraffin wax blended with several proportions of coconut oil (0wt%, 20wt%, 40wt%, and 60wt%) to create a low-temperature phase change material. Each ratio underwent 50, 100, 150, and 200 heat cycles. Paraffin wax, devoid of coconut oil, also underwent same thermal cycle testing for comparison. The thermal characteristics of these eutectics were assessed via Differential Scanning Calorimetry (DSC) for heat storage capacity, Thermogravimetric Analysis (TGA) for thermal degradation, and Fourier Transform Infrared Spectroscopy (FTIR) for chemical stability.

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Abstract ID: ABS - 067

Room Temperature Magnetoelectric Behavior in Photoferroic Co-SbSi Chalcohalide System

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Keywords

Photo-induced dielectric spectroscopy
Photo-induced magnetization
Magnetoelectric material

Abstract

Photo-induced magnetic and electric properties in magnetoelectric materials enable the tuning of photovoltaic properties with the manipulation of electric and magnetic field via stain interaction (photostriction). Here, photo-excitation leads to an increase in spin concentration of a magnetic system, causing the magnetic transition and triggers a variety of dynamical processes viz. magnetization reversal of spin. Significant experimental effort has been explored to characterize the optically assisted charge transfer of the magnetic and transport properties in transition element doped chalcogenide system composed of 1.0 mol% Co-SbSI nanorods. A non-disperse ferroelectric-like anomaly is observed Tc ~ 320 K, which concomitantly support the subtle magnetic ordering from isothermal magnetization-field sweeps (M vs. H). The observation of external magnetic field (~ 5 tesla) dependence dielectric response shows a noticeable increase in permittivity values, indicating a positive magnetodielectric response, which is seen in the vicinity of room temperature with the magnetodielectric ratio of 12% @30 kHz. The linearity of $-\Delta\varepsilon'(H)\%$ vs. M2 plot is phenomenologically described with the Ginzburg-Landau theory with the magnetoelectric coupling term $\gamma P2M2$. Finally, photo-induced dielectric enhancement under magnetic field is observed signifying the cross coupling between multiple functionalities like ferroelectric (P), ferromagnetic (M), and ferroelastic (ε). Elasto-optic phenomenon due to magnetic spin or the control of magnetic properties by photostriction is accompanied by the spin direction of electron which can strongly disturb the equilibrium between the mobile carriers (holes) and the lattice.

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Abstract ID: ABS - 068

Advanced Thermal Characterization of Rubitherm RT35 Melting Dynamics in a Horizontally Configured Energy Storage System with Eccentric Linear Heat Source

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Keywords

Rubitherm RT35
Thermal energy storage
Phase change material
Natural convection
Latent heat

Abstract

This study investigates the melting behaviour of Rubitherm RT35, a phase change material (PCM) with a melting point of ~35°C, in a horizontal shell-and-tube thermal energy storage system with an eccentrically positioned linear heat source. Rubitherm RT35 is commonly used in applications like solar thermal systems, waste heat recovery, and heating/cooling systems due to its ability to absorb, store, and release heat during phase transitions. The focus is on how the eccentric placement of the heat source—offset from the center of the shell—affects melting patterns, heat transfer efficiency, and the complete melting time. Eccentric positioning creates asymmetrical heat distribution, leading to faster melting near the heat source and slower melting in peripheral areas. Both conduction and convection influence the melting process, with eccentricity altering the dominance of each mode in different regions of the PCM. Buoyancy-driven convection currents in the liquid phase further impact the melting rate. A numerical analysis was conducted on three cases, with the heat transfer fluid (HTF) tube located at different positions relative to the shell's center. In Case 1, the tube was centered; in Cases 2 and 3, the tube was positioned below the central axis at distances of $1.5D_i$ and $3D_i$, respectively. After six hours of continuous heat dissipation, the melt fractions were 56.28%, 52.18%, and 70.25% for Cases 1, 2, and 3. The melt fraction contour highlights the liquid-solid interface, providing key insights for optimizing thermal energy storage system designs. These results can help reduce heat storage costs by informing better design choices for high-capacity systems.

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Abstract ID: ABS - 069

Transparent Concrete Using Glass Sphere in Roof Slab

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Keywords

Transparent Concrete
Optical Fibre
Glass Sphere
Daylight
Sustainable Development

Abstract

In India, the percentage of middle-class individuals is 31%; which expected to increase in future. This people prefer to buy less expensive plot based on their income. Due to rapid urbanisation, such plots are available mostly in slums, where people forced to share a common wall with their neighbours on both sides of the house which restrict the positioning of windows ultimately obstructing the daylight within the house. The lack of day-lighting results in higher electricity usage, which is seen as an important parameter of sustainable development. One way to get around this issue is to use transparent concrete having the optical fiber, a light-transmitting fiber, as a main constituent. Transparent walls as models for their investigations were discussed by the majority of researchers. A transparent roof slab constructed with optical fiber has certain limitations, such as the need for trained workers, the cost of the fiber, the quantity of fibers required in relation to the percentage of day-lighting required, which ultimately affect strength of concrete etc. This study suggests replacing optical fiber with a transparent glass sphere whose diameter is slightly larger than the thickness of the roof slab in order to get around these limitations. An experimental model has been created, to test the performance of glass sphere as a replacement for optical fibers, in terms of privacy, seepage, and solar transmission when cast into roof slabs.The project is expected to shed light on feasibility of the glass sphere in terms of achieving the goal of sustainable development.

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Abstract ID: ABS - 095

Biopolymer-derived Quasi-solid Electrolytes Comprising of Ionically-crosslinked Chitosan Hydrogels for Application in EDLCs

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Keywords

Hydrogel Membrane Electrolyte
Ionic crosslinking
Electrical Double Layer Capacitor

Abstract

Hydrogels are three-dimensional quasi-solid porous polymeric materials that absorb large quantities of water within their polymeric networks. Hydrogels are formed through self-assembly of precursor molecules via physical, covalent, or ionic cross-linking. Hydrogels containing dissolved electrolytes serve as quasi-solid electrolytes in energy devices, such as, electrical double-layer capacitors (EDLCs). In this work, surface-crosslinked chitosan hydrogel membrane electrolytes (SCHMEs) have been prepared by ionically crosslinking chitosan with varying concentrations of sodium carbonate (Na_2CO_3) and tested in EDLCs. SCHMEs prepared with 0.5 M Na_2CO_3 crosslinker (SCHME-0.5M) and 3 M Na_2CO_3 crosslinker (SCHME-3M) have been studied. SCHME-0.5M and SCHME-3M possess tensile strengths of 41.22 and 44.34 MPa, respectively. The SCHME prepared with 0.5 M Na_2CO_3 as the crosslinker has been found to be optimum, which has exhibited a water uptake of 112 % and an ionic conductivity of 3.73×10^{-4} S cm^{-1}. As revealed by LSV study, both the SCHMEs possess an electrochemical stability window of 0-2.1 V. SCHME-0.5M and SCHME-3M possess ion transference numbers of 0.983 and 0.969, respectively, which indicates the dominant role of ionic charge carriers. The EDLCs employing SCHME-0.5M and SCHME-3M have exhibited areal capacitances of 299.40 and 181 mF cm^{-2}, respectively, and charge-discharge cycle lives of 57,000 and 26,000 at 1 mA cm^{-2}, respectively. The EDLCs have been demonstrated to power an LED bulb.

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Abstract ID: ABS - 102

LLZO-Incorporated Duo-polymer based Composite Electrolyte: Boosting Critical Current Density and Long-term Stability for Solid-State Metal Batteries

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Keywords

Composite solid polymer electrolyte
Solid electrolyte
Solid-state battery
Ionic conductivity
Critical current density
Li dendrite growth

Abstract

The focus of advanced energy storage is now shifting towards high-performance metal batteries. While lithium-ion batteries (LIBs) have succeeded commercially with liquid electrolytes, they compromise on safety, energy and power densities. The main challenge is the inability to use lithium metal anodes, despite their high capacity of 3860 mAh.g-1. Achieving functional all-solid-state lithium metal batteries remains difficult due to issues with solid electrolytes and electrodes compatibility. In this scenario, composite solid polymer electrolytes (CSPEs) which generally combine the advantages of polymer and ceramic electrolytes are ideal candidates for metal batteries, offering flexibility, safety, stability, high ionic conductivity and compatibility with lithium metal. In this work, we developed a novel Duo-polymer (PVDF-HFP/PEO)/ Li6.25La3Ga0.25Zr2O12(LLGZO) CSPE using an easily scalable solution casting method. Firstly, the PVDF-HFP matrix provides mechanical robustness through its vinylidene fluoride and hexafluoropropylene units. Secondly, the PEO copolymer reduces the crystallinity of the polymer matrix, enhancing ionic conductivity. Thirdly, synthesized LLGZO acts as an active ceramic filler, aiding in the decomposition of LiTFSI and creating a fast Li+ transport pathway. Among the various concentrations of LLGZO in CSPE, 10 wt% of the ceramic filler delivers the highest lithium-ion conductivity of 1.08×10-4 S.cm-1 at room temperature and the lowest activation energy of 0.32 eV. Comprehensive electrochemical characterizations suggest that the developed CSPE with 10 wt% LLGZO demonstrates high critical current density (>1 mA.cm-2), long-term stability (>1000 hours), and excellent cycling performance. Thus, the compiled data suggest that the PVDF-HFP/PEO/LLGZO CSPE is a highly promising candidate for the development of metal batteries.

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Abstract ID: ABS - 105

α-MoO3 Rods as Electrode Materials: Synthesis, Characterization, and their Energy Storage Performance

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Keywords

α-MoO_3 rods
Supercapacitors
Hydrothermal
Synthesis
Energy density

Abstract

This work aims to explore the synthesis of α-MoO3 rods for their application as electrode material in supercapacitors. The α-MoO_3 rods were successfully synthesized using a hydrothermal method and investigated their potential for supercapacitor applications. X-ray diffraction (XRD) and Raman spectroscopy measurements were used to confirm the formation of a single-phase orthorhombic structure of α-MoO3. The optical band gap of the synthesized material was found to be 4.7 eV. Scanning electron microscopy (SEM) revealed that the synthesized rods have an average length of 2.6 µm and a width of 0.26 µm. The electrochemical performance of the material was evaluated by fabricating an electrode on Ni foam substrate using a slurry of the synthesized material. Cyclic voltammetry (CV) measurements displayed two distinct redox peaks, indicating the pseudocapacitive nature of the material. The CV curves remained stable even at higher scan rates, reflecting the electrode's excellent stability. Galvanostatic charge-discharge (GCD) analysis yielded a specific capacitance (SC) of 270 F/g at a current density of 1 A/g. Electrochemical impedance spectroscopy (EIS) further demonstrated a low charge transfer resistance, indicating good conductivity and efficient ion transport. The synthesized α-MoO_3 rods revealed excellent pseudocapacitive behaviour, high specific capacitance, and good stability, making them promising candidates for supercapacitor electrode applications. Their low charge transfer resistance and efficient ion transport further highlight their potential application in energy storage devices.

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Abstract ID: ABS - 111

Constructing Interfacial Bond Modulated Direct Z-Scheme Heterostructure by Enwrapping Cu_2SnS_3 Quantum Dots on BiOCl Nanosheets for Efficient Photocatalytic H_2 Generation

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Keywords

Z-scheme heterojunction
Photocatalytic H_2 production
Photoelectrochemical properties
Internal electric field
Interfacial bond
Charge transfer

Abstract

The advancement of photocatalysis technology for solar-driven hydrogen (H2) production remains hindered by significant challenges in designing and synthesizing highly efficient photocatalysts. These photocatalysts must achieve higher drift velocity of photoinduced carriers and effective harnessing of visible light. Herein, BiOCl/Cu2SnS3 (BCTS) heterostructure was synthesized by loading Cu2SnS3 (CTS) quantum dots (QDs) onto BiOCl 2D nanosheets which demonstrated excellent photocatalytic activity under visible light irradiation due to higher absorption of visible light. Notably, an improved photocatalytic H2 generation is owing to the interfacial Bi-S bond and internal electric field at the interface of BiOCl and CTS which facilitated a direct Z-scheme charge transfer pathway. The optimized BCTS heterostructure showed photogenerated charge injection and separation efficiencies of 80.20% and 26.74%, respectively. Under the intense synergy between Bi-S bond and interfacial electric field, the optimized BCTS heterostructure exhibited higher hydrogen evolution rate of ~ 8.27 mmol. g^{-1}. h^{-1} with 83% apparent quantum yield which was ~ 5-fold higher than the pristine BiOCl. This work demonstrates a unique approach to modifying direct Z-scheme charge transfer by using internal electric field and interfacial nanoscale-level bonding, resulting in significantly enhancement of photocatalytic performance and showcasing the potential of QDs based heterostructures for solar water splitting.

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Abstract ID: ABS - 113

Solid-State Synthesis of Titanium Carbonitride via Metastable Precursors for Energy Storage Applications

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Keywords

Solid-state reactions
Metastable precursor
Sodium-ion battery
Asymmetric supercapacitor

Abstract

Solid-state reactions are a facile synthetic procedure for synthesizing nanomaterials. However, the kinetics and feasibility of solid-state reactions are influenced by several factors, such as precursors selection, reaction conditions, structural properties of the reactants, and thermodynamic free energy. In this context, metastable precursors present a viable pathway for synthesizing the nanomaterials to overcome thermodynamic limitations, enabling the formation of products that would otherwise be challenging to produce using commercial precursors. Titanium carbonitride (TCN), known for its cubic crystal structure, exhibits excellent chemical, thermal, and mechanical properties, making it a promising candidate for electrode materials in energy storage. However, traditional synthesis techniques like mechanical alloying, carbothermal nitridation, and arc discharge are constrained by high reaction temperatures, prolonged processing times, excessive energy consumption, and difficulty in controlling the carbon-to-nitrogen ratio, which limits their suitability for large-scale industrial production. In this study, TCN was synthesized using a titanium-melamine (Ti-Mel) precursor. We evaluated TCN in sodium-ion batteries (Na-ion batteries) for the first time, achieving a specific capacity of 150 mAh/g at 0.1 A/g and 90 mAh/g at 1 A/g. TCN also showed 95% capacity retention after 3000 cycles with 100% coulombic efficiency at 0.5 A/g. Additionally, we explored TCN for asymmetric supercapacitors with nickel cobalt hydroxide (NCO-LDH), where the solid-state device reached 265 mF/cm² at 10 mA/cm² in PVA-KOH-KI gel, operating within a 1.4 V potential window. Overall, this work highlighted TCN's potential as an electrode material for energy storage applications.

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Abstract ID: ABS - 114

Catalytic Engineering of Bismuth Vanadate-Cerium Vanadate Composite to Yield a Bifunctional Photocatalyst for Simultaneous Energy Generation and Pollutant Degradation

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Keywords

Photocatalytic hydrogen generation
Dye degradation
Cerium vanadate
Bismuth vanadate

Abstract

Simultaneous hydrogen evolution and pollutant degradation via photocatalysis offer a promising approach for sustainable environmental and energy solutions, though challenges such as high charge carrier recombination and low light efficiency persist. Bismuth vanadate (BV) is a promising photocatalyst but faces charge recombination issues. On the other hand, cerium vanadate (CV) possesses lower band gap and can form better heterojunction with BV due to their similar crystal structures, consequently reducing the recombination rates with improved optical absorbance. In this study, a CV-BV composite synthesized via a simple hydrothermal method is exploited for achieving simultaneous hydrogen evolution and pollutant degradation from water. Though BV is capable of degrading the pollutant, it is not effective in hydrogen evolution. However, CV-BV system has achieved a notable hydrogen evolution rate of 1011 $\mu mol \bullet h^{-1} \bullet g^{-1}$ and 98% degradation of methyl orange (MO). Additionally, CV-BV system maintained a consistent rate of hydrogen evolution and pollutant degradation across four consecutive runs, demonstrating the material's good stability. Trapping experiments using specific scavengers revealed that superoxide radicals are the most significant in degrading MO, followed by electrons and hydroxyl radicals. For hydrogen production, the CV-BV composite absorbs a broad light spectrum, generating electron-hole pairs and electrons in conduction band of CV react with H+ to produce H_2, in presence of hole scavenger. Although individual vanadates have been studied for water splitting and degradation, the combined CV-BV system demonstrates remarkable efficiency in both hydrogen evolution and pollutant degradation, paving the way for advancements in photocatalytic applications.

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Abstract ID: ABS - 115

Synthesis of WSe_2@PANI Nanocomposite for Asymmetric Supercapacitor Device Application

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Keywords

Hydrothermal
WSe2@PANI
Electrode
Supercapacitor

Abstract

The necessity for robust, flexible, and lightweight portable energy storage devices has arisen due to the quick growth of intelligent, wearable, and small electronic equipment. In the changing era of modern electronics and renewable energy, the energy storage materials find many applications in hybrid electric vehicles, portable electronic and wearable device. Transition metal dichalcogenides (TMDs) (e.g., $MoSe_2$, MoS_2, WSe_2, WS2, and WTe_2) having 1D and 2D layered structures had been studied as promising materials for supercapacitor application. WSe_2 has layered structure and also has a higher electrical conductivity compared to MoS_2, $MoSe_2$, and WS_2. In the present study, we have synthesized binary composite of WSe_2@PANI by one-step hydrothermal method. The structural and morphological characterizations of prepared WSe_2@PANI is done by using X-ray diffraction (XRD) and scanning electron microscopy (SEM) measurements. The XRD patterns confirm the formation of binary composite of WSe_2@PANI. The specific capacitance (SC) of WSe_2@PANI electrode as calculated form CV curves at different scan rates turns out to be 800 F/g, at scan rate of 10 mV/s, in 3M KOH electrolyte with optimal cycling stability. Our WS_2@PANI binary nanocomposite is anticipated to be a promising option for energy storage devices.

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Abstract ID: ABS - 116

Micro-Nanostructured Co_3O_4 as an Anode for Lithium-ion Batteries

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Keywords

Micro-/nanostructured
Co3O4
Anode
Lithium-ion batteries
Rate capability
Cyclic stability

Abstract

Co_3O_4, has been considered a promising anode material in lithium-ion batteries (LIBs), an alternative to graphite because of its high theoretical specific capacity. However, its poor conductivity, short diffusion length and significant volume changes during the lithiation and delithiation process hamper its rate capabilities and cycling stability, hindering its usage as an anode in LIBs. To address these issues, many synthetic strategies such as elemental doping, surface coating, composites with carbon or graphene and heterostructures have been extensively explored. In this work, a micro-/nanostructured Co_3O_4 has been suitably designed to overcome the above-mentioned limitations by using a simple generic template approach. The physiochemical characteristics of Co3O4 have been investigated using various microscopic and spectroscopic techniques. The enhanced rate capabilities and cycling stability of the conversion-based anode without the need for any carbon support or composite could be attributed to the obtained micro-/nanostructuring. The as-synthesized micro-/nanostructured Co_3O_4 exhibited high-rate capabilities, delivering capacities of 615.4 and 239 mAh g-1 at current densities of 0.1 A g-1 at 5 A g-1 respectively. Further, the retention of a capacity of 590 mAh g-1 at 0.5 A g-1 for 800 cycles demonstrates its superior cycling stability. Even at a higher rate of 1 A g-1 and higher mass loading of 1.44 mg cm-2 at 0.5 A g-1, the anode exhibits a stable capacity of ~380 mAh g-1 for over 800 and 600 cycles, respectively. It is noteworthy that the significant capacitive component contributes to the rapid reaction kinetics, providing exceptional stability to the anode.

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Abstract ID: ABS - 117

Electrochemical Modelling and Numerical Investigation of Lithium-Ion Cell with Double-Layer Composite Phase Change Material (CPCM) and Finned Heat Sink

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Keywords

Battery thermal management system (BTMS)
Phase change material (PCM)
Composite phase change material (CPCM)

Abstract

The evolution of battery technology has been instrumental in powering numerous modern applications, from portable electronics to electric vehicles and space applications. In addition to the efficiency and lifespan of batteries, thermal management is a very crucial aspect during design as well as in operation. Phase change materials (PCMs), being a passive way of thermal management, are emerging as very effective solutions. Additionally, fins are also used as heat sinks in order to enhance effectiveness during thermal exchange. Due to extreme variation in environmental conditions, the Battery Thermal Management System (BTMS) is used either for hot or for cold climatic conditions, though a single system for both the conditions is also essentially required for the environment like India. In the present work, 3D-coupled electrochemical-thermal modelling is done for an NCA 18650 cylindrical cell having a nominal capacity of 2.9 Ah. The study also proposes a BTMS consisting of novel double-layer composite phase change material (CPCM) with finned heat sink. The purpose of the double layer is to lower the battery temperature to the desired range under high temperature climatic conditions while avoiding temperature loss under low temperature climatic conditions. Numerical simulation was carried out in COMSOL Multi-physics 6.2. The study also presents the effect of varying the C-rate (1-5), the PCM materials (paraffin wax, Eicosane, Tetracosane, PO, POE10, double layer CPCM), the fin number (2 plate fins, 4 plate fins), the fin thickness (1-4 mm), and the effect of variation of inclination angle. The investigation shows an increase in the performance of BTMS and hence better battery life.

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Abstract ID: ABS - 126

Metal Hydride Based Composite Material (Catalyst and Metal Hydride) for On-Board Hydrogen Generation and Storage

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Keywords

Metal hydride
Catalyst
Composite materials
Cyclic studies

Abstract

Metal hydrides ($LiAlH_4$) have long been recognized as a viable material for storing hydrogen due to a theoretically large gravimetric H2 capacity (10.6 wt %). The hydrogen absorption/desorption process is very slow and requires a suitable catalyst. The composite material integrating a catalyst with a metal hydride is synthesized to enhance hydrogen generation and storage. The catalyst accelerates the reaction kinetics, enabling faster hydrogen release at lower temperatures and storing high-density hydrogen. A series of composite materials (Catalyst/$LiAlH_4$, Catalyst: 15CaO-85TiO_2) were synthesized by the Facile solution approach. The synthesized materials were investigated for thermolysis-based hydrogen generation and storage at low pressures (1 bar, 5 bar, 10 bar, 20 bar and 30 bar) and temperature considering a high-pressure reactor. X-ray diffraction (XRD), thermogravimetry differential thermal analysis (TG-DTA), Raman spectroscopy, and Fourier transform infrared spectroscopy (FTIR) were used to characterize the composite materials. The composite material 10(15CaO-85TiO2)/LiAlH4 (~5.97 wt %) generated a significantly higher amount of hydrogen as compared to the pure LiAlH4 (~1.29 wt %) at 100 oC temperature and 1 bar pressure. System pressure plays a crucial role in hydrogen absorption and desorption during the storage and cyclic studies. The study suggested that elevating the system pressure improves the hydrogen storage capacity, and it was 150 °C/1 bar for desorption and 150 °C/30 bar for hydrogen absorption. The composite material released ~5.97 wt% hydrogen in 1st desorption, and ~1.9 wt% hydrogen in 30 minutes upto10 cycles.

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Abstract ID: ABS - 128

Spatio Temporal Analysis of Green Spaces for Energy Conservation: Case Study of Pune

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Keywords

Urban green spaces
Urban Heat Island (UHI)
Energy conservation

Abstract

In this century climate change is the most serious problem that people are facing. One of the main reasons for climate change is rapid urbanization which results in Urban heat island (UHI). Urban green spaces play a crucial role in mitigating the urban heat island effect, improving air quality, and enhancing energy efficiency. This study investigates the spatio temporal dynamics of green spaces of urban areas of Pune city located in Maharashtra, India. In Pune, rapid urbanization has led to significant loss of green spaces decreasing them from 18 sq km between 1992 and 2001 and a further 52.6 square kilometers from 2001 to 2013. This reduction has intensified the UHI effect in the city thus increasing the temperature by 2.99°C over the last decade. Pune now has only 1.4 square meters of green space per capita, which is far below the WHO's recommended 9 square meters. This study utilizes multi-temporal Landsat data from 1998, 2008 and 2018 alongside GIS techniques to analyse spatial and temporal changes in Pune's land surface temperature and green space distribution. It explores the corelation between green spaces and energy consumption, emphasizing the UHI effects contribution to 5-10% demand for cooling. It estimates that each 1°C temperature rise increases energy consumption by 3-6%. Study models will be used to analyse the same. Recommendations include integrating green infrastructure into urban planning policies and further give sustainable solutions for energy conservation wrt to green spaces and quantify long term benefits. The findings underscore the critical role of green spaces in mitigating UHI effects, reducing energy demand and improving air quality. The results highlight the potential for urban greenery to generate energy savings, contributing to the sustainability and livability of cities like Pune.

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Abstract ID: ABS - 135

Improvement of Electrochemical Performances of Zr4+ Doped Sodium Manganese Oxide as Cathode Material for Sodium Ion Battery

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Keywords

Sodium-ion batteries
Cathode materials
Sodium manganese oxide

Abstract

Sodium ion batteries are one of the most promising alternatives to lithium-ion batteries primarily due to the high abundance of sodium on the earth's crust. A large number of sodium manganese oxides have been proven to be good cathode materials for sodium-ion batteries. Owning to their various structures corresponding to the stoichiometry of sodium, manganese, and oxygen, they exhibit different ion insertion-extraction mechanisms. In this work, $Na_4Mn_{2-x}Zr_xO_5$ (x=0.1) was prepared by a sol-gel assisted solid-state method followed by a detailed investigation of their electrochemical performances as a cathode material for sodium-ion battery. The pristine $Na_4Mn_2O_5$ has structural instability due to the presence of Mn^{3+} and suffers from poor electrochemical performance with poor cycling stability. After doping it with Zr^{4+}, the electrochemical performance improves remarkably. The initial discharge capacity of Na_4Mn_2-xZrxO_5 was 245 mA h g-1, which retains to 82.8% after 250 cycles, delivering a capacity of 203 mA h g-1 at a current rate of 0.05 mA g-1. Besides the material yields a great initial columbic efficiency (ICE) of 97.6%. Moreover, at a higher current rate of 0.5 mA g-1, it offers a great capacity of 142 mA h g-1 even after 500 cycles with a capacity retention rate of 76.7%. The significant improvement of the doped material $Na_4Mn_{2-x}Zr_xO_5$ as compared to the pristine material is due to the substitution of Mn^{3+} with Zr^{4+} which mitigates the Jahn-Teller distortion providing structural stability. The DFT calculations have satisfactorily support this explanation.

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Abstract ID: ABS - 139

Thermoelectric Conversion Potential of 1D Van der Waals AlPS4 Atomic Chain Structures

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Keywords

AlPS4
Atomic chains
Electron-phonon transport
Charge-density-wave
Thermoelectrics
DFT

Abstract

Electronic thermoelectric materials offer promising potential for converting waste heat into electricity, addressing the significant loss of nearly two-thirds of generated energy as heat. However, current thermoelectric technologies face challenges related to low efficiency and reliance on rare, toxic, and expensive elements such as selenium, tellurium, lead, and bismuth for optimal performance. To overcome these limitations, interest in low-dimensional systems—especially 1D van der Waals atomic chains—has recently gained traction for enhancing thermoelectric performance by engineering electron and phonon transport. This work focuses on the thermoelectric potential and transport properties of orthogonal- and parallel-stacked 1D van der Waals AlPS4 atomic chains, composed of earth-abundant and environmentally benign elements, using ab initio density functional theory (DFT) calculations. The AlPS4 structures exhibit in-plane Seebeck coefficients ranging from ~1.58 to 0.2 mV K−1 for carrier concentrations of 1012 to 1021 cm−3 at temperatures of 300 to 600 K. The maximum power factor is ~1.5 to 2 mW m−1 K−2, and the lattice thermal conductivity is below ~0.15 W m−1 K−1. The notable power factor and ultralow lattice thermal conductivity are attributed to high electronic state densities at the band edges, quantum confinement effects, and restricted transport channelization. These findings demonstrate the potential of tuning thermoelectric properties through 1D van der Waals systems, assess the influence of charge-density-wave behavior on transport properties in AlPS4, and highlight the significance of exploring diverse, eco-friendly, next-generation crystal geometries.

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Abstract ID: ABS - 145

Enhancing Performance of Nanofiber-Based TENGs with Metal Oxides for Innovative Applications

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Keywords

Triboelectric
Nanogenerator (TENG)
Polyacrylonitrile (PAN)
Nickle oxide (NiO)

Abstract

The increasing use of wearable electronic devices necessitates finding alternatives to rechargeable batteries, which pose environmental hazards and disposal challenges. Triboelectric nanogenerators (TENGs) provide a promising solution by converting mechanical energy from human movement into electrical power. The choice of dielectric materials is critical for optimizing power output and enhancing energy conversion efficiency. While metal oxides have a high dielectric constant, they often lack flexibility. In contrast, nanofibers, known for their high surface area and flexibility, are excellent candidates for TENG applications. This research aims to maximize the power output of a TENG by utilizing electrospun polyacrylonitrile (PAN) as the tribo-negative material and electrospun polyamide (Nylon 6,6) as the tribo-positive material, further enhanced by incorporating nickel oxide (NiO). The addition of NiO significantly improves the TENG's performance. We constructed a TENG of Nylon 6,6 nanofibrous membranes at various concentrations (10 wt% to 20 wt%) and thicknesses, paired with 10 wt% PAN over a contact area of 4 cm^2. The energy generated from this configuration successfully powered 53 LEDs and charged a capacitor. Furthermore, it demonstrated potential applications in water splitting and self-powered gloves for individuals with disabilities. This ability to harness energy from human motion highlights the potential of TENGs as renewable energy sources. Overall, this study underscores the effectiveness of electrospun nanofibers in enhancing TENG performance, showcasing their promise as sustainable and efficient energy solutions for the future.

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Abstract ID: ABS - 149

Investigation of Heat Generation and Temperature Evolution for Cylindrical Cells under Drive Cycle Operation: A Combined Approach through Experiment and Simulation

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Keywords

Lithium-ion battery
Electro-thermal model
Realistic drive cycle
Temperature prediction
Heat generation rate
Battery thermal management

Abstract

Precise estimation of temperature in Li-ion batteries under actual driving conditions is crucial for the effective implementation of a reliable thermal management system. Conventional means of heat estimation work only for constant current discharge. The present study attempts a comprehensive investigation of heat generation and temperature evolution for an 18650 cylindrical lithium iron phosphate (LFP) cell under realistic drive cycle operation. A combined experimental and electrochemical-thermal simulation (through COMSOL Multiphysics) approach is used to develop the estimation methodology. The method can provide prior estimation for heat generation and temperature evolution under drive cycle operation. Experimental voltage curve is used to fit unknown electrochemical parameters resulting in a small RMS error of 2 %. Next, heat generation, state of charge and temperature evolutions are compared between experiment and simulation. A close match is observed for SOC and temperature values (RMS error is less than 5 % and 1.6^{o}C)). It is observed that for heat generation, experimental measurement through Bernardi equation is not very accurate under drive cycle operation which results in an RMS error of 23 % from the simulated value. It is also observed that the reversible heat generation is negligible compared to the irreversible part in Bernardi equation. Thus, the current study explores method to obtain data necessary for design of thermal management system for electric vehicles under drive cycle operation.

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Abstract ID: ABS – 152 (II)

An Investigation on Feed-in Tariff Policy to Promote Private Investment in Renewable Energy in Sudan

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Keywords

Feed-in tariff
Sudan
Solar photovoltaic
Onshore wind

Abstract

Sudan has significant untapped renewable energy potential, primarily in solar and wind resources. The electricity sector in Sudan operates as a natural monopoly. Additionally, electricity is sold at significantly subsidized rates, resulting in constrained public funding. Achieving universal access to electricity by 2035, in part through the utilization of renewable energy, necessitates active involvement from the private sector. This study analyzes the existing legislative framework and policies within the sector to identify obstacles to private sector participation, with the absence of incentives identified as a primary barrier. The feed-in tariff (FIT) has been examined as a means to encourage private investment. The power generation cost from solar photovoltaics and onshore wind technologies was estimated to serve as the basis for establishing a technology-specific feed-in tariff rate. Eight sites were selected: Toker, Nyala, Port Sudan, Omdurman, Elobied, Berber, El Daein, and Dongola, representing the three climate zones in Sudan. An analysis of the levelized cost of energy (LCOE) was conducted utilizing System Advisor Model (SAM) software for solar photovoltaic technology and RETscreen for onshore wind energy. It was found that the average LCOE for solar photovoltaic technology in Sudan is 6.84 ¢/kWh, with Toker and Port Sudan identified as outliers due to their limited solar resources. The average LCOE for onshore wind farms is 9.22 ¢/kWh, excluding El Daein and Port Sudan. The study compared the LCOE values derived from the analysis with the LCOE of operational power plants and the average retail energy price to inform an appropriate FIT rate.

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Abstract ID: ABS - 159

Beneficiation of Microcrystalline Graphite Using Evaporation-Assisted Film Flotation

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Keywords

Microcrystalline Graphite
Film Flotation
Graphite Beneficiation

Abstract

Many countries consider graphite a critical mineral for national security due to its diverse applications, particularly as the anode material in lithium-ion batteries, where natural graphite is preferred for its lower carbon emissions during production. However, natural graphite ore contains impurities, necessitating the separation of graphitic flakes from aluminosilicate-based impurities, with froth flotation being the most effective method for this process. As high-grade graphite ore depletes from prolonged extraction, the available ores are shifting toward microcrystalline graphite, which poses challenges for beneficiation using traditional flotation methods due to its smaller flake size, resulting in reduced particle-bubble collisions and inefficient separation. To address these challenges, we have developed a process that exploits differences in hydrophobicity at the microcrystalline scale for more efficient graphite beneficiation. The hydrophobic nature of microcrystalline graphite particles is significantly hindered by sterically adhered aluminosilicate minerals. Due to the heterogeneity of surface sites, the particles range from fully hydrophobic to fully hydrophilic. In this method, the ground ore powder is stirred in a high-alkali solution (pH > 10) at temperatures between 40°C and 80°C, resulting in the formation of a film at the liquid-air interface. This film contains a higher concentration of graphite, while the alkali solution maintains the dispersibility of the aluminosilicate minerals. We evaluate the recovery and yield of the film as functions of temperature and time and propose a separation model based on surface energy, wettability, and zeta potential.

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Abstract ID: ABS - 168

Study of Policies Framed by The Government of India to Achieve its Net Zero Target by 2070

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Keywords

Net Zero
GHG emissions
Policies

Abstract

One of the leading threats to mankind today is global warming. The irony of it is that this is human-induced! This global problem needs a global solution. To achieve this, every country contributing to emissions must actively find ways to reduce these emissions and keep them below the nationally determined contributions (NDC). India is committed to becoming net zero by 2070 and to achieve this target there needs to be a major reconstruction of the working of the biggest sectors contributing to emissions. The driving factor in this change is policies. This paper aims to study the effect of various policies on the net zero targets and create a scenario where all current policies are applied and recognize the change in technology and innovations required in every major sector contributing to emissions. To study the effect of various policies and initiatives on the emissions of a country, we shall be using the Energy Policy Simulator (EPS) which is developed by Energy Innovations LLC. The Indian BAU scenario has been developed in partnership with the World Resources Institute (WRI). The model divides emission sources into four broad categories; Industry, Agriculture (this is combined with industry), Buildings, and Transportation. The policies that have the most effect on GHG emissions in the Transport sector are the Faster Adoption and Manufacturing of (Hybrid &) Electrical Vehicles (FAME-2) policy and the Green Hydrogen Mission. Similar studies are being undertaken in all sectors.

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Abstract ID: ABS - 179

Potassium Poly (Heptazine Imide) as a Novel Binder for Lithium-ion Batteries

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Keywords

Binder
Battery

Abstract

A polymeric binder forms an essential element in a Lithium-ion battery (LIB) that holds the integrity of the electrodes together and moderates the degradation of it due to the continuous charging/discharging cycles. Though there have been several efforts for improving the battery performance by modifying active material, electrolyte and separator, the binder aspect still remains less explored. Among many commercially used binders, the most commonly used binder is polyvinylidene fluoride (PVDF) belonging to the category of polyfluorinated compound (PFCs), thus it is of great interest to explore the alternatives. Here we propose Potassium poly (heptazine imide) (K-PHI), from the carbon nitride family, as a binder for its application in LIBs for the first time. Compared to its synthetic precursor Melon and its aqueous counterpart as Hydrogen poly (heptazine imide) (H-PHI), K-PHI showed both better processibility as well as mechanical strength. In case of graphite, a specific capacity of around 360 mAh g-1 at 1C along with long term stability of 390 mAh g-1 at 0.5C was found with K-PHI while in case of lithium iron phosphate (LFP), specific capacity is found to be around 98 mAh g-1 at 3C. The battery performance including rate capability, cycling ability and specific capacity for K-PHI are found to be comparable with that of PVDF for both graphite and LFP which are commercially used anode and cathode respectively. K-PHI confirms to be an alternate for PVDF offering an eco-friendly route for battery fabrication which can open up new avenues to explore other materials in the near future.

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Abstract ID: ABS - 204

A Whale Hunting Optimization Approach for Strategic Electric Vehicle Charging Station Deployment

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Keywords

Whale Hunting Optimization
Electric Vehicle Charging Stations (EVSC)
Sustainable Transportation

Abstract

The rapid adoption of electric vehicles (EVs) necessitates the strategic placement of charging stations to ensure seamless charging accessibility and promote sustainable transportation. This research investigates the application of the Whale Optimization Algorithm (WOA) for identifying optimal locations for EV charging stations within a city. WOA, inspired by humpback whales' hunting behaviour, is a meta-heuristic optimization technique well-suited for solving complex combinatorial problems. The proposed methodology involves formulating an objective function that considers factors such as minimizing the total travel distance for EV users, maximizing the coverage of potential charging demand, and balancing the distribution of charging stations across the city. WOA is employed to iteratively explore the solution space and identify the most suitable locations that optimize the objective function. The performance of the proposed approach is evaluated using a case study of a real-world city, considering factors like road networks, population density, and EV ownership patterns. The simulations are carried out in MATLAB environment. The results demonstrate that WOA effectively identifies optimal locations for EV charging stations, leading to improved accessibility, reduced travel distances for EV users, and enhanced overall charging infrastructure efficiency. This research contributes to the advancement of sustainable urban planning by providing a data-driven and optimization-based approach for the strategic deployment of EV charging stations. The findings offer valuable insights for policymakers, urban planners, and EV charging infrastructure providers in making informed decisions to facilitate the transition to electric mobility.

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Abstract ID: ABS - 205

Overcoming Obstacles, Renewable-Powered System Application to EV Charging Systems: An Overview

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Keywords

Microcrystalline Graphite
Film Flotation
Graphite Beneficiation

Abstract

Transportation significantly contributes to carbon emissions, prompting increased attention from the research community and organizations that mitigate global warming. Electric vehicles (EVs) offer a promising solution, but only reliance on the conventional grid aggravates carbon-related issues. The renewable-based EV charging system (CS) emerges as a crucial player in addressing the effects of global warming. Power electronics developments create opportunities for effective use of renewable energy, which helps not only with EV charging but also in difficult-to-reach places. Renewable energy with energy storage devices with/without grid support shows scopes for achieving net-zero carbon emissions. Despite advances, the extensive integration of renewable energy sources (RESs) into EV charging infrastructure still needs to be improved. This article presents an overview of the current research trends and technical advancements in electric vehicle charging systems (EVCSs), recognizing transportation's essential role in carbon emissions.

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Abstract ID: ABS - 208

Internet of Things (IoT) Based Battery Monitoring System for Active Battery Management System

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Keywords

Internet of Things (IoT)
Battery Monitoring
Active Battery Management System
State of Charge
Predictive Maintenance
Energy Efficiency

Abstract

In recent years, the demand for reliable and efficient battery management systems (BMS) has surged, driven by the growth in electric vehicles (EVs), renewable energy storage, and portable electronics. This paper presents the development and implementation of an internet of things (IoT)-based battery monitoring system designed to enhance the functionality of active BMS. The proposed system leverages real-time data acquisition and wireless communication to monitor battery charging/discharging status along with voltage and state of charge (SoC). By integrating IoT capabilities, the system enables remote data access and analytics, offering insights into battery health and performance, and facilitating proactive maintenance and optimal energy usage. The proposed IoT-based battery monitoring system comprises low-power sensors, Wi-Fi enabled microcontroller, and a cloud-based platform for data storage and analysis. In this, data from the lithium-ion (Li-ion) batteries is transmitted wirelessly to the cloud, where it is processed to provide actionable insights into battery state and lifespan. Experimental results demonstrate the system's efficacy in delivering timely data with minimal latency, enabling predictive analysis and enhancing the operational efficiency of the proposed IoT-based battery monitoring system for active BMS. Furthermore, this IoT-based approach reduces battery degradation and extend service life, thus offering a cost-effective and scalable solution for Li-ion battery applications.

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Tailoring Dielectric and Mechanical Characteristics of PVDF-Based Flexible Nanocomposites with Ta_2O_5 Reinforcement

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Keywords

Tantalum pentoxide
Nanoparticles (Ta_2O_5 NPs)
PVDF
Nanocomposite thin films
Dielectric properties
Breakdown strength

Abstract

In this work, flexible nanocomposite thin films of polyvinylidene fluoride (PVDF) polymer matrix reinforced with tantalum pentoxide (Ta_2O_5) nanofillers of different weight ratios were prepared using a facile solution casting technique. A thorough examination of the structure and morphology of the films shows a homogeneous reinforcement of Ta_2O_5 nanoparticles (NPs) in the PVDF matrix. The dielectric behaviour of the nanocomposite films as a function of frequency (4 Hz-8 MHz) and temperature (30-1200C) has been studied through impedance spectroscopy. Typically, the polymeric film containing Ta_2O_5 NPs in 1.25 wt% at 1 KHz field frequency possesses a dielectric constant of ~ 17 and 40 at room temperature and 1200C respectively, which is much higher (~ 8 times) than that of pure PVDF, whereas the corresponding dielectric loss factor is relatively low (< 0.3) that shows the existence of less energy dissipation through the film. While the mechanical properties of the film remain almost similar to the pure PVDF film. This significant enhancement in the dielectric permittivity of the prepared films is mainly attributed to the superior dielectric behaviour of Ta_2O_5 NPs, enhanced β-phase crystallization in PVDF and interfacial polarization at the interfaces of Ta_2O_5 nanofillers and PVDF matrix. The improved dielectric and mechanical performance enable these nanocomposite thin films to meet the requirements of present demand of the flexible electronic and energy storage industries.

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Enhancing Stability in Solid-State Lithium Batteries: The Role of Metallic Interlayers in Preventing Dendrite Growth

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Keywords

Solid state electrolyte
Electrode/electrolyte interface
Solid state batteries

Abstract

Lithium-ion batteries (LIBs) are essential energy storage solutions in today's technology-driven world, used in a broad range of applications from light to heavy-duty. Unlike earlier battery systems, LIBs are known for their high gravimetric and volumetric energy densities and long cycle life. However, challenges such as thermal instability, flammability, and the electrochemical instability of liquid electrolytes can negatively affect their performance. These liquid electrolytes also limit the effectiveness of high-voltage cathodes and lithium metal anodes, as the latter can cause battery degradation due to dendrite formation. Solid-state electrolytes offer a potential solution to these problems. They are stable when used with high-voltage cathodes and lithium metal anodes, providing a wide electrochemical voltage window that is ideal for high-energy LIBs.Solid-state Li-ion batteries that use metallic lithium as the anode provide higher energy densities and greater safety compared to traditional liquid electrolyte-based Li-ion batteries. However, the formation of tiny lithium filaments, known as dendrites, within the solid-state electrolyte layer can cause early cell failure, limiting their practical application. The exact microscopic processes behind lithium dendrite growth in solid-state cells remain uncertain. In this study, we synthesized a garnet-based lithium-ion conductor $Li_7La_3Zr_2O_{12}$ (LLZO) solid-state electrolyte having conductivity in range of 10-4 Scm-1. We demonstrate that the effect of using metallic interlayers on the growth of interfacial voids, stability during lithium stripping/platting, impact on the critical current density and cyclability of Li|LLZO|Li symmetric cell at different temperatues has been studied. These interlayers enhance the dendrite growth tolerance of solid-state electrolytes without requiring excessively high stack pressures.

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Self-Assembled Bagasse-derived activated Carbon and MoS_2 Nanocomposite Electrode for Solid-State Supercapacitors

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Keywords

Supercapacitor
Bio-waste management
Transition metal
Chalcogenides

Abstract

Supercapacitors have become essential for powering daily and advanced electronic devices, and are also being explored for potential use in outer space. As such, there is a need for innovative, high-performance, and low-cost electrode materials. In recent years, carbon nanocomposites have received much attention for their potential to be used in next-generation energy storage devices. However, their low specific capacity, high cost, poor energy density, have been seen as hindrances. In this study, we present the electrochemical performance of a supercapacitor electrode made from a layered sugarcane bagasse-derived carbon and molybdenum disulfide (C-MoS_2) nanocomposite film when used in a solid-state supercapacitor with a PVA/H_2SO_4 gel electrolyte and C-MoS_2 electrodes, it demonstrated a specific capacitance of 443.7 F/g at a current density of 0.25 A/g. Furthermore, this device showed exceptional cycling stability, maintaining 98.71% Columbic efficiency over 5000 charge-discharge cycles with only a 2.34% loss. The C-MoS_2 device also exhibited a high-power density of 21.67 Wh/kg and an impressive energy density of 2463 W/kg at a current density of 0.25 A/g. As the preparation of the nanocomposite and its assembly into a film is both straightforward and affordable while also allowing for precise control of its electrochemical performance at the nanometer scale, the C-MoS_2 nanocomposite film electrode shows great potential as a sustainable and cost-effective option for future supercapacitors.

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Zn(II) Coordination Polymer-Based Hetero-Composites for Asymmetric Supercapacitor Applications

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Keywords

Coordination polymer
Heterocomposite
Topology
Asymmetric supercapacitor device
LED glow

Abstract

Enhancing charge storage and balancing energy and power density requires the development of a hybrid supercapacitor. In this regard, material with highly porous voids, well crystalline stability, and adjustable framework could be integrated with a large defective surface sheet of 2D materials. A hydrothermally synthesized Zn(II) based coordination polymer namely; [Zn(IPA)2(2-MI)2]n (MZ), [IPA: isophthalic acid, 2MI: 2-methylimidazole] and in-situ fabrication of heterocomposites on anchoring of MZ on graphene oxide (GO) and reduced graphene oxide (RGO) interlayer sheets. MZ and their heterocomposites were characterized by spectroscopic (SC-XRD for MZ, UV-Visible, FT-IR, PXRD with Rietveld refinement, and XPS) and nanoscopic (FE-SEM with EDS, and HR-TEM) technics to confirm their structural compositions. The topological underlying net of MZ shows the uninodal 2C1 net topology. The synergistic effect between MZ and GO/RGO delivered good supercapacitance (SC) properties. Three electrode-based electrochemical analysis (1M KCl, 1M KOH, 1M Na_2SO_4) revealed that GMZ23 and RGMZ11 exhibited superior performance in 1M KCl aqueous electrolyte as compared to MZ. Furthermore, designed symmetric (SSC) and asymmetric supercapacitor (ASC) devices were tested. RGMZ11 ASC device demonstrated remarkable specific capacitance, energy density, power density, and current density when analysed in organic electrolyte. The retention capacitance of RGMZ11 was retained up to 75% even after thousands of charging-discharging cycles. Optimized RGMZ11 was successfully checked by a glowing multi-colour disco and a red LED. The above study suggested that RGMZ11 heterocomposite exhibits better performance for SC application.

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