ABSTRACT BOOK

5th International Conference

Strategies toward Green Deal Implementation Water, Raw Materials & Energy in Green Transition

NOVEMBER 2024

Mineral and Energy Economy Research Institute
Polish Academy of Sciences

MEERI PAS

5th International Conference

Strategies toward Green Deal Implementation

Water, Raw Materials & Energy in Green Transition

November 27-29, 2024

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Strategies toward Green Deal Implementation
Water, Raw Materials & Energy in Green Transition

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Polish Academy of Sciences

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*Prof. **Marzena Smol***
Mineral and Energy Economy Research Institute
Polish Academy of Sciences
Division of Biogenic Raw Materials

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Dominika Szołdrowska
Mineral and Energy Economy Research Institute
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Division of Biogenic Raw Materials

Composition

Edyta Waluś
Mineral and Energy Economy Research Institute
Polish Academy of Sciences
Division of Biogenic Raw Materials

Correspondence address

Division of Biogenic Raw Materials
Mineral and Energy Economy Research Institute
Polish Academy of Sciences
J. Wybickiego 7A str., 31-261 Cracow, Poland
E-mail: smol@meeri.pl
www.min-pan.krakow.pl/psb

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Dr Monika Sady, *Krakow University of Economics, Poland*
Prof. Agnieszka Generowicz, *Cracow University of Technology, Poland*
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Prof. Sebastian Werle, *Silesian University of Technology, Poland*
Prof. Mariusz Dudziak, *Silesian University of Technology, Poland*
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Dr Magdalena Andrunik, *Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland*
Prof. Marzena Smol, *Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland; Member of the Polish Young Academy of the Polish Academy of Sciences*

Dear Readers,

I am pleased to share the Book of abstracts that have been presented during the 5th International Conference on Strategies toward Green Deal Implementation, that was held from 27th to 29th November 2024 in hybrid form (online and onsite in Cracow, Poland). This pivotal event brought together experts and researchers from around the world to explore and discuss the key strategies for achieving a sustainable and equitable Green Transition, focusing specifically on the vital sectors of Water, Raw Materials, and Energy.

As the world faces mounting environmental challenges and the urgent need to transition toward a more sustainable and resilient future, the Green Deal and other global sustainability frameworks are driving transformative changes. However, the path to a greener, more circular economy CE) requires complex, multi-faceted solutions, and collaboration across sectors is critical to realising these ambitious goals.

This conference served as a platform for in-depth discussions and knowledge sharing on the following core topics:

- Water Management in the Green Transition: Innovations and strategies for optimising water use, ensuring quality and accessibility, and addressing the challenges of water scarcity, pollution, and climate change.
- Raw Materials for a Circular Economy: Strategies to secure a sustainable supply of critical raw materials, improve recycling systems, and reduce dependence on non-renewable resources, all while supporting responsible mining and minimising environmental impacts.
- Energy Systems for a Green Future: Exploration of renewable energy solutions, energy efficiency measures, grid modernisation, and the role of digital technologies in supporting a carbon-neutral energy transition.

The conference included 13 sessions onsite and 12 session onsite, with >200 presentations - keynote presentations, oral presentations and poster presentations. Participants gained insights into the latest research, technological advancements, and policy initiatives, with a focus on actionable strategies for overcoming the challenges of the Green Transition.

I would like to thank all the Reviewers who took the time to review the abstracts, the Scientific and Organising Committees for their involvement in the organisation and substantive support of the conference, and the Moderators for running the sessions.

I also thank all Participants of our conference, committed to advancing sustainability — be it through science, technology, policy, or business — that have joined us for this exciting event and contribute to shaping the future of a greener, more sustainable world.

I look forward to welcoming you to the 6th International Conference in 2026.

Prof. Marzena Smol

Conference Chair

IGSMiE PAN

Division of Biogenic Raw Materials

Mineral and Energy Economy Research Institute
Polish Academy of Sciences

Division of Biogenic Raw Materials conducts research in the field of environmental management and engineering as well as biotechnology. The special interest is dedicated to the Circular Economy (CE) model and the Green Deal Strategies in food, water and raw materials sectors.

Division of Biogenic Raw Materials specialises in the analysis and assessment of specific problems and phenomena related to the management of fertiliser raw materials, with particular emphasis on phosphorus, nitrogen and potassium. A special area of interest are issues related to sustainable and circular management of the raw materials in order to optimise the use of resources at the local, regional, national and international levels.

The division's work includes:

- development of recommendations (road maps) for sustainable and circular management of biogenic raw materials;
- recovery of raw materials from waste, including phosphorus from waste generated in the water and sewage sector (fertilisers from waste);
- water in a circular economy and water footprint;
- assessment of technological, legal, environmental and social aspects of biogenic raw materials management;
- strategies for water protection against pollution with biogenic raw materials from anthropogenic sources and determination of directions for counteracting eutrophication;
- analysis of new materials (including nanomaterials) used in municipal and industrial sewage and soil treatment processes.

Division of Biogenic Raw Materials participates in international projects (Horizon 2020, Horizon Europe; EIT Raw Materials, NAWA, Visegrad Fund, Norway Grants) related to the management of phosphorus raw materials and the development of recommendations (roadmaps) for the management of raw materials in the context of implementing the assumptions of sustainable development (SD), circular economy and the European Green Deal in the water and sewage, fertiliser and agri-food sectors.

Division's Website: https://min-pan.krakow.pl/psb

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Abstracts

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SESSION

Strategies toward Green Deal Implementation

Plenary session

Green Deal Future – Water, Raw Materials and Energy

Marzena Smol[1*]

[1]Mineral and Energy Economy Research Institute, Polish Academy of Sciences (MEERI PAS), Poland

Abstract

In recent years, special attention has been paid to the green transformation, which is an integral part of ambitious strategies for the implementation of the European Green Deal (EGD). The main areas of interest of the European Commission (EC) are the sustainable and circular management of water, raw materials and energy. The paper presents the latest trends and recommendations of the EC in this area. In addition, examples of good practices are presented, in the area of water - innovative technologies for water recovery from municipal wastewater, in the area of raw materials - methods for the recovery of phosphorus from wastewater and sewage sludge and in the area of energy – its recovery from wastewater. In these areas, it is also possible to implement social innovations and new business models that should allow for better application of new technologies. In the coming years, financial support for innovations that could accelerate the green transformation is expected, including within the framework of European and national funds.

Keywords: green deal, green transformation, water, raw materials, energy

Acknowledgments: Paper prepared as a part of the subsidy of Division of Biogenic Raw Materials in MEERI PAS and the project "5th edition of the International Conference – Strategies toward Green Deal Implementation: Water, Raw Materials & Energy" co-financed from the state budget, allocated by the Ministry of Science and Higher Education Republic of Poland under the Excellent Science II Programme (Poland).

Ministry of Science and Higher Education Republic of Poland
Doskonała Nauka

* smol@meeri.pl

The European Green Deal as a challenge for environmental protection/engineering activities

Czesława Rosik-Dulewska[1*]

[1]Institute of Environmental Engineering, Polish Academy of Sciences, Poland

Abstract

The main goals of the European Green Deal (EGD) are to decouple economic growth from the consumption of natural resources and climate neutrality. The European Commission proposes that European entrepreneurs should move towards a circular economy, including mainly those industries that use many raw materials during production, i.e. mainly the clothing industry, construction, electrical industry and the production of plastics. The European Green Deal is a commitment of the European Union to achieve the goals of the Paris Agreement, mainly by making the 27 countries of the bloc carbon neutral by 2050.

Keywords: European Green Deal, environmental protection

* czeslawa.dulewska@ipispan.edu.pl

Current challenges of water and wastewater management

Maria Włodarczyk-Makuła[1*] | Wioletta M. Bajdur[1]

[1]Czestochowa University of Technology, Poland

Abstract

Sustainable water management is an important issue in the environmental policy in countries of the European Union. Rational water management and recoveries of water and raw materials from waste materials generated during wastewater treatment are one of the most important issues in green deal strategies. It is connect with a problem of ensuring access to clean water for people. In 2019 the shortages of clean water in EU countries averaged 29%. In the southern countries of the Europe 30% of the population lives in areas with constant water shortage, and up to 70% in areas with seasonal water shortage in summer. However, the problem also affects other regions in Europe. Therefore the recovery and reuse of water is now crucial problem in different countries. But technologies of water recovery require an assessment taking into account under environmental, economic and social aspects. Well known example is water recovery from various streams, such as treated wastewater, grey water and rainwater. The possibilities of reuse of rain and grey water focus on individual or group systems. Reuse of water recoveries from wastewater is possible in wastewater treatment plants or in technological processes in nearby located factories. Wider application of water recovered from wastewater require using of high effective treatment processes earlier.

Keywords: water, recovery, rain water, grey water

Acknowledgments: Work was financially supported by subvention of Czestochowa University of Technology.

* m.wlodarczyk-makula@pcz.pl

Hopes, opportunities and problems of material recovery as part of the Green Transformation

Stanisław M. Rybicki[1*]

[1]Cracow University of Technology, Poland

Abstract

The development of civilization from the earliest times depended on access to materials. This factor determined the location of cities and states, decided on the development of their economies, and sometimes constituted an element of threat. The development of modern technology in the 19th century caused a dynamic increase in demand for raw materials, first for coal and iron ore, later there was a need for other materials necessary for the development of energy, telecommunications and eventually other advanced fields. Leading to the complete globalization of the materials' market.

In our modern times access to raw materials used in the production of photovoltaic cells, energy storage systems, or aircraft and space structures has become crucial and new areas of urgent demand appear in each decade. The article shows trends in changes in the demand for materials (excluding oil and gas) of key importance to the modern economy. The problems of exerting pressure between countries to obtain access to these sources are presented. The issue of recovery of some materials from sewage and waste is discussed separately as the most important, prospective direction of solving the problem of depletion of their sources on a global scale. The article contains an analysis of trends in the demand for critical materials, especially taking into account the possibility of using CE. It shows the change in demand for different groups of raw materials, focusing on those that condition the implementation of the green transformation. It also proved the positive impact of the current change in the approach to CE in terms of reducing the demand for water and energy in relation to conventional methods of materials' acquisition.

Keywords: resource constraints, material recovery, threats to the economy, applied CE

* stanislaw.rybicki@pk.edu.pl

Energy in Green Transition

Sebastian Werle[1*]

[1]Silesian University of Technology, Poland

Abstract

The paper explores the processes of gasification and pyrolysis of various types of waste biomass, as well as the processes of solvolysis and oxidative liquefaction of composite waste materials. Experimental research was conducted to investigate these processes. The study emphasizes the significance of the circular economy and green deal aspects. It highlights the importance of circular economy and green transformation practices in addressing waste management challenges and achieving sustainable resource use.

* sebastian.werle@polsl.pl

Water in Green Transformation

Maris Klavins[1*] | Oskars Purmalis[1] | Marzena Smol[2]

[1]University of Latvia, Latvia
[2]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Abstract

Water is one of the critical resources needed for the existence of life on Earth and essential for human development. Water as a finite resource plays a key role for development of industrial production, agriculture and welfare of society in situation of increasing pressure on water availability and quality. Thus, to meet future challenges, such as climate change, growing limitations of resource availability, a major transformation in perspectives on water use are needed. Green transformation requires integration of circular economy concepts in water resource management and water treatment and purification technologies. To achieve green transformation aims measures should be taken to reduce the use of this resource where possible and to develop new water sources for human consumption, industries, agriculture, and energy production. To achieve these aims, both social and technological innovation have crucial significance. Water green transformations is related to reclaimed water reuse and recovery of elements and materials from used water streams at first closing water circulation loops, preventing environmental pollution, at the same time recovering resources of importance for society.

Keywords: reclaimed water, circular economy, material recovery

Acknowledgments: Paper was prepared as a part of the project “Closing local water circuits by recirculation nutrients and water and using them in nature” (ReNutriWater) financed by the European Regional Development Fund (ERDF), project no. #C016.

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* maris.klavins@lu.lv

Innovative applications of common mineral resources in sustainable environmental engineering

Tomasz Bajda[1*]

[1]AGH University of Krakow, Poland

Abstract

The innovative application of common mineral resources is essential for advancing sustainable environmental engineering and aligning with the goals of the Green Deal. This study explores how critical mineral resources, such as zeolites, clay minerals, diatomites, and bog iron ores, can be utilized to promote environmental sustainability and improve resource management through circular economy principles. Zeolites, known for their high adsorption capacity, play a vital role in water purification and environmental remediation. Their unique ability to adsorb heavy metals and organic pollutants makes them crucial in tackling water pollution. A significant advancement in this area is the synthesis of functionalized zeolites from fly ash, which provides an eco-friendly method for waste valorization and a sustainable alternative for industrial processes. Clay minerals are highlighted for their dual role: as effective sorbents for removing contaminants, particularly heavy metals, and organic compounds, from wastewater and as raw materials for the production of eco-friendly construction materials. Diatomites, characterized by their highly porous nature, serve as natural filters for air and water purification, offering a low-impact solution for environmental challenges. Bog iron ores, though historically significant, find new relevance in modern sustainability efforts. Their ability to capture heavy metals from industrial effluents makes them ideal for environmental remediation. The minerals also contribute to sustainable construction solutions, emphasizing their importance in historical and contemporary contexts. The potential to combine minerals for innovative environmental engineering solutions is emphasized alongside the need for interdisciplinary collaboration and supportive policies. The efforts are crucial for fully integrating these resources into sustainable practices, contributing to a greener, more resilient future.

Keywords: minerals, remediation, circular economy, sustainable construction

Acknowledgments: Research Project partly supported by program “Excellence initiative – research university” for the AGH University of Krakow.

* bajda@agh.edu.pl

SESSION

Water-Raw Materials-Energy and the Green Deal

Circular economy as a new paradigm in sustainable management

Ewelina Szczech-Pietkiewicz[1*]

[1]SGH Warsaw School of Economics, Poland

Abstract

The Circular Economy (CE) is emerging as a transformative paradigm in sustainable development, offering a comprehensive strategy to address environmental, economic, and social challenges. Unlike the traditional linear economic model, which follows a 'take, make, dispose' approach, the CE prioritizes resource efficiency by keeping products, materials, and energy in circulation for as long as possible. This model minimizes waste, reduces environmental impacts, and fosters innovation. As global sustainability goals gain prominence, particularly in the European Union (EU), the CE has become a vital instrument for advancing the objectives of the European Green Deal, which aims for carbon neutrality by 2050, decoupling economic growth from resource use, and protecting natural ecosystems.

At the enterprise level, the CE presents numerous opportunities for businesses to embed sustainability into their operations. Companies can redesign products for durability, repairability, and recyclability, adopt resource-efficient production processes, and implement innovative circular business models such as product-as-a-service and industrial symbiosis. These models not only reduce environmental footprints but also create economic value, enhance competitiveness, and meet regulatory standards.

The goal of this paper is to analyze how circular business models can be effectively adopted by enterprises to achieve the objectives of the European Green Deal. It explores specific strategies, such as product-as-a-service and industrial symbiosis, while addressing the challenges and opportunities involved in transitioning to a circular economy. Additionally, the paper emphasizes the importance of collaboration between policymakers, industries, and consumers in advancing the CE agenda.

Keywords: Circular Economy, business strategy, circularity

* eszcze@sgh.waw.pl

Circular Economy indices in Europe, differences and similarities: a review

Natalia Pakula[1*] | Zofia Łapniewska[2] | Cleber Dutra[2]

[1]PhD Student in the Economics and Finance, at the Doctoral School in the Social Sciences, Jagiellonian University in Kraków, Poland
[2]Institute of Economics, Finance and Management at the Jagiellonian University in Kraków, Poland

Abstract

The circular economy (CE) has emerged as a vital framework for promoting sustainability and mitigating environmental crises, particularly in the context of climate change. Officially introduced by the European Commission in 2014, the CE is a cornerstone of the European Green Deal, reflecting the EU's commitment to transforming economic practices toward resource efficiency and resilience.

The objective of this paper is to review the key indicators and approaches that are commonly used in the literature to assess the progress of EU countries in implementing CE solutions. To achieve this, a systematic literature review was conducted to synthesize existing research and replicate findings on the status of CE across member states from 3 papers that share the most similarities in terms of inputs and methods used. Additionally, we employed simple descriptive statistics to characterize the distinctive features of progress across different groups of countries.

Our review of current literature reveals a complex landscape of CE implementation, which underscores the need for a unified assessment framework, with a focus on enhancing data granularity and monitoring processes. Preliminary outputs show significant variability in CE adaptation among EU nations indicating a dual need for economic restructuring and a shift towards a more circular economy, while simultaneously addressing the root causes of unsustainable consumption patterns and the resulting pressure on natural resources. This study serves as a critical examination of existing research, informing future directions for policy and practice in advancing the circular economy within the EU.

Keywords: European Green Deal, circular economy, index, ranking, cluster

* npakula@doctoral.uj.edu.pl

Challenges for benchmarking program development in the context of new EU environmental policy

Jedrzej Bylka[1*]

[1]Institute of Environmental Engineering and Building Installations, Department of Environmental Engineering and Energy, Poznań University of Technology, Poland

Abstract

Benchmarking is one of the most important tools for supporting asset management in water utilities. Benchmarking activities are led both by water utilities (voluntary benchmarking) and governments (regulatory benchmarking). The current EU environmental policy introduces new requirements for water and wastewater management. The new Drinking Water Directive (DWD) and the Urban Wastewater Treatment Directive (UWWTD) introduce several obligations in the context of water management.

The main aim of this presentation is to highlight the new challenges for benchmarking. In the first part of the presentation, benchmarking projects (local, regional, and European) will be presented. The KPIs related to environmental assessment will be described. After a description of the new European directives, proposed changes to benchmarking projects will be outlined. Special attention will be given to indicators related to water losses and energy neutrality. The presentation will conclude with a general discussion on the challenges of implementing benchmarking and asset management initiatives.

Keywords: benchmarking, new green deal, Drinking Water Directive (DWD), Urban Wastewater Treatment Directive (UWWTD)

* jedrzej.bylka@put.poznan.pl

Electro discharge machining toward Green Transition – the possibilities of process modification

Agnieszka Żyra[1*] | Sebastian Skoczypiec[1]

[1]Faculty of Mechanical Engineering, Cracow University of Technology, Poland

Abstract

The electro discharge machining (EDM) is one of the most popular unconventional machining process. The expected growth of the global EDM market (volume), between 2019 and 2027 can reach approximately 6%. The growth is attributed to the demand for various industrial sectors' high-precision and quality machining designs. It is believed that Asia and North America will remain the dominant regions in the global discharge machine market.

From an environmental standpoint, conventional EDM presents significant challenges. The process generates harmful vapours, which can cause irritation and dermatitis to operators. These issues not only affect human health but also have a detrimental impact on the natural environment.

The study sought to identify and characterise alternative, more eco-friendly solutions in EDM, with a particular focus on aligning them with the European Green Deal strategy. The analysis encompasses the characteristics, trends and forecasts of the global EDM market, the potential economic obstacles and the ways in which the main objectives of the European Green Deal in the field of EDM can be achieved.

In order to justify the potential for process modification with a view to making the process more eco-friendly, the results of the experiments conducted in gaseous environment (CO2) in two configurations as a part of green-EDM strategy were presented. It was found out that with proper process parameters, EDM in CO2 with external workpiece cooling with deionised water reduces the surface roughness, increases material removal rate, reduces changes in the surface morphology as well as in chemical composition, comparing to dry-EDM.

Keywords: dry-EDM, global EDM market, forecasts, green transition

* agnieszka.zyra@pk.edu.pl

Microbial fuel cell technology for sustainability: biodegradation, green chemistry, monitoring and novel applications

Grzegorz Pasternak[1*]

[1]Wroclaw University of Science and Technology, Poland

Abstract

Microbial fuel cells (MFC) belong to a wider group of bioelectrochemical systems (BES). MFCs are devices, in which the electroactive microorganisms are oxidising organic matter and transfer the electrons to the electrode, while protons travel to the cathode. Through the electron transfer mechanisms, MFCs, together with other types of BES such as microbial desalination cells or microbial electrosynthesis cells, are capable of producing electricity but also to separate or precipitate ionic species. By applying various types of microorganisms which grow either on the surface of the BES electrodes or in electrolyte (medium), it is possible to synthesise various useful chemicals. These processes are called microbial electrosynthesis or electrofermentation. Our current research focuses on establishing various microbial consortia dedicated to bioelectrochemical synthesis of surfactants, resource recovery and biodegradation, while concomitantly generating electricity. In biodegradation process, the organic pollutants of hydrophobic nature are degraded in MFCs, which provide the non-limited electron acceptor to improve biodegradation rate in energy-positive process. Similarly, producing biosurfactants in bioelectrochemical reactors allow to carry out this process along with power generation, where surface active properties of these compounds is directly correlated with current, leading to facile method of monitoring of their activity. These new concepts of reactors open the avenues to more sustainable production processes, environmental decontamination and waste valorisation.

Keywords: MFC, bioelectrochemical systems, waste, energy, recovery

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* grzegorz.pasternak@pwr.edu.pl

Strategies for reducing direct emissions in the construction sector

Natalia Rucinska[1*]

[1]Menard Group

Abstract

The construction sector is a significant contributor to greenhouse gas emissions, with Scope 1 emissions - direct emissions from fuel consumption—posing a particular challenge. While efforts to reduce Scope 3 emissions related to material sourcing and supply chain optimization have gained traction due to the availability of alternative, low-carbon materials, reducing Scope 1 emissions remains complex. This is largely due to the heavy reliance on fuel-powered machinery and increasing activity within the sector. This paper provides a comprehensive review of the strategies available to address Scope 1 emissions in construction. It examines alternative fuels, electrification of equipment, operational efficiency improvements, and other technological innovations. By analyzing current approaches and emerging technologies, this article aims to offer practical insights for reducing the carbon footprint of construction activities, helping stakeholders meet climate targets in an ever-demanding environment.

Keywords: construction, decarbonization, scope 1

* nrucinska@sf-group.com

Microbial approach to the low-thermal pretreatment (LT-PT) process of food waste

Filip Gamoń[1*] | Małgorzata Szopińska[1] | Hubert Byliński[1] | Aneta Łuczkiewicz[1] | Sylwia Fudala-Książek[1]

[1]Gdańsk University of Technology, Faculty of Civil and Environmental Engineering, Poland

Abstract

Food waste (FW) presents a major global challenge, yet it also serves as a valuable source of organic compounds suitable for methane fermentation. However, due to the complex composition of food waste, pre-treatment through disintegration is necessary for effective fermentation. Low-thermal pretreatment (LT-PT) has emerged as a promising method for this purpose. The composition of the bacterial community involved in LT-PT is a crucial factor in the disintegration process. Identifying the key microorganisms active under different conditions can help optimize the development of bacterial strains to improve efficiency. This study focuses on identifying the essential microorganisms involved in the disintegration of two types of substrates during LT-PT: real food waste (RFW), sourced from the organic fraction at the Municipal Waste Treatment Plant in Gdańsk, and an artificial food waste (AFW), designed to mimic the former. The LT-PT process was conducted under anoxic conditions at temperatures of 45°C, 50°C and 55°C. The metagenomic approach was applied to analyse the shift in the microbial community of substrate prior to and during LT-PT of AFW and RFW. The significant increase of *Firmicutes* up to 90% suggests that this phylum plays a significant role in the LT-PT process across all conditions and substrate types. This also suggests a substantial role of these bacteria in the FW disintegration process. Additionally, a more detailed differentiation of microorganisms occurs at lower taxonomic levels depending on the process conditions. Taxonomic analysis revealed a dominant presence of two bacterial groups at the order level, *Lactobacillales* and *Bacillales*, which together accounted for over 70% of the total microbial community. The findings form the basis for implementing LT-PT for FW pretreatment with the aim of increasing the production of methane-rich biogas.

Keywords: food waste, LT-PT, metagenomics, methane fermentation, circular economy

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* filip.gamon@pg.edu.pl

SESSION
Challenges in achieving the goal of *Environment free from toxic substances*

Determination of heavy metal content in agricultural and urban soils by inductively coupled plasma mass spectrometry (ICP-MS) with validation elements and estimation of analytical process uncertainty

Dominika Uchmanowicz[1*] | Justyna Pyssa[1] | Katarzyna Styszko[1]

[1]AGH University of Cracow, Poland

Abstract

Soil, as a fundamental and vital component of the environment, serves as a foundation for plant growth, forming the basis of the trophic chain essential for life on Earth. The composition of soils and the concentration of key chemical compounds are influenced by numerous factors, and even small amounts of pollutants can disrupt the development of microorganisms and plants, which constitute the biocenosis. To ensure the preservation of an optimal environmental balance, regular monitoring of soil composition for harmful substances is essential. Accurate soil analysis relies on the appropriate selection of testing methods and proper equipment validation.

The study focused on assessing the presence of harmful elements in soil samples from agricultural areas in Baranówka and Głogoczów, as well as from an urban green space located at the Oil and Gas Institute in Krakow. Prepared samples were subjected to mineralization and analyzed using inductively coupled plasma mass spectrometry (ICP-MS). The concentrations of heavy metals were measured, and soil quality was evaluated according to guidelines found in Polish and European regulations.

To validate the process and assess the reliability of the sampling and analysis processes, uncertainty was estimated using the ROBAN program. The results allowed for an evaluation of both the accuracy of the method used and the overall condition of the soil. The results highlight the importance of precise testing and validation to environmental monitoring in order to reduce the potential risks caused by heavy metals.

Keywords: soil pollution, method validation, mass spectrometry ICP-MS, estimation of the uncertainty of the analytical process

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* dominika.uchmanowicz@gmail.com

Assessing the confluence of sustainability and business models in the mobile app development industry in Poland: an investigation into company strategies and user perceptions

Jędrzej Cieślak[1*] | Yash Chawla[1]

[1]Faculty of Management, Wroclaw University of Science and Technology, Poland

Abstract

This research investigates the confluence of sustainability and business models within the mobile app development industry in Poland, examining both company strategies and user perceptions. It addresses a knowledge gap by exploring how sustainability is perceived and implemented by companies and how end-users view these practices, particularly in light of initiatives like the EU Green Deal. Employing a mixed-methods approach, the study combines quantitative surveys of user perspectives with qualitative interviews of Chief Technology Officers (CTOs). The findings reveal that user awareness and attitudes towards sustainability significantly influence their app preferences. Companies, while recognizing the importance of sustainability, face challenges in its implementation and promotion. The research underscores the need for greater transparency and communication regarding sustainable practices, as well as the potential for sustainability to serve as a competitive advantage in the mobile app market, aligning with the broader goals of the EU Green Deal. It concludes by offering recommendations for companies to enhance their sustainability efforts and suggests avenues for future research in this evolving field.

Keywords: business practices, user perspective, mobile application, sustainable development Green Deal

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* 254939@student.pwr.edu.pl

Liquid-liquid extraction for caproic acid recovery from mixed-culture fermentation

Seyed Behzad Rouhipour[1] | Natalia Gutowska[1] | Nay Yee Wint[1] | Mateusz Łężyk[1] | Piotr Oleskowicz-Popiel[*]

[1]Water Supply and Bioeconomy Division, Faculty of Environmental Engineering and Energy, Poznan University of Technology, Poland

Abstract

In situ product recovery (ISPR) is a technique used to remove and recover the product from the reaction solution during the process. Implementing an ISPR can prolong the fermentation process by reducing the inhibitory effect of the product on the productivity and activity of microorganisms. This research aimed to investigate the impact of the in-situ liquid-liquid extraction on the open-culture fermentation process. In this study, vegetable oils, instead of fossil-based mineral oil, were used to make this process more environmentally friendly. Four vegetable oils with six extractants were first tested in terms of extraction efficiency (EE%), selectivity (S), and distribution coefficient (Kd) for caproic acid in the synthetic medium. The best EE% obtained was for canola oil with 5% trioctylphosphine oxide (TOPO) – 80%, olive oil with 5% TOPO – 74%, rapeseed oil with 5% TOPO – 73%, and sunflower oil with 5% TOPO – 72%. As TOPO demonstrated the best parameters (EE%, S, Kd), it was chosen for further study in the fed-batch experiment. The process was conducted for 24 days to check the EE% for 5% TOPO in different vegetable oils. All of the tested vegetable oils with 5% TOPO showed biocompatibility; moreover, the production of caproic acid was higher compared to the reference without the product extraction. The use of the ISPR allowed not only product recovery with high selectivity but also increased the production yield in the fermentation process.

Keywords: in-situ product recovery, caproic acid, vegetable oils, trioctylphosphine oxide, open culture fermentation

Acknowledgements: This work was financed by the National Science Center, Poland under the grant agreement no. 2021/43/B/ST8/00393.

* piotr.oleskowicz-popiel@put.poznan.pl

Magnetic adsorbents – where are we head it?

Paulina Pietrzyk-Thel[1*] | Magdalena Osial[1] | Michael Giersig[1]

[1]Institute of Fundamental Technological Research, Polish Academy of Sciences, Poland

Abstract

Global water pollution is one of the major problems facing the world today. Water can contaminated with a wide variety of chemicals, from heavy metal ions to pharmaceutical compounds, and research is aimed at improving the removal of harmful compounds from aqueous solutions. In addition to the many methods used in water purification is adsorption, which can accommodate low operating costs and easy maintenance of the material used as adsorbent. However, the effectiveness of the materials proposed for adsorption studies depends on experimental conditions, including pH, ionic strength, the presence of additional molecules, as well as contact time and adsorbent dose [1]. It is worth mentioning that one of the main environmental concerns related to the use of materials for adsorption of pollutants is ensuring that the adsorbed pollutants on the surface of the material do not get back into the environment during the adsorbent regeneration process [2].

Functional adsorbents including magnetic nanostructures and processed biomass are presented here and the results of their application in water purification are discussed. Both, magnetic and non-magnetic adsorbents were used to remove model pollutants like: crystal violet (CV), malachite green (MG) and methylene blue (MB). The effectiveness of the composite was compared to the literature and individual components of the functional nanostructures. The efficiency of the removal of dyes using nanostructural adsorbents was higher than 98% during the 2 hours for MG, MB, CV accordingly, where for carbon was close to 70% for CV. The effect of pH was studied, it confirmed that the adsorbent is stable and it has similar effectiveness of adsorption in the pH range 4 – 12. However, the ionic strength effect has an impact on the adsorption process for CV and MB, where the effectives decreasing to the 85%, therefore for MG ionic strength has not influence for adsorption process.

The effectiveness of the operation in highly saline environment also relates to the composition of used material. In the case of the incorporation of the magnetic nanostructures into the adsorbent the material applied for the water purification can be easily removed from the treated solutions through the magnetic separation and offers multiple cycles of operation. Application of highly acidic or alkali media can limit the operation of magnetic adsorbents reducing the pollutants removal effectiveness. Post-treated adsorbents can be reused in different fields including production of new composites.

Keywords: water pollutants, adsorption, magnetic nanoparticles, biomass, circular economy

References:

[1] P. Pietrzyk-Thel, M. Osial, A. Pregowska, M. Ambramowicz, T. P. Nguyen, W. Urbańska and M. Giersig, "SPIONs doped with cobalt from the Li-ion battery acid leaching waste as a photocatalyst for tetracycline degradation – synthesis, characterization, DFT studies, and antibiotic treatment," Desalination and Water Treatment, vol. 305, p. 155–173, 2023

[2] M. Krajewski, P. Pietrzyk, M. Osial, S.-C. Liou and J. Kubacki, "Iron−Iron Oxide Core−Shell Nanochains as High-Performance," Langmuir, vol. 39, no. 23, pp. 8367-8377, 2023

* ppietrz@ippt.pan.pl

SESSION

Implementing the Green Deal Strategy in the Water and Wastewater Sector

Phosphorus recovery from municipal wastewater: evaluating sorbent performance from lab to pilot scale

Ruta Ozola-Davidane[1*] | Julija Karasa[2] | Annija Emersone[3] | Solvita Kostjukova[1]

[1]Latvia University of Life Sciences and Technologies, Faculty of Forest and Environmental Sciences, Latvia
[2]University of Latvia, Faculty of Science and Technology, Latvia
[3]LLC "P-Agro Minerals", Latvia

Abstract

Phosphorus (P) is a vital element for global food production, but its unequal distribution poses significant geopolitical and economic risks. Improper P management, particularly from agricultural and wastewater runoff, contributes to environmental pollution and eutrophication. Although numerous methods exist for P removal, including adsorption and precipitation, only few studies have tested these sorbents with real wastewater or explored their potential for reuse as fertilizers. This research aims to evaluate P removal from municipal wastewater using innovative mineral-based composites from Latvian deposits, focusing on their performance in both lab and pilot-scale applications. The potential reuse of spent sorbents in agriculture was also assessed, with results compared to the commercially available adsorbent Polonite®. In lab-scale tests with a standard phosphate solution, calcium/iron rich composites demonstrated 1.6 times higher P removal compared to Polonite®, through mechanisms including adsorption, electrosorption, and precipitation. In pilot-scale tests at the Ādaži wastewater treatment plant, P removal efficiency remained above 90% for the developed sorbents after 5 hours, while Polonite® dropped to 75%. P-saturated sorbents from wastewater were also tested to evaluate their effects on plant growth. In the aquaponic system, composites showed no phytotoxic effects on field crops and enhanced growth at higher concentrations, indicating strong potential for agricultural reuse. These findings suggest that the developed sorbents are effective not only in controlling P pollution from wastewater and reducing eutrophication risk, but also in enriching soil, offering a promising solution for circular nutrient management.

Keywords: phosphorus recovery, wastewater treatment, mineral-based sorbents, nutrient recycling, circular economy

Acknowledgments: This research is funded by Fundamental and applied research project of the Latvian Council of Science "Unused Latvia's natural mineral resources for the development of innovative composite materials for phosphorus recovery from small municipal and industrial wastewater treatment plants to implement the principles of circular economy (CircleP, No. lzp-2021/1-0090)" and Administration of Latvian Environmental Protection Fund project No. 1-08/92/2023 "Evaluation of the application of filter L for the recovery of phosphorus from wastewater for the promotion of circular economy".

* ruta.ozola-davidane@lbtu.lv

CO_2 and catalytic gasification process of hydrochar derived from sewage sludge

Małgorzata Sieradzka[1*] | Klaudia Czerwińska[1] | Maciej Śliz[1] | Małgorzata Wilk[1]

[1]AGH University of Krakow, Faculty of Metals Engineering and Industrial Computer Science, Department of Heat Engineering and Environment Protection, Poland

Abstract

The production of clean energy from sewage sludge is possible through the processes of hydrothermal carbonisation and gasification, which convert waste into valuable syngas. This study focused on the production of high-quality syngas from sewage sludge and its hydrochar via gasification and catalytic gasification. Four types of sludge were studied: digested (MS1) and non-digested sludge (MS2) from municipal Wastewater Treatment plants (WWTPs), and two from industrial WWTPs (IS1, IS2). Hydrothermal carbonization was conducted at 200°C for 2 hours, resulting in hydrochar, labeled HC_MS1, HC_MS2, HC_IS1, and HC_IS2, respectively. The gasification process was performed under a CO_2 atmosphere at 850°C, while catalytic gasification used the same conditions with the addition of SrO as a catalyst. The chemical composition of syngas was analysed using gas chromatography, identifying H_2, CH_4, CO_2, CO, O_2, N_2, and higher hydrocarbons. The experiment was divided into two stages: heating and proper gasification. During heating, reactor reached 850°C for 15 minutes, followed by 15-minute gasification phase. The results demonstrated that the catalyst significantly increased H_2 yield in all cases, increased CH_4 yield, and decreased CO yield in most cases. Catalytic gasification also accelerated hydrogen formation, with the hydrogen yield increasing from 4% to 7.3% for the IS1 sample during heating. For IS2, no hydrogen was detected without the catalyst, while its presence increased the yield to 8.8%. These findings confirm the potential of syngas production from sewage sludge and hydrochars via gasification, contributing to resource recovery and supporting circular economy principles by turning waste into valuable energy resources.

Keywords: hydrothermal carbonization, gasification, circular economy, sewage sludge, gas chromatography

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* msieradz@agh.edu.pl

Experiences from the full-scale industrial deammonification process combined with partial nitrification/denitrification as the source of nitrites

Arkadiusz Stachurski[1,2*] | Adam Muszyński[1]

[1]Faculty of Building Services, Hydro and Environmental Engineering, Warsaw University of Technology, Poland
[2]Nijhuis Industries Central Europe Sp. z o.o., Poland

Abstract

Approximately 50% of the nitrogen in our bodies comes from natural sources and approximately 50% from industrial fixation, which means that nowadays, humanity fixes the same amount of nitrogen from the atmosphere as nature. Today's biggest challenge is removing nitrogen from the nitrogen cycle and returning it back to the atmosphere.

One of the largest poultry slaughterhouses in Europe equipped with an industrial WWTP combined with a full-scale Water Reuse System (WRS) from wastewater is challenged by nitrogen removal from the wastewater to provide high-quality feed (treated wastewater) to the WRS. The WWTP receives 10,000 m3/d of industrial wastewater with an average COD of 4000 mg/L, corresponding to 300,000 population equivalents with a total nitrogen load of approximately 3300 kgN/d. Low nitrogen in the WWTP effluent is the key factor for successful water reuse from the wastewater.

Effective nitrogen removal at WWTP strongly depends on a deammonification process called Nijhuis HRNR (High Rate Nitrogen Removal), in which over 30% of the total WWTP nitrogen load is removed. The full-scale deammonification reactor was combined with partial nitrification and partial denitrification separately as nitrite donors for anammox.

Improvements to the full-scale deammonification system increased nitrogen removal in HRNR from 71% to over 85%.

The main changes in HRNR operation were: feeding a special alternating aeration/anoxic sequence, proper dosing of an external carbon source, and an appropriate mechanism for separating anammox bacteria from other microorganisms using a unique fabric-drum filter.

Improved HRNR operation decreased industrial WWTP energy consumption by approximately 1 MWh/d, increased biogas production by approximately 1800 Nm3/d, and lowered excess sludge production by approximately 1.6 MgDS/d, which cut the bill by approximately 2,7 mln PLN/y. Furthermore, water recovery from treated wastewater would not be possible without effective nitrogen removal by HRNR due to the environmental discharge limits of WRS concentrates.

A unique configuration of a full-scale system with partial nitrification and partial denitrification providing NO2- for the deammonification reactor, combined with water reuse from the wastewater, are presented.

* arek.stachurski@nijhuisindustries.com

Understanding urban eutrophication: a case study of Staw Płaszowski and Zalew Nowohucki

Agnieszka Chechelska[1*]

[1]Cracow University of Technology, CUT Doctoral School, Faculty of Environmental Engineering and Energy, Poland

Abstract

Eutrophication remains one of the most pressing threats to aquatic ecosystems, impacting freshwater, coastal, and marine environments. Despite global efforts, recent events and forecasts suggest that eutrophication is not subsiding but intensifying, with severe consequences such as biodiversity loss and significant declines in water quality. This process is exacerbated by multiple factors, including rising temperatures linked to climate change.

A comparative study conducted from April to September 2024 in two urban water bodies — Staw Płaszowski and Zalew Nowohucki — revealed critical insights. Zalew Nowohucki showed significantly higher concentrations of chlorophyll-a and cyanobacteria, indicating advanced eutrophication. This highlights a growing issue in urban areas, where water bodies are often overlooked in broader watershed management strategies. In contrast, Staw Płaszowski exhibited much lower chlorophyll-a levels, suggesting greater resilience to eutrophication, potentially due to more effective management practices.

These findings underscore the importance of monitoring urban water bodies, which remain under-studied despite their vital role in overall watershed health. Understanding the resilience of systems like Staw Płaszowski could provide key insights into better managing and mitigating eutrophication, both in cities and beyond. Enhanced monitoring and management strategies will be essential to safeguard water quality and biodiversity, aligning with broader goals of sustainable urban development.

This study advocates for a more integrated approach to water body management, considering urban water systems as part of a holistic solution to the eutrophication crisis.

Keywords: eutrophication, urban water bodies, water quality monitoring

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* a.chechelska@doktorant.pk.edu.pl

Last resort antibiotics in hospital wastewater: are they a new health and environmental issue?

Joanna Wilk[1*] | Sylwia Bajkacz[1]

[1]Department of Inorganic Chemistry, Analytical Chemistry and Electrochemistry, Faculty of Chemistry, Silesian University of Technology, Poland

Abstract

Overuse and inadequate regulation have led to the emergence of antibiotic resistance, threatening health care and reducing the effectiveness of treatment. The World Health Organization has created the AWaRe (Access, Watch, Reserve) classification to categorize antimicrobials and emphasize prudent use. Reserve antibiotics are used to treat infections caused by multidrug-resistant microorganisms. They are primarily used for inpatient care and are therefore likely to be found in hospital waste. Once administered, antimicrobials are largely excreted in an unmetabolized, still-active form, which can lead to the emergence and spread of resistance through contact with microorganisms in the environment. Monitoring the condition of hospital wastewater is also important due to the lack of specialized systems at wastewater treatment plants to remove it and the inefficiency of conventional treatment methods. Hospital wastewater containing antimicrobial agents is then the first point of distribution of these drugs to other parts of the environment.

The study used solid phase extraction (SPE) and liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS). The developed method was validated and applied to the determination of reserve antibiotics (aztreonam, linezolid, ceftazidime, meropenem, tigecycline, fosfomycin, vaborbactam, cilastatin) in wastewater from 64 hospitals distributed throughout Poland. All antibacterials (except tigecycline) were detected in most of the samples at concentrations ranging from 0.40 ng/L to 22 μg/L. These results underline that the presence of reserve antimicrobials in hospital wastewater is prevalent and that controlling the spread of residues of these drugs is essential to prevent the development of antibiotic resistance to antibiotics of last resort.

Keywords: last resort antibiotics, reserve antibiotics, hospital wastewater, antimicrobial resistance, micropollutants

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* joanna.wilk@polsl.pl

Water – Food – Energy Nexus on the example of water supply for urban hydroponic

Joanna Bąk[1*] | Maja Radomska [1] | Tadeusz Żaba[1]

[1]Cracow University of Technology, Poland

Abstract

In the face of climate change, cities must preparing as part of adaptation to its effects, including searching for alternative water sources. However, it is important that when producing water from an alternative source, carbon dioxide emissions into the atmosphere are not increased through increased energy consumption. If this is impossible, the water production installation should be operated as efficiently as possible. Water shortages also affect food production, hence the growing popularity of hydroponic systems. However, the water for them must be of a specific quality, which in turn is associated with energy consumption in the production process.

The aim of the paper was to analyse the energy consumption during the preparation of raw water from different sources for the needs of food production. The research was conducted on a water treatment installation created as part of the SmartFood project.

The measurements were conducted for tap water taken from the water supply network and rainwater from various surfaces. The total energy consumption of the installation was taken into account, as well as the consumption of its individual modules. The results were confronted with data on energy consumption in the production of drinking water in various locations.

The results allowed for the assessment of energy consumption in the preparation of water from various sources for the purposes of food production. The obtained results allowed for the development of guidelines on the method of operation of water treatment installations and future recommendations on the selection of a water source for urban hydroponics.

Keywords: water demand, hydroponic, water treatment, rainwater, climate change

Acknowledgments: Research project SmartFood has received funding from the Norway Grants 2014-2021 and the state budget of Poland via the National Centre for Research and Development within "Applied Research" Programme. The project benefits from a € 1,364,249.99 grant from Norway as well as a € 240,750.00 grant from the state budget of Poland. The total project value is € 1,604,999.99. The aim of the project is to provide a novel evidence-based socio-technological framework of sustainable food production and consumption towards the sustainable smart city of the future.

* joanna.bak@pk.edu.pl

SESSION
Climate Action and Circular Economy

Concept for reducing salt content in mining water from a Hard Coal Mine

Barbara Tora[1*] | Jolanta Biegańska[1]

[1]AGH University of Kraków, Poland

Abstract

One of the hard coal mines located in southern Poland extracts energy coal (approximately 3 million tons annually).The extracted coal has the following parameter (ROM): calorific value of 16 GJ/ton. In order to obtain commercial coal with a calorific value of approximately 26 MJ/ton, the coal undergoes gravitational enrichment. Gravitational enrichment takes place in a water-based environment. The water used in the enrichment process comes from the mine and has a salinity of 23 g/liter. The coal concentrates (commercial coal) are dewatered, and the water from this process is discharged into the river. The environmental issue is the high salinity of the water, which significantly exceeds the values permitted by environmental protection laws. AGH has developed two concepts for handling the salty water from the mine:

- Washing out the salt during the enrichment process
- Constructing a saltworks to recover commercial salt (road salt)

Keywords: hard coal, water desalination, coal processing

* tora@agh.edu.pl

Assessment of the level of knowledge of ionising radiation among technical school students in the context of radiological education

Joanna Kubiak[1*] | Małgorzata Basińska[1]

[1]Poznan University of Technology, Faculty of Environmental Engineering and Energy, Institute of Environmental Engineering and Building Installations, Poland

Abstract

In the context of the debate on the introduction of nuclear-based energy solutions, raising awareness of ionising radiation and radiological protection is a key element of public acceptance. The aim of this study was to assess the level of knowledge about ionising radiation among young people attending a technical school. A questionnaire was conducted, the results of which indicate that despite the introduction of nuclear physics into the secondary school curriculum, the surveyed group does not have sufficient knowledge of the basics of radiological protection. Respondents often associated ionising radiation only with hazards, and their knowledge of the elements discovered by Marie Skłodowska-Curie was negligible. In addition, a large proportion of respondents were unaware of what radon - a naturally occurring, radioactive gas that accumulates in buildings - is. The results of the pilot study indicate the need for increased funding and more effective education about ionising radiation and radiological protection. The survey indicates that the Polish public is not prepared for the introduction of nuclear power in terms of awareness.

Keywords: nuclear energy, ionizing radiation, natural radioactivity, society

Acknowledgments: We would like to express our sincere gratitude to the Director of the Construction and Vocational Training School Complex in Konin for the opportunity to conduct a survey and to M.Sc. Katarzyna Pałaszyńska, for her assistance in distributing the questionnaires.

* joanna.kubiak@doctorate.put.poznan.pl

The impact of nature-based solutions on pollution removal and environmental risk reduction

Izabela Godyń[1*] | Agnieszka Grela[1] | Krzysztof Muszyński[1] | Justyna Pamuła[1]

[1]Faculty of Environmental Engineering and Energy, Cracow University of Technology, Poland

Abstract

The increasing urbanization in urban catchments and the discharge of stormwater directly into rivers cause their pollution. Measurements were made of the quality of stormwater discharged from residential areas, as well as the quality of the waters of the Sudół River in Krakow below the drainage outlet. The conducted environmental risk assessment showed that the aquatic ecosystem may be at risk. For N–NO3, Zn and Cu, among others, a risk indicator indicating a high risk resulting from environmental impacts was established. Nature-based solutions (NbS) can reduce these threats. A quantitative-qualitative approach was developed to simulate NbS (rain gardens, bioretention cells and vegetative bioswales) on an urban catchment scale. A simulation of NbS implementation was carried out for a selected housing estate in the Sudół catchment in Krakow. The results showed significant reductions in contaminants, including nitrates (6–31%), copper (7–42%), zinc (Zn; 14–78%), polycyclic aromatic hydrocarbons (16–90%) and hydrocarbon oil index (HOI; 15–84%). The reduction in contaminant concentrations reduces the human health risk associated with HOI from a low risk to a zero risk level, and the current ecological risk for Zn from a significant risk to a low potential negative impact. The obtained results provide another indisputable numerical argument, which is the reduction of environmental risk, which indicates the need for widespread implementation of NbS in stormwater management.

* izabela.godyn@pk.edu.pl

Energy transformation in transport – It's happening now!

Tomasz Tumiel[1*]

[1]Bialystok University of Technology, Poland

Abstract

Transport, especially long-distance transport, plays a crucial role in the modern economy. Until the 18th century, most long-distance transportation occurred mainly by sea, and communities relied largely on local resources. In the 19th century, the steam engine's widespread use led to the development of the steam locomotive, which enabled the growth of rail transport. The invention of the internal combustion engine further advanced both rail and road transport, and later aviation.

In the 21st century, the environmental impact of transport became a critical concern. This issue was highlighted in the European Green Deal, through which EU member states have committed to achieving climate neutrality by 2050.

The rail industry, which has long used electric power, must now focus on how energy is sourced, with renewable energy development being essential. Road transport faces the greatest transformation, as traditional combustion engines need to be replaced by electric ones. The key challenge lies in energy storage—specifically, improving battery technology.

Electrification in maritime and aviation sectors is still in its early stages. For maritime transport, modern electrically controlled sails are being considered. Aviation is searching for solutions to achieve sufficient flight times, taking into account the limited space available for batteries.

The transport industry is already implementing solutions to reduce its environmental impact. These efforts are at different stages of implementation, but there is a continuous need to intensify these changes and develop more efficient, eco-friendly solutions for widespread electrification.

Keywords: transformation, Green Deal, ecomobility, crisis

* tomasz.tumiel@sspb.pl

Dark fermentation of sizing waste

Marlena Domińska[1*] | Martyna Gloc[1,2] | Katarzyna Paździor[1] | Radosław Ślęzak[1] | Stanisław Ledakowicz[1]

[1]Department of Bioprocess Engineering, Faculty of Process and Environmental Engineering, Lodz University of Technology, Poland
[2]Lukasiewicz Research Network-Lodz Institute of Technology, Poland

Abstract

Sizing is a technical process in which warp yarns are treated with a wet application to impart the necessary characteristics for weaving, such as strength and smoothness. The success of this process depends primarily on how well the sizing agent adheres to the yarn. Removing the sizing agent from the machine is crucial, as this step is the main source of wastewater. Starch is the most commonly used sizing agent in textile production. As a result, the waste generated during the process is largely composed of starch and water. Starch itself is a glucose-based polysaccharide made up of two components: amylose and amylopectin. The proportion of these components, along with the length of the glucose chains, varies depending on the plant source. Starch is generally considered easy to ferment. Pre-treatment of starch involves breaking down its polysaccharides into simpler sugars, such as glucose and maltose, which can then be fermented. To explore this, an experiment was conducted to assess the potential of utilizing starch waste from sizing for hydrogen production through dark fermentation. This experiment was carried out in batch mode, under mesophilic conditions at 37°C, using bioreactors in a thermostated shaker. During the process, at least 400 mL of hydrogen was produced per gram of total volatile solids derived from the sizing waste. This yield is comparable to that obtained from dry starch and is more than three times higher than the amount of hydrogen produced through the dark fermentation of kitchen waste. These results highlight the potential of starch-based sizing waste as a valuable resource for biohydrogen production.

Keywords: dark fermentation, hydrogen, sizing waste, starch

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* marlena.dominska@dokt.p.lodz.pl

Selected proposals to reduce the negative impact of air transport on the natural environment

Marcin Robert Czubaszek[1*]

[1]Bialystok University of Technology, Poland

Abstract

The basic types of flying units include aerostats, airplanes and rotorcraft. Air transport is one of the commonly used methods of transporting goods and people over long distances. Flying units are used also in the rescue, research, defense-military and entertainment sectors. At the same time, due to the use of fossil fuels, they are responsible for significant atmospheric pollution with harmful substances. Effects of anthropogenic pressure on the natural environment have led to the commencement of work on reducing the negative impact of aviation. The aim of the article is to present and analyze selected proposals to reduce the negative impact of air transport on the environment. The research methodology was the analysis of scientific and popular science literature, press reports and stakeholders' websites. In order to summarize each proposal, a SWOT analysis of selected issues was performed. Identified and analized proposals includes research on the electrification of aircraft using alternative fuels, attempts to optimize routes and the construction of aircraft, including through the introduction of unmanned aircraft, the creation of modern transport gliders and the transfer of some cargo and passenger traffic to competitive, ecological forms of transport, in particular high-speed railways. Legal requirements and increasingly visible climate change indicate the need for rapid research and implementation of their results, while taking into account the primacy of safety. Using different solutions simultaneously can increase their effectiveness. Cost and reliability of technologies remain the main barriers and require further development and improvement.

Keywords: air transport, electrification of air transport, autonomous drones, green fuels

∗ marcin.czubaszek@onet.pl

Optimization of wastewater treatment conditions using activated carbon: a study on the influence of contact time and dose

Angelika Skorupa[1*] | Małgorzata Worwąg[1] | Mariusz Kowalczyk[1]

[1]Czestochowa University of Technology, Poland

Abstract

Pollutants present in industrial wastewater lower the quality of water and soil, which can negatively affect human health as well as the functioning of aquatic and terrestrial ecosystems. Wastewater from the coffee industry contains particles that are difficult to remove, making their elimination a challenge. The aim of the study was to develop optimal conditions for the treatment of synthetic wastewater with caffeine (1 and 10 mg/L) using two types of activated carbon (WG12 and WACC). The effectiveness of the purification process was measured by analyzing the total organic carbon content, turbidity, phosphate content and pH of the samples before and after the process. In the first stage, the contact time between activated carbon and wastewater was evaluated, using the following times: 1, 2, 3, 4 hours of shaking and 2 hours of shaking combined with 22, 46, 70 hours under static conditions. In the second stage, the effect of activated carbon dosage (1 and 2 grams) on the efficiency of the purification process was analyzed. Both types of activated carbon proved effective, and the best results were obtained with contact times of 24 and 72 hours, regardless of the sorbent dose used. The results of the study confirmed the high efficiency of activated carbon in the purification of wastewater with properly selected process parameters.

Keywords: please provide up to five keywords, activated carbon, wastewater treatment, sorption, caffeine, organic pollutants

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* angelika.skorupa@pcz.pl

SESSION
Projects for the implementation of the circular economy - Interreg Baltic Sea Region

The impact of wastewater treatment technology on the scope of risk assessment in water reclamation and reuse

Klara Ramm[1*] | Monika Wojciechowska[2]

[1]Faculty of Building Services, Hydro, and Environmental Engineering, Warsaw University of Technology, Poland
[2]Savonia University of Applied Sciences, Finland

Abstract

As part of the ReNutriWater project (Interreg Baltic Sea), research was carried out on the potential for using water recovered from wastewater to irrigate green areas. The feasibility of water reclamation from MBR (Membrane Bioreactor) treatment plants was tested in Poland. Meanwhile, a pilot technological system in Finland was used to reclaim water from a treatment plant based on activated sludge. The tested treatment plants correctly reduce COD, BOD, and TSS. The MBR treatment plants are particularly notable for their flexibility in nutrient removal, allowing nutrient levels to be maintained above the parametric values. This flexibility ensures that nutrient levels can be tailored to meet plants' specific needs. The pilot technological system in Finland is flexible enough to enable water recovery from any urban WWTP. Advanced Oxidation Processes (AOP) were tested there. A key challenge in water reclamation is the effective removal of microbiological contaminants. E. coli analysis was carried out on the studied WWTPs. This is a widely recognized primary indicator of the risk of fecal contamination. The authors compared results with diverse standards (EU 2020/741 regulation, ISO standards, requirements in California and Australia). Significant variability in E. coli levels was found in the WWTPs studied, suggesting that UV disinfection alone may be insufficient. The table shows the effectiveness of disinfection and the large discrepancy in the E. coli content in raw sewage.

Wastewater treatment plant	Max E. coli amount in WWTP effluent	Disinfection method in water reclamation	Log reduction
PL1 MBR	$240*10^6$	UV	5,38
PL2 MBR	1 000	UV	3
PL3 MBR	34 000	UV	2,53
FI1	415 000	AOP	total
FI2	107 500	AOP	total

In the risk assessment, paying attention to the significant unevenness of the inflow of microbiological contaminants in raw sewage is necessary. UV disinfection may be insufficient.

Keywords: water reuse, reclaimed water, risk assessment, MBR, AOP

* klara.ramm@pw.edu.pl

Practical approach to outreach and engaging of stakeholders in the ReNutriWater project

Daiva Jonuskiene[1*]

[1]Siauliai Chamber of Commerce, Industry and Crafts, Lithuania

Abstract

Water reuse, as a sustainable solution to address water scarcity, is gaining momentum in the Baltic Sea countries of the European Union. Producing freshwater requires diverse, expensive operations, but despite of that, freshwater is often being discharged after one-time use. This wastes water reserves, energy, money, and human labor. Better processes for reclaiming water would reduce these costs considerably. However, there are specific requirements for reclaimed water quality, which must be considered. This poses some challenges for the water reclaim operations. The Interreg BSR ReNutriWater project aims to study and present processes, how water reuse can be done in a safe and economically attractive way. This also paves the way for technology and implementation innovations. Recycled water can be used by municipalities and private entities for various purposes, such as cleaning streets, washing cars, filling fountains and ponds, watering recreational areas and plant breeding. After appropriate treatment, recovered, pathogen- and micropollutant-free water can also be safely used for domestic and drinking purposes. In this way, water management is made more sustainable in accordance with the principles of the circular economy. However, the successful implementation of water reuse projects often hinges on the active engagement and support of diverse stakeholders, including policymakers, water utilities, industries, and the public. Siauliai Chamber of Commerce, Industry and Crafts is a partner in the Interreg BSR ReNutriWater project, where the main task is to build and test pilot solutions. In Lithuania pilot is not implemented, nevertheless we have strategy how to share the experience and knowledge within project partnership. This presentation will explore our used strategies for effective outreach and motivation of stakeholders mostly at regional, and as well at the EU level.

Identifying key stakeholders: Mapping the relevant stakeholders, including communities, businesses, environmental groups, and government agencies. Web search and brainstorming. Stakeholder analysis Categorizing them in terms of their relationship to the project. Some of the stakeholders have the power to either block or advance your project. Some may be interested in what you are doing – others may not care. Stakeholder analysis is used to understand their behaviour, intentions, interrelations, interests, and the influence or resources they have brought or could bring to the project. Identifying the most influential, the most committed, the most accessible and the most negative ones. Power-Interest Grid may be used.

Tailored communication: Developing targeted messages and communication ways that resonate with different stakeholders. For example, for some stakeholders, face-to-face meetings are the most effective means for communicating and resolving issues, but for some face-to-face meetings may not be practical. Give each stakeholder a right amount of information depending on their interest and involvement in the project.

Building trust and long-term collaboration: Fostering dialogue, addressing concerns, and providing accurate information. Communication with proper intervals but within all project period, starting from small announcements and resulting in sharing project results and deliverables. For example, we managed to reach out to the EESC members and EP members.

Community involvement: Encouraging active participation through public events, workshops, competitions. This is especially relevant to our project as we should build user of reclaimed water confidence in safety, break the Jug - psychological barrier that people often have against using reclaimed water.

Addressing concerns and misconceptions: Identifying and discussing potential negative impacts while highlighting the project's benefits to the community. Practical knowledge of partners and experience of pilots, “knowing by seeing” – stakeholders’ visits to pilots in other countries.

Monitoring and flexibility: Continuously assessing stakeholder satisfaction and adapting strategies as needed. “A one-size-fits-all approach” doesn't work.

Conclusion: Successful water reuse projects hinge on active stakeholder engagement and collaboration. By fostering trust, addressing concerns, and employing effective communication strategies, stakeholders can contribute significantly to the further sustainability of these initiatives. The Siauliai Chamber of Commerce, Industry, and Crafts, as a partner in the Interreg BSR ReNutriWater project, is dedicated to promoting knowledge sharing and stakeholder motivation to advance water reuse as a viable solution for addressing water scarcity in the Baltic Sea region.

Keywords: MadeWithInterreg, water reuse, engagement, stakeholders, target groups

* daiva.jonuskiene@ccic.lt

Changes in fertilizing properties of treated wastewater in selected water recovery processes

Justyna Czajkowska[1*] | Alicja Knap-Bałdyga[1] | Monika Żubrowska-Sudoł[1]

[1]Department of Water Supply and Wastewater Disposal, Faculty of Building Services, Hydro, and Environmental Engineering, Warsaw University of Technology, Poland

Abstract

Treated wastewater is a valuable source of water for plant irrigation. In water recovery may be used processes that can change the qualitative composition, which is important from the fertilizing point of view. The study analyzed changes in the concentration of basic fertilizing components (N, P, and K) and changes in salinity (electrical conductivity - EC) of treated wastewater from a wastewater treatment plant (WWTP) with PE = 580 000. The study was conducted on selected unit processes used in water recovery: sand filtration (SF) (3, 5, and 10 m/h), volumetric coagulation (VC) and surface coagulation (SC) (3 m/h) carried out using aluminum-based coagulants ($Al_2(SO_4)_3$, PAX-XL19F, and PAX-XL1911), and activated carbon adsorption (ACA) (5, 10, and 15 m/h). EC in treated wastewater from the WWTP was on average 1180 µS/cm. Apart from the adsorption process, where the maximum reduction of EC was observed for the flow rate of 5 m/h, no significant changes in this indicator were observed. The average concentration of N, P and K in treated wastewater was 7.6 mg/l, 1.1 mg/l and 35.6 mg/l. The highest reduction of fertilizer compounds was observed in the case of the adsorption process at the flow rate of 5 m/h. The reduction of N, P, and K in this case was approx. 95%, 59% and 43%, respectively. On the other hand, the lowest N reduction - 4.9% - was observed in VC using $Al_2(SO_4)_3$, the lowest reduction of P (17.5%) and K (0.44%) was observed in SF at the flow rate of 15 m/h. Based on the studies, it can be concluded that the smallest reduction of P and K is caused by the sand filtration process, and in the case of N, by volumetric coagulation using $Al_2(SO_4)_3$.

Keywords: nutrients, water reuse, coagulation, adsorption, sand filtration

Acknowledgments: The paper was prepared as a part of the “ReNutriWater - Closing local water circuits by recirculation of nutrients and water and using them in nature” project financed by the European Regional Development Fund (ERDF), project no. #C016.

* justyna.czajkowska@pw.edu.pl

Looking for value proposition of recovered water: business model development for wastewater reclamation plant

Mateusz Skalny[1*] | Marzena Smol[1]

[1]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Abstract

Water scarcity has posed a significant challenge to humanity for centuries, nowadays, an increasing number of countries and communities are being impacted by this issue. One promising solution to regional water shortages lies in the implementation of water reuse strategies, where appropriately treated wastewater is repurposed for specific applications, such as aquifer recharge, greenfield irrigation, or street washing, thereby conserving freshwater resources. Furthermore, water reuse can be advanced through techniques like fertigation, where nutrient-rich wastewater is used for simultaneous irrigation and fertilization of crops. These approaches align with the circular economy model and maximize profits while managing waste materials generation issues.

Although water reclamation processes have achieved sufficient outcomes and a high technological readiness level, their implementation remains challenging due to ineffective business and market strategies. This study explores commercialization roadmaps for reclaimed water produced in reclamation plants that utilize effluent from municipal wastewater treatment plant as the input material. The analysis identifies the services and products that municipalities can introduce to the market. The Business Model Canvas (BMC) approach was employed to determine critical components of a business model for water reuse. Data for the business modeling process were collected through a systematic literature review and desk research. The identified highly promising products and services resulting from water reuse are nutrient-rich water for fertigation and reservoir recharge processes, respectively. The BMC analysis highlights the value proposition of recycled water in preventing resource loss, providing low-cost fertilization, and reducing environmental impact on water bodies and emphasizes the role of stakeholders such as farmers, recyclers, and municipal-industrial symbiosis.

Keywords: business model canvas, circular economy, resource recovery

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* maskalny@meeri.pl

Circular Economy (CE) solutions for forestry biomass utilisation in the Baltic Sea Region (BSR)

Paulina Marcinek[1*] | Dariusz Włóka[2] | Jarosław Osiadacz[1] | Marzena Smol[1]

[1]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
[2]GreenBack Ltd.

Abstract

The Baltic Sea Region (BSR) possesses vast resources of underutilised forestry biomass residues, including bark, needles, cones and other organic materials. Despite their abundance, the extent of utilisation of these resources varies significantly across countries in the region, reflecting differing levels of development and technological adoption. In many cases, these residues are predominantly used for lower-value applications, such as bioenergy production. However, this biomass holds untapped potential for extracting high-value compounds that can be applied across various industries.

The "Innovation in Forestry Biomass Residue Processing: Towards Circular Forestry with Added Value Products" (acronym: CEforestry) project addresses the challenge of shifting from traditional low-value uses of forestry biomass residues to innovative circular economy (CE) practices. Its primary goal is to develop and implement new CE concepts that transform forestry side streams into valuable products through cross-sector collaboration. The project will demonstrate these innovations via pilot facilities and develop CE business models (BMs) for recovering and utilising biomass residues. During the project four CE BMs has been development. The first focuses on extracting antibacterial compounds for use in wastewater treatment and the paper industry. The second explores the use of natural antibacterial extracts as food preservatives to extend shelf life while ensuring safety. The third model proposes the development of plant-based meat alternatives through fermentation, addressing the rising demand for vegetarian products. Lastly, the fourth model leverages antibacterial extracts for cosmetic production, offering a sustainable and natural alternative to synthetic agents, meeting consumer preferences for eco-friendly products.

These BMs, once validated, will provide practical recommendations for adopting CE practices in forestry, aligning with the EU's Green Deal, CE strategy, and the BSR bioeconomy strategy. By enhancing the use of forestry residues, the project will contribute to a circular and sustainable forest economy, benefiting enterprises and fostering the development of high-value products.

Keywords: Circular Economy, CE, forestry, business models, Baltic Sea Region

Acknowledgments: Paper was prepared as a part of the project "Innovation in forestry biomass residue processing: towards circular forestry with added value products" (CEforestry) financed by the European Regional Development Fund (ERDF), project no. #C023.

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CIRCULAR ECONOMY CEforestry

* marcinek@meeri.pl

Extraction and Investigation of the lipophilic fraction from Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) forestry side-stream biomass

Alise Zommere[1*]

[1]Department of Environmental Science, University of Latvia, Latvia

Abstract

Coniferous forests in the European Union are a crucial source of roundwood and different wood products, contributing to various industries. During harvesting of these trees a significant amount of needles and branches, known as logging residue, is left behind. This forestry side-stream is currently underutilised but shows potential for application in the bioeconomy due to its chemical composition. Extraction of biomass involves different methods and solvents, including petroleum-based solvents, posing both environmental and health risks. This study aims to investigate various extraction methods with a focus on reducing or eliminating the use of hydrocarbon solvents, thereby refining valuable compounds for various applications while also assessing the antimicrobial, antifungal and antioxidant properties of the obtained extracts. The most effective method in extracting pine and spruce logging residues was found to be maceration at boiling point, using methanol for pine and butanol for spruce extractions. Various groups of compounds were identified in the extracts such as fatty acids, resin acids, terpenes and more. The obtained extracts showed notable antimicrobial, antifungal and antioxidant activities.

Keywords: forestry side-stream, bioeconomy, green extraction

Acknowledgments: This research was supported by Interreg Baltic Sea Region project #C023 "Innovation in forestry biomass residue processing: towards circular forestry with added value products — CEforestry".

∗ alise.zommere@lu.lv

Applicability of spruce bark extract as biocide

Joonas Savelainen[1] | Pekka Oinas[1*]

[1]Aalto University, Finland

Abstract

Bacterial growth in the pulping and paper industry is a challenge that is especially present when the source of pulp is recycled materials. To control the growth of bacteria, antibacterial biocides are used. Biocides are often expensive and made from synthetic, inorganic materials. To offer a cheaper and more sustainable solution, the use of a tannin extract derived from Norway Spruce bark has been proposed. This work examines the applicability of the spruce bark extraction process to an industrial scale. A concept-level process design and a technoeconomic analysis are done. Scientific literature and online material were reviewed to better understand the feedstock and the biocide application and to support the process design. Pulp industry expertise was also utilized. Pilot-level tannin extraction and proof-of-concept bacterial growth experiment were conducted by National Resource Institute Finland (Luke) and Swedish University of Agricultural Sciences (SLU). The results of the pilot were used as the basis for process design, where all the main equipment were sized and a 3D model of an industrial process plant was done. The most effective way to implement the hot water extraction of spruce bark to industrial scale was determined to be a semi-batch process where the bark is loaded into an extractor using a basket with open, meshed endings. Closed water circulation would be implemented to enhance mass transfer and minimize energy consumption. Three 3.5 m^3 extractors were calculated to be sufficient to process 4.5 tons of bark and produce 1800 liters of tannin extract per hour, enough to fulfill the biocide needs of one average pulp mill. Based on the equipment designs and the process setup, investment costs and cash flows will be estimated and long-term profitability will be calculated. The results of this work will demonstrate how the bark extraction process could be implemented into a larger production system and estimate if the technology has the potential to be profitable.

Keywords: spruce bark extraction, tannins, process design, techno-economic analysis

Acknowledgments: Olof Öhgren, retired (Senior Process Engineer).

* oinaspa@gmail.com

SESSION
Monitoring the implementation of the Circular Economy in the water and wastewater sector

Remediation of micro- and nanoplastics by membrane technologies: a review

Michał Bodzek[1*]

[1]Institute of Environmental Engineering, Polish Academy of Sciences, Poland

Abstract

Various unit processes are used to remove microplastics (MPs) and nanoplastics (NPs) from the aquatic environment, such as physical, biological and chemical processes, the effectiveness of which depends on both the properties of the pollutant and the process used. MPs and NPs cannot be completely removed from water/wastewater in conventional wastewater treatment plants and drinking water treatment plants.

Membrane processes for MPs and NPs removal can be used in drinking water treatment and wastewater treatment. Pressurized membrane techniques, i.e. micro- ultra, nanofiltration and reverse osmosis, can be used in the context of MPs and NPs removal as a third step in integrated wastewater treatment systems. The most effective solution in this regard are membrane bioreactors (MBRs), which combine the process of biological wastewater treatment with membrane separation. MBRs can increase the removal rate of MPs and NPs from primary wastewater to 99.9%, especially of the smallest sizes and all shapes, which is significantly more compared to other advanced treatment methods.

MPs and NPs are being detected in drinking water, increasing concerns about the effectiveness of water treatment plants. Membrane separation technology is often used for drinking water treatment, with the advantages of stable quality of treated water and simple operation. The ultrafiltration process combined with coagulation/flocculation can be one of the main technologies for removing MPs and NPs in current water treatment plants.

Significant progress has been made in the removal of MPs and NPs using membrane processes, but further progress is needed to minimize fouling, extension MBR efficiency, and scale-up issues in implementing membrane processes into industrial practice.

Keywords: Micro- and nanoplastics removal, water and wastewater treatment, membrane processes, membrane bioreactors

* michal.bodzek@ipispan.edu.p

Hybrid methods for the elimination of pharmaceuticals from wastewater using cold plasma

Aleksandra Wypart-Pawul[1*] | Anna Grobelak[1]

[1]Częstochowa University of Technology, Poland

Abstract

The increase in pharmaceutical pollution in wastewater poses a significant challenge for environmental protection. Pharmaceutical substances present in municipal and industrial wastewater enter surface waters, negatively impacting living organisms and ecosystems. Traditional wastewater treatment methods, such as biological and chemical processes, are often insufficient for the effective removal of these compounds, necessitating the search for more modern and efficient technologies. This study analyzed the potential of hybrid methods for pharmaceutical elimination from wastewater, using cold plasma, perhydrol, and UV radiation. The combination aimed to enhance contaminant degradation through the synergistic interaction of plasma, hydrogen peroxide, and photolysis, offering new possibilities for pharmaceutical removal. The research was conducted on a laboratory scale, using treated wastewater samples. Among the pharmaceuticals, sulfamethoxazole was eliminated most effectively, with a reduction of over 80%. However, combining these three methods didn't always increase elimination efficiency, and in most cases, the best results were achieved using the plasma process alone. In conclusion, hybrid wastewater treatment methods combining cold plasma, perhydrol, and UV radiation show potential for eliminating certain pharmaceuticals. The synergistic action of these technologies can improve the degradation efficiency of hard-to-remove compounds, though detailed process optimization is needed. Findings suggest cold plasma, used alone, can achieve a comparable or even higher level of reduction than hybrid methods. Further development of this technology could enhance water quality and protect aquatic ecosystems from pharmaceuticals.

Keywords: cold plasma, pharmaceuticals, hybrid methods, treated wastewater

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* a.wypart-pawul@pcz.pl

Water reuse technology in the dairy industry towards circular economy by implementation of advanced process water recycling

Jan Marjanowski[1*] | Jan Hupka[2] | Jakub Drewnowski[2]

[1]MARCOR - Water Treatment Technologies Company
[2]Gdansk University of Technology, Poland

Abstract

According to the data published at the end of 2019 by the Polish Central Statistical Office, 72% of water consumption in Poland is attributable to industry, which uses 7 billion m^3 of water. In the Polish food industry, dairy plants together with meat plants, show the greatest demand for water [Steinhoff-Wrześniowska et al. 2013, the Statistical Yearbook 2019)] Water consumption in dairy production depends on the technology and production profile and is characterized by the unit water consumption coefficient expressed in dm^3 of water per 1 dm^3 of processed milk. This coefficient in the Polish dairy industry has been gradually decreasing over the last 30 years as presented below:

- 5 to 15 dm^3 of water per 1 dm^3 of processed milk [Neryng et al., 1990],
- 2 to 4 dm^3 of water per 1 dm^3 of processed milk [Bednarski et al., 2005],
- 2 to 6 dm^3 of water per 1 dm^3 of processed milk [Zander et al., 2009],
- 1.2 to 4.7 dm^3 of water per 1 dm^3 of processed milk [Steinhoff-Wrześniowska, 2013]

In 2013, water consumption in Poland ranged from 4.2 to 7.7 dm^3/dm^3 of processed milk, and the highest daily water uptake occurred in dairy plants with a milk powder plant [Wojdalski et al., 2013]. A few years later, water consumption in dairies in Poland was still at the level of 3.5–9.8 dm^3/dm^3 [Boguniewicz-Zablocka et al., 2019]. English dairies use 1 - 5 dm^3 of water per 1 dm^3 of milk according to data from 2006 [Rad and Lewis, 2013]. Water consumption in Irish dairies in 2013 was on average 2.28 dm^3/dm^3 of milk, while in Australia in the 2010/2011 season it was 1.75 dm^3/dm^3 of milk [Finnegan et al., 2015].

Water reuse practice towards circular economy in the dairy industry by implementation of advanced process water recycling showed much lower water consumption, which is observed in milk powder and cheese production plants, where condensates from milk evaporators and whey as the process water are recovered mainly for energy purposes. The use of post-process water generated during the processing of milk and whey may significantly reduce the unit consumption of water taken from deep water intakes, with no negative side effects, both in terms of sanitation and technology, that meets ideas of the Green Deal Implementation. Recovered post-process water should be well treated with hybrid methods using ion exchange and membrane technologies. Untreated water causes sediment problems in dairy equipment.

Keywords: dairy reuse water, water consumption, recycling water, post-process water, green deal implementation

* jm@marcor.com.pl

Developing technology for treating wastewater from the process of washing copper-containing fibers and enclosing it in circulation

Martyna Gloc[1,2*] | Katarzyna Paździor[2] | Joanna Olczyk[1] | Renata Żyłła[1]

[1]Lukasiewicz Research Network – Lodz Institute of Technology, Polnad
[2]Department of Bioprocess Engineering, Faculty of Process and Environmental Engineering, Lodz University of Technology, Poland

Abstract

One of the most pressing challenges facing humanity today is the ever-growing demand for clean water, which is vital for both daily life and a multitude of technological processes. However, the issue of global water scarcity arises not only from increasing consumption but also from the deteriorating quality of water, primarily due to inadequate wastewater treatment. Depending on its source, wastewater can contain hazardous substances, and the improper discharge of these contaminants into the environment can have serious and detrimental effects on entire ecosystems. Among these contaminants, heavy metals are particularly concerning due to their toxicity, persistence, and capacity to accumulate in living organisms.

This paper explores the potential for treating real textile wastewater using an innovative technology that combines biological methods with membrane filtration.

The study specifically focuses on laundry wastewater containing copper or its compounds. The experiment employed a sprinkled bioreactor filled with textile waste, which was connected to an external laboratory-scale membrane module. The results demonstrated the effectiveness of this technology, enabling the reuse of the treated water stream and facilitating the closure of the process water circuit.

Keywords: biological treatment, textile wastewater, copper, circular economy

* martyna.gloc@dokt.p.lodz.pl

Analysis of water from the Vistula River in terms of its treatment possibilities – a case study

Monika Ochmańska[1,2*] | Małgorzata Cimochowicz-Rybicka[3] | Dominika Łomińska-Płatek[3] | Tadeusz Bochnia[2]

[1]Cracow University of Technology, CUT Doctoral School, Poland
[2]Kraków Water
[3]Faculty of Environmental Engineering and Energy, Cracow University of Technology, Poland

Abstract

Drinking water for the residents of Krakow is mainly supplied from 4 surface river intakes: Rudawa, Dłubnia, Sanka, Raba (the Dobczyce Reservoir). Climate change has a significant impact on the amount of water in rivers.

The Dobczyce Reservoir plays a key role in stable access to water. The real problems related to water management (e.g. drought), theoretically, treating water from the Vistula it could provide additional supplies of safe water for Krakow. Currently, the problem is the instability of the quality of its waters, both in terms of microbiological and physico-chemical contamination.

The paper presents the results of water tests from the Vistula River. Since the beginning of 2024, microbiological variability has been observed in the range of coliform bacteria: 1800 - 65000 MPN/100ml, *E coli*: 100 - 7300 MPN/100ml, fecal *Streptococci*: 19 - 2000 cfu/100ml. The most problematic is significant salinity (physicochemical indicators) by chloride from 190 to 1100 mg/l. The ionic content for the subsequent ions was max (mg/l): 670 for sodium; 0.35 for ammonium; 9.5 for nitrates; 0.1 for phosphates; 2.07 for total iron. The presence of heavy metals was also detected: Mn, Zn, Cr, Ni. Total organic carbon ranged from 4.13 to 6.12 mg/l. The sum PFAS was determined at the level from 0.0243 to 0.0326 µg/l. Endocrine active were also detected: Bisphenol A (9.0091 - 10.5533 ng/l), 17β-Estradiol (0.1496 - 0.4388 ng/l) and Nonylphenol (4.1083 - 42.9839 ng/l).

Treating water from such a contaminated source, for drinking water purposes, would be expensive and technologically difficult.

Keywords: the Vistula River, raw water, indicators: microbiological and physicochemical, water safety

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* monika.ochmanska@doktorant.pk.edu.pl

Analysis of the possibilities of using selected technological waste from the water and sewage sector of the municipal economy of the City of Krakow – case study, part I

Małgorzata Cimochowicz-Rybicka[1*] | Dominika Poproch[2,3] | Justyna Górka[1]

[1]Faculty of Environmental Engineering and Energy, Cracow University of Technology, Kraków, Poland, Poland
[2]Cracow University of Technology, CUT Doctoral School, Poland
[3]Kraków Water

Abstract

The publication, part I, presents the possibilities of managing technological waste from the Kraków-Płaszów Wastewater Treatment Plant (WWTPK-P) and the Raba Water Treatment Plant (WTP-R). The materials selected for testing were: waste sand and ashes from the incineration of sewage sludge from the WWWPK-P and sludge from water clarification from WTP-R. The proposed use: in construction and in technological processes: for dewatering sewage sludge and for reducing pollutants contained in technological leachates.

The suitability of waste sand from sewage treatment processes for use in cement mortars was tested. In addition, sludge from water clarification processes was used to prepare ceramic materials. The scope of work using ashes from sewage sludge incineration included test series in which ashes were dosed in the following proportions: 5%, 10% and 20% of ashes mixed with sewage sludge by volume.

Based on the analysis of the grain size distribution of waste sand against the background of standard quartz sand, it can be stated that when the standard sand was completely replaced with waste sand, the flow value was reduced by only 5%. In the case of compressive strength testing, complete replacement of standard sand with waste sand causes a reduction of this parameter by up to 50%.

An increased susceptibility of sewage sludge to dewatering was observed (reduction of csk by approx. 60%). Moreover, a reduction in the concentrations of pollutants contained in the technological effluents was observed for the following indicators: COD, total phosphorus, orthophosphates and ammonium nitrogen.

Keywords: water treatment sludge, waste sand, sludge incineration, sludge dewatering,construction materials

Acknowledgments: The presented research results were carried out under the implementation doctorate contract no. DWD/5/0187/2021.

* mcrybicka@pk.edu.pl

SESSION
Sustainable management of Raw Materials

Spectroscopic techniques for determining the sapwood-to-heartwood ratio in sawdust from spruce and pine

Michael Finell[1*] | Isak Bäckman[1]

[1]Swedish University of Agricultural Sciences, Department of Forest Biomaterials and Technology, Sweden

Abstract

In Sweden, a mix of sapwood and heartwood from spruce and pine sawdust is used in pellet production. However, the sawmill industry often employs X-ray scanning to differentiate sapwood from heartwood, as their distinct properties significantly impact the quality of sawn products. Currently, sawdust, a byproduct of wood processing, is not sorted by sapwood and heartwood, despite laboratory-scale experiments demonstrating notable differences in the quality of pellets produced from each. This study focuses on developing methods to assess the proportion of sapwood and heartwood in sawdust, aiming to improve pellet quality.

Near-infrared (NIR) spectroscopy, combined with multivariate analysis, was used to create predictive models for estimating the sapwood-to-heartwood ratio in dry sawdust. NIR measurements were performed using two different instruments: Perten and ASD. The results indicated a high potential for accurately predicting the proportions of sapwood and heartwood, with coefficients of determination (R^2) ranging from 80% to 98%, depending on the instrument and tree species. The models developed for pine sawdust using the Perten instrument provided the highest predictive accuracy. These findings suggest that NIR spectroscopy is a promising tool for optimizing feedstock composition, enabling the production of higher-quality pellets by accounting for the sapwood and heartwood proportions in sawdust.

Keywords: heartwood, sapwood, NIR, pellets

* michael.finell@slu.se

A review on start-up strategies and operation for oxygenic photogranule (OPGs) process

German Smetana[1*] | Anna Grosser[1]

[1]Department of Infrastructure and Environmental Engineering, Czestochowa University of Technology, Poland

Abstract

Oxygenic photogranules (OPGs) are spherical microbial aggregates composed of filamentous cyanobacteria and microalgae in their outer layer and non-phototrophic microorganisms in their inner core. These structures hold promise technology for wastewater treatment plants due to their ability to in-situ oxygen production, which can be an alternative solution to mechanical aeration in conventional activated sludge systems. Also, the granules have better physical properties than activated sludge floc, such as settling velocity and density. Despite significant research on OPGs, including hydrostatic and hydrodynamic cultivation methods and pilot-scale applications in wastewater treatment, several key gaps remain in the literature. One major challenge is the lack of standardized protocol for initiating the OPG process, particularly regarding cultivation conditions and start-up parameters such as inoculum seeding density and types of wastewaters used in research. Variations between studies make establishing consistent protocols for their effective use difficult. Moreover, while factors influencing OPG formation have been investigated, there is no comprehensive synthesis of this data, creating a barrier to a deeper understanding of how various conditions affect OPG size, morphology, and performance in reactors. This variability complicates efforts to optimize OPG-based wastewater treatment processes. This literature review addresses these gaps by analysing the available OPG initiation, cultivation, and performance research. The review aggregates data on the formation factors, seeding densities, and wastewater types, providing a clearer understanding of OPG technology and possible practical applications in wastewater treatment systems.

Keywords: oxygenic photogranules, hydrostatic granulation, hydrodynamic cultivation, activated sludge, microscopy

Acknowledgments: This research in part was funded by the statute subvention of Czestochowa University of Technology (Faculty of Infrastructure and Environment).

* german.smetana@pcz.pl

Novel chitosan sorbent grafted with PAN ligand for the selective sorption of cobalt ions by ion imprinting technique

Łukasz Wujcicki[1*] | Joanna Kluczka[1]

[1]Department of Inorganic, Analytical Chemistry and Electrochemistry, Faculty of Chemistry, Silesian University of Technology, Poland

Abstract

Cobalt as a crucial raw material for many countries' economies has led to extensive exploration of deposits in central Africa, alongside nickel ores. Due to the high physicochemical similarity of cobalt and nickel, there are difficulties in separating them. One effective separation technique is ion imprinting, creating specific binding sites on the sorbent material to recognize and sorb the metal ions selectively. Chitosan is a sorbent possessing several advantages, such as availability, environmental friendliness, and biocompatibility. By modifying the surface of chitosan by imprinting ions, binding sites for cobalt ions can be prepared, enabling their selective removal from a mixture containing nickel ions. In this study, the selective sorption of cobalt ions on chitosan modified with PAN ligand (1-(2-Pyridilazo)-2-naphthol), imprinted with cobalt ions, and cross-linked with epichlorohydrin was investigated. The results showed a high affinity of the sorbent for cobalt ions ($q = 6.8$ mg/g) and a low affinity for nickel ions ($q = 0.9$ mg/g) for concentrations of both metals of 10 mg/dm^3 in the mixture. The pH level had an insignificant effect on the sorption selectivity and the degree of removal of cobalt and nickel ions, particularly in the pH range of 3 - 7. The maximum Langmuir sorption capacity for cobalt ions was 47.0 mg/g. The attempt to imprint ions on chitosan sorbent grafted with PAN ligand was successful, leading to an increase in the sorption capacity and selectivity coefficient of cobalt ions ($K_{IP} = 2.13$, $k' = 1.89$).

Keywords: chitosan, selective sorption, ion imprinting, cobalt ions, nickel ions

Acknowledgments: The research was financed by the Rector of the Silesian University of Technology as part of the Project Based Learning program "Initiative of Excellence - Research University".

* lukasz.wujcicki@onet.pl

Possibilities of the resources using the *Robinia* L. genus species in the Chernihiv city's green infrastructure (Ukraine) in connection with their different invasive activity

Oleksandr Lukash[1*] | Vitalii Morskyi[1] | Halina Tkaczenko[2]

[1]T.H. Shevchenko National University "Chernihiv Colehium", Ukraine
[2] Pomeranian University in Słupsk, Poland

Abstract

In the Chernihiv city's green infrastructure (Ukraine) there are two introducers of the *Robinia* L. genus originating from North America: *R. pseudoacacia* L. and *R. viscosa* Michx. ex Vent. The main objective of the study is to analyze the invasive activity of the *Robinia* genus species in the Chernihiv city's green infrastructure and to outline ways of using their resources. *R. pseudoacacia* has naturalized in the green infrastructure of the city of Chernihiv and covers the urban planting, anti-erosion plantings of sloping areas and mixed forests endangering biodiversity. Remoteness from natural plant communities and very low generative potential do not allow *R. viscosa* to actively show invasive properties. Instead, *R. viscosa* reproduces intensively by root sprouts. Seasonal rhythms of generative development determine the long periods of decorativeness of *R. viscosa*: from May to September. In order to regulate the population of *R. pseudoacacia*, it is worth using this adventive plant as much as possible, taking into account its high economic importance, in particular for dendromass production and honey-making. Special attention should be paid to the *R. pseudoacacia* spontaneous and planting stands as a potential pharmacological resource, because extracts from different parts of the plant have different antibacterial antioxidant, anticoagulant, and α-glucosidase inhibitory effects activities. For optimization of the Chernihiv city's green infrastructure, it is possible to create landscaping objects using different types of the *R. viscosa* plantings. In order to prevent invasive activity, a buffer zone must be left between artificial plantings and potentially vulnerable natural and semi-natural communities located in the immediate vicinity of the landscaping object when designing and reconstructing plantations. The *R. viscosa* potential of as an additional honey resource in the autumn period is also important for optimizing the Chernihiv city's green infrastructure.

Keywords: chernihiv, green infrastructure, invasive activity, *Robinia* L., resources

Acknowledgments: Grateful to the International Visegrad Fund (Scholarship ID #52410400).

* lukash2011@ukr.net

Investigation of qualities of layered geopolymer composites based on aluminosilicates and fibers of natural origin

Agnieszka Przybek[1*] | Michał Łach[1] | Maria Hebdowska-Krupa[1]

[1]Cracow University of Technology, Poland

Abstract

Numerous attempts and projects are being undertaken around the world to develop low-carbon materials, as well as advanced thermal insulation materials. In many countries, decarbonization policies are being implemented and special emphasis is being placed on solutions aimed at implementing materials with a low carbon footprint, among other things. The introduction of increasingly stringent heat transfer coefficient requirements for building materials and the drive for widespread adoption of passive construction are forcing the development of advanced building materials with thermal insulation properties. The use of post-mining waste is in line with the principles of Zero Waste Europe, Resource Efficient Europe and the Circular Economy. The benefit of developing modern materials based on geopolymers and natural fibers is also that such materials implemented on an industrial scale can be produced at a much lower cost and, in addition, due to the possibility of using waste and fibers (renewable material), do not contribute to excessive use of natural resources. This paper will present the results of physical, mechanical and thermal properties of layered gepolymer composites with the addition of natural plant fibers. The results show that it is possible to decrease the density by as much as 40%, the thermal conductivity coefficient by up to 60% while maintaining a bending strength of 5-7 MPa and a compressive strength of 26-34 MPa. This material can be successfully used in construction in the building envelope and prefabricated materials sectors.

Keywords: layered composite, geopolymer concrete, natural insulation material, composite reinforcement, CO_2 reduction

* agnieszka.przybek@pk.edu.pl

SESSION

Sustainable management of energy resources

Energy efficient pathways of recycling c-Si PV modules

Pradeep Padhamnath[1*] | Joanna Karbowniczek[1] | Mirosław Karbowniczek[1]

[1]AGH University of Krakow, Poland

Abstract

The cumulative photovoltaic (PV) installations in the world crossed 1.18 TW in 2023. While this is a much-desired response to manage the climate crisis by providing clean energy, managing the waste generated by End-Of-Life (EOL) PV panels is a challenge that needs immediate attention. Using a conservative approach, the cumulative PV module waste is expected to reach ≈ 8 million tonnes by 2030 and ≈80 million tonnes by 2050. While the average life of the panels is assumed to be 25 years, in reality a number of panels are discarded much earlier due to several reasons. It has also been estimated that by 2040, the weight of newly installed PV panels would almost match the weight of those decommissioned or discarded.

The generation of waste PV panels presents an opportunity to pursue new avenues in terms of recycling and improving the circularity of the PV panels. Recovery of raw materials from the PV panels could lead to establishment of new solar PV end-of-life industries. In-fact, solar PV recycling would be of paramount importance for the transition into a sustainable and economically viable renewables-based energy future. To unlock the mechanisms and possible advantages of PV panels recycling, it is important to research different avenues of reusing the end-of life PV modules in time to meet the expected surge in the PV panel waste. Hence, it is important to consider the pathways in which the components could be recycled or reused most effectively, minimizing the generation of the pollutants, unusable waste, and contaminated by-products of the module recycling process.

In this work we present experimental results for recycling c-Si PV panels using different methods of recycling. Further, we analyze the effectiveness of chemical treatment in removing metal from the silicon solar cells obtained from recycled c-Si PV modules. The silicon obtained from the recycled modules is treated with chemicals to leach out the metals. The silicon obtained as a filtrate is dried and melted in an arc furnace in argon atmosphere to form polysilicon and is analyzed for metallic impurities. It was observed that even after extended treatment with the acids, some traces of metallic impurities were present in the poly-Si. This shows that stringent quality control and characterization methods might be needed to recycle the silicon obtained from the recycled c-Si panels. Furthermore, novel uses of metal contaminated silicon for metallurgical purpose are investigated, promoting 100% reuse of the end-of-life c-Si PV panels.

References

IEA, *World Energy Outlook 2023*, Paris, 2023. https://www.iea.org/reports/world-energy-outlook-2023 (accessed April 11, 2024).

P. Padhamnath, M. Ślęzak, M. Karbowniczek, *EU PVSEC 2023*, Lisbon, Portugal, 2023: pp. 001–008.

S. Weckend, A. Wade, G. Heath, *End-of-Life Management: Solar Photovoltaic Panels, 2016*. https://www.irena.org/publications/2016/Jun/End-of-life-management-Solar-Photovoltaic-Panels (accessed September 8, 2023).

F. Cucchiella, P. Rosa, *Renewable and Sustainable Energy Reviews* 47 (2015) 552–561.

Keywords: sustainable development, Circular Economy, recycling, photovoltaics

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* ppadhamnath@agh.edu.pl

Techno-economic assessment of the Polish energy transition

Bartosz Sobik[1*]

[1]SGH Warsaw School of Economics, Poland

Abstract

Transition to a low carbon economy seems to be one of the most crucial challenges for the European countries so far. Poland is the most coal-dependent country in the European Union. The energy transition is therefore a huge challenge for Poland. The need to decarbonise the energy sector, avoid the problem of missing capacity in view of the existing investment gap and ensure energy security make the implementation of the energy transition in Poland a particular challenge. It is a key challenge for the Polish economy, conditioning its competitiveness in the coming years.

The aim of the work is to characterise the techno-economic factors influencing the shape of the transition to a low carbon economy in Poland, with particular emphasis on the merit order mechanism within the energy market using short-run marginal costs analysis and energy transition scenarios model.

The methods used in this research are literature review, data analysis, scenario analysis and linear non-optimisation models.

Rapid growth of renewable energy sources (RES), particularly photovoltaics, in the Polish energy system will worsen the economic efficiency of coal-fired power plants due to merit order effect, thereby accelerating decarbonisation. Energy technologies based on fossil fuels have a significantly higher interest rate than technologies nearly free of climate risk such as RES. Nuclear power investments have a high cost of capital due to the high level of financial risk. In contrast, market conditions support the development of RES, which have access to relatively cheap capital from a variety of sources.

Keywords: energy transition, sustainability, merit-order, renewable energy sources

* bartosz.sobik@doktorant.sgh.waw.pl

A tool for the feasibility study of energy efficiency projects of urban heating systems

Girts Karnitis[1*] | Edvins Karnitis[1] | Ugis Sarma[1] | Stanislavs Gendelis[1] | Maris Pukis[1] | Janis Bicevskis[1] | Edgars Diebelis[1]

[1]University of Latvia, Latvia

Abstract

The ambitious emissions reduction goals, outlined in the European Green Deal and its normative package Fit for 55, necessitate not only massive renovation of building stocks, but also reconstruction of urban heat generation and supply systems. At the same time funding for the program is extremely limited. Needed prompt and convincing response to any financing option prioritizes quick, simplified computations at the pre-design stage for comparative assessment of project variants over high accuracy.

The developed easy-to-use tool enables flexible, rapid and at the same time sufficiently accurate and objective computation of the benefits of various heating system retrofitting projects, following the principle of an innovative sandbox. It enables analysis of each project variant and the search for the optimum solution for the individual project, as well as the overall optimum of the program. The tool provides calculation of achievable heat consumption and primary energy savings, reduction of dominant CO2 emissions, changes in heating costs, and required investments. It asks for use of limited number of indicators, its usage does not require specific knowledge in thermal physics, economics, or construction. The tool is intended for use by: (1) national authorities for managing the energy efficiency and monitoring the national implementation of Fit for 55 normative requirements, (2) municipalities and local public institutions to streamline the sustainable planning and management of urban heating systems, enabling the identification of priorities and balanced actions, and (3) citizens and businesses to make objective decisions for sustainable managing their properties.

Keywords: urban heating system, energy efficiency, Fit for 55, GHG emissions reduction

Acknowledgments: The study has been supported by the Latvian Council of Science project lzp-2021/1-0108 (Nr. Z-LZP123-ZR-N-231) “Sustainable management of the urban heating system under EU Fit for 55 package: research and development of the methodology and tool“.

* girts.karnitis@lu.lv

Biogas enhancement via in-situ hydrogen and ex-situ bio-methanation in thermophilic and mesophilic anaerobic CSTR reactors

Grzegorz Cema[1*] | Mohamed S. Hellal[2] | Kishore K. Kadimpati[1] | Aleksandra Ziembińska-Buczyńska[1] | Joanna Surmacz-Górska[1]

[1]Environmental Biotechnology Department, Silesian University of Technology, Poland
[2]Water Pollution Research Department, National Research Centre, Egypt

Abstract

The study focuses on evaluating biogas upgrading through in-situ biological hydrogen methanation under mesophilic (37 °C) and thermophilic (55 °C) conditions. Two continuous stirred-tank reactors (CSTRs) with an effective volume of 5 L were installed, filled with inoculum sludge containing 1.5% volatile solids (VS). The reactors were fed with mixed waste sludge at an organic loading rate (OLR) of 1.5 g VS/L, and the sludge retention time (SRT) was set to 14 days under mesophilic conditions at 37 °C. One reactor served as a control, while the other was injected with H_2 through a micro-ceramic membrane diffuser, with the H_2 ratio ranging from 4:1 to 8:1 in both phases. The next stage involved transitioning from the in-situ system to an ex-situ system. The production of biogas was continuously monitored using gas meters and gas chromatography to assess the performance of each setup. The results indicated better performance of the bio-methanation process under thermophilic conditions compared to mesophilic ones. The biogas quality, as measured by CH_4 content, increased from 52% without H_2 injection to 78% under mesophilic conditions, while in thermophilic conditions it reached 85%, with almost complete (99.5%) conversion of CO_2 to methane. In the ex-situ configuration, methane content reached 77%, and methane production efficiency significantly increased compared to the in-situ configuration. These findings highlight the potential of thermophilic conditions in improving biogas quality and optimizing hydrogen conversion, suggesting that temperature plays a crucial role in enhancing the efficiency of biological methanation.

Keywords: anaerobic digestion, biogas, Bio-methanation, CSTR, hydrogen

Acknowledgments: This work is within the framework of project WasteValue funded by Norway grant No. (NOR/POLNOR/WasteValue/0002/2019-00).

* grzegorz.cema@polsl.pl

Enhancing metal recovery from lithium-ion battery cathodes: optimization of leaching and reactor configuration

Maria del Mar Cerrillo-Gonzalez[1*] | Maria Villen-Guzman[1] | Juan Manul Paz-Garcia[1] | Jose Miguel Rodriguez-Maroto[1]

[1]University of Málaga, Spain

Abstract

This study explores the application of hydrometallurgy for recycling lithium-ion batteries (LIBs), focusing on optimizing leaching processes to recover valuable metals. Conventional methods often require high acid concentrations, resulting in increased reagent consumption and environmental concerns. Typically, the leaching process is carried out in a batch reactor, where the solid material, acid, and reductant agent are loaded at the initial time. In contrast, this research study the use of a semi-batch reactor, where the acid is continuously fed to the system to mantain constant the reactant concentrations.

Experimental results demonstrate that the semi-batch configuration offers significant advantages over traditional batch reactors, including faster dissolution rates and higher extraction efficiencies. Optimizing the initial concentrations of HCl and H_2O_2 was critical in enhancing metal recovery while maintaining low reagent consumption. Specifically, the study found that high H_2O_2 concentrations improved reaction selectivity and extraction rates, reducing Co^{3+} to soluble Co^{2+}, whereas low HCl concentrations favored selectivity without significantly compromising the overall yield. The introduction of a double semi-batch system further optimized reactant use, achieving extraction efficiencies of up to 93% for lithium and 91% for cobalt, while reducing H_2O_2 consumption by 30%.

These findings highlight the potential of semi-batch reactors to improve both economic and environmental sustainability in LIB recycling processes. The proposed method could be integrated into existing industrial systems with minimal investment, offering a scalable solution for advancing the circular economy. Future work will explore the application of this approach to other LIB materials on a larger scale.

Keywords: Lithium-ion battery, recycling, hydrometallurgy, leaching, reactor configuration

* mcerrillog@uma.es

CLOSING SESSION

Implementation of the guidelines of Directive ((EU)2020/2184) by the Krakow Water

Małgorzata Cimochowicz-Rybicka[1*] | Monika Ochmańska[2,3] | Tadeusz Bochnia[3]

[1]Faculty of Environmental Engineering and Energy, Cracow University of Technology, Kraków, Poland, Poland
[2]Cracow University of Technology, CUT Doctoral School, Poland
[3]Kraków Water

Abstract

In recent years, we have observed a dynamic change in the regulations specifying the requirements for water supply companies: Council Directive 98/83/EC of 3 November 1998; EU Directive 2015/1787 of 10/2015, amending Annexes II and III to the Council Directive; Commission Directive 2009/90/EC of 31 July 2009 – monitoring the chemical status of water; new Directive (EU) 2020/2184 of 23 December 2020 (DWD). EU law requires the transposition of regulations into the law of European Union countries, including Polish law (Act of 7 June 2001 on collective water supply and sewage disposal). From the point of view of water supply companies, it is important to adapt to the key assumptions of the new Directive.

The publication presents the activities of the Krakow Water (WMK) aimed at adapting the enterprise to new requirements by: a) introducing new water treatment technologies, b) reducing water losses, c) improving the reliability of the water supply system. WMK is implementing the InTuDe project: "Innovative technology for the treatment of saline surface waters in a circular economy". In addition, the WMK Research and Development Center is conducting a project: "Expansion of the analytical potential of the Central Laboratory". WMK have purchased highly specialized research equipment.

The DWD provisions include requirements for the analysis of “emerging contaminants” and for the analysis of coliphages. The Krakow Water has adapted to the new requirements, which results in ensuring continuous safety in providing consumers with high-quality water supplies.

Examples and results of experimental research conducted up to now will be presented.

Keywords: Kraków Water, Directive (EU) 2020/2184, water pollution and safety

Acknowledgments: The presented research results were carried out under the implementation doctorate contract no. DWD/7/0144/2023.

* mcrybicka@pk.edu.pl

How ESG performance affects corporate green transformation

Monika Sady[1*]

[1]Krakow University of Economics, Poland

Abstract

In recent years, the integration of Environmental, Social, and Governance (ESG) criteria has emerged as a pivotal factor in shaping corporate strategies, particularly in the context of green transformation. This speech will explore the multifaceted relationship between ESG performance and corporate sustainability initiatives, highlighting how robust ESG practices can catalyze significant environmental changes within organizations.

Raising environmental and natural challenges, frequent natural disasters and climate risks have emerged as sustainable development, a theme of the current research. ESG encompasses environmental stewardship, social responsibility, and corporate governance, embodying the value and practical focus of sustainable development. Enterprises, as important players in the market, play a key role in promoting green and sustainable development. Scholars argue that ESG performance positively influences enterprises' green transformation and has a positive effect on enterprise green innovation, mainly by easing the pressure of the financing enterprise, aligning with stakeholders' environmental protection concepts, and fostering employee organizational identity to drive enterprise green innovation.

The presentation will examine the relationship between ESG metrics and corporate sustainability goals. Next, it will address the role of stakeholders—particularly investors, regulators, and consumers—in shaping ESG priorities. It will end with thoughts about ESG being a catalyst for green innovation, while the risk of greenwashing and the difficulty of aligning short-term financial goals with long-term environmental objectives pose significant hurdles.

Keywords: ESG, green transformation

∗ sadym@uek.krakow.pl

Gender importance in environmental sciences

Zofia Łapniewska[1*]

[1]Jagiellonian University in Krakow, Poland & Polish Economics Network , Poland

Abstract

How many women - pioneers of environmental studies can you name? Do you include them in your design of curricula? Is environmental science objective? What can help to include a gender perspective in future research conducted in this field? I will try to answer these questions during my short presentation on the role of gender in environmental science. I will indicate areas requiring change, as well as inspire research in the spirit of ecofeminism.

* z.lapniewska@uj.edu.pl

Abstracts

Oral presentations on-line

SESSION

The Green Deal and the recovery of biogenic raw materials

Recycled Raw Materials in 3D concrete printing

Adam Hutyra[1*]

[1]Cracow University of Technology, Faculty of Materials Engineering and Physics, Poland

Abstract

Concrete 3D printing (3DCP), being a niche technology in the construction industry, offers unmatched adaptability in both structural design and the materials that can be applied. The ability to tailor materials can be directed toward greener building solutions. Integration of recycled or natural raw materials presents an opportunity to promote sustainability in construction. This presentation describes several approaches, based on replacing concrete mix ingredients with recycled materials to reduce the overall carbon footprint. A basic solution involves the use of recycled aggregates, such as crushed concrete and ceramics from demolition waste. This strategy not only reduces the consumption of virgin materials but also addresses the issue of construction waste management. However, challenges remain, particularly with the variability of recycled aggregate properties and their impact on the consistency of print mixture. The presentation also highlights the promising use of recycled glass. Crushed glass can enhance both the aesthetics and durability of 3D-printed concrete. Its hardness and chemical resistance make it a suitable alternative to conventional fillers, although its brittle nature requires careful consideration during mix design. Finally, industrial by-products such as fly ash and processed blast furnace slag are being explored as cost-effective substitutes for binding materials. These materials significantly reduce the emissions associated with cement production while improving the workability of 3D concrete. Presented approaches offer reduction of emissions associated with construction. Although using advanced alternatives for raw materials introduces complications to the 3D printing process, these are offset by cost savings and reduced environmental impact.

Keywords: 3DCP, recycled aggregates, 3D concrete mix

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* adam.hutyra@doktorant.pk.edu.pl

Toward sustainable material use: fiber durability in geopolymer hardening solutions

Regina Kalpokaitė-Dičkuvienė[1*] | Jūratė Čėsnienė[1] | Rita Kriūkienė[1] | Anastasiia Sholokhova[1]

[1]Lithuanian Energy Institute, Laboratory of Materials Research and Testing, Lithuania

Abstract

Geopolymers, as inorganic materials, have received considerable attention in recent years for their potential as sustainable alternatives to cement-based materials [1]. A key area of research in this field involves incorporating reinforcing fibers to improve the mechanical properties of geopolymer composites [2,3]. Recovered fibers, derived from the pyrolysis of waste wind turbine blades, present an eco-friendly and sustainable option for fiber reinforcement [4]. However, the durability of these recovered fibers within the geopolymer matrix is a critical concern, as fiber degradation could undermine the composite's long-term performance. The present study investigates the degradation of recovered fibers when exposed to alkaline and acidic geopolymer hardening solutions at room temperature for up to 180 days.

Results revealed that the recovered fibers are much more susceptible to an alkaline than an acidic environment. When exposed to the alkaline geopolymer hardening solution for 120 days, the fiber diameter was reduced by nearly 70%. In contrast, the fibers showed greater resistance to degradation in the acidic solution, giving less than a 5% decrease in diameter. According to SEM-EDS and XRD analysis, calcium hydrosilicates and calcium carbonates formed mainly in an alkaline solution, whereas the deposition of calcium phosphates was detected in an acidic medium. Results suggest that the recovered fibers can be used as a durable reinforcing agent in geopolymer compositions, thus reducing the raw material resources needed for fiber production.

Keywords: geopolymer, recovered fiber, durability, microstructure

* regina.kalpokaite-dickuviene@lei.lt

Experimental study on filtration characteristics in selected alternative materials

Katarzyna Gabryś[1*]

[1]Department of Geotechnics, Institute of Civil Engineering, Warsaw University of Life Sciences – SGGW, Poland

Abstract

The rational management of natural resources and recycling are receiving increasing attention. The construction industry is no exception. The construction process uses, among other things, various rock aggregates, metals of all kinds, and, above all, cement obtained from marble, limestone, and clay. All of these raw materials are considered exhaustible, non-renewable natural resources that take too long to produce in human lifetimes. Recycling is the answer to the over-exploitation of natural resources In addition, the above solution has a positive economic balance compared to the cost of disposing of construction waste and purchasing new materials. Recycling is also ideal for processing rubber materials, such as used car tires, to obtain an alternative material. The resulting rubber granulate is a raw material that can be used for road surfacing, sports surfaces, or children's playgrounds. Alternative materials are worth using for environmental reasons. However, their physical, chemical, and mechanical properties must be regularly tested. One of the parameters necessary for the practical application of alternative materials is the filtration coefficient, the characterization of which is insufficiently documented in the literature. Therefore, this research focuses on the filtration characteristics of pure anthropogenic soil (here recycled concrete aggregate, RCA) and its modified version with recycled tire waste (RCA–RTW). RCA proved its good quality as a permeable material with the average coefficient of permeability (k_{avg}) in the range of 2.75×10^{-5} to 3.77×10^{-5} m/s, which is about 16% higher than k_{avg} for RCA–RTW mixture. The paper presents the concept of hydraulic conductivity as a function of hydraulic gradient. As the hydraulic gradient increases (from the value of approx. 0.4 to 0.8, by an average of 0.20), the filtration coefficient changes. It increases for the pure RCA and decreases for its modified version, which deviates from the criteria used and derived from Darcy's law. The differences, which are in the order of 5%, are not significant and can therefore be neglected for practical solutions. The methodology of the tests carried out, and the results are described, confirming the applicability of the tested materials for the construction of earth structures under the influence of the groundwater table.

Keywords: coefficient of permeability, anthropogenic materials, recycled concrete aggregate, shredded used tires, laboratory tests

* katarzyna_gabrys@sggw.edu.pl

Integrating chemical phosphorus precipitation and ammonia-oriented membrane distillation for enhanced nutrient recovery

Bogna Śniatała[1*] | Dominika Sobotka[1] | Giorgio Mannina[2] | Jacek Mąkinia[1]

[1]Faculty of Civil and Environmental Engineering, Gdansk Tech, Poland
[2]Department of Engineering, University of Palermo, Italy

Abstract

Transforming wastewater treatment plants into water resource recovery facilities requires integrating processes of efficient nitrogen (N) and phosphorus (P) removal and recovery. Even though, integrated macronutrients recovery technologies have been developed, at commercial scale the most often applied remain chemically intensive and energy demanding P-oriented chemical precipitation and N-oriented ammonia (NH_3) stripping with absorption. Moreover, the multi-stage technologies are space demanding, which limits their application at small WWTPs.

This study aimed to investigate (at laboratory scale) the possibility of saving chemicals, energy and space by integrating P chemical precipitation (in struvite form) and N recovery (in ammonium sulphate ($(NH_4)_2SO_4$) form) within gas-to-liquid membrane distillation (MD) in one reactor from anaerobic digester liquors (containing >200 mg P/dm^3 and >500 mg N/dm^3) and optimize the feed solution pH and temperature for efficient simultaneous P and N removal and recovery.

The most efficient P removal (95%) was achieved at pH 8 in the lower investigated range of nutrients (i.e. 400 mg P/dm^3; 1000 mg N/dm^3). Temperature of 20°C is suggested for struvite precipitation but is not effective for stripping gaseous NH_3. Up to 99% of N was removed at pH 10 and 50°C. However, too high efficiency of N removal led to the failure of P removal due to the disturbance of the N:P molar ratio.

The one-reactor process optimization showed the potential to achieve up to 81 %P and 89 %N recovery from wastewater of 400 mg P/dm^3 and 1000 mg N/dm^3 at pH 10 and 42 °C in crystal and liquid form fertilizer respectively.

Keywords: wastewater, nitrogen recovery, membrane distillation, phosphorus precipitation, fertilizer

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* bogna.sniatala@pg.edu.pl

Invasive plants as a resources of valuable lipids (fatty acids) for bioeconomy applications

Eva Borska[1*] | Māris Kļaviņš[1] | Jorens Kviesis[1]

[1]University of Latvia, Latvia

Abstract

Invasive plant spreading is continuously increasing, posing significant threats to biodiversity, ecosystems, agriculture, and the health of living organisms. Many questions remain unanswered regarding effective management and control, methods of utilization and processing, and the chemical composition and biological activity of these plants. Despite the fact that invasive plant biomass (waste material) can be used to generate energy, bioproducts, and other valuable resources—offering both economic advantages and supporting sustainability—a promising area of focus is the extraction and analysis of biologically active substances, for example, lipids, fatty acids and other substances.

Promising group of substances for applications are fattly acids. The fatty acid content in studied invasive plant biomass has been found to be highand its variations were determined in extracts The composition of the lipid extracts was analyzed using gas chromatography-mass spectrometry using lipid extracts fromdifferent biomass parts of several invasive plants common in North/Central Europe - Sosnowsky's hogweed (*Heracleum sosnowskyi*), Canadian goldenrod (*Solidago canadensis*), Bohemian knotweed (*Reynoutria × bohemica*), Japanese knotweed (*Reynoutria japonica*), and Sakhalin knotweed (*Reynoutria sachalinensis*). Differing levels and quantities of fatty acids for potential use in obtained extracts have been found. Invasive plant lipid analysis demonstrated presence of many substances of interest for applications in bioeconomy.

Keywords: fatty acids, invasive plants, biomass, bioeconomy

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* eva.borska@lu.lv

Utilization of dairy effluent for production of food grade enzymes

Madhu Parakkottil Chothi[1*]

[1]MET'S School of Engineering, India

Abstract

Utilization and treatment in the dairy industry play a pivotal role in managing the wastewater generated during various operations in the dairy industry. These treatment are to remove harmful contaminants and pollutants from the wastewater before it is discharged into the near by freshwater bodies. Proteases are proteyolytic enzymes having application in baking, food processing, protein modification etc. As a commodity product, pressure on protease market is on prize reduction and increasing performance. There are three types of industrial protease such as Acid protease, Alkaline protease and Nutral protease and nutral proteases are the most utilizing proteins among the three enzymes.

Objective: The main objective of the present study was to isolate a potent protease-producing microorganism and formulate a cost effective medium for neutral protease synthesis by the potent microbial culture.

Result and Conclusion: In order to achieve the objective, a proteolytic bacterium was isolated from soil using milk agar medium and the bacteria was identified as *Bacillus* sp. by morphological and biochemical characterization. Dairy industry effluent was then studied as a medium for neutral protease synthesis by the potent bacteria. Supplementation of mineral salt to the medium did not show profound influence of environmental factors such as medium pH, incubation temperature, agitation rate and incubation time on enzyme production. Optimum enzyme titers were found at pH7 when incubated at 37°C and 120 rpm 48 h. Dairy industry effluent was thus found to be a cost effective medium for neutral protease synthesis by *Bacillus* sp.

Keywords: dairy effluent, milk agar, *Bacillus* sp., neutral protease

* drmadhu@metsengg.ac.in

Combined treatment of dual-species biofilms with essential oil and *Rhodococcus erythropolis* IMV Ac-5017 surfactants mixture

Anastasiia Okhmakevych[1*] | Tetiana Pirog[1,2]

[1]National University of Food Technologies, Ukraine
[2]Institute of Microbiology and Virology, National Academy of Sciences of Ukraine, Ukraine

Abstract

Biofilms are responsible for infections. Combined biofilms are commonly encountered. The *Rhodococcus erythropolis* IMV Ac-5017 surfactants are non-toxic, biodegradable, and can be used as antibiofilm agents. The biological activity of *R. erythropolis* IMV Ac-5017 surfactants can be enhanced by introducing *Saccharomyces cerevisiae* BTM-1 into the cultivation medium. Additionally, a synergistic antimicrobial effect was observed with a complex of *R. erythropolis* IMV Ac-5017 surfactants and tea tree essential oil.

Research objective: to determine the extent of dual-species biofilms destruction under the influence of a mixture (1.25-640 μg/ml) of lemongrass essential oil and *R. erythropolis* IMV Ac-5017 surfactants, synthesized with the yeast inducer.

The maximum degree of destruction of the biofilm *Escherichia coli* IEM-1 with *Staphylococcus aureus* BMS-1 after treatment with a mixture of lemongrass oil and *R. erythropolis* IMV Ac-5017 surfactants, synthesized with live *S. cerevisiae* BTM-1 cells, as well as the corresponding supernatant, was 83-86%. In contrast, under the influence of monobiocides the degree of destruction did not exceed 59-65%.

In case of treatment of the biofilm *Candida albicans* D-6 with *Pseudomonas* sp. MI-2 with a mixture of oil and surfactants synthesized with heat-inactivated yeast cells, the degree of destruction was 4-22 and 2-32% higher than under the action of only corresponding surfactants and oil.

Consequently, the possibility was established of a significant increase in the degree of dual-species biofilm destruction after treatment with a mixture of lemongrass oil and *R. erythropolis* IMV Ac-5017 surfactants, synthesized with yeast *S. cerevisiae* BTM-1, compared with the effect of the individual substances.

Keywords: *Rhodococcus erythropolis* IMV Ac-5017 surfactants, biological inducer, dual-species biofilms destruction, synergistic effect, lemongrass essential oil

Acknowledgments: Authors thank to the Department of Biotechnology and Microbiology of the National University of Food Technologies.

* anastasia01.roza@gmail.com

SESSION
Waste, wastewater and innovation

Determination of iodine contrast agents in hospital wastewater using HPLC– ICP– MS

Katarzyna Wrzesińska[1*] | Jacek Czerwiński[1]

[1]Faculty of Environmental Engineering, Lublin University of Technology, Poland

Abstract

Iodinated contrast compounds (ICM) are concentrated organic solutions with a benzene ring structure linked to iodine atoms. Among other things, ICM are used in radiological studies to increase tissue resolution. The use of iodine in contrast agents is due to its low toxicity and strong absorption of X-rays. More than 75 million examinations with iodinated contrast agents are performed annually worldwide, resulting in high concentrations and significant bioaccumulation of these compounds. ICM are present not only in hospital wastewater, but also in surface water, groundwater and drinking water. Wastewater treatment plants do not provide a sufficiently effective barrier against the entry of harmful substances into the aquatic environment. Even low concentrations of iodine can lead to disinfection by–products. As evidenced by literature data, disinfection by–products can be toxic and mutagenic to both aquatic organisms and humans. The major concept of the research was to develop and validate an analytical procedure for the determination of iodinated contrast agents. Advanced high-performance liquid chromatography (HPLC) combined with inductively coupled plasma mass spectrometry (ICP– MS) was applied. This system allowed satisfactory results of iodinated contrast agents determination in real wastewater.

Keywords: iodinated contrast agents, high-performance liquid chromatography, environmental pollution

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* d589@pollub.edu.pl

Development of the novel strategy for effective reject water treatment

Aleksandra Szaja[1*]

[1]Faculty of Environmental Engineering, Lublin University of Technology, Poland

Abstract

During the processing of sewage sludge, highly concentrated wastewater called reject water is generated, characterised by high nitrogen and phosphorus contents. Despite its small share in the inflow of wastewater treatment plants, it might lead to many operational problem in such facilities. Therefore, before it recirculation to main wastewater stream, it should be pre-treated. In this study, a novel strategy using hydrodynamic cavitation (HC) and subsequent absorption and ion exchange using natural zeolites was adopted. In HC experiments, three inlet pressures of 3, 5 and 7 bar and two type of inducer were evaluated. The effectives of HC was examined at 0, 5, 10, 20, 30, 45 and 60 min were evaluated. The absorption and ion exchange experiment was performed in batch mode using clinoptolite. In this case, two contact times were tasted: 0.5 and 24h. The following doses of zeolites will be applied: 50, 100, 200 g/L. The most favourable results in terms of improved biodegradability and removal of ammonium nitrogen and phosphates were obtained using HC orifice plate with 9 cylindrical holes with diameter of 1 mm, pressure of 3 bar and time of 30 min, contact time of 24h and zeolite dose of 200g/L.

Keywords: reject water, zeolites, hydrodynamic cavitation, technological development, removal of ammonia nitrogen and phosphates

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* a.szaja@pollub.pl

Optimizing biochar-based column filtration systems for enhanced pollutant removal in wastewater treatment: a preliminary study

Sofiane El Barkaoui[1,2*] | Laila Mandi[1] | Massimo Del Bubba[2] | Naaila Ouazzani[1]

[1]Laboratory of Water, Biodiversity and Climate Change, Biology Department, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco
[2]Department of Chemistry, University of Florence, Italy

Abstract

Sustainable development aims to ensure universal access to water as a main objective and reduce waste. An innovative approach is the treatment and reuse of wastewater in combination with the recycling of agricultural waste. By converting these residues into biochar, we can not only reduce agricultural waste but also use the biochar to treat wastewater, creating a circular system that promotes resource conservation and environmental protection. In this study, the removal of pollutants from wastewater was compared using a column filtration (CF) based on sand (CFS), olive pomace biochar (CF.BOP), orange waste biochar (CF.BOW), filao biochar (CF.BF), and cypress biochar (CF.BC). The results showed that biochar-based CF provided higher removal efficiencies for total nitrogen (TN), ammonium (NH_4^+-N), chemical oxygen demand (COD), and absorbance (ABS 254 and 420 nm). Notably, CF.BOW has the best removal rates compared to CFS for TN (45% vs. 27%), NH_4^+-N (87% vs. 78%), COD (63% vs. 47%), ABS 254 nm (40% vs. 34%), and ABS 420 nm (35% vs. 34%). The higher removal of NH4+-N was accompanied by a high release of nitrate (NO_3^--N) due to nitrification. However, no significant effect of biochar integration was observed for phosphorus removal. In addition, biochar-based CF showed higher removal of bacteriological indicators, such as total coliform (TC), fecal coliform (FC), and fecal streptococci (FS), compared to CFS for the removal of TC, FC, and FS.

Keywords: biochar type, biochar properties, wastewater treatment, column filtration

* sofiane.elbarkaoui@unifi.it

SESSION

Implementing the Green Deal strategy in the water and wastewater sector

Quality of biochar as a recycling-product from sewage sludge

Maria M. Estevez[1*] | Renata Tomczak-Wandzel[1] | Mari Espelund[1] | Susanne Eich-Greatorex[2]

[1]Aquateam COWI, Norway
[2]NMBU, Faculty Of Environmental Sciences And Natural Resource Management, Norway

Abstract

Within the frame of the Norwegian research project RenCARBio, samples of sewage sludge were evaluated for biochar production. The project aims to apply anaerobic digestion and pyrolysis as a combined and safer handling solution for this municipal organic waste-stream, in the search of reducing the volume of sludge to manage, improving the recirculation of its nutrient-value, and minimizing the input of harmful contaminants to the soil.

Samples of raw and anaerobically digested sewage sludge that originated from biological or chemical treatment, were provided by the different wastewater treatment plants located in Norway.

The sludge samples were used as feedstocks on batch-scale pyrolysis trials, with a rotary furnace-pyrolysis unit of 2 L working volume, run at 400 °C. The quality of the sludge and biochar's (elemental composition, heavy metals, micro- and macronutrients, selected pharmaceuticals) was analyzed.

After pyrolyzing the samples, the total-N content was reduced for all samples, with 6 % for the raw bio-sludge's biochar versus 4,5 % for digested bio-sludge's biochar. Digested bio-sludge samples had a lower content than raw bio-sludge ones, and phosphorus concentrated during the pyrolysis process, with the content in digested bio-sludge char still lower than for raw bio-sludge biochar (21 % vs. 33 %). Regarding heavy metals, the content of copper, zinc, nickel and cadmium reached values that would restrict the direct use of the biochar as organic fertilizer for all samples, according to the Norwegian organic fertilizer regulation. Most pharmaceuticals detected in the feedstocks were reduced by 80-99,9% after pyrolysis.

Keywords: sewage sludge, pyrolysis, biochar

Acknowledgments: RenCARBio project is funded by the Norwegian Research Council under the SIRKULÆRØKONOMI program (Project nr. 326914). The project is also supported by The City of Bergen, ÅRIM IKS, IVAR IKS, Kalnes Agricultural Highschool and WAIES AS. The application process was supported by COWIfonden.

* mmes@aquateam.no

Climate change and strategies toward climate neutrality

Ayla Novruzova[1*]

[1]University of Maria Curie Sklodowska, Poland

Abstract

In the context of global climate change, this study seeks to evaluate contemporary strategies and methodologies for achieving climate neutrality. It explores the main causes of climate change, including greenhouse gas emissions, and their impacts on both society and the environment. The research focuses on various strategies to reduce carbon emissions, such as shifting to renewable energy sources, developing low-emission technologies, and improving energy efficiency. The following strategies warrant particular attention: *Transition to Renewable Energy Sources, Development of Low-Emission Technologies, International Collaboration, Adaptation Measures.* The study uses a mixed methods approach, integrating qualitative case studies with quantitative data analysis. This combination gives rise to diverse possible options. The strategy highlights technologies and concerted international efforts to mitigate climate change impacts as a part of in diverse socio-economic conditions and developing policies that support sustainability and sustainable development within practices.

Keywords: climate change, neutrality, low emission, greenhouse, strategies

* aylanv94@gmail.com

Circular Economy on olive mill wastewater management in Greece

Iosif Emm Kapellakis[1*]

[1]Department of Civil Engineering, School of Architecture, Engineering, Land and Environmental Sciences, Neapolis University Pafos, Cyprus

Abstract

Olive mill wastewater (OMW) is the liquid by-product derived in huge quantities during olive oil production and is characterised by distinct and severe properties. Due to the spatial nature of the problem, which is mainly confined to the Mediterranean EU countries, no EU Directive or Regulation has yet been adopted to provide specific provisions for the management of olive residues. Consequently, each EU member state has its own legal framework, which is often very different compared to those of the other EU countries.

In Greece, the first comprehensive effort to manage industrial environmental issues dates back in 1965, while the first systematic efforts to adopt the principles of circular economy -and more specifically land application- on OMW management are dated back in 2011, efforts that were later amended.

The aim of this study is to determine the degree of adoption of the principles of the circular economy and the flexibility of the recycling opportunities of the legal framework. For this reason, the Messara basin is examined, an area covering 400 km² in Crete, Greece, and characterized by high olive oil production, which ranged from 8,225 to 41,166 tons/yr for the period 2005-2023. About 90 olive mills operate in the area and management of OMW includes Calcium hydroxide treatment and disposal in evaporation ponds. The detailed analysis on current management practices revealed that land application of OMW, as proposed by the legal framework, lacks practicality while more incentives and initiatives must be given to olive mills to achieve a more sustainable by-product management.

* i.kapellakis@nup.ac.cy

Circular Economy in African companies: evolution, challenges and opportunities

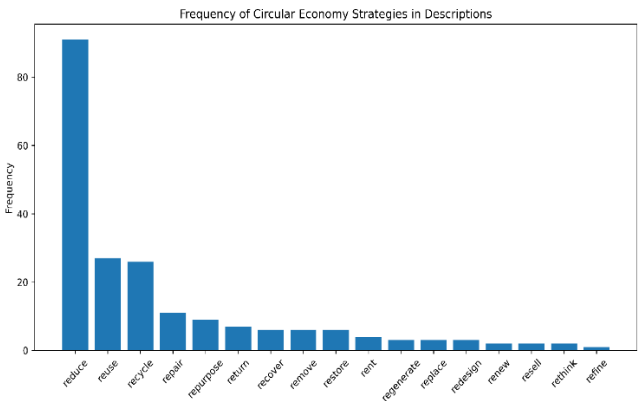
Georgios Tsironis[1*] | Theodoros Daglis[1] | Konstantinos P. Tsagarakis*[1]

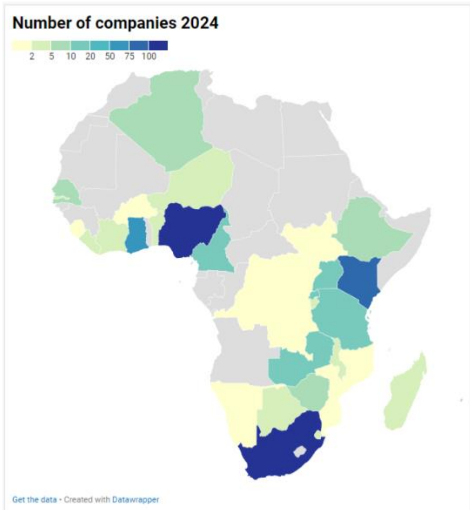
[1]School of Production Engineering and Management, Technical University of Crete, Greece

Abstract

This study explores the evolving landscape of the Circular Economy across Africa by leveraging data from LinkedIn company profiles. Over a three-year period, with data collected at one-year intervals, we examined the profiles of 340 companies in 2022, 460 in 2023, and 637 in 2024, focusing on companies from 55 African countries that reference "Circular Economy." Key profile sections analysed include the year of foundation, headquarters location, industry sector, number of followers, staff counts, and specialties. Our findings indicate that the majority of these companies were established around 2020, likely influenced by the impacts of the COVID-19 pandemic. Statistical analysis, specifically the Friedman test, revealed a significant increase in the number of followers for Circular Economy-related companies over time, suggesting a growing interest in this field. In contrast, the growth in staff numbers was much slower, indicating that while awareness and engagement with the circular economy are rising, employment within these companies has not kept pace. Reduce, Reuse, and Recycle remain the most popular strategies following the global pattern. Overall, the results highlight a strong emerging trend towards the Circular Economy in Africa, positioning the continent as a potential key player in global sustainability efforts.

Keywords: Circular Economy, social media, africa, trend analytics, LinkedIn





* ktsagarakis@tuc.gr

Electric vehicles adoption, Green Transition and Climate Change: a cross-country study

Issa Hamadou[1*] | Alioum Hamadou[1,2]

[1]Faculty of Economics and Business, Universitas Islam Internasional Indonesia (UIII)
[2]Faculty of Economics and Management, University of Garoua, Cameroon Riliwan.

Abstract

There is no denying the existence of climate change. It affects humans and the natural world worldwide. Climate change and global warming have been connected to many phenomena, including hurricanes, drought, flooding, excessive or delayed rainfall, intense heat waves, rising sea levels, etc. Human activities, particularly those related to energy extraction, significantly contribute to the greenhouse gases causing global warming. Therefore, cleaner renewable energy sources must take the place of ongoing energy sourcing from fossil fuels that emit greenhouse gases in order to tackle climate change. This research tries to examine the impact of electric vehicle adoption and green transition on climate change. Panel Data of 30 countries from 2010-2022 are analysed using dynamic panel model with GMM approach. System GMM is used to ensure the robustness of the results. The share of electric vehicles is a proxy for electric vehicle adoption (EVA) the share of renewable energy in total of final energy is a proxy for green transition, per capita CO2 emission and fossil fuel energy consumption as proxies for climate change. The results suggested that electric vehicle adoption is positively affecting per capita CO2 emission and fossil fuel energy consumption. This can be due to the low adoption of electric vehicles in some countries. On the other hand, Renewable energy impact negatively greenhouse gas emissions. Our research motivates us to suggest legislative changes that will encourage the further advancement of electric vehicle adoption and renewable energy for climate change mitigation.

Keywords: climate change, electric vehicles, renewable energy, SDGs

* hamamdouissa16@gmail.com

Climate change impacts on water resources - detail analysis

Coimbatore Vedavyasan[1*]

[1]Desalination Process Specialists, India/Oman

Abstract

Water scarcity is one of the most pressing challenges facing our planet with 80 % of the population facing the ongoing threat of scarcity. The global water resources is affected by extreme weather impacts, primarily in Europe / Africa / Australia / Southern U. As was observed recently on the dwindling water resources ,increased pollution – as in the Darling rive; The net result: a spurt in the proposed desalination plants is envisaged.

Quite an identical study / effects in CA (California) wildfires was conducted -an impact of wider climate change; most of the European rivers taking a toll on the manifold pollution such as in Germany , Greece, Austria ..Quantity as well as water quality is predominantly impacted. The real-time rate of such impacts is staggering . This is a wake-up call on the much-needed proactive measures on the water resources with sustainable solutions.

Effects of climate change include increased evaporation rates, higher proportion of precipitation received as rains, earlier/shorter run-off, increase in water temperature, decrease in overall water quality. Life-threatening droughts due to climate change will have serious consequences on water management. Prolonged droughts in southern and western US had cost $ 6 billion damages to the agricultural and municipal sectors. These droughts impose cost in terms of wildfire. Rising temperatures will increase the proportion of winter precipitation, as rain, with snow receding. We are just half-way through this year , yet extreme weather events has led to the global water challenges in Africa; Spain; South Africa, Tornados and storms in the US, heat waves across Asia and SEA; overwhelming floods in NT(northern territory) Australia; UAE rains.

Conclusion: Tap into green hydrogen, renewables on a wider scale. Sustainable water solutions are presented for efficient water management. Modelling of weather events is highlighted. Embrace green technology. Collective proactive approach; conservation techniques; reuse is the way to go forward towards SDG.

Keywords: sustainable, fossil fuels, challenges, climate action, proactiveness

* ved_vyas@hotmail.com

Monitoring of off-gassing during storage of wood pellets

Mehrdad Arshadi[1*]

[1]Deptartament of Forest Biomaterials and Technology, Swedish University of Agricultural Sciences (SLU), Sweden

Abstract

During production and storage of wood pellets spontaneous auto-oxidations of the fatty and resin acids may occur. During auto-oxidation of fatty acids volatile organic compounds like aldehydes and ketones will be released. Further oxidation of aldehydes to low molecular carboxylic acids may occur as well. Off-gassing of non-condensable gases like CO2 and toxic CO from wood pelletsmay occur. Self-heating in pellets is mainly due to chemical oxidation and various physical processes and can lead to spontaneous ignition within a few days, but more commonly after a few months or longer, depending on the circumstances.

Two antioxidants, TBHQ (tertButylhydroquinone) and PG (propyl gallate), have been used as additives during pellets production in order to investigate how effective these antioxidants are in blocking autoxidation. The produced pellets stored in closed system and off-gassing of volatile organic compounds and CO, CO2 and CH4 have been monitored during several days.

The results show that TBHQ is an efficient antioxidant at a low concentration (0.5%) in blocking autoxidation of fatty/resin acids in wood pellets. The CO emissions are reduced between 72 and 90% depending on the pellets temperature.

Keywords: pellets, solid biofuels, emissions, oxidation, volatile organic compounds

* mehrdad.arshadi@slu.se

SESSION
Green transition in the energy sector

Hydrogen: the energy of the future. A technical and economic analysis of levelized production costs

Idiano D'Adamo[1] | Massimo Gastaldi[2] | Marco Giannini[3*]

[1]Department of Computer, Control and Management Engineering, Sapienza University of Rome, Italy
[2]Department of Industrial and Information Engineering and Economics, University of L'Aquila, Italy
[3]Independent Researcher, Italy

Abstract

This study investigates the techno-economic feasibility of producing green hydrogen through a photovoltaic and electrolysis plant. The primary objective is to determine the levelized cost of hydrogen (LCOH) and assess its competitiveness in the energy market. A comprehensive techno-economic model was developed to evaluate the various cost components associated with the hydrogen production process, including capital expenditures, operational expenses, and energy inputs. The model considers a 25-year plant lifetime and incorporates a levelized cost of energy (LCOE) calculation for the photovoltaic system. The results indicate a levelized cost of hydrogen of €3.65/kg, based on an LCOE of €0.068/kWh. However, this cost is expected to decrease significantly over time due to technological advancements and economies of scale. Several sensitivity analyses were conducted to identify the key factors influencing the LCOH, such as electricity prices, electrolyser efficiency, and financing costs. The study highlights the importance of supportive policies and market mechanisms to accelerate the deployment of green hydrogen. Policy instruments such as subsidies, feed-in tariffs, and carbon pricing can play a crucial role in reducing production costs and stimulating demand. Additionally, the development of hydrogen infrastructure and storage solutions will be essential for the successful integration of green hydrogen into the energy system. In conclusion, while the current cost of green hydrogen remains relatively high, the technology shows great promise for decarbonizing various sectors, including transportation, industry, and power generation. Continued research and development, coupled with supportive policies, are expected to drive down costs and make green hydrogen a viable and sustainable energy carrier in the future.

Keywords: green hydrogen, sustainability, decarbonization, renewable energy, SDG

Acknowledgments: This study was carried out within the PEACE (Protecting the Environment: Advances in Circular Economy) which received funding from the "Fondo per il Programma Nazionale di Ricerca e Progetti di Rilevante Interesse Nazionale (PRIN)" Investimento M4.C2.1.1-D.D. 104.02-02-2022, 2022ZFBMA4. This manuscript reflects only the authors' views and opinions, and can be considered responsible for them.

* marcogiannini97@gmail.com

Empowering renewable energy communities: the key role of public administration

Idiano D'Adamo[1] | Massimo Gastaldi[2] | Linda Lezzi[3*]

[1]Department of Computer, Control and Management Engineering Antonio Ruberti (DIAG), Sapienza University of Rome, Italy
[2]Department of Industrial and Information Engineering and Economics, University of L'Aquila, Italy
[3]Sapienza University of Rome, Italy

Abstract

Under the motto "leave no one behind, "Renewable Energy Communities (RECs) represent an innovative model of energy production, management, and consumption, based on the active participation of citizens, local authorities, businesses, and other local stakeholders. However, the latest data from the “Gestore dei Servizi Energetici” (GSE) highlights a significant gap between the potential of RECs and their current implementation, with the number of RECs falling well short of government targets. Public administration, particularly local authorities, plays a crucial role as a driver in promoting and facilitating the establishment of RECs, aiming to reduce this gap.

This article seeks to evaluate whether public administration can truly be considered a driver for the development and promotion of RECs, by analyzing the perceptions of both citizens and public administration employees. The study focuses on three key areas: the ability to legislate and regulate, access to financial resources, and the provision of technical and training support to communities.

The results reveal a widespread awareness of RECs within the community and strong trust in the public administration's role. Interestingly, citizens showed a preference for participating in their local REC, even if this results in higher energy costs. Additionally, the study provides a classification of the influence of various local authorities in specific actions related to REC formation.

Keywords: renewable energy communities, sustainability, local government, community engagement, energy efficiency

Acknowledgments: This study was carried out within the PEACE (Protecting the Environment: Advances in Circular Economy) which received funding from the “Fondo per il Programma Nazionale di Ricerca e Progetti di Rilevante Interesse Nazionale (PRIN)” Investimento M4.C2.1.1-D.D. 104.02-02-2022, 2022ZFBMA4. This manuscript reflects only the authors’ views and opinions, and can be considered responsible for them.

* lezzilinda2@gmail.com

Integrating renewable energy sources for efficient seawater desalination: a hybrid approach

Salima Boudraham[1*] | Jamal Mabrouki[1] | Ilham Ait Oujallal[1] | Younes Abrouki[1]

[1]Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterials, Water and Environment, CERNE2D, Mohammed V University in Rabat, Faculty of Science, Morocco

Abstract

The desalination of seawater offers a promising solution for providing drinking water, especially in coastal or remote areas. However, its widespread implementation is often hindered by the high energy requirements of the process. Renewable energy sources, being inexhaustible, present a significant advantage by reducing both operational costs and environmental impact, making them an appealing option for powering desalination systems. The large-scale adoption of renewable energies like solar and wind is driven by their low environmental impact, broad accessibility, competitive costs, and abundant availability. In this context, hybrid renewable energy systems (HRES) present a significant advancement, as they help address the inconsistencies associated with relying on a single energy source, such as fluctuations in solar or wind power. By combining multiple renewable sources, an HRES provides a more stable and efficient energy supply. This study explores various strategies for combining and sizing HRES, offering a comprehensive analysis of methodologies for integrating different renewable energy sources into a cost-effective and reliable hybrid system, which is crucial for developing modern energy networks that benefit the economy, environment, and society.

Keywords: seawater desalination, renewable energy, hybrid renewable energy systems (hres), integration, sizing

* salimaboudraham@gmail.com

Improving energy efficiency and product quality in solar drying of argan press cake: the role of temperature and airflow rate

Haytem Moussaoui[1*] | El Houssayne Bougayr[2] | Ali Idlimam[3]

[1]Laboratory of Engineering in Chemistry and Physics of Matter, Faculty of Sciences and Technics, Sultan Moulay Slimane University, Morocco
[2]Engineering & Applied Technologies Laboratory (LITA), Higher School of Technology – Beni Mellal, Sultan Moulay Slimane University, Morocco
[3]Laboratory of Processes for Energy & Environment ProcEDE, Cadi Ayyad, University, Morocco

Abstract

This study investigates the solar drying of Argan press cake, focusing on the effects of temperature and airflow rate on drying time, energy consumption, and efficiency. Results reveal that higher airflow rates (from 150 to 300 m³/h) increase thermal energy consumption due to enhanced convective heat transfer, promoting faster moisture evaporation. Additionally, higher temperatures (40–60°C) contribute to increased thermal energy consumption but also lead to more efficient drying. The total energy consumption, including electrical and thermal energy, was higher at lower airflow rates and temperatures, highlighting the need for optimizing electrical energy use for sustainability. Specific energy consumption decreased with increasing temperature, indicating more efficient drying, while higher airflow rates generally led to greater energy requirements. Thermal efficiency improved at higher airflow rates and temperatures, showing enhanced heat transfer and moisture removal. Furthermore, the study examined the heat utilization factor (HUF) and coefficient of performance (COP), revealing improvements with higher airflow rates and temperatures. At 40°C and 150 m³/h, the HUF was 0.83, indicating efficient heat utilization, while the COP was 0.17. These values improved at higher temperatures and airflow rates, suggesting better system performance. Overall, the findings underscore the importance of optimizing both temperature and airflow rate to enhance drying efficiency, energy utilization, and sustainability in solar dryers for Argan press cake.

Keywords: solar drying, argan press cake, energy efficiency, heat utilization factor, coefficient of performance

* haytem.moussaoui@gmail.com

First-principles calculations to investigate structural, electronic, elastic and thermoelectric properties of CaCdGe half-Heusler for renewable energy applications

Aya Righi[1*] | Fatima Bendahma[1] | Abbes Labdelli[2] | Khedidja Mechehoud[1] | Mohamed Mana[2]

[1]Laboratory of Technology and Solid Properties, Abdelhamid Ibn Badis University, Mostaganem, Algeria,
[2]Biotechnology Laboratory Applied To Agriculture And Environmental Preservation, Abdelhamid Ibn Badis University, Mostaganem, Algeria

Abstract

Thermoelectricity represents a sustainable technological advancement that facilitates the conversion of waste heat into electrical energy and the reverse process, all while ensuring the absence of any deleterious emissions.Through an ab initio computational approach, a comprehensive study was performed on CaCdGe half heusler alloy .The study includes an investigation on its structural, electronic,elastic and thermoelectric properties. The exchange and correlation potential is treated by Tran–Blaha-modified Becke–Johnson (TB-mBJ–GGA), revealing that this alloy has semiconductor behavior. The structural outcomes obtained throughout this investigation are in robust alignment with empirical measurements and demonstrate that the ground state of this material is nonmagnetic.Electronic results ensure that this compound is semiconductor having a direct band gap equal to 0.69 eV.The mechanical stability of the materials was confirmed through elastic constants analysis.Furthermore,the thermoelectric properties such as Seebeck coefficient, electrical conductivity, electronic thermal conductivity, and figure of merit have been explored using semiclassical Boltzman transport theory implemented in the BoltzTraP code.Our findings show a high ZT value,indicate that CaCdGe is potential candidate material for thermoelectric applications and renewable energy.

Keywords: thermoelectricity, half heusler, tb-mbj–gga, semiconductor, figure of merit, renewable energy

* righiaya60@gmail.com

SESSION
Trends supporting the implementation of the Green Deal

Trends and themes in Green Deal and Green Transition: evidence from bibliometric and topic analysis approach

Theodoros Daglis[1]* | Georgios Tsironis[1] | Maria Bakatsaki[1] | Konstantinos P. Tsagarakis[1*]

[1]Technical University of Crete, Greece

Abstract

This study examines the scientific research regarding the Green Deal and the Green Transition. To do so, this work employs bibliometric analysis and topic modeling for the publications identified from the Scopus database, pertaining to the keywords “green deal” and “green transition”. According to the results, there is an increasing interest in the volume of publications, with Italy, China, Germany, and Poland emerging as leading contributors. The network analysis demonstrates two primary clusters of research: one mainly centered on "sustainable development" and "European Union" and the other on "greenhouse gases" and "green transitions." As for the Latent Dirichlet Allocation results, seven distinct topics were identified, specifically, energy and carbon, concentrating on energy management, renewable resources, and strategies for reducing carbon emissions and enhancing energy efficiency; European Policies and Climate Action, exploring the role of European policies, including the European Green Deal, in shaping climate action and sustainability efforts; Food and Sustainable Agriculture, addressing sustainable practices in agriculture, the environmental impact of food production, and the integration of sustainability within food systems; Circular Economy and Environmental Impact, focusing on the circular economy model, emphasizing waste reduction through recycling, reusing materials, and efficient resource management; Green Industry and Economic Development, investigating how green technologies and sustainable industry practices contribute to economic growth and environmental sustainability; Environmental Research and Innovation, highlighting advancements in environmental research, green technologies, and innovative approaches to addressing environmental issues; Economic and Environmental Outcomes, analyzing the impacts of economic and environmental policies, including the effectiveness of sustainability measures and the interplay between economic factors and environmental outcomes. Concluding, this work underscores the dynamics behind “green deal” and “green transition” demonstrating in which ways the scholar engage with these notions.

Keywords: topic analysis, bibliometric analysis, green deal, green transition

* ktsagarakis@tuc.gr

Sustainable agriculture policies - the European Green Deal and the EU agriculture

Wioletta Wrzaszcz[1*]

[1]Institute of Agricultural and Food Economics National Research Institute, Poland

Abstract

Agriculture sustainability is one of the most important scientific topics since the beginning of 90. XX. The premises to develop this way of agricultural activity arise from the need for natural environment protection and climate stabilization. At the end of 2019, the European Green Deal (EGD) strategy was announced, which framed the next reform of the CAP for the years 2023-2027 and the EU country's involvement in environmental and climate purposes achievement. EGD strategy intensified discussion about involvement of EU Member States in the achievement of specified long-term aims, especially in the perspective of 2030. One of the most important sectors – in the context of sustainable development – is agriculture. The research aims to underline the significance of the EU strategy - the European Green Deal (EGD) - for the Common Agricultural Policy (CAP) in supporting agriculture sustainability development.

The EGD goals were reflected in the CAP rules at the EU and member state levels. The negotiated participation of Poland in the EU agricultural targets is lower than the average for the EU, but it doesn't mean that their achievement will be common and simple. National goals are adopted for local problems. The CAP for 2023-2027 intensely emphasized subsidy connection with the environment and climate protection in agricultural practices. The achievement of strategic aims in agriculture in the perspective of 2030 is burdened with the risk of their partial unfeasibility, which raises opportunity and threat analysis. Wide scale farmers' informing is prerequisite for EGD realization. Summing up, the chosen direction of development in the EU is right and even necessary, but at the same time not easy to implement in the current global conditions.

Keywords: European Grean Deal, F2F, common agricultural policy, environmental sustainability, farm's sustainability, agriculture sustainability

* wrzaszcz@ierigz.waw.pl

Informed decision-making for the Green Deal: a sustainability evaluation of renewable energy technologies

Abdelhadi Makan[1*] | Mohamed Gouraizim[1]

[1]Team of Environmental Management and Civil Engineering (GEGC) National School of Applied Sciences (ENSAH) Abdelmalek Essaadi University, Morocco

Abstract

With the goal of becoming a regional leader in clean energy, Morocco has invested heavily in renewable energy mega-projects over the last decade, including the Noor-Ouarzazate complex, the largest concentrated solar power (CSP) plant in the world. To continue accelerating its energy transition and achieve renewable energy targets by 2030, Morocco should focus on small-, medium-, and large-scale projects. However, choosing the most sustainable renewable energy technology (RET) is a complex decision-making problem. This study proposes a novel hybrid multi-criteria decision-making framework to evaluate the sustainability of various RETs in the context of the Green Deal. By evaluating the existing RETs (wind, CSP, solar PV, hydro, and biomass) in terms of environmental, economic, technical, and social criteria, the study aims to assist decision-makers in selecting the most sustainable option. The cardinal (CAR) method was used to elicit criteria weights, with economic (30.7% of weight) and environmental (29% of weight) criteria being prioritized. The PROMETHEE method was then used to rank the alternatives, with solar PV emerging as the most sustainable technology, followed by wind, hydro, CSP, and lastly biomass. It should be noted that the PROMETHEE I partial ranking indicated that wind and hydro were both ranked second in terms of sustainability, highlighting the need for careful consideration when choosing between these two options. By informing decision-makers, this research can support the effective implementation of the Green Deal and accelerate the country's transition to a clean energy future.

Keywords: multi-criteria decision-making, renewable energy technologies, sustainability criteria, PROMETHEE method, cardinal ranking

* abdelhadi.makan@gmail.com

Assessing the influence of reverse logistics on green supply chain management - in the context of the European Green Deal

Elizabeth Serwaa Boateng Koomson[1]* | Bismark Kyei[2]

[1]Management Institute, Warsaw University of Life Sciences, Poland
[2]Department of Procurement and Supply Chain Management, Kumasi Technical University, Ghana

Abstract

The European Green Deal's lofty objective of achieving carbon neutrality by 2050 requires a fundamental transformation in business practices. This study examines the essential functions of reverse logistics in achieving this goal. This study seeks to enlighten policymakers and enterprises by investigating the advantages, obstacles, and successful methodologies for executing reverse logistics. The report investigates the adoption rates and effects of reverse logistics through comprehensive interviews with key stakeholders in Poland. Research reveals that 75% of Polish enterprises have implemented reverse logistics strategies, resulting in considerable environmental advantages. This encompasses a 22.5% reduction in carbon emissions, an 18.2% decrease in waste, and a 12.1% reduction in expenses. The study highlights the beneficial effects of reverse logistics, while also recognising infrastructural constraints and financial obstacles as significant impediments to broader implementation. In order to resolve these difficulties, enterprises must promote teamwork and utilise data-informed decision-making. By understanding the potential of reverse logistics and addressing its challenges, Poland can achieve considerable progress towards a more sustainable and circular economy. This article offers critical insights for governments and businesses to harmonize their operations with the Green Deal's lofty objectives.

Keywords: reverse logistics, carbon emissions, waste reduction, sustainability, green deal

* elizabeth_koomson@sggw.edu.pl

AI-Driven collaborative framework for managing sustainable consumer behaviour in urban environments

Viktor Melnyk[1*] | Yash Chawla[1]

[1]Faculty of Management, Wrocław University of Science and Technology, Poland

Abstract

Current urban waste management strategies, while incorporating awareness campaigns, waste segregation systems, and regulations, often lack coordination among key stakeholders – governments, consumers, waste disposal companies, and packaging manufacturers. This study identifies this lack of collaboration as a significant impediment to achieving effective and sustainable waste management practices.

To address this challenge, we propose an AI-driven collaborative framework that fosters synergy among these stakeholders. The framework will leverage AI to analyze packaging data, consumer waste segregation behavior, and city-specific waste policies to generate real-time guidance and actionable insights for all involved parties. By integrating data analytics and user engagement, the framework will establish a continuous feedback loop that drives iterative improvement in waste management practices.

This paper will present an analysis of existing solutions, current trends in waste management, and a detailed implementation plan for the proposed AI-driven framework. The conference presentation will highlight the framework's potential to promote sustainable consumer behavior and contribute to more effective urban waste management.

Keywords: sustainable consumer behaviour, AI-driven framework, waste management, stakeholder management, urban environments

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* 251528@student.pwr.edu.pl

Biodegradable hydrogels for enhanced irrigation systems

Achraf Berradi[1,2*] | Ahlam Lafdali[1,2,3] | Laila Mandi[1] | Faissal Aziz[1]

[1]Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Morocco,
[2]National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Morocco
[3]Laboratory of Innovative Materials, Energy and Sustainable Development (IMED-Lab), Faculty of Science and Technology, Cadi Ayyad University, Morocco

Abstract

The rapid growth of the agricultural sector, driven by the rising global demand for food and textiles, is confronted with the urgent need for sustainable water management. This issue is especially acute in dry regions, where water shortages contribute to soil degradation, desertification, and lower agricultural yields. Our research seeks to tackle these problems by creating eco-friendly hydrogels from biopolymers.

These bio-based hydrogels, sourced from renewable materials, offer non-toxicity, cost-effectiveness, biocompatibility, and biodegradability advantages. Their exceptional ability to retain and absorb water makes them particularly useful for improving irrigation systems. Additionally, they show promise for wastewater treatment through adsorption and as slow-release nutrient carriers in fertilizer applications.

To assess the hydrogels' effectiveness, we employed Fourier Transform Infrared Spectroscopy (FTIR) to characterize the materials and verify successful synthesis. Further studies of their morphology and swelling behavior demonstrate their potential to enhance soil moisture retention and support plant growth while reducing water wastage. The hydrogels achieved a swelling capacity exceeding 850 g/g, highlighting their efficiency in absorbing and retaining water.

Keywords: agriculture, biobased, biopolymer, hydrogel, irrigation, retention

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* achraf97berradi@gmail.com

SESSION

Sustainable management of raw materials and waste

From trash to treasure: waste recycling in space

Giulio Bonifazi[1] | Idiano D'Adamo[2] | Robetra Palmieri[1*] | Silvia Serranti

[1]Department of Chemical Engineering, Materials and Environment, Sapienza University of Rome, Italy
[2]Department of Computer, Control and Management Engineering, Sapienza University of Rome, Italy

Abstract

Recycling end-of-life materials in space is one of the most critical challenges for the future of space exploration and orbital sustainability. Innovative solutions for reusing materials are essential with the increasing amount of space debris, driven by the growing number of satellites and missions. Future in-orbit recycling technologies could transform space waste, such as decommissioned satellites and spacecraft debris, into valuable resources for construction and repairs directly in space, reducing the need for Earth-based launches and lowering operational costs. These prospects include the development of advanced processes for breaking down and re-manufacturing metal, plastic, and composite materials using 3D printing and autonomous robotics directly by space crews. Additionally, space waste recycling is vital for limiting orbital pollution, reducing the risk of collisions that could endanger essential infrastructure. Innovations in this field could revolutionize how we manage resources in space, enabling longer, more sustainable, and safer missions, marking a critical step toward a future circular space economy. Therefore, the presented study explores the topics of cutting-edge technologies that might improve space recycling efforts.

Keywords: circular economy, space recycling, sustainability, innovative technologies

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MICS

* roberta.palmieri@uniroma1.it

Environmental and health risks at waste disposal sites: an analysis of selected case studies

Anna Podlasek[1*] | Wojciech Pietruszewski[1] | Eugeniusz Koda[1]

[1]Warsaw University of Life Sciences, Poland

Abstract

Waste landfills significantly threaten environmental quality and public health through soil and water pollution, air quality degradation and ecological disruption. This study aimed to assess the overall environmental quality and the ecological and health risks associated with waste landfills at two selected sites in central Poland. The assessment was carried out using specific indicators that quantified the extent of pollution and its potential impact on human health and ecosystems in different areas of the landfills. Soil and water sampling was carried out at different time points to allow monitoring of seasonal changes in the indicator parameters and a comparative analysis between the two landfill sites. By analysing parameters such as heavy metals (HMs), pH, and salinity, the study provided critical insights into the level of contamination at these sites. The results indicated significant environmental hazards, including water and soil contamination, which can adversely affect local communities and ecosystems. Lead (Pb) has been detected in surface water at a level of 0.015 mg/L. In addition, a higher electrical conductivity (EC) of surface water was observed at the landfill outflow (880 μS/cm) compared to the inflow area (480 μS/cm). The high values of the Geoaccumulation Index (Igeo) for Pb, cadmium (Cd), zinc (Zn) and copper (Cu) (locally Igeo > 5) were mainly indicative of severe contamination. A similar trend was observed for the Pollution Index (PI) and Nemerow Pollution Index (NPI), which locally reached values as high as 2970 and 2100, respectively, for the assessment of Cu contamination, indicating significant contamination. In addition, the research highlighted the potential health risks to people living near these landfills. The health risk expressed by the Hazard Quotient (HQ) showed that the exposure pathways of HMs were mainly by ingestion (HQ from 4.82E-04 to 8.16E-02). The study demonstrates the urgent need for improved waste management practices and ongoing environmental monitoring to reduce the health and environmental risks associated with landfills. It paves the way for future research to investigate the long-term effects of contamination and the effectiveness of different remediation strategies.

Keywords: landfill, heavy metals, water quality, indicators, waste management

* anna_podlasek@sggw.edu.pl

Treatment and recycling of municipal solid waste incineration fly ash using plasma technology

Viktorija Grigaitiene[1*] | Vitas Valincius[1] | Romualdas Kezelis[1] | Zydrunas Kavaliauskas[1] | Mindaugas Milieska[1]

[1]Plasma Processing Laboratory, Lithuanian Energy Institute, Lithuania

Abstract

The use of natural resources, the increased consumption, and the growing amount of waste require serious work in the waste management field to be undertaken as soon as possible and progress towards a more circular economy. In many countries, municipal wastes are used as fuel and burned in cogeneration power plants, where heat and electricity are produced for urban purposes. Unfortunately, the bottom ash and fly ash are produced after the waste incineration. In particular, fly ash contains high concentrations of hazardous substances, and its secondary use is limited. Therefore, the object of this research is the experimental application of thermal plasma technology for incineration ash processing and recycling into valuable and environmentally safe products, such as vitrified slag and fiber. A specially designed plasma–chemical reactor was used for treatment, maintaining process temperatures above 2000°C to ensure the complete neutralization of hazardous compounds. Elemental and structural analyses of the obtained vitrified products revealed significant changes post-treatment, characterized by a predominantly amorphous structure due to vitrification. The results will contribute to a deeper understanding of thermal waste treatment technologies and lead to solutions for potential industrial applications in waste management.

Keywords: plasma processing, vitrification, fly ash treatment, hazardous waste, fibers

* viktorija.grigaitiene@lei.lt

Implementing agile management practices in regional municipal waste processing installations

Natalia Kosińska[1*] | Yash Chawla[1]

[1]Faculty of Management, Wrocław University of Science and Technology

Abstract

The paper aims to investigate how Agile management practices can improve municipal waste processing installations, contributing to the goals of the European Green Deal. The increasing waste production and the urgent need for sustainable solutions challenge traditional waste management methods. Agile methodologies, known for their adaptability and continuous improvement, offer a promising path to enhance the efficiency and responsiveness of waste management systems, aligning with the Green Deal's circular economy objectives.

The study combines literature analysis and empirical research to assess the current state of waste processing installations and identify best practices for implementing Agile methods within the context of sustainability goals. The primary conclusions indicate that Agile practices can significantly contribute to the operational efficiency, resource optimization, and overall sustainability of municipal waste processing installations, supporting the transition to a circular economy. The research also highlights challenges, including resistance to change and insufficient regulations for effective waste segregation. To address these, the study emphasizes the importance of fostering a mindset that embraces adaptation and continuous improvement, essential for promoting sustainable waste management practices.

This research contributes a comprehensive analysis of Agile practices in a non-IT context, providing practical recommendations specifically tailored for practitioners in the waste management sector to advance the Green Deal agenda. By bridging theory with practice, the paper offers actionable insights to enhance the efficiency, resourcefulness, and sustainability of waste management systems, supporting the transition to a circular economy.

Keywords: waste management, municipal installations, circular economy, agile project management, Green Deal

Acknowledgments: The work was financed by the National Science Center (NCN, Poland): grant no. 2022/47/D/HS4/03444. Sincere gratitude is extended to all the interview participants. Their collaboration, trust, and generous contribution of time were invaluable to the completion of the paper. Without their insightful input and willingness to engage, this work would not have been possible.

* n.n.kosinska@gmail.com

Anthropogenic pollutants in the bottom sediments: occurrence, mechanism of migration and transformation

Abdullah Maqsood[1*] | Ewa Łobos-Moysa[1] | Muhammad Zia-ur-Rehman[2] | Muhammad Usman[2] | Muhammad Rizwan[2]

[1] Department of Water and Wastewater Engineering, Faculty of Energy and Environmental Engineering, Silesian University of Technology, Poland
[2] Institute of Soil and Environmental Sciences, University of Agriculture, Pakistan

Abstract

Anthropogenic pollutants originate from various sources, including treated municipal wastewater, urban agglomerations, and tourist resorts. In the case of lakes, pollutants accumulate in both the water column and bottom sediments, while in rivers, they tend to concentrate in meanders and sediment layers, reflecting the extent of anthropogenic contamination in surface waters. Bottom sediments act as reservoirs for a wide range of contaminants, including nutrients (e.g., phosphorus), heavy metals (Pb, Hg, Cd, As, Cr, Cu, Zn), pharmaceuticals (anti-inflammatories, anticonvulsants, antibiotics), personal care products (preservatives, UV filters, disinfectants, insect repellents), pesticides (herbicides, insecticides, fungicides), polyaromatic hydrocarbons (benzo[a]pyrene, naphthalene, phenanthrene), and microplastics (MP). Phosphorus is often found in the hypolimnion due to the biodegradation of pollutants in upper water layers and surface runoff from agricultural fields, later accumulating in bottom sediments. Treated municipal wastewater also contributes to phosphorus levels in aquatic environments. Anthropogenic pollutants, both organic and inorganic, can exhibit toxic, mutagenic, and carcinogenic properties, often present in concentrations ranging from mg/kg to µg/kg of dry sediment. Microplastics, which appear in the environment as either primary or secondary particles, have been detected in sediments at levels reaching several thousand particles/Kg of dry sediment. These pollutants pose significant risks to aquatic organisms living in the benthic zone, particularly those inhabiting the sediments. Literature indicates that anthropogenic contaminants accumulate in the tissues of these organisms, with MP found in the gills and digestive systems of fish. This review aims to summarize and synthesize the current state of knowledge on anthropogenic pollutants, focusing in particular on their sources and occurrence in the aquatic environment, water/bottom sediments transfer, and transformation into degradation or biodegradation results.

Keywords: bottom sediments, accumulation, nutrients, heavy metals, pharmaceuticals, PCP, pesticides, PAH, MP

* abdullahmaqsood414@gmail.com

Antagonistic activity of strain *Bacillus sp* A3 against phytopathogenic bacteria for sustainable agriculture

Yevheniia Arkhipova[1*] | Liudmyla Butsenko[2] | Yuliia Kolomiiets[1]

[1]National University of Life and Environmental Sciences of Ukraine, Ukraine
[2]D.K. Zabolotny Institute of Microbiology and Virology of the National Academy, Ukraine

Abstract

Bactericides, among other pesticides, are commonly used in agriculture for crop protection. However, usage of these chemicals is a rising concern for collateral environmental contamination. The risk involves potential harm to human and animal health, poisoning food products, and accumulating hazardous residues in soil and water. On top of that, this type of pesticide is often represented by antibiotic substances, which may induce horizontal gene transfer as one of the reasons for antibiotic resistance.

On the other hand, there is an eco-friendly option without the listed side effects, which is applying antagonistic microorganisms. It provides sustainability as they are a natural part of ecosystems. Newly introduced to the rhizosphere, these bacteria colonize it, competing with pathogens.

For testing this type of biocontrol, we used strain *Bacillus sp* A3 deposited at D.K. Zabolotny Institute of Microbiology and Virology of the National Academy of Ukraine. It had been previously isolated from soil in Kyiv region. Its level of antagonistic activity was tested by the method of deferred antagonism.

Diameters of corresponding inhibition zones due to antagonistic activity for each species most found in agrocenoses are *Pseudomonas syringae pv species. Syringae* (30,6±8,1 mm), *Pectobacterium carotovorum* (32,0 ± 8,1 mm), *Xanthomonas campestris pv. Campestris* (66,0 ± 2,2 mm), and *Clavibacter michiganensis* (48,7 ± 2,6 mm).

The study show that strain *Bacillus sp*. A3 is a strong antagonist with a wide range of activity, which confirms the prospects of using *Bacillus sp*. A3 in the composition of drugs to control pathogens of bacterial diseases.

Keywords: strain Bacillus sp A3, bacterial antagonism, sustainable agriculture

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* arkhipova.yevheniaa@gmail.com

SESSION

Sustainable development in the regions

Implications of land use and cover change for ecosystems and biodiversity in teiči strict nature reserve, Latvia

Jānis Krūmiņš[1*] | Māris Kļaviņš[1]

[1]Faculty of Science and Technology, Department of Environmental Science, University of Latvia, Riga, Latvia

Abstract

This research investigates land use and land cover changes in the Teiči Strict Nature Reserve, Latvia, from 1982 to 2023, and projects future impacts on ecosystems and biodiversity through 2064 under four distinct legislative scenarios. The study aims to evaluate the efficiency of current conservation zoning in preserving biodiversity and maintaining ecosystem functionality amidst increasing anthropogenic pressures, including agricultural expansion, urbanization, and climate change. Using remote sensing, geographic information systems, and scenario-based land use and land cover modeling, the study identifies significant ecosystem alterations, such as a reduction in peat bogs and forest cover, leading to habitat fragmentation. Scenario analysis suggests that without adaptive management strategies, these trends will likely aggravate ecological degradation. The findings emphasize the necessity for dynamic conservation frameworks that can respond to evolving environmental pressures, ensuring the long-term resilience of ecosystems and biodiversity within the reserve. This research highlights the critical role of predictive modeling in informing conservation planning to enhance the sustainability of protected areas.

Keywords: conservation zoning, land use and land cover modelling, nature reserves, protected areas, scenario modeling

Acknowledgments: This research was supported by the Horizon Europe project "Towards Sustainable Land-use Strategies in the Context of Climate Change and Biodiversity Challenges in Europe (Europe-LAND)" under grant agreement No.101081307.

* krumins.janis@lu.lv

Impact of organic management systems on carbon sequestration dynamics in agricultural soils of central Italy

Abhay Kumar[1*] | Gabriele Antoniella[1] | Emanuele Blasi[1] | Tommaso Chiti[1]

[1]Department for Innovation in Biological, Agro-food and Forest Systems (DIBAF), University of Tuscia, Italy

Abstract

The Mediterranean region, particularly Italy, represents a crucial European biodiversity hotspot, characterized by diverse ecosystems increasingly vulnerable to climate change. Agriculture, fundamental for food security, significantly contributes to greenhouse gas (GHG) emissions, often through the overuse of agro-chemicals. Addressing these challenges highlights the essential role of soil in enhancing agri-food system resilience, supporting food security, and promoting ecosystem services critical for climate change mitigation. Sustainable practices such as carbon (C) farming are key to reducing GHG emissions, improving soil health, and increasing nutrient availability while fostering a favorable environment for beneficial soil organisms by regulating soil organic carbon (SOC) and humic substances. Therefore, this study examines the distribution of C in bulk mineral soils and their fractions across three farms in Central Italy, comparing conventional and organic management practices. Soil samples were collected from 0–15 cm and 15–30 cm depths, and humic substances such as humic acid, fulvic acid, and humin were quantified using the acid-alkali extraction method. The results indicate that organically managed soils showed considerably higher levels of humic acid at site 2 and SOC at sites 1 and 3 across both depths, suggesting a greater capacity for long-term C storage. However, fulvic acid remained unchanged, while C-humin was increased in organically managed soils compared to conventional systems. These findings suggest that organic management enhances SOC stocks, potentially mitigating GHG emissions. Further research with extended field trials is necessary to fully understand the stability of C storage under organic management in Mediterranean soils, contributing to long-term climate resilience.

Keywords: carbon farming, climate change, humic substances, organic management, soil organic carbon

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* abhay.kumar@unitus.it

Towards integrating wetlands into urban design

Kemo Usto[1*] | Lineker Max Goulart Coelho[1]

[1]DTU – Technical University of Denmark, Denmark

Abstract

With the current growth in consumption in cities, increase in CO_2 emissions and loss of biodiversity, there is a lack of examples where ecological awareness can be implemented into a different kind of practice at a larger scale. A trajectory that is important to consider is that of autopoietic performance as seen in ecosystems (Upreti 2024) - and the challenge is how this could be transferred into an urban context.

In doing so, the study explores how wetlands and an increased cultivation of biomass (reeds) within urban areas can provide building façade material while holding potentials for CO_2-sequestration, increasing of biodiversity, water handling, prevention of floods along with recreative outdoor qualities in the given urban context.

This prospective study was done by first analyzing a large area for “blue spots” and then exploring an interdisciplinary urban and architectural design scheme for constructed wetlands that have an autopoietic relation with the building stock (and users of said urban context). The case study area is located in the metropolitan region of Copenhagen in the city of Ballerup. Bluespots were analyzed using Scalgo, a GIS-based hydrological webbased modeling platform capable of simulating static and dynamic flooding analysis. From the results best locations were identified in terms of suitability for installation of water handling solutions, material cultivation potential and recreational infrastructure. The proposed framework shows to be a valuable pathway to support urban plan development under the umbrella of the urban wetland concept supporting environmental protection, social and recreative affordance.

Keywords: constructed wetlands, urban design, autopoiesis

* kemu@dtu.dk

Assessment of trihalomethanes levels in chlorinated drinking water from various sources in Morocco

Marwa Cheddad[1*] | Naaila Ouazzani[1]

[1]Laboratory of Water, Biodiversity and Climate Change (EauBiodiCc), Faculty of Sciences Semlalia, Cadi Ayyad University, Morocco

Abstract

Starting in 1974, with the first discovery of trihalomethanes (THM) disinfection by-products, the world began to sound the alarm about the toxicity of disinfection by-products (DBPs). Disinfection by-products (DBPs) generated during drinking water disinfection have attracted worldwide attention. In this context, efforts have been made to investigate the potential for DBP formation, assess their toxicity and carcinogenicity, and improve conventional water treatment methods to remove DBP precursors. In particular, trihalomethanes can be harmful to human health. They can cause cancer and non-cancerous diseases. The main purpose of this study was to determine the concentrations of four THMs. Two water sources were examined: surface water and groundwater. The sampling points were from the water source to the consumer's tap, through treatment plants and drinking water reservoirs. Surface water had a higher THM formation potential than groundwater. Total THM concentrations were 0 µg/l (raw water), 24.11 µg/l (filtered water), 24.82 µg/l (disinfected water), 29.98 µg/l (reservoir), and 31.69 µg/l (tap water). The average percentages of THM species chloroform, bromodichloromethane, dibromochloromethane, and bromoform were 42%, 34%, 24%, and 0%, respectively. The concentrations found were well below the maximum permissible values in the WHO guidelines.

Keywords: disinfection by products, trihalomethanes, drinking water, groundwater, surface water

Acknowledgments: The authors gratefully acknowledge the facilities and scientific support of the advanced characterization laboratories in University Cadi Ayyad for their sincere contributions to the chromatographic analysis of the samples.

* marwa.cheddad@ced.uca.ma

Impact of green supply chain management practices on the enviromental performance of manufacturing industries in the northern Nigeria

Umar Abdullahi Mai'auduga[1*] | Patrick Bogoro[2] | Umar Usman[2] | Muazu Umar[2] | Sunusi Abdulkarim[3]

[1]PhD Scholar at the Department of Management & Information Technology, Abubakar Tafawa Balewa University, Nigeria
[2]Department of Management & Information Technology, Abubakar Tafawa Balewa University, Nigeria
[3]Department of Transport & Logistics Management, Nigerian Army University Biu, Nigeria

Abstract

Adopting "Sustainable Manufacturing Practices (SMPs)" is necessary for manufacturing supply chains to embrace the concept of sustainability. The main objective of the research is to study the impact of green supply chain management practices (GSCMP) on the environmental performance of manufacturing industries in Northern Nigeria. The study is quantitative and employs a descriptive survey design. The population comprises 495 registered Manufacturing Association of Nigeria (MAN) members. A cluster sampling technique was used to select 239 respondents, of which 196 (82%) were found valid for the analysis. The data of the study were analysed with the help of SMART-PLS 4. From the result, it was established that eco-design (β=0.389, t=4.551, p< .001), green distribution (β=0.202, t=2.216, p<.005, green production (β=0.048, t=0.604, p>.005) have a positive and significant relationship with environmental performance. The study concluded that manufacturing industries practicing GSCMP have a competitive advantage over their competitors. Also, due to the growing demand for environmental protection in today's business activities, firms need to cooperate with different stakeholders to effectively handle green related activities in their operations.

Keywords: green supply chain management, eco-design, green distribution, green production, environmental performance

* umaiauduga@gmail.com

Transformative capacity building for urban transformations through force field analysis

Jolanta Dvarionienė[1*] | Kristina Kamičaitytė[2] | Džiugas Dvarionas[1]

[1]Kauno Technologijos Universitetas, Lithuania
[2]Alytus City Municipality Administration, Lithuania

Abstract

Alytus is a city in Lithuania that has the potential to develop urban transformative capacities for a sustainable future. Considered potential areas of the focus are: 1) Renewable energy; 2) Sustainable transportation; 3) Green spaces; 4) Circular economy; 5) Sustainable food systems. Through focusing on these areas and collating them with EU good practices for urban development, Alytus is developing urban transformative capacities for promotion of sustainability, resilience, and well-being. When it comes to directing urban transformations, a method of force field analysis (FFA) was considered as highly effective, because the force field theory developed by Kurt Lewin suggests that human behaviour is the result of the interaction between two types of forces: driving forces that encourage a particular behaviour, and restraining forces that discourage it. Overall, the FFA method provides a structured approach for directing Alytus' urban transformations by identifying and analysing the different forces that are driving or resisting change in the urban environment. By developing a city strategy based on this analysis and citizens' involvement in the decision making process, urban planners and policymakers can take a more informed and targeted approach to addressing the challenges and opportunities facing their communities. After analysis of a city strategy for 2030 (Alytus strategy 2030) and after revision of completed full SWOT analysis, some major threats and opportunities from presented SWOT analysis were taken for identification of the driving and restraining forces that are impacting the urban environment.

Keywords: urban transformations, transformative capacity building, force field analyses, sustainable future

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* jolanta.dvarioniene@ktu.lt

SESSION
Water recycling and supporting technologies

Green building certification systems as a lever to encourage tox-free construction

Jolita Kruopienė[1*] | Edgaras Stunžėnas[1] | Lucas Schmitz[2] | Ingrida Bremere[3] | Gražvydas Jegelevičius[4]

[1]Institute of Environmental Engineering, Kaunas University of Technology, Lithuania
[2]Baltic Environmental Forum, Germany
[3]Baltic Environmental Forum, Lithuania
[4]Baltic Environmental Forum, Lithuania

Abstract

Construction materials are sources of indoor and environmental exposure to hazardous chemicals. While a non-toxic environment is a prominent objective within the EU, the necessary tools to achieve this goal have still to be established. Environmental claims is one such tool that highlights the environmental and health aspects of construction products. For buildings themselves, there are building certification systems, which are used to assess and recognise buildings that meet certain sustainability requirements or standards. Certifications vary in their approach and can be applied to different stages of building, from the planning and design, through construction, eventually until demolition phase. More than 10 building certification systems are used in countries of the Baltic Sea region. Those systems cover various aspects, or evaluation areas: energy issues, materials and resources, indoor air, water management, etc. Focus of our study was the coverage of hazardous substances issue in the building certification systems used in the Baltic Sea region. We aimed to clarify to what degree and in what way hazardous substances are included among the assessment criteria, to find the best practice examples, and to provide recommendations for the choice of certification system for those wanting to concentrate on tox-free construction. The partial benchmark for the analysis was the Nordic Swan ecolabelling criteria for buildings. Our findings show that toxic substances are mostly not covered very explicitely in building certification systems.

Keywords: building certification systems, certification criteria, hazardous substances, tox-free construction

Acknowledgments: The work was performed within the Interreg Baltic Sea Region programme project #014 “Reducing hazardous substances in construction to safeguard the aquatic environment, protect human health and achieve more sustainable buildings” (NonHazCity 3).

* jolita.kruopiene@ktu.lt

Rainwater: a sustainable water source for non-potable use

Małgorzata Komorowska-Kaufman[1*] | Marzena Windysz[1]

[1]Poznan University of Technology, Faculty of Environmental Engineering and Energy, Institute of Environmental Engineering and Building Installations, Poland

Abstract

The progress of civilization, the availability of new technological solutions, and the improvement of living standards affect the increase in the demand for drinking water. At the same time, environmental changes influenced the water cycle and caused the occurrence of water deficits in places where access to water was not a problem before. The need for searching the alternatives to drinking water in economic applications is now necessary. Rainwater can be a good water source, for example, for flushing toilets, maintaining green areas, farm parts, washing cars, etc. The use of rainwater has its advantages (e.g., reduction of rapid surface runoff, lower water costs) and disadvantages (e.g., uncertainty of the amount of available water). The quality of rainwater and the safety of its use are also important issues. The presented study determined the quality of rainwater depending on the frequency and intensity of rain in a selected catchment area and the effects of its purification in the water treatment installation for non-potable usage.

Keywords: rainwater, quality, sustainable water source, threats, treatment,

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* malgorzata.komorowska-kaufman@put.poznan.pl

Evaluation of leaf-based adsorbents for rapid dye removal from water

Dominika Nowacka[1*] | Anna Skwierawska[1]

[1]Gdańsk University of Technology, Faculty of Chemistry, Department of Chemistry and Technology of Functional Materials, Poland

Abstract

In this study, six plant-derived materials – *Alnus glutinosa* (Alder), *Fraxinus ornus* (Ash), *Fagus sylvatica* (Beech), *Acer platanoides* (Maple), *Quercus robur* (Oak), and *Salix alba* (Willow) – were evaluated as potential adsorbents for the removal of dyes from water. The physical and chemical properties of the adsorbents were thoroughly characterized using a combination of the Boehm titration method, scanning electron microscopy (SEM), and Fourier-transform infrared (FTIR) spectroscopy. The adsorption behavior of methylene blue (MB), a model contaminant, was investigated through both kinetic and equilibrium studies. Results indicated that rapid adsorption of MB occurred within the first minute for all adsorbents tested. Kinetic modeling revealed that the adsorption data for Alder, Beech, Maple, and Willow fitted well with the pseudo-second order model, while Ash and Oak were best described by the pseudo-first order model. Isotherm analysis using the Langmuir and Jovanovic monolayer models demonstrated exceptionally high maximum adsorption capacities, ranging from 963.40 mg g^{-1} to 1429.80 mg g^{-1} across the different materials. Given the low-cost nature of these materials, regeneration was not performed, and instead, a degradation study was conducted. Notably, Maple exhibited the highest weight loss (43%) during exposure to yeast, indicating a higher degree of biodegradability. Furthermore, nearly complete removal of cationic dye was achieved in real water samples, underscoring the practical applicability of these materials in water treatment.

Keywords: natural adsorbents, green materials, adsorption, environmental pollution, water treatment

* dominika.nowacka@pg.edu.pl

Treatment of surface water using multiple barrier technique

Edwin Adomhokhai[1*] | Michael Osahon[1]

[1]Amhanokha, Ambrose Alli University, Nigeria

Abstract

Treatment of surface water was carried out using Multiple Barrier Technique, which comprised of calcite, marble, and limestone in a bucket fitted with tap. Water samples were collected from Ibiekuma River in Ekpoma, which serves as the principal source of water to Ambrose Alli University. The following physicochemical parameters: Total Solid (TS), Total Dissolved Solids (TDS), Suspended Solid (SS), Turbidity (Turb) and pH, were used to evaluate the raw water and to monitor the treatment process. The results obtained showed how the interaction with the mineral barriers moderated these parameters over time with SS (0.56mg/l), TDS (3.89mg/l), TS (4.45mg/l), and Turb (0.003NTU). The study revealed that the pH of the river is mildly acidic (4.82) which was immediately moderated to 7.76 on contact with the mineral barriers. While the analysis of the mineralogy constitutent of the water was not conducted, the results of the research captures to hardness materials that the treatment of rocks added to the water. It is recommended that portable water should have some medium level of hardness. This research shows how the mineral materials can influence the overall hardness of water over time within the safety limit for domestic, agricultural, and industrial usage as set by World Health Organization (WHO) and Standard Organization of Nigeria (SON).

Keywords: physicochemical parameters, surface water, calcite, marble, limestone

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* alkemistaau@gmail.com

Aquatic food systems in the context of blue economy

Olga Iermakova [1*]

[1]Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine, Ukraine

Abstract

The research proposes a comprehensive approach to providing the population with domestic products from aquatic bioresources and increasing the competitiveness and productivity of domestic producers through the formation of aquatic food systems - production and sales chains that combine aquatic food producers according to their functional characteristics (from primary production to sales of products to consumers and secondary processing), their interconnected activities to create added value and ensure the general availability of healthy food rations on the basis of environmental protection, sustainable management of the resources' usage and preservation of biodiversity.

Integrated aquatic food systems can be set up in the form of clusters, and later be scaled to the format of eco-industrial parks and bioregions, the main task of which is the transition to a wider use of local renewable resources to solve a complex of socio-ecological and economic problems. The unifying basis of such systems is the concept of circular bioeconomy, when waste from some enterprises becomes raw material for others. For example, in an integrated system that includes fish farming, animal husbandry, and crop production, fish and livestock waste can be used as fertilizer for plants, and plant residues can be used to feed animals and fish.

Investments and innovations are necessary resources for the implementation of this concept. In the world, there is a steady trend towards the growth of investments in the blue sectors of the economy, in particular, aquaculture. Stimulation of innovation and investment activities will contribute to the increase in the production of aquatic products with high added value, the economic development of the aquatic food system and the growth of the competitiveness of its products, the reduction of import dependence, the improvement of the scientific support of the industry, and the increase of export opportunities of domestic enterprises.

Keywords: aquatic food system, blue economy, sustainability

* impeer@ukr.net

Preparation and characterization of biochar from olive stones via microwave-assisted acid activation for the adsorption of methyl orange dye from aqueous solutions

Kaouthar Benahdach[1*] | Youssef Aoulad el hadj ali[1] | Azouz Abdelmonaim[1] | Anass Wahby[1] | Rachad EL Mail[1] | Brahim Arhoun[1]

[1]Laboratory of Water, Studies and Environmental Analysis, Faculty of Sciences, Abdelmalek Essaadi University, Tetouan, Morocco

Abstract

The olive sector is a vital socio-economic contributor in the Mediterranean region; however, olive oil production is resource-intensive and poses considerable environmental challenges, particularly in water and soil pollution, as well as the generation of by-products such as olive stones. The valorization of this waste, notably through the production of biochar for removing pollutants from wastewater, is a crucial strategy for advancing sustainability and supporting a circular economy.

In this study, biochar was prepared from olive stones (OS@B) using microwave-assisted H_2SO_4 activation and employed for the removal of methyl orange (MO) dye from aqueous solutions. Batch experiments were conducted to examine the influence of parameters such as contact time, pH, adsorbent dose, initial dye concentration, and temperature on the adsorption process. The prepared OS@B was characterized using various techniques, including SEM, BET analysis, XRD, and FTIR, to assess its suitability as an adsorbent. The equilibrium data were analyzed using Langmuir, Freundlich, and Sips isotherm models, with the Sips model providing the best fit and estimating an adsorption capacity of 81.46 mg g^{-1} at 40 °C. Kinetic studies were performed using pseudo-first-order (PFO), pseudo-second-order (PSO), and Elovich models, with the Elovich and PSO models showing the best fit for the adsorption kinetics. Thermodynamic parameters, indicating that the adsorption process was spontaneous and endothermic.

In conclusion this research highlights the potential of OS@B as an efficient and eco-friendly adsorbent for the remediation of methyl orange dye from wastewater.

Keywords:olive stones, biochar, microwave-assisted acid activation, adsorption, methyl orange dye, wastewater

Acknowledgments: Benahdach acknowledges the Predoctoral grant obtained from Ministry of Higher Education, Scientific Research and Innovation of Morocco.

* kaouthar.ben98@gmail.com

SESSION
Minimizing carbon footprint and innov ation in the energy sector

Opportunity analysis for secondary utilization of wind turbine blades

Vilma Snapkauskienė[1*] | Viktorija Grigaitienė[1] | Romualdas Kėželis[1] | Regina Kalpokaitė-Dičkuvienė[1]

[1]Lithuanian Energy Institute, Lithuania

Abstract

The increasing focus on sustainability has highlighted the need for effective recycling methods, especially for materials like wind turbine blades (WTB). They are predominantly composed of composite materials, primarily glass fibers, and polymeric resins, making their recycling complex and challenging due to contamination and structural integrity issues. The remaining mass includes various plastics and protective coatings, complicating recycling too. Existing recycling technologies (mechanical, thermal, and chemical) often result in contaminated outputs with reduced mechanical strength and other undesirable properties. Problems such as surface defects, changes in thermal conductivity, and harmful substance release are prevalent. The inefficient recycling processes contribute to environmental pollution and generate secondary waste. To address these challenges, plasma degradation technology is being explored as a viable solution for recycling WTBs. Plasma technology can effectively decompose complex composite materials into secondary raw components without harmful contaminants. The process can yield solid-phase melts and fiber suitable for creating structural composite products. According to the EU's circular economy policy, waste should be recycled and used. This paper analyzes the suitability of microfill for concrete production from the obtained recycled solid-phase melt, which could replace part of Portland cement in the production of concrete and its products. This would save the expensive Portland cement and reduce CO_2 emissions, which is relevant from the point of view of climate change.

Keywords: wind turbine blades, recycling, plasma, solid-phase melt, cement

* vilma.snapkauskiene@lei.lt

Enhanced thermoelectric performance in Ti(Fe,Co)Sb pseudo ternary Half-Heusler alloys

Hamadi Zineb[1*] | Bessaha Fatiha[2]

[1]Laboratory of Technology and Solid Properties, Abdelhamid Ibn Badis University, Mostaganem, Algeria
[2]Structure Development and Applications of Molecular Materials, Abdelhamid Ibn Badis University, Mostaganem, Algeria

Abstract

Thermoelectricity is a kind of clean and noiseless energy recovery technology that can directly convert waste heat into electricity. The conversion efficiency of a thermoelectric device is governed by the Carnot efficiency and the material-dependent figure-of-merit ZT, many thermoelectric materials have been explored for power generation applications. Currently, thermoelectric materials such as Heuslers alloys can supply inexpressive electricity and green Energy without making waste that is harmful to the environment. These materials, with their high-performance thermoelectric, could play a crucial role in the prevention of the energy crisis, as well as in the reduction of greenhouse gas emissions, by serving as a source of green energy. In this context, our work consists of studying the thermoelectric performance of a Heusler material, namely Ti(Fe, Co)Sb, by using the DFT approach based full potential linearized augmented plane-wave (FPLAPW) method as implemented in WIEN2k as part of the Generalized Gradient Approximation (GGA) was used for the calculation of structural and various properties. The semi-classical theory of Boltzmann implemented in the BoltzTraP code is applied to study the thermoelectric properties (TE). The high peak value of the figure of merit was achieved to make the Ti(Fe, Co)Sb compound a promising candidate for TE applications.

Keywords: heusler material, figure of merit, energy crisis, thermoelectricity, boltzman

* zinebhamadii@gmail.com

District heating for more sustainable cities – case of lithuania based on life cycle assessment

Aistis Rapolas Zubas[1*]

[1]Kaunas University of Technology, Lithuania

Abstract

The district heating system is considered as a more environmentally sustainable alternative to individual household heating. This system enables higher fuel efficiency, better control over pollutant emissions, and the utilization of fuels that are unsuitable for smaller-scale applications. However, it remains crucial to quantitatively assess its environmental impact to ensure its sustainability.

This study examines the environmental impact of Lithuania's district heating system based on fuel consumption from 2013 to 2023. A life cycle assessment (LCA) was conducted using SimaPro software to analyse the effects of use of various fuel sources across environmental impact categories. The results revealed significant shifts, particularly with the increased use of biomass (e.g., logging residues, low-grade firewood) replacing fossil fuels. This transition contributed to a substantial reduction in greenhouse gas emissions. In 2013, the district heating system was responsible for 1.71 Mt CO_{2e} in total emissions, corresponding to 190 t CO_{2e}/GWh of produced energy. By 2023, these values were reduced to 0.71 Mt CO_{2e} in total emissions and 85 t CO_{2e}/GWh. Despite these advancements, the energy production process within the district heating system remained predominantly combustion-based, leading to the release of air pollutants, including carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter, etc. The integration of renewable energy sources, such as wind, hydropower, and solar energy, into electricity-to-heat conversion processes presents a pathway for reducing the environmental footprint of district heating systems.

Keywords: district heating, life cycle assessment, fuel consumption

Acknowledgments: This research was funded as part of the Excellence Centre of the Technology and Physical Sciences (TiFEC) *project* (*Nr. S-A-UEI-23-1) at* Kaunas University of Technology funded by the Lithuanian Science Council and the Ministry of Education, Science and Sport of the Republic of Lithuania through the state budget under the programme "University Excellence Initiative".

* aistis.zubas@ktu.edu

Low-carbon industrial production: case study within solar modules Production Company

Kliopova Irina[1*] | Genaras Samsonik[2]

[1]Institute of Environmental Engineering, Kaunas University of Technology, Lithuania
[2]Institute of APINI, Kaunas University of Technology, Lithuania

Abstract

According to the Lithuanian National GHG Inventory Report, in 2022, Lithuania emitted 18.904 million tonnes of GHGs or about 61% less compared to 1990. Up to 62% of GHGs was generated in the Energy sector, incl. stationary combustion equipment in different sectors of economy. EU countries have committed to achieving climate neutrality by 2050, so energy efficiency and the development of RES are given special attention.

A Lithuanian company, producing solar modules with 13 years of experience in the solar energy sector, was selected for the study. During the analysed year, the company produced solar modules with a total installed capacity of 8.1 MW. The impact on GWP amounted to 59.057 t CO2e per year or 7.291 kg per produced kW. The results of the material and energy flows analysis showed that during the production, the direct impact on GHGs was due to natural gas combustion for heating purposes, and the indirect - due to electricity consumption from network.

By applying the principles, of Cleaner Production Conception, 2 alternatives were proposed, the implementation of which could bring the company closer to becoming climate neutral:

- implementation of an air-to-air recuperator in ventilation system (CO2e reduction –14.7%);
- installation of a photovoltaic power plant (300 kWp) (CO2e reduction – over 80%).

The possibilities of reducing electricity consumption by changing the raw materials used in the lamination process are also evaluated.

The results of the feasibility analysis of the proposed innovations will be presented at the conference.

Keywords: climate neutrality, renewable energy sources, solar energy, cleaner production

Acknowledgments: We would like to thank the UAB „Via Solis“ for the opportunity to analyse the processes and conduct the study.

* irina.kliopova@ktu.lt

Assessment of possibilities of using alkaline reactive aggregates for concrete production

Filip Chyliński[1*] | Piotr Kupisz[1] | Jacek Zychowicz[2]

[1]Building Research Institute, Poland
[2]Military University of Technolog, Poland

Abstract

Concrete is the widest used building material among other. Aggregates states up to 80 % of its volume. Resources of natural aggregates which might be used for concrete production is decreasing rapidly. There are available deposits of natural aggregates with good properties for concrete such as quartzite, however they are not allowed for concrete production due to their alkaline reactivity. Alkali aggregate reaction (AAR) is a corrosive process which causes degradation of concrete. AAR to occur needs reactive aggregate and suitably high level of alkalis. Also environment in which concrete is exposed might be crucial as the higher humidity and temperature promotes AAR. Experiment carried by the ITB and WAT is focused on inhibiting AAR in concretes containing alkali reactive quartzie aggregate by using pozzolanic active additives such as silicerous fly ash and ilmenite mud waste (R-MUD). Ilmenite mud waste is a waste which is created during production of titanium dioxide in sulphate method. Results of previous tests have shown that R-MUD is a pozzolanic reactive material. AAR tests of concretes containing alkaline reactive aggregates were carried according to *AAR-10 Recommendation of RILEM TC 258-AAA: RILEM AAR-10: determination of binder combinations for non-reactive mix design using concrete prisms–38° C test method*. According to those recommendations AAR tests should be carried at least for one year, however by now results of 180 days tests have been collected. Preliminary results of tests carried up to 180 days shows that addition of pozzolanic material might cause decrease of AAR and possibly might allow for safe use of reactive aggregates for concrete production. Further tests are being continued.

Keywords: alkali aggregate reaction, concrete, quartzite, pozzolanic additives, ilmenite mud waste

* f.chylinski@itb.pl

Comparative LCA of pipe materials to assess the environmental impact of residential building installations

Lineker Max Goulart Coelho[1*] | Jesper Molin[1] | Michael Mast[1] | Jens Michael Bertelsen[1]

[1]Technical University of Denmark, Denmark

Abstract

More than one third of energy demand and greenhouse gases emissions in EU are related to buildings. For operation phase heating systems have the big share in energy demand, whereas for construction concrete and steel are the main responsible for GHG emissions. The EU Green Deal outline 55 different aspects required to promote the green transition and in order to assess that a holistic and multicriteria analysis is required. Indeed, environmental impact involves energy consumption, GHG, and other aspects. Embedded energy, resources depletion, acidification and ecotoxicity are examples of relevant environmental categories. In this respect, building elements like pipe installations can potentially play an important role for some of this categories. PE, PVC, PEX, copper and stainless steel are examples of different pipe materials used in buildings. So, the aim of this study is to assess the environmental impacts of residential buildings installations made with different pipe materials. The environmental impact analysis was performed using LCA methodology. LCA was carried out in 4 phases: goal and scope definition, Life Cycle Inventory (LCI), Life Cycle Impact Assessment (LCIA) and Interpretation. The results shows that the environmental impacts from different pipe materials can lead to completely different impact results. The diversity of raw materials, manufacturing process, and construction procedures among pipe types was reflected in the LCA results, differing in terms of carbon footprint and other categories. Buildings aiming to minimize environmental impacts must consider pipe choice a relevant aspect.

Keywords: building installations, pipes, environmental impact, multicriteria, LCA

* linco@dtu.dk

Synthesis and characterization of Pd-Ag_2O-Fe_3O_4 composite nanoparticles: In-situ generation of H_2O_2 and heterogeneous Fenton-like decolorization of Direct Red 23

Memduha Ergüt[1*] | Ayla Özer[2]

[1]Sivas University of Science and Technology, Department of Chemical Engineering, Türkiye
[2]Mersin University, Department of Chemical Engineering, Türkiye

Abstract

In this study, Pd-Ag_2O-Fe_3O_4 composite nanoparticles were synthesized as a catalyst for the decolorization of cationic dye Direct Red 23 (DR 23) by heterogeneous Fenton-like reaction with in-situ generated H_2O_2 by formic acid decomposition. Characterization studies were performed with SEM, XRD, FT-IR, and VSM analyses. The SEM images showed that the morphology consisted of spherical nano-sized particles. The mean particle size of the spherical composite nanoparticles was determined to be 64.149 ± 16.242 nm using Image J software. According to the results of XRD analysis, characteristic peaks of Fe_3O_4, Ag_2O, and Pd were obtained. FT-IR analysis was used to determine the functional groups in the structure. According to VSM analysis, the saturation magnetization (Ms) of Pd-Ag_2O-Fe_3O_4 nanocomposite was determined to be 7.96 Am^2/kg and it was observed that they could be easily separated from the reaction medium. In the second part of the study, the effects of parameters such as the initial pH, catalyst concentration, initial dye concentration, and formic acid concentration on color removal of DR 23 by heterogeneous Fenton-like reaction with in-situ synthesized H_2O_2 were investigated. The optimum conditions were determined as an initial pH of 3.0, a catalyst concentration of 2.0 g/L, an initial dye concentration of 25 mg/L, and a formic acid concentration of 500 mM. Under these conditions, 90.47% color removal was achieved at 10 h reaction time. The maximum in situ-generated H_2O_2 concentration was determined as 3.61 mg/L after 7 h reaction time. Consequently, the Pd-Ag_2O-Fe_3O_4 nanocomposite displayed high decolorization performance for DR 23.

Keywords: composite materials, Iron-containing nanoparticles, In-situ H_2O_2, heterogeneous Fenton-like reaction, Direct Red 23

* memduha.ergut@gmail.com

Exploring green hydrogen: a socio-economic framework for sustainable operations

Francesco Bonesso[1*] | Idiano D'Adamo[2] | Massimo Gastaldi[2]

[1]Independent Researcher, Italy
[2]Department of Computer, Control and Management Engineering, Sapienza University of Rome, Italy

Abstract

This study investigates the socio-economic viability of green hydrogen as a sustainable energy solution within Europe. The proposed Levelized Cost of Hydrogen (LCOH) is 3.60 €/kg for a 30 MW wind and 18.5 MW electrolysis plant in southern Italy, capable of producing 1,776,000 kg of hydrogen in its first year. Sensitivity analyses reveal that LCOH could vary between 2.81 and 4.48 €/kg, with inflation and capacity factors significantly influencing these costs. A decrease in capacity from 35% to 25% results in an LCOH increase to 5.25 €/kg. The survey indicates that 72.5% of Italians are unaware of the differences between green and grey hydrogen, with knowledge peaking among men over 35. Willingness to pay (WTP) for green hydrogen is approximately 10%, with the highest acceptance found among women aged 18-24. Acceptance of wind power installations shows a WTP of 8.7%. The study highlights that 68.6% of LCOH values cluster between 3.20 and 4.00 €/kg at a 35% capacity factor, emphasizing the need for public education and engagement to enhance acceptance. Overall, while green hydrogen presents significant economic potential, addressing knowledge gaps and societal resistance is essential for broader implementation, requiring strategic spatial energy planning.

Keywords: green hydrogen, levelized cost of hydrogen (LCOH), renewable energy, public acceptance, socio-economic analysis

Acknowledgments: This study was carried out within the PEACE (Protecting the Environment: Advances in Circular Economy) which received funding from the “Fondo per il Programma Nazionale di Ricerca e Progetti di Rilevante Interesse Nazionale (PRIN)” Investimento M4.C2.1.1-D.D. 104.02-02-2022, 2022ZFBMA4 funded by the European Union - Next Generation EU. This manuscript reflects only the authors’ views and opinions and can be considered responsible for them.

∗ bonesso.francesco@gmail.com

SESSION
Water-Raw Materials & Energy in green transition

Use of vermiculture to manage organic waste

Vasylyna Petrovets[1*] | Beata Wasąg[2]

[1]Institute of Physical Culture Science, University of Rzeszów, Rzeszów, Poland,
[2]Scientific Club for Sustainable Development of the University of Rzeszow, Renewable Energy Sources and Waste Management, Institute of Agricultural Sciences, Environmental Protection and Management, University of Rzeszów, Poland

Abstract

The article deals with the sustainable use of vermiculture for organic waste management. The authors determined the effect of test media on the abundance and biomass of the age structure of the earthworm population of *Dendrobaena veneta*, i.e. the entire earthworm population, mature individuals and immature individuals, as well as cocoons deposited by the study earthworms. The results of the study showed that earthworms of the *Dendrobaena veneta* species are suitable for organic waste disposal, but the composition of the test media should be modified accordingly. The study was carried out at the Department of Fundamentals of Agriculture and Waste Management, Institute of Agricultural Sciences, Conservation and Environmental Management, University of Rzeszow, for a period of 5 months - from December 2022 to April 2023. Raw materials of plant origin were used, namely waste rapeseed cake and earthworms of the *Dendrobaena Veneta* species.

Keywords: sustainability, organic waste, vermicomposting, vermicompost, earthworms

* v.petrovets01@gmail.com

Raw materials of the future – bioleaching of metals from spent Li-ion batteries and extraterrestrial resources

Weronika Urbańska[1*] | Ewa Borowska[1,2]

[1]Faculty of Environmental Engineering, Wrocław University of Science and Technology, Poland
[2]The College of Inter-Faculty Individual Studies in Mathematics and Natural Sciences, University of Warsaw, Poland

Abstract

Resources of critical metals are currently among the most sought-after in the world - for both economic and technological reasons. Their availability determines the key technologies of the European Union economy related to electronics, electromobility, energy transformation, as well as the space and defense sectors. Nevertheless, the increased demand for raw materials significantly affects their natural resources, which are constantly being depleted. Therefore, the possibilities of processing waste, such as polymetallic spent lithium-ion batteries, are constantly being considered using methods that will not only allow for effective metal recovery but will also be environmentally friendly following the principles of sustainable development and the circular economy. In this context, the most appropriate seems to be the use of biological methods with extremophiles - microorganisms capable of existing in conditions that are extreme for humans, e.g. high temperatures, extreme pH values or high metal concentrations. At the same time, this indicates the possibility of their use in exploring other planets and the Moon. The use of terrestrial bioleaching technology for the extraction of raw materials may contribute to the extraction of various raw materials "in situ", which will allow for the exploration of space in a much broader scientific dimension than is currently possible. It may additionally contribute to the colonization of other planets in the future.

The aim of presentation is to show and discuss the possibilities of biological recovery of metals from spent lithium-ion batteries, as well as the potential of using such a method for the exploration of extraterrestrial resources.

Keywords: critical raw materials, extremophiles, bioleaching, spent lithium-ion batteries, extraterrestrial resources

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* weronika.urbanska@pwr.edu.pl

The influence of methyl esters from the rapeseed oil on the properties of anticorrosive coatings of cooling towers

Robert Hunek[1*]

[1]Lublin University of Technology Doctoral School, Poland

Abstract

The research on the physical properties of concrete with anticorrosive coatings was presented in the paper. The starting materials are the silanes and epoxy resin modified with methyl esters from the production of rapeseed oil. In total, 5 new resins were produced. In order to combine the phases of the above ingredients, ultrasound was used. The new resins were tested: viscosity and density. The basic characteristics of concrete with coatings: water absorptivity, contact angle (CA), frost resistance, resistance to salt crystallization pressure, UV radiation resistance were defined. Concrete mixture was prepared in the laboratory. After 28 days, concrete samples were covered with the new coatings twice with a brush. The tests were performed 7 days later. The smallest water CA (10°) was obtained by reference concrete and the highest water CA (122°) was obtained by Bel4151+EM (80% epoxy resin and 20% methyl ester). Whereas concrete with Bel5811+EM is characteristic of the lowest absorptivity (2.29%) among the tested samples. After 50 cycles of freezing-thawing (F-T) the concretes are characterized by an insignificant mass change in the case of the concrete with epoxy resins – 0.01-0.2%, reference concrete samples – 3.11%. Concrete with new coatings showed very good resistance to salt crystallization, while the reference concrete showed a 15% weight loss. The aging test showed that most resins are UV resistant.

Studies have shown that methyl esters derived from rapeseed oil can be used as anticorrosive coatings for concrete of cooling towers

Keywords: concrete, methyl ester, coating, water resistance, frost resistance

Acknowledgments: Ministry of Science and Higher Education – Poland, within the project no. DWD/7/0365/2023.

* d597@pollub.edu.pl

Perspectives on the use of sand from sewer cleaning as full replacement of fine aggregate in concrete

Monika Czop[1*] | Beata Łaźniewska-Piekarczyk[1] | Elwira Zajusz-Zubek[1]

[1]Silesian University of Technology, Poland

Abstract

Sand is a key raw material widely used in the construction industry in the broadest sense, for example, for the production of various types of concrete, for the production of mortar, for earthworks, for construction works in building structures and road structures, or for winter maintenance of roads and sidewalks. Global sand consumption exceeds 150 billion Mg annually while in Poland it is 150-200 million Mg. Due to the non-renewability of natural river sand resources, alternatives are being sought, both in the context of a closed-loop economy and sustainable, green materials in the construction sector. Reusing waste sand for concrete can reduce the use of increasingly expensive natural aggregates.

Preliminary tests included the following parameters: moisture content, organic matter content, bulk density, and grain size. The tests were carried out for waste sand generated by sewer cleaning. The waste sand was characterized by organic carbon content (2.75%), and the bulk density was 1350 kg/m^3. In the next research step, cement mortars were designed and prepared in which 100% of the natural aggregate was replaced by waste sand. The results of compressive and crushing strength of the tested mortars are 37% lower compared to the results of mortars based on natural aggregate. The paper also presents tests on the leachability of contaminants from waste sand and cement mortars. The obtained leachability results confirm that both waste sand and cement mortars based on it do not pose a potential threat to the environment.

Keywords: waste sand, fine aggregate, flexural strength, compression strength, leaching characteristics

* monika.czop@polsl.pl

Utilizing urban mining of platinum group metals to optimize precipitation conditions of pgm nanoparticles for the degradation of pharmaceuticals in aquatic environments

Wiktoria Stachowicz[1*] | Martyna Rzelewska-Piekut[1] | Wojciech Smułek[1] | Magdalena Regel-Rosocka[1]

[1]Institute of Chemical Technology and Engineering, Poznan University of Technology, Poland

Abstract

Platinum, palladium, and rhodium are classified as platinum group metals (PGMs), representing the most valuable elements in the world. Demand for these metals is growing faster than the availability of resources, which keeps their price high. In light of the declining natural reserves of these metals, there is increasing emphasis on the exploration of alternative resources, including the utilization of spent automotive converters (SACs). The recycling of these catalysts, classified as urban mining, is becoming the primary method of PGMs recovery. The objective of the study is to identify the optimal conditions for the precipitation of PGM nanoparticles (PGM-NP) in the presence of a bioreducer, with the aim of achieving a high effectiveness of PGM-NP precipitation. The precipitation efficiency obtained for the tested systems, which included: PGM precursor (Pt(IV)), saponin (soapnut), ascorbic acid, and pH regulation through the application of Na_2CO_3, exceeded 90%. The catalytic properties of PGM-NPs should have a beneficial impact on accelerating of the degradation reaction of pharmaceutical contaminants (e.g., ibuprofen) present in aqueous environments. This solution for drug degradation will contribute to improvements in water quality and reductions in the threats to human and animal life (e.g., antibiotic resistance, histopathological changes, metabolic disorders, allergic reactions) caused by the presence of pharmaceutical substances in the environment.

Keywords: PGM, nanoparticles, saponins, pharmaceuticals, aquatic environment

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* wiktoria.stachowicz@doctorate.put.poznan.pl

Abstracts

Poster presentations on-site

Competitive adsorption of selected potentially toxic metals on Slovak bentonites

Matej Šuránek[1*] | Zuzana Melichová[1] | Maciej Thomas[2]

[1]Department of Chemistry, Faculty of Natural Sciences, Matej Bel University Banská Bystrica, Slovak Republic
[2]Department of Environmental Technologies, Faculty of Environmental Engineering and Energy, Cracow University of Technology, Poland

Abstract

The presented work focuses on the competitive adsorption study of potentially toxic metal ions, specifically copper and nickel, onto selected types of bentonites. Adsorption experiments were conducted using a binary aqueous metal solution of Cu and Ni with different initial metal ion concentrations on two samples of bentonites from the Slovak deposit named Lutila. The obtained results were evaluated using linear and nonlinear Langmuir and Freundlich adsorption isotherm models. The adsorption data from the binary systems indicated that this type of adsorption follows the Langmuir adsorption isotherm model, from which the maximum monolayer adsorption capacity values (q_m) were calculated. The q_m values obtained from the linear model of the Langmuir adsorption isotherm were 7.27 – 30.30 mg/g for Cu and 5.45 – 6.59 mg/g for Ni. The q_m values obtained from the nonlinear model of the Langmuir adsorption isotherm were 7.68 – 29.00 mg/g for the adsorption of Cu onto and 7.67 – 8.31 mg/g for Ni. The experimental value of the maximum adsorption capacity (q_e) was 7.95 – 27.49 mg/g for the adsorption of Cu and 6.67 – 9.82 mg/g for the adsorption of Ni. The maximum monolayer adsorption capacity (q_m) and the experimental maximum adsorption capacity (q_e) demonstrate a preference for the adsorption of Cu onto both types of adsorbents.

Keywords: adsorption, bentonite, copper, nickel, isotherm

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* matej.suranek@umb.sk

Microwave-assisted synthesis of chitosan hydrogels for heavy metals removal

Marek Piątkowski[1*] | Anita Wójcik[1] | Natalia Wacławik[1]

[1]Cracow University of Technology, Faculty of Chemical Engineering and Technology, Department of Biotechnology and Physical Chemistry, Poland

Abstract

Development of different branches of industry increases the formation of toxic waste that often is not subjected to purification in industrial water plants. Elimination of heavy metal ions directly to soil, river or sea can destroy the ecosystem. That is why the new ecofriendly sorption agents are looked for by all scientists all over the world.

Chitosan is a biodegradable polymer received from waste biomass like crustaceans' shells (crabs or shrimps). It can be chemically modified by different organic acids to form hydrogels that can be applied in heavy metal ions sorption. Synthesis procedure according to Green Chemistry Principles, as well as Sustainable Development can be devised by application of unconventional synthesis methods like microwave radiation.

The main objective of this study was a development of chitosan hydrogels' synthesis method with the use of microwave radiation, as well as determination of sorption properties for heavy metal ions. Applied procedure enabled great reduction of synthesis time, fast sorption of heavy metal ions, as well as eliminated the need of toxic catalysts application.

Keywords: heavy metal ions sorption, chitosan derivatives, chemical modification, microwave radiation

* marek.piatkowski@pk.edu.pl

Impact of industrial incinerator ash on the polymerization kinetics of epoxy resins

Grzegorz Przesławski[1*] | Dorota Tomczak[1] | Joanna Szymańska[1] | Katarzyna Szcześniak[1] | Agnieszka Marcinkowska[1]

[1]Poznan University of Technology, Department of Chemical Technology, Department of Polymers, Poland

Abstract

Epoxy resins are extensively utilized in construction as adhesives, grouts, insulators, and binders in repair applications. Modifying epoxy resins with additives can influence the conversion of epoxy groups, while also presenting a potential ways for waste management through filler incorporation.

This study investigates the impact of industrial incinerator ash on the curing process of epoxy resins. A two-component epoxy resin based on bisphenol A, combined with a cycloaliphatic polyamine hardener (CES H71a), was modified with 20, 35, and 50 wt.% of ash from Lech Ltd. PUHP's waste incineration plant. Detailed studies of the kinetics of the polymerization process were carried out using differential scanning calorimetry (DSC). The samples were heated in an argon atmosphere from 0 to 200°C at rates of 5, 10, 15, and 20 °C/min.

Results show that the addition of ash alters the viscosity of the resin mixtures but does not significantly affect the overall shape of the kinetic curves. However, both the heat release during the reaction and the time to reach the maximum temperature of polymerization decreases with increasing ash content. The degree of conversion at maximum polymerization reaction temperature also decrease with higher filler content.

Although ash does not have a significant effect on the curing process, making it a viable option for ash recycling (as well as reducing resin production costs), the decrease in conversion rates suggests that ash may affect the mechanical properties of epoxy resins.

Keywords: epoxy resin, polymerization kinetics, industrial ash, waste management

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* grzegorz.przeslawski@doctorate.put.poznan.pl

Water from green roofs as an alternative source of water in cities

Joanna Bąk[1*] | Andrzej Bielski[1] | Maciej Thomas[1]

[1]Cracow University of Technology, Poland

Abstract

The ongoing climate change forces decision-makers managing water in cities to take a number of actions, including searching for alternative water sources to tap water. Such water can be used for various purposes – it is only important that its use reduces the volume of tap water consumption in the city. This will increase the security of tap water supplies during shortages of water obtained from traditional sources.

Rainwater is one of the basic alternatives to tap water considered in cities. However, its quality varies depending on, among other things, the location of the collection point and the surface from which it is collected. On the other hand, a parallel direction of adapting cities to climate change is blue-green infrastructure, including green roofs. It is therefore important that the implementation of these actions proceeds synergistically.

The aim of the research was to assess the quality and suitability of rainwater discharged from the drainage of various model green roofs for use for selected purposes. Research stations were constructed to allow the collection of rainwater filtered through various systems of green roof layers. Selected water quality parameters were tested in the collected water samples. Among them, color, turbidity and pH, as well as the content of biogenic compounds. The results obtained allowed for the formulation of recommendations for the construction of green roofs in cities for the purpose of retaining excess rainwater, as well as their later use.

Keywords: water demand, green roof, water treatment, rainwater, climate change

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* joanna.bak@pk.edu.pl

Removal of hydroxyl derivatives of polycyclic aromatic hydrocarbons with microplastics as adsorbent

Laura Frydel[1*] | Jagoda Worek[1] | Daniel Kaleta[1] | Katarzyna Styszko[1]

[1]AGH University of Krakow, Poland

Abstract

Polycyclic aromatic hydrocarbons (PAHs) are known contaminants with negative impact on organisms and environment. Their presence in the environment has been widely confirmed. Studies have shown that these compounds can have mutagenic, carcinogenic and teratogenic effect. During metabolization or environmental processes PAHs can be converted to hydroxylated forms (OH-PAHs), which can be even more dangerous, due to their higher solubility in water and bioavailability. Furthermore, OH-PAHs can be treated as biomarkers of exposure to PAHs. According to the studies, PAHs, as well as OH-PAHs, are detected in various environment samples. Therefore, it is crucial to find an effective method of removing these compounds from the environment. Adsorption is easy, fast and effective method of removing of contaminants from the environment. Microplastics (MPs) are fragments of plastic with size < 5 mm. MPs can be found in many different environmental samples and even in human's body. Microplastics can have a large specific surface area and strong hydrophobic nature, therefore MPs can be used as adsorbents of micropollutants, such as OH-PAHs. In this study the influence of aging process of microplastics was used to determine the possibility of removing OH-PAHs from water. Aging process of MPs include using of ultraviolet radiation and hydrogen peroxide solution. The FT-IR spectra were recorded in order to compare the differences between modified and unmodified microplastics. Microplastics with and without aging process were used as adsorbents of OH-PAHs from water. Microplastics after aging process were more effective adsorbents in removing all OH-PAHs from water than unmodified microplastics.

Keywords: OH-PAHs, microplastic, adsorption, micropollutants

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* frydel@agh.edu.pl

Use of green energy for hydrogen production – electrolysis process, storage in underground gas caverns (UGS) and monitoring of environmental threats

Paulina Cyran[1,2*] | Andrzej Gardeła[1] | Małgorzata Gierek[1] | Karol Jońca[1] | Piotr Skubisz[1] | Mateusz Zając[1]

[1]Research and Development Center Mining of Chemical Raw Materials "CHEMKOP" Ltd., Poland
[2]AGH University of Krakow, Poland

Abstract

In the face of growing demand for renewable energy sources, green hydrogen production could play a key role in the future of the energy industry. Unlike traditional fossil fuels it does not generate carbon dioxide, making it an attractive option for global efforts to reduce greenhouse gas emissions. One of the methods of producing green hydrogen is water electrolysis, which involves splitting water into hydrogen and oxygen using excess electricity from renewable energy sources. This process uses renewable energy sources such as solar, wind or water energy. Once hydrogen is produced, one of the most attractive concept is to store it in the underground gas caverns (UGS) for future use or transport. UGS are artificial underground spaces that can hold large amounts of gases under very high pressure, making them ideal for storing hydrogen. UGS allow for easier distribution and ensure a constant and reliable supply of this clean energy source. Due to the chemical properties of hydrogen and its high permeability, periodic monitoring should be carried out when hydrogen is stored in underground gas storage caverns leached from salt deposits. Its purpose is to detect possible leaks early. A trap method has been developed, which involves placing appropriately modified piezometers with the so-called "hydrogen space" in the subsurface soil layer and a specific methodological method of gas sampling. By using renewable energy sources to produce hydrogen and safe methods of storing it, we can reduce our dependence on fossil fuels and thus reduce carbon dioxide emissions.

Keywords: green energy, green hydrogen, underground gas storage cavern (UGS), electrolysis, hydrogen trap

* paulina.cyran@chemkop.pl/ cyran@agh.edu.pl

Bio-based compounds: modified polysaccharides, proteins, and calcium phosphates as materials for scaffolds preparation

Katarzyna Haraźna[1*] | Dominika Träger[1] | Kamila Lis[1] | Dagmara Słota[1] | Karina Niziołek[1] | Bożena Tyliszczak[1] | Agnieszka Sobczak-Kupiec[1]

[1]Cracow University of Technology, Faculty of Materials Engineering and Physics, Poland

Abstract

Natural macromolecules, such as proteins and polysaccharides, are widely utilized in the development of materials for tissue engineering due to their favorable compatibility with human tissues, which ranges from good to excellent. Polysaccharides i.e. pullulan, which are natural polymers derived from sugars, are particularly favored for their biocompatibility and biodegradability, as well as their capacity for chemical modification and crosslinking. These properties make them ideal candidates for creating hydrogels designed explicitly for cartilage repair, fulfilling all three functional categories [1].

Various additives, such as calcium phosphates, are incorporated into the material to enhance or impart bioactive properties to promote the regeneration of calcified cartilage and the underlying bone. Ceramics like calcium phosphate and hydroxyapatite (HAp) are commonly utilized due to their favorable biocompatibility, bioactivity, and osteoconductive characteristics. Furthermore, calcium phosphate possesses piezoelectric properties, attributed to the movement of ions within its structure when subjected to mechanical stress [2]. These compounds adhere to natural bone and facilitate the formation of an apatite layer. The calcified cartilage layer, along with the subchondral bone beneath it, is primarily composed of nanohydroxyapatite (nanoHAp, >65%). This compound enhances the differentiation of bone marrow mesenchymal stromal cells (BMSc) into osteoblasts, thereby accelerating the development of subchondral bone and establishing a suitable interface between calcified cartilage and bone [3].

This study assessed the possibility of combining substrates, i.e., modified polysaccharides (PS-mod), proteins, and calcium phosphates, to produce tissue engineering scaffolds. In the long term, these materials may find application in the treatment of calcified cartilage or osteochondral tissue.

Keywords: biopolymers, renewable resources, scaffolds, tissue engineering, osteochondral defects

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References:

[1] Zhang, Y., et al. (2017). Natural Polymers for Tissue Engineering Applications. Journal of Biomedical Materials Research Part A, 105(9), 2443-2455.
[2] Barbosa, A. I., et al. (2022). Piezoelectric Properties of Calcium Phosphate Ceramics. Journal of Materials Science, 57(4), 1234-1245.
[3] Zhang, H., et al. (2021). The Influence of Nano-Hydroxyapatite on Bone Regeneration. Biomaterials, 267, 120467.

* katarzyna.harazna@pk.edu.pl

Behavior and impact of biodegradation of the Personal Care Products

Helena Hybská[1*] | Martina Mordáčová[1] | Mária Gregušová[1]

[1]Department of Environmental Engineering, Faculty of Ecology And Environmental Sciences, TUZVO - Technical University in Zvolen, Slovakia

Abstract

Excessive consumption of cleaning and disinfecting agents, which constitute a distinct group of emergent pollutants known as PPCP´s ("Pharmaceutical and Personal Care Products"), results in their accumulation in aquatic environments. Conventional wastewater treatment plants are unable to effectively remove the emergent pollutants that are present, including personal care product residues. This study focuses on the determination of surfactant substances in model samples prepared from selected personal care products and their biodegradability under laboratory-created aquatic ecosystem conditions. The conducted biodegradation processes, based on the monitored content of the surfactants in the model samples, confirm that the utilization of aquatic vegetation and gravel substrates can efficiently eliminate the present contaminants. Insights gained from researching the biodegradability of PPCP´s group products are applicable, including experiences with plant compositions used in aquatic environments, particularly in the construction of root-zone wastewater treatment systems.

Keywords: Pharmaceutical and Personal Care Products (PPCP´), surfactants, biodegradation, aquatic ecosystem

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* hybska@tuzvo.sk

Plasma electrolytic oxidation as a source of hybrid TiO_2-ZnO coatings for photocatalytic water pollutant removal

Magdalena Marny[1*] | Maciej Sowa[1] | Joanna Michalska[1]

[1]Faculty of Chemistry, Silesian University of Technology, Poland

Abstract

Oxide coatings produced by plasma electrolytic oxidation (PEO) are becoming increasingly popular. This is due to the unique properties that can be imparted to the material by selection of process conditions. These range from improved corrosion resistance to surface modification for electronics, implantology and even catalysis. However, there are still applications for PEO coatings that require further development.

One example is the idea of depositing hybrid coatings of ZnO and TiO_2 on titanium, Ti Cp. There are reports on the effective incorporation of ZnO particles by PEO process. However, none of them concern the Ti Cp substrate, which is particularly promising. Such a solution should fill the individual deficiencies of these two oxides that inhibit their application in the photocatalytic elimination of pollutants from water in advanced oxidation processes (AOPs). The question is whether it is possible to synthesize such coatings using the PEO method?

The research conducted aimed at the PEO synthesis of TiO2-ZnO coatings on Ti Cp and to determine their potential for AOP through material characterization. The results indicate that the hybrid coatings may exhibit photocatalytic properties due to the effective incorporation of ZnO NPs into the oxide layer, the presence of photocatalytically active anatase and high surface development. Furthermore, the incorporation of ZnO NPs enhances the surface hydrophilicity and its, which is also positive for water treatment applications. These findings open new avenues for the PEO application for coatings production, offering a potential solution to environmental challenges, particularly in water purification technologies.

Keywords: Ti CP, TiO_2-ZnO, ZnO, plasma electrolytic oxidation, photocatalysis

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* magdalena.marny@polsl.pl

Invasive plant composting as a tool of their eradication and biomass waste valorisation

Evelina Niedrite[1*] | Oskars Purmalis[1] | Linards Klavins[1] | Linda Dobkevica[1] | Maris Klavins[1]

[1]Department of Environmental Science, University of Latvia, Latvia

Abstract

Invasive plant species pose significant ecological threats worldwide, affecting the stability and biodiversity of local ecosystems. As a result of their control, a significant amount of plant biomass is produced requiring solutions for safe utilisation. As a promising tool to achieve both invasive plant eradication aims, and safe biomass utilization composting can be considered. Five different composts were prepared from three invasive plant species abundant in Northern and Central Europe – *Reynoutria japonica*, *Solidago canadensis*, *Lupinus polyphyllus*. The stages of composting have been investigated and recommendations for process optimization have been made based on the quality characterization of the final compost. The composition of invasive plant biomass composts has been characterised, considering nutrient concentrations, humification degree, composition of compost humic substances concentration, and concentration of mineral substances as well as heavy metals. Obtained compost quality complies with the EU regulations for fertilizing products and soil amendments thus it can be considered equivalent to industrially produced composts. Seed germination tests confirm suitability of invasive plant composts for agricultural applications. Based on pilot-scale trials, recommendations for invasive plant composting have been suggested, thus supporting use of their biomass waste in bioeconomy.

Keywords: invasive plants, composting, compost quality, gemination tests

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* evelina.niedrite@lu.lv

Ecological method for obtaining hybrid hydrogel biomaterials using polysaccharides

Karina Niziołek[1*] | Dagmara Słota[1] | Agnieszka Sobczak-Kupiec[1]

[1]Cracow University of Technology, Poland

Abstract

Advances in regenerative medicine and tissue engineering require the search for new, sustainable solutions that are both effective and environmentally friendly. In response to these challenges, an eco-friendly method for synthesizing hybrid hydrogel biomaterials has been developed, based on the principles of "green chemistry" and the "Zero Waste" concept. The presented technology uses renewable raw materials such as polysaccharides (e.g. pullulan) and biopolymers, which were subjected to a photocrosslinking process using UV light for 4 minutes. This process does not require the use of toxic solvents or aggressive reactants, making it safe for both the body and the environment.

The obtained hydrogel biomaterials are characterized by high flexibility, biocompatibility and the ability to adapt their physicochemical properties to specific medical applications. A 14-day incubation in fluids simulating the body's internal environment confirmed their stability and minimal pH changes, indicating their potential in clinical applications such as controlled drug release systems and tissue regeneration.

The proposed method generates no waste, making full use of raw materials, which allows for rational resource management and lower production costs. The technology makes it possible to create materials of any shape, which gives the possibility to personalize the biomaterial according to the patient's needs. Thanks to its innovation and sustainability, this technology has the potential to become a good solution in the production of biomaterials dedicated to the medicine of the future.

Keywords: biomaterials, photocrosslinking, biopolymers, pullulan

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* karina.niziolek@doktorant.pk.edu.pl

Recent trends in textile waste recycling: an overview

Lyudmila Slobodkina[1*] | Roksana Muzyka[2] | Marcin Sajdak[2] | Szymon Sobek[3] | Sebastian Werle[1]

[1]Silesian University of Technology, Department of Thermal Technology, Poland
[2]Silesian University of Technology, Department of Air Protection, Poland
[3]Silesian University of Technology, Department of Heating, Ventilation, and Dust Removal Technology, Poland

Abstract

The global textile industry not only produces apparel and fabrics but also generates a substantial volume of waste annually, exacerbating environmental, economic, and social challenges. Based on the information of the European Environment Agency, approximately 80% of the total climate impact from textiles arises during the production phase. Distribution and retail activities contribute 3%, while the usage phase (washing, drying, and ironing) accounts for 14%. The end-of-life stage, encompassing collection, sorting, recycling, combustion, and disposal, adds another 3%. European Union (EU) per capita apparel consumption has surged by 40% in a short time and clothing is the fourth biggest polluter in the EU, due to falling pricing and faster fashion delivery.

Despite these rising consumption levels, less than 50% of used clothing is collected for reuse or recycling, and less than 1% is transformed into new garments. This gap is primarily due to the nascent state of technologies capable of recycling textiles into fresh fibers. The recycling of textile waste is hindered by the heterogeneous composition of garments, which are often blends of fibers. Current mechanical and chemical recycling technologies face significant technical and economic barriers in effectively separating these diverse materials for reuse, leading to a considerable portion of textile waste being landfilled, incinerated, or exported. Furthermore, the presence of additives such as dyes, flame retardants, and surface treatments presents additional complications.

This study explores the scope of the problem, reviews existing legal frameworks, and analyzes current solutions, proposing novel approaches to textile waste recycling. It also identifies emerging innovations aimed at promoting a closed-loop textile economy.

Keywords: textile waste, circular economy, fibers, sustainability, recycling

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* milamd357@gmail.com

Experimental laboratory research on the disinfection of rainwater for potential application in swimming pools

Rafał Rapacewicz[1,2*] | Edyta Kudlek[1] | Katarzyna Brukało[2,3]

[1]Department of Water and Wastewater Engineering, Faculty of Energy and Environmental Engineering, Silesian University of Technology, Poland
[2]PB LEMTER, Poland
[3]Department of Health Policy, School of Health Sciences in Bytom, Medical University of Silesia in Katowice, Poland

Abstract

The background of the topic discussed in the presented research is the need for improved water management in urban areas due to water scarcity in Poland, exacerbated by climate change and more frequent extreme weather events. To address challenges in water supply and intense precipitation overwhelming sewage systems, the proposed rainwater application in swimming pool facilities is to enhance rainwater retention and manage it at the point of origin.

The primary objective of this paper is to assess various proposed methodologies to ensure the safety of harvested rainwater when used in swimming pools.

The scope of this paper encompasses experimental laboratory studies on rainwater disinfection processes employing chlorine compounds and UV radiation. Disinfection constitutes a critical unit process in the rainwater treatment, which, as numerous previous studies have indicated, is significantly contaminated with microbial pollutants.

The findings of the conducted experiments demonstrate that the most optimal water quality can be attained through the implementation of a two-stage disinfection process involving sequential UV/chlorination. This approach effectively achieves rainwater purification and guards against secondary contamination, while concurrently limiting the production of chlorination by-products.

It was concluded that thorough rainwater treatment, inclusive of disinfection procedures, can effectively eliminate harmful microbiological contaminants, thereby rendering it suitable for potential integration into swimming pool facilities.

Keywords: rainwater disinfection, swimming pool installations, rainwater harvesting

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* rafal.rapacewicz@polsl.pl

Assessment of phytotoxicity of the paper sludge

Dagmar Samesova[1*] | Adam Pochyba[1]

[1]Technical University in Zvolen, Slovakia

Abstract

The goal of our paper was to evaluate the use of paper waste sludge for the improving soil properties when the growing cultural plants. The paper sludge leachate and sludge dewatering water had a positive effect on the yield of cress (*Lepidium sativum L*) and the lettuce (*Lepidium sativum*) plants. A slightly negative effect was recorded on germination, which fell to 83.3% compared to the control. Testing included the assessment aerobic and anaerobic degradation of paper waste sludges. Tests were conducted using the OxiTop® OC 110 instrument, utilizing respirometric measurement principles. Tests followed adapted standards, including OECD 311, OECD 301 D, ISO/DIS 14851:2016 E, and OECD 302 B, adamted to our specific requirements and conditions. The results of the anaerobic biodegradability tests showed that the paper sludge had no toxic or inhibitory effects on the bacterial consorptium of the anaerobic sewage sludge and supplied the necessary nutrients for the development and growth of microorganisms. Aerobic biodegradability tests showed that increasing sludge concentration improved the decomposition of organic substances, with pH and COD_{Cr} being positive indicators.

Keywords: paper sludge, biogas, biodegradability, phytotoxicity

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* samesova@tuzvo.sk

Hydrodynamic disintegration impact on digestate dewatering capacity

Katarzyna Umiejewska[1*] | Agnieszka Garlicka[1] | Katarzyna Sytek-Szmeichel[1] | Monika Żubrowska-Sudoł[1] | Justyna Walczak[1]

[1]Faculty of Building Services, Hydro and Environmental Engineering, Warsaw University of Technology, Poland

Abstract

The anaerobic digestion process is commonly used in medium and large wastewater treatment plants. In recent years, co-digestion and/or disintegration of substrates directed to the digestion process have been used to improve digestion efficiency and increase biogas production. One method of mechanical feedstock pre-treatment is hydrodynamic disintegration. In municipal wastewater treatment plants, excess sludge, which is more difficult to stabilise, is most often disintegrated. The use of a substrate pretreatment process not only affects the efficiency of the stabilisation process, but also the dewaterability of the digestate, which is an important step to reduce a plant's biosolids output. The dewaterability of digestate can be described in two ways. The first is the rate of separation, and the second is extension of separation. The rate of separation is typically measured by Capillary Suction Time (CST). The purpose of the study was to analyse the impact of hydrodynamic disintegration substrates for the CST of the digestate. The mesophilic digestion process (37°C) was carried out in the AMPTS II (Automatic Methane Potential Test System). The substrates for the fermentation process was sewage sludge (raw or disintegrated).

The disintegration process was conducted at seven levels of energy density (ε_L), namely: 6, 12, 18, 35, 70, 140 and 210 kJ/L. The obtained results show that the low energy density in the process of hydrodynamic disintegration led to the shortening of the digestate's CST by 16-21.6%.

Keywords: sludge, anaerobic digestion, hydrodynamic disintegration, dewatering, capillary suction time

* katarzyna.umiejewska@pw.edu.pl

Tracking of per- and polyfluoroalkyl substances (PFAS) hot spots in the South Baltic region. Polish case study

Małgorzata Szopińska[1*] | Filip Pawlak[1] | Katarzyna Kozłowska-Tylingo[1] | Filip Gamoń[1] | Hubert Byliński[1] | Natalia Walczak[1] | Aneta Łuczkiewicz[1] | Sylwia Fudala-Książek[1]

[1]Gdańsk University of Technology, Faculty of Civil and Environmental Engineering, Poland

Abstract

Per- and polyfluoroalkyl substances (PFAS) are persistent, toxic contaminants present in various water matrices, known as 'forever chemicals.' They exhibit diverse properties, such as biomagnification and water solubility, making them environmentally mobile. PFAS are regulated by the Stockholm Convention on Persistent Organic Pollutants and the EU Directive 2020/2184, which mandates a 'Sum of PFAS' limit of 0.10 μgL^{-1} in drinking water. This study analyzed PFAS in runoff water, landfill leachates, and wastewater using targeted analysis for 24 PFAS. Solid phase extraction and high-performance liquid chromatography tandem mass spectrometry was applied. Concentrations ranged from 120.6–226.9 ngL^{-1} in runoff water, 1073–6405 ngL^{-1} in landfill leachates, 209.2 ngL^{-1} in raw wastewater, and 183.8 ngL^{-1} in treated wastewater. Immediate action is required for landfill leachate treatment, and improved treatment technologies for wastewater and runoff water are necessary to safeguard drinking water sources. However, temporal variations of PFAS in leachate still remain poorly understood. Hence, these knowledge gaps must be addressed to properly design efficient on-site treatment technologies.

Keywords: PFAS, water protection, environmental monitoring, water resource

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* lszopi@pg.edu.pl

Computational intelligence for cleaner energy generation technologies

Katarzyna Szramowiat-Sala[1*]

[1]AGH University of Krakow, Poland

Abstract

The transition to cleaner energy generation technologies is vital to addressing global climate change and achieving sustainable energy systems. Computational intelligence (CI) techniques, such as machine learning, neural networks, and optimization algorithms, offer innovative approaches to optimizing energy production processes, reducing emissions, and enhancing system efficiency. This work disscusses the potential of CI in cleaner energy generation, with a focus on its application to renewable energy sources, emissions control, and process optimization. CI can be applied to predict and manage energy generation from intermittent renewable sources like solar and wind power, enhancing grid stability and reliability. It also aids in improving the efficiency of energy conversion technologies, such as fuel cells and thermoelectric generators, by optimizing operational parameters in real-time. In emissions control, CI techniques help identify complex relationships between fuel characteristics, combustion processes, and pollutant formation, enabling the design of low-emission combustion systems and improved catalytic converters. Furthermore, CI-driven simulations allow for faster development of new materials and technologies by exploring vast design spaces more efficiently than traditional methods. The integration of computational intelligence into cleaner energy technologies represents a paradigm shift in energy management and generation, offering the potential to significantly reduce carbon footprints while increasing energy system efficiency and reliability. By harnessing the power of data-driven insights, CI contributes to a more sustainable energy future.

Keywords: computational intelligence, cleaner energy technologies, machine learning, emissions control, process optimization

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* katarzyna.szramowiat@agh.edu.pl

Materials of natural origin as potential fillers of polyurethane elastomers

Maciej Tomaszczak[1*] | Przemysław Bartczak[1] | Sławomir Borysiak[1]

[1]Poznan University of Technology, Faculty of Chemical Technology, Poland

Abstract

This study focuses on the use of agricultural by-products as biofillers for polyurethane matrix in order to obtain innovative elastomers. The natural materials of plant origin were added into a commercial polyurethane system.

The main objective was to find a new application for popular waste material, which corresponds to the principles of circular economy. In addition, the use of the biofillers had the purpose of reducing the final cost of the product by diminishing consumption of the expensive petrochemical raw materials – polyols and isocyanates. This will also minimise the overall carbon footprint of the final product by decreasing the demand for these components. Moreover, the addition of the fillers was analysed for its capability to enhance performance of the final polyurethane products in order to create an alternative to traditional materials. The obtained polyurethane elastomer biocomposites were examined in terms of processing parameters, performance properties, morphology and composition.

The introduction of additional hydroxyl groups from added compounds and intermolecular interactions between the biofiller and the polymer, improved the abrasion resistance and tensile strength, as well as increased the hardness and elongation at break of the samples. Importantly, the addition of fillers did not negatively affect the other analysed properties.

The results confirmed the application potential of used natural materials as biofillers of polyurethane elastomers. An innovative, eco-friendly, and cost-effective polyurethane biocomposite was developed. What is more, polyurethane biocomposites demonstrate a wide range of potential applications.

Keywords: polyurethane, elastomers, biofillers, biocomposites, circular economy

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* maciej.tomaszczak@doctorate.put.poznan.pl

Hydrogel materials in modern medicine: controlled release and eco-friendly synthesis

Wiktoria Wrzesińska[1*] | Bożena Tyliszczak[1]

[1]Cracow University of Technology, Faculty of Materials Engineering and Physics Department of Material Engineering, Poland

Abstract

Hydrogel materials, characterized by their three-dimensional, cross-linked polymeric structure, can absorb and retain significant amounts of water or other fluids. Their unique properties, such as biocompatibility, biodegradability, and the ability to control the release of active substances, make them promising carriers for a variety of applications. This study focuses on the potential of hydrogel materials in the fields of medicine and pharmacology, where they can facilitate controlled drug delivery, enhancing therapeutic efficacy while minimizing adverse effects. Additionally, in cosmetology, hydrogels are used in products such as moisturizers and anti-aging formulations due to their ability to gradually release active substances like hyaluronic acid. Active substances, defined as chemical compounds with specific biological, pharmacological, or chemical properties, can exert antimicrobial, anti-inflammatory, or therapeutic effects. Hydrogels are particularly valuable for their responsiveness to environmental stimuli, such as pH or temperature changes, which can be leveraged for targeted delivery. An additional innovation in this field is the use of waste-free UV-induced synthesis, which offers an environmentally friendly approach by reducing by-products and minimizing the need for purification steps. This green chemistry technique enhances the sustainability of hydrogel production, aligning with modern demands for eco-friendly processes. Despite the promising potential, challenges remain in the long-term storage of active substances within hydrogel matrices, which warrants further research. Overall, hydrogels as carriers of active substances offer innovative solutions with wide-ranging applications in various scientific and industrial domains.

Keywords: hydrogels, controlled drug delivery, biocompatibility, green synthesis, green chemistry

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* wiktoraia.wrzesinska@student.pk.edu.pl

Solid-state fermentation of spruce needles (*Picea abies*): microbiological and chemical criteria

Irena Mačionienė[1*] | Sandra Kiselioviėnė[1] | Darius Černauskas[1] | Alvija Šalaševičienė[1]

[1]Food Institute, Kaunas University of Technology, Kaunas, Lithuania

Abstract

Spruce needles (*Picea abies*) are a significant forestry byproduct, often underutilized in industrial applications. Due to their potential as natural food additives, fermentation processes have gained increasing interest, particularly regarding the microbiological and chemical properties of the final product.

This study aimed to optimize solid-state fermentation conditions of spruce needle biomass and evaluate the microbiological and chemical characteristics of the fermented product for potential food production applications.

Spruce needles were collected from local forests, washed (moisture content 58-59%), and dried at 60-70°C for 4-6 hours. The dried needles (moisture content 2.8-2.9%) were crushed (0.5-1.0 mm particle size) and sterilized. For fermentation, the biomass was mixed with sterile tap water (1:4 ratio), 5.0% (w/v) glucose, 0.3% (w/v) sodium bicarbonate, and 5% (v/w) *Lactiplantibacillus plantarum* LP1 suspension (10^8-10^9 CFU/mL). Fermentation was carried out for 48 hours at 30°C, and the fermented biomass was centrifuged to obtain the liquid product as the final product.

During fermentation, *L. plantarum* LP1 viable cell count increased from 10^7 to 10^8 CFU/mL, while pH dropped from 5.8-6.0 to 4.8-5.0. The chemical composition of the fermented product was analyzed, revealing the presence of organic acids (lactic acid 241.50 mg/100g, citric acid 27.49 mg/kg, shikimic acid 7.15 g/L), micronutrients (potassium 47.22 mg/100g, magnesium 8.22 mg/100g, calcium 4.30 mg/100g), carbohydrates (10.64%), and moisture (88.6%). Microbiological analysis confirmed the absence of yeast, fungi, *Salmonella* spp., and *E. coli*.

In conclusion, the chemical and microbiological properties of the fermented product suggest its potential to enhance food safety and quality.

Keywords: spruce, needles, fermentation, *Lactiplantibacillus plantarum,* pathogens

Acknowledgments: This work was supported by the Interreg project C023 Innovation in forestry biomass residue processing: towards circular forestry with added value products (CEforestry)".

* irena.macioniene@ktu.lt

Regulatory framework and circular economy implementation in water sector

Karan Chabhadiya[1,2*] | Marzena Smol[2]

[1]Krakow School of Interdisciplinary PhD Studies, Poland
[2]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Abstract

European Union's (EU) implementation of circular economy (CE) practices paves the road for its efficient resource management goals. It is important to analyse the policies and regulations for the implemented CE principles and review for any potential advancements in the water management sector. The 2020 EU Regulation highlights the minimum requirements for water reuse which signifies guidelines on water quality, monitoring, and risk assessment, supporting sustainable reuse practices. The key EU directives like Water Framework Directive (WFD), the Urban Waste Water Treatment Directive (UWWTD), and the Circular Economy Action Plan highlights the importance of circularity and promotes resource recovery, water and wastewater treatment. Moreover, importance is emphasized on areas like nutrient and energy recovery, and integration of technologies like digital and smart water metering for more sustainable management of the water resource. Several case studies covering EU member states, show cased the effective water management and nutrient recovery from the wastewater treatment by adopting CE strategies. However, the challenge remains on CE implementation, identification of regulatory gaps, and barriers to implement CE principles at wider and different regions. Also, challenges persists on financing and implementing advanced technologies, unified legislation, and public-private partnership for CE in water sector. Ultimately, the research is focused on recommendation for enhancing regulations to implementation of CE strategies in EU water sector by collaboration, cooperation and contribution to long term environmental and economical resilience.

Keywords: water, wastewater treatment, circular economy, sustainable development, regulatory framework

* karan@meeri.pl

Nanocarriers in medicine new perspectives and applications

Krzysztof Cholewa [1*] | Bożena Tyliszczak[1]

[1]Cracow University of Technology, Faculty of Materials Engineering and Physics Department of Material Engineering, Poland

Abstract

Nanocarriers such as platinum nanoparticles (PtNPs) have attracted significant interest in nanomedicine due to their unique physicochemical properties, including high catalytic activity, stability, and biocompatibility. These characteristics make PtNPs highly promising for various medical applications, particularly in drug delivery, cancer therapy, and diagnostic tools. The primary objective of this study is to investigate the synthesis, functionalization, and potential biomedical applications of PtNPs, with a specific emphasis on their role in cancer treatment and targeted drug delivery systems.

In this research, PtNPs were synthesized using a green, eco-friendly method to reduce the use of harmful chemicals while maintaining high yield and purity. The nanoparticles were functionalized with ligands to enhance their biocompatibility and targeting efficiency toward cancer cells. Advanced characterization techniques, such as transmission electron microscopy (TEM), dynamic light scattering (DLS), and UV-vis spectroscopy, were employed to evaluate the size, morphology, and stability of the PtNPs.

The study demonstrated that functionalized PtNPs exhibit precise targeting abilities, effectively delivering therapeutic agents to cancer cells while minimizing off-target effects on healthy tissues. The PtNPs also showed a high drug-loading capacity and controlled release properties, which significantly improved the efficacy of cancer treatments.

In conclusion, platinum nanoparticles offer new perspectives and applications in medicine, particularly in cancer therapy. Their ability to enhance targeted drug delivery while minimizing side effects underscores their potential as a versatile platform for future clinical use.

Keywords: green chemistry, platinum nanoparticles, nanocarriers, drug delivery, targeted therapy

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* krzysztof.cholewa@student.pk.edu.pl

Fluorescent dyes - aminobenzophenoxazine derivatives for dyeing polyester fabric

Magda Adamczyk[1,2*] | Radosław Podsiadły[2] | Iwona Masłowska-Lipowicz[1]

[1]Lukasiewicz Research Network - Lodz Institute of Technology, Poland
[2]Lodz University of Technology, Faculty of Chemistry, Institute of Polymer and Dye Technology, Poland, Interdisciplinary Doctoral School

Abstract

Textile finishing processes, including dyeing, are an environmental nuisance due to high water consumption and the content of chemicals and dyes in the wastewater. The designed group of dyes imparts a permanent fluorescence function to textiles and bioactivity against representative bacterial strains. The combined synergistic effect of the dyes is a significant advantage of the solution in terms of science and technology development, striving for scientific excellence in the present field.

Fluorescent dyes have a wide range of applications mainly in medicine and molecular biology, but typical fluorescent dyes for textile applications are lacking. An important group of fluorescent dyes are benzo[a]phenoxazine derivatives due to their high molar absorption coefficient, good photochemical stability and non-toxicity compared to other dyes. In addition, they have a flat shape, favorable π - π interactions and good intramolecular charge transfer. In the available scientific and patent literature there are no reports on the use of benzo[a]phenoxazine derivatives as fluorescent suspension dyes for dyeing polyester fabrics. A synthesis route based precisely on the benzo[a]phenoxazine backbone was designed. The synthesized dyes were used to dye polyester fabrics. The colors of the dyes obtained were very intense, which is extremely important in terms of the next stages of the research. In addition, the dyed fabrics were tested on DataColor and MiniScan equipment. Lightfastness tests of the dyed polyester fabrics were also performed.

Keywords: synthesis, dyes, fluorescence, dyeing processes

Acknowledgments: This research has been completed while the first author was the Doctoral Candidate in the Interdisciplinary Doctoral School at the Lodz University of Technology, Poland.

* magda.adamczyk@lit.lukasiewicz.gov.pl

Analysis of Dal Lake ecosystem transformation, Kashmir, India

Irfan Ali[1*]

[1]AGH University of Krakow, Poland

Abstract

In recent decades, Dal Lake, a major freshwater body in Srinagar, India, has undergone a rapid ecological decline due to intensified eutrophication. The lake's water quality deteriorated swiftly, marked by increased algal blooms, excessive aquatic vegetation growth, and diminishing native fish populations. These alterations have not only affected the lake's ecosystem but have also impacted the economic activities of local communities reliant on the lake for tourism and fishing. This study sought to evaluate the trophic state dynamics of lake using the methodology based on Index of Trophic State (ITS), which assumes the biotic balance approach to the assessment of water ecosystem trophic status. The validity of the application of the selected criterion was confirmed by statistical analysis and determination of the nature and strength of correlations (R=0,97) between the factors constituting the basis of the selected method. Data analysis and trophic state assessment was based on data bank from 5-year period (2019-2023) of Dal lake monitoring within its four lake basins: Hazaratbal, Nishat, Nagin, and Gagribal. The results of the assessment allowed to state a steady intensification of eutrophication process in all lake basins. The Hazaratbal Basin water shifting from mesotrophic to eutrophic state and the other basins transitioning from mesotrophic to eutrophic state over the studied period. By 2023, the entire lake was classified as eutrophic, showing the trend towards advanced eutrophication. The main factors driving eutrophication were identified: different human activities in the catchment area, pollution discharge and overexploitation of lake resources. This research underscores the pressing need for a comprehensive lake protection strategy elaboration,. The results of research made it possible to verify that the selected methodology for assessing the trophic state based on ITS index serving as an effective tool for water ecosystem state assessment and can be the base of effective water management strategie in the region. Safeguarding Dal Lake is vital given its ecological, economic, and cultural importance to the region and its inhabitants. Lake deterioration has prompted local authorities and environmental groups to implement various restoration measures, including sewage treatment, weed removal, and shoreline and catchment area management. However, these initiatives have encountered obstacles owing to the intricate interplay of factors contributing to eutrophication, such as agricultural runoff, urban expansion and climate change. Tackling these issues requires a holistic, multi-stakeholder approach that integrates scientific research, legislation improvement, policy interventions, and community involvement to develop sustainable solutions for the lake's long-term health and ecological balance.

Keywords: Dal Lake, eutrophication, trophic state assessment, water management

[*] aliirfan@agh.edu

Water reuse policy related to circular economy and implementation of the Green Deal Strategies in sector of the dairy industry

Jan Marjanowski[1*] | Jakub Drewnowski[2] | Jan Hupka[2]

[1]MARCOR - Water Treatment Technologies Company, Poland
[2]Gdansk University of Technology, Poland

Abstract

The global food market is also the market for the water contained in this foods, however its recovery requires the implementation of specific technologies and solutions to fulfill the legal policies. Regulation (EC) No. 853/2004 of the European Parliament and the Council of the European Union on April 29, 2004 lays down specific hygiene rules for food of animal origin, which also covers water if recovered from milk and dairy products. The water reuse policy such as treatment and use of primary origin water, i.e. technological water (understood as water which came into contact with food) and technical water (i.e. boiler and cooling water), has the key importance in the circular economy related to the implementation of the Green Deal Strategies in sectors of the dairy industry, where secondary water (i.e. from recycling) commonly referred to as "cow water" plays more and more significant role for dairy plants in recent time. It is practically biowater and as such should continue to be used in the dairy industry, but after appropriate treatment.

According to the United Nations, by 2050, global water demand will increase by 20% to 30%. A report published on October 28, 2021 by the Ceres Feeding Ourselves Thirsty organization indicates that the food and agricultural industries use 70% of the world's freshwater resources [Ceres FOT, 2021]. Without properly managing in tracking of the emerging water scarcity and ignoring the innovations, that are aimed to save the water resources, food companies face market and financial risks, as well as they are prone to lose their good reputation and new market opportunities. From the legal point of view, the parameters of water intended for human consumption, contained in the EU regulation, i.e. the Directive of the European Union Council 98/83/EC of November 3, 1998, and national regulation of Poland, i.e. the Regulation of the Minister of Health of 7 December 2017 on the quality of water intended for human consumption have to be fulfilled. The policy of such water requires microbiological, physicochemical and organoleptic quality control, and since 2015 also the radioactivity concentrations (radiation density). Due to water reuse policy related to circular economy and implementation of the Green Deal Strategies in sector of the dairy industry, the water that comes into direct contact with food or surfaces, that come into contact with food, must meet the criteria of drinking water and/or the quality of water used in food industry plants (i.e. milk and dairy products) , regardless of the processes, that it has undergone earlier.

Keywords: dairy reuse water, recovery water, recycling water, post-process water, green deal implementation

* jm@marcor.com

Development of energy storage in Poland in the energy transition process

Damian Tomczyk[1*] | Zofia Łapniewska[2]

[1]Doctoral School in the Social Sciences, Jagiellonian University in Kraków, Poland
[2]Institute of Economics, Finance and Management at the Jagiellonian University in Kraków, Poland

Abstract

In the face of ever-increasing global energy demand, the increasingly emerging question of how to improve the energy system and make it less carbon-intensive has become part of the public debate, especially in the European Union. Renewable electricity generation solutions, despite contributing to the European Green Deal goals of increasing RES use in the national energy mix and achieving climate neutrality by 2050, are proving insufficient. With currently available technology, it is impossible to make economies solely dependent on energy from 'green sources', mainly due to the cyclical nature of production, which is strongly dependent on latitude or the seasons. Energy storage is a solution for adapting the structure of electricity supply and demand.

Although the topic of electricity storage has been resounding in the European debate for nearly 10 years, it has only a few years' history in Poland. As much as 85% of the energy storage potential in Poland lies in pumped storage power plants [1]. Given the circumstances, the subject of the presentation will be to show the potential of the Polish energy storage market, not only in terms of available technologies, but also the share of energy storage in the energy system. The impact of governmental and EU programmes financing investments in 'green sources', with an emphasis on energy storage, will be revealed. The authors will also attempt to identify the reasons why energy storage technologies have gained high recognition in selected (mainly European) countries and represent both energy and export potential. A multi-faceted approach to the topic will allow conclusions of an applied nature to be drawn.

Keywords: electrical energy storage, European Green Deal, photovoltaic systems, prosumer, renewable energy sources

References:

[1] Urząd Regulacji Energetyki (2024b). Magazynowanie energii elektrycznej – Raport 2024. Warszawa, czerwiec 2024, p. 3.

* damian.tomczyk@doctoral.uj.edu.pl

Transfersomes in Targeted Skin Cancer Therapy

Dominika Wanat[1*] | Bożena Tyliszczak[2]

[1]Cracow University of Technology, CUT Doctoral School, Faculty of Materials Engineering and Physics Department of Material Engineering, Poland
[2]Department of Materials Engineering, Faculty of Materials Engineering and Physics, Cracow University of Technology, Poland

Abstract

Transfersomes are lipid-based nanocarriers known for their flexible and deformable structure, allowing them to penetrate the deeper layers of the skin. This unique property makes them a promising tool for targeted drug delivery in skin cancer therapy. The application of transfersomes addresses challenges in conventional cancer treatments by enhancing drug permeability and retention in tumorous tissues while minimizing systemic side effects. These vesicles can encapsulate a variety of therapeutic agents, including chemotherapeutic drugs and biological molecules like proteins and peptides, offering a versatile approach to treating different skin cancer types, such as melanoma and basal cell carcinoma.

This study explores the potential of transfersomes in delivering anti-cancer agents directly to the affected skin areas, reducing drug wastage and improving treatment efficiency. The transfersomes' biocompatibility and ability to bypass the stratum corneum, the skin's outermost barrier, are discussed, emphasizing their role in sustainable and non-invasive cancer therapies. The project aligns with the sustainable development goals (SDGs) by promoting health and well-being (Goal 3) and responsible consumption and production (Goal 12), reducing the environmental impact of cancer treatments by minimizing pharmaceutical waste.

Keywords: transfersomes, skin cancer, drug delivery, sustainable therapy, nanotechnology

* dominika.wanat@doktorant.pk.edu.pl

The effect of cold plasma on the elimination of ibuprofen from water and wastewater

Estera Baor[1*] | Anna Grobelak[1] | Aleksandra Wypart-Pawul[1]

[1]Częstochowa University of Technology, Poland

Abstract

Pharmaceutical residues in wastewater and surface waters pose an increasing environmental and public health challenge. Nonsteroidal anti-inflammatory drugs, such as ibuprofen, are among the most commonly used medications for pain relief. Moreover, they are widely accessible to patients as they are sold over the counter. However, it is important to remember that the human body does not fully metabolize pharmaceuticals. Their residues end up in wastewater treatment plants. Wastewater treatment systems cannot effectively remove all of these substances, leading to their entry into surface water, groundwater, and in some cases, even drinking water. This pollution not only affects aquatic organisms, disrupting their development, reproductive functions, and behavior but also contributes to the development of antibiotic resistance in the environment, which poses a serious threat to human health. The conducted studies aimed to assess the impact of cold atmospheric plasma on the elimination of ibuprofen from wastewater and water. Samples with a volume of 10 liters, containing a specific concentration of ibuprofen, were subjected to plasma treatment at time intervals ranging from 1 to 25 minutes. The effectiveness achieved for the water samples was over 67%. In contrast, for the wastewater samples, the effectiveness was very low, at less than 3%. The use of cold plasma for ibuprofen elimination appears to be very promising, as indicated by the results obtained for the water samples. However, the process requires optimization in terms of contact time or plasma power for wastewater samples.

Keywords: cold plasma, pharmaceuticals, ibuprofen

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* esterabaor28@gmail.com

Application of advanced oxidation processes for effective Reactive Red 241 degradation

Izabela Płonka[1*] | Barbara Pieczykolan[1] | Edyta Kudlek[1]

[1]Silesian University of Technology, Faculty of Energy and Environmental Engineering, Department of Water and Wastewater Engineering, Gliwice, Poland

Abstract

The research was conducted using advanced oxidation processes to decolourise an aqueous solution containing the Reactive Red 241 (RR 241). RR 241 is used to dye silk, cotton, and wool. It has a negative impact on the natural environment and organisms. It causative agent for cancer, kidney damage, damage to the nervous system. Therefore, untreated sewage containing dyes cannot be discharged directly into the environment. The degradation studies of RR 241 were conducted in two stages. In the first stage, the Fenton reagent and its modifications with sodium percarbonate and magnesium dioxide were used as alternative sources of hydrogen peroxide. In the second stage, the Fenton/UV, Fenton-$Na_2H_3CO_6$/UV, and Fenton-MgO_2/UV processes were carried out using a medium-pressure lamp. In the preliminary studies, the most favourable pH of the processes and the doses of reagents were determined. In the last step, the effect of reaction time and exposure time on the efficiency of dye solution decolorization was assessed. In the case of Fenton and Fenton-like processes resulted in a very high degree of dye removal. During the decolorization in the Fenton reagent process the increase of the oxidation time from 5 to 60 minutes resulted in an increase in efficiency from 99.1% to 99.9%. On the other hand, in the case of Fenton-sodium percarbonate and Fenton-MgO_2 processes, the increase in the oxidation time resulted in a negligible increase of efficiency from 99.8 to 100.0%. In contrast for UV/Fenton and UV/Fenton-like processes the efficiency of the process was increased from 82.8% for 5 minutes to 99.2% after 60 minutes.

Keywords: advances oxidation process, Fenton process, Fenton-like processes, UV/Fenton, UV/Fenton-MgO_2, UV/Fenton-$Na_2H_3CO_6$, Reactive Red 241

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* izabela.plonka@polsl.pl

Effect of tire microparticles on the sorption and migration of NSAIDs in water systems: a study on pollution co-transport

Jagoda Worek[1*] | Adam Rybczyński[1] | Katarzyna Styszko[1]

[1]AGH University of Krakow, Poland

Abstract

Micropollutants, such as non-steroidal anti-inflammatory drugs (NSAIDs), are a significant problem in the context of aquatic pollution. Due to their widespread use, NSAIDs are increasingly detected in surface waters, where their presence may negatively affect marine organisms. At the same time, microparticles from tire wear are becoming an increasingly recognized source of pollution that can act as carriers for other chemicals. These particles are characterized by a large specific surface area and a tendency to sorb organic pollutants, which may favor the co-transport of micropollutants such as NSAIDs in the aquatic environment.

Research on the mechanisms of NSAIDs sorption on tire microparticles is crucial for understanding the transport and retention processes of pollutants in aquatic ecosystems. This work examines the interactions between tire microparticles and NSAIDs in the context of their ability to bind and migrate in the marine environment, which may have important implications for water quality management and ecosystem protection.

The experiment examined the sorption of NSAIDs on tire microparticles and their impact on the migration of micropollutants in the aquatic environment. Tire and pharmaceutical residues were used, and NSAID concentrations were monitored using high-performance liquid chromatography (HPLC) coupled with tandem mass spectroscopy. After 3 hours of contact with tire microparticles, the drug concentration was below the detection limit. The experimental results showed that tire microparticles effectively adsorb drugs, indicating their potential as carriers of micropollutants. The study conclusions suggest that tire microparticles may contribute to the co-transport of NSAIDs in the aquatic environment, which requires further analysis.

Keywords: micropollutants, Non-Steroidal Anti-Inflammatory Drugs, tire microparticles, sorption, co-transport of pollutants

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* jworek@agh.edu.pl

Identification of the degree of exposure of the population to environmental contamination with xenobiotics using the circular epidemiology method based on wastewater and sewage sludge analysis

Justyna Pyssa[1*] | Katarzyna Styszko[1] | Dominika Uchmanowicz[1] | Ewa Pyssa[2]

[1]AGH University of Krakow, Poland
[2]Jagiellonian Univerity in Krakow, University School of Physical Education in Krakow, Poland

Abstract

Introduction: PAHs are common environmental pollutants derived from the incomplete combustion of organic materials. They can also be of natural origin. Some of the polycyclic aromatic compounds have been found to be carcinogenic or mutagenic. A feature that characterizes most higher PAHs is their slow degradation, which can cause a long-term potential threat to humans and the natural environment.

Methods: The paper is a review. Based on the latest literature on the subject, selected metabolites of PAHs, i.e. their hydroxyl derivatives (OH-PAHs), which are indicated as biomarkers in human biomonitoring, are presented. Most often, PAHs exposure can be assessed by analyzing all components of the environment.

Main findings: The analysis of human exposure to PAHs would involve both economic (they are expensive) and technical (they are time-consuming and labour-intensive) difficulties. Hence the proposed approach to biomonitoring by measuring PAHs and their metabolites as biomarkers.

Conclusions: Wastewater-based epidemiology (WBE) is one of the innovative tools that allow to obtain objective conclusions resulting from the chemical analysis of specific human metabolites in wastewater.

Keywords: sewage sludge, PAHs – polycyclic aromatic hydrocarbons, OH-PAHs – hydroxyl derivatives of polycyclic aromatic hydrocarbons, WBE – wastewater-based epidemiology

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* jpyssa@agh.edu.pl

Experimental studies of a stormwater settling tank

Kamil Pluta[1*] | Robert Malmur[2]

[1]Czestochowa, Poland
[2]Czestochowa University of Technology, Department of Infrastructure and Environment, Czestochowa, Poland

Abstract

Stormwater runoff from urban areas is mainly controlled by the use of storm sewage systems. These systems are expected to ensure efficient drainage of rainwater from urbanized areas in terms of quantity (prevention of flooding) and quality (reduction of pollutant load discharged to natural water reservoirs). It can be expected that standards for protecting surface water from rainwater runoff discharges will be tightened in the near future, and modernization of existing stormwater sewage systems will be necessary. This may require the expansion of existing sewer system with devices for treating stormwater. The main pollutant of stormwater is total suspension solids (TSS), which is also a carrier of other pollutants found in stormwater runoff. The discharge of stormwater without treatment to receivers should be limited. The devices whose main task is to retain as many pollutants as possible are settling tanks.

The paper proposes a device for treating stormwater before discharge into the receiver. The device combines the function of a settling tank and a retention tank. The proposed design is used in stormwater sewage systems and wherever there is a need to manage stormwater. The laboratory tests conducted and described in the paper aimed to verify the theoretical assumptions regarding the hydraulic operation of the proposed solution. They also allowed for the assessment of the efficiency of removing suspensions by the settling tank.

For this purpose, a physical model of the settling tank was built and a test stand was prepared consisting of the following elements: a settling tank model, a tank for preparing sewage, a suction-pressure pump, a system for regulating flow rates and flow meters. As the obtained results show, the variant of the settling tank presented in the paper is a solution that allows to significantly reduce the amount of pollutants reaching the receiver.

Keywords: sewage system, settling tank, SWMM 5.1, quality of stormwater

* kamil-pluta@o2.pl

Recent overview of the use of hydrogels to support collagen production in the skin

Kamila Lis[1,2*] | Katarzyna Haraźna[3] | Dagmara Słota[1] | Karina Niziołek[1] | Agnieszka Sobczak-Kupiec[3]

[1]Cracow University of Technology, Poland
[2]CUT Doctoral School, Faculty of Materials Engineering and Physics, Poland
[3]Cracow University of Technology, Faculty of Materials Engineering and Physics, Poland

Abstract

Hydrogels are considered to be one of the most promising materials for medical applications, particularly for developing hydrogel dressings. This is due to their versatile properties, e.g., biocompatibility and stability, and being excellent active substance carriers. The skin regeneration process is very complex and involves several stages related to cell inflammation, proliferation and remodelling. Collagen plays a vital role in this process, as it is the skin's scaffolding, enabling it to rebuild and accelerate the regeneration process through the proliferation of new cells and the synthesis of new collagen fibres.

Hydrogels are used to stimulate collagen production in the skin. These can be enriched with active ingredients such as curcumin [1]. It is a natural pigment of plant origin obtained from the lint of the long oyster. It exhibits anti-inflammatory, antioxidant and antibacterial effects. Curcumin reduces the secretion of cytokines and also increases the biosynthesis of proteins such as collagen, which contributes to faster skin regeneration [2]. In addition, such a hydrogel will act as a barrier against impurities by protecting the skin from bacterial infections. They can absorb wound exudate and relieve pain due to a cooling sensation at the application site. Most importantly, they do not stick to the wound, thus causing no additional pain or trauma during removal. Moreover, it improves blood circulation and supplies oxygen to the wound. To conclude, such materials represent a valuable object for further applied research to accelerate skin regeneration by increasing collagen expression in the skin [1].

Keywords: hydrogel, curcumin, stimulation of collagen production, biomaterials

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[1] Guo, G., Li, X., Ye, X., Qi, J., Fan, R., Gao, X., Wu, Y., Zhou, L., & Tong, A. (2016). EGF and curcumin co-encapsulated nanoparticle/hydrogel system as potent skin regeneration agent. International Journal of Nanomedicine, Volume 11, 3993–4009. https://doi.org/10.2147/IJN.S104350
[2] Hewlings, S., & Kalman, D. (2017). Curcumin: A Review of Its Effects on Human Health. Foods, 6(10), 92. https://doi.org/10.3390/foods6100092

* kamila.lis@doktorant.pk.edu.pl

Antioxidant hydrogel materials obtained by waste-free photopolymerization method

Katarzyna Sala[1*] | Magdalena Bańkosz[2] | Magdalena Kędzierska[3] | Bożena Tyliszczak[1]

[1]Department of Materials Engineering, Faculty of Materials Engineering and Physics, Cracow University of Technology, Poland
[2]Cracow University of Technology, CUT Doctoral School, Faculty of Materials Engineering and Physics Department of Material Engineering, Poland
[3]Department of Chemotherapy, Medical University of Lodz, Copernicus Memorial Hospital of Lodz, Poland

Abstract

Antioxidant hydrogel materials are a promising group of biomaterials used in medicine and pharmacology, mainly due to their ability to neutralize free radicals and protect cells from oxidative stress. These materials, forming three-dimensional polymer networks, can bind large amounts of water and active substances, allowing their controlled and gradual release, which is particularly important in antioxidant therapy.

This study focuses on the synthesis of hydrogel materials obtained based on the principles of green chemistry and photopolymerization technology. Green chemistry, as a concept of sustainable and safe approach to chemical processes, is the foundation for the developed synthesis process. The research includes the use of raw materials of natural origin and the complete elimination of toxic solvents, thus minimizing the negative impact on the environment. Photopolymerization, as a method of initiating the polymerization reaction using light, enables precise and controlled synthesis of hydrogel materials, ensuring their high efficiency.

From the perspective of sustainable chemistry, special attention was paid to precise control of the polymerization process and reaction time, which allowed optimization of synthesis conditions. The results confirmed that the application of green chemistry principles combined with photopolymerization technology leads to hydrogel materials with controlled antioxidant properties while having minimal environmental impact. In terms of potential applications, their importance in regenerative medicine, biomaterials and dermatology was highlighted.

The innovative combination of these technologies opens up new opportunities in the field of sustainable biomaterials, representing an important step toward reducing the negative environmental impact of chemical processes.

Keywords: photopolymerization, green chemistry, synthesis, hydrogel materials

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* katarzyna.sala@student.pk.edu.pl

Optimization of synthesis conditions of gradient composites for biomedical applications

Magdalena Bańkosz[1,2*] | Julia Sadlik[1,2] | Edyta Kosińska[1,2] | Agnieszka Tomala[1]

[1]Cracow University of Technology, Poland
[2]CUT Doctoral School, Faculty of Materials Engineering and Physics Department of Material Engineering, Poland

Abstract

This paper presents the results of a study on optimizing the conditions for the synthesis of gradient composites for biomedical applications. These composites were obtained by sintering, using hydroxyapatite (HAp) obtained by wet precipitation and Ti 6Al-4V alloy. The aim of the optimization was to reduce the phase transformations of hydroxyapatite, which is crucial for maintaining its bioactivity and mechanical properties.

Tests were carried out in which the time and temperature of the sintering process were changed, which made it possible to obtain gradient structures with different compositions and properties. Detailed characterization was carried out for the obtained composites using X-ray diffraction. The results showed that appropriate adjustment of the process parameters minimizes the phase transformation of HAp.

The application of gradient composites in regenerative medicine can significantly improve therapeutic outcomes, and their manufacture in a more efficient way is a step towards sustainable production of biomedical materials. The research presented here can lay the foundation for further work on the development of innovative and environmentally friendly materials for medical applications.

Keywords: gradient composites, hydroxyapatite, sustainable development

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* magdalena.bankosz@pk.edu.pl

Review of methods for detection of water leaks in water supply network

Mateusz Rożnowski[1,2*] | Barbara Tchórzewska-Cieślak[2]

[1]Doctoral School of the Rzeszów University of Technology, Poland
[2]Department of Water Supply and Sewerage Systems, Faculty of Civil, Environmental Engineering and Architecture, Rzeszow University of Technology, Poland

Abstract

According to the International Water Association (IWA), one of the elements of the water balance is the volume of water leaks in water supply networks. The water balance allows the determination of the volume of water lost, which is then necessary for the calculation of the Infrastructure Leakage Index (ILI). In Directive 2184/2020 on the quality of water intended for human consumption, this indicator was suggested for assessing the amount of water leaks and the possibilities for enhancing leak reduction. The guidelines of the Directive apply to companies that provide at least 10,000 m3/d or serve at least 50,000 people. By the 12th of January 2026, companies that meet the aforementioned prerequisites are required to evaluate the extent of leakages in water supply networks. Additionally, by the 12th of January 2028, companies that exceed a specific threshold based on the ILI index (or another suitable method) are required to present an action plan to mitigate water losses. One method for reducing water losses is to separate an Active Leakage Control (ALC) unit. The foundation of ALC operations is the Integrated Water Leakage Management System. It includes the monitoring of water supply networks for the purpose of reducing water losses, the detection of leaks, and the subsequent localisation of the source utilising an appropriate methodology. The utilisation of specialised devices, such as loggers and correlators, in conjunction with leak detection methods, such as Minimum Night Flow, enables water companies to expedite the detection of leaks, thereby reducing water losses and lowering distribution costs. The reduction of water leaks in water distribution systems is consistent with the assumptions of the Circular Economy.

Keywords: water leaks, water supply system, active leakage control

* m.roznowski@prz.edu.pl

Assessment of biomass and biochar contaminated with heavy metals on the functional potential of microorganisms in soil

Piotr Cichy[1*] | Joanna Kalka[1]

[1]Environmental Biotechnology Department, Faculty of Energy and Environmental Engineering, Silesian University of Technology, Poland

Abstract

In recent years, it has become necessary to evaluate biochar impact on the environment using ecotoxicity tests, although studies tend to focus most on plants and animals. As important however is the analysis of the microbial environment. In this study, the metabolic activity and functional diversity of microbial communities in the soil, containing biomass or biochar of either low or high heavy metal concentrations, were evaluated following a germination and early plant growth test utilizing wheat, garden cress and cucumber. Microbial activity tests were performed using the Community Level Physiological Profiling technique employing Biolog®EcoPlate™, where microbial activity is assessed based on their ability to degrade various carbon substrates. To compare the functional diversity of microorganism communities in the studied soils, Average Well Color Development (AWCD) values and selected indices of functional potential, including the functional diversity indices of Shanonn-Wiener (H'), McInthosh (U) and Simpson (D), evenness index (E) and metabolic richness index (RS), were calculated. Soils with the amendments of biomass with a low content of heavy metals were characterized by higher values of the functional potential parameters than the control, i.e. greater functional diversity. In turn, soils with the addition of the other biomass, depending on the plant species, exhibited lower or similar parameters values to the control – lower or similar functional diversity. Likewise, soils with the addition of biochars also had similar functional diversity to that of the control. The metabolic microbial profile of the soil is therefore determined by several factors.

Keywords: biochar, biomass, heavy metals, Biolog®Ecoplate™, microbial functional diversity

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* p.cichy00@gmail.com

Hybrid methods for wastewater ibuprofen removal using low-temperature plasma

Dominika Augustajtys[1*] | Anna Grobelak[1] | Aleksandra Wypart-Pawul[1]

[1]Częstochowa University of Technology, Poland

Abstract

Pharmaceutical residues in wastewater are becoming an increasing threat to the environment and public health. With the rise in drug consumption, significant amounts of active substances are entering sewage systems from households, hospitals, veterinary clinics, and pharmaceutical companies. Unfortunately, traditional wastewater treatment methods are not capable of effectively removing all of these chemical compounds, leading to their infiltration into surface water, groundwater, and even drinking water sources. One of the most frequently detected nonsteroidal anti-inflammatory drugs in wastewater is ibuprofen. The aim of the study was to evaluate the effectiveness of its removal using hybrid methods based on the application of low-temperature atmospheric plasma. The test sample consisted of wastewater with the addition of ibuprofen at a known concentration of 10 mg/l. The tests were conducted in three process configurations: plasma treatment, plasma treatment with the addition of hydrogen peroxide, and plasma treatment with the addition of hydrogen peroxide and UV radiation. The variable parameter was the exposure time to oxidizing agents, ranging from 1 minute to 1 hour. The best efficiency was achieved with the simplest variant – treating the sample with low-temperature plasma. The use of hybrid methods did not increase the level of efficiency, which positively impacts the plasma treatment process itself. Therefore, the use of low-temperature plasma is a promising technique for the elimination of pharmaceutical residues from wastewater. However, further research is required to optimize the process.

Keywords: low-temperature plasma, ibuprofen, hybrid methods, wastewater

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∗ daugustajtys@gmail.com

Innovative process development for co-torrefaction of sewage sludge and biowaste using autogenous steam: enhancing waste management through torgas utilization

Przemyslaw Seruga[1*] | Agnieszka Piekara[1] | Lukasz Niedzwiecki[2] | Malgorzata Krzywonos[1] | Halina Pawlak-Kruczek[3]

[1]Wroclaw University of Economics and Business, Department of Bioprocess Engineering, Poland
[2]University of Trento, Department of Civil, Environmental and Mechanical Engineering (DICAM), Italy
[3]Wrocław University of Science and Technology, Department of Energy Conversion Engineering, Poland

Abstract

This study focuses on the innovative development of a process of co-torrefaction using autogenous steam, aimed at improving waste management practices for sewage sludge and biowaste, including agricultural residues. The primary objective is to optimize the co-torrefaction of sewage sludge (SS), alongside various types of waste biomass, including grain straw, green waste, wood chips, and rapeseed straw.

Key aspects of the research include determining the optimal process conditions to obtain high quality fertilizer with energy self-sufficiency. Methodology involves dynamic thermogravimetry of mixed samples, consisting of SS, with potential co-feedstocks. This will allow determination of the co-torrefaction parameters, which could be applied in the pilot scale installation that belongs to WUST.

Currently, the predominant method of sewage sludge disposal in Poland is land reclamation and other treatment methods, followed by agricultural use. In the EU dominant is the incineration. When it comes to land application, significant limitations include the rapid release of nutrients, which can lead to eutrophication (an environmental threat), as well as negative impacts on crop yields (excessive nutrient dosing per hectare). Additionally, the high moisture content of sewage sludge significantly restricts its transport options for land application due to transportation costs relative to dry mass. Currently, there are several dozen mono incinerators for sewage sludge in Poland. However, a cost factor arises from the ash produced during the incineration of sewage sludge (approximately one-third of the dry mass of the sludge), which is a non-negligible waste, and its disposal is associated with regulatory restrictions and related costs.

Keywords: co-torrefaction, sewage sludge, biowaste, torgas, process optimization

* przemyslaw.seruga@ue.wroc.pl

The W.E.T.recycle (Wasser.Energie.Technologie) system - an efficient method of water recovery in the swimming pool industry

Weronika Solecka[1*] | Edyta Kudlek[1]

[1]Silesian University of Technology, Poland

Abstract

The backwash water is considered too valuable to be discharged into the sewage system and not be used to its full potential. By using the W.E.T.recycle system, valuable water is recovered, which allows it to be reused within the facility as a supplement to the water in the swimming pool basin or for domestic purposes, e.g. for flushing toilets. This solution fits in with the idea of a circular economy, which we are pursuing in every area of life. Studies have proven that the use of the W.E.T.recycle system leads to significant benefits. A reduction in operating costs has been achieved, in particular heating energy savings because the recycled filling water no longer needs to be heated up to pool temperature. At the same time, the costs for fresh water supply and wastewater discharge can be minimised. As a result, short payback periods are achievable. The use of membrane modules (ultrafiltration and reverse osmosis) has resulted in great water quality, and the small height and width of the design means that this can be used for almost any pool. Operation is fully automated which has made maintenance by individuals minimal.

Keywords: backwash water, ultrafiltration, reverse osmosis, water recovery

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* werosol453@student.polsl.pl

Rainwater purification through UV-assisted filtration

Edyta Kudlek[1*] | Anna Lempart-Rapacewicz[1] | Rafał Rapacewicz[1] | Oliwia Pietranek[1]

[1]Silesian University of Technology, Poland

Abstract

Rainwater represents a valuable water resource with diverse potential applications beyond traditional uses such as irrigation and sanitation. The study attempted to purify rainwater collected on the surface of a building located within an industrial zone. The purification process was carried out using filter columns filled with various types of deposits, i.e. filter glass (with a diameter of 0.5 - 1.0 mm), activated carbon and quartz sand. The filtration process was supported by UV radiation emitted from a low- and medium-pressure filament. The effectiveness of the process was assessed based on the degree of removal of organic micropollutants present in rainwater. It was shown that the filtration process on activated glass and activated carbon supported by UV radiation allows for completely removing substances from the PAH group, phthalates and phenols primarily in rainwater. Furthermore, activated carbon filtration facilitated the retention of intermediate products resulting from impurity decomposition during UV irradiation. The utilization of a high-pressure lamp extended the operational duration of all examined filter beds.

Keywords: rainwater, micropollutants, adsorption, UV light

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* edyta.kudlek@polsl.pl

Gradient bone mimicking Ti/HAp composites

Agnieszka Tomala[1*] | Julia Sadlik[2] | Edyta Kosińska[2] | Magdalena Bańkosz[2]

[1]Cracow University of Technology, Faculty of Materials Engineering and Physics, Poland
[2]Cracow University of Technology, CUT Doctoral School, Faculty of Materials Engineering and Physics, Poland

Abstract

The purpose of this research work is to demonstrate an innovative material system developed with powder metallurgy method of biomaterial preparation for regenerative medicine. The resulting gradient structure consists of two compositions Ti6Al4V alloy+5%CMC (carboxymethylocelulose) and Ti6Al4V alloy+5%CMC+10%HAp (hydroxyapatite) in order to mimic the structure of bone tissue. Sintering parameters were established based on numerous experiments using XRD to determine the presence of HAp crystal structure in the final composite. Stable sintering process includes at first drying the composites at 300°C to remove the porophore CMC, next sintering inside the ZrO_2 powder under Ar protective atmosphere at 1200°C with the speed 2°C/min, and kept this temperature for 4,5 hours. The developed composite material achieved the porosity in the range from 15-20% with the pores of 10-100 um in size will enable bone cells to penetrate the implant and regenerate bone. The presence of all elements characteristic for Ti alloy and HAp in the composite was confirmed by linear SEM/EDS measurement of a gradient sample. The roughness profile of the sectional micrograph unveil smooth sintered Ti6Al4V part where roughness is oscillating around 0.2um and highly porous Ti/HAp 100 um thick layer with roughness of 6,4um. The addition of hydroxyapatite was observed to reduce the microhardness of the composite. The samples showed similar mechanical properties to Ti6Al4V sheet, but contain hydroxyapatite with bioactive properties in their composition.

Keywords: hydroxyapatite, Ti6Al4V alloy, gradient, porous, biomaterials

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* agnieszka.tomala@pk.edu.pl

Reclamation of post-mining lands by conversion of industrial waste and combustion by-products into soil covers: a study in Poland and Slovenia

Angelika Więckol-Ryk[1*] | Alicja Krzemień[1]

[1]GIG-National Research Institute, Plac Gwarków 1, Katowice, Poland

Abstract

This paper presents a study of land rehabilitation of coal-mine affected areas with intensely eroded slopes, highly acidic characteristics, and the possibility of subsidence in two post-mining areas (Poland and Slovenia). The primary purpose of this research was to convert coal combustion by-products (CCPs), industrial waste, and organic materials into high-quality artificial soils with parameters for plant growth and development.

Several mineral products including fly ashes, aggregates, sludges, slags, or decarbonization lime with amendments of organic materials (carbon lignite or spent mushroom compost) have been investigated as components of soil substitutes. A series of physicochemical and phytotoxicity tests of the artificial soils and their water leaches showed that the content of valuable nutrients (N, P, K, Ca, and Mg) was adequate for proper plant growth. The concentration of toxic elements (As, Cd, Cu, Cr, Ni, Pb, and Zn) did not exceed the permissible thresholds and may be applied in green areas, including wooded or shrublands.

Furthermore, the possibility of using industrial water from Slovenian lignite mine for irrigation soil substitutes was investigated. The concentrations of ions responsible for salinity (SO42−, Cl−, Na+, and K+) and the content of heavy metals did not exceed the limits for irrigation water.

The results revealed that mixtures of CCPs with mining and organic wastes have great potential for use as soil covers due to their physicochemical properties and negligible environmental risk. Moreover, applying soil substitutes for land reclamation supports the circular economy approach, which aims to minimize waste and reuse.

Keywords: coal combustion by-products, reclamation, heavy metals, artificial soils, circular economy

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[*] awieckol@gig.eu

Peptide nanocarriers as a revolutionary tool in medicine

Oliwia Grzywacz[1*] | Bożena Tyliszczak[1]

[1]Cracow University of Technology, Faculty of Materials Engineering and Physics Department of Material Engineering, Poland

Abstract

Peptide nanocarriers have emerged as a revolutionary tool in medicine, capable of enhancing the bioavailability of drugs and therapeutic compounds. This study focuses on the green synthesis of peptide nanocarriers designed for the delivery of adaptogens—natural substances known for their ability to modulate immune responses and reduce oxidative stress. Green synthesis processes, which minimize the use of harmful chemicals, provide an eco-friendly and sustainable approach to developing advanced drug delivery systems. The objective of this study is to explore the efficacy of peptide nanocarriers in delivering adaptogens, aiming to improve therapeutic outcomes in conditions requiring enhanced immune support and stress regulation.

In this study, peptide nanocarriers were synthesized through environmentally friendly methods and optimized for the transport of adaptogens. These nanocarriers were tested for their capacity to enhance the stability and bioavailability of adaptogens in biological systems. Characterization techniques such as dynamic light scattering (DLS) and transmission electron microscopy (TEM) confirmed the size and stability of the peptide nanocarriers. In vitro experiments demonstrated that the adaptogen-loaded nanocarriers exhibited significantly improved cellular uptake compared to free adaptogens, leading to enhanced therapeutic effects.

The results highlight the potential of peptide nanocarriers as an effective delivery system for adaptogens, providing a targeted, sustainable, and biocompatible approach to drug delivery. While the findings are promising, future research must address challenges related to long-term stability, interactions with healthy tissues, and the scalability of green synthesis methods for large-scale production.

In conclusion, peptide nanocarriers produced through green synthesis offer an innovative solution for delivering adaptogens, with promising implications for modern medicine.

Keywords: green chemistry, peptide, nanocarriers, drug delivery, green synthesis

Acknowledgments: The project is financed with funds from the state budget granted by the Minister of Science within the framework of the "Student Scientific Clubs Create Innovations" (SKN/SP/601893/2024) "Application of Biohydrogels Containing Adaptogens in Innovative Chronic Wound Therapy" .The research work was carried out within the SMART-MAT Functional Materials Science Club (section Smart-Mat) at the Faculty of Materials Engineering and Physics of the Cracow University of Technology.

* oliwia.grzywacz@student.pk.edu.pl

3D printing and new materials - their impact on sustainability

Dagmara Słota[1*] | Karina Niziołek[1] | Edyta Kosińska[1] | Julia Sadlik[1] | Agnieszka Sobczak-Kupiec[1]

[1]Cracow University of Technology, Poland

Abstract

Over the past few decades, there has been a constant increase in the impact of human and industry on the environment. Manufacturing is of particular concern, consuming significant amounts of natural resources as well as generating large amounts of waste. It also involves massive emissions of carbon dioxide, and as a consequence contributes to climate change. These translate into an increase in average temperature and resulting global warming.

A real opportunity to solve or minimize these problems is 3D printing. The technology can be applied to a wide range of industries ranging from biomaterials, medical implants, aerospace engineering, road engineering or consumer products. There are several factors that make 3D printing sustainable. Firstly, because of its additive nature, it generates less waste than traditional manufacturing processes as it uses only the amount of material needed to create a product. Traditional manufacturing methods often require large amounts of energy as well as the use of large amounts of water for cleaning or cooling. 3D printing requires no water and also needs much less energy, resulting in overall lower water and energy consumption. Also important is the possibility of local production on a smaller scale, which do not involve transporting raw materials or products over long distances. This makes the process less energy and carbon intensive. In the case of biomaterials, the ability to personalize products, tailored to the needs of individual patients, is particularly important. Therefore, 3D printing is a real solution to the problems generated by industry and human activity, with a sustainable future.

Keywords: 3D printing, biomaterials, eco-friendly

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* dagmara.slota@pk.edu.pl

Bottom sediments of water reservoirs – a valuable substrate for pro-ecological technologies in the production of artificial composites (aggregates)

Maksymilian Cieśla[1*] | Adam Masłoń[1] | Renata Gruca-Rokosz[1] | Małgorzata Franus[2] | Katarzyna Kalinowska-Wichrowska[3]

[1]Rzeszow University of Technology, Poland
[2]Lublin University of Technology, Poland
[3]Bialystok University of Technology, Poland

Abstract

The main aim of the study was to assess the application potential of bottom sediments toward use as a base substrate in pro-ecological technologies for the production of artificial composites (aggregates).

Eight dam reservoirs located in four voivodeship of southeastern Poland were initially selected for the study. The reservoirs selected for the study differed not only in size, age, nature of the catchment area, but above all in the quality of the sediments deposited at their bottoms.

In an era of increasing climate change, bottom sediments, resulting in part from the sedimentation of suspended matter in reservoirs, pose significant challenges in terms of their management. Both scientists and the industrial sector agree, that the right solution to these issues may be a holistic approach implemented within the framework of a sustainable, closed-loop economy. It is widely agreed that recycling of bottom sediments is beneficial for the preservation of natural resources, reduces environmental degradation, as well as the effects of climate change.

The paper presents the results of conducted research in, among other things, the chemical composition of selected components from the matrix of bottom sediments (including the heavy metals).

It turned out that the chemical and physical properties (including the occurrence of sand, clay fraction, organic matter content) of bottom sediments determine the possibility of their subsequent use. Finally, based on the results obtained, it was indicated that the sediments from the Nielisz Reservoir have high application potential (especially in the autoclaving process).

Keywords: dam reservoirs, bottom sediments, synthetic composites, lightweight aggregates

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* cmax@prz.edu.pl

From gaps to growth: navigating challenges in sustainable soil management

Edyta Waluś[1*] | Magdalena Andrunik[1] | Marzena Smol[1]

[1]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Abstract

Soil, a vital ecosystem component, is understood differently across disciplines and stakeholders. This evolving perception, shaped by scientific, historical, and cultural contexts, complicates defining soil health, which is crucial for advancing soil literacy. Diverse perspectives, from farmers to policymakers, require an adaptive, interdisciplinary approach to soil literacy. Despite ongoing efforts, soil health remains a challenge across European landscapes, especially in agricultural, forest, and peatland soils. Historically, soil science has shifted from an agricultural focus to a global perspective, addressing climate change, biodiversity loss, and food security challenges. The review of available data on knowledge gap in sustainable soil health was based on the analysis of current, available publications using the desk research method. The European Soil Mission highlights soil literacy as crucial for sustainable soil health. However, a singular definition of soil health is lacking, necessitating an adaptive approach. Key knowledge gaps include unclear definitions of soil health and literacy, limited research on soil literacy in Europe, and a lack of progress indicators. Additionally, the absence of standardized methods for land degradation and unsustainable farming practices hampers effective management. Solutions like agroforestry and regenerative agriculture show promise but require further research to assess their impact on SOC and biodiversity. This research proposes a holistic roadmap for improving soil health, calling for harmonized methodologies, cross-sector collaboration, and innovative solutions to meet the EU's 2030 and 2050 sustainability targets. Enhanced monitoring protocols, policy integration, and long-term restoration plans are critical for combating soil contamination and promoting healthy ecosystems.

Keywords: soil health, soil literacy, carbon sequestration, land degradation, sustainable soil management

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* ewalus@meeri.pl

Innovative solutions for sustainable water management - application of IT tools

Dominika Szołdrowska[1*] | Marzena Smol[1]

[1]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Abstract

IT tools are becoming increasingly popular in various sectors of the economy. Their use can contribute to achieving the goals set by the European Union (EU) regarding sustainable resource management and the transformation of the economic model into a circular economy (CE). A literature review identified many tools that were created for the fertiliser sector to optimize the use of fertilisers in agriculture, thereby managing nutrients such as phosphorus - P, nitrogen - N and potassium - K in a sustainable and safe way for the environment and human health. Actions have been taken to use the IT tool also in the water and wastewater sector, because in recent years there has been a lot of pressure on water resources.

The ReNutriWater project is developing an IT tool aimed at protecting and reusing water from wastewater. The main function of the tool will be to make calculations based on wastewater parameters entered by the user in order to select the optimal purpose for further use of reclaimed water, e.g. for reusing water for irrigation various types of plants. The tool will indicate the appropriate method of wastewater treatment for a specific purpose, taking into account technological, environmental and economic aspects. The tool will also have an additional function such as a compendium of knowledge providing information on current legal standards for water reuse and treatment methods. In this way, the IT tool can significantly contribute to economic transformation in the water and wastewater sector.

Keywords: IT tools, water reuse, water sector, circular economy

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* szoldrowska@meeri.pl

Possibility of application the hydrothermal carbonization process of agricultural digestate in the production of liquid fertilizers

Joanna Mikusińska[1*] | Klaudia Szkadłubowicz[1] | Zuzanna Prus[1] | Małgorzata Wilk[1]

[1]AGH University of Krakow, Poland

Abstract

In agricultural biogas plants the by-product of the anaerobic fermentation process is digestate. It is a mixture of liquid and solid phase and its composition depends on the feedstock used in a biogas plant. Due to the high moisture and organic content of digestate, it can be applied in the hydrothermal carbonization process (HTC). One of the products of this reaction is process water, which is obtained in the largest amount (c.a. 80%). It can be used as a liquid fertilizer, therefore determining the content of nitrogen and phosphorus is a crucial issue. In this research the HTC process was performed at the temperature 190 and 210°C and 1, 1.5 and 2 h residence time. Process water was then analysed for nitrogen and phosphorus content. Moreover, pH, conductivity, total organic carbon (TOC), phenol and chemical oxygen demand (COD) were examined. The results confirmed that the greater values of phosphorus and nitrogen content were obtained for the HTC 210°C than for the 190°C. For HTC 190°C the highest phosphorus content was obtained for 1 h and the nitrogen content for 2 h. For HTC 210°C it was respectively 1.5 h and 1 h. The research shows that higher HTC temperatures result in higher phosphorus and nitrogen content in process water. The application of process water from HTC of agricultural digestate is in line with green deal implementation of innovative technology and circular waste management.

Keywords: digestate management, biogas plants, hydrothermal carbonization, process water

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* jmikusi@agh.edu.pl

Polymer composites as a way to manage ash from waste incineration

Dorota Tomczak[1*] | Joanna Szymańska[1] | Grzegorz Przesławski[1]

[1]Institute of Chemical Technology and Engineering, Faculty of Chemical Technology, Poznan University of Technology, Poland

Abstract

One of the objectives of a circular economy is sustainable waste management. A way to reuse waste incineration residues is to use them as a filler in polymer composites. The study conducted here involved obtaining polymer composites with an epoxy resin matrix filled with waste incinerator ash. The composites were obtained by the casting method, and the filler concentrations in the composites were 20, 35 and 50%. The obtained materials were tested for the effect of the filler on the mechanical properties of the samples, including three-point bending and Charpy impact strength. Microscopic images of the fracture surfaces of the samples showing the internal structure are also presented. At a filler concentration of 35%, the flexural strength decreased by about 11% relative to pure resin, and Young's modulus increased by 15%, so this is the system with the highest ash concentration and at the same time the properties most similar to pure resin. The addition of 20% filler caused a significant deterioration in impact strength, but further increases in filler content did not impair it. This shows the potential for good mechanical properties of composites at fill rates as high as 50% when interfacial adhesion between matrix and filler is improved, which is significant in the context of waste reuse in a circular economy.

Keywords: ash waste, epoxy resin, composite, circular economy, polymer composite

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* dorota.tomczak@doctorate.put.poznan.pl

Stakeholder and policy roles in the Circular Economy

Magdalena Andrunik[1*] | Marzena Smol[1]

[1]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Abstract

The circular economy (CE) is a critical framework for fostering sustainability, and its success heavily depends on the roles of policymakers and stakeholders across various sectors. This study focuses on the bio-based soil improvers and fertilising products sector, which plays a vital role in sustainable agriculture and resource management. It examines the interplay between policy frameworks and stakeholder engagement to advance CE goals.

The research employs a systematic stakeholder analysis, utilising survey data from key actors including policymakers, industry representatives, and agricultural practitioners. Stakeholders are categorised based on their levels of interest and influence. The stakeholder analysis was conducted using a survey-based approach, specifically the Computer Assisted Web Interview (CAWI) method. A policy review highlights the alignment of existing regulations, such as the European Green Deal and the Farm to Fork Strategy, with CE objectives, while also identifying gaps in implementation.

Findings show that collaboration among stakeholders is crucial for overcoming policy barriers and promoting sustainable practices. Stakeholders with significant influence, such as farmers and producers, must be closely managed to ensure the uptake of bio-based solutions. The importance of evidence-based policymaking and supported by continuous stakeholder engagement is crucial to ensure the successful integration of CE principles in agriculture. In conclusion, the research underscores the need for coordinated efforts between policymakers, industry, and other key stakeholders. By addressing policy gaps and fostering collaboration, the sector can move towards a more sustainable and circular approach, contributing to broader environmental goals.

Keywords: stakeholder analysis, environmental policy, stakeholder matrix, survey analysis, sustainable resource management

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* andrunik@meeri.pl

Epoxy resin composites with waste ash fillers

Joanna Szymańska[1*] | Dorota Tomczak[1] | Grzegorz Przesławski[1]

[1]Institute of Chemical Technology and Engineering, Faculty of Chemical Technology, Poznan University of Technology, Poland

Abstract

Due to sustainable development and circular economy, it is important to plan the full life cycle of the materials and products. It is necessary to think in a conscious way about the reuse and reprocessing of materials. The planned work dealt with the management of waste fly ash from the waste incineration process. After characterisation and pre-treatment, the material was used as a filler for epoxy resin matrix composites. The composites obtained were analysed for the effect of the filler addition on the structure of the polymer matrix. The description of the properties directly influences the mechanical properties of the composites, which translates into the performance of the material. The proposed issue is relevant from the point of view of the Closed-Circuit Economy (GOZ). By doing so, it is possible to reduce the consumption of plastics and to manage waste materials.

Keywords: polymer composite, ash, epoxy resin, sustainable development, circular economy

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* joanna.szymanska@doctorate.put.poznan.pl

Degradation of vancomycin in aquatic matrix via peroxymonosulfate photocatalytic activation: an eco-friendly solution to antibiotic pollution

Paulina Sowik[1*] | Katarzyna Kowalska[1] | Ewa Felis[1]

[1]Silesian University of Technology, Faculty of Energy and Environmental Engineering, Environmental Biotechnology Department, Poland

Abstract

Recently, AOPs based on highly reactive sulfate radicals (SR-AOPs) have been attracting increasing attention because of their strong oxidation ability and mineralization efficiency. Sulfate radicals ($SO_4^{\bullet-}$) have multiple advantages over •OH, such as a higher selectivity or longer half-life. $SO_4^{\bullet-}$ can be generated by photocatalytic activation of peroxymonosulfate (PMS). A wide range of reactive species are generated in SR-AOPs to degrade organics, offering a promising solution to environmental pollution. This eco-friendly approach minimizes harmful by-products, making it a sustainable alternative for removing persistent pharmaceutical residues from water systems.

The aim of the study was to assess the removal efficiency of vancomycin (VAN) by solar-driven photocatalysis using TiO_2 and ZnO. Tests were also conducted in the presence of PMS. The experiments were carried out in Milli-Q water (MW) spiked with 2 mg L^{-1} of VAN, with photocatalyst concentrations at 20 mg L^{-1} each, and PMS at two different concentrations: 20 mg L^{-1} and 200 mg L^{-1}. Studies were carried out in a solar radiation simulator.

Studies have shown that VAN was completely removed (>99%) during photocatalysis with TiO_2 and ZnO and in processes conducted in the presence of PMS. However, it was observed that the efficiency of VAN degradation depends on both the type of photocatalyst used and the concentration of PMS. The significant increase of VAN degradation efficiency in the presence of PMS suggests that processes utilizing PMS have the potential to be effectively applied in wastewater treatment for the removal of organic micropollutants.

Keywords: peroxymonosulfate, photocatalysis, titanium dioxide, vancomycin, zinc oxide

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* paulina.sowik@polsl.pl

Study of energy consumption in swimming pool facilities: efficient energy management

Anna Mika-Shalyha[1,2*] | Joanna Wyczarska-Kokot[2] | Anna Lempart-Rapacewicz[1,2]

[1]PPUH Transcom Sp. z o.o., Poland
[2]Department of Water and Wastewater Engineering, Faculty of Energy and Environmental Engineering, Silesian University of Technology, Poland

Abstract

Swimming pools are increasingly valued as a form of physical activity, particularly in the context of sedentary lifestyles. Municipal authorities are allocating resources to establish these facilities as vibrant hubs of movement and participation for residents. However, concerns arise regarding the substantial financial commitment required for the maintenance of such amenities, particularly within the contemporary emphasis on conserving non-renewable energy resources and mitigating human impact on the environment. Swimming pools present a considerable energy demand attributed to the necessity of maintaining uninterrupted water circulation, operating pumps and blowers for pool attractions, whirlpool baths, and sauna zones. This characteristic makes them an exemplary subject for the study of energy management, optimal solution selection, and analysis of device work schedules. Three swimming pool facilities, each with a water surface area and operating at a station efficiency of 538 m^3/h, were evaluated. These facilities were outfitted with an array of water and air attractions, e.g., air benches, wall and neck massages. The collective installed power of all electrical devices for swimming pool technology was 124 kW. Detailed scrutiny encompassed the design assumptions and management methodologies of the facilities, including the actual consumption differentials between swimming pool facilities with similar configurations but varying attendance and customer demographics. Thorough data analysis and meticulous monitoring are imperative for the introduction of contemporary solutions and the implementation of energy management strategies grounded in sustainable development, while maintaining service quality. Only through a comprehensive analysis can a judicious energy policy be devised to effectively address the customer and environmental requirements.

Keywords: swimming pool, energy management, monitoring, energy policy, non-renewable energy resources

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* anna.mika-shalyha@polsl.pl

Abstracts

Poster presentations on-line

Applying extended urban metabolism approach and sustainability indicators for the slum upgrading in barangay kamuning, quezon city, philippines

Airish Castillo[1*]

[1]Nicolaus Copernicus University in Toruń, Poland

Abstract

In the 1970s, the Philippine government adopted the slum upgrading approach to address the shelter dilemma of the urban poor. However, rapid urbanization has since exacerbated the proliferation of slum areas, particularly in Quezon City. This research focuses on the slum settlement in Barangay Kamuning's Bernardo Park area, which faces significant challenges due to the city's reliance on a linear metabolism that contributes to environmental degradation.

This research aims to apply the Extended Urban Metabolism & Sustainability Indicators framework to develop spatial planning solutions that improve living conditions in Barangay Kamuning. A sequential explanatory approach was used, beginning with a quantitative Life Cycle Assessment (LCA) to evaluate environmental impacts, followed by qualitative in-depth interviews with stakeholders to ensure a participatory process. The gathered data was used in generating plans to be applied elsewhere in the city or in other slum settlements with similar landscape characteristics.

The study's findings highlight the environmental impact of Quezon City's metabolism, with the depletion of fossil fuels identified as the most significant impact category. These findings served as Sustainability Indicators, guiding targeted interventions to enhance the city's environmental sustainability and improve the livability of slum dwellers. The study's assessment provides valuable insights for policymakers, urban planners, and relevant stakeholders in prioritizing efforts towards a more sustainable city metabolism in slum upgrading.

Keywords: extended urban metabolism, circular economy, spatial planning, landscape interventions, slum upgrading

* 324731@stud.umk.pl

sustainable removal of pollutants and recovery of nutrients from wastewater by eco-technological approaches using cohesive phyto-microbial-electrochemical processes

Usharani Rathinam Krishnaswamy[1*] | Gustavo HRD Silva[1]

[1]Department of Civil and Environmental Engineering, UNESP, Brazil

Abstract

Organic and inorganic pollutants are the main environmental pollutants, and groundwater poses a serious threat to human health and the aquatic ecosystem. Phyto treatment processes are cost-effective natural green, and sustainable technology with long-term applicability. The aquatic free-floating plants (*Lemna minor, Azolla sp, Utricularia sp, mosquito fern*, etc.,) grasp sharp competence for the removal of organic and inorganic pollutants and were accumulator plants for the remediation of prominent contaminants including Nitrate, Nitrite, Ammonia, Phosphate, Sulphate along with pesticides, metals, endocrine disrupting chemicals, Pharmaceutical and Personnel care products, etc. The phytoremediation potential of aquatic floating plants can be further enriched by the application of microbial electrochemical processes and progressive approaches. The use of aquatic free-floating plants in phytotechnology is gathered in directive to present the broad applicability of a natural-based system of remediation. The collective or sequential phytotechnology with engineered system infusion of the microbial electrochemical process into water, an advanced bio-oxidation process. Consequently, this outcome makes it a valuable reuse of water and nutrients for sustainable development of urban and agricultural perspectives. The disposal of plant biomass is used to produce biogas and animal feed. Moreover, the use of aquatic floating plants in this treatment does not require any post-filtration and can be effectively used to treat polluted water on site with cost-effectiveness and advantageous for the sustainability of whole ecosystems. Therefore, cohesive integrated eco-technological remediation can be applied for wastewater treatment to reduce water pollution, and such efforts can certainly contribute significantly towards sustainable development and a circular economy.

Keywords: phyto-microbial-electrochemical remediation, wastewater treatment, pollutants removal, nutrient and energy recovery

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* usharaniks2003@yahoo.com

Toxicity of antibacterial wet wipes according to a growth test with *Lepidium sativum*

Nataliia Tkachuk[1*] | Liubov Zelena[2] | Yaroslav Novikov[1]

[1]Department of Biology, T.H. Shevchenko National University "Chernihiv Colehium", Ukraine
[2]Department of Virus Reproduction, Danylo Zabolotny Institute of Microbiology and Virology, NAS of Ukraine, Ukraine

Abstract

The pursuit of a zero-pollution, toxic-free environment is envisaged, among other things, within the framework of the integrated approach of the EU Green Deal. The use of wet wipes in everyday life and the growth of their accumulation in the environment determines their consideration as pollutants. The aim of this study was to investigate the toxicity of antibacterial wet wipes using a *Lepidium sativum* growth test. 5 types of antibacterial wet wipes produced in Ukraine and freely available in the country's retail network were used. The seeds of *L. sativum* were germinated for 5 days on the surface of circles, cut from the studied wet wipes (experiment) or filter paper (control), moistened with distilled water. The energy of seed germination, seed germination, the length of roots and the above-ground part of seedlings were defined. A statistically significant decrease in the energy of seed germination and its germination compared to the control was established under the influence of 4 types of analyzed wet wipes. The index of the length of the roots and the above-ground part of the seedlings was significantly less than in the control under the influence of all analyzed wet wipes. Thus, the tested wet wipes are extremely toxic and may be a potential source of toxic substances. Reducing the toxicity of these products, in particular, by using eco-friendly substances for their hydration, should be one of the priorities of achieving the decrease of the pollution levels below the threshold of danger for human health and the environment.

* nataliia.smykun@gmail.com

Clinching as a low-carbon metal joining process

Karolina Sulima[1*] | Damian Hadry[1] | Krzysztof Chyła[1]

[1]Silesian University of Technology, Poland

Abstract

Clinching is an innovative mechanical joining process that offers a low-carbon alternative for connecting metal components, particularly in industries such as automotive manufacturing, where sustainability and energy efficiency are increasingly prioritized. Unlike traditional welding techniques (e.g., MIG/TIG/laser welding), which are energy-intensive and generate significant CO2 emissions, clinching does not require heat or additional materials, such as fasteners or adhesives. This cold-forming process involves locally deforming and interlocking sheets of metal, resulting in a secure joint without altering the material's structural integrity. The absence of thermal processes significantly reduces energy consumption and the emission of greenhouse gases and welding fumes, aligning with global efforts to minimize environmental impact and carbon footprints.

Furthermore, clinching provides several advantages, including high strength and durability of joints, suitability for joining dissimilar materials, and potential for automation, which can lead to improved production efficiency and lower operating costs. The process also offers enhanced safety due to the elimination of risks associated with high-temperature operations. This paper explores the mechanical properties, environmental benefits, and economic implications of adopting clinching as a sustainable joining method. By optimizing clinching parameters and tooling design, this study aims to demonstrate the feasibility of integrating this technology into mass production settings, thereby supporting the industry's transition towards greener manufacturing practices.

Keywords: please provide up to five keywords, clinching, low carbon, joining

* karolina.regulska1993@gmail.com

Low-cost purified pyrophyllite ultrafiltration membrane with efficient azoic dyes removal

Sanaa Adlane[1*] | Ahlam Essate[1] | Brahim Achiou[1] | Abdellah Aaddane[1] | Mohamed Ouammou[1] | Saad Alami Younssi[1]

[1]Laboratory of Materials, Membranes and Environment, Faculty of Sciences and Technologies of Mohammedia, Hassan II University of Casablanca, Morocco

Abstract

Recently, membrane separations have been widely adopted as a green separation technology due to their attractive advantages including high separation efficiency. They are viewed as an efficient and environmentally friendly method that can handle the largest amount of liquid while maintaining a controlled transmembrane pressure.

This work aims to develop novel ceramic ultrafiltration membranes made from purified pyrophyllite. Natural pyrophyllite was purified via an optimized physicochemical protocol. The purified pyrophyllite and PVA were used to prepare a slip to be deposited as a thin selective layer on pyrophyllite support via vacuum filtration method. Thereafter, the membrane was sintered at different temperatures to investigate its influence on membrane characteristics. The prepared membrane was deeply investigated using scanning electron microscopy, and measuring pore size, water permeability and antifouling parameters. The optimized membrane sintered at 1050 °C exhibits 53.14 L h^{-1} m^{-2} bar^{-1} of permeability. As application, the prepared membrane was used for removal of direct red 80 (DR 80). The obtained membrane was applied for tangential filtration of DR 80 under a pressure of 3 bar, the rejection of dye achieves 91.1%. More importantly, the preliminary filtration results show that the pyrophyllite-based membrane could be effective for the treatment of colored wastewater.

Keywords: ultrafiltration, pyrophyllite, ceramic membrane, textile wastewater, sintering

* sanaa.adlane-etu@etu.univh2c.ma

Preparation and characterization of biochar from lignocellulosic biomass for mercury removal from wastewater

Anass Wahby[1*] | Nouha EL Mail[1] | Kaouthar Benahdach[1] | Brahim Arhoun[1] | Rachad EL Mail[1] | Anas EL Laghdach[1]

[1]Laboratory of Water, Studies and Environmental Analysis, Faculty of Sciences, Abdelmalek Essaadi University, Morocco

Abstract

Heavy metals in natural waters pose serious threats to human health and the environment. Adsorption presents a cost-effective solution for treating effluents contaminated with heavy metals. This study synthesized porous biochar from lignocellulosic biomass through pre-oxidation treatment, carbonization, and CO_2 activation to remove mercury (Hg^{2+}) from aqueous solutions.

The textural properties of a series of porous biochars, produced from lignocellulosic precursors via carbonization at different temperatures (673 K, 823 K, and 1123 K) followed by CO_2 activation, were characterized using N_2 and CO_2 adsorption at 77 K and 273 K, respectively. Additionally, the effect of biochar pre-oxidation was examined using temperature-programmed decomposition to assess the influence of oxygen content on mercury removal performance. Hg^{2+} adsorption experiments were conducted in aqueous solutions at room temperature. The results demonstrated that all biochar samples exhibited high microporosity. Moreover, the amount of surface oxygen functional groups increased after pre-oxidation, leading to a substantial enhancement in Hg^{2+} uptake, with an improvement of up to 72 %.

In conclusion, introducing functional groups increased the hydrophilicity of the biochar, thereby improving its efficiency in Hg^{2+} adsorption.

Keywords: pre-oxidation treatment, carbonization, lignocellulosic biomass, biochar, mercury, adsorption

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* a.wahby@uae.ac.ma

Biosorption of crystal violet dye from textile wastewater using agri-food waste

Nouha EL Mail[1*] | Souad Benaisa[1] | Mouna Achabdan[1] | Anass Wahby[1] | Anas EL Laghdach[1] | Brahim Arhoun[1]

[1]Laboratory of, Water, Studies and Environmental Analysis, Faculty of Sciences, Abdelmalek Essaadi University, Morocco

Abstract

Agrifood processing generates large quantities of waste that pose significant environmental problems. Simultaneously, the textile industry consumes substantial amounts of water, which becomes polluted by the end of the process, leading to risks for human health and the deterioration of water resources. Utilizing agrifood waste as a low-cost biosorbent for dye removal presents a promising alternative for effective waste management.

This study investigated the efficiency of removing crystal violet dye from aqueous effluents using raw avocado peel. Surface morphology was characterized using scanning electron microscopy, while Fourier Transform Infrared Spectroscopy evaluated the functional groups responsible for dye adsorption. Kinetic analysis of biosorption indicated that the pseudo-first-order model best described the dye uptake. The Langmuir model was used to determine the maximum adsorption capacity under optimal conditions (pH=6.21, S/L=7 g L^{-1}, T=25 ºC). Thermodynamic studies revealed that the biosorption of crystal violet dye by raw avocado peel is both exothermic and spontaneous. Regeneration studies showed that the adsorbent could be effectively reused for five consecutive cycles with 0.1 M NaOH, with minimal loss in adsorption efficiency.

In conclusion, due to its chemical composition, avocado peel proves to be a viable and sustainable biosorbent for removing dyes from industrial effluents

Keywords: biosorption, avocado peel, crystal violet dye, isotherm, kinetic, regeneration

Acknowledgments: EL Mail and Achabdan, PhD students, acknowledge the financial support provided by Abdelmalek Essaadi University.

* nouhielmail@gmail.com

Adsorption of Cu^{2+}, Zn^{2+}, and Ag^{+} ions onto natural zeolites and humic acids

Michal Hromják[1*] | Tomáš Bakalár[1]

[1]Technical University of Košice, Slovakia

Abstract

This study focuses on the adsorption of metal ions Cu^{2+}, Zn^{2+}, and Ag^{+} from solutions containing $Cu(NO_3)_2$, $Zn(NO_3)_2$, and $AgNO_3$, onto natural materials zeolites (ZeoCem Micro 50, Micro 20, and Micro 15) from ZeoCem a.s. and humic acids (HUMAC Agro < 200 µm) from HUMAC s.r.o. The concentration of these ions in both initial solutions and filtrates, along with diluted and undiluted samples of the natural materials, was evaluated. The results were analyzed through Atomic Absorption Spectroscopy (AAS) and X-ray Fluorescence (XRF). The adsorption behavior was described using Freundlich, Langmuir, and Redlich-Peterson isotherms, which provided insight into the adsorption capacities of the materials. The maximum adsorption capacity for Cu^{2+}, Zn^{2+}, and Ag^{+} was derived from the Langmuir isotherm. HUMAC Agro < 200 µm exhibited the highest adsorption capacity, ranging from 11.45 to 78.13 $mg \cdot g^{-1}$. ZeoCem Micro 15 followed with a range of 7.94 to 38.46 $mg \cdot g^{-1}$, then ZeoCem Micro 20 with 5.26 to 36.36 $mg \cdot g^{-1}$, and finally ZeoCem Micro 50 with 4.24 to 32.79 $mg \cdot g^{-1}$. These results indicate that HUMAC Agro < 200 µm had a significantly higher adsorption capacity for Cu^{2+}, Zn^{2+}, and Ag^{+} compared to the zeolites, which showed similar adsorption capacities. The experimental results were also compared with those from other studies, where the used natural materials demonstrated moderately good adsorption capacities. In conclusion, it can be stated that the evaluated materials – ZeoCem Micro 50, Micro 20, Micro 15, and HUMAC Agro < 200 µm – are effective for the adsorption of Cu^{2+}, Zn^{2+}, and Ag^{+}.

Keywords: adsorption, zeolite, Humac, AAS, XPS

* michal.hromjak@student.tuke.sk

Green synthesis and characterization of magnesium oxide nanoparticles using *Oxalis pes-caprae* plant extracts and their photocatalytic activity

Yasmine Khane[1,2*] | Zoulikha Hafsi[1,2] | Djaber Aouf[1] | Fares Fenniche[1,2]

[1]Materials, Energy Systems Technology and Environment Laboratory, Faculty of Sciences and Technology, University of Ghardaia, Algeria
[2]Faculty of Sciences and Technology, University of Ghardaïa, Algeria

Abstract

This study included the biosynthesis of magnesium oxide nanoparticles (MgO-NPs) by an environmentally benign sol-gel auto-combustion technique, utilizing plant extract from *Oxalis pes-caprae*, obtained from southern Algeria (Ghardaïa). Both fresh and dried extracts functioned as stabilizing and reducing agents owing to their phytochemical constituents. The synthesis of MgO nanoparticles and the impact of different factors on their size and morphology were validated using scanning electron microscopy (SEM), which demonstrated that the MgO nanoparticles were mostly spherical. The EDX spectra also corroborated the synthesis of MgO-NPs. The crystalline characteristics and dimensions of the MgO-NPs were analyzed by X-ray diffraction (XRD) patterns, revealing a face-centered cubic structure with average diameters between 25.8 and 28.5 nanometers. The photocatalytic efficacy of MgO-NPs was evaluated in the degradation of the organic dye Malachite Green (MG) in aqueous solution. Two kinetic adsorption models, the pseudo-first-order model and the pseudo-second-order model, were used to mathematically quantify the MG degrading process. The pseudo-second-order kinetics exhibited strong concordance with the experimental results.

Keywords: MgO nanoparticles, oxalis pes-caprae, sol - gel auto-combustion, photodegradation

* yasminekhane@yahoo.fr

Application of avocado peel as a biosorbent for removal of green malachite dye from aqueous solution

Souad Benaisa[1*] | Nouha EL Mail[1] | Anas Chraka[2] | Youssef Aoulad el Hadj Ali[1] | Anass Wahby[1] | Anas EL Laghdach[1] | Brahim Arhoun[1]

[1]Laboratory of, Water, Studies and Environmental Analysis, Faculty of Sciences, Abdelmalek Essaadi University, Morocco

[2]Laboratory of Materials Engineering and Sustainable Energy, Faculty of Science, Abdelmalek Essaadi University, Morocco

Abstract

Wastewater from the textile industry is rich in dyes and other pollutants, which significantly contribute to environmental contamination. Green technologies such as biosorption are being increasingly utilized to mitigate this negative impact. Notably, biosorbents made from agricultural waste have emerged as a cost-effective, efficient, and eco-friendly solution for removing pollutants from textile wastewater.

In this study, avocado peels (AP), an abundant byproduct of the food industry, were used in their natural form as a biosorbent to effectively remove malachite green dye from aqueous solutions in a batch biosorption process. The surface characterization of AP was conducted using scanning electron microscopy and Fourier transform infrared spectroscopy. Several parameters were evaluated, including contact time, solution pH, biosorbent dose, initial dye concentration, and temperature, to determine the optimal conditions for the batch process. Kinetic analysis revealed that the pseudo-second-order model best described the dye biosorption. The Langmuir model was used to determine the maximum adsorption capacity, which was 47.34 mg/g under optimal conditions (natural pH, S/L = 7 g/L, T = 25°C), with a high R^2 value of 0.991 and a low RMSE of 1.23. Thermodynamic studies indicated that the biosorption of malachite green dye by raw avocado peel is endothermic and spontaneous. Regeneration studies showed that the biosorption capacity of avocado peel, using 0.1 M HCl as the desorbing agent, slightly decreased after five adsorption and desorption cycles.

In conclusion, agro-food waste such as avocado peel can be a sustainable biosorbent for removing dyes from textile wastewater.

Keywords: biosorption, agri-food waste, avocado peel, green malachite dye, isotherm, kinetic, regeneration

Acknowledgments: The authors acknowledge the financial support provided by Abdelmalek Essaadi University.

* souadbenaisa@gmail.com

Utilization of by-products from green pea processing as a low-cost biosorbent for eriochrome black-t removal: kinetic, isotherm and thermodynamic studies

Mouna Achabdan[1*] | Kaouthar Benahdach[1] | Maria del Mar Cerrillo-Gonzalez[2] | Anass Wahby[1] | Rachad EL Mail[1] | Brahim Arhoun[1]

[1]Laboratory of Water, Studies and Environmental Analysis, Faculty of Sciences, Abdelmalek Essaadi University, Morocco
[2]Department of Chemical Engineering, University of Malaga, Spain

Abstract

The food processing industry generates large quantities of waste, often available in bulk at no cost. Green peas are one of the most important vegetable crops globally, with industrial processing producing significant waste, accounting for 30 to 40% of the total weight. Inefficient waste management of this by-product can lead to serious environmental consequences. Meanwhile, azo dyes, widely used across various industries, contribute to large volumes of wastewater, posing threats to human health and degrading water resources. The valorization of pea waste as a biosorbent presents a promising approach to mitigate these environmental challenges and reduce the costs associated with wastewater treatment.

This study investigates the biosorption of Eriochrome Black T (EBT) dye using green pea pods under optimized conditions. Experimental parameters included initial dye concentrations ranging from 25 to 100 mg/L, adsorbent doses from 1.25 to 20 g/L, pH values between 2 and 10, and temperatures from 25 to 45 ºC. Nonlinear models were applied to the kinetic and isotherm data, with the pseudo-second-order kinetic model and the Freundlich isotherm model providing the best fit. The maximum adsorption capacity was 82 mg/g under optimal conditions (natural pH, S/L = 5 g/L, C_0 = 5-250 mg/L, T = 25 ºC). The biosorption process of EBT was found to be endothermic and spontaneous.

In conclusion, green pea pods proved to be an effective biosorbent for removing Eriochrome Black T from wastewater, offering a cost-effective solution for managing the by-products of green pea processing.

Keywords: food processing waste, biosorption, green pea pods, eriochrome black T dye, isotherm, kinetic, thermodynamic

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* mouna.achabdan@gmail.com

The use of cactus cladode (Opuntia Ficus Indica) as bio-flocculant for wastewater treatment

Racha Medjda Bouchenak Khelladi[1*] | Abdelghani Chiboub Fellah[2] | Roumeissa Lalimi[1] | Anfal Zeroual[1]

[1]Djilali Liabès Univeristy, Faculty of Technology-Sidi Bel Abbès-Algeria, Laboratory of Civil Engineering and Environment
[2]Abou Bekr Belkaid University, Faculty of Technology- Tlemcen-Algeria, Laboratory of Valorization of Water Resources VRE N°60

Abstract

Urbanization, industrialization and extensive agricultural production are responsible for generating polluted effluents which need to be treated. Various treatment methods have been applied for the removal of pollutants from wastewater. The coagulation/flocculation processes have remained the most widely practiced techniques in wastewater treatment for removing particulate, organic matter, color, and heavy metal. The use of conventional chemical-based flocculant increases residual levels of chemical products, that are harmful to the environment and toxic to fauna and flora. The use of eco-friendly bio-flocculants in wastewater treatment has become essential due to the health implications of chemical flocculants. Because of their non-toxic and biodegradable nature, plant-based bio-flocculants have become popular as an alternative to synthetic flocculants in wastewater treatment. They are abundantly available from renewable resources and have no negative environmental effects. The objective of this study was to investigate the ability of cactus Opuntia ficus-indica, used as a natural flocculant in the treatment of an urban wastewater, and another bio-coagulant “bentonite” was also tested as coagulant. Different coagulation-flocculation experiments were conducted in a jar test apparatus to evaluate the performance of the bio-flocculant by comparing it with common coagulant (aluminum sulfate) and flocculant (polymers) with natural ones. Also, the effect of coagulant dose on some water parameters such as turbidity, pH, conductivity, chemical oxygen demand (COD), suspended solids and azote were investigated. The results showed that the use of bio-coagulants and bio-flocculant has given better reduction in turbidity about 92% while for aluminum sulfate and polyamide about 91%, same reduction in azote and COD were observed for both chemical and natural coagulant and flocculant about 77% and 78% respectively. We conclude that the bio-material can replace the chemical reagent for the coagulation-flocculation process while giving better rate reduction in turbidity.

Keywords: bentonite, bio-coagulant, bio-flocculant, coagulation-flocculation, jar-test, opuntia ficus indica

* rashamajda@hotmail.fr

Optimizing water use and energy efficiency: the impact of wastewater heat recovery and water recycling in residential buildings

Wiktoria Sidło[1*] | Robert Kowalik[1]

[1]Kielce University of Technology, Faculty of Environmental Engineering, Geodesy and Renewable Energy, Poland

Abstract

The production of domestic hot water in Poland accounts for approximately 15% of total energy consumption in a typical household. According to EU data, energy consumption for lighting and powering appliances is comparable to the energy used for heating water, making it a significant operational cost, second only to heating buildings..

Heat recovery from wastewater presents a promising method for reducing energy losses, potentially lowering the costs associated with heating water. When combined with water recycling technologies, particularly greywater from showers and washing machines, it can further reduce the demand for fresh water. This approach decreases energy consumption and supports more sustainable water resource management.

There is a relationship between daily shower duration and number of users and possible financial savings. Financial efficiency increases as shower duration and water consumption increase. Therefore, it is most cost-effective to benefit from a heat recovery system for large families, sports, service and industrial facilities where showers are frequently used. For families of at least 4 people, with each person using the shower at least once a day for 5 minutes, the payback time should not exceed a period of 5 years.

This study analyzed the financial viability of wastewater heat recovery and water reuse in residential buildings. Results indicate that the payback period for these systems can be under five years for families of four who use the shower daily. Annual savings vary from PLN 799 to PLN 2922 based on shower duration. Larger families or high-usage facilities, such as gyms, see the greatest financial benefits, affirming the effectiveness of these systems in enhancing both energy and water efficiency.

Keywords: wastewater heat recovery, water recycling, greywater reuse, sustainable water management, water conservation

* wsidlo@tu.kielce.pl

Migration of contaminants to soil from the snow cover depending on the location

Małgorzata Widłak[1*] | Robert Kowalik[1]

[1]Kielce University of Technology, Faculty of Environmental, Geomatic and Energy Engineering, Department of Water Supply and Sewage Technology, Poland

Abstract

The aim of this study is to determine the level of soil contamination under snow cover at the depth of 30 cm and 90 cm depending on the chemical composition of the snow cover and its location. Climate change and its effects are recorded in various areas of people's everyday life, it is associated with population growth, industrial development and agricultural development. Atmospheric water is one of the most important climatic factors shaping the vegetation of the Earth. Thanks to its existence in three physical states, it circulates and regulates the conditions of life on Earth. Snow samples were collected in the season: December 2021, January 2022, February 2023 from 3 places located in the city of Kielce near operating CHP (combined heat and power plant) plants and from 3 places of agricultural areas located in the Swietokrzyskie Voivodship in the southern, northern and north-eastern parts.The following parameters have been determined in the studies: pH, conductivity and total hardness of water, the content of trace elements (Cd, Cr, Ni, Cu, Pb, Zn, Co) in snow water as well as the pH, content of organic matter, sorption and metal content of trace elements (Cd, Cr, Ni, Cu, Pb, Zn, Co) in the soil under the snow cover at a distance of approx. 2000 m from the emission source. The analysis carried out showed an increased level of cadmium in relation to copper and lead in snow water in urban areas, in the range of 53% - 100% in relation to the applicable standard (Journal of Laws), also in urban soils in mobile fractions F1 (carbonate) and F2 (oxide).

Keywords: sequential extraction, mobility of heavy metals, afterglow water, organic matter

* mwidlak@tu.kielce.pl

Evaluation of the benefits and water services provided by green roof - The case study from the WULS campus

Agnieszka Bus[1*] | Zofia Zalech[2]

[1]Institute of Environmental Engineering, Warsaw University of Life Sciences - SGGW, Poland
[2]Faculty of Civil and Environmental Engineering, Warsaw University of Life Sciences – SGGW, Poland

Abstract

Green roofs are one of the nature-based solutions (NBS) strategies to counteract the effects of climate change in urbanized areas. Such natural and semi-natural areas and other environmental features are designed and managed to deliver a wide range of ecosystem services (ES) within the boundary of a city.

The study aims to identify a set of NBS specifically for green roofs and analyze the associated ecological effect of water retention.

The green roof is at Warsaw University of Life Sciences, Warsaw, Poland. It is located above the underground parking, previously pavement, and rearranged as a green roof in 2016. The green roof provides primary ES for supporting (providing habitat for flora and fauna), regulating (regulation of the urban thermal climate, retention and filtration of stormwater, improving air quality), and culture (supporting physical and mental well-being). The average green roof water retention potential from 2016 to 2022 was 3,358 m^3 (SD±770 m^3). In contrast, the ecological effect calculated as a difference between retention on green roofs and pavement was 2416 m^3 (SD±554 m^3), corresponding to the value of € 5,883 (SD± € 1,610) calculated as the equivalent of tap water.

Green roofs and their associated ecosystems provide several ecosystem services and simultaneously increase the urban environment's green-blue infrastructure potential and water resilience.

Keywords: ecosystem services, evaluation, green roof, water retention

* agnieszka_bus@sggw.edu.pl

Efficient use of water, process wastewater, and rainwater in a swimming pool complex - a case study

Joanna Wyczarska-Kokot[1*] | Karolina Kruczek[1] | Marta Sage[1]

[1]Faculty of Energy and Environmental Engineering, Silesian University of Technology, Poland

Abstract

The main objective of this work is to present the possibility of effective use, in accordance with the principle of sustainable development and closed-loop economy, of water from swimming pools, technological wastewater generated after washing of filtration beds (washings), and rainwater in the area of a selected swimming pool complex. The analysed complex consists of six swimming pool circuits, equipped with water treatment plants, supplying 18 pools. The total flow capacity of the circuits is 780 m^3/h. A balance study of water demand and the volume of wastewater discharged has been carried out. The monthly water demand is 836 m^3. Technological purposes account for 66% of total demand and hygiene and sanitary purposes for 34%. The amount of washings is 1,070 m^3/month, and the amount of rainwater discharged into the sewerage system from the roof slopes averages 100 m^3/month. Based on the physicochemical analysis of washings and rainwater samples, it was found that direct use of total suspended solids (>30 mg/L), free chlorine (>0.2 mg Cl_2/L), chemical oxygen demand (>125 mg O_2/L), biochemical oxygen demand (> 15 mg O_2/L), total phosphorus (> 1 mg P/L)) and total organic carbon (>30 mg C/L), it is not possible. It is proposed that they be treated using: dechlorination (for pool water), sedimentation, and coagulation (for washings and rainwater), and then their use for flushing toilet bowls, washing waste containers, watering green areas, cleaning and washing paved surfaces in the area of the complex and retention for fire-fighting purposes. The rational use of large volumes of water in pool facilities and the search for opportunities to manage wastewater is important not only to reduce operating costs, but also to sustainably manage dwindling water resources, introduce the principles of a closed-loop economy, and partially or fully recover water for domestic purposes from process wastewater and rainwater.

Keywords: closed-loop economy, sustainably manage of water resources, pool water, process wastewater, rainwater

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* joanna.wyczarska-kokot@polsl.pl

Estimation of recyclability of waste printed circuit boards by solvent delamination

Vidas Makarevičius[1*] | Inna Pitak[1] | Rita Kriūkienė[1] | Gintaras Denafas[1]

[1]Lithuanian Energy Institute, Lithuania

Abstract

Efficiently and environmentally friendly recycling of waste printed circuit boards (WPCB) poses a significant challenge due to the rising global generation of electronic waste. Waste multilayer composites, including PCBs, are difficult to recycle due to their complex structure. Solvent delamination was suggested to dissolve thermosetting polymers from WPCBs, enabling more efficient recycling of multilayer PCBs. This way, the organic part and fiberglass are separated from metals which could be extracted from it by various recovery techniques.

Six different types of motherboards produced from 2007 to 2011 were used for delamination tests. Selected WPCBs were cut into 10 x 10 mm pieces by a shear cutter. Dimethyl sulfoxide (DMSO) was used as a solvent for the separation of motherboard layers at 130-160 °C.

The waste PCBs were separated into single glass fibre layers, copper foil, and metal parts. The chemical composition and structure of WPCBs before and after delamination were studied by the SEM-EDS technique. The main metals found in the separated parts were Fe, Al, Cu, and Sn.

The results show that WPCB layers could be separated under mild conditions (130°C–160°C), and 85% of used DMSO could be recovered. However, depending on the type of PCB, the duration of delamination differs significantly.

Keywords: recycling, WPCB, delamination, DMSO

* vidas.makarevicius@lei.lt

Comparing the effectiveness of synthesized photocatalyst Ag-TiO_2 with TiO_2 in degradation of antiviral drug by advance oxidation process

Humam Ahmed[1*] | Ewa Felis[1]

[1]Silesian University of Technology, Faculty of Energy and Environmental Engineering, Environmental Biotechnology Department, Poland

Abstract

Industrialization has increased the release of pharmaceutical pollutants into water bodies. This has impaired the quality of drinking water and is harmful to humans and animals. These pharmaceutical pollutants include antibiotics, anticancer drugs, antidepressants, etc., which are highly stable and persistent in water and detrimental to life. At times, the secondary pollutant formed after degradation is more potent than the parent drug. In this study an effort is made to investigate the degradation of the antiviral drug isoprinosine (IPN) in Milli-Q water (MQ) using a photocatalyst, Ag-doped TiO_2, under solar light irradiance (500 W/m^2) and compared its efficiency to that of pure TiO_2 used as a reference catalyst. Ag-TiO_2 nanoparticles were synthesized using the sol-gel method and analyzed using X-ray powder diffraction (XPRD), energy-dispersive X-ray microanalysis (EDX), and transmission electron microscopy (TEM). The TEM analysis of pure TiO_2 exhibited a particle size of 27 nm, while the size distributions of Ag doped TiO_2 NPs yielded average sizes of 4.2 nm and 28 nm, respectively. Diffractograms for Ag-doped TiO_2 and pure TiO_2 indicated the pure anatase (α) phase of TiO_2 with a peak at 2θ of 27.4°. Ag-doped TiO_2 contained rutile (β), anatase (α), and metallic silver (ε). Moreover, the presence of the rutile phase reduced the photocatalytic activity of Ag-TiO_2 in degrading IPN compared to pure TiO_2. IPN photodegraded faster at a concentration of 20.0 mg/L of TiO_2 ($k = 0.0483$ min^{-1}). After 30 minutes, TiO_2 completely decomposed IPN in the solution, while the Ag-TiO_2 photocatalyst only removed 21% of IPN. Although Ag-TiO_2 is less efficient than standard TiO_2 however it is effective under sunlight, making it valuable for environmental applications due to the widespread availability of sunlight as a renewable energy source.

Keywords: antiviral drug, AOPs, photocatalytic degradation, Ag-doped TiO_2, sol-gel method

* humam.ahmed@polsl.pl

Endophytic bacteria of the genus *Bacillus* (from *Vaccinium* plants) with antifungal activity against powdery mildew and the effect of BacMix on the chemical composition and microbiota of strawberry

Ingrida Mažeikienė[1*] | Neringa Rasiukevičiūtė[1] | Irena Mačionienė[2] | Darius Černauskas[2]

[1]Lithuanian Research Centre for Agriculture and Forestry, Institute of Horticulture, Lithuania
[2]Food Institute, Kaunas University of Technology, Radvilėnų, Avenue 19, 50292 Kaunas, Lithuania

Abstract

Unlike chemical fungicides, bacterial agents can positively affect plant growth and development in parallel with protection. A suitable search field for plant probiotics is plant endophytic communities. After examining 26 Bacillus spp. endophytes isolated from blueberries, cranberries, and lingonberries plants, were found 2 strains of *B. velezesis* and 2 of *B. halotolerans* (PRJNA991431 in NCBI) with inhibitory effect *in vitro* against *Botrytis cinerea*. Genetic characteristics of these strains after WGS was done. A wide range of genes and gene clusters related to the synthesis of bioactive compounds identified. Antifungal effect on cv. Elsanta and cv. Sensation in the greenhouse after the inoculation was investigated and approved. It was found that the best antifungal effect on plants has been received by a mix of bacteria (BacMix) instead of one by one. Sugars quantity and quality in berries, amino acids, and leaf microbiota changes were investigated. BacMix is involved in intricate molecular dialogue with strawberry according to these parameters. Amino acids changes indicated better adaptability and defense readiness of the plants. The composition of sugars and the taste of the berries were better than after chemical protection. The leaf microbiota was richer at bacteria taxons level after the BacMix impact, and a lower abundance of pathogenic bacteria was identified according to Shotgun metagenomic sequencing data. In conclusion, BacMix induces systemic resistance in strawberry plants, activating the plant's immune responses, and can be represented as a practical and powerful biocontrol agent that can be used as an alternative to synthetic agrochemicals.

Keywords: *Bacillus* spp., bio-fungicide, shotgun metagenome sequencing, whole genome sequencing

* ingrida.mazeikiene@lammc.lt

Comparison of OH-PAHs concentrations in the air by season using chromatographic analysis

Karolina Cwynar[1*] | Katarzyna Styszko[1]

[1]Faculty of Energy and Fuels, Department of Fuels Technology, AGH University of Krakow, Polandd

Abstract

PAHs are a group of compounds that contain two or more aromatic rings. The group of these compounds includes more than 10,000 substances, 16 of which are considered particularly hazardous. As a result of the carcinogenic properties of these compounds, it is important to monitor them and determine their concentrations in the air. Given their easy accumulation and their harmfulness to organisms, they pose a danger to health. This group includes benzo[a]pyrene, anthracene, naphthalene, pyrene, among others. PAHs in the air undergo an oxidation reaction when exposed to sunlight, where hydroxy derivatives of PAHs are formed. Hydroxy derivatives of PAHs show a higher uptake into the body. In the present study, the concentrations of selected OH-PAHs contained in the air were determined. Among the substances analysed were: 1-OH-naphthalene, 2-OH-naphthalene, 2-OH-fluorene, 9-OHfluorene, 9-OH-phenanthrene, 1-OH-pyrene, and 3-OH-benzo[a]pyrene. To determine OHPAHs concentrations and compare the concentration values according to the season, a winter and summer measurement campaign was conducted. The sampling process used a sampler in which a quartz filter was placed. The filter allowed for the accumulation of airborne particles, on whose surface OH-PAH compounds are absorbed. Samples were sequentially extracted with a mixture of cyclohexane and dichloromethane and then subjected to chromatographic analysis (GC-MS). The resulting concentrations of OH-PAHs will allow the assessment of exposure and the risk associated with OH-PAHs. Continuous monitoring is important in terms of safety and determining potential human exposure to a group of harmful compounds that include OH-WWA.

Keywords: OH-PAHs, gas chromatography, hydroxy derivatives

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* kcwynar@agh.edu.pl

The pyrolysis of leather and textile mixtures from post-consumer footwear in carbonized materials as an element of the circular economy model

Anna Kowalik-Klimczak[1*] | Maciej Życki[1] | Monika Łożyńska[1] | Bogusław Woźniak[1]

[1]Łukasiewicz Research Network–Institute for Sustainable Technology, Poland

Abstract

The dynamic development of the footwear industry resulted in ca. 24 billion pairs of footwear being manufactured worldwide in 2022. The rapid production and consumption of footwear, in accordance with the linear economic model, is responsible for the considerable quantities of post-consumer footwear stored in landfills. The multiple-material composition of this waste is an issue when selecting rational methods of its management/ disposal. The possibility of using pyrolysis to valorise post-consumer footwear uppers, a mixture of leather and textile materials has been analysed in this paper. The effect of pyrolysis temperature was investigated on the physico-chemical properties, composition, structure, and formation of the specific surfaces of carbonised materials produced by means of a thermal treatment of uppers without oxygen access to the reaction chamber. The results imply that, as the pyrolysis temperature grows, the efficiency of carbonization declines. The produced carbonized materials consist primarily of C, O, N, and H, whose contents depend on the pyrolysis temperature. Moreover, all the carbonised materials display the presence of two G and D bands, typical for carbon materials. Based on the peak intensities of the bands, I_D/I_G coefficients are calculated to assess the organization of the materials' structures. As the pyrolysis temperature rises, the structure organisation declines, contributed to an increased material porosity and thus a greater specific surface of carbonized materials. This study contributes some data about the thermal management and pyrolytic processing of leather and textile waste into useful carbonized materials, according circular economy model.

Keywords: pyrolysis, post-consumer footwear, mixture of leather and textiles, composition and structure of carbonized materials, valorisation of waste

Acknowledgments: This research was carried out as part of the project 'Recycling processes and dismounting of general footwear components, including electronic modules, with ways of reusing components and materials, based on a modular construction' (Acronym: ReProcess_Shoe) co-financed by the National Center for Research and Development under the Cornet Initiative (Agreement No. COR-NET/33/141/ReProcessShoe/2023).

* anna.kowalik-klimczak@itee.lukasiewicz.gov.pl

The impact of algae biochar on improving soil properties in the process of plant growth

Karolina Dziosa[1*] | Monika Kozieł[2] | Makowska Monika[1] | Gałązka Anna[2]

[1]Łukasiewicz Research Network – Institute for Sustainable Technologies, Poland
[2]Institute of Soil Science and Plant Cultivation State Research Institute. Poland

Abstract

With increase of industry to the natural environmental cause a lot of polution in the world. The process of accumulation of these substances in soils is particularly ecologically dangerous. One of the solutions in this area is the use of a mixture of soil and biochar. The use of biochar in plant production will contribute to improving the quality of crops, the fertility of arable and degraded soils, and the development of symbiotic microorganisms present in the soil. An excellent raw material for thermal conversion to obtain biochar, due to its chemical composition and rapid growth rate, is algal biomass, in particular the Chlorella sp. species. The aim of the research was to assess the impact of biochar produced from Chlorella sp. algae biomass on the properties and functional biodiversity of microorganisms in the environment soil. In the first stage of the research, biochar was produced from the biomass of microalgae Chlorella sp. Biochar was produced as a result of the low-temperature pyrolysis process (400ºC) in an atmosphere of carbon dioxide. In the second stage of the planned work, soil samples of the selected field bean plant were prepared on a substrate consisting of soil and various contents (1%, 2.5%, 5%) of biochar. During cultivation, the following parameters were monitored: temperature and irrigation. The cultivation time was 60 days. After completing the tests, research work was carried out for each plant and each substrate, including determining the activity of soil enzymes (dehydrogenase, alkaline and acid phosphatase), and determining the fresh and dry weight of above-ground parts and plant roots. The most favorable results of the tests carried out compared to the control sample were obtained when biochar was added in amounts of 1% and 2.5%. The addition in larger amounts did not increase the tested soil parameters and did not have a beneficial effect on the growth of above-ground parts and roots in the tested plants.

Keywords: algae, biochar, soil, legumes

* karolina.dziosa@itee.lukasiewicz.gov.pl

PFAS – the Forever Chemicals in Water - what we do (and don't) know?

Magdalena Herok[1*] | Hanna Barchańska[2] | Monika Partyka[1]

[1]i2 Analytical Limited, Poland
[2]Silesian University of Technology, Faculty of Chemistry, Department of Inorganic Chemistry, Analytical Chemistry and Electrochemistry, Poland

Abstract

PFAS belongs to group of compounds, called as "forever chemicals". Since their development and first synthesis on the beginning of XX century – they have been used in various branches of industry and economy, as for example fire retardants and waterproof coating.

Their unique properties became a reason of negative influence of environment and human health. They are very stable in environment and difficult to degrade. They also have potential cancerogenic properties.

In this work current knowledge about fate of PFAS compounds in water is presented as well as current law requirements (based on Polish, European and British requirements). In this work analytical methods possibilities are also presented.

Keywords: PFAS, LC MSMS, environment, contamination

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* m.herok@i2analytical.com

The utilization of pyrolysis technology in the cascading use of sawmill residues

Wiktor Pacura[1*] | Julia Domagała[1] | Tomasz Mirowski[1]

[1]Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland

Abstract

In the wood industry, including sawmills, lignocellulosic residues are most often burned in boilers with varying efficiency. In many cases, simple heating devices, such as furnaces or basic stoves, are used primarily to dispose of the waste rather than to produce heat, which can result in excess heat being generated even when there is no real demand for it. This leads to energy losses and inefficiencies. Biomass gasification is a promising, high-efficiency technology that enables more effective use of lignocellulosic residues.

In this study, three gasifiers with approximately 50 kW_{el} of electrical output and 100-130 kW_{th} of thermal output were compared to assess their efficiency, performance, and environmental impact. The research focused on evaluating the fuel conversion efficiency, heat recovery, and electricity generation capabilities of each gasifier. Detailed analysis was conducted to determine which design offered the best balance between electrical and thermal outputs, ultimately identifying the most effective solution for optimizing energy utilization in cogeneration systems.

The application of gasification, combined with cogeneration, allows not only for minimizing losses but also for improving waste heat recovery, significantly increasing the utilization of available energy resources. Additionally, the energy produced from this process could be used directly by companies for their own energy needs, such as heating, powering technological equipment, or electricity generation, leading to significant operational cost reductions. This would enable sawmills to not only minimize waste but also enhance their economic efficiency, becoming more energy-independent and environmentally sustainable.

Keywords: pyrolysis, biomass, sawmill residues, cascading use, CHP

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* pacura@min-pan.krakow.pl

ESG reporting in the energy sector: an overview of implemented standards

Justyna Cader[1*] | Renata Koneczna[1]

[1]Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland

Abstract

In recent years, there has been increasing pressure on companies to include Environmental, Social, and Governance (ESG) criteria in their reporting alongside financial aspects. Also, the Global Reporting Initiative (GRI) standards, widely adopted globally, have promoted transparent reporting.

Simultaneously, the European Commission, as part of the European Green Deal, committed to reviewing non-financial reporting regulations. This resulted in the development of the European Sustainability Reporting Standards (ESRS) to improve the quality and comparability of non-financial disclosures in line with the Corporate Sustainability Reporting Directive (CSRD).

This study aims to analyze the scope of environmental non-financial disclosures in energy sector companies. The research includes a review of sustainability reports published in 2023 by several companies listed on the Warsaw Stock Exchange, which will be required to report based on ESRS in the coming years.

While most companies follow GRI guidelines, only one fully complies with ESRS, indicating many are still preparing for CSRD implementation. The findings of the study show that despite the use of GRI guidelines, the level of disclosures varies significantly among companies. The majority of published indicators relate to environmental categories, while economic and social areas remain challenging. The number of GRI-compliant indicators used ranges between 59 and 92.

The study highlights the need for further actions by companies to meet future reporting obligations and the necessity to increase transparency and data availability, which is crucial for creating long-term value for all stakeholders.

Keywords: ESG, ESRS, GRI, sustainability reporting, energy sector

* jcader@meeri.pl

Personality traits for implementing sustainable procurement

Owais Khan[1*] | Andreas Hinterhuber[1]

[1]Venice School of Management, Ca' Foscari University of Venice, Italy

Abstract

Climate change is a significant threat to our world, but companies can help mitigate its effects by adopting comprehensive sustainability initiatives such as reducing emissions and promoting resource efficiency. In this context, procurement professionals play a vital role within the broader corporate structure by driving sustainability throughout supply chains. However, the role or influence of these professionals, particularly from psychological and behavioural perspectives, is not yet well-explored. We assessed how the personality traits of these professionals contribute to sustainable procurement through their willingness to pay (WTP). We tested the hypotheses drawn from the Five-Factor Model with a sample of 465 procurement professionals based in the EU through partial least squares structural equation modelling. We found that agreeableness and openness are significantly associated with WTP, which underscores the influence of these traits in actualizing sustainable procurement. Hence, companies should actively attract and cultivate individuals who exhibit high levels of agreeableness and openness, with an emphasis on fostering a sense of community and innovation, respectively. We advance our understanding of how individual-managerial factors contribute to fostering sustainability within companies.

Keywords: personality traits, PLS-SEM, supply chain management, sustainability, willingness to pay

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* owais.khan@unive.it

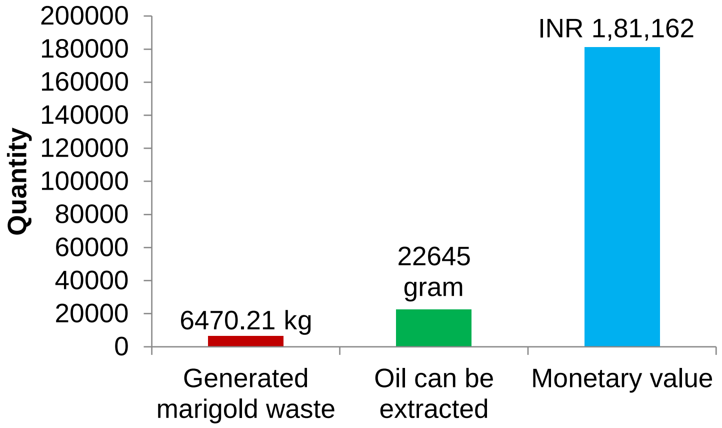
Extraction of essential oil from marigold Tagetes erecta L., an economical and eco-friendly approach to floral waste management with cost analysis

Praveen Soni[1] | Anish P. Jacob[2*] | Ishita Pant[2] | Avinash Pali[2]

[1]IIT-Bombay, India
[2]MITS Gwalior, India

Abstract

According to the current scenario in India, waste flowers generated from temples are being directly disposed in nearby water bodies or dumped at one place for decomposition. Of all floral waste, marigold flowers are commonly used for offering and decorating temples. These practices of floral waste disposal pose a remarkable challenge to existing waste management. There have been many studies regarding the disposal of floral waste; however instead of direct disposal, there is still vast scope for using these waste flowers. The major use of this waste marigold can be carried out in the form of essential oil extraction. Waste flowers from the temples are collected and then, using a hydro- distillation approach, oil is extracted. The yield of oil obtained from these waste marigolds was compared with that of fresh marigold flowers. Cost analysis conducted to check whether the approach is cost effective. On a normal day, 22.645 kg of essential oil per day can be extracted within a Hyderabad city, India. The yield of oil obtained is 0.349% per kg of waste mixed marigold while the yield of fresh marigold was 0.35% for yellow and 0.43% for orange. The percentage savings obtained from presented study for Hyderabad city is 72.53 which in itself is a big number. The % yield variation with time analysis will be productive in essential oil extraction. With the help of this study one can clarify the applicability of similar approach to their location. Production of oil from marigold waste is economical and sustainable. This essential oil has various uses such as mosquito repellents. The major concern is to make the whole process environmentally friendly. In addition to the other direct benefits, it provides new employment opportunities to the people, which will be a better asset to India's GDP growth.



Keywords: hydrodistillation, anti-inflammatory, monetary savings, vapourizer repellent

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* anishjaco@mitsgwalior.in

Anti-corrosive properties of sustainable biomass waste-based inhibitors for Cu-Zn alloys in a simulated saltwater environment: characterization, electrochemical analysis, SEM/EDX characterisation, DFT calculations and MD simulations

Fatima Janoub[1*] | Aanas Chraka[1] | Saloua Tazi[1] | Brahim Arhoun[2] | Dounia Bouchta[1] | K. Draoui[1] | Faiza Chaouket[1] | Nordin Ben Seddik[1] | H.Oulad Idriss[1] | Aya Ghajjou[3] | Ihssane Raissouni[1]

[1]Laboratory of Materials Engineering and Sustainable Energy (IMED-LAB), Faculty of Science, Abdelmalek Essaadi University, Morocco.
[2]Laboratory of Water, Studies and Environmental Analysis, Faculty of Sciences, Abdelmalek Essaadi University, Morocco
[3]Applied Organic Chemistry Laboratory, Department of Chemistry, Faculty of Sciences of Tetouan, University Abdelmalek Essaadi, Morocco

Abstract

In the realm of green chemistry, biomass waste has recently garnered interest as a sustainable corrosion inhibitor due to its biodegradability, eco-friendliness, low cost, and wide availability. This study aimed to evaluate the protective effect of expired spent coffee grounds (SCGW) extract on Cu–Zn alloy in a 3% NaCl solution through chemical characterization using high-performance liquid chromatography (HPLC), electrochemical analysis via potentiodynamic polarization (PDP) and electrochemical impedance spectroscopy (EIS), surface morphology analysis through scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX), and computational techniques such as density functional theory (DFT) and molecular dynamics (MD) simulations. The SCGW extract (EX-SW) was mostly composed of cafeine (31.2%) and cafeic acid (31.2%), with cyanidin-3-glucoside (20.74%) also present. The EIS analysis revealed 95 % inhibition efficiency of the EX-SW, at an inhibitor concentration of 1 g/L. PDP tests showed that this extract acted as a cathodic inhibitor. SEM/EDX analysis revealed the formation of an inhibitor film on the Cu–Zn alloy surface, effectively preventing its deterioration. These findings confirm that the adsorbed layer of EX-SW molecules inhibited the dissolution of the Cu–Zn alloy. Additionally, computational investigations using MD simulations and DFT approaches demonstrated considerable adsorption of EX-SW compounds on copper and Zinc surfaces (Cu (111)/Zn (110)). The combination of theoretical and experimental methodologies demonstrates the potential of EX-SW compounds as long-term and efficient corrosion inhibitors, furthering our knowledge of the corrosion inhibition mechanism. This extensive study sets the path for future research into optimising these extracts for actual corrosion resistance applications.

Keywords: biomass wastes, ground coffee waste, corrosion inhibitors, brass, SEM/EDX, HPLC

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* f.janoub@uae.ac.ma

Biochemical methane potential of palm leaflet waste and fruit and vegetable waste. kinetic modeling and influence of the mixture ratio

Brahim Arhoun[1,2*] | Ana Belén Muñoz Cabello[1] | María del Mar Cerrillo-Gonzalez[1] | Souad Benaisa[2] | Carlos Vereda-Alonso[1] | Cesar Gomez-Lahoz[1]

[1]Chemical Engineering Department, Faculty of Sciences, University of Malaga, Spain
[2]Laboratory of, Water, Studies and Environmental Analysis, Faculty of Sciences, Abdelmalek Essaadi University, Morocco

Abstract

Palms in urban environments provide numerous ecosystem benefits and contribute to residents' physical and mental well-being. However, their maintenance generates substantial amounts of waste. This study explores the recovery of palm leaflet waste (PLW) within the bio-circular-green economy framework by co-digestion with fruit and vegetable waste (FVW). The biochemical methane potential (BMP) test, a widely used technique for assessing methane generation potential from substrate mixtures, was employed to optimize waste management possibilities in a centralized facility

In this study, a series of batch assays conducted under mesophilic conditions for 30 days, palm leaflet waste (PLW) was digested with FVW in varying proportions (100:0, 80:20, 60:40, 20:80, and 0:100, on a total solids basis) to identify co-substrate synergism. The first-order Monod type kinetic model and modified Gompertz kinetic model were employed to assess the kinetic behaviors of the codigestion.

The experimental BMP results revealed that FVW exhibited a much higher methane generation potential (453.32 $NmlCH_4\ g_{VS}^{-1}$) than PLW (165 $NmlCH_4\ g_{VS}^{-1}$). Notably, no synergistic ratio above unity was observed. The results demonstrated that the first-order kinetic model fit well with the experimental data, exhibiting the highest R^2 values (0.988–0.996) and the lowest RMSE values (3.24 - 11.50).

In conclusion, the recovery of palm leaflet waste (PLW) through anaerobic co-digestion with food vegetable waste (FVW) is more attractive due to its numerous economic, social, and environmental benefits.

Keywords: palm leaflet waste, fruit and vegetable waste, biochemical methane potential, kinetic models, mixture ratio

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* arhoun.b@uma.es

Effect of citric acid on concrete

Olga Szlachetka[1*] | Joanna Witkowska-Dobrev[1] | Marek Dohojda[1]

[1]Institute of Civil Engineering, Warsaw University of Life Sciences - SGGW, Poland

Abstract

The rapid growth of agro-food industries has led to an increase in the production of wastewater, which, if not neutralized, becomes a significant source of environmental pollution and also a cause of concrete degradation.

The purpose of the study was to discuss a method for preliminary evaluation of the durability of concrete structures exposed to citric acid. The types and degree of damage were analyzed, and the usefulness of surface morphology studies in this evaluation was demonstrated. The experiment focused on exposing samples of ordinary concrete of C20/25 and C45/55 class to citric acid.

The samples were immersed in citric acid for 365 days. The 4% acid concentration used was adopted according to the so-called accelerated method. This allows faster evaluation of the effects of acid corrosion of concrete under laboratory conditions. Subsequently, the compressive strength of the specimens was determined, and their surface morphology was evaluated by measuring roughness parameters.

It was shown that the compressive strength of C45/55 and C20/25 class concrete samples stored in citric acid 4% was 47% and 52%, respectively lower when compared to the reference samples. The decrease in strength for samples with higher compressive strength class was not observed. Analysis of surface roughness confirmed the destruction mechanisms occurring due to the reaction of citric acid with the cement matrix due to the formation of solid complexes with calcium (Ca), aluminum (Al), and iron (Fe) ions. A large amount of salt also precipitated on the surface and detached from the samples.

Keywords: concrete, acid corrosion, environmental protection, microscopic analysis

* olga_szlachetka@sggw.edu.pl

Effect of lactic acid on concrete

Joanna Witkowska-Dobrev[1*] | Olga Szlachetka[1] | Filip Chyliński[2] | Barbara Francke[1] | Magdalena Frąk[3]

[1]Institute of Civil Engineering, Warsaw University of Life Sciences - SGGW, Poland
[2]Building Research Institute, Poland
[3]Department of Environmental Improvement, Warsaw University of Life Sciences - SGGW, Poland

Abstract

Lactic acid is produced by the lactic fermentation of sugar in milk, cheese, and sauerkraut, so it is a common ingredient in pickling juices. This and other organic acids pose a threat to the environment. They must be safely stored before treatment, as, for example, when they come into contact with concrete elements, they cause their degradation, shortening the structure's life.

This study tested the resistance of concrete of compressive strength classes C20/25 and C45/55 to organic acids. The samples were immersed in lactic acid for 365 days. The 4% acid concentration used was adopted according to the so-called accelerated method. This allows faster evaluation of the effects of acid corrosion of concrete under laboratory conditions. Subsequently, the compressive strength of the samples was determined, and their surface morphology was evaluated by measuring roughness parameters.

It was shown that the compressive strength of specimens with strength class C45/55 and C20/25 seasoned in lactic acid 4% decreased by 25% and 36%, respectively, relative to the reference specimens. As the concrete class decreased, there was a decrease in the resistance of the concrete to lactic acid. Analysis of surface roughness also confirmed the destruction mechanisms occurring due to the reaction of lactic acid with Portlandite, the C-S-H phase, and the leaching of calcium ions.

Increasing the strength class of concrete used in agro-food infrastructure can be a simple and effective way to increase their durability and extend their service life, with tangible economic benefits for the farm and environmental benefits for the environment.

Keywords: concrete, acid corrosion, environmental protection, microscopic analysis

* joanna_witkowska@sggw.edu.pl

Detection of hydroxy polycyclic aromatic hydrocarbons in stabilised sewage sludge using GC-MS/MS identification method

Zuzanna Prus[1*] | Karolina Cwynar[2] | Laura Frydel[2] | Jagoda Worek[2] | Katarzyna Styszko[2]

[1]AGH University of Krakow, Department of Heat Engineering and Environment Protection, Kraków, Poland
[2]AGH University of Krakow, Department of Fuel Technology, Kraków, Poland

Abstract

Hydroxy polycyclic aromatic hydrocarbons (OH-PAHs) are derivatives of polycyclic aromatic hydrocarbons (PAHs) and pose significant environmental and health risks. As metabolites of their parent compounds, OH-PAHs can be more reactive and toxic, raising concerns about their impact on the environment and human health. Exposure of humans and the environment to OH-PAHs can lead to significant health and environmental risks due to their potential toxicity, mutagenicity and endocrine disrupting properties. These emerging organic compounds are increasingly being detected in environmental samples such as sewage sludge. Sewage sludge, as a by-product of wastewater treatment processes, can accumulate many contaminants present in treated wastewater, including OH-PAHs. The analysis of OH-PAHs is challenging due to their typically low concentrations in environmental samples, the complex nature of matrices such as sewage sludge, and the lack of standardised detection methods. This study focuses on the separation, identification and quantification of common OH-PAHs from stabilised sewage sludge using the QuEChERS extraction method and GC-MS/MS analysis. The results show the presence and concentration levels of OH-PAHs and provide insight into the environmental impact of sewage sludge disposal according to circular economy principles. This study highlights the importance of monitoring OH-PAHs to support toxic-free wastewater management.

Keywords: Hydroxy polycyclic aromatic hydrocarbons, sewage sludge, environmental contaminants, circular economy, toxic-free wastewater management

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* zprus@agh.edu.pl

Green MXENs as potential titanium implant coatings

Edyta Kosińska[1*] | Julia Sadlik[1] | Agnieszka Tomala[1]

[1]Cracow University of Technology, Faculty of Materials Engineering and Physics Department of Materials Engineering, Poland

Abstract

An aging population is a growing phenomenon around the world. The emerging problem is contributing to a greater demand for bone implants. Coating titanium implants with MXENs can help increase the functionality of biomaterials, and the introduction of green MXENs will positively impact the environment.

MXENs are relatively newly discovered 2D nanostructures with a patch structure. MXenes combine the characteristics of light and transition metals and are characterized by the notation 'Mn+1Xn', which reflects their stoichiometric arrangement, where: M is a light transition metal, X is carbon and/or nitrogen, while n = 1, 2 or 3. MXenes have excellent tribological properties, which makes them ideal as lubricants or composite components. Those that contain elements such as Ti or Nb introduce biocompatibility, bioactivity and biodegradability. It should be noted that Mxenes are used in many other fields, such as the environment, in addition to nanomedicine. They can be used, for example, as absorbers of various environmental pollutants, including heavy metal ions. MXenes introduce properties that could have a huge impact on the development of many fields, including biomaterials, but their production involves many aspects far from ecology. For this reason, green MXens are being developed, which will be produced with strategic syntheses that are more environmentally sustainable and use environmentally safe substances.

The purpose of this article is to review a greener way of synthesizing MXenes - green MXenes, which will have less impact on the environment.

Keywords: green MXens, biomaterials, titanium alloy

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* edyta.kosinska@doktorant.pk.edu.pl

Efficiency and reliability coefficients for the removal 1 of pollutants from municipal wastewater at a rural area

Justyna Koc-Jurczyk[1*] | Łukasz Jurczyk[1] | Agnieszka Podolak[1] | Aleksandra Kuźniak[1]

[1]Institute of Agricultural Sciences, Environment Protection and Management, University of Rzeszow, Poland

Abstract

Rural wastewater treatment is a critical element of sustainable development within the Green Deal. In this study used Weibull reliability theory to analyse the technological reliability of the operation of rural municipal wastewater treatment plants. Furthermore, a reliability coefficient (RC) was determined for the pollutant parameters analysed (BOD_5, COD, TSS, TN and TP). Full-scale technical tests were carried out in a facility with a mean throughput of 450 m^3/d. Weibull analysis of test results for the reliability of pollutant removal up to maximum effluent discharge levels yielded the following results. BOD_5, COD, and TSS - 100%, TN - 10%, and TP - 3%. These results were confirmed by reliability coefficient analysis, which was 0.2 for BOD_5 and TSS, 0.4 for COD, 1.8 for TN, and 4.9 for TP. This shows that the concentrations of pollutants in the raw wastewater for BOD_5, COD and TSS did not exceed the normative values throughout the analysis period and that the system was reliable in removing these pollutants. However, it did not provide effective removal of nutrients, with TN and TP concentrations of 36 and 11 days a year, respectively, below or equal to the regulatory values. The large-scale use of this type of treatment plant can contribute to eutrophication of the receiving water bodies.

Keywords: municipal wastewater treatment plant, Weibull technological reliability, reliability coefficient, rural area

* jkoc@ur.edu.pl

Powder metallurgy as a waste-free form of composite consolidation

Julia Sadlik[1*] | Edyta Kosińska[1] | Agnieszka Tomala[1]

[1]Cracow University of Technology, Faculty of Materials Engineering and Physics Department of Materials Engineering, Poland

Abstract

Powder metallurgy (PM) has emerged as an ecological technique for the consolidation of composite materials, particularly in the fabrication of titanium alloy Ti6Al4V (Ti64) combined with hydroxyapatite (HAp). This method stands out for its ability to minimize waste throughout the production process, aligning with the principles of sustainability and resource efficiency. Ti64 is widely recognized for its excellent mechanical properties and biocompatibility, making it a preferred material for biomedical applications, particularly in orthopedic implants. Hydroxyapatite, a naturally occurring mineral form of calcium apatite, is known for its osteoconductive properties, enhancing bone integration and regeneration. Moreover, the waste-free aspect of PM is underscored by its ability to recycle excess powder and minimize material loss during processing. This not only reduces production costs but also mitigates environmental impact.

The PM process facilitates the distribution of HAp within the Ti64 matrix, enabling the development of composite materials that leverage the strengths of both constituents. This study investigates the fabrication of Ti64/HAp composites through PM techniques, such as cold isostatic pressing and sintering, highlighting the significance of process parameters, including temperature, and sintering time. The resulting composites exhibit good mechanical properties while retaining the bioactive characteristics of HAp.

Keywords: powder metallurgy, titanium, composites

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* julia.sadlik@doktorant.pk.edu.pl

Elimination of arsenic in drinking water

Ana Belén Muñoz Cabello[1*]

[1]University of Malaga, 29071 Málaga, Spain

Abstract

The presence of arsenic in groundwater in high concentrations is considered a global problem. Activities such as industry, mining and agriculture contribute significant amounts of this contaminant to the environment, which can contaminate aquifers through geothermal, geohydrological and biogeochemical pathways.

The World Health Organization has established 10 μg L^{-1} of As as the maximum permissible limit for drinking water. However, around 50 million people in the world are exposed to concentrations of As in drinking water exceeding 50 μg L^{-1}. This type of contamination has been reported in several countries around the world as Bangladesh, India, Taiwan, China, Hungary, Romania, Mexico, Chile, Argentina, the United States, Thailand, Nepal and Vietnam.

Different techniques can be used to remove arsenic from water, including adsorption. The most commonly used adsorbents to remove arsenic are activated carbon, activated alumina, calcium and magnesium, and mainly those containing iron due to the high affinity of this element for arsenic.

This paper presents the results obtained in the adsorption of As using an adsorbent obtained from a ferric sludge generated in water treatment plant that use $FeCl_3$ as a flocculant. This adsorbent incorporates iron oxide nanoparticles between clay layers that give rise to a porous material of the pillared layered structures (PLS) type.

Two types of adsorption tests were performed: kinetic and isothermal. Using kinetic models, the adsorption rate of the two arsenic species was calculated and the maximum adsorption capacity of the ferric sludge was estimated using isotherms.

Keywords: please provide up to five keywords, Arsenic, adsorbent, ferric sludge

* bmunozcabello@uma.es

Analysis of land resources and climate change effects

Karim Ennouri[1*]

[1] Digital Research Center of Sfax, Sfax, Tunisia

Abstract

Satellites are now necessary for an increasing number of mapping and monitoring applications due to the dramatic increase in the use of remote sensing technology. Polar-orbiting satellites' capacity to periodically return to the same locations allows for advanced monitoring. Satellite images thus make it easier to identify, research, and continuously evaluate surface processes all over the world, which is vital for fields dealing with risk assessment and climate change. Recent years have seen a notable increase in interest in the use of satellite images of the same area taken at various times to identify changes. This heightened interest is due to a multitude of factors. There are currently many operational satellites, each equipped with a range of sensor systems, including optical and synthetic aperture radars, providing three distinct resolutions: spectral, geometric, and radiometric. Global climate models that consider various emission trajectories and simulation scenarios also forecast future climate patterns. Smaller spatial scale forecasts are achieved by means of statistical and dynamic downscaling. Gaining a better understanding of anticipated local climate conditions can be highly beneficial for researchers and decision makers. As remote sensing techniques improve in their ability to detect changes, our understanding of surface dynamics and the possible effects of climate change at various scales will undoubtedly grow.

Keywords: Remote sensing, change detection, satellite

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* karimennouri1@gmail.com

A sustainable chitosan-based composite material for chromium removal. Kinetic study and adsorption mechanism

Imene Slamani[1*] | Zohra Bengharez[1] | Ahmed Amine Bendaoudi[1]

[1]Laboratory of Advanced Materials and Physico-Chemistry for Environment and Health, Djillali Liabes University, Algeria

Abstract

The contamination of water sources by heavy metals is a significant global environmental issue, threatening both human health and ecosystems. In line with the UN Sustainable Development Goals, developing ecological and cost-effective methods for removing these pollutants is essential for protecting the environment and ensuring the availability of clean water for future generations.

In this context, an original biomaterial based on chitosan and natural phosphate from the deposit of Djebel Onk (34°42′ N, 8°00′ E) Tebessa (35° 24′ 19″ N, 8° 06′ 59″ E), Algeria was prepared, deeply characterized and investigated for hexavalent chromium removal (Cr(VI)). The characterization results showed the successful production of the composite. The Cr(VI) adsorption process was rapid and exhibited a strong fit to the pseudo-second-order kinetic model with a coefficient of determination equal to 0.999.

The maximal adsorption capacity of the synthesized material was evaluated at 150 mg / g, significantly higher than that of pure chitosan. This enhancement could be explained by the incorporation of phosphates , which increase the adsorptive surface area and provide more active sites for Cr(VI) adsorption. The adsorption mechanism primarily involved electrostatic interactions and hydrogen bonding.

The overall results demonstrated the high efficiency of the chitosan-natural phosphate composite in removing Cr(VI), highlighting its potential as a promising material for water treatment applications.

Keywords: chitosan, natural phosphate, hexavalent chromium, adsorption, mechanism

* imene.slamani@yahoo.fr

Valorization of leather and textile waste using thermal conversion methods in anaerobic conditions

Maciej Życki[1*] | Monika Łożyńska[1] | Anna Kowalik-Klimczak[1] | Paweł Radulski[1]

[1] Łukasiewicz Research Network–Institute for Sustainable Technology, Poland

Abstract

In 2020, global textile fiber production reached 109 million tons, nearly doubling compared to 2000. The average European buys 26 kg of clothing annually, of which 11 kg is discarded, and only 1% is recycled. The most common methods for managing textile and leather waste are export outside the EU, incineration, and landfilling (87%). This paper proposes an innovative approach to processing textile (cotton) and leather (chrome-tanned) waste through pyrolysis - a thermal conversion process in an oxygen-free environment. The research was conducted at 360°C in a CO_2 atmosphere for 30 minutes, with a temperature rise rate of 5°C/min. Physicochemical analyses of the samples before and after the process were performed, including moisture content, elemental composition (XRF), C,H,N,S content, and calorific value. An increase in carbon content was observed in the pyrolyzed samples (from 48.26% to 52.20% for leather and from 43.73% to 61.30% for cotton), as well as an increase in calorific value by 6.847 MJ/g for cotton and 4.110 MJ/g for leather. The results indicate that products with higher energy potential than the raw materials can be obtained even at relatively low process temperatures. Future research will focus on analyzing the energy potential of the produced syngas and conducting structural analysis of the solid fraction to identify other potential applications, such as graphite replacement.

Keywords: leather-textile wastes, thermal conversion, calorific value, pyrolysis

Acknowledgments: This work was carried out as part of the project “Recycling processes and dismounting of general footwear components, including electronic modules, with ways of reusing components and materials, based on a modular construction” (Acronym: ReProcess_Shoe) co-financed by the National Centre for Research and Development (NCBR) under the Cornet Initiative (Agreement No. CORNET/33/141/ReProcessShoe/2023).

* maciej.zycki@itee.lukasiewicz.gov.pl

Optimizing leaching of $LiCoO_2$ Using Fe^{2+} as a reducing agent: kinetic and diffusion modelling

Maria del Mar Cerrillo-Gonzalez[1] | Gabriel Castello-Ortega[1] | Juan Manuel Paz-Garcia[1] | Jose Miguel Rodriguez-Maroto[1] | Maria Villen-Guzman[1*]

[1]University of Málaga, Spain

Abstract

Lithium-ion batteries are crucial for electronic devices and electric vehicles, and their integration with the electrical grid promotes energy sustainability. However, their increasing use poses environmental problems, such as resource depletion and waste generation. In response, the European Union has implemented strict regulations to ensure a sustainable supply and manage waste, highlighting the importance of recycling key materials. The development of efficient recycling methods is crucial from both an economic and environmental perspective.

The hydrometallurgical recycling method for batteries stands out due to its high efficiency in terms of recovery and purity, though it is costly and generates waste. Recent research focuses on optimizing the leaching of metals from cathode materials. This work studies the leaching of $LiCoO_2$ using HCl and Fe^{2+} as a reducing agent. A model has been formulated to describe the leaching process through competitive reactions, under the specified conditions and to predict the shift from chemical kinetics as the rate-controlling step, to the diffusion process.

The results demonstrated that Fe^{2+} is an effective reducing agent for Co^{3+} in the acidic leaching process of $LiCoO_2$ with HCl, achieving high extraction rates for Li and Co (93.56% and 93.18%, respectively) with a 2M HCl and 1M Fe^{2+} solution. The mathematical model was developed to predict the leaching behaviour, proposing a relationship to calculate the diffusion constant based on the solution concentration. Additionally, the use of Fe^{2+} in the leaching of real battery waste was explored, suggesting a sequential metal extraction process, and areas for future studies were identified.

Keywords: lithium-ion battery, recycling, hydrometallurgy, leaching, diffusion

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* mvillen@uma.es

Implementation of the "Green Deal" through the complex use of dispersed iron-graphite waste of metallurgy

Leonid Dan[1*] | Trofimova Larysa[1]

[1]Priazovsky State Technical University, Ukraine

Abstract

Enterprises of the metallurgical industry of Ukraine and several other countries remain one of the main sources of waste, occupying significant areas for dumps and polluting air and water basins. Dispersed iron-graphite wastes (DIGW) are generated at all stages of pig iron processing. Their formation is connected with decreased carbon solubility at lower temperatures and other processes occurring in liquid pig iron. The problem of using accumulated waste remains unsolved, despite the various measures taken.

In the industrial practice of Ukraine DIGW is used in the production of battery graphite, graphite lubricants, as additives in agglomerate, in foundries - to produce non-stick paints.

In our opinion, this approach only partially reduces the environmental impact by using either the graphite-containing or iron-containing component of the waste. Currently, existing methods of iron-graphite waste processing do not cover all possible applications of products for which they can be raw materials.

For more than 40 years, scientists of the Priazovsky State Technical University have been conducting research on the morphology, properties of DIGW, and ways of their utilization. Having in its composition graphite, metallic iron, and its oxides, DIGW after their physical and chemical processing turned out to be a promising raw material for obtaining new materials with a valuable combination of electrophysical (radio shielding and radio-absorbing) properties. Based on the results of research, a technological scheme of the complex processing of these wastes was developed, which, when implemented, ensures their full use and minimization of harmful impact on the environment.

Keywords: dispersed iron-graphite waste, complex utilization

Acknowledgments: Prof. Vladimir Maslov.

* danleonid.alex@gmail.com

Second life for industrial waste - preliminary ecotoxicological studies

Agnieszka Podolak[1*] | Justyna Koc-Jurczyk[1] | Łukasz Jurczyk[1] | Zuzanna Sylwestrzak[2] | Waldemar Prokop[3]

[1] Institute of Agricultural Sciences, Environment Protection and Management, College of Natural Sciences, University of Rzeszow, Poland
[2] Faculty of Oceanography and Geography, University of Gdańsk, Poland
[3] C4IN, Poland

Abstract

The circular economy is about reusing existing materials for as long as possible, thereby reducing negative impacts on the environment. Due to the importance of the issue, the aim of the research was to determine the potential toxicity of a composite prototype produced from industrial waste that could be used in the production of some commercial products.

Water extracts in three concentrations: 50g/1000ml (A), 100g/1000ml (B) and 150g/1000ml (C) were tested using test organisms representing all trophic levels. Acute toxicity tests were carried out on the diatom *Skeletonema costatum* (ISO10253) and of the Emergence and Seedling Growth Test on the *Avena Sativa L.* (OECD). *Dendrobaena veneta* were tested according to the Earthworm, Acute Toxicity Tests (OECD) and luminescent bacteria *Aliivibrio fischeri* were tested using BioLight Toxy® (Microtox®) (ISO:9001, ISO13485:2016).

For *S. costatum* after 48 hours of exposure to concentration A, an 82% inhibition of population growth was observed, while it was 97% in concentration B. The most toxic effect was caused by concentration C, because no living cells were observed after 72 hours of testing. For *A. Sativa L*., no significant differences in seedling germination were found between subsequent concentrations and the control, similarly to *D. veneta*, where no animal mortality was observed. The toxic effect of the tested extracts was visible in the form of a significant decrease in the bioluminescence of *A. fischeri*. The studies showed a diverse response of individual species to the tested extracts, therefore the studies will be extended to include chronic toxicity studies.

Keywords: sustainable development, waste management, recycling, biotests, acute toxicity

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* apodolak@ur.edu.pl

Treatment of explosive wastewater in membrane processes

Gabriela Kamińska[1] | Grzegorz Michalski[2*] | Ewa Puszczało[1] | Anna Marszałek[1]

[1]Silesian University of Technology, Institute of Water and Wastewater Engineering, Poland
[2]Nitroerg S.A., Poland

Abstract

The aim of this study was to develop effective strategies for treating explosive wastewater that contains high concentrations of lead, sodium, and nitrate. To achieve this, the performance of nanofiltration and reverse osmosis (RO) under various configurations were studied. The filtration processes were conducted in cross-flow mode using a plate-frame membrane module (SEPA-CF) and different polymer membranes. The transmembrane pressure varied from 2 to 4 MPa. Results demonstrated that a single-stage reverse osmosis process achieved a reduction in the concentrations of lead, sodium, and nitrate, with an average removal degree of approximately 50%. In contrast, the two-stage reverse osmosis configuration yielded even more impressive results, achieving a pollutant removal rate of around 85%. This substantial reduction in contaminants indicates the potential of reverse osmosis as an effective treatment option for explosive wastewater. Additionally, we conducted an economic analysis to evaluate the feasibility and cost-effectiveness of the proposed treatment strategies. This study highlights the importance of advanced membrane technologies in addressing the challenges associated with treating contaminated wastewater, paving the way for sustainable environmental practices in managing hazardous waste streams.

Keywords: explosive wastewater, nanofiltration, reverse osmosis

* g.michalski@nitroerg.pl

Assessment of heavy metal mobility and environmental risks of sewage sludge application in agriculture

Agata Janaszek[1*] | Małgorzata Widłak[1] | Wiktoria Sidło[1] | Robert Kowalik[1]

[1]Kielce University of Technology, Faculty of Environmental Engineering, Geodesy and Renewable Energy, Poland

Abstract

This study presents a comprehensive analysis of the potential use of sewage sludge in agriculture, focusing on heavy metal contamination and their mobility in sludge-soil mixtures. An innovative approach using BCR sequential extraction provides insights into the environmental impacts of heavy metals. Samples of sludge and soil were collected from three different soil types, allowing for the examination of heavy metal mobility under varying environmental conditions.

The study also assesses the environmental risks associated with the agricultural application of sewage sludge through various contamination risk indices. The findings emphasize that understanding the forms and mobility of heavy metals in sludge is crucial for its safe use in agriculture.

Additionally, the potential impact of sewage sludge on groundwater quality is a key concern. Heavy metals can migrate deeper into the soil, posing a risk to groundwater resources and leading to contamination. The results show that both soil composition and the properties of the sludge significantly affect the rate and extent of this migration. This highlights the importance of monitoring and regulating the use of sewage sludge in agriculture to minimize environmental risks.

Keywords: sewage sludge, heavy metals, ecological indicators, sludge-soil mixture, environmental pollution

* ajanaszek@tu.kielce.pl

Comparison of membrane filtration efficiency of wastewater emitted during vibroabrasive processing of metal and non-ferrous elements

Jolanta Janiszewska[1*] | Paulina Rajewska[1,2]

[1]Łukasiewicz Research Network – Institute for Sustainable Technologies, Poland
[2]Warsaw University of Technology, Faculty of Chemistry, Poland

Abstract

Closing industrial water cycles, through the treatment of industrial wastewater and the reuse of reclaimed water, is essential to reducing environmental pollution and protecting natural water resources, thus contributing to sustainable development efforts. Reusing reclaimed water in industrial processes not only saves valuable water resources, but also reduces operating costs by reducing the need for a constant supply of fresh water. It increases resource efficiency and supports circular economy goals, especially in water-scarce regions or in industries with high water demand.

In this study, the efficiency of treatment of real industrial wastewater (2 types) generated in a company representing the metal and non-ferrous metals industry was compared. The research focused on wastewater generated during vibro-abrasive machining of steel and Zn-Al alloy details. The tested wastewater was treated under the same process conditions, i.e. on a laboratory scale; using membrane ultrafiltration (transmembrane pressure 4 bar, polyacrylonitrile membrane), preceded by preliminary treatment using a bag filter (pore diameter 5 μm). A higher filtration flux was obtained for wastewater obtained after vibroabrasive machining of Zn-Al alloy details, while the retention coefficients for the tested physicochemical parameters were comparable for both types of wastewater, e.g. turbidity was reduced by 99.8% for the Zn-Al alloy and 92.2% for steel, respectively. In both cases, the entrepreneur considered that the obtained degree of wastewater purification was sufficient for its reuse in the vibroabrasive treatment process.

Keywords: membrane filtration, wastewater treatment, closed water circuit, metal and non-ferrous metals industry

* jolanta.janiszewska@itee.lukasiewicz.gov.pl

Exploring sustainable solvent alternatives for PET processing

Paulina Rajewska[1,2*] | Jolanta Janiszewska[1] | Magdalena Mazurek-Budzyńska[2] | Paweł Parzuchowski[2]

[1] Łukasiewicz Research Network – Institute for Sustainable Technologies, Polamd
[2] Warsaw University of Technology, Faculty of Chemistry, Poland

Abstract

Polyethylene terephthalate (PET) is an attractive material for membrane filtration due to its favorable mechanical, thermal, and chemical properties. PET, widely known for its use in the production of plastic bottles, offers numerous advantages that make it suitable for various filtration applications especially in the water and wastewater treatment industries, as well as in gas separation, biomedical, and other specialized fields. The main limitation of using PET for membrane production via wet phase inversion is its solubility in only a few toxic organic solvents. Chemical modification of the PET chain can improve its solubility in a broader range of solvents, potentially allowing for safer, non-toxic solvents.

The work aimed to change the properties of PET by chemically modifying its chain. Depolymerization of the PET was carried out by glycolysis. Different functional groups, such as pentanediol, neopentyl glycol, a mixture of neopentyl glycol and hexanediol, and oligocarbonates of various chain lengths were introduced into the polymer structure during the transesterification reaction (180ºC). Their solubility in 7 solvents: tetrahydrofuran (THF), butanol, acetone, CYRENE®, dimethylformamide (DMF), ethylene acetate, dimethylsulfoxide (DMSO), were determined. Polymers were dissolved for 15 min to 24 h at temperatures of 40°C and 60°C. Commercial PET is insoluble in any of the selected solvents. Most polymers are partially or completely soluble in THF, acetone, DMF, and ethyl acetate. Promising results have been obtained for CYRENE®, which is a non-toxic and biodegradable solvent.

Keywords: PET, chemical modification, solubility, solvents

* paulina.rajewska@itee.lukasiewicz.gov.pl

Comparison of structural properties of biochars in terms of their potential use in water and wastewater treatment

Wioletta Barszcz[1,2*] | Monika Łożyńska[1] | Paweł Radulski[1]

[1]Lukasiewicz Research Network – Institute for Sustainable Technologies, Bioeconomy and Ecoinnovation Centre, Poland
[2]Warsaw University of Technology, Faculty of Building Services, Hydro and Environmental Engineering, Poland

Abstract

Water resources in the world, both fresh and salt water, are decreasing every year. In Poland, these resources are the lowest in Europe, and what is more, they are very diverse, both in time and space. Current research on limiting the use of natural water resources and recovering water from sewage focuses, among others, on the use of biochar as a sorbent. The research work carried out mainly includes the use of biochar to remove pollutants from water and soil, i.e. cationic aromatic dyes, artificial fertilizers, antibiotics and drugs, polycyclic aromatic hydrocarbons or volatile organic compounds, organic and inorganic pollutants, such as heavy metals, which are not biodegradable, has also been confirmed. The experimental work carried out in this area concerns for example the removal of ions such as: Pb^{2+}, Cu^{2+}, Cr^{3+}, naftalene, ibuprofen, different deyes. Biochar is also being tested for adsorption of compounds present in industrial and municipal sewage, i.e. NO^{3-}, NH^{4+} or H_2S. In order for biochar from waste biomass to be used as an alternative to activated carbon in sorption processes, it must have appropriate structural properties, i.e. specific surface area, extensive microporous structure or the presence of acidic/basic functional groups. The aim of the research was to process two types of waste biomass in the form of apples and alfalfa into biochar by pyrolysis, and then determine the potential of using this type of biomass to produce sorption material for water and sewage treatment.

Keywords: biomass, biochar, pyrolysis, structural properties

* wioletta.barszcz@itee.lukasiewicz.gov.pl

Steel and titanium alloys with laser textures and MXene as sustainable biomaterials

Hakan Göçerler[1*] | Agnieszka Tomala[2] | Carsten Gachot[1]

[1]Vienna University of Technology, Institute for Engineering Design and Product Development, Poland
[2]Cracow University of Technology, Faculty of Materials Engineering and Physics, Poland

Abstract

Steel and titanium alloys has a significant environmental impact in the industrial sector. They are commonly used in aerospace and medical sectors. TiAl6V4 is particularly favoured due to their superior mechanical properties and exceptional corrosion resistance. However, TiAl6V4's high coefficient of friction (COF), low wear resistance, low plastic deformation resistance face challenges. Laser surface texturing (LST) has demonstrated significant improvements in tibological properties, and corrosion protection in a wide range of industrial applications. Furthermore the integration of MXene two-dimensional coatings enhancing the tribological properties of steel and titanium alloys. The results show that steel substrates, LST in combination with MXene coatings leads to friction reduction and enhancement in durability. The textures on the steel surfaces together with the MXene coatings provide constant lubrication, and minimizing wear. The observed wear reduction and COF values for steel samples underline the superior compatibility of MXenes with steel. The interaction between MXenes and titanium substrates is advantageous due to their shared titanium-based composition, enabling enhanced compatibility and performance.

Keywords: steel and titanium alloys, rribology, laser structuring, MXene coatings

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* hakan.gocerler@tuwien.ac.at

Water and wastewater management at a tanning plant

Maciej Dziadel[1*] | Katarzyna Ignatowicz[1]

[1]Bialystok University of Technology, Faculty of Civil Engineering and Environmental Science, Poland

Abstract

One of many is the tanning industry, whose initial production is based entirely on wet operations. The cycle of tanning raw hides requires proper baths, with numerous rinses in between. Tanning in a wet workshop is water-intensive and results in a large volume of waste water. This is problematic where it is not possible to treat the wastewater on site, sub-treat it, or divert it to nearby treatment plants. In addition, wastewater after tanning processes should be separately collected due to the significant concentration of chromium, making it required to be treated in adapted facilities. Adequate water and wastewater management at the plant leads to a reduction in the amount of water used in processes and periprocess operations. These values can be related to a ton of raw hides treated, and the discrepancy between the data is significant. The amount of water in the wet stages up to and including the tanning process can range from 22 to 60m^3 of water per ton of raw hides. The differences are due to the different degree of development of the plants and the individual approach to the tanning processes, despite the relatively same production line. Changes in water management are required not only for environmental reasons, but also for economic reasons, reducing expenditures and all costs associated with water and wastewater management. The purpose of this research is to determine water management in a small tannery plant and determine the parameters of wastewater, generated in the course of processes.

Keywords: tannery, chrome, water and wastewater management

Acknowledgments: The research was carried out as part of research work no. WI/WB-IIŚ/10/2023 at the Bialystok University of Technology and financed from subsidy provided by the Ministry of Education and Science.

* maciej.dziadel@sd.pb.edu.pl

Electrodialytic desalination of wastewater effluent

Elena Olivares-Ligero[1,2*] | María Villén-Guzmán[2] | María J. Martínez-Salaverri[1] | Juan A. Báez-Durán[1] | José M. Rodríguez-Maroto[2] | María M. Cerrillo-González[2] | Juan M. Paz-García[2]

[1]SANDO AGUA, Spain
[2]Departament of Chemical Engineering, University of Malaga, Spain

Abstract

Electrodialytic desalination (EDD) is a promising technique for wastewater treatment that uses an electric field to drive the movement of ions through ion-exchange membranes, effectively removing salts and other impurities from water. This process has been successfully applied to produce water suitable for drinking and agricultural purposes. Compared to traditional methods like reverse osmosis, EDD offers significant advantages, including lower energy consumption and reduced chemical use, while avoiding the generation of highly concentrated brine.

EDD aims to reduce the conductivity of water in a single pass through the membrane system. Additionally, the design of a four-compartment cell prevents the formation of harmful chlorine gas at the anode, while generating valuable by-products such as HCl, $FeCl_3$, and NaOH-rich solutions along with the diluted water stream. The $FeCl_3$ and $FeCl_2$ produced during EDD can be recuperated and reused for flocculation-coagulation in primary and tertiary wastewater treatments, enhancing the sustainability and efficiency of the overall process.

By adjusting the inflow concentrations, applied electrical current, and flow rate through the channels, the desalination process can be optimized for energy efficiency. Experimental results demonstrate a significant reduction in NaCl concentration in the treated wastewater, as well as the generation of valuable HCl and NaOH solutions in the collecting compartments. Although the theoretical possibility of producing $FeCl_2$ and $FeCl_3$ has been demonstrated through a process model, experimental validation is still ongoing.

EDD presents a promising, energy-efficient alternative for desalinating wastewater and generating valuable by-products for further use in water treatment processes, contributing to both environmental sustainability and resource recovery.

Keywords: water reuse, water recycling, electrodialytic water treatment, ferric oxide generation

Acknowledgments: Authors acknowledge the financial support from Sando Agua, S.L.

* elenaolivaresligero@uma.es

Cleaner Production options to reduce greenhouse gases in the dairy industry: a case study in Lithuania

Kliopova Irina[1*] | Eimantas Pikturna[2]

[1]Institute of Environmental Engineering, Kaunas University of Technology, Lithuania
[2]Faculty of Mechanical Engineering and Design, Institute of Environmental Engineering, Kaunas University of Technology, Lithuania

Abstract

Taking into account the obligations of EU countries to reduce GHGs by at least 55% by 2030 compared to the 1990 level, Lithuania's National Energy and Climate Action Plan for 2021 –2030 envisages an increase in the efficiency of final energy consumption by over 26%, compared to 2020, the share of renewable energy sources (RES) in total final energy consumption should be at least 55%.

The object of this study is a milk processing plant with annually production – over 75 thousand tonnes of various dairy products (milk, butter and cheese, dry milk, etc.). By applying the principals of the Cleaner Production, an analysis of material and energy flows was carried out, main environmental problems were determined. It was identified that the impact on GWP, analysed in scopes 1 and 2, is 20.7 thousand tonnes CO2-eq per year or about 74 kg CO2-eq per tonnes of raw milk, including more than 48% due to electricity consumption and about 13% due to natural gas combustion.

The study proposes innovations related to increasing the energy efficiency by reducing heat energy losses during production and regenerating excess from ammonia refrigeration system. This would allow reducing natural gas consumption by 15%. It is also proposed to analyse the possibilities of switching to RES use: burning bio methane and buying electricity produced from RES. This would allow reducing the impact on climate change by more than 60%.

The main results of the problem identification and feasibility analysis of proposed alternatives will be presented at the conference.

Keywords: cleaner production, dairy industry, greenhouse gases (GHGs), renewable energy sources (RES).

* irina.kliopova@ktu.lt

Investigation of the kinetics of Acid Red 18 adsorption on the waste sorbent produced from post-coagulation sludge

Barbara Pieczykolan[1*]

[1]Silesian University of Technology, Faculty of Energy and Environmental Engineering, Department of Water and Wastewater Engineering, Poland

Abstract

The coagulation/flocculation is widely used in water and sewage treatment systems. It consists of introducing reagents, mainly aluminum or iron salts, into the treated medium. As a result of hydrolysis and chemical reactions, a floc-like suspension is produced. The flocs of this chemical suspension are characterized by the ability to retain contaminants contained in water or sewage on their surface. After the treatment process, this suspension is separated from the treated medium as sediment (so-called post-coagulationsludge) and disposed of. A post-coagulation sludge from a surface water treatment plant (aluminum sulphate was used in the coagulation/flocculation treatment system) was tested in the study. The sludge was dehydrated, dried, subjected to pyrolysis in the nitrogen atmosphere, and then activated with NaOH. The post-coagulation sludge prepared in this way was implemented as a waste sorbent in the batch adsorption process of the azo dye Acid Red 18 (AR18). Kinetics studies were conducted for two AR18 concentrations (100 and 700 mg/dm^3) and contact times ranging from 5 to 240 minutes. Based on the experimental results, nonlinear estimation (by minimizing the RMSE or chi-square error value) was conducted to determine the parameters of three adsorption kinetics models: pseudo-first-order, pseudo-second-order, and Elovich. The studies showed that pseudo-second-order and Elovich kinetics showed a better fit to the experimental results than pseudo-first-order kinetics. Both the pseudo-second-order and Elovich models are used to describe chemical adsorption kinetics.

Keywords: adsorption process, adsorption kinetics, post-coagulation sludge, dye

Acknowledgments: This work was financed by the Ministry of Science and Higher Education of Poland within statutory funds of the Silesian University of Technology, 2024.

* Barbara.Pieczykolan@polsl.pl

Adsorption of pollutants from rainwater: an efficient combination of fly ash and activated carbon

Anna Marszałek[1*] | Mariusz Dudziak[1] | Ewa Puszczało[2]

[1]Silesian University of Technology, Department of Water and Wastewater Engineering, Polamd
[2]Silesian University of Technology, Department of Air Protection, Poland

Abstract

The aim of the study was to evaluate and compare the adsorption efficiency of pollutants from rainwater using fly ash and fly ash combined with waste activated carbon. Both adsorbents were regenerated with a sodium hydroxide solution. The activated carbon was sourced from household used water jug filters, while the fly ash was obtained from the Nowe Jaworzno power plant. The research focused on assessing the adsorption capacity of heavy metals such as nickel, lead, and copper, as well as bisphenol A. The adsorption processes carried out allowed the adsorption processes to be determined, determining the effectiveness of pollutant removal, optimal adsorbent dosage, process duration, and the impact of the pH of the solution on adsorption efficiency. Additionally, adsorption isotherms and kinetics were studied. The adsorbent characterization was determined by measuring surface area and pore size distribution using nitrogen adsorption and desorption techniques at low temperatures, according to the Brunauer, Emmett, and Teller (BET) method. The addition of waste activated carbon to fly ash, combined with its activation using sodium hydroxide, was found to improve the simultaneous removal of heavy metals and organic compounds from rainwater. The highest adsorption efficiency was observed for lead, reaching 100%. Furthermore, the combination of these two waste materials increased the removal rate of bisphenol A from rainwater by 44%. In conclusion, the results obtained confirm that combining fly ash with activated carbon provides an efficient and environmentally friendly method for purifying heavy metals and micropollutants, with potential applications in environmental engineering and waste management.

Keywords: adsorption, rainwater, fly ash, activated carbon, heavy metals, bisphenol A

* anna.marszalek@polsl.pl

Magnetic nanocomposite as adsorbent for the removal of heavy metals from wastewater

Ghitri Feriel[1*] | Belkhouche Nasreddine[1] | Oukebdane Khalil[1]

[1]Department of Chemistry - Faculty of Science, University of Abou Bekr Belkaid, Algeria

Abstract

The presence of heavy metals in the environment, as a result of industrial wastewater discharges, causes considerable damage to the natural balance of the aquatic ecosystem when they exceed certain concentrations. Nickel is one of the most toxic heavy metals, and has a harmful impact on aquatic fauna and flora, and therefore on human health. Therefore, several methods have been developed for wastewater decontamination including chemical precipitation, ion exchange, ultrafiltration, reverse osmosis, electrodialysis, and adsorption. The aim of our work is to use magnetic nanocomposite as adsorbents to remove nickel (II) from an aqueous medium. The magnetic nanocomposite was characterized by Thermogravimetric analysis (TGA), Fourier Transform-Infrared Spectroscopy (FT-IR), X-ray Diffraction (XRD), and zeta potential measurements. The adsorption process is studied by varying experimental parameters, including contact time, pH, adsorbent quantity, initial Ni(II) ion concentration and temperature. The results showed that 15 minutes were sufficient for a quantitative extraction at an optimum pH of 4.5. The adsorption kinetics was found to follow pseudo-second-order kinetic model. The Langmuir isotherm was well suited to adsorption equilibrium measurements compared to the Ftreundlich, Temkin and Dubinin Radushkevich isotherms. Thermodynamics study indicated that the adsorption of Nickel(II) onto magnetic nanocomposite was spontaneous at room temperature and exothermic.

All these results make magnetic nanocomposite a suitable adsorbent for practical application and can be exploited for the development of purification and extraction.

Keywords: wastewater treatment, heavy metals, adsorption, nanocomposite, nickel(II)

* ferielghitri13@gmail.com

Synthesis and characterization of activated carbon from natural waste: application on the sorption of emerging pollutants

Meriem Turkman[1*] | Bouthaine Badaoui[1] | Rayane Mezyane[1] | Nadji Moulai-Mostefa[1] | Omar Bouras[2]

[1]Materials and Environmental Laboratory, University of Medea, Algeria
[2]Water Environment and Sustainable Development Laboratory, University of Blida 1, Algeria

Abstract

Activated carbon (AC) is a crucial adsorbent for mitigating environmental pollution, owing to its extensive surface area, porous architecture, and selective pollutant absorption capability. In addition, the low cost and superior qualities of AC make it a material suitable for a wide range of adsorption applications. Carbonaceous natural raw materials provide a renewable, biodegradable supply for the synthesis of AC.

The main objective of this study was to prepare and characterize AC from waste that resulted from extracting essential oil (EO) of *Mentha Spicata L*. *MS*. EO was obtained by hydrodistillation using the Clevenger apparatus for 03 h. The residues that remained in the flask after the extraction of the *MS* EO were recovered and dried until a constant mass, ground and sieved for a particle size class (250 µm). The obtained material was dried at 105 °C for 24h and ground. The preparation of activated carbon was carried out by a carbonization process at 300 °C for 01 h, which was linked to a sulfuric acid activation process. The material then obtained was characterized in terms of physicochemical and structural properties. A kinetic experimental study of the adsorption of paracetamol on the produced AC in batch mode was realized.

FTIR analysis confirmed the presence of carboxyl and hydroxyl groups in the prepared AC. The kinetic study revealed that the pseudo-second-order model effectively fitted the kinetic profile of paracetamol sorption on AC, which was corroborated by the relatively reduced values of the normalized standard deviation.

Keywords: activated carbon, wastes, adsorption, paracetamol, kinetic modeling

* turkmedea@gmail.com

Environmentally friendly nanoparticles for phenol adsorption in olive mill wastewater

Imane Haydari[1,2*] | Naaila Ouazzani[1,2] | Laila Mandi[1,2] | Faissal Aziz[1,2]

[1]Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Morocco
[2]National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Morocco

Abstract

Verbena officinalis was utilized as an eco-friendly reducing agent in a novel synthesis of reduced graphene oxide (RGO). The RGO was cross-linked with sodium alginate (SA) to form SA-RGO beads, which were employed for treating wastewater from olive oil mills (OMWW). This wastewater contains high levels of toxic phenolic compounds that inhibit biological degradation. The freshly prepared SA-RGO beads were characterized using scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), X-ray diffractometry (XRD), BET surface analysis, and Fourier transform infrared spectroscopy (FTIR). Batch and fixed-bed column adsorption tests were conducted to assess the performance of SA-RGO beads. The kinetics, isotherm models, and adsorption thermodynamics indicated that the pseudo-second-order and Freundlich models best described the phenol adsorption process, which was endothermic. The Thomas and Yoon-Nelson models effectively described fixed-bed column adsorption. Optimal adsorption parameters were an adsorbent dose of 3.68 g L^{-1}, pH 4.0, an adsorption time of 135 minutes, and a temperature of 25°C. Reuse and regeneration experiments of the SA-RGO beads with 0.5 M hydrochloric acid (HCl) in fixed-bed reactors demonstrated a phenol adsorption capacity of 994 mg g^{-1} for an initial concentration of 4000 mg L^{-1}.

Keywords: adsorption, olive mill wastewater, phenol, SA-RGO beads, verbena officinalis

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* ih.haydari@gmail.com

Microextraction techniques for antibiotics

Joanna Antos[1*] | Marianna Piosik[1] | Dobrochna Ginter-Kramarczyk[1] | Izabela Kruszelnicka[1] | Joanna Zembrzuska[2]

[1]Department of Water Supply and Bioeconomy, Faculty of Environmental Engineering and Energy, Poznan University of Technology, Poland
[2]Faculty of Chemical Technology Institute of Chemistry and Technical Electrochemistry, Poland

Abstract

Pharmaceuticals commonly detected in aquatic environments include non-steroidal anti-inflammatory drugs, antibiotics, female sex hormones, antiepileptic drugs, and beta-blockers, typically at concentrations in the ng/L range. Despite these low levels, they can negatively impact aquatic organisms by disrupting vital life processes, and may pose risks to human health. The presence of antibiotics in water also contributes to bacterial resistance, diminishing the effectiveness of these drugs. While monitoring antibiotic use and resistance is crucial, there remains a lack of standardized methods and comprehensive long-term data across various animal species. In recent years, microextraction techniques, aligned with the principles of green analytical chemistry, have gained prominence. These methods minimize the use of solvents, reagents, and samples, promoting more sustainable and eco-friendly approaches to extraction and analysis. Additionally, innovative solvents such as natural deep eutectic solvents (NADES) and supramolecular solvents (SUPRAS) present new opportunities for enhancing microextraction. This stage is vital for achieving high analytical performance, as it ensures that samples are adequately prepared and that target compounds are efficiently extracted from complex matrices. A well-optimized microextraction process can also reduce matrix effects, which, if left unaddressed, may lead to inaccurate results. The integration of these advanced solvents with refined extraction techniques not only enhances precision and reliability but also promotes environmentally sustainable analytical practices.

The aim of this research is to provide an overview of the progress (2018-2024) that microextraction techniques have facilitated in monitoring antibiotic use in the food chain and environment.

Keywords: microextraction, antibiotics, environment, green analytical chemistry, antibiotic resistance

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* joanna.antos@doctorate.put.poznan.pl

Waste-to-resources: comparison of copper leaching from e-waste with deep eutectic solvent and solution of lactic acid

Lavanya Seetharaman[1*] | Magdalena Emmons-Burzynska[2] | Magdalena Regel-Rosocka[2]

[1]SASTRA Deemed to be University, School of Chemical and Biotechnology, Thanjavur, India,
[2]Poznan University of Technology, Institute of Chemical Technology and Engineering, Poland

Abstract

As the fastest-growing waste stream with significant environmental risks, electronic waste recycling presents a strong opportunity to recover valuable metals and reduce environmental impact effectively. This project investigates the leaching of copper and silver from waste printed circuit boards (PCBs) using a hydrometallurgical process with lactic acid (LA) and deep eutectic solvent (DES_LA), comprising choline chloride and lactic acid. X-ray diffraction confirmed the presence of Cu and Ag in the ground PCB fractions, while UV spectroscopy confirmed the presence of Cu in the liquid phase after leaching. Statistical analysis was performed to identify the optimal leaching conditions. Results showed that the maximum leaching efficiency obtained is for the smallest size fraction with 86.86% using DES_LA with H_2O_2 for Cu and 79.37% using LA for Ag. ANOVA analysis showed that the significant factors affecting copper leaching were particle size and H_2O_2 volume, while for silver, particle size and the quadratic interaction between parameters were significant. Pareto chart demonstrated the positive and negative impacts of various parameters. Model equation for the amount of metal ions leached was formulated using regression coefficients. Surface plot analysis using the model showed that the highest amount of Cu can be recovered from the largest size fraction with highest volume of H_2O_2 and the highest amount of Ag can be recovered from the smallest size fraction at 77°C with an addition of H_2O_2. The findings provide a solid foundation for optimising leaching processes and advancing sustainable practices in e-waste management.

Keywords: e-waste treatment, waste-to-resources, deep eutectic solvent, copper leaching, lactic acid

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* lavanya.gsraman@gmail.com

The impact of input parameters on the thermal power of shallow geothermal systems: a case study of Kielce, Poland

Izabela Trybek[1] | Edyta Nartowska[1*]

[1]Faculty of Environmental Engineering, Geodesy and Renewable Energy, Kielce University of Technology, Poland

Abstract

The main objective of this study was to evaluate the impact of input parameters on shallow geothermal systems. Specifically, it focused on the water temperature at a given depth and the temperature of the cooled water, as well as their effects on the calculated thermal power, using groundwater intakes in Kielce as a case study. The analysis included archival data from the Polish Geological Institute, from which 63 intakes were selected that met the requirements for use in heat pump installations. Fifty-four methods for parameter selection in thermal power calculations were considered, and an optimal calculation variant was proposed. The results showed significant differences in thermal power depending on the selected parameters, emphasizing their crucial role in system performance. Based on the optimal variant, the total thermal power of all considered intakes was determined to be 23,339.97 kW, with active intakes contributing 13,878.44 kW. Wells with a power exceeding 1,000 kW account for approximately 24% of all active intakes. While Kielce lacks sufficient potential for large-scale shallow geothermal energy as a primary heat source, groundwater intakes could still be utilized for small- to medium-scale heat pump installations. Future verification of intake efficiency and assessment of economic feasibility will be essential to fully explore their heating potential.

Keywords: database, hydrogeology, heat pump, low-temperature geothermal energy, groundwater

* enartowska@tu.kielce.pl

Sustainable energy management in utility infrastructure for enhancing efficiency and self-sufficiency

Katarzyna Pietrucha-Urbanik[1*] | Paweł Kut[2]

[1]Department of Water Supply and Sewerage Systems, Faculty of Civil Engineering, Environmental Engineering and Architecture, Rzeszow University of Technology, Poland
[2]Department of Heat Engineering and Air Conditioning, Faculty of Civil Engineering, Environmental Engineering and Architecture, Rzeszow University of Technology, Poland

Abstract

The research explores sustainable energy management within a selected water and sewage company. The primary objective of the study is to analyze the company's consumption of electricity and heat, along with its production of energy from renewable sources. The research covers various aspects, including the energy demand of the water supply and sewage treatment systems, annual energy production from photovoltaic installations, and biogas production at the sewage treatment plant.

The study also evaluates the efficiency of cogeneration processes and thermal energy generation from biogas-powered equipment. Key areas of focus include analyzing energy balances for both water supply and sewage systems, as well as identifying opportunities to improve energy efficiency. The company has made significant progress in using renewable energy, achieving a high level of self-sufficiency in both electricity and heat production.

Recommendations for further improving the company's energy independence include upgrading biogas generators for better efficiency and installing heat pumps to recover energy from treated wastewater. Overall, the analysis aims to enhance the company's energy self-sufficiency, reduce operational costs, and minimize its environmental impact through improved energy management practices.

Keywords: sustainable energy management, renewable energy, energy efficiency, biogas production

* kpiet@prz.edu.pl

The transformative role of drone technology in water sciences

Bartosz Nycz[1*]

[1]Department of Heat Engineering and Air Conditioning, Rzeszow University of Technology, Poland

Abstract

This study explores the innovative use of drones equipped with specialized sensors for water sampling and quality assessment. As part of the strategies toward the Green Deal, the integration of drone technology in environmental monitoring presents a promising approach to addressing water management challenges. The drone, designed for real-time data collection, is equipped with advanced sensors capable of measuring key water quality parameters such as pH, dissolved oxygen, conductivity, and temperature. By accessing hard-to-reach water bodies and gathering high-resolution data, the drone enhances the accuracy of hydrological models and supports sustainable water resource management. Preliminary findings indicate that this method offers a cost-effective, agile, and environmentally friendly solution for continuous water monitoring, contributing to the Green Transition goals.

Keywords: drones, water quality, environmental monitoring, hydrology

* bartosz.nycz@prz.edu.pl

The influence of different concentrations of argentum nitrate on the biosynthesis of silver nanoparticles by the yeast *Saccharomyces cerevisiae* M437

Oksana Skrotska[1*] | Valeriia Marchenko[1]

[1]National University of Food Technologies, Ukraine

Abstract

In the modern world, the most common approach to treating infections is still the use of antibiotics. However, the rise of antibiotic resistance makes this approach less effective. Since silver is already a natural antimicrobial agent, the search for new and environmentally friendly methods for obtaining silver nanoparticles (AgNPs) is relevant today due to their promising antimicrobial properties. AgNPs can be synthesized using various methods, among which the biological method, involving the use of biological objects, is noteworthy. In our research, the yeast *Saccharomyces cerevisiae* M437 is used for this purpose. The optimal size of synthesized AgNPs also plays an important role in their antimicrobial action. Thus, it is necessary to find optimal biosynthesis parameters, such as temperature, pH, silver nitrate concentration, and others, to obtain nanoparticles with better morphological characteristics. Previous studies used different temperatures for AgNP biosynthesis, showing an optimal temperature of 45°C under static conditions for 72 hours. In new studies, we compared the effect of 1 mM and 4 mM $AgNO_3$ concentrations on the biosynthesis of silver nanoparticles. The studies showed that higher concentrations of $AgNO_3$ led to the formation of agglomerates over time, with broad absorption peaks observed during spectrophotometric analysis in the UV-visible range. Meanwhile, the biosynthesis with a lower silver nitrate concentration resulted in a narrow absorption peak, indicating the formation of smaller particles. Thus, the biological synthesis of silver nanoparticles using the cell-free aqueous extract of yeast *S. cerevisiae* M437 with different silver nitrate concentrations (1 mM and 4 mM) was demonstrated.

Keywords: silver nanoparticles, biosynthesis, yeast, silver nitrate

* o.skrotska@gmail.com

Recovery of silica sand from wastewater for industrial applications as a step toward circular economy in transforming WWTPs into WRRFs

Aleksander Czapla[1*] | Jakub Drewnowski[1]

[1]Gdańsk University of Technology, Poland

Abstract

The recovery of silica sand from wastewater and its innovative application in glass-reinforced plastic (GRP) composite pipes present a promising opportunity to enhance the sustainability and economic viability of Wastewater Treatment Plants (WWTPs). This approach supports the transition of WWTPs into Water Resource Recovery Facilities (WRRFs) and aligns with circular economy principles. Utilising silica sand extracted from wastewater could offer a sustainable alternative to the conventional extraction of virgin raw materials, potentially reducing environmental degradation and conserving resources.

Materials and Methods:

This study focuses on the recovery of silica sand from wastewater and employs a coagulation-flocculation-sedimentation-filtration (CFSF) technique. This process is used to effectively separate and purify silica sand particles from wastewater sludge, ensuring their quality for industrial applications. Various analytical methods, such as chemical purity analysis and particle size distribution, are then used to assess the properties of the recovered silica sand. Following these assessments, the recovered silica sand is incorporated into the GRP composite pipe to conduct a series of mechanical tests (such as tensile, flexural, and compression strength tests) to accurately evaluate the performance of the GRP pipes containing recovered silica sand.

Results and Findings:

Preliminary test results, along with insights from existing literature, confirm the viability of using recovered silica sand in GRP pipes. The next phase aims to further validate these findings through mechanical and chemical analyses. The recovered silica sand is expected to meet industry specifications for GRP composites, with chemical purity and particle size distribution comparable to virgin silica sand in addition to reducing the industry's dependence on it and minimising waste from WWTPs. This approach lowers greenhouse gas emissions by reducing energy consumption, which strongly aligns with the European Green Deal and circular economy principles.

Keywords: silica sand recovery, GRP pipes, circular economy, sustainable infrastructure, wastewater treatment

* a.czapla.1993@gmail.com

Identification of microplastics in rainwater from the roof of a single-family house

Katarzyna Moraczewska-Majkut[1*] | Witold K. Nocoń[1] | Edyta Kudlek[1]

[1]Silesian University of Technology, Poland

Abstract

Rainwater collection and its use for various purposes are becoming increasingly important topics for researchers in the field of environmental engineering. This is due to the ongoing climate change leading to droughts in regions previously considered water-rich. However, using rainwater requires proper purification to remove micropollutants, including microplastics. The conducted study aimed to assess the concentration of microplastics in rainwater collected in 360 L and 1000 L HDPE tanks. The water was collected from the roof of a single-family house between 1 July 2024 and 31 August 2024v located in an agricultural region in Upper Silesia. The tests revealed the presence of numerous microplastic particles, with the main source being plastic gutter elements and atmospheric deposition. The microplastic particles were mainly brown, white, and blue fibers in shape, which corresponded to the colors of the plastic elements that drain and collect water. Microplastic particles that did not correspond qualitatively to these materials were also determined. This may indicate the transport of microplastic particles with rainwater.

Keywords: rainwater, microplastic, rainwater harvesting, single-family house

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* katarzyna.moraczewska-majkut@polsl.pl

The influence of the composition of the mineral mixture on luminance

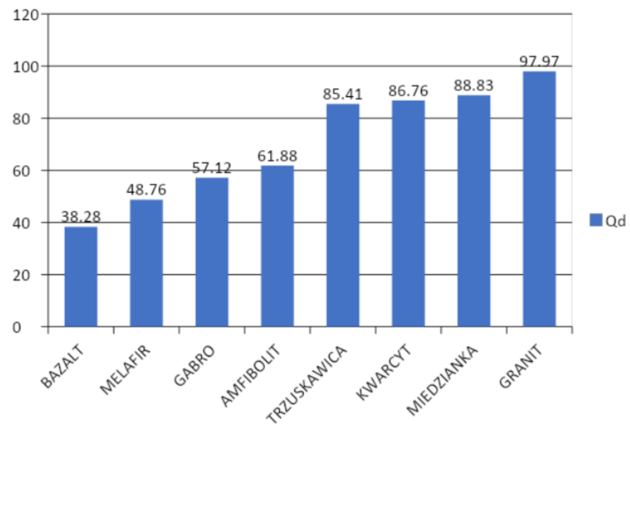
Paulina Bąk- Patyna[1*]

[1]Kielce University of Technology, Poland

Abstract

Measuring road surface luminance allows you to determine the brightness level of the road surface observed by the driver. While driving, the driver has to deal with other road users (motorized and non-motorized), with obstacles (pavement damage, road surface unevenness, speed bumps), with narrowings (traffic separators), with curves (road geometry, shoulder width), with changes in traffic organization (temporary detours, additional road markings, road connections, exits, unevenness). The driver can only notice an obstacle on the road when there is a contrast between the object and the road surface. When it gets dark, the appropriate contrast will be provided by installed lighting along the roads. Additionally, improving visibility, which translates into proper assessment of the road situation, is possible by using a surface with a texture that disperses reflected light, thus enabling the visibility of a dark obstacle against the road background. Properly designed lighting translates into uniformity of reflected light and means that vehicle drivers do not have to worry about shadow zones and darkness that make it impossible to see pedestrians or cyclists traveling at night without reflective elements. Preparing mixtures that ensure the appropriate level of luminance will make it easier for drivers to navigate the road after dark in the light of headlights and street lighting and will increase their safety by giving them the opportunity to notice threats earlier. The current standards for road lighting are specified in the PN-EN 13201:2016 standard. The aim of the research is to change the composition of the mineral substance on the luminance of the abrasive road surface. The implementation of these tasks will require tests using a pellet in various percentages of aggregates. The main goal imposes two additional uses. The first one will concern resolution, which will correlate with the temperature distribution. it occurred that the relief from solar radiation by the light surface lowered the temperature within the road surface. The second goal will be related to the luminance with the transmission streams and the adhesion of the car wheel to the road surface. The effect of lightening the structure and relating to its micro- and macro-texture properties and distribution will be applied to the throwing by the use of both light and dark aggregates with different sizes and porosities.

Chart.1. Average Qd values of aggregates from all gradations



Keywords: luminance, mineral and asphalt mixture, scattered light

∗ pbak@tu.kielce.pl

Recovery of fluoride from wastewater in the form of cryolite granules by fluidized-bed homogeneous crystallization process

Boris Brian B. Quedi[1*] | Florencio C. Ballesteros Jr.[1] | Anabella C. Vilando[2] | Ming-Chun Lu[3]

[1]University of the Philippines Diliman, Philippines
[2]Bicol State College of Applied Sciences and Technology, Philippines
[3]National Chung Hsing University, Taiwan

Abstract

Aquatic ecosystems are harmed by high fluoride levels, which can disturb the equilibrium of water, plants, and animals and reduce biodiversity. Fluoride contamination in water sources can pose health risks and it is crucial to remove fluoride to prevent adverse effects on the environment and public health. Green technology is employed to recover fluoride from simulated fluoride-rich wastewater. The fluidized bed homogeneous crystallization (FBHC) process is an advanced methodology that removes contaminants from wastewater through supersaturation to recover nontoxic granules that can be used for other purposes. This study compared the fluoride recovery between batch crystallization and the FBHC process in terms of the molar ratio (MR) of $[F^-]$:$[Al^{3+}]$ between [1] and [3] and the pH influence on the recovery and crystallization. The concentration of $[Al^{3+}]$ was varied at 37, 74, and 111 mM, along with the influent flow rates of 4, 8, and 12 $mL \cdot min^{-1}$. FBHC systems offer improved control of pH levels, creating a stable environment for crystallization. Unlike batch systems, these continuous operating systems are more resilient to pH fluctuations due to efficient mixing, maintaining a consistent pH throughout the process. Using Box-Behnken Design (BBD) for the FBHC, optimal conditions were 74 mM initial [Al] concentration, MR of $[F^-]$:$[Al^{3+}]$ of [2]:[1], and 8 $mL \cdot min^{-1}$ influent flow rate resulted in 93% fluoride removal (FR) and 91% crystallization ratio (CR). XRD and SEM-EDS data showed similarities between the peaks and compositions of cryolite (Na^3AlF^6). FBHC was able to produce granules based on the reaction mechanism in the synthesis of cryolite.

Keywords: fluoride, wastewater, fluidized bed, homogeneous crystallization, cryolite

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* bbquedi@up.edu.ph

From waste to energy: theoretical considerations on bioethanol production from fruit residues

Anna Gnida[1]*

[1]Silesian University of Technology, Faculty of Energy and Environmental Engineering, Environmental Biotechnology Department, Poland

Abstract

Poland is one of Europe's leading fruit producers, generating significant quantities of waste from fruit processing. These wastes, including solid and moist by-products such as peels, seeds, and pulp, represent a valuable resource for bioethanol production. Utilizing such waste not only helps manage organic matter disposal but also supports the circular economy by converting waste into renewable energy.

Given the high moisture content of many fruit residues, technologies that can process them in their natural state are particularly advantageous, as they reduce the need for additional water, thus lowering energy consumption and processing costs. The fermentation of sugars present in fruit waste into ethanol can be efficiently achieved using existing microbial and enzymatic processes, contributing to Poland's energy mix and reducing dependence on fossil fuels.

The presentation shows a theoretical exploration aimed at determining the potential of fruit pomace for alcohol production. By examining the availability of fruit waste and its inherent properties, the study highlights the feasibility of using these by-products as a viable raw material for bioethanol production. This approach offers a sustainable solution for both waste management and renewable energy production, benefiting the environment and the local economy. By capitalizing on Poland's fruit production waste, the country can lead the way in bioethanol production from agricultural by-products.

Keywords: fruit pomace, solid state fermentation, bioethanol, waste utilisation

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* anna.gnida@polsl.pl

New indicators of sorption and natural gas capacity of coal beds

Bezruchko Kostiantyn[1*] | Karhapolov Andrii[1] | Chelkan Vira[1]

[1]M.S. Poliakov Institute of Geotechnical Mechanics of the National Academy of Sciences of Ukraine, Ukraine

Abstract

Coal production in coal mines during their operation and after the completion of coal-face works is constantly accompanied by methane emission into the mined-out space. The purpose of the work is to determine the general patterns in the formation of the sorption capacity of coal and the natural regional methane content of coal beds. New indicators have been proposed – the relative gradient of sorption methane-bearing capacity and the relative gradient of methane content, which allow comparison of these characteristics measured in absolute values for individual coal beds of different grades of metamorphism, at various depths and lying in different geological conditions. Based on experimental data regarding the sorption methane-bearing capacity and natural gas content of Donbas coal beds, we analyzed, processed, and generalized the obtained results. A regular change in the relative gradient of methane content has been established. It has been proven that the sorption capacity of coal matter determines the natural regional (background) methane content of coal beds, and naturally, according to a hyperbolic dependence, decreases with increasing stratification depth and also naturally decreases in each of the depth intervals from low-metamorphosed coal to highly metamorphosed one, with a relative gradient that asymptotically approaches 1 at pressures above 6 MPa. The obtained dependences of the relative gradient of gas content on depth and gas pressure for various grades of metamorphism can be used to predict the natural regional (background) gas content of coal beds by determining the maximum sorption capacity and calculating the desired depth or pressure.

Keywords: coal beds, natural gas capacity, sorption capacity

* bkaigtm@gmail.com

Application of Zr-MOF for the effective removal of a cationic dye from aqueous solutions in wastewater treatment

Mokri Hafsa[1*] | Boukli-Hacene Leila[1]

[1]Laboratory of Inorganic Chemistry and Environment, Faculty of Sciences, University of Tlemcen, Algeria

Abstract

Water pollution from industrial effluents has become a significant concern over the past 50 years. In response, the use of Metal-Organic Frameworks (MOFs) for wastewater treatment has gained attention as a promising technology. Various physico-chemical techniques, such as coagulation, flocculation, advanced oxidation processes, and biological treatments, are available for dye removal, with adsorption using porous materials like activated carbon being particularly effective. Recently, the discovery of MOFs, known for their high porosity, large specific surface area, and substantial pore volume, has shown potential for efficient dye adsorption. This study focused on evaluating the Zr-based Metal organic framework (MOF), MIP-202, for its effectiveness in removing a cationic dye from the phenothiazine family, methylene blue. Various parameters were optimized to enhance dye degradation, including the initial pH of the solution, the initial dye concentration, and the adsorbent mass. The adsorption process was monitored using UV/Vis spectrophotometry, and the results demonstrated that under optimal conditions (T=20°C, pH=6.7, [MB]=10 mg/L, m(MIP-202)=60 mg), a removal efficiency of 80% was achieved after 180 minutes of treatment.

Keywords: water pollution, metal-organic frameworks, wastewater treatment, methylene blue, MIP-202

* rmahafsa@gmail.com

The impact of bioaugmentation and varying moisture levels on the biodegradation of diesel oil in soil contaminated with microplastics

Tomasz Ciesielski[1*] | Marta Woźniak-Karczewska[1] | Anna Parus[1] | Łukasz Chrzanowski[1]

[1]Faculty of Chemical Technology, Poznan University of Technology, Poland

Abstract

Polymer production continues to rise annually, currently estimated at nearly 400 million metric tons, with projections suggesting it will surpass one billion tons by 2050. This growing production leads to the increasing presence of polymers in aquatic and soil environments, often in the form of microplastics, which are described as particles sized between 5 mm and 100 nm. The role of microplastics in affecting soil ecosystem dynamics has increasingly captured the attention of the scientific community. Despite this growing interest, limited research has been conducted on how microplastics influence the breakdown of xenobiotics such as antibiotics, herbicides, or hydrocarbons within the soil environment. To address this, an experiment was conducted to assess the effects of ABS microplastics and varying soil moisture levels, defined by parameters such as Permanent Wilting Point (PWP), Field Capacity (FC), and Saturation (SAT), on diesel biodegradation in soil. The findings revealed that at minimal soil moisture (PWP), the mineralization rates were the lowest, with a peak of 5 mmol CO_2. However, when soil moisture was at its optimal level (FC) or fully saturated (SAT), mineralization rates increased significantly, reaching 20 to 25 mmol CO_2, which was nearly five times higher than for PWP conditions. Interestingly, ABS microplastics did not exert a notable influence on the mineralization process. The findings suggest that soil water availability, rather than the presence of microplastics, is the primary factor influencing diesel mineralization, with higher moisture levels leading to increased mineralization.

Keywords: microplastic, hydrocarbons, mineralization

Acknowledgments: This research resulted from OPUS 21 funded by the National Science Centre in Poland, conferred on the basis of decision DEC-2021/41/B/ NZ9/03981. The grant title is: “Multilevel relationships between the presence of micro/nanoplastics (MNPs) in soil and the amount and availability of water as well as sorption of model xenobiotics in terms of changes in biodegradation kinetics and soil microbial communities”.

* tomasz.ciesielski@doctorate.put.poznan.pl

The influence of microplastics aging on interactions with surfactants in water ecosystems

Natalia Lisiecka[1*] | Anna Parus[1] | Joanna Zembrzuska[1]

[1]Institute of Chemical Technology and Engineering, Poznan University of Technology, Poland

Abstract

Microplastics have emerged as a pervasive and persistent pollutant in aquatic ecosystems, increasingly recognized as a vector for the transport and accumulation of various environmental contaminants. Surfactants, which are widely used in detergents, personal care products, and industrial processes, are particularly problematic due to their ability to persist in water and their potential toxicity to aquatic life. The interaction between microplastics and surfactants represents a growing environmental concern, as microplastics can act as carriers for these compounds, influencing their distribution, bioavailability, and toxicity. Understanding the behavior of surfactants in the presence of microplastics, especially in water environments, is essential to assess the broader ecological risks posed by these combined pollutants.

This study focuses on the sorption of dodecyltrimethylammonium, a common surfactant, onto acrylonitrile butadiene styrene (ABS) microplastics, examining the differences between pristine and aged microplastics in aquatic conditions. Aging of ABS dramatically increased the ability of aged microplastics to adsorb surfactants from water. Sorption of cation increased twice, highlighting the enhanced capacity of aged microplastics to retain surfactants.

These results underscore the critical role of aged microplastics in the aquatic environment as new sorbents of surfactants, raising concerns about their contribution to the persistence and accumulation of chemical pollutants in water. The increased sorption of surfactants by microplastics not only alters the fate of these chemicals but also amplifies the potential risks they pose to aquatic organisms and ecosystems. Further research is needed to fully understand the long-term environmental implications of microplastics and their interactions with surfactants.

Keywords: adsorption, aquatic environment, emerging contaminants, microplastics, surfactants

Acknowledgments: The work was carried out under the OPUS 21 grant funded by the National Science Center under decision DEC-2021/41/B/NZ9/03981 and by the Polish National Agency for Academic Exchange (NAWA) under the STER programme, aimed towards the Internationalization of the Poznan University of Technology Doctoral School (2022-2024).

* natalia.lisiecka@doctorate.put.poznan.pl

Experimental and modeling study of dye adsorption on modified clay

Bessaha Gania[1*] | Benhouria Assia[2] | Medjedoub Aicha[1] | Benalioua Bahia[2] | Boucif Fatima[1] | Mahrez Nouria[1] | Bendahma Fatima[3] | Bessaha Fatiha[1] | Khelifa Amine[1]

[1]Department of Process Engineering, Laboratory of Structure, Elaboration and Applications of Molecular Materials (S.E.A.2M), Abdelhamid Ibn Badis University, Algeria
[2]Department of Process Engineering, Laboratory of Materials Development, Abdelhamid Ibn Badis University, Algeria
[3]Laboratory of technology and properties of solids, Abdelhamid Ibn Badis University, Algeria

Abstract

Nowadays, the excessive use of dyes and the penetration of colored compounds into the environment have given rise to concern throughout the world. Consequently, there is a need for an effective system to remove these compounds from the aquatic environment. The adsorption process is one of the most effective methods for removing dyes. The study focuses on removing anionic dye from an aqueous solution using modified bentonite. Batch experiments were carried out on the adsorption process to study the effect of contact time, solution pH, and temperature. Several isotherm adsorption models have been fitted to the experimental data and the parameters of the models have been determined. The adsorption time was 30 min and the solution pH was at 5. The Langmuir-Freundlich and Langmuir models could well fit the adsorption of ER by raw bentonite data. The coincidence of experimental and theoretical quantities and the values of statistical errors: $\chi 2$, and SSE calculated confirm the validity of these models. This work proves the effectiveness of modified bentonite as an adsorbent for removing ER from wastewater.

Keywords: dye, intercalation, modeling, statistical errors

* gania.doct@gmail.com

Circular Economy in the cosmetics industry

Katarzyna Maj-Zajezierska[1*]

[1]University of Applied Sciences in Tarnow, Poland

Abstract

Sustainability and concern for the environment is an important aspect in every industry, including the cosmetics industry. Adapting to current EU and national legislation is a challenge for cosmetic companies. One such challenge is the introduction of a circular economy into the cosmetics industry. This is a very difficult task, as plastic-containing packaging can not to be completely eliminated in this sector. Approaching the topic requires understanding the concept of a circular economy and making changes at every stage of cosmetic product manufacturing to minimise waste generation and increase plastic recycling.

The paper outlines the cosmetics industry's efforts to introduce a circular economy. It identifies the need to optimise the entire life cycle of products - from the design of packaging and cosmetic formulations, through manufacturing processes, to recycling and reuse of materials. Tasks are described including designing products with a longer shelf life, minimising the use of plastic and other non-renewable raw materials, and using biodegradable packaging.

Keywords: circular economy, cosmetic industry, sustainability, LCA, recycling

* kmajzajezierska@gmail.com

Optimization of heat recovery from wastewater using heat pumps: a case study of the Gorzyce wastewater treatment plant in the Podkarpackie voivodeship

Robert Kowalik[1*] | Paulina Berezowska-Kominek[1] | Justyna Lisowska[1]

[1]Kielce University of Technology, Faculty of Environmental Engineering, Geodesy and Renewable Energy, Poland

Abstract

Around the world, there is a drive to seek alternative solutions and replace traditional mining deposits with renewable energy sources. One of the innovative directions is the use of wastewater as a low-grade heat source. This article presents an analysis of the thermal power obtained from wastewater for each month, using the example of the Gorzyce wastewater treatment plant located in the Podkarpackie Voivodeship. To calculate the amount of recovered heat, measurements of the temperature of raw sewage in the sewer leading to the treatment plant and the temperature of treated sewage in the channel discharging the wastewater into the receiver were conducted. Simultaneously, the flow rates of raw and treated wastewater were analyzed. The measurements were performed in 2023. A heat pump operation scheme was presented, and its COP (Coefficient of Performance) was calculated. Based on the obtained results, the thermal power recovered from the wastewater ranged from 2.76 kW to 33.89 kW, showing significant variability in energy potential depending on the season. The average energy recovery was 13.59 kW

Keywords: heat recovery, wastewater as a low-grade heat source, heat pumps, wastewater treatment

* rkowalik@tu.kielce.pl

Synthesis and testing of thermoacoustic properties of metakaolin geopolymers doped with Nd_2O_3 for use in the construction industry

Sanja Knežević[1*] | Snežana Nenadović[1] | Miloš Nenadović[2] | Ljiljana Kljajević[1] | Sanja Pavlović[3] | Nataša Mladenović Nikolić[1] | Marija Ivanović[1]

[1]Department of materials, „VINČA" Institute of Nuclear Sciences - National Institute of the Republic of Serbia, University of Belgrade, Serbia
[2]Department of Atomics Physics, Vinča Institute of Nuclear Sciences, National Institute of the Republic of Serbia, University of Belgrade, Serbia
[3]The Academy of Applied Studies Polytechnic,Belgrade, Serbia

Abstract

Metakaolin-based geopolymers incorporated with 1% and 5% Nd2O3 were synthesized, and their thermoacoustic properties were examined. Metakaolin-based geopolymers are widely used in the construction industry due to their high mechanical resistance, chemical stability and environmental friendliness. Determining the thermal conductivity of geopolymers is crucial because they often serve as insulating materials in construction [1]. Low thermal conductivity enables better energy efficiency of buildings, reducing the need for additional heating and cooling systems [2]. In addition, determining the acoustic properties of geopolymers is important because materials with good sound insulation properties improve comfort and privacy inside buildings, which is especially important in densely populated urban areas [3]. These properties make geopolymers attractive for use in modern construction. Geopolymers are most often intended for application in conditions where thermal treatment is not present, such as building walls or insulating materials. To better understand the value of thermal conductivity, the results will be compared with data from the literature. The literature data for the thermal conductivity range for ordinary cement and lightweight concrete is between 0.4 and 2.5 W/mK [4]. The achieved results prove that the incorporation of Nd_2O_3 opens up new possibilities for the production of thermoacoustic insulation materials, thus making a significant contribution to the development of innovative and sustainable materials with wide applications in various industrial sectors.

Keywords: metakaolin, geopolymer, Nd_2O_3, thermoacoustic properties, insulating materials

References:

1. Rao, P. R., Momayez, M., Runge, K. A., Muralidharan, K. Recent developments in thermally insulating materials based on geopolymers—a review article. *Mining, Metallurgy & Exploration*, 2020, *37*, 995-1014. https://doi.org/10.1007/s42461-020-00201-0
2. Pásztory, Z. An overview of factors influencing thermal conductivity of building insulation materials. *Journal of Building Engineering*, 2021, *44*, 102604. https://doi.org/10.1016/j.jobe.2021.102604
3. Fediuk, R., Amran, M., Vatin, N., Vasilev, Y., Lesovik, V., Ozbakkaloglu, T. Acoustic properties of innovative concretes: A review. *Materials*, 2021, *14*(2), 398. https://doi.org/10.3390/ma14020398
4. Khushefati, W. H., Demirboğa, R., Farhan, K. Z. Assessment of factors impacting thermal conductivity of cementitious composite s— A review. *Cleaner Materials*, 2022, *5*, 100127. https://doi.org/10.1016/j.clema.2022.100127

* sanja.knezevic@vin.bg.ac.rs

The influence of hydrodynamic disintegration on the process of aerobic stabilization of excess sludge

Justyna Czajkowska[1]* | Maciej Malarski[1] | Justyna Walczak[1]

[1]Department of Water Supply and Wastewater Disposal, Faculty of Building Services, Hydro, and Environmental Engineering, Warsaw University of Technology, Poland

Abstract

Sewage sludge – waste generated in the wastewater treatment process – must be stabilized due to the significant content of organic matter susceptible to putrefaction. One of the commonly used methods in small and medium-sized wastewater treatment plants (WWTPs) is aerobic stabilization – based on the action of microorganisms. Due to the need to supply large amounts of oxygen for many days, this is a very energy-consuming process. Hydrodynamic disintegration of sludge can accelerate this process by breaking down flocs and cell membranes, thus increasing the efficiency of the first stabilization phase – hydrolysis.

The results of research on the aerobic stabilization of excess sludge from WWTP with a PE of 70 000, which were subjected to hydrodynamic disintegration with different energy densities: 10, 25, 35, 45, 60, 70, 105, 140, and 175 kJ/L. The minimum aeration times were determined to achieve a 38% reduction of organic compounds compared to the initial value. In the case of the control sample (non-disintegrated), a 38% reduction of organic compounds can be achieved in 25.5 days of the process, while for energy density of 70 kJ/L the estimated time is 21.5 days. Taking into account the energy costs related to sludge disintegration and shortening the aeration time, it turned out that the energy gain (for a disintegration energy density of 70 kJ/L) is 16%. In the case of extreme values of the analyzed energy densities of 10 kJ/L and 175 kJ/L, an energy loss of 7 and 4% was noted, respectively, in relation to the control sample.

Keywords: sewage sludge, sludge stabilization, disintegration, organic compounds

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* justyna.czajkowska@pw.edu.pl

Impact emergency discharges of industrial wastewater containing phenol and propylene oxide on biological purification efficiency

Agnieszka Bluszcz[1*] | Krzysztof Barbusiński[2] | Barbara Pieczykolan[2]

[1]Silesian University of Technology, Poland
[2]Silesian University of Technology, Department of Water And Wastewater Engineering, Poland

Abstract

Management of a biological sewage treatment plant, such as the Central Sewage Treatment Plant PCC Energetyka Blachownia, which in addition to sanitary sewage, also receives industrial wastewater, always encounters many difficulties. The operation carried out activities which effort to minimize negative impact of industrial wastewater, in particular in emergency discharges situations, on purification process in biological wastewater treatment plant. These activities include studies to determine the impact of industrial wastewater on purification efficiency of wastewater treatment on a laboratory scale. Furthermore, the maximum loads of pollutants contained in this wastewater, that can be fed to the treatment plant, without negatively affecting the treatment process were examined. Purification efficiency tests were conducted for industrial wastewater containing phenol and propylene oxide. These experiments consisted of increasing volume share of industrial sewage in relation to sanitary wastewater, until problems were observed with degradation of controlled pollutant. Purification efficiency in the laboratory model was controlled by selected physicochemical parameters, moreover during the studies degree of removal of phenolic index and non-ionic surfactants were controlled. The research began with the share of industrial wastewater in relation to sanitary sewage of 13,7%, than increased to 20,4%, 27,1%, and at the end – 33,8%. For the first two volume shares the laboratory model worked correctly. However, for the volume share of 27,1% increase concentration of parameters: $ChZT_{Cr}$ 142 mg O_2/dm^3, BZT5 65 mg O_2/dm^3 and non-ionic surfactants 21 mg/dm^3 were observed. Extension of research by the volume share – 33,8% confirmed that the rest of carbon is not biodegradable.

Keywords: industrial wastewater, wastewater treatment, improvement of efficiency, purification efficiency, phenols

* agbluszcz@polsl.pl

Alkali activated fly ash and wood ash

Marija Ivanović[1*] | Miloš Nenadović[2] | Sanja Knežević[1] | Nataša Mladenović Nikolić[1] | Ljiljana Kljajević[1] | Snežana Nenadović[1]

[1]Department of Materials, „VINČA" Institute of Nuclear Sciences - National Institute of the Republic of Serbia, University of Belgrade, Serbia,
[2]Department of Atomics Physics, Vinča Institute of Nuclear Sciences, National Institute of the Republic of Serbia, University of Belgrade, Serbia

Abstract

Alkali activated materials (AAMs) of aluminosilicate origin, based on the different ashes, fly and wood are very attractive and can be applied in various technological fields due to their thermal stability, resistance to thermal shock, high porosity, the high sustainability and finally low energy loss during production. Fly and wood ash are actually by-products of burning process of coal and wood, respectively. Only few percent of the total amount of fly ash produced in power plants in Serbia is used annually in construction, while the majority of fly ash ends up in open dumps and represents a serious threat to public health. The AAMs based on fly and wood ash can be obtained by changing process parameters during "green" synthesis such as activator molarity, liquid/solid ratio, or adding additives. The chemical composition of wood ash shown the high percent of CaO, and incorporation of calcium during synthesis of alkali-activated materials will cause the different reaction pathway and increasing sample strengths. The consolidation process of the activated raw materials occurs by curing at temperature in interval 60 to 80°C. One of the goals of our research is the monitoring of physico-chemical, thermal properties and capability for disposal some kind of harmful substance into AAMs. To develop a cheap, environmentally friendly and sustainable technology for the use or reuse of local industrial waste for the production of green materials is very important in sense of circular economy.

Keywords: fly ash, wood ash, aluminosilicate, geopolymerization, circular economy

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* marija@vin.bg.ac.rs

Spatial planning of engineering facilities for environmental protection

Paweł Wolski[1*] | Sławomir Rogoz[1]

[1]Czestochowa University of Technology, Faculty of Infrastructure and Environment, Poland

Abstract

Spatial development policy in municipalities is a current issue, sometimes arousing controversy among residents. The construction of engineering structures for environmental protection is sometimes a controversial issue. A landfill is one of the examples where construction near the place of residence is a controversial issue. Searching for places away from residents in favorable geological conditions without harming the environment is sometimes difficult but feasible.

The article presents a theoretical analysis of issues related to engineering structures for environmental protection using the example of a landfill located in the Silesian Voivodeship. The engineering structure under construction illustrates the scale of the problem of protecting the contaminated environment, the need to counteract threats to the environment and protect human health. The disposal of such a large amount of waste is devoted to one goal - the environment, in which the most important thing should be to ensure the health of several hundred thousand people. The specific geological structure of the land at the site of the threat and the existing hydrogeological conditions, the directions of migration of pollutants from unsecured waste, are a source of essential information for engineers designing and implementing a landfill of this size.

The analysis of the described undertaking shows that neutralisation of hazardous substances by building a permanent waste storage facility requires a detailed analysis of the prevailing hydrogeological, geotechnical and construction conditions. Most of the substances neutralised in the storage facility are poisons. A significant part of them has penetrated into underground water reservoirs. Considering the migration of chemical substances, there is a need to urgently complete the isolation of this mass of waste in a storage facility prepared for this purpose.

Keywords: spatial planning, engineering facilities, environmental protection

* pawel.wolski@pcz.pl

Microplastics in water samples collected from urban fountains

Ewa Wiśniowska[1*] | Agnieszka Popenda[1] | Witold Nocoń[2] | Monika Lelonek[3] | Karolina Żbikowska[2] | Martyna Stasz[2]

[1]Czestochowa University of Technology, Poland,
[2]Silesian University of Technology, Poland
[3]SmartMembranes GmbH, Germany

Abstract

Microplastics are tiny (sizes from 1 micrometer to 5 mm) pieces of various shapes plastics, such as micro pellets, fragments, pieces of foil, fibers, etc., which are common pollutants of the natural environment and urban areas. They are of primary or secondary origin. Microplastics are common in surface waters such as rivers, lakes, or dam reservoirs, and their concentrations correlate with the degree of urbanization. Concentrations of microplastics are within the wide range from a few to several thousand pieces in 1 cubic meter. Important sources of the plastics are wastewater treatment plant effluent discharges, but these micropollutants can also be transferred and deposed from the air. It was confirmed that microplastics are present in dust and soils. A few research works focused on microplastics' presence in water samples taken from urban fountains. The present study aimed to evaluate concentrations of these micropollutants in such samples taken from several fountains in big cities in Poland and Germany. The samples were analyzed under an optical microscope to evaluate microplastic concentration and shapes in the fountain water. The samples did not undergo additional treatment before the plastics were counted. The results indicated that the dominant fraction of microplastics in the fountains were fibers, followed by micro pellets. No foil fragments were found, but a few plastic fragments were present. The type of microplastics was typical for the individual fountains but not the city. Fountain water from German cities contained fewer microplastics than the one taken in Polish cities. One of the reasons was probably the fact that less dust and soil particles were present on the surface of German pavements. In contrast, the concentration of dust was significantly higher in Poland. Microplastic concentrations in fountain water were in a wide range.

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* ewa.wisniowska@pcz.pl

Prospects for the extraction of critical raw materials from organic sediments of Ukraine

Volodymyr Baranov[1*] | Kateryna Babii[1]

[1]Poliakov Institute of Geotechnical Mechanics of the National Academy of Sciences of Ukraine, Ukraine

Abstract

Humanity is now on the threshold of the 4th industrial revolution. It requires not only new technologies, but also new materials, which are called "critical raw materials". There is a significant demand for these raw materials, since they are used for transition of countries to green energy, which has no alternative. The European Union plans to switch to renewable energy by 2050. In 2021, Ukraine formulated a state program "Critical and strategic mineral resources of Ukraine in the context of globalization and climate change", which has good ground for our country. The authors of this abstract were instructed to analyze possible sources of germanium production. In Ukrainian coals, the average increased content of trace elements is associated with host rocks that were demolished from the crystalline shield.In the sediments on the surface of the crystalline shield, there are layers of oxidized coal, which are more like soot. No work has been done to study these coal residues. Now it is possible to test the upper layers of oxidized coal in the Dnieper basin and Donbass.Another potential source of germanium extraction in our country is waste rock dumps of coal mines - waste heaps, which contain many valuable and rare elements.In addition to coals of the Donetsk basin, where there is germanium, it is worth noting the prospects of the Transcarpathian deposits and lignite ore occurrences at an insignificant depth, in which the average germanium content reaches 200 g/t.

* andreevich7526@i.ua

Investigation of coal-combustion products of Ukrainian thermal power plants as an alternative source of rare elements

Yana Antipovych[1*] | Piotr Kunecki[2]

[1]Poliakov Institute of Geotechnical Mechanics of the National Academy of Sciences of Ukraine, Ukraine
[2]Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland

Abstract

According to rough estimates, 6-7 million tons of coal-combustion products (CCP) are generated in Ukraine annually. As part of the transition to green energy, the secondary processing of these products will solve not only the environmental issue, but also the resource problem, since they can be considered as a source of critical raw materials, in particular, rare elements.Within the cooperation agreement between the Mineral and Energy Economy Research Institute of the PAS and the M.S. Poliakov Institute of Geotechnical Mechanics of the NAS of Ukraine it was agreed to conduct joint studies of CCP from some of Ukrainian thermal power plants to determine whether they contain critical raw materials.According to the developed methodology, more than 40 samples of bottom ash, sludge and filter ash were selected from the Pridneprovska thermal power plant (Ukraine).The most representative samples were studied using SEM, XRD, Laser Diffraction Particle Size Analyze and Spectral analysis.According to the SEM results, the most common elements in CCP are Si, Fe, Al, K, Ca, Ti.Spectral analysis was used to establish the presence of rare elements in the samples. In particular, it showed that the CCP contain such rare elements as V, Zr, Nb, Ga, Ge, Rb, Re, Y.The obtained results are only the first stage of research in this direction. In the future, it is planned to conduct similar studies using additional methods. Also, it is necessary to think about the development of technologies that will allow extracting rare elements from CCP, taking into account the profitability of the process.

* yana_antipovich@ukr.net

Use of mineral materials to capture CO^2 generated in metallurgical processes

Marta Dzięgielewska[1*] | Maria Bukowska[1] | Amelia Bartusiak[1] | Zofia Fabrowska[1] | Aneta Jałowiczor[1] | Aleksandra Kaganek[1] | Maja Kuśmierczyk[1] | Rozalia Stępień[1] | Oliwia Wydrzyńska[1]

[1] AGH University of Krakow, Poland

Abstract

The main objective of this study is to explore the potential of silicate minerals, such as zeolites, clays, and smelting slags, for capturing and sequestering atmospheric CO_2 generated in metallurgical processes. The research will focus on mineral materials' structural and chemical properties that facilitate CO_2 adsorption and, thus, the carbonization process. The study investigates how these mineral materials interact with CO_2 to form stable carbonate compounds, offering a long-term solution for CO_2 storage. Previous studies have demonstrated the effectiveness of zeolites in the selective adsorption of CO_2 relative to other gases. Key findings highlight the effectiveness of zeolites in selective CO_2 adsorption, attributed to their large surface area, pore volume, and active sites. Clays also demonstrate significant potential with their layered structure and high cation exchange capacity. Modifying zeolites and clays with amine-based organic compounds further enhances their CO_2 capture capabilities. The study identifies industrial by-products, such as slag, as promising materials for CO_2 sequestration due to their high CaO content. Despite these promising results, the study underscores several challenges, including optimizing conditions for maximum CO_2 capture, improving the efficiency and scalability of mineral carbonation, and ensuring the long-term stability of stored CO_2. The conclusions emphasize the need for continued interdisciplinary research to overcome these challenges and scale these technologies globally.

Keywords: CO_2 sequestration, silicate minerals, mineral carbonation, zeolites and clays, carbonate formation

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* martadzi@student.agh.edu.pl

TANDEM - insights from the Krzywcza commune meeting. Energy transition challenges and consumer perspectives

Wojciech Kowalik[1*] | Wit Hubert[2] | Lidia Gawlik[2] | Dominik Kryzia[2] | Monika Pepłowska[2] | Aleksandra Komorowska[2]

[1]AGH University of Krakow, Faculty of Humanities, Poland
[2]Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, The Division of Minerals and Energy Sustainable Development, Poland

Abstract

This article presents the findings from the first deliberative panel conducted in the Krzywcza commune as part of the TANDEM project, focusing on energy transition and local energy practices. The panel's participants represented a demographically diverse group, with households utilizing a range of heating sources. Key themes emerged from the discussion, including concerns over the high uncertainty and risks associated with energy markets, driven by fluctuating energy prices, geopolitical factors, evolving technologies, and shifting regulations for prosumers.

Residents identified energy market instability as a driver for preferring solutions that enhance energy security, such as diversifying household heat sources. Panelists recognized wood as a strategic backup fuel. Additionally, convenience was a significant motivator for investing in modern energy technologies (such as heat pumps, high-efficiency boilers, PV installations, and energy storage systems), with participants noting that these investments contributed to shifts in lifestyle, blurring the distinctions between urban and rural living.

Participants shared individual experiences regarding their investments in energy technologies and their use of various energy carriers and renewable energy sources. This led to the development of a comprehensive list of factors characterizing each energy source. Using clustering techniques, Four main dimensions were distilled using clustering techniques and further analysis led to construction of the Causal Loop Diagrams (CLD).

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* wkowalik@agh.edu.pl

Co-creation between local authorities and collective actions for a sustainable transition (CO-SUSTAIN)

Wit Hubert[1*] | Wojciech Kowalik[2] | Monika Pepłowska[1] | Dominik Kryzia[1] | Aleksandra Komorowska[1] | Lidia Gawlik[1]

[1]The Division of Minerals and Energy Sustainable Development, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland
[2]Faculty of Humanities, AGH University, Poland

Abstract

This article presents the CO-SUSTAIN project, which aims to address the shifting landscape of political participation prevailing currently, where traditional institutional involvement is declining while non-institutional, grassroots participation is on the rise, particularly in the context of climate transition. These emerging forms of participation create alternative spaces (niches) that incubate innovative ideas and novel political practices. CO-SUSTAIN aims to identify these niches, facilitating transformative changes in the socio-technical system necessary for a sustainable climate transition. To better understand political participation in relation to environmental, political and social imperatives, the project will examine eighteen historical examples in six European countries. These examples will be analyzed within the MLP framework, which includes engagement, civic engagement, formal political participation and activism. Institutional ethnography and systems mapping will be used to explore the dynamics and governance of participation. In this way, the best practices that can stimulate citizen engagement in a sustainable transition will be identified. The project will test these best practices through four case studies: energy communities in Spain (engagement), food solidarity initiatives in Turin, Italy (civic engagement), government-led participatory processes in Northern Europe (formal political participation) and activism through the Lobau Bleibt movement in Austria. The findings will help define new, democratic paths for climate policy in Europe.

In Poland, the identification of existing forms of participation will be carried out based on three case studies: the “Przylesie” Housing Energy Community, the Clean Transport Zone in Krakow and the Krakow Smog Alert Association. A key aspect of this research is the identification of stakeholders and the assessment of social networks. These historical examples provide the basis for institutional ethnography and systems mapping, and the results obtained will be crucial for understanding how these different forms of participation shape the path towards a democratic climate transition.

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* whubert@meeri.pl

Environmental risks coming from urban dust pollution of rainwater

Agnieszka Popenda[1*] | Małgorzata Kryłów[2] | Ewa Wiśniowska[1]

[1]Częstochowa University of Technology, Faculty of Infrastructure and Environment, Department of Sanitary Networks and Installations Poland
[2]Cracow University of Technology, Faculty of Environmental Engineering and Energy, Department of Environmental Technologies, Poland

Abstract

The urban dust that covers the surfaces of roads and pavements and often accumulates at kerbs or near sewer gullies is a common pollutant present both in large agglomerations and in smaller towns and cities. Urban dust can be contaminated with organic micropollutants such as polycyclic aromatic hydrocarbons (PAHs) or polychlorinated biphenyls (PCBs). Inorganic micropollutants, including heavy metals, may also sorb on the dust surface. Micropollutants can occur in varying concentrations and, not least, in different mixtures.

During rainfall, dust is washed away from paved and unpaved surfaces into the combined sewer or stormwater drainage system. Rainwater can be characterised by different pH values and also by the presence of compounds other than micropollutants, such as surfactant residues, oils and fats. These substances can influence the behaviour of micropollutants present in dust, including their release into rainwater. Dust can also be characterised by varying concentrations of micropollutants.

The aim of this study was to determine, on the basis of own research and literature data, the concentration ranges of organic and inorganic micropollutants in road dust from areas from large agglomerations and smaller towns. Basing of these data, it was determined whether there were characteristic patterns of dust contamination with micropollutants (e.g. predominant PAH compounds, predominant heavy metals). In addition, based on the concentrations of selected micropollutants, their susceptibility to leaching was estimated. The collected data, in combination with toxicological data, allowed the estimation of the ecological risk associated with urban dust contamination of rainwater.

[*] agnieszka.popenda@pcz.pl

Influence of biochar type and mechanical disintegration on heavy metal immobilization in soil

Mariusz Z. Gusiatin[1*] | Paweł Osowski[1]

[1]University of Warmia and Mazury in Olsztyn, Poland

Abstract

Soil contamination with heavy metals poses significant environmental and public health risks. Biochar, a carbon-rich product of biomass pyrolysis, shows promise for immobilizing these contaminants, with effectiveness influenced by biomass type and post-production modifications. This study examines the impact of physical biochar modification on heavy metal remediation, focusing on biochar derived from the slow pyrolysis (400°C) of agricultural waste, nut shells, and wood chips. Biochars were tested in their original form (2-0.5 mm) and as ground particles (<90 μm) to assess their influence on soil properties and immobilization of copper (Cu), lead (Pb), and zinc (Zn), with initial average concentrations of 660 mg/kg and bioavailable fractions of 57%, 23%, and 65%, respectively. A 12-week incubation with a 5 wt% dose of biochar in soil under controlled humidity was conducted, assessing parameters like pH, total organic carbon, dissolved organic carbon, cation exchange capacity, and metal fractions using the BCR procedure. Results indicated that the effectiveness of biochar in remediating heavy metal-contaminated soil depended more strongly on the type of biomass used for biochar production than on particle size. Immobilization efficiency varied by metal, with biochar from agricultural waste showing the highest effectiveness, achieving 91-96% immobilization for Pb and 90-93% for Cu.

This suggests that agricultural waste biochar is particularly suitable for remediating soils contaminated with Pb and Cu, offering a sustainable solution for soil health restoration.

Keywords: biochar modification, remediation, soil, heavy metals

* mariusz.gusiatin@uwm.edu.pl

Methane yield from Chlorella vulgaris: assessing its potential for anaerobic digestion in biogas production

Petra Wojnarová[1*] | Piotr Jachimowicz[1] | Jiří Rusín[1]

[1]Institute of Environmental Technology, CEET, VŠB – Technical University of Ostrava, Czech Republic

Abstract

This study investigates the potential of Chlorella vulgaris for biogas production through anaerobic digestion, with a focus on optimizing the process to achieve higher methane yields. Algal biomass is a promising feedstock for renewable energy due to its rapid growth rate and high lipid content. Chlorella vulgaris was cultivated under controlled conditions using the BG 11 medium, maintaining temperatures between 24-26°C and pH levels from 6.5 to 7.5. The algae were then subjected to a biochemical methane potential (BMP) test under anaerobic conditions at 40 °C for 40 days. Two different organic loading rates (OLRs) were tested: 3.48 kgVS m^{-3} and 7.19 kgVS m^{-3}.

The results revealed that methane production was significantly higher at the lower OLR of 3.27 kgVS m-3, reaching 0.4918 m^3/kgVS, while biogas production was recorded at 0.7604 m^3/kgVS. Additionally, the average methane content in the biogas was greater at the lower OLR, averaging 64.7 vol. %. In contrast, the methane content was lower at the higher OLR (61.2 vol. %) and in the inoculum without substrate (60.7 vol. %). These findings indicate that Chlorella vulgaris is easily and rapidly biodegradable, making it a suitable and efficient substrate for biogas production, especially at lower OLRs.

The study also suggests the possibility of integrating algae cultivation with biogas processing, using treated digestate as a nutrient source for algae growth. This approach could enhance the sustainability and efficiency of biogas production by creating a circular system. Overall, Chlorella vulgaris shows great potential as an addition to feedstock for biogas plants, offering a viable alternative to conventional biomass sources.

Keywords: biochemical methane potential test, algae biomass, chlorella vulgaris

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* petra.wojnarova@vsb.cz

Effect of the biostimulant activity of lignin nanoparticles on the growth of a cereal

Rihab Hannani[1*] | Zohra Bengharez[1] | Yamina Bouchikh[2]

[1]Djillali Liabes University, Algeria,
[2]National Institute for Agronomic Research (INRA), Algeria

Abstract

Algeria is the seventh largest producer of olive oil globally. The valorization of olive by-products, including margines and pomace, is crucial for the promotion of sustainable agricultural systems.This research aimed to investigate the biostimulant activity of lignin nanoparticles (LNPs) on the growth and development of maize. Lignin was extracted from olive pomace from an oil mill in Sabra (34° 49′ 39″ N, 1° 31′ 42″ W), Algeria and processed into nanoparticles using using triethylammonium hydrogen sulfate [Et3NH][HSO4]. The study evaluated the effects of varying concentrations of LNPs (25 mg/L, 50 mg/L, and 100 mg/L) on both the germination and growth of maize plants under controlled conditions.The findings indicated that LNPs, especially at 50 mg/L, significantly enhanced plant growth. Stem length, root length, and both fresh and dry weights showed positive responses to the treatments, with 50 mg/L being the most effective concentration. However, higher concentrations of LNPs (100 mg/L) showed diminishing benefits, suggesting that excessive LNPs may have inhibitory effects. In addition, it was observed that as LNP concentration increased, there was a slight decrease in the germination rate, with 100 mg/L significantly reducing seed germination compared to lower concentrations and the controlIn conclusion, LNPs exhibit promising biostimulant properties, enhancing maize growth, but their concentration needs to be carefully managed to avoid negative impacts on seed germination. This work highlights the potential of using lignin-based biostimulants in sustainable agricultural practices.

* rihabhannani930@gmail.com

Sewage sludge processing into organic fertilizer as a key element of the Green Deal Strategy – innovative approaches in water and waste management

Anna Grobelak[1*]

[1]Czestochowa University of Technology, Poland

Abstract

In the face of advancing climate change and the efforts to achieve the goals of the Green Deal and sustainable development, efficient waste management and its transformation into renewable resources have become key challenges. The research compared the fertilizing properties of composts, biochar, and hydrochar produced from sewage sludge. The aim of the study was to assess the effectiveness of these materials as organic fertilizers, considering their impact on soil quality improvement, nutrient delivery efficiency, and the reduction of negative environmental impacts.

Advanced composting, pyrolysis, and hydrothermal carbonization process represent innovative technologies for converting sewage sludge, aligned with the concept of a circular economy. The materials were compared based on their physicochemical properties, including the content of macro- and microelements, organic matter stability, and potential contaminants. The results showed that both composts and hydrochar are rich in nutrients, with hydrochar and biochar exhibiting greater stability in soil, which may contribute to long-term carbon sequestration.

In the context of the Green Deal and sustainable development, these materials have the potential to replace conventional synthetic fertilizers, contributing to the reduction of greenhouse gas emissions, the improvement of soil structure, and the limitation of erosion. The study's conclusions indicate the need for further optimization of production processes to maximize fertilizing efficiency while minimizing negative environmental impacts.

Keywords: soil amendments, organic fertilizers, sewage sludge treatment

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* anna.grobelak@pcz.pl

Spectroscopic analysis and energy assessment of agricultural straw biomass: Raman and FTIR spectra in the context of combustion heat

Paweł Radulski[1*] | Maciej Życki[1]

[1]Department of Bioeconomy and Ecoinnovation, Lukasiewicz Research Network – Institute for Sustainable Technologies, Poland

Abstract

Agricultural straw, with an annual production of 24-26 million tons in Poland and 2.1-2.3 billion tons worldwide, is a significant source of biomass. In the context of global regulations like the Green Deal and the move away from fossil fuels, biomass, particularly biochar from pyrolysis, plays a key role in the energy transition. This study analyzes the energy potential and structural characteristics of agricultural straw subjected to pyrolysis at 500°C and 700°C, focusing on Raman and FTIR spectra and their relationship to combustion heat. The raw biomass had a combustion heat of 17.1 MJ/kg. Pyrolysis at 500°C increased the biochar's energy value to 21.4 MJ/kg, while at 700°C it was 20.5 MJ/kg. Raman spectra showed graphite-like structures at 500°C with a low ID/IG ratio of 0.09, indicating a well-ordered structure. At 700°C, the ID/IG ratio increased to 0.38, suggesting more defects. FTIR spectra at 500°C showed many functional groups, highlighting its potential as a heavy metal sorbent. At 700°C, fewer oxygen-containing groups were observed. These structural changes affect combustion heat—simpler structures at higher temperatures may lower the energy value. Biochar can be used as a renewable fuel or a graphite substitute in industrial lubricants, aligning with circular economy goals and Green Deal objectives for more sustainable, environmentally friendly solutions.

Keywords: agricultural biomass, thermal conversion, combustion heat, pyrolysis, Raman and FTIR spectroscopy

* pawel.radulski@itee.lukasiewicz.gov.pl

Microbial consortia-driven paraben degradation: a comparative study of synthetic wastewater and nutrient broth using HPTLC

Bhautik Dave[1*] | Rushikesh Joshi[2] | Milan Thakar[3] | Ewa Lobos Moysa[1] | Pooja Trivedi[3] | Gaurang M. Sindhav[3]

[1]Department of Water and Wastewater Engineering, Silesian University of Technology, Poland,
[2]Department of Biochemistry and Forensic Science, University School of Sciences, Gujarat University, Ahmedabad, India
[3]Department of Zoology, BMT, HGC & WBC, University School of Sciences, Gujarat University, India

Abstract

This study explores the potential of microbial consortia to enhance the biodegradation of persistent organic pollutants in synthetic wastewater, with a focus on paraben degradation. The key objective was to introduce and validate High-Performance Thin-Layer Chromatography (HPTLC) as a reliable analytical tool for tracking biodegradation in both synthetic wastewater (SWW) and traditional nutrient broth (NB) growth media. The study utilized a bacterial consortium composed of Enterobacter spp., Alcaligenes spp., and Microbacterium spp. to facilitate the degradation process. HPTLC was rigorously calibrated to detect and quantify paraben degradation at a 1 mg/mL concentration, providing both qualitative and quantitative insights into the degradation dynamics. The results showed that paraben degradation in SWW reached 82.85% after 120 hours, demonstrating sustained and efficient removal over time. In comparison, the nutrient broth medium achieved a higher degradation rate of 89.1% within the same period. However, the degradation profile in SWW indicated greater long-term stability and practical relevance for real wastewater treatment systems. This study emphasizes the effectiveness of microbial bioremediation strategies and highlights the role of HPTLC as a valuable tool for monitoring pollutant degradation, suggesting that SWW may offer a more viable solution for the treatment of persistent organic contaminants in industrial applications.

Keywords: paraben degradation, synthetic wastewater, bacterial consortia, HPTLC, bioremediation

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* bhautik.dave@polsl.pl

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