3rd International Conference

Strategies toward Green Deal Implementation

Water, Raw Materials & Energy

Mineral and Energy Economy Research Institute
Polish Academy of Sciences

Abstract book

5 - 7 DECEMBER 2022
ONLINE

MEERI PAS

Conference proceedings

3rd International Conference
Strategies toward Green Deal Implementation
Water, Raw Materials & Energy

5 – 7 December 2022

SCIENTIFIC EDITOR

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

REVIEWERS

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

COVER

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

COMPOSITION

Dominika Szołdrowska
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

The conference received funding from the Ministry of Education and Science (Ministerstwo Edukacji i Nauki) under the program "Excellent Science - Support for Scientific Conferences" (Doskonała Nauka – Wsparcie Konferencji Naukowych)

ISBN 978-83-67606-00-4

Scientific committee

Prof. Marzena Smol, *Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland, Chairwoman*

Prof. Krzysztof Galos, *Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland*

Prof. Zenon Pilecki, *Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland*

Prof. Eugeniusz Mokrzycki, *Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland*

Prof. Magdalena Wdowin, *Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland*

Prof. Lidia Gawlik, *Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland*

Prof. Miriam Balaban, *University Campus Bio-Medico of Rome, Italy*

Prof. Michał Bodzek, *Institute of Environmental Engineering of the Polish Academy of Sciences in Zabrze, Poland*

Prof. Idiano D'Adamo, *Spienza University of Rome, Italy*

Mr. Ludwig Hermann, *President of the European Sustainable Phosphorus Platform (ESPP), Proman Management GmbH, Austria*

Prof. Mika Horttanainen, *Lappeenranta-Lahti University of Technology, Finland*

Prof. Māris Kļaviņš, *University of Latvia, Latvia*

Prof. Jiří Jaromír Klemeš, *Brno University of Technology, Czech Republic*

Prof. Jolita Kruopienė, *Kaunas University of Technology, Lithuania*

Dr. Edyta Kudlek, *Silesia University of Technology, Poland*

Prof. Alfonso Mejia, *Pennsylvania State University, USA*

Prof. Majeti Narasimha Vara Prasad, *University of Hyderabad, India*

Prof. Eric Pirard, *University of Liège, Belgium*

Dr. Monika Sady, *Cracow University of Economics, Poland*

Prof. Agnieszka Sobczak-Kupiec, *Cracow University of Technology, Poland*

Prof. Krzysztof Szamałek, *University of Warsaw, Poland*

Dr. Beata Szatkowska, *Aquateam COWI, Norway – Poland*

Dr. Renata Tomczak-Wandzel, *Aquateam COWI, Norway – Poland*

Prof. Konstantinos Tsagarakis, *Democritus University of Thrace, Greece*

Prof. Sebastian Werle, *Silesian University of Technology, Poland*

Prof. Czesława Rosik-Dulewska, *Corresponding Member of the Polish Academy of Sciences, Institute of Environmental Engineering of the Polish Academy of Sciences in Zabrze, Poland*

Prof. Maria Włodarczyk – Makuła, *Czestochowa University of Technology, Poland*

Dr. Kari Ylivainio, *Natural Resources Institute (Luke), Finland*

Prof. Jacek Mąkinia, *Gdańsk University of Technology, Poland*

Dr. Klara Ramm, *EurEau & Chamber of Commerce Polish Waterworks, Belgium – Poland*

Dr. Marcin Kuczera, *CreativeTime, Poland*

Prof. Aleksandra Radlińska, *Penn State College of Engineering, USA*

Prof. Alina Pruss, *Poznań University of Technology, Poland*

Prof. Joanna Duda, *AGH University of Science and Technology, Poland*

Dr. Christine Costello, *Penn State College of Engineering, USA*

Dr. Tóth Zoltán, *University of Pannonia, Hungary*

Prof. Alexandros Stefanakis, *School of Environmental Engineering, Technical University of Crete, Greece*

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.

Contents

Introduction

I am very happy to share Book of abstracts, that includes all papers presented during 3th International Conference on Strategies toward Green Deal Implementation – Water, Raw Materials & Energy (ICGreenDeal2022).

The purpose of this conference was to present possible solutions that fit into the green economy and can be implemented under the Green Deal Strategies. This event is a is a continuation of the 1st International Conference Strategies toward Gren Deal Implementation – Water and Raw Materials, and 2nd International Conference on Strategies toward Green Deal Implementation – Water, Raw Materials & Energy (ICGreenDeal2021) which turned out to be a great success with more than 1500 Participants from all over the world.

The purpose of the ICGreenDeal2022 was to present the issue of climate change and ways to prevent it eg. innovative solutions (technological, environmental, economic, and social) that can be implemented under the Green Deal Strategies.

This publication includes papers presented at the ICGreenDeal2022 that took place 5-7 December 2022, online and was organised by the Division of Biogenic Raw Materials of the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences. I would like to thank all Participants – both Presenters and Listeners for sharing and listening almost 150 oral and poster presentations in 14 thematic sessions during this 3-days online Conference.

Together we CAN save the Planet!

Prof. Marzena Smol
ICGreenDeal2022 Chairwoman

Green Deal Strategy

5 December 2022

Marzena Smol
Mineral and Energy Economy Research Institute, Polish Academy of Science, Poland

Introduction – Inventory of Green Deal Strategies

In the process of green transformation, that is promoted all over the world, the green deal strategies (GDSs) play a critical role. The GDSs are dedicated to build a cleaner environment and to reduce human pressure on it, however the GDSs are not new proposals. In the last decades, the main assumptions of the GDSs were launched at the national (eg. in United Kingdom, United States, Canada, China, India), regional (eg. in Australia), the European (as European Green Deal) and international (United Nations) levels. They present several various measures to prevent climate change and counteract adverse effects (adaptation to climate change). It is worth to notice that they are important element of sustainable development, that aims to save water, energy and raw materials. The GDSs mainly focus on reduction of emissions of carbon dioxide and other greenhouse gases through limiting the role of fossil fuels in the energy mix in various countries and regions. It is worth to notice that the biggest economies as United States, China, or European Union indicated that actively participate in activities aimed at achieving climate neutrality, which is a common goal of various GDSs. This can be considered a global goal to protect our planet for both current and future generations.

Keywords: green deal, green deal strategies (GDSs), sustainable development

Ludwig Hermann
President of the European Sustainable Phosphorus Platform (ESPP), Proman Management GmbH, Austria

Importance of Raw materials – current trends and future perspectives

The global community has set itself ambitious goals: The 2030 Agenda for Sustainable Development, adopted by the UN General Assembly (193 nations) on September 25, 2015. In 2019 the European Union has adopted the Green Deal including Farm-to-Fork Strategy, Biodiversity Strategy, Chemicals Strategy, Zero Pollution Action Plan, and Circular Economy Action Plan. Among others, goals and strategies respond to the concern that planet earth does not have enough natural resources to allow consumption patterns of high-income countries for all: decoupling of material consumption from wellbeing is needed. Yet, the transition to renewable power sources like wind and solar, require extensive mineral resources to manufacture the required infrastructure for fossil-free energy. While we burn some 15 billion tons of fossil fuels to cover our current energy demand, we will need some 3 billion tons of – partly critical – minerals and metals to make use of wind and solar power as energy carriers. As Simon P. Michaux has calculated and outlined in the 2021 GTK Study (https://tupa.gtk.fi/raportti/arkisto/42_2021.pdf) 4 times the current power generation will be needed to phase out fossil fuels completely. Planet Earth's mineral reserves currently cover only 21,1% of Nickel, 8,9% of Cobalt, 23,2% of Lithium, and 49,2% of Graphite needed for one Li-ion battery for each of 1,39 billion vehicles of the current global transport system. We neither have the time nor the resources to replace all fossil fuels be wind- and solar derived electricity. Measures must be taken to increase efficiencies in all aspects of energy and materials consumption. The war in Ukraine has disrupted fertiliser supply chains and sky-rocketed natural gas prices, leading to a shut-down of at least 50% of European ammonia production capacities and threatening food-security, particularly in low-income countries. 4R agricultural practices, nature-based biodiversity support and recovery of nutrients can at least partially replace not-available fossil resources and become more important than ever.

Keywords: critical raw materials, decoupling, materials consumption, wellbeing, ammonia, 4R, efficiency, recycling

Iceland Liechtenstein Norway grants

Water in Circular Economy – water reuse

As part of the waterCEmanagement project

5 December 2022

Marzena Smol
Mineral and Energy Economy Research Institute, Polish Academy of Science, Poland

Water-CE-management in practice – key role of water in the transformation process towards a circular economy (CE)

Water, as one of the most common chemical compounds on Earth, has always been the most valuable natural resource, the importance of which cannot be overestimated. Its availability, in the right quantity and quality, determines the existence and development of all forms of life and is of key importance in the context of socio-economic development. From the beginning of the existence of primitive civilisations, their development took place only in places with high access to fresh water.

As a result of technological progress, there is a constant increase in the demand for water, whose resources, although constantly renewed, are not unlimited. According to a report by the United Nations (UN), water will become a scarce resource for more than half of the population our planet. To secure the water resources, that are currently being lost with wastewater, in the project „Water-CE-management in practice – developing comprehensive solutions for water recovery and raising awareness of the key role of water in the transformation process towards a circular economy (CE)" we aim to strengthen the transformation towards a circular economy (CE) in terms of circular management of water resources. The project objective is to develop a water reuse technology based on wastewater and rainwater reuse. Moreover, the project targets relatively low public awareness of circular and sustainable water management by a dedicated social information-educational campaign to popularise good practices of water recovery and building social acceptance for secondary water sources for household and industrial use.

Keywords: water reuse, circular economy, water

Acknowledgments: The study was conducted as a part of project „Water-CE-management in practice – developing comprehensive solutions for water recovery and raising awareness of the key role of water in the transformation process towards a circular economy (CE)", which is financed by Iceland, Liechtenstein and Norway through the EEA and Norway Grants.

Iceland Liechtenstein Norway grants

*Klara Ramm**
Chamber of Economy Polish Waterworks, Warsaw University of Technology

Water reuse in Poland - good examples

Due to climate change, water recovery from waste water is no longer applicable only in the countries of southern Europe. The use of reclaimed water can apply everywhere and in many branches of the economy (green areas, urbanized areas, agriculture, industry). In addition, it complies with the guidelines of the European Green Deal and the values of the circular economy. In Poland, water recovery from waste water is becoming more and more common for the internal needs of urban waste water treatment plants (technological purposes). Other applications are individual, but they can become good examples for subsequent implementations. Interesting case studies include the following applications:

- Józefów: purified water is used as a source for the heat pump, it is also supposed to be used to clean the streets.
- Katowice: treated municipal waste water is directed to the heat and power plant, where it is used as cooling water after treatment.
- Kasina Bike&Ski: reclaimed water is used to produce snow and irrigate the biologically active area.
- Kraków: reclaimed water is used to clean the streets.
- Płock: a project to transport treated waste water to an oil refinery is at the planning stage.

Water reuse is certainly an excellent method of saving resources and closing local water circuits. Urban waste water seems to be a good source of reclaimed water due to its rather stable and predictable composition. However, this does not exempt operators from appropriate quality control, conducting a reliable risk assessment and implementing an effective risk management system.

Keywords: water reuse, reclaimed water, circular economy

* k.ramm@igwp.org.pl

*Māris Kļaviņš**
University of Latvia, Latvia

Water reuse in Latvia - good examples

After regaining of independence Latvia declared strategy of national development and as one direction of activities was change of wastewater treatment practices and major reduction of loadings of pollutants. Major changes of wastewater treatment technologies as well as significant reduction of wastewater volumes was achieved because of significant investments in the sector and adoption of best practices as well as active international cooperation and support.

However, several problems were left without attention and some of problems were related to specific features of water management system of Latvia. So, for example as a significant problem can be considered lack of adequate wastewater treatment sludge processing capacities, missing approaches of recovery of substances from wastewater streams, reluctant attitudes in respect to development of special wastewater purification technologies from emerging pollutants (pharmaceuticals, microplastic, nanomaterials etc).

At the same time there is a consensus in respect to develop and expand water reuse at first in urban environments and keeping up of territories, reuse of water in agriculture, especially considering growing risks of drought, in industries, especially considering in various operations to use low quality water, as well as in recreation, forestry and other directions. As main barriers in respect to reuse of water can be considered lack of integration of water reuse options in water management planning, relatively increased costs of recovered water in comparison with costs of conventional water, technological limitations, lack of investments. Still as one of major obstacles can be mentioned low awareness of society in respect to reuse of water as well as high prioritisation of investments in climate change related problems and need to solve urgent energy independence challenges.

As success stories of water reuse can be mentioned intensive reuse of water in some industries, for example at production of glass fibres at washing stages, in plywood production and other fields. There is growing interest form municipalities on reuse of water for watering of parks. Highly prospective approach is use of grey waters for cultivation of energetic plants as the efficiency of this method has demonstrated its potential. Of growing interest especially from side of rural municipalities is development of artificial wetlands for low-cost purification of wastewaters at the same time recovering nutrients.

Keywords: wastewater, resource recovery, sludge, reuse, circular economy, water resource management

* maris.klavins@lu.lv

Renata Tomczak-Wandzel, Beata Szatkowska*
Aquateam COWI, Norway – Poland

Good practices in implementing green and blue infrastructure in Norway

Norway is often mentioned as a precursor in sustainable urban development. Nowadays the urban development's plans of the cities are influenced by climate change effects. Extreme precipitation challenges the conventional urban water management systems. Stormwater that runs off from impermeable areas increases the volumes of wastewater needs to be treated. Inefficient combined stormwater/sewage systems cause overflows allowing untreated wastewater to enter the environment. In some cases, stormwater can damage urban infrastructure. There is an ongoing transition towards more sustainable urban water management creating green climate-adapted, and flood-resilient cities. Investments in blue–green infrastructure (BGI) are increasingly considered to address these issues.

The selected examples of green and blue infrastructure implemented in Norway will be presented. Asker Panorama in Oslo is one of the first urban construction projects in Norway with a great biological diversity combined with strong investment in sustainable water management. The project in Asker municipality exemplifies high-tech blue-green cultivations on scarce land. The solutions prevent flood problems in the area. Green roof gardens retain stormwater. A large rain bed cleans and drains stormwater together with overflow surfaces and filter masses in "cleaning cassettes" below ground. Another example is Klosterenga Park in Oslo. The stream flowing through the park has a central role in adapting to climate change, dealing with stormwater and flood events, improving the water environment, facilitating fishing environments, strengthening urban ecology, connecting the sculptures, increasing opportunities for outdoor life and better public health.

Keywords: green roofs, ecosystem services, urban planning, green space, climate change

Acknowledgments: The authors gratefully acknowledge co-funding from the National Fund for Environmental Protection and Water Management (MFEOG.07.03.03-50-0114/21-00) under the EEA Financial Mechanism 2014-2021.

* retw@aquateam.no

*Ahmad Elmoll**
Univesite Libanaise, Lebanon

Eco-innovative technology for wastewater treatment and reuse in Eastern Mediterranean region: Case of Lebanon

Climate change, coupled with water mismanagement and overconsumption, is causing droughts and water shortages across many parts of the globe. Due to climate change, two-thirds of mankind will face water scarcity by 2025. On the other hand, 15 million m3/day of untreated wastewater is used globally for crop irrigation, polluting the soil with pathogens, heavy metals and excess salts. Add to that, wastewater generation is expected to increase by 51% by 2050.

Despite the opportunities that wastewater presents, the global reality is that only a very small portion of the total wastewater produced is collected and treated, let alone harnessed for resource recovery. According to UN Water, in low-income countries, only 8% of the wastewater generated undergoes any treatment.

To overcome water scarcity and protect the environment, a paradigm shift is needed to improve wastewater management and adopt green solutions in the water sector. This means investing in environmentally friendly technologies, recovering materials based on technological innovation and the circular economy

The objective is to go beyond depollution and seek to recover waste water. As a result, the wastewater sector in the Mediterranean region must instead begin to see the potential of treatment plants as water resource recovery facilities.

These reclamation facilities can protect human health, recover and conserve resources with the ability to recover valuable resources from wastewater, such as phosphorus, nitrogen, and biogas, as well as conserving water for reuse, drinking, and agriculture use.

This paper discusses the water scarcity and potential of wastewater as a resource A scientific approach to wastewater recovery and reuse. The paper starts with a brief explanation of the current global situation regarding wastewater and a simple overview of wastewater treatment, before going into more detail about the resources that can be recovered from it and how. To conclude, a summary in using wastewater as a resource is provided along with an overview of recent technological developments in the processing of wastewater adopting circular economy principles.

Keywords: wastewater, resource recovery, water scarcity, reuse, circular economy, sustainability

* aelmoll@ul.edu.lb

Circular Economy & Green Deal challenges

5 December 2022

David Knäble[1], Konstantinos Tsagarakis[2]*
[1]Hochschule Offenburg, Germany
[2]Technical University of Crete, Greece

German companies engagement in Circular Economy: A LinkedIn approach

The Circular Economy (CE) relevance in Germany is discussed based of LinkedIn available data. Our sample included information from company profiles with "circular economy" in their description or any other field collected at three consequent time sampling periods. In total data from 428 companies were collected with location in 15 of the 16 German administrative regions. Most companies are reported in the federal state of Berlin (106) followed by North Rhine-Westphalia (83) and Bavaria (64). An increase in CE companies was recorded in 13 of the 16 federal states over an eight-month period. In terms of the "industry" field companies are self-classified with the most dominant industries: environmental services (46), management consulting (43), renewables & environment (41), research (27) and think tanks (15). Regarding the employees of those companies with LinkedIn activity, 11674 people are employed in the 428 companies, from one to 1303 employees per company. All examined companies have a total of 511356 followers on LinkedIn, ranging from none to 33719. Finally, based on the R-strategies, we looked into the companies' profiles and found that about 20% of them involved the term "Recycling" in their specialities, while the terms "Refurbish", "Repurpose" or "Rethink" were not specified by a single company. Some of them employ "Reuse", "Recovery", "Repair", "Remanufacturing" or "Reduce" activities. This work not only provides data into the increasing relevance and marketing trends of the circular economy in German companies, but also essential insights to conduct further national or regional studies with readily available data from LinkedIn.

Keywords: circular economy, industry sectors, social media, sustainability, LinkedIn

* david.knaeble@hs-offenburg.de

George Tsironis[1], Theodoros Daglis[2], Konstantinos Tsagarakis[3]*
[1]Democritus university of Thrace, Greece,
[2]University of the Aegean, Greece,
[3]Technical University of Crete, Greece

Circular economy companies in LinkedIn

The aim of this paper was to deliver valuable insights regarding the circular economy (CE) business activities, worldwide. Those insights arise from data extraction regarding companies' profiles on LinkedIn. LinkedIn is a social media networking platform, providing users with publicly available data related to user and company profiles, job advertisements, groups, events, services, etc. More precisely, we performed text mining from companies' profiles containing the term circular economy, in any profile field. In this context, 7533 companies were selected, and their data were extracted and stored into excel sheets for further analysis. At first, we present the companies' geographical distribution according to their headquarters (UK=865 companies, USA=635, Netherlands=569, Italy=453, Germany=398, etc.). The companies are self-classified in the distinguished industries: Environmental Services (1190), Renewables & Environment (1070), Management Consulting (474), Research (271), Information Technology & Services (239), Apparel & Fashion (235), Design (235), Non-profit Organization Management (202), Plastics (185), Biotechnology (151), etc. Moreover, we further analyzed the Companies' LinkedIn employees, followers, and year of foundation, with the last one indicating a significant increase in new CE companies over the last decade. Additionally, we filtered all keywords that contained in the companies' "Specialties" description. Among them, we have located about 60 R strategies, practices, functions, conceptualizations, and approaches leading to circular economy transition. Finally, comparing those findings with other studies, we found that Linkedin provides a high-quality pool of data, regarding industry and business sectors.

Keywords: circular economy, sustainability, business, LinkedIn, text mining

* gtsironi@env.duth.gr

*Hanna Tiutiunnyk**
State Organization "Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine", Ukraine

Blue and green zones in Circular Economy in the context of aquaculture development

The main objective of the study is the scientific concept of the development of eco-industrial parks with a focus on agricultural and aquaculture products based on a creative and innovative approach is the basis of a new look at circular economy models with an emphasis on increasing the ecological and aesthetic value of blue and green zones, recreational and innovative use in addition to economic. This model provides for the formation of organizational and economic mechanisms and tools (for example, rainwater) to increase the effectiveness of the sustainable development of the aquaculture market on the basis of the introduction of circular economy models, taking into account the best international practices.

The Eco-Industrial Park will be a place for business and community leaders to unite economic, social and environmental goals, develop marine research and technology. This is a model in which vegetation and associated commodities will be used to generate electricity, which is channeled into the commercial production of aqua- and mariculture, organic vegetables, and water treatment (e.g. protection of sensitive ecosystems, restoration of natural resources, construction of stormwater catchment ponds). The Eco-(Aqua)-Industrial Park is a demonstration of the connections between ecosystem health, food systems, community health, economic and creative opportunities.

Keywords: aquaculture, eco-industrial park, blue zones, green zones, mariculture, circular economy

* ecoregnaturres@ukr.net

Szymon Kilian, Katarzyna Pawęska, Aleksandra Bawiec*
University of Environmental and Life Sciences, Poland

Green and blue infrastructure in cities

Green and blue infrastructure in modern cities (e.g. inner city water reservoirs, constructed wetlands, city parks) is an important element of urban landscape. They increase biodiversity, mitigate heat islands effect, create additional retention, which is crucial as water stress induced by global climate change is increasing. Due to their function they receive a number of pollutants, resulting in degradation of water quality. This results in a need of revitalization treatments, which are not carried out mainly due to the high cost of their implementation. Thus there is a need to implement new solutions.

Main goal of this study is to review carried out, and future studies about natural based solutions (NBS) meant to improve green and blue infrastructure overall quality in Wroclaw city.

In Wrocław city (51° 6' 36"N, 17° 1' 48"E) were investigated two inner-city water reservoirs. Pond in Stanisław Tołpa park and the City Moat. In S. Tołpa Park pond mean value of ammonium nitrogen is 0.20 mg/dm3. Total nitrogen has mean value of 15.19 mg/dm3. Total phosphorus mean value is 0.756 mg/dm3. In the City moat mean value of ammonium nitrogen is 0.16 mg/dm3. Total nitrogen has mean value of 2.97 mg/dm3. Total phosphorus mean value is 2.90 mg/dm3. Based on carried out studies various NBS were proposed for both reservoirs.

Main factors shaping quality in those reservoirs is runoff from impermeable surfaces and infernal loading phenomenon. One of NBS showing promising results are floating islands systems.

Keywords: green and blue infrastructure, inner city water reservoirs, natural based solutions, floating islands

* szymon.kilian1@upwr.edu.pl

Wioletta Wrzaszcz, Konrad Prandecki*
Institute of Agricultural and Food Economics National Research Institute, Poland

Opportunities and threats to achieve the strategic objectives of the European Green Deal in agricultural sector in Poland

European Green Deal (EGD) strategy intensified discussion about involvement of EU Member states in the achievement of specified long-term aims, in majority, in the perspective 2030. Superior issue of EGD is transformation of the EU towards wider and more advanced sustainability, including economic, social and environmental aspect. One of the most important sector – in the context of sustainable development – is agriculture. Agricultural production fulfils different functions, i.e. agricultural and food production, economic benefits and environmental and climate protection. The appointment and reinforcement of sustainable path of agriculture development is a key to environment and climate consideration and EGD purposes achievement. The aim of the paper was identification of the main opportunities and threats to achieve strategic objectives of the EGD in agriculture in Poland. Research methodology was based on literature and legal – the EU and Polish – documents analysis, as well as empirical research based on public statistics data. The negotiated participation of Poland in the EU targets is lower than the average for the Community, but it doesn't mean that achievement of established aims in agriculture will be common and simple. One of the main opportunity in this transformation will be implementation of Polish Strategic Plan for 2023-2027, offering wide range of measures for farmers and their environment. While as a threat, insufficient farmers` conviction that green transformation is profitable and coherent with market rules, can be indicated. The achievement of strategic aims in agriculture in the perspective of 2030 is burden with the risk of partial unfeasibility.

Keywords: European Green Deal, agriculture, sustainability, Poland

* wrzaszcz@ierigz.waw.pl

Bioeconomy & Climate

5 December 2022

*Olga Iermakova**
State Organization "Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine", Ukraine

Factors of ecological interactions of the aquaculture sector and the environment

The main objective of the study is a sustainable development of the aquaculture sector in context of ecological concepts, such as ecosystem approach, Green Deal, blue economy, blue food, organic production, circular economy, inclusive markets. Factors and indicators of sustainable development of the aquaculture sector were determined. It is revealed a mutual influence of aquaculture activities and the environment. On the one hand, aquaculture objects are sensitive to changes in environmental conditions: pollution of the aquatic environment, unsatisfactory water quality, evaporation and a significant decrease in the water level in rivers and ponds, unsatisfactory quality of aquatic biological resources, illegal fishing that violates the biobalance. On the other hand, aquaculture activities have both positive and negative effects on the environment. The negative impact of the aquaculture sector on the environment is characterized by the following factors: irrational usage of resources, pollution (chemical, organic) of water bodies, genetic pollution, infectious diseases and parasites, energy consumption, depletion of natural resources, CO2 emissions, sewage pollution, non-productive fish losses. The model of sustainable development of the aquaculture sector that is based on improvement of economic and social indicators together with reduction of the negative impact on the environment is proposed in the research. On the basis of the conducted analysis, the following main tasks of implementing the policy of ecologically safe development of the aquaculture sector were determined: regulating the volume of water usage and ensuring the quality of water in aquaculture production; optimization of energy usage, including the involvement of alternative energy sources; reduction of CO2 emissions; waste processing.

Keywords: aquaculture, environment, sustainable development, mutual influence

* impeer@ukr.net

*Majeti Narasimha Vara Prasad**
University of Hyderabad, India

Plant diversity for environmental cleanup and bioeconomy

Plants are the most appropriate organisms to mitigate pollution. This aspect is highly emphasized for their utility in contemporary science. Several of the members of Amaranthaceous, Asteraceae, Brassicaceae, Brassicaceae, Cannabaceae, Cannaceae, Caryophyllaceae, Chenopodiaceae, Cunoniaceae, Cyperaceae, Euphorbiaceae, Fabaceae, Flacourtiaceae, Lamiaceae, Poaceae, Pontederiaceae, Salicaceae, Typhaceae and Violaceae are the potential candidates for phytoremediation, a concept evolved due to the adaptive and tolerance strategies of the different plant taxa

Brassicaceae had the largest number of taxa viz. 11 genera and 87 species. Different genera of Brassicaceae are known to accumulate metals. Ni hyper accumulation is reported in 7 genera and 72 species, and Zn in 3 genera and 20 species. Among monocots, grasses viz. *Agrostis capillaries* and *Festuca rubra* are proven globally for reclamation technology for a variety of mine tailings and metal contaminated soils.

To date approximately 400 taxa of metal tolerant plants ranging in growth habit from annual herbs to perennial are known. Hyper accumulator plants have been identified on all continents, both in temperate and tropical environments *Sebertia acuminata*, (A tree Sapotaceae, endemic from new Caledonia,) is the classic example capable of concentrating Ni up to 26% (on dry matter basis) in the xylem tissue. In Portuguese serpentine ecosystems, *Alyssum serpyllifolium* a dominant weed accumulates up to 10,000 ppm of Ni in the leaves.

Therefore, in this paper these aspects shall be highlighted for the role of plant growth promoting rhizo- and/or endophytic bacteria in accelerating phytoremediation.

Keywords: bioeconomy, environmental, plants

* mnvsl@uohyd.ac.in

Adam Nawrocki, Robert Popek, Arkadiusz Przybysz*
Warsaw University of Life Science, Poland

We are what we breathe – urban meadow as a promising solution for clean air in the vicinity of roads

Improving the quality of urban air is a difficult task. Many urban areas are characterized by polluted air that endangers the health of the inhabitants. One of the most dangerous air contaminations is particulate matter (PM). The main source of PM in the urban areas is road traffic. It is well known that the air can be biofiltered by plants, especially trees and shrubs. Unfortunately, little attention has been paid to herbaceous plants growing in the urban meadow. In this study, the biofiltration potential of an urban meadow located close to the high traffic road in the Warsaw (Poland) was investigated. The amount of PM accumulated by the urban meadow was measured in four seasons (spring, summer, autumn, winter). Plants samples were harvested from different distance from the road (1 m and 8 m). The plants height, their air-dry weight and species composition of the meadow were assessed. The level of PM concentration in the air was detected with Air Dust Controller. The obtained results showed that urban meadow have a great potential to accumulation PM emitted from road sources and play significant role in purification of air all year round, also in winter.

Keywords: air pollution, herbaceous plants, particulate matter (PM), urban meadow

Acknowledgments: This research was partly funded by National Science Centre, Poland [Grant number: 2020/39/D/NZ9/00969].

* adam_nawrocki@sggw.edu.pl

German Smetana, Anna Grosser*
Częstochowa University of Technology, Poland

Kinetic study of high-solids anaerobic co-digestion of pre-treated organic waste in terms of methane production

Waste management and fossil fuel dependence still pose a serious problem globally, and existing solutions not always can cope with their inherited limitations. Recognized methods of management of biodegradable waste, including sewage sludge, supported by many years of experience are composting and anaerobic digestion (AD). Currently, the most used solution in the world is wet anaerobic digestion (wet-AD). However, it has some limitations resulting from the high hydration of the feed, which requires the construction of large-volume anaerobic digestion chambers. In addition, wet-AD is characterized by a high demand for water, which may be debatable in regions struggling with its shortage, such as India. Managing digested sludge (digestate) is also problematic; dewatering and drying digestate requires a high demand for surfaces and energy and may lead to the loss of nutrients. For this reason, more and more attention is paid to the development of dry technologies, which is supported primarily by the possibility of working with a higher load of organic load, a smaller volume of reactors and the minimum need for digestate dewatering. For these reasons, this study aimed to conduct mesophilic and thermophilic batch high-solids anaerobic digestion (HSAD) of sewage sludge (SS) with grease trap sludge (GTS) and algae biomass (AB). Additionally, to shorten the long digestion time, which is the bottleneck of the process, in this study, various pre-treatment methods were used. The effectiveness of the conditioning methods was assessed based on the results of the biochemical determination of the methane potential and the analysis of the kinetics of the process with the use of five kinetic models. The thermochemical pre-treatment method observed the most pronounced pre-treatment effect on the studied SS/GTS/AB mixture at mesophilic temperature. Its methane yield was 109.48 ± 0.00 N-mL-CH4 ·g-VS-1, which was 110% higher in comparison to the control (52.21 ± 0.00 N mL-CH4 ·g-VS-1). High-solids co-digestion significantly increased lag phase time (more than 30 d). However, thermochemical pre-treatment improved that parameter by 26.3% compared to the control.

Keywords: anaerobic digestion, algae biomass, kinetic study, co-digestion, biogas, wastewater treatment, renewable energy, grease trap sludge, sewage sludge.

Acknowledgments: The scientific research was funded by the statute subvention of Czestochowa University of Technology (BS/PB-400/301/22).

* gerkus20123@gmail.com

*Dominika Bar-Michalczyk**
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Nitrogen leaching losses from agricultural area in central Europe under climate changes scenarios

The European Green Deal as previous strategy documents as the EU Water Framework Directive require put a lot of effort into reducing nitrogen (N) loadings to water ecosystems like rivers, lakes and seas. Besides changes in socioeconomic developments, future climate change will affect effectiveness of mitigation measures. The aim of the study was to compare the effects of different climate changes scenarios to the leaching losses of nitrogen from agricultural area in central Europe, the Baltic Sea region – Kocinka catchment area.

The baseline period for land use, land management and climate was 20-years period of 1991-2010. The climate and socioeconomical change scenarios cover also 20-year period (2041-2060) and was based on the RCP8.5 emission scenario and four climate models. Future changes were based on scenario taken from the Shared Socioeconomic Pathways (SSP) SSP1 show sustainability, pro-ecological path of future development and SSP5 fossil fuelled development. The effects on N leaching were analysed with the NLES4 leaching model. Model was recalibrated for the climate change scenarios using baseline data with the Daisy simulation model.

Results shows that climate change generally leads to higher N loads. The mean N leaching from agriculture land was 28-34 kg N ha-1 in baseline period and increase to 38-52 28-34 kg N ha-1 under climatic changes. The leaching in SSP1 was higher in future climate scenarios than in baseline and it was reduction by 2-3 kg N ha-1 under baseline climate and 3-5 kg N ha-1 under future climate. However, in SSP5 N leaching was increased by 3 kg N ha-1 under baseline climate and 4-5 kg N ha-1 under future scenarios . Results shows that measures to reducing N losses will have to be applied to a great extent to avoid to reduce the efficiency.

Keywords: nitrate, climate changes, Shared Socioeconomic Pathways

Acknowledgments: The work was supported by BONUS-Soils2Sea project (http:/www.soils2sea.eu) financed by the European Commission 7 FP contract 226536 and the statutory funds of the AGH University of Science and Technology (project No.11.11.140.026 and 11.11.220.01).

* dominikabm@meeri.eu

Raw materials & Sustainability

6 December 2022

Jolita Kruopienė, Inga Gurauskienė, Aušra Randė*
Kaunas University of Technology, Lithuania

Lithuanian situation in the context of planetary boundaries for biochemical flows of P

Biochemical flows of phosphorus (P) are one of the planetary boundaries, which is already beyond the zone of uncertainty, meaning that too much P is transported via freshwater systems into the ocean. The global situation is made of the regional situations. Thus, an analysis was carried out to assess biochemical flows of P in Lithuania: surface waters from its territory enter the eutrophication-affected Baltic Sea, the bottom of which sometimes has anoxic conditions.

The updated analysis of the planetary boundaries presents Lithuania as a territory that stays within the boundaries for phosphorus, i.e. safe. Nevertheless, according to our estimates, more than 1000 tons of P reach the Baltic Sea each year because of anthropogenic activities in the country. The most systemic options to keep within the planetary and regional boundaries are to reduce the use of "new" P. Agriculture, especially crops growing, is the main consumer of P in the country. Analysis showed that almost 16% of phosphorus entering the soil of agricultural areas in Lithuania is "non-new", i.e. secondary phosphorus. More than half of that comes from livestock manure; then follows P in compost and P with sewage sludge. The analysis confirmed that there is no excessive accumulation of phosphorus in the soil. At the same time, there are still opportunities to increase the share of secondary phosphorus by developing and implementing circularity solutions.

Keywords: phosphorus, Lithuania, biochemical flows, secondary phosphorus

* jolita.kruopiene@ktu.lt

Tejaswini Dash, K. Sowjanya Sree*
Central University of Kerala, India

Sustainable shrimp culture effluent remediation by duckweed

Untreated Shrimp culture effluent is one of the causes of water pollution. Duckweed-based wastewater treatment is a sustainable way to remediate wastewater rather than conventional treatment as it can uptake nutrients from the polluted water body. These plant species are the fastest-growing flowering plants, grouped into five genera and 36 species. In the present report, we investigated the relative growth rate of a clone of Spirodela polyrhiza in different dilutions of shrimp wastewater: 50%, 25%, and 10%, including undiluted shrimp wastewater, collected during various stages of shrimp culture, such as fry, post-larval, and adult stages. Water samples were collected from shrimp culture pond in Kerala. The growth rate was calculated after 14 days of the experiment. Data were analyzed through one-way ANOVA. A negative growth rate was found in undiluted samples, whereas a positive growth rate was found in 25% and 10% dilutions of wastewater collected from the three stages of shrimp culture and in the half-diluted, only in the fry stage. A higher growth rate was observed in 10% dilutions of wastewater in all three phases of shrimp cultivation. The biomass of duckweed thus produced can be put to sustainable use.

Keywords: duckweed, sustainability, shrimp culture effluent, relative growth rate

* tejaswini.dash835@gmail.com

*Oleksandr Laiko**
State Organization "Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine", Ukraine

Sustainable manufacturing development and its effect on cohesion policy realization in Ukrainian economic system

The importance of the industrial development of regional economic systems according to the SDGs and EU cohesion policy is determined by the need for resilience building in Ukraine under the war influence. The main scientific task is to determine the methodology of the industrialization ensuring of the regional economies on the basis of value added, defence and humanitarian security increasing and decoupling.

The paper objectives include analysis of the prospects for the implementation of SDGs 9 and 11 for the regions of Ukraine under the influence of war, determining strategic directions, mechanisms and tools for ensuring the resilience of regional economic systems to external influences based on processing enterprises development as the main producers of value added.

The methodical approach to assessing the implementation of SDGs 9 and 11 is proposed, which expands the list of indicators with 15 measures of waste-free processing industry, decoupling, innovativeness and inclusiveness in the formation of functional settlements with safety and self-realization opportunities for Ukrainian regions in context of the war influence and relocation of enterprises from war zones.

The results of the analysis obtained using the statistical methods and modelling substantiated 3 main strategic directions for achieving the goals: creation of multifunctional industrial parks combined with settlements; support of spatial and sectorial cooperation for decoupling and cohesion; digitalization and inclusiveness in global transfer of innovations processes. Financial, investment, institutional mechanisms and tools for implementation of the strategic directions are defined.

The conclusions of the research confirm the need for state support for the industrialization of regional economic systems, in particular through the implementation of local, regional and national strategies for the functional settlements formation with industries location.

Keywords: sustainable manufacturing, economic cohesion, economic resilience

* alexlayko@gmail.com

*Weronika Muszyńska**
SGH Warsaw School of Economics, Poland

Sustainable human resource management from the perspective of people holding managerial positions in Polish enterprises

The birth of the concept of sustainable human resource management is a consequence of the interest of theoreticians and practitioners of management in the issues of sustainable development. Currently, people in managerial positions are assigned a major role in the process of transforming modern enterprises into sustainable organizations. The aim of the paper was to present the concept of sustainable human resource management and to try to answer the question of how people holding managerial positions in Polish enterprises understand sustainable human resource management. In order to achieve the indicated goals, a qualitative study was conducted in the form of individual in-depth interviews (IDI). 12 people holding managerial positions in service enterprises located in Warsaw were included in the study. The conducted study allowed to conclude that sustainable human resource management by the respondents is understood: as a challenge posed by the organization to the changing environment, as an opportunity to stand out from the competition, and also as an aspect that will be increasingly paid attention by employees. However, in the opinion of some respondents, reliable and comprehensive implementation of the concept of sustainable human resource management is a long-term process generating only costs for the enterprise. But some of the respondents were not able to assess which of the initiatives implemented in their organizations, can be considered as part of the concept of sustainable human resource management. The obtained results open the field for further empirical exploration.

Keywords: sustainability, HRM, sustainable HRM, managers, service enterprises

* wm83763@doktorant.sgh.waw.pl

Energy & Raw Materials in Green Deal

6 December 2022

Māris Kļaviņš, Linda Ansone-Bertina, Lauris Arbidans, Una Celma*
University of Latvia, Latvia

Progress at development of carbon capture technologies a tool to achieve carbon neutrality aims

Climate change problems are becoming a priority issue worldwide and requiring urgent actions to reduce emissions of greenhouse gasses (GHG). However, reduction of GHG emissions alone cannot help to reach climate neutrality aims as it is stated in EU Green Deal. To reach climate neutrality aims at the same time keeping up welfare level of society, it would be important to capture carbon emitted during different technological processes, at first as a result of combustion or incineration technologies. Thus, major efforts should be put on development and implementation of carbon capture and storage (CCS) technologies. There are several approaches suggested and already implemented at pilot scale. But further testing of different approaches still is actual. One of sectors, where CCS technology application would be essential is waste processing technologies. Aim of our research is to study possibilities to develop materials for CCS and demonstrate their potential for small scale CCS, relevant for waste treatment. The application of pre-combustion carbon capture to waste gasification syngas can provide opportunities to reduce emissions of CO_2. A number of sorbents, prospective for CCS have been elaborated and their application potential demonstrated.

Keywords: carbon capture and storage, gasification, metal organic frameworks, hydrochar

Acknowledgments: Research is supported by ERDF project Nr.1.1.1.1/19/A/013 "Innovation of the waste-to-energy concept for the low-carbon economy: Development of novel carbon capture technology for thermochemical processing of municipal solid waste (Carbon Capture and Storage from Waste - CCSW)".

* maris.klavins@lu.lv

*Bartosz Sobik**
SGH Warsaw School of Economics, Poland

Challenges related to Polish Energy Transition – technical, financial and social aspects

Energy transition is a key challenge not only on a cross-sectoral perspective, but also on an entire economy-wide level. The energy transition aggregates three levels: technical, financial and social. Each of these brings with it a number of challenges. The existing investment gap in the electricity sector, problems related to acquiring capital for large investment projects, as well as the need to decarbonise the energy sector are the fundamental challenges facing the energy sector in Poland. The main aim of the paper is to present the key challenges to the implementation of the energy transition in Poland, as well as the steps that need to be taken to implement key energy investments. Current troubles related to the investment in the shift towards green energy in Poland, as well as the reality of the energy and geopolitical crisis makes the energy transition an even greater and more important challenge. Lack of investments and difficulties in capital gaining from EU could pose a threat on entire energy transition plan. Energy transition in Poland is a crucial part of improving the energy security. Thus, the topic addressed in that speech is vital for whole economy.

Keywords: energy transition, green finance, renewable energy, investment, energy sector

* bs68126@doktorant.sgh.waw.pl

*Irina Kliopova, Ugnė Jomantienė**
Kaunas University of Technology, Lithuania

Energy efficiency opportunities in industrial sector: case study

Within the framework of the Climate Change Mitigation Program in Lithuania, it is planned to reduce the amount of GHGs by 30% (compared to 2005), the share of RES in the balance of final energy consumption should be 45%. The main direct and indirect source of GHGs in the Lithuanian manufacturing industry is associated with the production and use of energy (thermal, electricity, and cold). Therefore, improving the energy efficiency of technological and energy production processes by implementation of Cleaner Production methods, the use of RES provides an opportunity for the industry to contribute to the achievement of above mentioned goals.

For the study, a pet food production company was selected. Energy intensity within the company is up to 556 kWh per tonne of manufactured products (MP), level of GHGs is 0.097 t CO2e/t MP. It was determined that a significant amount of energy is consumed specifically in auxiliary processes, such as heating, ventilation, air conditioning, as well as in the production of thermal energy by burning natural gas.

During the feasibility analysis it was evaluated that the installation of air coolers, operating on the principle of water evaporation, would reduce electricity consumption in the ventilation system by 6.4 times, eliminate the use of Freon R410A; implementation of condensing economizers within the combustion plant would increase efficiency of energy production by ≈9%; installation of a solar power plant (1200 kWp) would produce ≈7% of electricity from RES. The implementation of these alternatives would allow reducing GHGs by more than 15%.

Keywords: energy efficiency, Cleaner Production, reduction or GHGs

* ugne.novogreckaite@ktu.edu

Baibhaw Kumar, Gábor L. Szepesi, Zoltán Szamosi and Gyula Krámer*
University of Miskolc, Hungary

Combined solar drying analysis of wood-chips, sawdust and pellets

The future of conventional fuels has limited sustainability and creates disquietude because of the ubiquitous energy crisis worldwide. The judicious use of biomass or wood-based fuels is inevitable. The quality of wood fuels depends on the moisture content, and henceforth, solar drying solutions can play a vital role in properly storing and controlling moisture in the fuels. In the present study, a novel cabinet solar dryer was developed and investigated for its thermal performance. An Artificial Neural Network (ANN model) was created to predict the final moisture content of the drying system. The drying behavior of three distinct wood fuels i.e. woodchips, sawdust, and pellets were kept under observation to plot the drying curve based on their calculated moisture ratio. The dryer reached a maximum temperature of 60°C with maintaining a temperature gradient of 10-20°C. The maximum thermal energy and exergy efficiency was recorded as 55% and 51.1%, respectively. The ANN-optimized model was found suitable with reasonable values of coefficient of correlation (R) for the model.

Keywords: solar drying, woodchips, sawdust, pellets, artificial neural network

* kumarbaibhaw09@gmail.com

*Pinar Kocabey Çiftçi**
Gaziantep University, Turkey

The Importance of Energy Efficiency Efforts for Textile Industry via Corporate Carbon Footprint Analysis

Energy is one of the vital sources for sustainability of manufacturing systems. Most of the industries perform their product and service productions highly depended on the imported energy for their facilities. Textile sector can be accepted among the industries which require high amount of energy. For that reason, using the energy more efficiently is one of the vital factors for these companies. In this study, how several different energy efficiency efforts can affect the corporate carbon footprint of a company is investigated. The corporate carbon footprints of the company before and after the energy efficiency efforts are calculated. The results indicate that even small efforts have high potential to decrease corporate carbon footprint of the studied company. In particular, indirect emissions tend to decrease due to the decrease at the imported energy from outside of the company boundaries. Thus, it is important to state that although the companies cannot have enough budgets to make an expansive modernization for their technology and energy supply system, they can still improve their energy efficiency with simple techniques and measurements and decrease their environmental impacts.

Keywords: energy efficiency, carbon footprint, textile industry

* pinar_kocabey@gantep.edu.tr

Sustainable waste management

6 December 2022

*Irina Kliopova, Ieva Martinaitytė**
Kaunas University of Technology, Poland

Application of the principles of Integrated Waste Management to paper mill sludge: case study in Lithuania

The objective of this study was to investigate the waste management system in the paper manufacturing company Grigeo AB, which has been implementing circular economy principles in Lithuania for many years: over 40% of its products are made from paper and cardboard waste. The company has implemented several cleaner production projects that have enabled it to optimize the use of materials and energy, and to reduce natural gas consumption.

This study focuses on paper mill sludge, which is currently being dewatered and composted. The results of the laboratory analysis showed that despite its high organic matter content (≈36 % DM), this sludge does not have composability due to its high content of carbon (≈35 % DM) compared to nitrogen (up to 0,22 % DM) also the sludge contains calcium (≈19,3 % DM). The study proposes to analyse the sludge as a by-product in the production of ceramic bricks as a burning additive (clay and quartz sand mixed with dried sludge at 10 % by mass). Another alternative considered is the production of a solid biofuel derivative (using 15 % of the optimum amount of dried sludge) and burning it in the company's biofuel combustion plant.

Keywords: paper mill sludge, integrated waste management, solid biofuel

Acknowledgments: We would like to thank the employees AB Grigeo for the opportunity to analyse the processes and conduct the study.

* ievukasmartin@gmail.com

Rosa Nascimento[1], Emmanouil Papaioannou[2], Teresa Brás[3], João Crespo[4], Luísa A. Neves[4]*
[1]NOVA University Lisbon, Portugal
[2]Lancaster University, United Kingdom
[3]Alentejo Biotechnology Center for Agriculture and Agro-food (CEBAL), Portugal; MED – Mediterranean Institute for Agriculture, Portugal
[4]NOVA School of Science and Technology, Portugal

From agriculture and food industry wastes to biopolymers: cellulose extraction from banana plant pseudostem and beetroot pulp

Juice, canned, frozen fruits and vegetable industries generate approximately 11.5 million tonnes of waste annually after their processing. At the same time, other agricultural commodities produce residues, such as the banana production, which generates around 114.08 million tonnes wastes. These waste materials can lead to environmental problems, such as microbial growth and the emission of greenhouse gases. This work is focused on the recovery of nanocellulose from beetroot pulp, a residue from juicing industry, and banana plant pseudostem, a residue from banana production, in line with the principles of circular economy. Initially, both biomasses' composition was characterized in terms of ashes, extractives, hemicellulose, holocellulose, lignin and moisture content. Banana plant pseudostem shows a higher cellulose content (18.45% w/w) than beetroot pulp (11.42% w/w). Subsequently, these biomasses were used for cellulose extraction by enzyme-assisted hydrolysis. Five different enzymatic preparations were evaluated, with appropriate combinations of laccase, pectinase and cellulase enzymes. The enzymatic cocktail that led to the lowest fibre size for both biomasses was the one comprising simultaneously the 3 enzymes tested, being selected for optimization using a Response Surface Methodology. A Box Behnken design was chosen as design model, using 3 factors: enzyme concentration (expressed in enzymatic activity units), pH and temperature. The responses were evaluated in terms of reduction of particle size, which is related with the amount of non-cellulosic material digested by this pre-treatment. The lowest particle size obtained for the banana plant pseudostem was 22.6 µm, corresponding to a decrease in size of 83.62%, compared with the initial particle size (138 µm) before enzymatic hydrolysis; and for the beetroot pulp the lowest particle size obtained was 4.95 µm, which corresponds to a 95.05% particle size reduction (199 µm). These results confirm that beetroot pulp has the highest potential for extraction of nanocellulose.

Keywords: banana plant pseudostem, beetroot pulp, nanocellulose, enzyme-assisted extraction, circular economy.

Acknowledgments: This research was funded by the Associate Laboratory for Green Chemistry - LAQV which is supported by national funds from FCT (UIDB/50006/2020, UIDP/50006/2020). The PhD scholarship of Rosa E. A. Nascimento (2020.05490.BD) was funded by FCT-Portugal. The authors also acknowledge the International Exchanges 2020 Round 1 of The Royal Society, contract number IES\R1\201204 for the financial support.

* re.nascimento@campus.fct.unl.pt

Anna Bogush[1], Ondřej Mašek[2], Wolfram Buss[2], Konstantin Ignatyev[3]*
[1]*Coventry University, United Kingdom*
[2]*University of Edinburgh, United Kingdom*
[3]*Diamond Light Source, United Kingdom*

Residues from Biomass Thermal Treatment and Wastewater Treatment Plants as Agricultural Fertiliser: Nutrients Harvesting from Waste

Synergistic solutions, such as industrial symbiosis, when wastes/by-products from one industry can be considered as resources/materials for another industry, are becoming very attractive for sustainable development and circular economy. Residues from biomass thermal treatment and wastewater treatment plants are rising continuously. This study represents potential utilisation of wastes/by-products (e.g. biomass ash, biochar and sewage sludge) in agriculture as sustainable industrial symbiosis solution. Comprehensive characterisation of biomass ashes and biochars with emphasis on element speciation, and solubility of nutrients (e.g., potassium - K and phosphorus - P) and pollutants were investigated for potential utilization of these residues for soil nutrition. The proposed chemical classification for biomass ashes is useful to make appropriate selection of biomass ashes for effective application and predict their performance. Biochar is inert and safe to use, but typically contains low amounts of K and P available to plants, thus making its usefulness limited. In an innovative process, sewage sludge was treated with a low-cost potassium acetate followed by pyrolysation. The percentage of water-extractable P was increased nearly 240-fold in comparison with a control. Using X-ray Absorption Near Edge Spectroscopy and synchrotron X-Ray Fluorescence mapping, highly soluble potassium hydrogen phosphate was found. This modification would seem to be both simple and cost-effective, enabling the use of waste to produce biochar with the potential to be used as a fertiliser with available P which also supplies and can sequester carbon. This research highlights green chemistry, industrial symbiosis and circular economy that is becoming very important in sustainable development.

Keywords: biomass ash, sewage sludge, biochar, phosphorus and potassium, circular economy

* ad2855@coventry.ac.uk

Wiktoria Piątek-Gołda, Justyna Sulej, Monika Osińska-Jaroszuk*
Maria Curie-Sklodowska University, Poland

Antimicrobial properties of lactobionic acid

Aldonic acids are a group of compounds with enormous biotechnological potential, and one of its components is lactobionic acid (LBA). It is a polyhydroxy acid composed of a galactose bound to a gluconic acid molecule through an ether type linkage. The conversion of lactose to lactobionic acid consists of the oxidation of the free aldehyde group of glucose on the lactose molecule to the carboxylic group. LBA can be produced through microbial or enzymatic methods. Lactobionic acid is known for its antioxidant, chelating, stabilising, acidifying and moisturising properties, but its antimicrobial properties have become increasingly interesting to researchers. The use of naturally derived compounds, such as LBA, instead of chemicals would have a positive impact on the environment. The aim of this review is to present the latest developments and research on its antimicrobial potential, which will enable lactobionic acid to be used on a larger scale mainly in the food industry. The results show that lactobionic acid significantly affects the viability of bacteria, by damaging the cell membrane or causing changes in the genetic material of bacteria. Based on the results published by the researchers, it can be concluded that LBA is a compound with tremendous biotechnological potential, but more research is needed for better understanding of the antimicrobial properties of this compound. Determining the exact effect of LBA on bacteria would be a milestone on the way to bringing the compound to the global market.

Keywords: lactobionic acid, antibacterial activity, industry

* wiktoria.piatek-97@wp.pl

Water in Circular Economy

6 December 2022

*Markus Hjort**
CONCAWE Environmental Science for European Refining, Belgium

Upcoming Water Challenges for EU Fuel Manufacturing Sector – in Light of a Dynamic Legislative Environment

The EU Fuel Manufacturing Industry is currently facing a dynamic legislative environment with regard to water. The EU Green Deal (EGD) accelerates the drive to action with several legislations being revised affecting e.g. (waste)water discharge quality and water (re)use. Concawe leads research to support fuel manufacturers addressing these regulatory challenges and at the same time provides scientific input into the regulatory process as accredited stakeholder. Present the challenges Concawe is addressing in 1) collecting and analysing sector data; 2) ensuring legislative proposals are based on well-established definitions, sound science and achievable targets; and 3) combining scientific input into both industrial practice and regulatory process. Set out the complexity of EU fuel manufacturing sites (e.g. oil refineries) water management systems and link with various (anticipated) legal requirements. With that basis, explain how Concawe is operating within this topic to ensure that regulatory developments are technically feasible, achievable and viable. Concawe has outlined focus areas where projects are ongoing, or being planned, to address anticipated upcoming water challenges for the sector. The focus areas include:

- Improved data quality from the sector regarding water emissions;
- Improved understanding of sector water use and efficiency;
- Addressing scientific gaps with regard to monitoring and analysis of chemical and ecotoxicological parameters.

The EGD poses challenges on several sectors, including fuel manufacturing, regarding water (re)use and (waste)water discharges. Although considerable effort is still needed, Concawe has started to address the challenges ahead via various projects.

Keywords: water discharges, water reuse, fuel manufacturing industry, best available techniques

Acknowledgments: Members of Concawe Water, Soil & Waste Management Group and its Special Task Forces (STF) for guidance and support.

* markus.hjort@concawe.eu

Anna Gierek-Ożóg[1], Małgorzata Cimochowicz-Rybicka[1], Tadeusz Żaba[1,2]*
[1]Cracow University of Technology, Poland
[2]Kraków Water, Poland

Water safety in internal water supply system

Legal regulations in Poland, including the new Directive (EU) 2020/2184 of the European Parliament and of the Council require water at the point of use to be healthy and clean. In 2019 1.23 mln people died from unsafe water source. The article presents a large group of water-borne diseases which are related to contamination that occurs in the internal water supply system in the building and with the presence of pathogens found in that water. Water contamination can result from presented design errors, water age, condition of infrastructure, age and type of installation material, number and type of water sources. These factors may influence the potential microbiological, chemical, physical or radiological contamination of the water. Since the 1960s, the World Health Organization has promoted a risk-based approach most effective for managing water quality. Studies have shown that Heterotrophic Plate Count, representing microbial growth in the water supply system, decreased in a statistically significant manner in the samples after Water Safety Plans implementation, in the population where Water Safety Plans was implemented, was 14% less likely to develop clinical cases of diarrhea. The Water Safety Plans implementation also significantly reduced the number of non-compliance cases. Studies will be presented in the article. Water Safety Plans are now used in many regions of the world and required by legislation in some countries. Currently, the implementation of Water Safety Plans in Poland is in initial phase. Considering new European legal regulations and growing environmental and economic awareness of consumers, there is a need to undertake research on water quality in internal water supply systems.

Keywords: water quality, risk analysis, Water Safety Plans, legislative changes, environmental management

* anna.gierek-ozog@doktorant.pk.edu.pl

*Beena Kouser**
The Indira Gandhi National Open University (IGNOU), India

Assessment of groundwater quality for agriculture purposes in the part of Kathua region, Jammu and Kashmir, India

Groundwater is an important natural resource in the Kathua region of the Union Territory of Jammu and Kashmir, Northern India, where it is used for domestic, irrigation and industrial purposes. The main focused of the present study to assess the suitability of groundwater for irrigation purposes because of intensive agriculture in this area. The major environmental issues related with the groundwater quality, reduce the soil quality because of excessive use of chemical fertilizers. It is necessary to understand the quality and quantity of water needed for adopting good crop production systems that minimize environmental pollution, favor water saving, while improving yield in irrigated rice. A total (N=75) groundwater samples were collected from different water wells during the pre-monsoon season 2021. The groundwater parameters such as electrical conductivity (EC), sodium percentage (Na+%), sodium adsorption ratio (SAR), residual sodium carbonate (RSC), Kelly ratio (KR), magnesium absorption ratio (MAR) and permeability index (PI) was calculated. The results infer that according to the Wilcox and USSL diagrams, and permeability index and most of the groundwater samples are suitable for irrigation purposes except some locations. The RSC indicates that at three locations the water is not suitable for the irrigation purposes and MAR analysis, nearly 18% of the groundwater samples were found to be unfit for irrigation purposes, whereas KR shows that approximately 5% of the groundwater samples were found to be unsafe for irrigation purposes. The PI indicates that most of the samples are good for the irrigation purposes and cations ion exchange is the main factor controlling chemical composition of the groundwater.

Keywords: groundwater, irrigation water quality, wilcox, USSL diagram, Northern India

* beenajucryosphere@gmail.com

Joanna Bąk[1], Sondre Meland[2]*
[1]Cracow University of Technology, Poland
[2]Norwegian Institute for Water Research, Norway

Comparative analysis of rainwater quality in selected European cities as a next step towards the implementation of circular water management and the accomplishment of selected sustainable development goals

The ongoing climate change force the introduction of circular water management and the implementation of sustainable development goals. In turn, the use of alternative water sources makes the realization of these activities possible. For example, the use of treated rainwater for food production implements selected goals of sustainable development. However, it should be added that using the harvested rainwater for purposes other than standard requires a number of preparatory works.

There is a lot of data available in the literature on the quality of rainwater and runoff from roofs, but these studies usually focus on a limited number of selected contaminants (common to most studies), and additionally each includes other indicators that typically can be found only in a small number of studies. Most of the studies on rainwater collected from roof runoff does not include green roofs. Research on green roofs' runoff quality is usually the subject of separate works.

The aim of the paper was to compare the quality of rainwater flowing from different roof surfaces in different European cities. The conducted analysis allows for the development of a comprehensive list of pollutants found in roof runoff from various cities. The output gains insight of the preferred roof coverings for rainwater harvesting, as well as development of a complete list of preliminary tests. The results are also form the basis for the initial selection of a water treatment system for the needs of hydroponics, aquaculture and aquaponics systems in the city.

Keywords: rainwater, aquaponics, water circular management, SDGs, green roof

Acknowledgments: The research project USAGE no. NOR/IdeaLab/USAGE/0004/2020-00 leading to these results 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.

* joanna.bak@pk.edu.pl

Arun Lal Srivastav, Lata Rani, Prakriti Sharda, Ajay Sharma, Varinder Singh Kanwar*
Chitkara University Himachal Pradesh, India

Application of biochar adsorbents in the removal of synthetic dyes from water: State of art, challenges and future

Synthetic dyes are being extensively used in many industries such as textile, oil, leather in large amounts which ultimately may deteriorate the ecosystem because of their toxic nature. Further, these dyes are not only harmful to the plants or aquatic animals but also can cause severe health disorders among the human beings through the process of biomagnification and/or bioaccumulation. Therefore, dyes containing wastewater must be properly treated before discharging to the aquatic environment. Adsorption is a process which is able to remove diverse types of synthetic dyes from the water. Biochar proved to be a potent adsorbent because it has provided various types of benefits like use of diverse raw materials, cost effective, easy to use in water treatment. Biochar is efficient in removing various dyes from water such as methyl orange, malachite green, crystal violet, congo red, etc. The main objective of this review paper is to provide a summary of the application of biochar adsorbents for the removal of synthetic dyes from water in terms of expected challenges, state of art along with future scope.

Keywords: biochar, adsorption, water, remediation

* prakriti60sharda@gmail.com

Paulina Pietrzyk, Agnieszka Pregowska, Magdalena Osial*
Institute of Fundamental Technological Research, Polish Academy of Sciences, Poland

Current trends of removal dyes from water by magnetic nanomaterials application

Due to the global pollution of aqueous reservoirs, there is a deep need to develop water purification techniques, including applying sorbent materials. Among many sectors, the textile and paper industry generates a tremendous amount of water pollutants leading to the dyes and pigments released into the environment, particularly groundwater and drinking water. Such compounds harm health leading to many disorders, so their removal is essential. In this work we focused on removal anodic dye especially Congo Red (CR). In this work, we present iron oxide-based nanoparticles doped zinc Fe3O4@Zn as a material that can be used for water purification. The nanoparticles were prepared using co-precipitation method and subsequently characterized to determine morphology, optical properties, magnetization and crystallinity. Among different Zn dopant content in the nanoparticles, Fe_3O_4@Zn sample offered the highest effectiveness of the photocatalytic degradation of CR, in particular 70% effectiveness at 60 minutes. Proposed material works not only as a photocatalyst but can also be used as a magnetic separator of pollutants making it promising material for environmental application.

Keywords: water pollution, dyes, wastewater treatment, magnetic nanoparticles

* paulina.pietrzyk.t@gmail.com

Wastewater & Sewage sludge

7 December 2022

*Małgorzata Komorowska-Kaufman**
Poznan University of Technology, Poland

Treated municipal wastewater as a reliable source of water in selected industrial plants

Climate change is contributing to the exacerbation of water stress in many parts of the world. At the same time, the development of the economy increases the need for water for the production of goods and energy. A huge potential in preventing fresh water resources lies in the reuse of wastewater, as highlighted in Agenda 2030 for Sustainable Development. Apart from irrigation in agriculture and forestry, the reclaimed water can be used for environmental, municipal and industrial purposes.

The research results confirmed that the strengthening of requirements regarding the quality of wastewater discharged to the receiver allows for its direct reuse for different non-consumption purposes. Comparing many parameters determining the quality of surface water and treated wastewater, it was found that in the case of treated wastewater most of them are better or slightly worse than in the case of surface waters. The usage of treated wastewater as a source of raw water for an industrial water treatment plant (WTP), especially chemical ones, allows, without changing the configuration of the WTP system, to clean it to the quality required in further production processes.

Keywords: municipal wastewater reuse, power industry, sustainable development, water savings

Acknowledgments: The research was financed by the Ministry of Science and Higher Education, Research Subsidy of the Poznan University of Technology 2022 entitled: "Improving methods, devices, and systems of environmental engineering for sustainable development" (5200 201/0713/0010/SBAD/0958).

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

Klaudia Całus-Makowska, Anna Grosser, Anna Grobelak*
Czestochowa University of Technology, Poland

High-Performance Liquid Chromatography (HPLC) in the determination of pharmaceuticals in wastewater and sewage sludge

Currently one of the biggest problem is the pollution of the environment with pharmaceuticals. The main source of these pollutants is wastewater and sewage sludge. It is extremely important to effectively determine the content of pharmaceuticals in wastewater and sewage sludge and develop effective methods for neutralizing and removing these substances. High-Performance Liquid Chromatography (HPLC) coupled with a UV/VIS detector, fluorescence detector or mass spectrometry (MS) allows for detailed analysis of pollutants present in sewage and sewage sludge. Thanks to the use of HPLC, it is possible to perform both qualitative and quantitative analyses. Due to the easy change of the parameters of the HPLC process and the possibility of using various columns and eluents, this method allows the determination of most pharmaceuticals and their metabolites. The simplicity and short time of analysis as well as the wide range of substances that can be detected using HPLC are the main advantages of this method. However, this method requires optimization both in the extraction of pharmaceuticals itself and in the detection technique. The highest challenge is optimization towards the labelling of the largest possible number of pharmaceuticals, with the best possible recovery and also with economic optimization. This work describes the issues of labelling pharmaceuticals in difficult environmental samples such as wastewater and sewage sludge.

Keywords: pharmaceuticals, HPLC, multi-analysis

Acknowledgments: The research was financed as part of the GeneInUse Student Science Club project and the student project No. SKN / SP / 496788/2021 financed by the Minister of Education and Science from the state budget as part of the program "Student science clubs create innovation" and the internal project of PCz BS / PB-400/301 / 22.

* k.calus-makowska@pcz.pl

Katarzyna Pawęska, Aleksandra Bawiec, Ewa Burszta-Adamiak, Wiesław Fiałkiewicz*
Wrocław University of Environmental and Life Sciences, Poland

Municipal and industrial wastewater as a source of water - opportunities, threats and barriers to wastewater reuse on the example of Polish experience

Water is the most exploited resource used in all aspects of human activity. At the same time, due to its wide application, it is contaminated with a number of substances, which significantly worsen its quality and the possibility of reuse. The response of the European Union (EU) countries to the growing problem of water shortages is the reuse of sewage treated from municipal treatment plants. The aim of the paper was to assess the amount of water consumption, as well as the amount of generated wastewater, based on statistical data and surveys among representatives of industry and waterworks. At the same time, an attempt was made to identify opportunities, threats and barriers related to the re-use of treated wastewater in various industries and the introduction of closed water circuits in settlement units, under Polish conditions. Collected data shows that the total water consumption in Poland, in 2019 was 9209.5 hm3, including 6292.5 hm3 of water for production purposes, for irrigation in agriculture and forestry, as well as for replenishing ponds fish - 847.4 hm3. Barriers to wastewater reuse have been identified both in the legal area as well as economic and psychological ones. On the basis of identified problems, the recommendations for water and wastewater reuse were prepared.

Keywords: wastewater reuse, closed water circuits, industry, water consumption, barriers and opportunities

Acknowledgment: The presented data was collected as part of the project SMART-WaterDomain: Framework for organizational decision-making process in water reuse for smart cities.

* aleksandra.bawiec@upwr.edu.pl

Ewa Neczaj, Anna Grosser*
Czestochowa University of Technology, Poland

Reuse of municipal wastewater treatment plant effluents – challenges and barriers

Water is a critical component of sustainable development, economic growth and our environmental security and health. Currently, problems related to its limited sources, constantly growing pollution and poor management of resources are a key issue around the world. New legal regulations proposed by the European Commission encourage the reuse of water, which leads to attempts to recover it, e.g. from effluent from municipal wastewater treatment plants. The quality of the water obtained in this way should meet certain requirements, both microbiological and physico-chemical.

This paper reviews the treatment processes used for municipal wastewater reclamation and reuse. The existing technological solution was discussed in terms of the direction of re-use of treated wastewater.

A particular attention was paid to emerging contaminants, such as organic dyes, pharmaceuticals, microplastic and pesticides, because most of the existing municipal wastewater treatment plants are not adapted to remove this type of pollutants. Some of the micropollutants are biodegradable or adsorbed in the sewage sludge but some of them flow into natural water bodies where cause different environmental problems.

This paper identifies the unique challenges and barriers associated with the technical, regulatory, and economic and social aspects of municipal wastewater reuse.

It was concluded that use of highly treated effluent for many different beneficial purposes could significantly increase a local available water resources what is very important due to population increase, economic development and climate change.

Keywords: water reuse, municipal wastewater treatment

Acknowledgments: The research has been funded by project BS/PB-400/301/22.

* ewa.neczaj@pcz.pl

Kinga Marek, Aleksandra Bawiec, Katarzyna Pawęska*
Wroclaw University of Environmental and Life Sciences, Poland

Analysis of the granulometric composition of wastewater flowing out of the third stage of treatment - the case of the hydroponic lagoon

Paper was aimed at determining the changes that take place in the purification processes in the hydroponic lagoon and whether its use in the third stage of purification is justified. The work includes research with the use of a granulometer to determine the particle size distribution of pollutants in the wastewater, and a particle shape and size analyser was used to identify particles from photos taken with a microscope camera. Wastewater samples were collected from November 2020 to January 2021 from a hydroponic lagoon. The results of the research show that the majority of particles smaller than 200 µm are present in the wastewater at the outflow of the hydroponic lagoon in the total volume of suspensions, and the total amount is dominated by particles with diameters below 10 µm. A lack of particles with diameters larger than 1000 µm was observed, which indicated the phenomenon of sedimentation taking place in the hydroponic lagoon, as well as the retention of particles with a diameter below 2 µm in the system. According to the obtained results, it was found that the analysed hydroponic system works efficiently, allowing to obtain a satisfactory quality of sewage at the outflow of the wastewater treatment plant. The particle size composition tests could should be commonly used to control technological processes in sewage treatment plants and ensure effective removal of pollutants.

Keywords: particle size distribution of wastewater, laser diffraction analysis, hydroponic lagoon

* kinga.marek@upwr.edu.pl

Marek Klimasz, Anna Grobelak*
Częstochowa University of Technology, Poland

Wastewater treatment plant as a source of soil contamination with microplastics

The presence of microplastics in the aquatic environment is well documented, but there is significantly more research in marine waters than in groundwater and surface waters. The variety of microplastic particles and the lack of a uniform research methodology create a significant problem in the quantitative assessment of this contamination. As indicated in the literature, wastewater treatment plants are the main source of the spread of microplastics through the use of sewage sludge (containing plastics) in agriculture. Due to the low level of biodegradation, the concentration of microplastics in soils increases. The paper discusses the methods of sample analysis, separation and identification of microplastics, as well as the efficiency of microplastics elimination in a conventional two-stage and three-stage purification system.

Keywords: microplastics detection, soil, risk, contamination

Acknowledgments: The research was financed as part of the GeneInUse Student Science Club project and the student project No. SKN / SP / 496788/2021 financed by the Minister of Education and Science from the state budget as part of the program "Student science clubs create innovation" and the internal project of PCz BS / PB-400/301 / 22.

* marek.klimasz@pcz.pl

Bogna Śniatała, Dominika Sobotka, Jacek Mąkinia*
Gdańsk University of Technology, Poland

Intensified nitrogen recovery from anaerobic digester liquors through the use of gas permeable membranes

In recent years, a numerous nitrogen (N) and phosphorus (P) recovery processes from waste streams in the form of so-called waste-derived fertilizers have been developed. However, it is already clear that in order to close these macronutrient cycles, no single technique will be the ultimate solution. Therefore, a novel integrated technology for N and P removal and recovery (INPORR) was proposed. The INPORR technology consists of three stages. In the first reactor (R1), the P chemical precipitation (in the struvite form) from the anaerobic sludge digester liquors occurs. The precipitated struvite is separated from the liquors, which are subsequently directed to a gas permeable membranes reactor GPMR (R2). In the R2 the remaining N is transformed (by increasing the solution pH > 10) into gaseous ammonia (NH3), which is absorbed to sulfuric acid (H2SO4) circulating in the membranes providing ammonium sulphate (NH4)2SO4 recovery. In the third stage, the effluent from R2 is directed to deammonification reactor (R3), where additional NH3 removal is carried out. This work aims to present the preliminary results of the basic research on the N recovery in the GPMR carried out as the first stage of the INPORR project. The tests on the impact of acid flux, operating pH, and effective membrane surface on the N recovery efficiency were carried out. The average rate equal 14.0 ± 2.7 mgN/L*h was observed in the conducted experiments, which is comparable to the results obtained by other researchers. Further experiments on the reactors work phases, and the process of the final products drying are required before the pilot-scale tests running.

Keywords: wastewater-derived fertilisers, gas-permeable membrane, ammonia recovery, circular economy

Acknowledgments: The research leading to these results has received funding from the Norway Grants 2014-2021 via the National Centre for Research and Development under the grant number NOR/SGS/INPORR/0074/2020-00.

* bogna.sniatala@pg.edu.pl

Challenges and perspectives for the implementation of the European Green Deal

In Polish

7 December 2022

Michał Bodzek[1], Anna Kwiecińska-Mydlak[2]*
[1]Institute of Environmental Engineering Polish Academy of Sciences, Poland
[2]Institute for Chemical Processing of Coal, Poland

Water and wastewater disinfection by nano-photocatalysis

One significant technological progress in photocatalysis observed within the last decade is to use nanosized particles (1-100 nm), as they reveal excellent photocatalytic potential due to unique physico-chemical properties. Nanoparticles (NPs) are currently being viewed as a powerful nanotechnology to control hazardous microorganisms due to their intrinsic antimicrobial properties. More recently, several natural and engineered nanomaterials have also been shown to have strong antimicrobial properties. Unlike conventional chemical disinfectants, these antimicrobial nanomaterials are not strong oxidants and are relatively inert in water. Therefore, they are not expected to produce harmful disinfection by-products. If properly incorporated into treatment processes, they have the potential to replace or enhance conventional disinfection methods. A large number of synthetic NPs have been explored for their antimicrobial properties. The most important nanomaterials that commonly used for antibacterial activity in the water and food industry are oxides of zinc (Zn) and titanium (Ti). Despite intensive research on novel photocatalysts (e.g. carbon based semiconductive nanoparticles, MoS2, WO3 and Fe2O3), titanium dioxide (TiO2) and zinc oxide (ZnO) nanoparticles are known to be one type of inorganic multifunctional substances that are able to inhibit the growth of microbes and they have been listed as Generally Recognized As Safe (GRAS) by the U.S. FDA. It has been found that the nano-photocatalysis allows for deactivation of various types of microorganisms. The antibacterial effect has already been checked on a number of gram-positive and gram-negative bacteria including Escherichia coli, Staphylococcus aureus, Streptococcus pneumonia, etc. Moreover, the actions targeted on destruction of fungi like Aspergillus niger, Fusarium graminearum, algea (Tetraselmis suecica, Amphidinium carterae, etc.) and viruses have also been performed.

Keywords: photocatalysis, nanoparticles, disinfection, waste and wastewater treatment

* michal.bodzek@ipispan.edu.pl

Justyna Górka[1], Dominika Poproch[1], Małgorzata Cimochowicz-Rybicka[1], Bartosz Łuszczek[2], Ewelina Chrapusta-Srebrny[2]*
[1]Cracow University of Technology, Poland
[2]Krakow Water, Poland

Circular economy at the WWTP Cracow-Płaszów – selected aspects

In recent years, with the rapid growth of the world's population, waste management issues have become increasingly central to promoting sustainable development and environmental protection. We note the development of technologies that both minimize the amount of waste generated and those related to their disposal and economic use. When wastewater treatment processes are carried out, by-products in the form of waste are generated. The recovery and management of waste is part of the model of a closed-loop economy and sustainable development concerning natural resources; in addition, this procedure is economically beneficial. The paper inventoried and characterized the wastes generated in the technological line of wastewater and sludge treatment. The morphology, leachability results and selected geotechnical parameters of the wastes are showed, along with the possible method of its management. The method of pre-treating biologically treated wastewater for use in street washing is also presented.

Keywords: circular economy, wastewater treatment plant, technological waste

Acknowledgments: The research was carried out as part of a Research project funded by the Ministry of Education and Science, Implementation Doctorate Program, DWD/5/0187/2021.

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

Iwona Francuziak, Marzena Smol*
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Socio-economic analysis of water reuse for agricultural and other purposes

Water is a basic necessity for living organisms and its availability is crucial for economic development. The reserves of fresh water on Earth are not sufficient to meet the water demand resulting from the successive growth of human activity. What is more, extreme climatic events and decreasing amounts and regularity of rainfall as a result of climate change will impede access to drinking water. Therefore, an implementation of circular economy (CE) practices in water and wastewater management started is extremely important. One of the CE examples is water recovery from wastewater that is supported by the European Commission (EC) recommendations, as a part of the transformation toward the CE model. Increasing the scale of practices to successfully implement CE model requires not only technological changes but also an understanding of the socio-political context essential to translate technical solutions into practice. Despite various of technological studies dedicated to water reuse, there are significant gaps in the literature that focuses on social, political, legal and economic aspects of water reuse. The implementation of CE requires a holistic perspective covering the above-mentioned factors. Paper presents a macroeconomic analysis of water reuse from wastewater, based on the PESTEL analysis, that includes political, economic, social, technological, environmental and law factors which may drive or slow down the implementation of the CE model in the water and wastewater sector. Several barriers have been identified ranging from social distrust to regulatory and financial gaps. Research shows that public acceptance of water reuse cannot be improved until there are clear quality standards for reclaimed water that ensure safe use. Activities in the legal context, such as the development of coherent statutory, executive regulations and government support programs would enable to create efficiently functioning system. In that case, further research is conducted to support the implementation of water reuse in the European countries.

Keywords: PESTEL analysis, water reuse, circular economy

Acknowledgments: The study was conducted as a part of project „Water-CE-management in practice – developing comprehensive solutions for water recovery and raising awareness of the key role of water in the transformation process towards a circular economy (CE)", which is financed by Iceland, Liechtenstein and Norway through the EEA and Norway Grants.

Iceland Liechtenstein Norway grants

* francuziak@meeri.pl

*Mateusz Rychlak**
Jagiellonian University, Poland

Normative concept of energy security in the context of the assumptions of the European Green Deal

In the face of the energy crisis affecting the European economy, priority has been given to the implementation of specific assumptions of the European strategy known as the European Green Deal (EGD). The main factor determining all activities so far, which was ensuring net zero emissions by 2050, gives way to securing the energy interests of the European Union, and above all, the implementation of the energy security postulate of the Member States. In the present situation, it becomes necessary to ask the question of what importance should be given to the term "energy security" appearing in the Act of April 10, 1997 Enrrgy Law (Prawo energetyczne), and how it should be interpreted in the context of the EGD, which is the aim of this study.

The analysis of this concept leads to the conclusion that in broad terms it is not only a description of the actual state of the economy, but has its own normative content, which in turn leads to the conclusion that it can be given the character of not only a general postulate but also a principle closely related to the constitutional principle of sustainable development. The second element of the study allowed for the identification of the most important links between the assumptions of the European Green Deal and the understanding of the concept of "energy security" presented by this strategy, and the meaning of the principle of "energy security" resulting from the Act of April 10, 1997.

Keywords: energy security, European Green Deal, systemic interpretation, sustainable development

* mateusz.rychlak@student.uj.edu.pl

*Przemysław Ogarek**
Doctoral School of Engineering and Technical Sciences at the Rzeszów University of Technology, Poland

Hydrogen generation for stabilising the operation of energy systems: achievements and prospects

Climate change and the rapidly advancing exploitation of fossil fuel deposits, as well as the current fluctuations in the global energy market, are prompting an accelerating search for alternative solutions that could neutralize the problems identified. One of them could potentially become the use of hydrogen, a renewable fuel with a high gravimetric density that has a wide range of methods for its production. Currently, hydrogen is mainly used in the chemical and refining industries. However, there are many other uses for hydrogen and the energy carriers produced from it. In the future, its increasing contribution to the long-term storage of seasonal energy surpluses is expected. This paper presents a comparative review of the use of hydrogen technologies in relation to the potential stabilization of the operation of decentralized energy systems. Hybrid hydrogen power plant projects utilizing the capabilities of hydroelectric power plants are analyzed. A review of ongoing projects and source materials published to date clearly indicates that systems based on hybrid facilities supported by hydrogen storage are technically feasible and have increasing efficiency and stability of operation. However, the main challenge to the commercialization of such solutions remains the high investment costs. The key purpose of this paper was to investigate the current state of knowledge on the planned implementation of hydrogen in energy systems of the future.

Keywords: distributed generation, hydrogen, P2H, hydropower

* p.ogarek@prz.edu.pl

Angelika Skorupa, Małgorzata Worwąg*
Częstochowa University of Technology, Poland

Management and use of by-products from coffee bean processing

In the last few years, environmental and climate changes have become increasingly evident, so new environmentally friendly solutions are being sought to reuse the waste generated. Increasingly, the world is moving towards a circular economy, which is an alternative model of economy based on the principle of closing the life cycle of a product. It is estimated that the European Union produces about 100 million tons of food waste per year, of which an average of 30% comes from the agro-food industry. Coffee is a widely distributed and sold commodity on the global market. Given that coffee is the second largest commodity sold in the world, with global production reaching 105 million tons per year worldwide, the industry is responsible for generating large amounts of waste. Depending on the coffee bean processing technology used, various wastes can be generated, including solid waste and wastewater. The high amount of waste negatively affects the environment. According to available literature and research, coffee bean processing waste shows great potential as a renewable source of raw materials in the fuel and energy industry, for the production of biodegradable packaging and soil additives. The purpose of this study was to review the literature on the management and use of coffee bean processing by-products.

Keywords: circular economy, environmental sustainability, coffee waste, raw materials

Acknowledgments: The study was carried out in the framework of the statutory funds for research, financed by the Ministry of Science and Higher Education.

* angelika.skorupa@pcz.pl

Maria Włodarczyk-Makuła
Czestochowa University of Technology, Poland

Session summary - WATER : HYDROGEN : CARBON

Session concerned current issues regarding the Green Deal policy, at the same time the subject of the papers was in the area of the 3W initiative (in Polish WODA : WODÓR : WĘGIEL) - WATER : HYDROGEN : CARBON.

In the field of WATER, papers were presented in which the issues of water and wastewater treatment using advanced processes and taking into account the reuse of reclaimed water were presented.

In the field of HYDROGEN - papers on hydrogen and energy security were discussed.

In the field of COAL - papers focused on the use of waste for the production of sorbents were presented.

In conclusion, the activities in the field of taking up and implementing the principles of the circular economy (CE) were excellently presented.

Bio-based fertilisers of the Future

Cross-H2020-seminar LEX4BIO & FERTIMANURE

7 December 2022

*Marzena Smol**
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Introduction - Bio-based fertilisers of the Future

Bio-based fertilisers (BBF) provides farmers an alternative to mineral fertilisers (originating from living organisms). However, lack of information regarding the optimal and safe use of bio-based fertilisers in agriculture restricts their wider acceptance. Optimising the use of BBF according to crop requirement in variable growing conditions across the EU increases the economical return of agricultural production and provides farmers the most efficient BBFs for a given region. There are several examples of BBFs, as chicken manure incineration ash (fertiliser type: ash), sewage sludge ash (fertiliser type: ash), anaerobically digested bio-waste (fertiliser type: compost), sewage sludge (fertiliser type: compost), chicken manure with mixture of plant biomass (fertiliser type: compost), or pig slurry 9fertiliser type: slurry). Usage of BBF supports the transition towards a circular economy (CE) by enhancing the use of nutrient-rich side-streams as BBFs.

Keywords: bio-based fertiliser, agronomic efficiency, phosphorus, nitrogen, food safety

Acknowledgments: This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818309 (LEX4BIO).

* smol@meeri.pl

*Kari Ylivainio**
Natural Resources Institute Finland (Luke), Finland

LEX4BIO project scope

LEX4BIO is a Horizon 2020 -project (Grant No 818309) and objectives of the project is to reduce EU´s dependency on imported phosphorus (P) and nitrogen (N) fertilisers. Phosphorus is a finite natural resource whereas production of N fertilizers is an energy intensive process, relying on availability of natural gas. However, at the same time vast amount of nutrient-rich side-streams (NRSS), mainly manures, biowaste, municipal sludges and animal by-products are produced but often considered as waste. These NRSS provides starting material for bio-based fertilizers (BBF) and thus improving EU´s self-sufficiency in fertilizer production. In LEX4BIO we are focusing on the most promising BBFs already on the market and the most promising novel technologies for producing BBFs. Project will develop profound knowledge basis and new coherent methods to take full advantage of BBFs. These include application methods and suitability of different BBFs for various climatic and soil conditions across the EU while ensuring optimal crop production, minimising risks to the environment, both gaseous and leaching losses, ensuring food and feed safety and protecting human health.

Keywords: bio-based fertiliser, agronomic efficiency, phosphorus, nitrogen, food safety

Acknowledgments: This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818309 (LEX4BIO).

* kari.ylivainio@luke.fi

*Laia Llenas Argelaguet**
BETA Technological Center

FERTIMANURE – From Farm to Market: Upcycling Manure to improved fertilising products

Livestock farming is an extremely important activity for the European economy as a whole. According to the European Commission, in 2017 livestock farming reached a turnover of up to 170,000 million euros, which represents 40% of the total agricultural activity. Annually, total farm livestock population in Europe excrete around 1400 Mt of manure, and more than 90% of this manure is returned to agricultural fields increasing soil contamination and greenhouse gas emissions.

FERTIMANURE project aims to develop, integrate, evaluate, and validate innovative strategies and technologies for nutrient management, that allow recovering efficiently mineral nutrients and other elements with agronomic potential from animal manure. FERTIMANURE produces reliable and safe bio-based fertilisers (BBF), that have potential to compete in the European fertilisers market, through 5 different biorefinery configurations proposed specifically to valorise animal manure directly on-farm. The technologies integrated within the 5 pilots are different and complementary, including technological solutions such as membrane systems, stripping-scrubbing, pyrolysis, freeze concentration, thermo-catalytic reforming, biodrying, microalgae cultivation and enzymatic hydrolysis. Overall, 18 different BBFs with different characteristics are produced, including ammonium and phosphorus-based mineral fertilisers, organic amendments and biostimulants which are claimed to meet the quality parameters shown by conventional fertilising products in European market.

All FERTIMANURE products generated are fully characterized and quality and safety parameters checked, with the final aim to evaluate the alignment of the FERTIMANURE BBFs with the European fertilising products regulation (Regulation (EU) 2019/1009). In terms of regulation, organic farming is also considered, and FERTIMANURE is working on evaluating the feasibility of the BBFs produced to be used in this sector, which is expected to substantially grow during the following years.

FERTIMANURE is also working on the agronomic and quality assessment of all the BBFs produced. Moreover, specific Tailor Made Fertilisers (TMF), resulting of a blending of different BBFs and synthetic mineral fertilisers, are formulated and tested to meet with specific soil-crop requirements.

Environmental and economic feasibility of FERTIMANURE biorefineries and products (BBFs and TMFs) are assessed and compared to conventional fertilisation strategies based on mineral fertilisation or raw animal manure to evaluate their potential for improving the environmental performance of crop fertilisation and capability of substituting conventional fertilising products in the European market.

Overall, FERTIMANURE seeks to provide an innovative circular economy model to favour rural development in agricultural sector by creating real synergies and links within farmers and other industrial activities.

Keywords: Fertimanure, project scope, manure, farming

* laia.llenas@uvic.cat

*Ivona Sigurnjak**
University of Ghent, Belgium

Agronomic performance of the use of BBFs

Currently, it is estimated that around 7.8 % of all livestock manure in Europe is processed. This involves 108 million tonnes of animal manure containing 556,000 tonnes N and 139,000 tonnes P (Flotats et al., 2013). FERTIMANURE project aims to stimulate further processing of animal manure and assess agronomic and environmental performance of recovered biobased fertilisers (BBFs) as compared to their conventional counterparts.

The assessment of 15 FERTIMANURE produced BBFs is currently on-going, both at laboratory and field level. Combination of fully controlled lab trials and the field full scale trials provides a full range of data that allows full comprehension and comparison of novel fertilising products against mineral fertilising products. To this end, the FERTIMANURE consortium conducted 13 field trials and 6 pot trials across Spain, France, Belgium to assess fertiliser potential of manure-derived ammonium sulphate, ammonium nitrate, ammonium water, biochar, liquid K solution (i.e. mechanically separated liquid fraction of digestate or manure after ammonia stripping) and several tailor-made fertilisers (i.e. blend of the BBF(s) and synthetic mineral fertilisers) in cultivation of wheat, spinach, potatoes, maize, rye-grass, sauerkraut cabbage, sugar beet and grass. Preliminary results show that in terms of crop yield, nitrate residue, fertiliser efficiency and greenhouse gas emissions, ammonium salts have potential to be used as N fertilisers. Biochar has potential to be used as C source and P fertiliser, whereas liquid K solution can be used to replace synthetic K fertilisers. The validation of results through second year of field trials is currently on-going.

Keywords: bio-based fertilisers, carbon and nitrogen mineralization, greenhouse gas emissions, field trials, nitrogen fertilizer replacement value

Acknowledgments: This work was conducted within the framework of FERTIMANURE project. This project received funding from the EU Horizon 2020 Research and Innovation Programme under grant agreement No. 862849.

* Ivona.Sigurnjak@UGent.be

Boris Jansen[1], Nicolas Estoppey[2]*
[1]University of Amsterdam, Netherlands
[2]Norwegian Geotechnical Institute, Norway

Potential risks related to the use of BBFs

In the EU funded LEX4BIO project we explore the exciting opportunity of closing agricultural nutrient loops by applying biobased fertilizers (BBFs) originating from organic waste streams as sources of N and P. However, such application risks inadvertently introducing pollutants into the soil and crops. Here we present the results of screening of multiple BBFs for the presence of a wide range of potential pollutants. Firstly, a broad QuEChERS based sample preparation method followed by LC-MC/MC analysis was developed and applied to simultaneous target screening of 80 pesticides and 18 pharmaceuticals in selected plant-, animal- and sludge-based BBFs as well as agricultural soil. The results showed only trace amounts of a small number of these compounds present in BBFs and/or soil. Secondly, selected BBFs were analyses for microplastics using Micro-Fourier Transform Infrared Spectroscopy (Micro-FTIR) after chemical digestion of organic matter, and density separation; as well as PCBs, PAHs, dioxins, furans and PFASs using GC-MS/MS, GC-HRMS and LC-MS/MS. The number of plastic fragments in BBFs increased when moving from plant- to animal-, and then sludge-based BBFs, with a maximum in composts. For the other pollutant classes, the concentrations were (much) below the (few) existing (national) limit values, and expected concentrations in soils and plants are low. The high concentration of PAHs (up to 6.9 mg/kg) and PFASs (up to 73.3 ug/kg) found in some BBFs will be discussed in more details.

Keywords: biobased fertilizer, BBF, pollution, agriculture

Acknowledgments: The presented research has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818309 (LEX4BIO).

* B.Jansen@uva.nl

Pollutants and micropollutants in Environment

7 December 2022

*Edyta Kudlek**
Silesian University of Technology, Poland

Decomposition of organic micropollutants under the influence of solar radiation

Solar radiation is considered as a free source of energy. It also plays a key role in the decomposition of pollutants introduced by humans into the environment. It is possible to integrate the process of natural photo-decomposition with other physicochemical processes in the water purification technology. However, it should be noted that the radiation intensity varies throughout the year. Model aqueous solutions were spiked with analytical standards of diclofenac, triclosan, butylated hydroxytoluene, and 4-tert-octylphenol and exposed to the direct action of sunlight. The tests were conducted in the winter (January), spring (April), summer (July), and fall (October) periods. The concentration of the tested compounds before and after the subjection to solar radiation was estimated using the gas chromatographic analysis GC-MS. This technique was also used for the identification of the formed compound decomposition by-products. Moreover, the post-process solutions were subjected to the toxicological analysis performed on the Microtox bioassay. The decomposition rate of all tested compounds strongly depends on the period of the year. It is related to the different intensity of solar radiation reaching the earth's surface. The highest number of by-products of the decomposition of individual compounds was observed in the spring and autumn periods. This post -process solutions also were characterised by a higher toxicity then those processed at the summer and winter time.

Keywords: micropollutants, sunlight, by-products, toxicity

Acknowledgments: This work was supported by Ministry of Science and Higher Education Republic of Poland within statutory funds, BKM-679/RIE4/2022.

* edyta.kudlek@polsl.pl

*Marta Gmurek**
Lodz University of Technology, Poland

Toxicity Assessment Of Contaminants Of Emerging Concern After Photochemical Treatment

The contamination of water is major environmental problems therefore water protection is one of the main challenges of the century. Due to the fact that human activity generates wastewaters comprising bio-refractory and toxic compounds, the effective and environmental method of its degradation must be applied. It should be important that the purification of water did not require the introduction of additional chemical compounds - oxidants, also polluting the environment. The traditional wastewater treatment processes are inefficient on the removal of Contaminants of Emerging Concern (CEC) in low concentration.

It is well-known that Advanced Oxidation Processes (AOPs) efficiently eliminate organic pollutants during water treatment. However, most of CEC are not completely mineralized during AOPs but only partially oxidized into transformation products (TPs). Importantly, the environmental impacts of the CEC have not been adequately explored and information on toxicological assessment is required, particularly taking into account its phototransformation during light exposure.

Considering all these aspects the main goal of the presented study was to investigate the photochemical decomposition of CEC under UV as well as synthetic (visible) and natural sunlight from toxicity point of view.

The toxicity assessment of the harmful TPs that are generated in UVC/H2O2, photocatalysis (initiated by UVC and UVA) as well as photosensitized oxidation have been studied extensively. It was showed that toxic TPs may be generated during hydroxylation, dealkylation, and deamination. Among various reactions, TPs generated under natural sunlight treatment process were generally less toxic than the parent contaminants.

Keywords: Contaminants of Emerging Concern, wastewater treatment, toxicity assessment

* marta.gmurek@p.lodz.pl

Kaouthar Benahdach, Aoulad El Hadj Ali Youssef, El Laghdach Anas, El Mail Rachad*
Abdelmalek Essaâdi University, Morocco

Removal of congo red from aqueous solution using activated carbon based pomegranate peel

The adsorption process of Congo Red dye onto the activated carbon developed from natural agricultural waste (pomegranate peel (PP)) synthesized using microwave-assisted method as well as H2SO4 activator agent was well investigated. The pomegranate peel based activated carbon (PPAC) used as an adsorbent to remove an anionic dye Congo Red (CR), from an aqueous solution in a batch system, as a function of contact time, pH, adsorbent dose, temperature and initial dye concentration. The proposed adsorbent was characterized using several techniques such as scanning electron microscopy (SEM), Brunauer–Emmett–Teller (BET) analysis, X-ray diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR). The adsorption equilibrium isotherms of CR removal described using Langmuir, Freundlich and Sips models. The equilibrium is perfectly adapted to the Freundlich model with a maximum adsorption capacity of 9.92 mg g^{-1} at 40C°. In order to study the adsorption mechanisms, the first- and second-order kinetic models were used. The adsorbent produced from the PP had the ability to uptake CR from the solution, and then the experimental data well fitted with the expression of the second-order. Thus, this study convinced that the PPAC proved to be an alternative, attractive, effective, economic, and environmentally friendly adsorbent for CR dye removal from aqueous solution.

Keywords: adsorption, congo red, activated carbon, pomegranate peel, isotherms

* kaouthar.ben98@gmail.com

Sanaa El Aggadi, Mariem Ennouhi, Amale Boutakiout*
Abderrahim El HourchMohammed V University, Morocco

Electrocatalytic Decomposition of Reactive Yellow 14 by Fe/C-Doped Lead Dioxide Modified Anode

Electrocatalytic oxidation process is a promising technology for the treatment of dangerous, toxic and highly concentrated organic wastewater because of its ease of control, high efficiency, low time consumption, versatility, and environmental sustainability. Throughout the electrocatalytic process, the anode material is a key factor in the oxidation efficiency of organic pollutants. Many types of electrodes have been studied, such as platinum, MnO2, PbO2, RuO2, SnO2 and boron doped diamond. Among these electrodes, PbO2 is one of the best candidates widely used in electrocatalysis due to its high oxygen evolution potential (OEP), good corrosion resistance, low price and high electrocatalytic activity. However, due to its fragility and ease of deactivation, many attempts have been made to improve the performance of the PbO2 electrode. A frequently used method consists in doping the PbO2 layer with some materials. Our investigation focuses on the modification of the PbO2 electrode in order to increase the electrochemical activity. In this work, lead dioxide electrodes undoped and doped with Fe3+ and/or carbon black were successfully synthesized via electrodeposition technology. The morphology, crystalline structure and electrochemical performances were characterized. Reactive Yellow 14 (RY14) azo dye was chosen as the model pollutant for electrocatalytic oxidation to evaluate electrochemical activity of the electrodes.

Keywords: anodic oxidation, lead dioxide, decolorization, electrocatalysis, modified electrode

* Sanaa.elaggadi@gmail.com

*Lata Rani, Jyotsna Kaushal, Arun Lal Srivastav**
Chitkara University Himachal Pradesh, India

Modified biochar as efficient adsorbent for the removal cadmium from water

Heavy metal pollution in the environment's water is getting worse with societal advancement and industrial development. The adsorption and immobilisation effectiveness of biochar still has to be increased, despite the fact that it is a cheap and environmentally benign adsorbent for heavy metal ions. Modified biochar has received a lot of interest in the research world as an improved variant of biochar. This study provided a summary of current research on biochar-based techniques for treating cadmium pollution in water. The benefits and characteristics of biochar modification methods such as physical, chemical, and biological modifications, as well as other kinds of biochar, were reviewed. The method by which modified biochar removes cadmium from water was outlined. After alteration, it was discovered that biochar performed better because it had greater surface areas, functional groups, and binding sites to combine heavy metal ions. A very promising contender for eliminating cadmium from the environment is biochar. A high-efficiency modified biochar with low price, higher adsorption capacity, high photocatalytic efficiency, environmental friendliness, and no secondary pollution in the future is still the goal.

Keyword: biochar, modification technique, heavy metal, water, purification

* arun.sarivastav@chitkarauniversity.edu.in

Green Deal for the Future

7 December 2022

Poster session

5 – 7 December 2022

Agnieszka Bus, Kamila Budzanowska*
Warsaw University of Life Sciences, Poland

Comparison of the sorption capacity of raw and calcinated eggshells as a reactive material for phosphate removal from wastewater

The study aimed to compare the sorption properties of raw and calcined at a temperature of 900°C chicken eggshells for phosphate removal from wastewater. The eggshells are characterized by a relatively stable content of CaCO3 (94% - 97%). That gives this material great potential to remove phosphorus (P) from aqueous solutions. The affinity to bind P may be increased by the calcination process promoting the decomposition of CaCO3 to CaO. The sorption properties of both materials in the wastewater as adsorbates were tested during a kinetic test in contact time ranging from 5 min. to 48 h. After 48h, the sorption of raw eggshell equaled 0.90 mgP-PO4/g which corresponded to the phosphate removal ratio of 55%. In contrary, the calcined eggshells are characterized by high sorption properties and fast and rapid reactions with phosphates. The P-PO4 removal increased rapidly in a concise contact time and then achieved equilibrium. After 5 min of contact time, an entire load of P-PO4 was removed from the wastewater. The sorption equaled 1.71 mgP-PO4/g and corresponded to a 100% reduction. The calcined eggshells are characterized by almost 2-times higher P-PO4 sorption and reduction than raw eggshells which makes it an efficient phosphate-reactive material in the circular economy approach.

Keywords: chicken eggshells, phosphorus removal, reactive materials, wastewater treatment

* agnieszka_bus@sggw.edu.pl

Marzena Smol[1], Alfonso Mejia[2], Marina Howarth[2]*
[1]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
[2]The Pennsylvania State University, USA

Business approaches in the water and wastewater sector – CircuWater project

Circular economy (CE) is a regenerative system where the value of resources is maintained as long as possible in the economy and the production of waste is minimised. This paper presents an overview of the CE business opportunities for different actors involved in the water and wastewater sector, and provides examples of key benefits from Circular Business Models (CBMs) implementation. The analysed examples of good practices were divided into six action areas for businesses, following the Ellen MacArthur Foundation and McKinsey's ReSOLVE framework: Regenerate, Share, Optimise, Loop, Virtualise, and Exchange. There are several possibilities to implement CE in the analysed sector, including recovery of renewable energy and nutrients from waste generated in the water and wastewater treatment plants; providing water supply systems in cities and rural areas; optimisation of the amount of energy, minerals, and chemicals use in operation of water systems; water reuse for agricultural and industrial purposes; digitisation of device controllers in water treatment stations and wastewater treatment plants; and replacing industrial devices with more energy-saving ones. The implementation of such CE solutions are an important element of CBMs creation. CBMs should contribute to creating a balance between the economic, social and environmental dimensions that are the basis of sustainability. Therefore, an economic feasibility assessment of proposed projects should also take into account social, environmental and resource availability. The current economic systems, including the water sector, are seeking CE solutions since CE can create a series of business and economic opportunities, next to environmental and social benefits.

Keywords: business, Circular Business Models, circular economy (CE), water, wastewater

Acknowledgments: This research was funded by the project "CircuWater" co-financed by the Kosciuszko Foundation - The American Centre of Polish Culture under the Exchange Program to the US and subsidy of the Division of Biogenic Raw Materials at the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland.

* smol@meeri.pl

Dominika Szołdrowska, Marzena Smol*
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Sewage sludge treatment methods in the context of nutrients recovery and heavy metals reduction

Sewage sludge is an important and specific group of waste, in terms of physicochemical composition. It should be treated in accordance with the currently applicable legal regulations and strategic documents, which may differ in individual European Union (EU) Member States. Sewage sludge should be disposed based on the waste management hierarchy presented by the EU in the Waste Directive (2008/98/EC). According to the waste management hierarchy, the storage of sewage sludge should be avoided by retaining it in the economy as long as possible, which is part of the circular economy concept. The recommended ways are recycling or other ways of recovering valuable raw materials. Sewage sludge is rich in biogenic elements such as nitrogen (N), phosphorus (P) and potassium (K) and others, which determine the proper growth of plants. However, sewage sludge can also contain heavy metals such as lead (Pb), cadmium (Cd), chromium (Cr) and others, which inhibit the proper development of plants. In order to maximise the potential of sewage sludge (e.g. as a fertiliser), it should be subjected to appropriate treatment that could minimise the content of heavy metals present in it. Sewage sludge processing methods are divided into biological, which include composting, vermicomposting, anaerobic digestion, and thermal and thermochemical, which include incineration, pyrolysis, and gasification. Processed sewage sludge can be successfully used in agriculture as a valuable fertiliser. The paper presents an analysis of the physicochemical composition of sewage sludge and the methods of its processing in the context of nutrient recovery and heavy metals reduction, and in the further perspective of agricultural use.

Keywords: sewage sludge, treatment methods, nutrients recovery, heavy metals

Acknowledgments: Work carried out under the subsidy of the Division of Biogenic Raw Materials MEERI PAS.

* szoldrowska@meeri.pl

Paulina Marcinek, Marzena Smol*
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Grey water as an alternative solution for a sustainable management of water resources

Demographic growth due to urbanisation and economic development is reducing the world's water resources. Water scarcity is currently one of the key problems in most regions of the world. Paying attention to alternative ways of sustainable management of water resources has become necessary, above all, in arid areas, where the scarcity, variability of precipitation, and rapid evaporation due to high temperatures adversely affect the natural environment and the society living in such conditions. An effective alternative method of using water resources is grey water reprocessing and its reuse.

Grey water is contaminated water that is free of faeces as defined in European Standard 12056-1. These are mainly sewage generated during household activities such as washing dishes, bathing or washing. Grey water includes all water used in homes and apartments, except toilet flush water, which varies greatly in both the amount and variety of chemicals and bacteria it contains. There is a possibility of recycling such water. In a traditional household, 50–80% of the wastewater can be used as grey water. Reusing grey water is a recommended solution to the world's water scarcity, which will affect 2.7 billion people by 2025, according to a United Nations report.

The paper presents examples of good practices of grey water reuse. The advantages and savings resulting from the application of solutions to restore grey water to circulation are indicated. The reuse of reclaimed water has great development potential but is still not widely implemented in most countries. This is due to various limitations (technical, economic, social). For this reason actions aimed at educating the public and disseminating information on solutions supporting sustainable environmental management should be continued.

Keywords: grey water, water reuse, sustainable development, water resources, good practices

Acknowledgments: The study was developed under the project: "Water-CE-management in practice – developing comprehensive solutions for water recovery and raising awareness of the key role of water in the transformation process towards a circular economy (CE)", which is funded by Iceland, Liechtenstein and Norway under the EEA Financial Mechanism.

Iceland Liechtenstein Norway grants

* marcinek@meeri.pl

Remigiusz Gut[1], Wiktor Jasiński[1], Andrzej Duszyński[1], Aleksander Czapla[2], Jakub Drewnowski[2]*
[1]*Instytut Badawczy Dróg i Mostów, Żmigród*
[2]*Gdańsk University of Technology, Poland*

Analysis of the influence of wall thickness on the fatigue of the soil-shell structure with a non-circular cross-section, made of a polymer-glass composite (GRP)

Culvert structures made of plastics are widely used in transportation engineering in the construction of new facilities as well as in the renovation and strengthening of existing buildings. Due to the high costs of materials for the production of these products, the aim is to reduce the thickness of the walls, which, however, may lower the stiffness of the system. The article presents comparative tests of culverts made of GRP (glass reinforcement polyester), built in natural conditions and loaded with a system of forces simulating traffic loads in accordance with the "Load Model 1" according to PN-EN 1991-2: 2007 Eurocode 1. The tests were carried out at the Test Stand for Static, Dynamic and Fatigue Tests "STEND", located at the Research Institute of Roads and Bridges - Wrocław Branch. The stand is built of a reinforced concrete foundation 80,0 m long and 12,0 m wide with a hall and a steel frame constituting a retaining structure for hydraulic load-forcing devices. It is equipped with a SCHENCK hydraulic actuator system with measurement systems, as well as a control and power system. Two structures with identical cross-sections (bell profile DN3000 / 2400) but different wall thicknesses: standard 45 mm and reduced 35 mm were subjected to comparative tests. The tests included measurements of vertical and horizontal displacements of the structure as well as wall deformations in the middle part of the section and at the joint. The test results were analysed in order to check the influence of a significant reduction of the wall thickness on the deformation of the internal cross-section of the structure and on the stresses in the walls. The article also contains information on the functional properties of GRP pipes used in transportation engineering.

Keywords: GRP, flexible culverts, model tests, new structures

* a.czapla.pg@gmail.com

Joanna Witkowska-Dobrev, Olga Szlachetka, Justyna Dzięcioł, Marek Dohojda*
Warsaw University of Life Sciences, Poland

Effect of slurry on the compressive strength of concrete and its geometric surface structure

Concrete elements, mainly floors in livestock buildings, are subject to degradation due to contact with substances with low pH. The study was conducted to compare the results of strength tests and surface structure analyses of samples under laboratory and polygon conditions in the context of the effect of low pH environment on concrete. Cubic samples of ordinary concrete made from two different mixtures were immersed in 2% and 3% acetic acid as part of laboratory tests, and under polygon conditions in an open-tank slurry, for a period of 290 days. The measured compressive strength values were compared with those of a control sample not under the influence of an aggressive environment. Strength tests were supplemented by analysing the surface of the samples with respect to roughness and chemical composition. Microscopic imaging, integrated with strength tests, made it possible to diagnose the deterioration of concrete as a result of the progressive corrosion process with organic acids.

Keywords: livestock buildings, concrete, acid corrosion, environmental protection, microscopic analysis

* joanna_witkowska@sggw.edu.pl

*Katarzyna Maj-Zajezierska**
Academy of Applied Sciences in Tarnów, Poland

Analysis of the proposal to adopt air quality standards in the EU in accordance with the WHO recommendations

The problem of air pollution is a global challenge. In the EU, Poland is one of the top countries with the worst air quality. PM 2,5 and PM 10 have a large share in this. In response to the growing scale of the problem, on 26.10.2022, the EU proposed adopting more stringent regulations on the level of PM 2,5 in line with the latest WHO guidelines. The proposal is one of the stages in the implementation of zero pollutant emissions under the European Green Deal.

The aim of this study was to compare the current limit values for PM 2,5 and air pollution in Poland and the EU. The literature related to changes in PM 2,5 concentration and the effect on the exposed population was analyzed. The new regulations change the allowed annual average value for PM 2,5 from 20 to 5 µg/m3. An unquestionable benefit from tightening regulations will be the improvement of the health of EU residents. Numerous studies described in the literature prove the relationship between the increased concentration of air pollutants and a higher number of daily deaths and hospitalizations due to cardiovascular and respiratory diseases. Particulate matter significantly affects the health of a population exposed to air pollution in the short term. Studies described in the literature show that a decrease in suspended dust concentration by 10 µg/m3 significantly reduces the number of deaths caused by cardiovascular diseases, and a decrease of 15 µg/m3 may contribute to the extension of life by up to 2 years.

Keywords: PM 2,5, ambient air pollution, air quality

* k.majzajezierska@gmail.com

Magdalena Budych-Górzna[1], Małgorzata Komorowska-Kaufman[2], Piotr Oleśkowicz-Popiel[2]*
[1]*Aquanet S.A., Poland*
[2]*Poznan University of Technology, Poland*

Application of waste activated sludge mid-temperature alkaline pre-treatment for increasing biogas production at wastewater treatment plant

Considering the trends of Sustainability and the Circular Economy, there is an increasing emphasis on achieving energy self-sufficiency in wastewater treatment plants. This can be achieved by reducing energy consumption and alternatively by maximising energy recovery through the production of biogas from sewage sludge.

Raw sludge from primary treatment is easily degradable in the anaerobic digestion (AD) but waste activated sludge (WAS) from biological part of WWTP is difficult to digest effectively. The use of sludge pre-treatment can improve the digestibility of WAS and increase biogas production. Alkaline pre-treatment is relatively simple to implement in the full-scale wastewater treatment plant, because it does not require sophisticated devices and is easy to operate.

The aim of this work was to investigate the effect of mid-temperature alkaline pre-treatment with different doses of NaOH and a mixture of NaOH and Mg(OH)2 on WAS disintegration, methane yield as well as digestate dewatering properties. The use of small doses of 13.6 g NaOH/kg TS, while heating at 60oC for 30 min, allowed to obtain the sludge disintegration degree of 25%. As a result, the methane yield increased by up to 11% in a 21.5-day anaerobic digestion trial. Application of 10.2 g Mg(OH)2/kg TS for pre-treatment did not affect the biogas production process, but improved dewaterability of digestate and supernatant turbidity.

Keywords: waste activated sludge pre-treatment, anaerobic digestion, biogas production, dewatering

Acknowledgments: The work was founded from the Polish-Norwegian Research Programme operated by the National Centre for Research and Development under the Norwegian Financial Mechanism in the frame of the POLNOR, Project No. NOR/POLNOR/SIREN/0069/2019 "Integrated system for SImultaneous Recovery of Energy, organics and Nutrients and generation of valuable products from municipal wastewater (SIREN)".

* m.budych_gorzna@wp.pl

Magdalena Bilińska, Lucyna Bilińska, Marta Gmurek*
Lodz University of Technology, Poland

Industrial ozone installation for textile wastewater reuse. The study of optimal ozone dose

Textile production is one of the most water-consuming industrial branches. Closing the water loop by treatment and recycling is a highly expected approach in this area. However, textile wastewater treatment is not standard on an industrial scale, and the Polish textile factory Bilinski is one of very few having a functional wastewater recycling system. This study investigates industrial ozone system operational conditions in Bilinski Co. The ozone reaction column by Thies GmbH (Germany) of the volume of 7 m3 was tested for the optimal ozone dose in a closed loop of textile wastewater reuse. The ozone measurement system by BMT, ozone concentration meter type 965OG, and dehumidifier type DH7, helped investigate ozone in the gas phase. The applied ozone dose, AOP, and transferred ozone dose, TOD, were calculated based on this data. Three values of TOD, 62.9, 37.7, and 27.0 g/m3, were used to treat the wastewater. The color reduction of 97% was possible after 8, 9, and 11 minutes of treatment, respectively. The test showed the higher TOD was, the shorter treatment was. Consequently, the average optimal ozone concentration was 32.4±5.5 g/m3. However, this value is roughly estimated because of the industrial scale of the process. It can be assumed that after transferring this ozone concentration, 97% color removal is possible. Finally, the faster the optimal ozone concentration would be transferred, the shorter the treatment time needed. The experiment showed how operational conditions could be investigated in a high-volume industrial system.

Keywords: industrial ozone system, textile wastewater, wastewater recycling, ozone measurements

Acknowledgments: The research leading to these results has received funding from the Norway Grants 2014-2021 via the National Centre for Research and Development under grant NOR/SGS/TEX-WATER-REC/0026/2020-00.

* magdalena.bilinska@dokt.p.lodz.pl

Noura Fathy Adel Salam[1], Sara Mohamed Elhosary[1], Magdi F. Abadir[1], Magdalena Zabochnicka[2]*
[1]Cairo University, Egypt
[2]Czestochowa University of Technology, Poland

Optimization of methyl orange removal from textile wastewater by electro-coagulation cell using RSM

The performance of the electrocoagulation (EC) in the treatment of synthetic wastewater containing textile dyeing such as methyl orange (MO) was investigated using Surface Response Methodology in 33 full factorial design experiments. Electrolysis of wastewater was carried out by means of iron electrodes under different operating conditions of initial dye concentration, applied voltage and electrolysis time at room temperature and pH=7. The results showed that using EC has proven to be a promising method in the color removal from textile dyeing wastewater. The maximum color removal efficiency was 96.77% at an applied voltage of 15 V, an electrolysis time of 30 minutes and at an initial dye concentration of 50 mg/L. Under these conditions the corresponding Electrical Energy Consumption (EEC) was 23.7 kWh/m-3. Most of the color removal occurred in the first 20 min whereby 87.50-91.00% of the color was removed.

Keywords: electrocoagulation; methyl orange; wastewater; textile; dye

Acknowledgments: This scientific work was supported by the statute subvention of the Czestochowa University of Technology.

* nourafathy@eng.cu.edu.eg

Paulina Bąk-Patyna, Hubert Patyna*
Kielce University of Technology, Poland

Examination of light reflection and luminance of mineral-asphalt mixtures

The brightness of the road surface largely translates into road safety. Bright surfaces provide better visibility at night, heat up less in a period of high sunlight limiting the phenomenon of ruts, translate into savings in lighting design due to better light reflection parameters. Obtaining a mixture of a certain brightness (not including modified mixtures) is carried out by using aggregate with the desired parameters. Several selected types of aggregates were tested to determine their luminance coefficient in scattered light. For this purpose, special forms have been created to ensure proper laboratory conditions for the use of a road reflectometer. After testing the mineral samples, the results were systematized and collected, which were used to create asphalt mixtures with specific brightness parameters. The mixtures prepared in this way, after removing the asphalt film from them, were tested for the luminance coefficient, which served to compile the final results.

Keywords: light reflection, the brightness of the surface, luminance factor, Retroreflectometer, Mineral-asphalt mixtures, aggregates

* pbak@tu.kielce.pl

Paweł Kut, Katarzyna Pietrucha-Urbanik*
Rzeszow University of Technology, Poland

Operation and Failure Analysis of Photovoltaic Installations

The development of photovoltaics represents an opportunity for enhancing national energy independence, which in the current geopolitical situation is a strong argument for investing in renewable energy sources. The expected rapid demand on energy worldwide would give rise to serious consequences: energy shortage and unaffordable energy prise. However, the development of distributed sources such as photovoltaic installations poses a serious problem for countries where the energy comes overwhelmingly from large coal-fired power plants and other hydraulic and fossil power plants. One example of such a problem is the disconnection of inverters after an excessive voltage increase at the main grid. Consequently, the development of distributed sources requires the modernisation of electricity grids. Therefore, it is important to analyse all aspects of photovoltaic installations, such as potential failures. A failure is a state in which a system fails to realize its expected function. A photovoltaic power plant usually consists of photovoltaic panels, an inverter, and the electronics and power electronics that control the plant. The causes of failure can be the following: operational, environmental, regulatory. The high probability of failures is related to the mechanical degradations. If the installation is frequently disconnected, this can have a significant impact on the profitability of the investment. The industrial can reduce the risk by selecting high quality components designed and installed by highly qualified people and supported by the proper servicing of the installation.

Keywords: photovoltaic, energy, operation, failure, risk assessment

* p.kut@prz.edu.pl

*Weronika Urbańska**
Wrocław University of Science and Technology, Poland

The potential of recovering critical raw materials from polymetallic waste

Efficient and sustainable management of raw materials is one of the most critical challenges in the modern system of environmental and natural resources protection. Rapid technological development constantly affects the increase in the number of produced electronic devices, used by individual users and industry, including medical, energy, IT or defence sectors. Changes in the global electronics market are also influenced by legal conditions and environmental aspects, an example of which may be the recent trends in the automotive market, particularly the interest in electromobility. Various types of metallic raw materials are required for the production of both electronic equipment and modern passenger vehicles, including critical metals - lithium and cobalt used in Li-ion batteries (LiBs), rare earth elements - neodymium, cerium, lanthanum and yttrium found in hybrid and electric vehicles, as well as precious metals - gold, silver and palladium contained in electronic systems (printed circuit boards – PCBs). The increased demand for this type of raw material significantly affects the state of natural resources, which in turn may lead to their depletion. An alternative to the extraction of metals from natural resources is the possibility of their recovery from polymetallic waste e.g., spent Li-ion batteries or printed circuit boards and re-use in new products of this type.

The aim of the paper was to analyze the state of metallic raw materials management, with particular emphasis on critical metals and the possibility of their recovery from waste batteries and printed circuit boards.

Keywords: critical raw materials, spent Li-ion batteries, printed circuit boards, metals recovery, circular economy

* weronika.urbanska@pwr.edu.pl

Ewa Gawlak, Jagoda Worek, Katarzyna Styszko*
AGH University of Science and Technology, Poland

Microplastics in sewage samples – the content and the origin

The production of plastics grows exponentially for over a hundred years and currently reaches several hundred milion tons per year. For a long time we are aware of its negative environmental influence, however due to the economic profits and wide application, it does not slow down. Scientific research show new environmental problems which comes with this – microplastics, which are small plastic particles. The size of them does not exceed 5 mm, which makes it easy to spread within ecosystems.

The aim of this research was to determine the content of microplastics in municipal sewage samples. After filtrations, samples were cleaned of organic matter with perhydrol (H_2O_2) and subjected to density separation with the use of saturated calcium chloride $CaCl_2$. The identification of microplastics, for which microscopy and spectroscopy FT-IR with the ATR variant was used, allowed to group particles by shape and colour, and define their chemical content.

During the analysis of more than 4500 particles, results shown a significant difference in microplastics content for raw and treated sewage. This indicates the fact that nowadays water treatment plants are efficient in removing microplastics to some degree. However, this is not a satisfactory, so deepening of research and taking real action is suggested.

Keywords: microplastic, plastic, sewage samples, environmental

* ewagawlak@student.agh.edu.pl

Achraf Berradi, Laila Mandi, Faissal Aziz*
Cadi Ayyad University, Morocco

Biobased hydrogels for a smart irrigation

The agricultural sector is among the most growing sectors due to the requirement for food and fabrics to satisfy the growing demand of the expanding world population. However, the use of water sources is becoming more and more important, especially in drylands, as water scarcity causes degradation, desertification and salinization of soils due to dryness of soils, especially in arid and desert regions, in addition to the fact that plants and soils have low water retention capacity which results in the use of very large amounts of water during irrigation. This reduces soil productivity, crop growth, availability, and wastewater.

This study aims to prepare hydrogels based on a bio-sourced polysaccharide for agricultural application while valorizing the waste of the olive industry to extract the cellulose, which makes the base of our superabsorbent hydrogel. This biobased hydrogel displays significant advantages like nontoxicity, availability, low production cost, biocompatibility, and biodegradability, with huge water retention and water absorption capacity without dissolution. Before studying its morphological, thermal, mechanical, and swelling properties, this material's synthesis is confirmed using Nuclear magnetic resonance (NMR) and Fourier Transform infrared spectroscopy (FTIR).

Keywords: biobased-cellulose, hydrogel, irrigation, water-retention, agriculture

Acknowledgments: This work was supported by the Morocco-Tunisian bilateral scientific cooperation project (20 /PRD-MT).

* achraf97berradi@gmail.com

Alina Pruss[1], Agata Pruss[2], Jacek Karolczak[1], Paweł Pruss[3], Beata Mądrecka-Witkowska[1], Małgorzata Komorowska-Kaufman[1]*
[1]Poznan University of Technology, Poland
[2]Technical University of Denmark, Denmark
[3]AQUA S.A., Poland

Sustainability between trees

Polish scouts are members of the movement, which also acts for worldwide sustainability. The United Nations, an intergovernmental organization, in 2015 developed the Sustainable Development Goals plan. Achieving these 17 goals and 169 targets connected with them means that humans develop in a sustainable way. Sustainable development allows for meeting the needs of the present generations without limiting the possibilities of the future ones. This is the global issue, but acting locally is also important, and Polish scouts should be concerned. For example, they can reduce their negative impact on the environment by, for example, removing plastic bottles during their camps. During this study, we did more – we applied engineering knowledge into the pilot scheme and provided water to the scout camp without harming nature. Our study proved that it is possible to abandon the use of single-use plastic water containers and other non-eco-friendly solutions during the scout camps and provide a water supply in a more sustainable way. The next step will be to apply this conclusion to scout camps during the next summer. Following this study, organizers can reduce the negative impact on the environment on the campsite.

Keywords: Sustainable Development Goals, sustainability, scout camp, sanitation systems, drinking water

Acknowledgments: The research was financed by the Ministry of Science and Higher Education, Research Subsidy of the Poznan University of Technology 2022 entitled: "Improving methods, devices, and systems of environmental engineering for sustainable development" (5200 201/0713/0010/SBAD/0958).

* s222917@student.dtu.dk

Aleksandra Kozłowska-Woszczycka, Katarzyna Pactwa*
Wrocław University of Science and Technology, Poland

Public Participation Geographic Information System in post-mining management in the face of Just Transition

Ongoing and upcoming changes related to the transition to a sustainable zero-emission economy require measures to protect the areas exposed to the negative effects of the transformation. The Just Transition Fund (JTF) is the key tool of the European Union and aims to help the areas that depend on fossil fuels and are exposed to severe socio-economic consequences as they strive to achieve climate neutrality. One of the regions that can apply for JTF support is the Wałbrzych subregion, which undertook the development of the Just Transition Plan. In June 2022, the European Commission issued comments on the Plan, which indicated that the proposed actions did not address the effects of mitigating the transition process and that not all stakeholders were involved in the planning. For this reason, it becomes necessary to conduct a comprehensive diagnosis of the area, which will consider social issues and identify the expectations of stakeholders in terms of planning the revitalization process. Thanks to this, it will be possible to plan such activities that will be consistent with the areas of Just Transition investments. Involving the community in decision-making processes requires the use of innovative solutions ensuring effective communication. An approach based on PPGIS (Public Participation Geographic Information System) is proposed for conducting interactive public consultations to obtain reliable spatial information. The data obtained in this way are then processed and subjected to detailed spatial analyzes. A diagram of research based on PPGIS was presented, leading to a comprehensive post-mining diagnosis of the Wałbrzych subregion.

Keywords: Just Transition, mine closure, post-mining area

* aleksandra.kozlowska-woszczycka@pwr.edu.pl

Anna Jasińska, Anna Grosser*
Częstochowa University of Technology, Poland

Biochemical methane potential (BMP) study of anaerobic co-digestion of sewage sludge, poultry manure and selected local organic waste

The market for anaerobic digestion is growing throughout Europe and is expected to exceed USD 8 billion by 2024. The development of research into this process has progressed in tandem with advances in environmental protection, primarily the introduction of sustainable waste management methods. However, the effectiveness of anaerobic digestion is limited by the specific properties and lack of homogeneity of some of the wastes, especially manure and sewage sludge. Poland is one of the leaders of the poultry industry in Europe. It is estimated that it generates more than 4 million tonnes of manure each year, the management of which is still problematic. In the case of sewage sludge, although there is a progressive modernisation and expansion of the infrastructure for sewage disposal and treatment, most digesters are oversized, so the organic load contained in them is low. The co-digestion of sewage sludge and poultry manure with other wastes therefore appears to be a favourable strategy due to the possibility of increasing methane yields, as well as making full use of the facilities available at treatment plants. The BMP study was carried under mesophilic conditions in Automatic Methane Potential Test System and included 3 stages: 1) assessment of the methane potential of selected local wastes; 2) determination of the most beneficial inoculum to substrate ratio; 3) anaerobic co-digestion of poultry manure, sewage sludge and selected co-substrate. The best results were obtained for co-digestion mixture of poutry manure, sewage sludge together with grease waste, where methane yield was 0,49 L/kg VS.

Keywords: anaerobic digestion, anaerobic co-digestion, biogas, biomethane, methane, waste management, sewage sludge, poultry manure

* anna.jasinska@pcz.pl

Asmae Ben Abdelhadi[1], Rachid Ouarsal[1], Mohammed Lachkar[1], Michal Dusek[2], Brahim El Bali[2]*
[1]University Sidi Mohamed Ben Abdellah, Morocco,
[2]Independent Scientist, Morocco

New hybrid organic-inorganic phosphite $(N_2H_5)2Co(H_2PO_3)_4.2H_2O$: Synthesis, Structural characterization, physicochimical application and catalytic activity

A new hybrid phosphite $[(N_2H_5)2Co(H_2PO_3)_4].2H2O$ containing hydrazinium cations has been prepared by a slow evaporation at room temperature and characterized using single cristal X-ray diffraction and spectroscopic techniques. The crystal structure determination confirme that this compound crystallizes in the Triclinic structure (space group P_1^{-}). The crystal structure consist on a octahedral geometry formed by four oxygen from the pseudo-tetrahedral units $[H_2PO^{3-}]$ and two nitrogen atom from the hydrazinium cations N2H5+ on both sides. The characteristic bands of hydrazinium cations and phosphite groups are present in the infrared spectrum. Thermogravimetric Analysis shows that the thermal decomposition of the compound consiste mainly of the loss of the water molecules and the organic moiety. UV-Vis technique was used in studying the evolution of the catalytic activity. Oxidative degradation of methylene blue (MB) using the title complex as a catalyst with H2O2 in aqueous solution was studied. Nearly complete decolorization (68% of the dye was obtained in less than 10 min and 88% after 2 h). The synthesized catalyst displayed good performance toward the catalytic reduction of p-nitrophenol (4-NP), o-nitrophenol (2-NP) and m-nitrophenol (3-NP) into the corresponding aminophenols.

Keywords: organic-inorganic phosphite, cristal structure, IR, physicochemical properties, catalytic activity, methylene blue oxidation and reduction of nitrophenol

* b_elbali@yahoo.com

Deepti Negi[1], Achlesh Daverey[1], Punyasloke Bhadury[2]*
[1]*Doon University, India*
[2]Indian Institute of Science Education and Research Kolkata, India

Rice husk biochar augmentation in Cyperus alternifolius and Acorus calamus planted CWs for nitrogen removal a preliminary study

Constructed wetland (CWs) offers a long-term solution for wastewater treatment due to its high nutrient removal efficiencies, multifaceted ecological benefits and low costs. Similarly, biochar an organic carbon-based compound as a potential media amendment in CWs offers a low-cost technique for increased water treatment and reduce carbon footprint. The objective of this preliminary study was to evaluate the efficiency of biochar amended CWs for the nitrogen removal from wastewater. In this study, rice husk biochar was utilized to intensify two lab-scale vertical flow CWs planted with Acorus calamus (ACW) and Cyperus alternifolius (CCW) for nitrogen removal from a simulated wastewater. The wastewater was simulated using (NH4)2SO4, glucose, KH2PO4 and trace elements among which the concentration of NH4+-N, COD and PO43- were 50 mg/l, 200 mg/l and 20 mg/l, respectively. Treated effluent samples were collected from the bottom layer in time interval of 2 days. Results showed that the average ammonium nitrogen removal efficiency of ACW and CCW was 77.9% and 84.5%, respectively which were higher than control i.e., 71.98%. Also, the average COD removal efficiency of ACW, CCW and control were 80.8%, 80.6% and 79%, respectively. A significant increase in the height and biomass was recorded for both the planted systems. In conclusion, the preliminary study showed that rice husk biochar augmentation to Cyperus alternifolius and Acorus calamus planted CWs improved the overall nitrogen removal.

Keywords: constructed wetland, nitrogen removal, biochar, nutrient removal

Acknowledgments: Deepti Negi [IF190890] would like to gratefully acknowledge the DST INSPIRE Fellowship, Govt. of India.

* deeptinegi.phd@doonuniversity.ac.in

Dorota Babilas, Piotr Dydo*
Silesian University of Technology, Poland

Influence of $[Bmim]^+$ ion concentration and linear flow velocity on the limiting current density during electrodialysis process

Ionic liquids (ILs) are a group of compounds gaining an important role in the fields of chemistry and environmental protection. Unfortunately, due to the good miscibility of ILs with most solvents, their recovery and separation from the solution by classical separation methods is often inefficient. One of the method used for IL recovery can be electrodialysis (ED). The important parameter in the description of ED is the limiting current density (LCD). Thus, the aim of this work is to determine the influence of $[Bmim]^+$ ion concentration and linear flow velocity on the LCD during ED.

The ED experiments were carried out using an EDR-Z/10-0.8 module (MemBrain, Czech Republic) with an effective single-membrane area of 64 cm^2. There were five pairs of membranes in the ED stack. The ion-exchange membranes (IEMs) used in this investigations were heterogeneous AM(H)-CM(H) (Ralex, Czech Republic). The LCDs were determined based on current–voltage curves using the Cowan–Brown method, for solutions with [Bmim]Cl concentrations of 0.01, 0.05, 0.10, 0.25, and 0.50 mol/L, at various linear flow velocity (1-5 cm/s). The applied voltage was increased stepwise at a rate of 0.5 V/min. The concentrations of the [Bmim]Cl solutions were determined with a UV-VIS spectrophotometer (Varian Cary 50 Scan, Agilent, USA).

In this work the LCDs in the assumed ED parameters were determined. As suspected, the LCD depended upon the [Bmim]Cl concentration in the diluate solution and linear flow velocity. It was proven that the LCD increased linearly with increasing [Bmim]Cl concentration in the diluate and linear flow velocity.

Keywords: ionic liquids recovery, 1-butyl-3-methylimidazolium chloride, limiting current density, electrodialysis

Acknowledgments: This work was supported by the National Science Centre, Poland, under research Project No.: 2021/43/D/ST8/02776.

* dorota.babilas@polsl.pl

Ghizlane Akhouy, Lhoucine Gebrati*
Cadi Ayyad University, Morocco

Olive Pomace: a renewable resource for developing bio-based and biodegradable food packaging

Waste management in the olive industry is one of the major and topical environmental issues. The olive oil industry produces mainly olive oil and, therefore, large quantities of waste and oil residue harmful to the environment. Although their chemical composition is rich in recoverable organic matter, their valorization is necessary. On the one hand, our work consists of recovering the waste from the olive industry and, on the other hand, developing plastic packaging that is harmless to health and the environment. measurements were done to investigate the surface hydrophobicity of the fiber mat samples.

This study transforms olive pomace waste into a solution to today's environmental and societal concerns, particularly the plastic problem. The first step was to extract different biopolymers from the olive pomace. Then, the development of nanocomposites based on these biopolymers, using the electrospinning method under controlled parameters was conducted. After optimizing these conditions and their resistance to water, morphological properties, biodegradability and antimicrobial activities were determined and optimized. In addition, and to improve the antimicrobial activities of biomembrane, the essential oils, after their extraction from two plant species, they were encapsulated in the structures of nanofibres.

The Fourier Transformed Infrared (FTIR) spectra of the nanofibrous mats were acquired using a Bruker ALPHA FTIR Spectrometer. Differential thermal analysis (DTA) and thermogravimetric analysis (TGA) were used to better understand nanofibers' thermal behavior. To further understand gas permeability, porosity measurements were performed.

Keywords: olive pomace, biopolymers, biomembrane, electrospinning, food packaging

Acknowledgments: This work was supported by the Morocco-Turkish bilateral scientific cooperation project (CNRST/TUBITAK., 23/24).

* ghizlaneakhouy86@gmail.com

Imane Haydari, Faissal Aziz, Naaila Ouazzani, Laila Mandi*
Cadi Ayyad University, Marrakech

Facile preparation of novel low-cost sorbent for olive mill wastewater treatment and phenol recovery

This work presents a preparation of bio-sorbent based on olive pomace waste. The morphology of the prepared bio-sorbent was examined by scanning electron microscopy, energy dispersive X-ray spectroscopy, and Fourier transform infrared spectroscopy. Next, batch and column adsorption tests were performed to recover phenol from oil mill wastewater. Various parameters influence the adsorption: contact time, pH, initial concentration and temperature. The adsorption of phenol fitted well to the pseudo-second-order kinetic model and Langmuir isotherm model. The thermodynamic parameters $\Delta G°$, $\Delta H°$ and $\Delta S°$, were shown that the adsorption phenomenon was spontaneous and endothermic. The Thomas model better describes fixed-bed column adsorption. In addition, the average adsorption efficiency of phenol was 74 %, which emphasizes the bio-sorbent efficiency.

Keywords: bio-sorbent, fixed-bed column adsorption, olive pomace, phenol recovery

Acknowledgments: This work was supported by the Morocco-Tunisian bilateral scientific cooperation project (20 /PRD-MT-02).

* ih.haydari@gmail.com

Imane Adouar, Smaiel Herradi, Souad Rakib, Brahim El Bali, Mohammed Lachkar*
University Sidi Mohamed Ben Abdellah, Morocco

Comparative study of hydroxyapatite nanocomposites used as slow release fertilizers

Agriculture is the major user of phosphorus fertilizers, accounting for 80-90% of the world demand. With the increasing population, rising demands for bio-energy crops will increase the future demand for chemical fertilizers. However, intensifying the application of these fertilizers will damage the environment, human being health and all living creatures as well.

Hydroxyapatite (HAp) is a mineral, Ca_{10} $(PO_4)6OH_2$, that is the principal storage form of calcium and phosphorus in bones. The nanoparticles of HAp are considered as one of the most important element in agricultural applications, which can provide phosphorus nutrient. The use of HAp, however, focused on its biomedical applications because of its excellent biocompatibility and bioactivity, but the agricultural applications are recently taken into consideration.

The purpose of this study is to synthesize hydroxyapatite nanocomposite for agricultural applications and compare it with other types of nanocomposite in order to protect the environment and increase crops production with the minimum and efficient use of chemical fertilizers.

Keywords: hydroxyapatite, phosphorus fertilizers, nanocomposite

* adouar.imane@gmail.com

*Iwona Deska**
Czestochowa University of Technology, Poland

The role of extensive green roofs in rainwater management and climate changes mitigation in urban areas

Paper investigates a role of extensive green roofs in rainwater management and climate changes mitigation in urban areas. The urbanization and population growth lead to a development of cities and as a result to sealing of the ground surface in urban areas. It results in an increase of the surface runoff rate and intensity as well as the rise of the risk of flooding. At the same time, rise of impermeable areas in cities lead to a decrease of share of an infiltration in the water cycle. Therefore, in the urban areas there is a need to use the Sustainable Urban Drainage Systems (SUDS) which can support the operation of traditional stormwater sewage systems. Examples of SUDS are, among others, the green roofs. Vegetated roofs may be an effective tool for the rainwater management. Use of these solutions in the urban areas carries many ecological and economic benefits. The green infrastructure may be a very effective tool for the climate changes mitigation, especially in the great cities with the dense buildings. The green roofs have a potential to diminish the air temperature and thus to reduce "the urban heat island" effect in cities. They can contribute to a reduction of greenhouse gas (GHG) emissions into the atmosphere. The leaves and stems of plants have a potential to absorb the atmospheric pollutants including the particulate matter {PM10 and PM2.5) due to the wind action. There is a need to use and promote the green infrastructure strategies, technologies and measures in order to climate change mitigation and adaptation.

Keywords: green roof, climate change mitigation, stormwater management

Acknowledgments: The scientific research was funded by the statute subvention of Czestochowa University of Technology, Faculty of Infrastructure and Environment.

* iwona.deska@pcz.pl

*Izba Ali**
KU Leuven, Belgium

Production of hydrogen peroxide in a photo-electrocatalytic system

Hydrogen peroxide (H2O2) is often employed for the treatment of (waste)water due to its highly oxidative and non-polluting nature as it only breaks down to harmless compounds (i.e., water and oxygen). H2O2 is mainly produced in industrial settings which is expensive and demands extreme care with handling, shipping, and storage. This has led to an increase in research trends to devise an in-situ, decentralized, and small-scale H2O2 generation and utilization facility for the purpose of water treatment. Photo-electrochemical production of H2O2 has become an increasingly attractive option as the H2O2 produced can be instantaneously brought into utilization for in-situ treatment of water. In a photo-electrochemical system, a photoanode generates photocurrent and H2O2 is formed at the cathode surface via oxygen reduction. Photoelectrochemical H2O2 production was studied in a double chamber cell composed of photoanode and reticulated vitreous carbon (RVC) cathode. A proton exchange membrane (Nafion 117) separates the anodic and cathodic chambers. The photoanode was prepared by depositing a heterojunction of BiVO4/graphene oxide/TiO2 on the FTO glass plate and RVC was prepared by the polymerization and subsequent carbonization of furfuryl alcohol on a polyurethane sponge. In the presence of light, the photoanode generates photocurrent and produces H2O2 without any external current bias. The maximum rate of H2O2 was 5.4 μM/min, achieving about 100% faradic efficiency. These results promote the route for storing solar energy in the form of chemical energy (H2O2) by using economical materials to manufacture electrodes, while later can be used for environmental remidiation.

Keywords: photoelectrochemical, hydrogen peroxide, photoanode, water treatment

Acknowledgments: This research was supported by the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 861369 (MSCA-ETN InnovEOX) and by the KU Leuven Industrial Research Council under grant number C24E/19/040 (SO4ELECTRIC).

* izba.ali@kuleuven.be

Jakub Copik, Edyta Kudlek, Mariusz Dudziak*
Silesian University of Technology, Poland

Sonocatalysis - effective method of organic micropollutants removal from water

Nowadays, many harmful organic micropollutants (OMPs) were found in diverse aquatic systems, drinking water, groundwater and surface water. In addition, many identified OMPs are resistant to biodegradation, thus having the potential for persistence and accumulation in the ecosystem. Although they occur in low concentrations (typically up to µg L-1.), they may cause serious health problems, including cancer. Therefore, many advanced oxidation processes (AOPs) have been proposed to remove OMPs from water systems e. g. Fenton reaction, electro-oxidation, ozonation, UV irradiation, hydrogen peroxide treatment, and cavitation processes. Currently, there is also a tendency to combine the above-mentioned technologies to increase treatment efficiency and to make them more environmentally friendly. The ultrasonication process which is one of the AOPs was recently found to be very effective in many harmful substances removal from water. It is based on acoustic cavitation phenomena which is related to extreme temperature and pressure condition occurrence. However, due to some limitations of this technique, growing attention on sonocatalysts and sonosensitizers usage can be observed. For that purpose, several inorganic and organic materials can be used such as TiO_2, curcumin, ZnO, chitosan nanoparticles, sand and broken glass particles, rose Bengal, etc.

Keywords: ultrasound, AOPs, sonocatalysts, sonosensitizers, organic micropollutants

Acknowledgments: This work was supported by the Ministry of Science and Higher Education Republic of Poland within statutory funds, 2022.

* jakub.copik@polsl.pl

Juris Burlakovs[1], Zane Vincevica-Gaile[2], Mait Kriipsalu[3], Magdalena Wdowin[1]*
[1]Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
[2]University of Latvia, Latvia
[3]Estonian University of Life Sciences, Estonia

Rejected by Waste Recycling Material for Enhancing Methane Degradation in Landfill Biocovers

Landfill gas consists mainly of CO_2 and CH_4, but the latter contributes to a more remarkable greenhouse gas effect that seriously impacts climate change. Of all global emissions, methane emissions from the waste sector comprise about 18%, predominantly released from landfills. The emission extent can be reduced by gas collection; however, residual methane always remains and is released into the atmosphere. The biological degradation of methane in constructed biocover layers may serve as a sustainable solution. The novelty of the research is related to the use of waste-derived materials lost to recycling but utilised in the production of biocovers. Rejected material from the waste recycling process was collected in landfills located in Estonia and Lithuania, followed by the accomplishment of chemical and physical analyses. Preliminary experiments on the material application in functional biocover development were performed. The effectiveness of elaborated biocover was studied at a laboratory scale in column experiments and field studies conducted at the landfill. The results revealed that rejected by waste recycling material, such as the fine fraction of waste, is efficiently applicable for the methane degradation layer, subsequently used as landfill cover material. The course of the study makes beneficial steps to long-term sustainability according to the Circular Economy Action Plan concepts of the European Union.

Keywords: advanced functional materials, circular economy, waste valorization

Acknowledgments: The work was supported by the PASIFIC program GeoReco project funding from the European Union's Horizon2020 research and innovation program under the Marie Sklodowska-Curie grant agreement No.847639 and from the Ministry of Education and Science of Poland.

* juris@meeri.pl

Justyna Dzięcioł, Wojciech Sas*
Warsaw University of Life Sciences, Poland

Machine Learning as a Component of a Sustainability Policy for the Civil Engineering Sector on the Example of Permeability Coefficient Estimation

Global steel production in 2021 increased by 3.8% compared to 2020. This was a new world record for raw steel production, which also impacted the amount of slag produced along with this production. Waste from industrial and construction production, accounts for as much as 48% of the total waste produced throughout the European Union. In these circumstances, waste management should provide for the recycling of as many resources as possible. This is in line with the aims of the circular economy in Europe focusing on the concept of the "Green Deal", whose ambitious strategies concentrate on providing policy coherence in the areas of climate, energy efficiency, construction and demolition waste management and resource efficiency. Slags have been a material of interest to researchers for a long time in regard to their application in construction. Slags are becoming better known, on the one hand, but on the other hand we are becoming more certain of the heterogeneity of these materials, whose parameters are influenced by many factors, including the type of furnace in which they are produced. This prompts the search for tools to support the determination of slag parameters based on already available data. The purpose of the research was to verify the hypothesis that it is possible to determine the paramenter of the coefficient of permeability, relevant to applications in earth constructions with the use of a Machine Learning algorithm - Gradient Boosting. In this study, two types of material were analyzed: blast furnace slag and combustion slag. The results of the analysis allowed obtaining a high coefficient of determination (R2) - 0.97. This leads to a conclusion that the algorithm can be useful in determining filtration parameters in slags.

Keywords: sustainability development, slags, machine learning, gradient boosting, permeability of coefficient

* justyna_dzieciol@sggw.edu.pl

Justyna Cader, Renata Koneczna*
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Compilation and comparison of hydrogen economy indicators

Hydrogen has a wide potential of current and possible applications. This has been recognized in recent years e.g., by the European Commission, especially in the context of developing

a sustainable energy system. The European Green Deal, together with a hydrogen strategy for a climate-neutral Europe, identify green hydrogen as the key to a clean and circular economy. International organizations are also involved, inter alia, in popularizing green hydrogen, which could help developing countries and emerging economies in energy transformation. Accelerating the hydrogen economy (HE) is particularly important in the context of reducing dependence on fossil fuels and boosting the green transition to climate neutrality. Thus, indicators for measuring the transformation to HE should be one of the top priorities for stakeholders i.e., governments, businesses, civil society, and non-governmental organizations.

Therefore, the main purpose of this study is to verify the existing HE indicators. The analysis included a review of national strategies and roadmaps towards developing a HE, specialised reports and databases of international agencies and organizations, as well as scientific articles. Furthermore, the essential purpose of this paper is to summarise the indicators proposed so far, as well as to synthetically recommend a monitoring framework based on the existing indicators and targets set.

A comprehensive review revealed that despite the explicitly stated priorities and milestones towards creating a hydrogen value chain, direct indicators and metrics for assessing HE implementation are still in the early stages of development. Hence, the compiled indicators are a contribution to establishing a unified monitoring framework.

Keywords: hydrogen, hydrogen economy, national policies and strategies, indicator framework, climate neutrality

* jcader@meeri.pl

*Katarzyna Gabryś**
Warsaw University of Life Sciences, Poland

Cyclic behavior of recycled concrete aggregate – recycled tire waste mixture

In civil engineering practice, the use of waste car tires have gained wide popularity in various applications over the past three decades. They are used as additives or replacements for conventional materials in construction work. In geotechnical engineering, tires shredded to a certain size and mixed with soil can be especially used as backfill material behind retaining walls or road embankment fill material. Compared to the soil, rubber has a high damping capacity and a low shear modulus. This, therefore, requires the determination of the cyclic properties of soil-rubber mixtures. In this study, the cyclic behavior of composite materials, recycled concrete aggregate (RCA) and crushed pieces of recycled tire waste (RTW), was examined. Laboratory experiments were carried out in a resonant column□cyclic torsional shear system. The effect of different parameters such as the amount of RTW, confining pressure, the number of cycles, and cyclic frequency were studied. This research aimed to understand the fundamental cyclic behavior of the RCA-RTW mixture by evaluating the variation in shear modulus (G) and damping ratio (D) from small-to-large strains. The G and D parameters were determined from hysteresis loops. The G-modulus was found to decrease with shear strain and rubber content. In contrast, the elasticity of the shredded rubber gives the mixture a greater ability to withstand large deformations, leading to less stiffness degradation. The Dmin increased with rubber waste, at a higher rate in sand-like soils (RTW - 10%), while a more linear evolution was exhibited by rubber-like soils (RTW > 10%).

Keywords: recycling, environment, rubber waste, anthropogenic soil, cyclic behavior

Acknowledgments: This work is the result of the implementation of research project No. DEC-2020/04/X/ST8/00732 founded by the National Science Centre, Poland.

* katarzyna_gabrys@sggw.edu.pl

*Maciej Miturski**
Warsaw University of Life Sciences, Poland

Dispersed reinforcement as a factor in reducing the amount of cement in stabilised soils

One of the basic techniques used to improve the soil's properties is stabilising it using hydraulic binders. The method is commonly used in infrastructure construction. Considering the high carbon dioxide emissions during the production of hydraulic binders, innovative techniques to reduce binder consumption are being investigated. This study investigated the effect of dispersed reinforcement in the form of polypropylene fibres on the unconfined compressive strength of cement-stabilised soils at varying initial moisture content. Tests were carried out on three types of mixes, which consisted of soil, binder and dispersed reinforcement. Each mix was tested at a variable moisture content in the range of 7% to 13%. As a result, the possibility of reducing the cement content of the mixtures depending on the amount of reinforcement used and on the initial moisture content of the mixtures was presented. In addition, the study determined the influence of polypropylene fibres on the classification of stabilised soil according to European standards.

Keywords: soil stabilisation, dispersed reinforcement, fibres, binder

* maciej_miturski@sggw.edu.pl

Maria del Mar Cerrillo-Gonzalez, Maria Villen Guzman, Juan Manuel Paz-Garcia, José* Miguel Rodríguez Maroto
University of Malaga, Spain

Critical Raw Materials as a Limiting Factor in Lithium-Ion battery market

The energetic transition is crucial to reach the climate and sustainable development goals. However, this transition is limited by the well-known Critical Raw Materials (CRMs), which are materials with a high economic importance as well as a high supply risk. These materials are presented in almost all low-carbon technologies: batteries, wind-turbine, electrolysers and photovoltaics. In the last years, the number of CRMs has increased significantly, and currently, there are thirty materials classified as critical by the European Union, including cobalt and lithium, essential elements for lithium-ion batteries (LIBs)1. In this work, a review of critical raw materials in the field of lithium-ion battery manufacturing was presented, mainly focused on cobalt, lithium, graphite, and bauxite. Moreover, nickel and manganese were included in the study. Although these elements are not classified as CRM, they are crucial in the LIBs composition and they have a high economic importance. Their global distribution and reserves, mining, processing and manufacturing were analysed to understand the effect of these elements in the LIBs market. Another important issue included in this review was the recycling rate of these elements from LIBs wastes and the different strategies implemented in the European Union to turning the challenge of CRMs dependence into a strategic strength for a competitive and sustainable battery value chain.

Keywords: CRM, lithium-ion batteries, circular economy, urban mining, recycling

Acknowledgments: This work has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 778045. Authors acknowledge the funding from the University of Malaga (B1-2021_35). Cerrillo-Gonzalez acknowledges the FPU2018/04295 grant obtained from the Spanish Ministry of Education. Paz-Garcia acknowledges the financial support from the program "Proyectos I+D+i en el marco del Programa Operativo FEDER Andalucía 2014-2020", No. UMA18-FEDERJA-279.

* mcerrillo@gmail.com

Maria del Mar Cerrillo-Gonzalez, Maria Muñoz-Espinosa, Maria Villen-Guzman,*
University of Malaga, Spain

Role of Citric Acid and Cupper in the leaching of $LiCoO_2$

Lithium-ion batteries (LIBs) recycling is a key factor to make them a true enabler of the green transition. The growing demand of these batteries lead to an increase in the generation of waste as well as in the demand of raw material. Therefore, recycling is not only focused on the reducing the environmental impact of waste and mining, but also it is focused on the recovery of valuable components from LIBs waste. Regarding the currently existing LIBs recycling technologies, they can be classified into pyrometallurgical and hydrometallurgical. Pyrometallurgy use high temperature smelting to recover cobalt, copper, and nickel alloys, while hydrometallurgy use chemical acidic leaching to dissolve the metal containing components, followed by chemical separation and recover. Compared to pyrometallurgical method, hydrometallurgy has higher recovery efficiency, lower energy consumption and lower gaseous emissions, make it more environmentally friendly technique. However, its sustainability is questioned due to the use of huge amount of water as well as inorganic acid (HCl, H_2SO_4, HNO_3) and H_2O_2 as reducing agent. Hence, the search of green acids and reducing agents is gaining importance to develop a more sustainable process 1 2. In this work, the role of citric acid and cupper as extracting and reducing agent in the leaching process of cobalt and lithium was evaluated. Batch extraction experiments were carried out using commercial LiCoO2. Different parameters, such as the temperature, citric acid and cupper concentration were evaluated. According to experimental results, citric acid and cupper has a huge potential to be used in the leaching process.

Keywords: lithium-ion batteries, recycling, hydrometallurgy, organic acid, alternative reductant

Acknowledgments: This work has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 778045. Authors acknowledge the funding from the University of Malaga (B1-2021_35). Cerrillo-Gonzalez acknowledges the FPU2018/04295 grant obtained from the Spanish Ministry of Education.

* mcerrillo@gmail.com

Meryem Idboumlik[1], Ivan da Silva[2], Brahim El Bali[3], Mohammed Lachkar[1]*
[1]University Sidi Mohamed Ben Abdellah, Morocco
[2]Rutherford Appleton Laboratory – UKRI, United Kingdom
[3]Independent Scientist, Morocco

Structural characterization and catalytic activity of a novel hybrid decavanadates material for methylene blue oxidation

Wet chemistry was used to create a new hybrid material with decavanadate units utilizing ethylenediamine as a structure-directing agent. Single crystal X-ray diffraction analysis shows that it crystallizes in the monoclinic system (S.G. C2/c). The isolated moieties that make up the crystal structure, which is composed of [V10O28]6- monomers, ethylenediamine cations, and H_2O molecules, are organized into layers along the c-axis. As a result of the interaction between the diprotonated organic molecules located between the parallel layers and the inorganic system via N-H…O and O-H…O hydrogen bonds, a three-dimensional array is created. The Fourier transform infrared result displays distinctive bands that correspond to organic compounds and decavanadate groups. The loss of organic moieties and water molecules makes up the majority of the hybrid compound's thermal breakdown. The catalytic activity of the new decavanadate compound was assessed by oxidizing methylene blue with hydrogen peroxide.

Keywords: decavanadates, structural description, IR, oxidation catalysis

* Meryem.idboumlik@gmail.com

Olga Szlachetka, Justyna Dzięcioł, Marek Dohojda*
Warsaw University of Life Sciences, Poland

Perlite-concrete as a construction material, basic properties and prospects for sustainable application

The contemporary building is an object containing elements of rational technical solutions known from history, co-operating with elements of the modern knowledge and technology. Nowadays a lot of attention in the building construction is focused on sustainability and environmental protection. The materials applied in construction should be safe, free of toxins, but also in accordance with the idea of circular construction.

Therefore, materials as clay or thatch, recycled materials or others again find increasing application in the building construction. Quests for a smart material having appropriate structure and composition, unifying features both of a building material and insulating material (thermally and acoustically) and environmentally friendly material turned attention in this paper on the perlite. The aim of the study was to analyse the results of the experimental determination of the basic physical, mechanical and chemical parameters of perlite blocks. The focus was on determining the following parameters: volumetric and specific density (with determination of pore volume), compressive strength, thermal conductivity, diffusion resistance coefficient of water vapour, chemical composition and environmental impact. Above parameters allow to determine the applicability of these materials and further research directions.

Keywords: sustainable construction, natural building material, perlite, mechanical parameters

* olga_szlachetka@sggw.edu.pl

Oskars Purmalis, Māris Kļaviņš*
University of Latvia, Latvia

Thermogravimetric characteristics of invasive plant biomass

Lignocellulosic biomass is with high importance in energy production and due to increased energy demand their usage increases. As source of these materials can be not only already well known types of biomass, but also other plants which can create biomass in noticeable amount. One of these materials can be invasive plants; because some of them continuously expends despite applying different kind of eradication methods. As common method for limiting their expansion is cutting, therefore are available their produced biomass which can be used also for energy production. To analyse suitability of invasive plants for energy production thermodecomposition characteristics are substantial. Therefore the aim of study is to analyse thermogravimetric characteristics of invasive plants in Latvia. In this study were investigated different parts of 5 invasive species: Canada goldenrod (Solidago canadensis), Sosnowsky's hogweed (Heracleum sosnowskyi), Garden Lupin (Lupinus polyphyllus), Himalayan balsam (Impatiens glandulifera) and Canadian Waterweed (Elodea canadensis Michx.). Typical thermal decomposition is dived in three stages where first is related to loss of moisture, the second stage from 165 to 435 °C to major volatile compounds and third related to decomposition of lignin. Also in investigated plants and their parts (stems, leaves, roots, flowers, seeds) most of compounds decompose in temperature range 165 to 435 °C and presence of lignin can be described as low. However there are differences between plants and their parts during thermal decomposition indicating several peaks in DTG curves. Observed amount of volatile matter and cellulose indicates potential of invasive plants for energy production.

Keywords: invasive plants, thermogravimetric analysis, biomass

Acknowledgments: This work was supported by the European Regional Development Fund under project number 1.1.1.2/VIAA/1/16/001, Post-doctoral research project number 1.1.1.2/VIAA/4/20/723.

* oskars.purmalis@lu.lv

Paulina Sowik, Katarzyna Kowalska*
Silesian University of Technology, Poland

Solar-driven TiO2-based photocatalysis -as a method to treat wastewater contaminated by anti-microbial drugs

Wastewater reuse for agricultural purposes is limited due to the inefficient removal of contaminants of emerging concern (CECs) such as anti-microbial drugs by conventional wastewater treatment plants (WWTPs). The limitations are related to the potential uptake and accumulation of the drugs in crops irrigated with WWTPs effluents. Advanced oxidation processes (AOPs), especially photocatalysis, feature prominently due to the high degradation efficiency of this type of micropollutant from the aquatic environment.

The aim of the study was to assess the removal efficiency of sulfonamides (SAs), namely sulfadiazine(SD), sulfamethazine (SMT), and sulfamethoxazole (SMX) by solar-driven TiO_2-P25-based photocatalysis. The experiments were carried out in distilled water (DW) and municipal wastewater effluent (MWWE) spiked with 500 µg L^{-1} of each SAs, and photocatalyst concentrations of 40 mg L^{-1} and 80 mg L^{-1}. Control tests: photolytic degradation of SAs and sorption of SAs on TiO2-P25 particles were performed in parallel with the photocatalytic experiments. Primary studies in DW and MWWE were carried out in a solar radiation simulator, while secondary studies in MMWE were carried out in a CPC photoreactor under natural solar radiation.

During the experiments, the concentrations of target SAs were reduced in DW and MWWE by the solar-driven TiO_2-P25-based photocatalysis. The photocatalytic degradation of the studied SAs depends on the photocatalyst concentration, complexity of the matrix, and incident solar UV radiation. Solar-driven TiO2-P25-based photocatalysis]carried out in suitably operating parameters is a promising method to treat wastewater contaminated by anti-microbial drugs and WWTPs effluent reuse for crop irrigation.

Keywords: advances oxidation processes, photocatalysis, sulfonamides, titanium dioxide, wastewater reuse

Acknowledgments: This research was supported by the Ministry of Education and Science (Poland) (Project 08/070/BK_22/0012).

* Paulina.Sowik@polsl.pl

Piotr Kanarek, Barbara Breza-Boruta, Wojciech Poćwiardowski, Anna Ligocka, Justyna Bauza-Kaszewska*
Bydgoszcz University of Science and Technology, Poland

A study of the effects of silver ions and hydrogen peroxide on selected waterborne pathogens and the possibility of using these disinfectants for sanitizing swimming pool water

Recycling of rinse water from pool filter rinsing is in line with the principles of a circular economy. Reducing water consumption translates into economic and environmental benefits, leading to a water footprint reduction, according to Green Deal. The inactivation of waterborne pathogens, which can pose a threat to public health, is an important part of water treatment. The aim of this study was to determine the action of silver ions and hydrogen peroxide in limiting the growth of selected bacteria that are indicators of water purity and to determine the values of minimum inhibitory (MIC), and bactericidal concentrations (MBC) for these compounds. The following pathogenic bacteria were used in the study: Escherichia coli, Enterococcus faecalis, Pseudomonas aeruginosa, Staphylococcus aureus, Legionella pneumophila, and Clostridium perfringens. Studies on the effect of chemical compounds on growth limitation of the tested bacteria were performed using the microplate method. Based on the in vitro tests, it was found that the highest MIC value of the tested disinfectants was determined against bacteria of the Pseudomonas aeruginosa species. For silver ions, the MIC value was - 0.00047 mol/dm^3, and for H_2O_2- 0.18%, respectively. The highest MBC (minimum bactericidal concentration) of silver ions was found for L. pneumophila - 0.0007 mol/dm^3 and P. aeruginosa - 0.00047 mol/dm3. The least sensitive to H_2O_2, on the other hand, was P. aeruginosa (MBC value - 0.18%), followed by Legionella pneumophila (MBC - 0.025%).

Keywords: water recycling, waterborne pathogens, disinfectants, MIC (minimum inhibitory concentration)

* piokan004@pbs.edu.pl

*Ruchi Upadhyay**
Silesian University of Technology, Poland

Mycoremediation: A remedy for alleviation of Ecotoxicity Risk of wastewater contaminated with Synthetic dye?

Overwhelming industrialization has played an important role in soil, water and air pollution. Synthetic dye containing effluents show toxicity towards fauna and flora and even genotoxicity if they are released directly into water bodies and it may undergo biomagnification process, which ultimately end up in spreading toxicity to other organisms also. The purpose of mycoremediation technologies is to diminish the burden of environment by degrading the toxic pollutants with use of fungi and decreasing its toxicity. The enzymatic mechanism of fungi helps in degradation of synthetic dye, and results in decolorization of wastewater. Ecotoxicity analysis provide information about toxicity of pure dye and post process sample. For zoo toxicity analysis, Daphnia magna acute immobilization test is performed whereas Lemna minor, Zea mais are being utilized for phytotoxicity test. The test is important for recycling of industrial eluent into farming. In genotoxicity test, the DNA damage capacity of dye is tested which is responsible for carcinogenic nature. The phytotoxicity test was conducted using Lectuca sativa before and after biosorption and biodegradation of Procion Red MX-5B with help of A.niger and A.terreus. After biosorption with A.niger, the growth inhibition percentage were decreased. But after biodegradation with A.terreus, almost 10 times increase in toxicity was observed after 336 h of treatment. Hence, it was concluded that the mycoremediation has potential to alleviate the ecotoxicity risk of wastewater polluted with dyes but still there is a scope to optimize the process in a manner that reduces toxicity of dye along with good decolorization efficiency.

Keywords: mycoremediation, synthetic dyes, toxicity analysis, wastewater

* Ruchi.Manishkumar.Upadhyay@polsl.pl

Mehdi Sharif Shourjeh[1], Przemysław Kowal[1], Bartosz Szeląg[2], Jakub Drewnowski[1]*
[1]*Gdansk University of Technology, Poland*
[2]*Kielce University of Technology, Poland*

Effect of free ammonia and free nitrous acid on inhibition NOB activity in the SBR under elevated temperatures for lower energy strategies

Successful start-up of a partial nitrification (PN)-anammox system for sidestream can be achieved by regulation of free ammonium (FA) and free nitrous acid (FNA) concentrations to outcompete NOB at elevated temperatures specified for reject water from the anaerobic digestion. In this study, stand-alone FA inhibition and combined influence of FA and FNA on NOB suppression and AOB activity in a lab-scale environment, during synthetic reject water treatment at an elevated temperature (up to 30°C) was investigated. At pH=8.3 and FA=17.2 mg/L, the most favourable NO2-N accumulation/AUR ratio (0.49) occurred, indicating a nearly 50% decrease in nitrate accumulation and the strongest inhibitory effect on NOB activity. The findings demonstrated the importance of operational parameters in controlling the activity of AOB and NOB throughout the nitrification process, whether acting alone or in combination with FA-FNA components. Although the combined impact of FA and FNA enhances NOB suppression, the FA approach alone outperformed other method in terms of nitrite build-up and process effectiveness since it maintained greater AOB activity.

Keywords: FA-FNA, NOB suppression, WWTP, SBR, AOB

Acknowledgments: This work was financially supported by National Science Centre as a result of the research project no.2017/26/D/ST8/00967.

* mehdi.sharifshourjeh@pg.edu.pl

Safaa Hidaoui[1], Najlaa Hamdi[1], Mohamed Akouibaa[1], Mohammed Lachkar[1], Eigner Vaclav[2], Michal Dusek[2], Brahim El Bali[3]*
[1]University Sidi Mohamed Ben Abdellah, Morocco
[2]Institute of Physics AS CR, Czech Republic
[3]Independent Scientist, Oujda, Morocco

Synthesis, crystal structure and Application of (C4H12N2)[Co(H2O)6](HPO4)2 for the reduction reaction of the three

A new hybrid phosphate (C4H12N2)[Co(H2O)6](HPO4)2 has been synthesised using the slow evaporation method in the presence of piperazine as a structure-directing agent. The compound crystallises in the monoclinic system (S.G.: P21/c) with the cell parameters (Å,°): a = 6.2959(2) , b = 9.5613(3) c = 12.7942(4) , β = 92.718(3). Its crystal packing is made of isolated $[Co(H_2O)_6]$ octahedra, regular $[PO_3(OH)]$ tetrahedra and protonated piperazine $[C_4H_{12}N_2]^{2+}$. Supramolecular interactions such as N─H···O, O─H···O and C–H···O hydrogen bonds build the three-dimensional network, ensuring the connection between organic cations, water molecules, and the inorganic framework. The FTIR spectroscopy shows the expected bands of piperazine and phosphate groups. The catalytic efficiency of the synthesised compound was tested with the reduction reaction of the three nitrophenol isomers (paranitrophenol 4-NP, metanitrophenol 3-NP and orthonitrophenol 2-NP).

Keywords: cobalt, crystal structure, spectroscopy, catalysis

* HIDAOUISafaa@gmail.com

Smaiel Herradi, Imane Adouar, Sara Bouhazma, Sanae Chajri, Mohammed Khaldia, Brahim El Bali, Mohammed Lachkar*
University Sidi Mohamed Ben Abdellah, Morocco

Synthesis of a pure hydroxyapatite by microwave-assisted sol–gel technique using triethylamine (TEA) as a chelating agent

Hydroxyapatite (HA) has been successfully synthesized by a modified microwave-assisted sol–gel technique using triethylamine (TEA) as a chelating agent. The powder thus obtained was characterized using X-ray diffraction and FT-IR. XRD patterns and FT-IR spectra confirm that both the as-prepared and the calcined powder at 600°C are composed of pure HA phase. Moreover, the crystallinity increased from 18.02% for the as-prepared powder to 60% for the calcined one. Further, the values of the lattice parameter a and the volume of the unit cell are slightly decreased for the calcined powder however the lattice parameter c is slightly increased. The average crystallite size markedly increased from 17.7 to 19.62 nm respectively for the as-prepared and the calcined powder.

Keywords: TEA, sol gel, microwave, XRD, IR, hydroxyapatite

* smaiel_her@hotmail.fr

Victor Adebiyi, Anna Bogush*
Coventry University, United Kingdom

Microplastics in Bottled Drinking Water

The World Health Organisation (WHO) published a review about the potential risks of microplastics (MPs) in drinking water in which they outlined potential impact to human health. Microplastics presented in bottled water can pose direct human exposure risk. The presence of MPs in bottled drinking water has been highlighted recently. The main goal of this study is to investigate MPs contamination in the bottled drinking water purchased from the UK supermarkets.

Materials and Methods:
• The 23 plastic bottled drinking waters manufactured in the UK, Ireland, US, France, and Austria were bought from the different UK supermarkets.
• Water samples were filtered through silicon filters with a pore size of 1 µm and 1 cm diameter using a vacuum enhanced filtration system.
• Each filter was analysed by Fourier-Transform Infrared (FTIR) microscopy (Thermo-scientific, Nicolet iN10, UK) to identify number, size, morphology, and type of MP particles. The identified FTIR spectrum were searched and matched with the FTIR spectrum library databases.

Results and Discussion:
• MPs were detected in all bottled drinking water samples and number of the MPs particles were ranged from 75 to 2275 MPs/L.
• The size of the identified MPs ranged from 10 µm to 1500 µm.
• With regard to MPs morphology, MPs fragments and fibers were dominant in the analysed bottled water samples. The most frequently detected was polyethylene terephthalate (PET), followed by polyamide (nylon).

Conclusion:
• MPs were detected in all bottled water samples purchased from the UK supermarkets and it requires urgent attention.
• The PET plastic bottle packaging has a significant impact on the MPs contamination in the bottled water. Other identified MPs might be from the bottled water production process and water sources.
• Having abundant smaller-sized particles (especially of <50 µm) in drinking water are a matter of concern. They are more threatening, in terms of cytotoxicity in human cells, than larger particles. The long-term exposure to plastic particles through MPs contaminated bottled water enhances human health risks.

Keywords: microplastics, bottled drinking water, fourier transform infrared microscopy (FTIR), polyethylene terephthalate (PET), polyamides

* adebiyiv@uni.coventry.ac.uk

Wioleta Bolesta[1], Marcin Głodniok[2], Katarzyna Styszko[1]*
[1]AGH University of Science and Technology in Krakow, Poland
[2]GIG Research Institute Katowice, Poland

Pharmacological Contamination in Sewage Sludge: An Update on the Status of Agricultural Use

Sewage sludge, which is a by-product of wastewater treatment, requires ecological and economic management. In Poland, almost 1 million tons of dry matter of sewage sludge were generated in 2020. One of the ways of solving the problem of large amounts of sewage sludge is agricultural use, e.g., processing it into an organic mineral fertilizer. The agricultural use of the sludge is preceded by tests of the sludge for the presence of parasites and the concentration of heavy metals. So far, studies on the content of micropollutants, such as pharmaceuticals, and the possibility of their spreading in the soil have not been undertaken.

Currently, many different groups of pharmaceuticals have been detected in sewage sludge, such as NSAIDs, antiobiotics, hormones, β-blockers and hypolemic drugs. Their content depends, for example, on the molecular weight, acid dissociation constant (pKa), octanol-water partition coefficient (Kow), and biodegradability and can range from a few nanograms per gram to even several hundred milligrams per gram.

The fate of soil micropollutants is also varied. Soil pharmaceuticals can be broken down by photodegradation or biodegradation. Some of them are adsorbed on soil particles, others are transported with water. The use of sewage sludge in agriculture may contribute to the transfer of pharmaceuticals to the soil and living organisms in the area. The first negative effects of such treatments were noted, e.g. antibiotic resistance, accumulation of pharmaceuticals in plants, or negative effects on the reproduction of aquatic organisms.

This article es the issues of physicochemical differentiation of pharmaceuticals detected in sewage sludge, with particular emphasis on their spread in the soil as a result of the agricultural use of sludge.

Keywords: pharmaceuticals, sewage sludge, sewage sludge management, fertilizer

Acknowledgments: Research supported under the Implementation Doctorate in the program of the Ministry of Science and Higher Education.

* bolesta@agh.edu.pl

Mohammed Zerrouk[1], Rachid Ouarsal[1], Mohammed Khaldi[1], Brahim El Bali[2], Mohammed Lachkar[1]*
[1]University Sidi Mohamed Ben Abdellah, Morocco
[2]Independent Scientist, Oujda, Morocco

Synthesis, Structural Characterization, and Biological Activities of New Organic–Inorganic Hybrid Phosphite $(C_2H_{10}N_2)Ni(H_2PO_3)_2Cl_2$

A new hybrid phosphite, (C2H10N2)Ni(H2PO3)2Cl2, has been synthesized under normal conditions and characterized by single-crystal X-ray diffraction, infrared spectroscopy and TGA-DTA analysis. The compound crystallizes in the monoclinic space group P21/c (n. 14) with the following unit-cell parameters: a = 8.6336 (3) Å, b = 7.2578 (3) Å, c = 9.6749 (4) Å, β (°) = 112.788 (4), Z = 2 and V = 558.92 (4) Å3. The final R factors are R/wR = 0.018/0.081. The crystal structure consists mainly of isolated polyhedrons [NiO4Cl2] connected through O- P-O bridges of the [H2PO3] units, that gives rise to an inorganic layer of [Ni(H2PO3)2Cl2]2-, which is further stacked as parallel layers along bc plane. The protonated organic molecules ethylenediammonium are located between the layers via strong hydrogen bonds responsible for the cohesion between organic- inorganic parts and leading so to the stability of the structure.

Keywords: inorganic–organic compounds, chemical synthesis, IR, TGA/DTA, X-ray diffraction

* zrkmed0650@gmail.com

Joanna Antos, Aleksandra Makała, Joanna Zembrzuska, Joanna Jeż-Walkowiak, Dobrochna Ginter-Kramarczyk, Izabela Kruszelnicka*
Poznan University of Technology, Poland

Analysis of contamination of the Warta River by selected drugs

In recent years, the growth of pharmaceutical industry been noted significantly. Antibiotics, non-steroidal anti-inflammatory drugs (NSAIDs), and hormonal drugs are the most popular drugs used by humans and animals.

The aim of the study was to analyze the contamination of the Warta River with antibiotics such as: sulfamethoxazole, trimethoprim and non-steroidal anti-inflammatory drugs: ketoprofen, naproxen, ibuprofen, fenoprofen and paracetamol. An important stage of the research was to examine the dependence of NSAIDs and antibiotics concentrations in water due to season, month, pandemic time. Analytes from the surface water were separated and concentrated by solid phase extraction and then determined by LC-MS/MS technique.

The results obtained indicate a constant level of concentrations of individual pharmaceuticals in surface water in Poznań. Concentrations depended on weather conditions and disease periods (seasonal, epidemic).

The research was carried out with financial support from the Ministry of Education and Science, research project 0911/SBAD/2204.

Keywords: pharmaceuticals, non-steroidal anti-inflammatory drugs, antibiotics, solid phase extraction, contamination

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

Joanna Witkowska-Dobrev, Olga Szlachetka, Marek Dohojda*
Warsaw University of Life Sciences, Poland

Chloride corrosion of paving blocks

Concrete elements, mainly floors in livestock buildings, are subject to degradation due to contact with substances with low pH. The study was conducted to compare the results of strength tests and surface structure analyses of samples under laboratory and polygon conditions in the context of the effect of low pH environment on concrete. Cubic samples of ordinary concrete made from two different mixtures were immersed in 2% and 3% acetic acid as part of laboratory tests, and under polygon conditions in an open-tank slurry, for a period of 290 days. The measured compressive strength values were compared with those of a control sample not under the influence of an aggressive environment. Strength tests were supplemented by analysing the surface of the samples with respect to roughness and chemical composition. Microscopic imaging, integrated with strength tests, made it possible to diagnose the deterioration of concrete as a result of the progressive corrosion process with organic acids.

Keywords: livestock buildings, concrete, acid corrosion, environmental protection, microscopic analysis

* joanna_witkowska@sggw.edu.pl

Yosura El Mouine[1,2,3], Amal El Hamdi[1,2,3], Moad Morarech[2], Vincent Valle[1], Hasna Yachou[3], Houria Dakak[3], Abdelmajid Zouahri[3]*
[1]Avignon University, France
[2]Abdelmalek Essaâdi University, Morocco
[3]National Institute of Agricultural Research (INRA), Morocco

Impact of landfill leachate on the groundwater quality — a case study of Tadla Plain

In many parts of the world, the impact of open landfills on soils, biosphere and groundwater has become a major concern. This study was carried out on an uncontrolled landfill in the Tadla plain, Morocco's main agricultural region. The study of physicochemical parameters of water resources sample suggests that the evaluation of water quality parameters as well as water quality management practices should be carried out periodically to protect the water resources, and on the other hand to confirm groundwater pollution due to a pollution plume. Physico-chemical analyses of leachate thus carried out in order to determine the leachate nature of the landfill. The leachate of Souk-Sebt have a brownish black color and the strong noisome smell of the landfill leachate may present the first pollution indicator, and also a strong mineralization by chemical elements.

The characterization of leachate has shown that those are mature leachates, with high mineral and organic load. Organic load is translated by the high values of COD. On the other hand, as for the mineral pollution, it is translated by the high values of NH^{4+} (mg / l), NO^{3-} (mg / l), and PO^{4-} (mg/l).

Higher concentrations of sulfates were observed in wells close to the dumping site The highest value was recorded in well located in downstream hydrogeological which is 106 m away from the site. Nitrogen is present in water mainly as nitrate (NO^{3-}), but under reducing conditions, it can be present as ammonium (NH^{4+}).

Keywords: physicochemical parameters, landfill, water, prediction, leachate

Acknowledgments: The authors thanks to Avignon and Abdelmalek Essaadi university, the Dean of National Institute of Agriculture researchers. The author also acknowledges the help and support of the Dean and staff of The Scientific Research Deanship at Hydrogeology Laboratory of Avignon for their Critical and constructive review of the manuscript by the reviewers is greatly treasured.

* valles.vincent@gmail.com

Mariem Ennouhi, Sanaa El Aggadi, Jamal Mabrouki, Amale Boutakiout, Mohammed Dahou, Mohammed Alaoui El Belghiti*
Mohammed V University, Rabat, Morocco

Efficiency in optimizing the pre-treatment process in water desalination

Membrane fouling is a major challenge in membrane processes. The causes are often specific and depend on the constituents of the feed water, the interaction between feed water quality, the pretreatment process and the used chemicals. This study aims to investigate the effect of the pre-treatment on the membrane fouling. Various studies were carried out to identify the reasons for membrane fouling: A membrane autopsy and a pretreatment optimization. The results of the membrane autopsy by Scanning Electron Microscopy/Energy-dispersive Xray Spectroscopy (SEM/EDS) revealed that the main causes of membrane fouling are: calcium carbonate $CaCO_3$ (38.70 %), aluminum oxide Al_2O_3 (17.42 %) and barium sulfate $Ba(SO_4)_2$ (15.23 %). The results of the pretreatment optimization allowed to reduce significantly the residual aluminum concentration and the clogging index after the 5 µm cartridge filters. Likewise, it allows to decrease the clogging rate of reverse osmosis membranes.

Keywords: desalination, reverse osmosis, brackish water, fouling, coagulation-flocculation

* mariem.ennouhi90@gmail.com

*Bidisha Mondal[1], Ishita Sarkar[1], Aleksander Czapla[2], Jakub Drewnowski[2], Mahesh Ganesapillai[1]**
[1]Vellore Institute of Technology, India
[2]Gdansk University of Technology, Poland

Sustainable resource recovery in agriculture and animal husbandry along with reduction in ammonia volatilization

The research suggests that ammonia volatilization along with urea recovery may be minimised by using physical adsorption techniques in continuous packed-bed columns. The feasibility of employing microwave activated coconut shell-derived activated carbon to retrieve urea from cattle urine was examined. To explore the influence of initial concentration, flow rate, and size of carbon support in a continuous, down-flow mode packed column, the carbon was immobilised onto etched glass beads. Furthermore, the experimental results were compared against several kinetic models to characterise the sorption behaviour. The breakthrough curve study revealed the following advantageous operating parameters: sorbate flow (8 L.h-1), initial urea concentration (60%), and glass bead support size (1.5 cm). There was an equilibrium sorption of 802.8 mg. g-1 and up to 80% urea recovery. Over seven cycles of sorption/desorption, regeneration tests allowed for over 95% urea recovery with sorbent capacity dropping by 5%. A comprehensive analysis of the benefits and expenses of alternative fertiliser production in comparison to the standard (industrial) process would highlight the locations and degrees to which phases of the nutrient cycle may be improved by the suggested solution(s), and it might even demonstrate how competitive the solutions are in comparison to conventional methods. This study demonstrates a continuous process of recovering urea from cattle urine through immobilization of the prepared AC onto etched glass beads to ease post-experimental recovery of the adsorbed urea.

Keywords: microwave activated carbon, packed bed column, sustainable agriculture

* drmaheshgpillai@gmail.com

Poster session

In Polish

5 – 7 December 2022

*Dariusz Boruszko, Ada Wojciula**
Bialystok University of Technology, Poland

Evaluation of the efficiency of PAHs removal from leachates after ATAD by activated sludge method using Effective Microorganisms

The increase in environmental awareness in many countries around the world has influenced the establishment of legal requirements mandating the proper treatment of sewage sludge before further use. For this purpose, the ATAD method is increasingly being used, as it allows simultaneous stabilization and hygienization of sludge. After stabilization, sewage sludge is dewatered and then transported to biological systems. It has been proven that leachates after ATAD contain toxic PAHs. Returning them to biological reactors can place a burden on municipal wastewater treatment plants. In addition, contact of PAHs with other matrix components often results in the formation of toxic derivatives or forms with more rings. Such a situation results in a potential threat to the environment, as inferior quality wastewater may enter receiving waters. The scope of the work included subjecting ATAD leachates to treatment by activated sludge. The research was conducted in a GUNT model system. The research work also involved adding EM to the system. PAHs, COD and BOD5 were determined in the raw and treated leachates. The aim of the work was to evaluate the degree of biosorption and reduction of PAHs under specific conditions in leachates after ATAD. The study showed that numerous transformations of PAHs occurred during the biological treatment process. The highest biosorption, as well as reduction of total PAHs, occurred in the test series where EM was used. These series also showed the highest biosorption of PAHs with heavy fractions, such as chrysene, benzo(b)fluoranthene, anthracene, phenanthrene, and fluorene.

Keywords: biodegradation, PAHs, ATAD, sewage sludge, effective microorganisms

* a.wojciula@doktoranci.pb.edu.pl

Anna Kowalik-Klimczak[1], Maciej Życki[1], Anna Gajewska-Midziałek[2], Zofia Buczko[2], Tadeusz Gorewoda[3], Jadwiga Charasińska[3], Jacek Jurczyk[4]*
[1]Łukasiewicz Research Network - Institute for Sustainable Technologies, Poland
[2]Łukasiewicz Research Network - Institute of Precision Mechanics, Poland
[3]Łukasiewicz Research Network - Institute of Non-Ferrous Metals, Poland
[4]Fabryka Drutu Gliwice S.A., Poland

Application of membrane processes for the recovery of water from post-production galvanic baths

Currently, there are over 1,200 plants associated with the production of metal products registered in Poland, including approx. 330 plants operating in the field of metal processing and application of coatings on metals. According to the data of the Central Statistical Office of Poland from 2017, only 3.6% of all registered plants have systems enabling the complete closing of the technological water cycle. Currently, chemical methods, ion exchange and electrocoagulation are most often used for the treatment of galvanic wastewater. However, traditional method for treatment of galvanic wastewater are not efficient enough. For this reason, searching for a new methods for galvanic wastewater management is a challenge for technologists and engineers.

The paper presents the current results and conception of implementation the membrane techniques for galvanic wastewaters treatment. In the first stage, water that is using to flush metal elements after degreasing, pickling, galvanizing and passivation processes is treat by using pre-treatment methods and low pressure membrane processes. The next stage is high pressure membrane processes of used for water recovery from pre-treat wastewater. The filtrate stream is using as technological water for flush metal elements and concentrate stream is using to reuse the galvanic bath.

The propose pathway will help reduce the amount of water using in galvanic industry and rise increase efficiency of using raw materials during production.

Keywords: galvanic wastewaters, membrane processes, wastewater treatment, recovery of water, reuse galvanic bath

Acknowledgments: The work was created as part of the project: Comprehensive technology for the purification of post-consumer liquids after the galvanizing process, enabling the closure of the technological water cycle and the management of treatment products' (Acronym: GalvaWaterCycle) co-financed by Łukasiewicz Research Network under special-purpose subsidies (Agreement No. 1/Ł-ITEE/CŁ/2021).

* anna.kowalik-klimczak@itee.lukasiewicz.gov.pl

Anna Marszałek, Mariusz Dudziak, Edyta Kudlek*
Silesian University of Technology, Poland

Treatment of rainwater from a highway retention tank using membrane processes

The aim of the study was to determine the pollution of rainwater sourced from a reservoir located on the highway. A series of analyses were conducted to determine physicochemical contaminants (heavy metals), chromatographic determinations (micropollutants), analyses for toxicity and microbiology. Membrane processes were conducted including ultrafiltration and nanofiltration to assess the effectiveness of removing heavy metals and micropollutants present in rainwater. The research was designed to test how much pollution from the highway as well as from other road elements affects the environment. Rainwater contained heavy metals, which can have a definitive impact on the quality of the receiving water. The heavy metal content was as follows: nickel 0.41 mg/L, zinc 5 mg/L, lead 0.52 mg/L. In the rainwater compounds that have been determined are both typically industrial compounds (biphenyls, polycyclic saturated hydrocarbons, aromatic hydrocarbons phenols and bisphenol A), naturally occurring compounds and components of plant protection products. The toxic effect of rainwater was expressed as the percentage of inhibition of luminescence of the bacteria Vibrio fischeri after 5 minutes and 15 minutes of incubation, and based on the growth of the freshwater vascular plant Lemna minor. The water showed toxicities at 27.52% (5min) and 16.26% (15min). Membrane processes ensured the removal of the toxic effect and complete removal of zinc. The concentration of nickel and lead in the nanofiltration process decreased by 82%, and 83%, respectively. It was found that urban runoff showed toxicity to both marine and freshwater species, where zinc was the main cause of toxicity.

Keywords: rainwater, ultrafiltration, nanofiltration, micropollutants, heavy metals

Acknowledgments: This research was funded by the Polish Ministry of Science and Higher Education.

* anna.marszalek@polsl.pl

Edyta Nartowska, Marta Styś-Maniara, Tomasz Kozłowski*
Kielce University of Technology, Poland

The potential environmental and society influence of the inorganics salt hydrates used as a phase change material for thermal energy storage in solar installations

The purpose of this paper was to assess the potential impact of inorganic salt hydrates, used as PCM material in solar installations, on the environment and human health, and to evaluate public attitudes toward this technology. Eight considered to be the most promising inorganic salt hydrates used in solar installations were reviewed in terms of their thermophysical properties and their potential for improvement. The cost of the substances was also considered. Next, the chemical risks of salt hydrates to the environment and humans were assessed. Next, the disadvantages of inorganic salt hydrates were characterized, which can contribute to shortened PV life and the release of substances into the environment. These included supercooling, phase separation, and corrosivity. The publication then evaluated the possibility of disposing of used salt hydrates. Then, with the help of questionnaires, the public's attitude to solar installations with an integrated converter containing salt hydrates was evaluated. Disodium hydrogen phosphate dodecahydrate was shown to be the most promising salt in terms of environmental as well as thermophysical, economic properties for solar applications. Due to the high public concern about the impact of inorganic salt hydrates on the environment and human health, and the ignorance indicated in this regard, extensive information and promotional activities should be undertaken on PV panel technologies containing inorganic salt hydrates as PCM material, before they are introduced to the commercial market.

Keywords: solar installation, inorganic salt hydrates, PCM material, environment and human health

* mmaniara@tu.kielce.pl

Anna Piotrowska, Dariusz Boruszko*
Białystok Technical University, Poland

The role of Effective Microorganisms in the light of the circular economy

Human activity and the development of new technologies contribute to the change of biodiversity and ecosystems. Modifying the environment to the needs of society has serious consequences. Pollution of the natural environment caused by human economic activity is associated not only with an increase in the concentration of trace elements, but also with an excess of Aromatic Polycyclic Hydrocarbons. PAHs are very persistent in the environment, they bioaccumulate in soil and water sediments. Due to their hydrophobicity and stable chemical structure, PAHs quickly accumulate in the organic components of the soil. Agricultural production depends primarily on soil condition, which is a measure of the complex biological, chemical and physical interactions driven by microorganisms. The search for new solutions combining the environmental and social aspect with the economic issue becomes the key role. One of the possibilities that will ensure the stability of the environment is the use of biopreparations in the form of Effective Microorganisms. Adding EM to agricultural ecosystems will restore the properties that determine the absorption of nutrients and will have a positive effect on the condition of soils excessively fertilized with chemical fertilizers. Effective Microorganisms increase the population of beneficial microorganisms in the soil, leading to sustainable plant production. The paper below presents the results of own research on the analysis of the impact of Effective Microorganisms on changes in the content of PAHs in the soil. The content of polycyclic aromatic hydrocarbons in the soil was determined by gas chromatography with mass spectrometry (GC-MS). The test was carried out in accordance with the PN-ISO 18287:2008 standard. It has been shown that the EM Naturally Active microbiological preparation reduces the amount of PAHs in the soil. The aim of the study was to present the possibility of using Effective Microorganisms as an ecological and economic alternative in a circular economy.

Keywords: microorganisms, circular economy, pollution

* anna.piotrowska.pb@wp.pl

*Artur Kuźniacki**
ESV S.A., Poland

High-efficiency cogeneration technology as an effective component for stabilising electricity and heat supply costs while improving the energy efficiency of a production company

The sharp increase in the price of energy carriers observed from 2021 onwards, triggered by the Pandemic and the war in Ukraine, is crucial for maintaining the economics of industrial production. It is becoming increasingly important for companies to operationally update strategies related to the management of electricity and heat supply costs while preparing prospectively for the implementation of the Green Deal Strategy. The cost structure of the electricity and heat supply of a model SME is presented, as well as the importance of a properly harmonised energy strategy within the company. The advantages of using cogeneration technology in industrial processes, both in terms of economics and ecology, are indicated. On the basis of the research carried out, it was concluded that the main factors influencing the reduction of the cost of supplying an industrial plant with energy carriers include: lowering the energy intensity of the process per unit of production, lowering the unit cost of energy and the compilation of these measures to achieve a synergistic effect. In the long term, energy strategies should envisage a move away from technologies using coal as a high-carbon fuel due to the impact of CO2 emissions on the final cost of the product, resulting from the Carbon Border Adjustment Mechanism programme. It was also agreed that, in the Polish reality, it is crucial to be able to choose flexibly at the operational level the technology of heat generation and the fuel used by the plant. Reducing energy intensity and stabilising prices of energy carriers becomes particularly important when these issues are considered in the light of the competitiveness of Polish industry within global supply chains. The above-mentioned factors should be taken into account when updating energy strategies, both at enterprise and central level.

Keywords: energy strategies, energy efficiency, cost of energy carriers, energy technologies, cogeneration

* artur.kuzniacki@esv.pl

Monika Metryka-Telka, Robert Kowalik, Marta Styś-Maniara, Jarosław Gawdzik*
Kielce University of Technology, Poland

Effect of geological structure on ^{222}Rn activity in water

Radon is known as a radioactive element that easily dissolves in water. It is worth noting that it is available in all possible reservoirs. Its concentration cannot be measured directly, but only on the basis of emitted radiation. The study analyzed water quality and ^{222}Rn content for tap water and surface water at the Saint Catherine Nature Reserve. The results were analyzed in detail, among other things, in terms of permissible concentrations. The influence of geological location on radon content in tap and surface water was determined.

Keywords: radon, water quality, chemical stability of water, ^{222}Rn, geological structure

* mtelka@tu.kielce.pl

*Barbara Pieczykolan**
Silesian University of Technology, Poland

Kinetics of adsorption of Methylene Blue and Direct Red 81 onto water treatment residuals

The studies aimed at determining the kinetics of adsorption of dyes adsorbed on the surface of the waste sorbent was carried out. Dried sludge, formed in the process of surface water coagulation, were used as the adsorbent. In the experiments, using different contact times, two dyes were used: Methylene Blue and Direct Red 81. Based on the results of these experiments, using non-linear estimation (by minimizing the RMSE error), the parameters of three kinetic models (pseudo-first-order, pseudo-second-order and Elovich) were calculated. Moreover, during the study, it was determined which of kinetic model best describes the experimental results. Based on the intraparticle diffusion model the adsorption mechanism was examined. The studies showed that for both dyes, the greatest match to the experimental results was obtained for the Elovich model, then for the pseudo-second-order model, and the smallest match was obtained for the pseudo-first-order model. These results indicate that a chemical adsorption process occurred. The studies showed that a higher value of the adsorption rate constant was obtained for Methylene Blue than for Direct Red 81 (it is evidenced by the values of the rate constants determined both from the pseudo-second-order kinetics model and from the Elovich kinetics model). The analysis of the results of the estimation conducted for the intraparticle diffusion model shows that the intraparticle diffusion process was not the only process limiting the rate of the adsorption process.

Keywords: synthetic dyes, adsorption kinetics, water treatment residuals

Acknowledgments: Research carried out under the research subsidy of the Silesian University of Technology thanks to financial support from the Ministry of Science and Higher Education.

* barbara.pieczykolan@polsl.pl

*Edyta Łaskawiec**
Silesian University of Technology, Poland

Growth of plant biomass in the presence of washings from swimming pool facilities: selected indicators in the context of the possibility of wastewater recycling

Although swimming pool water circuits are an example of closed circuits in which the water is continuously treated and disinfected, they still generate significant volumes of wastewater. The demand for water for economic and domestic purposes results not only from the need to ensure sanitary standards of facilities and the hygienic needs of users but also from the need to replenish losses in basins and clean filter beds.

Under the Regulation of the European Parliament and the Council (EU) 2020/741 of 25 May 2020 on the minimum requirements for water reuse, we are obliged to implement solutions allowing wastewater reuse while maintaining safety for the natural environment. One possibility is to use the washings to irrigate greenery in urban recreational or sports areas during drought or insufficient rainfall. This would reduce the consumption of tap water, which in the face of dwindling water resources, should not be used for such purposes. However, the discharge of backwashings directly to the ground requires that they meet quality standards.

The research aimed to conduct an extended analysis of the quality of the washing. To assess the swimming pool wastewater recycling potential, solutions after treatment (sedimentation /dechlorination), diluted in water matrices (deionized water, tap water, rainwater) were used, with the volume fraction of the washings ranging from 5 to 100%. The research was carried out on selected plant indicators - Lepidium sativum, Sinapis alba, Lemna minor.

Keywords: ecotoxicology, circular economy, water recovery, wastewater, growth inhibition

Acknowledgments: The research was carried out with funds for the statutory work of the Faculty of Environmental and Power Engineering of the Silesian University of Technology. This research was funded from grants for young scientists BKM-687/RIE7/2022 (08/070/BKM22/0017).

* edyta.laskawiec@polsl.pl

*Ewa Okoniewska**
Częstochowa University of Technology, Poland

Methods for the removal of dyes - a review

Some industries are sources of wastewater from the production and use of dyes. A large group are plants related to the textile and leather industries. There are factories specialising in the production of dyes used to colour textiles and leather. In today's industry, dyes are used in a very wide range of other industries, making them automatic sources of wastewater from dyeing and dyeing processes. Examples of such sources of wastewater from dye production are plants producing various types of paints and varnishes. This group of plants includes manufacturers of emulsion paints, oil paints, acrylic paints for the construction industry and the automotive industry. Dyes are also used in the food industry, for example in the production of beverages and confectionery. The chemical industry and plants producing cosmetics, medicines and plastics also use dyes in their production process.

The chemical industry and companies involved in the production of cosmetics, pharmaceuticals and plastics also use various dyes to colour their products.

The aim of this study is to present modern wastewater treatment methods with a particular focus on the processes for treating wastewater generated in the production of various dyes. Based on a literature review, the currently most effective methods of treating wastewater from dye production will be identified in terms of their efficiency and effectiveness when wastewater from mass production processes needs to be treated.

Keywords: dyes, removal of dyes, physical methods, biological methods

Acknowledgments: The scientific research was funded by the statue subvention of Czestochowa University of Technology, Faculty of Infrastructure and Environment.

* ewa.okoniewska@pcz.pl

*Ewa Puszczało**
Silesian University of Technology, Poland

Evaluation of the effectiveness of water treatment in filter bottles

The demand for high-quality drinking water has increased in recent years. This applies both to tap water supplied by the water supply network, but also to bottled water. We pay attention not only to the organoleptic characteristics of water, i.e. its taste and smell. There is also growing public awareness of organic and inorganic contaminants, which are usually present in trace amounts.

Although the quality of tap water is subject to strict control, and the content of individual substances in it must not exceed the values specified in the Regulation of the Minister of Health on the quality of water intended for human consumption, people are concerned about even small concentrations of pesticides, pharmaceuticals and heavy metals.

Tap water can be exposed to secondary contamination by heavy metals as a result of their leaching from water transport pipes and structural elements of tap faucets. Their presence in drinking water adversely affects human health.

The purpose of the study was to determine the effectiveness of bottle filtration in removing hardness from tap water and removing chlorine and copper. The study compared four filter cartridges from commercially known manufacturers.

The study used model water prepared from tap water with the addition of sodium hypochlorite and copper. The tap water was taken from a tap at the Silesian University of Technology in Gliwice.

Keywords: heavy metals, filtration, drinking water

* Ewa.Puszczało@polsl.pl

Ewa Łobos-Moysa, Edyta Kudlek, Ewa Felis*
Silesian University of Technology, Poland

Hazardous accumulation of common product ingredients: assessment of AHTN and HHCB sorption on natural materials in an aquatic environment

Synthetic fragrances are a component of products commonly used on a daily basis. These fragrances include polycyclic musk, nitro musk, and macrocyclic musk, and among the polycyclic groups, tonalide (AHTN) and galaxolide (HHCB) are dominant.

Due to their widespread use, the mentioned pollutants are present in raw municipal wastewater, and also in treated wastewater. However, HHCB may occur in more than ten times higher concentrations than AHTN. Also in the natural environment - rivers, and seas, higher concentrations of HHCB than AHTN are observed. At a comparable log Kow, i.e. 5.09 and 5.70 respectively, the higher content of HHCB than AHTN in bottom sediments may be related to the amount of these pollutants released into the environment. A similar observation applies to the presence of these pollutants in the tissues of marine organisms such as fish, mollusks, or seafood in general.

The studies assessed the accumulation rate of HHCB and AHTN in bottom sediments depending on external factors. The initial concentration of both pollutants was set at 100 ng/L. The accumulation rate was calculated based on chromatographic analysis of HHCB and AHTN concentrations estimated by the use of liquid chromatography equipped with a DAD detector.

Keywords: AHTN, HHCB, synthetic volatile fragrances, accumulation, bottom sediments

Acknowledgments: Research project "Transformations of organic cosmetic ingredients in brackish water" No. 08/040/SDU/10-21-01 financed in the Pro-quality Program "Excellence Initiative - Research University" of the Silesian University of Technology.

* ewa.lobos-moysa@polsl.pl

Jagoda Worek, Ewa Gawlak, Kamil Kawoń, Wioleta Bolesta, Joanna Chwiej, Katarzyna Styszko*
AGH University of Science and Technology, Poland

Circular economy - the risk of using fertilizers made from sewage sludge

One of the main goals of the circular economy is the use of waste as a source of raw materials. A great example of this practice is the use of stabilized sewage sludge for the production of fertilizers. However, sewage sludge, in addition to easily digestible elements such as nitrogen, phosphorus, and calcium, contains, among others, pharmaceuticals such as nonsteroidal anti-inflammatory drugs, steroids, and microplastics. Therefore, there is a risk of paired pollutants returning to the environment as expressed with the fertilizer.

The purpose of the research was to analyze the stabilized sewage sludge in terms of its microplastics content. The analysis was carried out in two stages. The first stage was divided into two parts. The first involved the oxidation of the organic substance that was in the sample matrix. The second part consisted of the separation of microplastics with a saturated solution. The second stage consisted of qualitative and quantitative analysis of the obtained microplastics. For this purpose, the ATR FTIR infrared spectroscopy and the FTIR microscope were used. Additionally, a confocal Raman microscope was used.

Stabilized sewage sludge were analyzed depending on the day of collection. the largest amount of microplastic was detected in the samples from Monday, Friday, and Saturday. This may be related to the increased amount of cosmetics released that contain plastic microgranules. It is also confirmed by the qualitative analysis which showed the highest amount of microplastics fractions from LDPE (Low Density Polythylene) the highest amount of microplastics per 100 grams of dry weight was 1084 fragments and 1128 fibers each for a total of 2212 microplastic particles. The research has shown that the use of sewage sludge to create fertilizers will contribute to the emission of a significant number of microplastics to the environment, and because of the high risk of pollutant emissions, this cannot be underestimated.

Keywords: microplastic, circular economy, fertilizers, stabilized sewage sludge

Acknowledgments: The research project was partially financed by the "Initiative for Excellence—Research University" programme for the AGH University of Science and Technology. Research project partly supported by program "Excellence initiative—research university" for the University of Science and Technology No. 2071 and 2803.

* styszko@agh.edu.pl

Joanna Wyczarska-Kokot, Karolina Oszek*
Silesian University of Technology, Poland

Quality and management options of washings discharged from swimming pool filters with a zeolite-active carbon bed

The high cost of water supply and discharge of washings formed as a result of rinsing filter beds in swimming pool water treatment circuits leads to a search for opportunities to reduce these costs. Depending on the quality of the washings, it is possible to use them, for example, for domestic purposes, infiltration into the ground, watering greenery, feeding retention ponds, or other watercourses. Analysis of selected physicochemical parameters was carried out for washings samples discharged from the recreational pool circuit and the sports pool circuit, equipped with pressure filters filled with a zeolite bed with a layer of activated carbon. The possibility of discharge of the washings into a water reservoir located in the municipal park, close to the pool facility under study, was considered. The results of the analyses were compared with the permissible values included in the Regulation of the Minister of Maritime Affairs and Inland Navigation of 12 July 2019, on substances harmful to the aquatic environment and conditions to be met when discharging waste water into waters or into the ground (Journal of Laws 2019, item 1311) and with the water quality parameters in the water body under consideration. It was found that direct discharge of the washings into the reservoir was not possible, primarily due to suspended solids amounts well above 35 mg/L. Therefore, the washings samples were subjected to a sedimentation and coagulation process. The high efficiency of both processes and the possibility of discharging the supernatant water (approximately 75% of the washings volume) into the reservoir were shown. An economic analysis of three options related to the management of the water consumed in the washing of the zeolite-carbon bed was also carried out. Variant I assumed the discharge of 100% of the washings into the sewage system, variant II assumed the use of 75% of the supernatant water, and variant III assumed the use of 96% of the supernatant water with the use of a commercial washings treatment system.

Keywords: quality of washings, swimming pool filters, a zeolite-active carbon bed, economic analysis

Acknowledgments: This work was supported by the Ministry of Education and Science of the Republic of Poland within statutory funds.

* joanna.wyczarska-kokot@polsl.pl

Krzysztof Wiśniewski, Gabriela Rutkowska, Katarzyna Jeleniewicz, Norbert Dąbkowski, Jarosław Wójt*
Warsaw University of Life Sciences, Poland

Ecological friendly building materials on the example of clay-ash composite as good management of fly ashes from thermal conversion of sewage sludge

The reduction of carbon dioxide emissions, introduced by the European Union, opened the possibility of conducting experimental works on a new generation of building materials—ecological and environmentally friendly ones. Such materials include those which combine raw natural resources with waste subject to disposal and that materials are the subject of this work. The presented research complements the research carried out at the Institute of Civil Engineering Warsaw University of Life Science, aimed at developing innovative building materials that fully meet the assumptions of sustainable development.

The paper proposes a method of the enrichment of clay with fly ash, which would lead to the neutralization of heavy metals in the burnt matrix, possible oxidation of organic substances present in the ashes, or the destruction of pathogens, as well as an increase of the resistance of the clay ceramics to low temperatures. Clay samples were prepared with the addition of the fly ash from two sewage treatment plants. The experiments encompassed investigations of physical and chemical properties of samples heated at temperatures of 900 °C. The obtained test results confirm the possibility of manufacturing a product modified with the fly ash from the thermal treatment of sewage sludge and the tests exhibit the high properties of the clay-ash composite.

Keywords: fly ash, clay-ash composite, compression strength, ecological building material

* katarzyna_jeleniewicz@sggw.edu.pl

Katarzyna Pactwa, Michał Cytryński*
Wroclaw University of Science and Technology, Poland

Mining through the eyes of students - green transformation or stagnation?

Just changes, taking into account environmental, social and regulatory requirements, are a challenge faced by countries belonging to the European Union, including Poland. This work attempts to answer the question of how the generation entering adulthood relates to the current state and the upcoming transformation of the mining and energy industry. The results of a pilot survey carried out in a group of students of one of the Polish universities are presented. The questionnaire addressed to a group of more than 100 people was intended to collect data on opinions on the current state of the mining industry and suggested changes, including the closure of mining plants and increasing the share of alternative energy sources. The results obtained show that academic youth are definitely not in favor of closing hard coal mines, although they are critical of the management of the industry. This does not mean that climate issues are alien to them, but it is a liberal voice, and energy issues are not structured in the study group. The young generation also has a low awareness of social and environmental issues and the challenges of achieving sustainable development goals that the mining industry faces.

Keywords: mining, coal, students, energy, social responsibility

* katarzyna.pactwa@pwr.edu.pl

*Paweł Wolski**
Częstochowa University of Technology, Poland

Właściwości filtracyjne kondycjonowanych osadów ściekowych

The article presents the results of research on the influence of various conditioning methods on the filtration properties of sludge, i.e. specific resistance, efficiency and filtration speed. The research substrate was excessive sewage sludge from a mechanical and biological sewage treatment plant. The conditioning of the sludge was carried out using the thermal method, the ultrasonic field and the combination of the previous methods, the so-called hybrid conditioning. The research was carried out for both unfermented sludge and fermented sludge in laboratory flasks for 10 days.

The conditioning methods used increased the filtration efficiency and speed. Fermentation was a factor reducing the values of the discussed parameters.

In the process of sonication of sewage sludge, the value of specific resistance increased. The stabilization process caused its reduction, systematically reducing the resistance values with each day of the process. The lowest values were obtained for conditioning with the UD field with a wavelength of 31.54 and 39.42 μm, and on the 5th day the resistance values were 4.37 - 4.29 x 1012 m / kg. For these wavelengths, the sediments also had the highest filtration velocity values. On the 10th day of the process, they were 0.203 cm3/s (amplitude 80%) and 0.253 cm3/s (amplitude 100%). During thermal conditioning, the resistance values increased with increasing temperature. The stabilization process did not cause major changes in its values. In the case of the temperature of 80 oC, only a decrease of the discussed index was observed.

Keywords: Sewage sludge, conditioning, fermentation, filtration efficiency and speed

Acknowledgments: The scientific research was funded by the statute subvention of Czestochowa University of Technology, Faculty of Infrastructure and Environment (BS/PB-400-301/22).

* pawel.wolski@pcz.pl

Sebastian Górecki, Dorota Babilas*
Silesian University of Technology, Poland

Application of membrane processes in selected metals recovery from aqueous solutions

As is well known, environmental pollution by wastewater containing heavy metals is a serious problem. Unfortunately, the metals present in wastewater, in the form of cations, accumulate in living organisms, causing their poisoning and the death of the ecosystem.Hence, it is very important to treat wastewater from metal contamination. The main sources of heavy metals pollution in wastewater are the metallurgical, energy, mining, and transport industries. The methods used in wastewater treatment can be divided into biological, chemical, and physical processes. The primary technologies used to remove heavy metals from wastewater are chemical precipitation, electrolysis, or ion exchange. However, they have many drawbacks: the use of chemicals, which generates additional waste, the high operational costs, and the lack of reuse of metals, e.g. in the electroplating industry. Therefore, membrane processes will be a much more advantageous techniques for wastewater treatment. Membrane techniquesallow for purification and concentration solutions for their further reuse, andsave a significant amount of money. Membrane processes used in the treatment of heavy metal saltwastewater are, for example, electrodialysis or reverse osmosis.

This work will evaluate the effectiveness of purification of heavy metal salt solutions by membrane methods and their advantages and disadvantages. In particular, attention will be paid to the electrodialysis process in which the driving force of the purification process is the electrostatic potential difference. The efficiency of theelectrodialytic wastewater treatment method as well as the costs of using such a method will be evaluated. Electrodialysis in wastewater treatment will also be compared with other membrane methods.

Keywords: metalsrecovery, wastewater treatment, membrane processes, electrodialysis

Acknowledgments: The work was financed from the statutory subsidy of the Faculty of Chemistry of the SilesianUniversity of Technology, Poland, under research project No.: 04/010/BKM22/1041.

* sg301135@student.polsl.pl

Sylwia Sady[1], Anna Muzykiewicz-Szymańska[2], Małgorzata Krzywonos[3], Alfred Błaszczyk[1], Bogdan Pachołek[1]*
[1]Poznań University of Economics and Business, Poland
[2]Pomeranian Medical University in Szczecin, Poland
[3]Wroclaw University of Economics and Business, Poland

Design of experiments in the optimization of the extraction process of grape by-products

The by-products of grape processing are characterized by a high content of bioactive compounds, especially with antioxidant potential. Therefore, to fully exploit them, it seems important to search for the possibility of modeling and optimizing extraction processes. Researching for optimal extraction conditions of bioactive compounds obtained from grape pomace by the one-dimensional method is very expensive and time-consuming. An alternative to the standard one-dimensional approach is to use a methodology based on the design of experiments (DOE). DOE as one of the statistical quality control tools enables us to determine the factors most strongly affecting the variable characterizing the tested process, as well as to indicate the values of factors for which the result variable reaches the expected value or the lowest variability. Properly selected parameters of plant extraction should guarantee the maximum recovery of valuable metabolites in the shortest possible time, with better efficiency and safety, and with lower expenses. The purpose of the study was to characterize the methods applied to design experiments to optimize grape pomace extraction. The used models were discussed, and independent variables' impact on the analyzed extraction processes was examined. Moreover, the DOE methods used were assessed in terms of technological, environmental and economic aspects.

Keywords: design of experiments, grape pomace, optimization of the extraction, statistical optimization

* sylwia.sady@ue.poznan.pl

Paweł Malinowski, Wojciech Dąbrowski, Sylwia Bagińska, Białystok Technical University, Poland, Beata Karolinczak*
Warsaw University of Technology, Poland

Elimination of bacterial contamination from domestic sewage by means of vertical flow constructed wetland

The constructed wetlands plants are successfully used for treating various types of wastewater. Their most popular use is for the treatment of domestic sewage. The main aim of the research was to find out the change of microbiological parameters (total coliform TC, faecal coliform FC, total number of mesophilic and psychrophilic bacteria, number of enterococci) during domestic sewage treatment. The concentration of organic matter, total Kjeldahl nitrogen TKN, ammonia nitrogen NH4-N, and total phosphorus were also analyzed.

The system used in the research was based on two vertical flow constructed wetlands - bed A filled with a Certyd produced in the sintering process of an ash and bed B filled with appropriate fractions of mineral aggregate. Both beds were planted with reeds and worked in parallel with hydraulic load of 0.1 m d-1. The research were conducted during the growing season.

The TC was decreased from 8,82E+06 to 6.12E+03 (Certyd bed) and 1.94E+06 (mineral bed), while the FC from 3,16E+6 to 1.85E+03 and 8.12E+05 respectively. A high removal efficiency of N-NH4 was obtained for both beds: 86.1% (Certyd bed) and 84.9% (mineral bed). The efficiency for BOD5 removal was 94.3 and 91.3 % respectively. Conducted research proved high efficiency of constructed wetlands in removal microbiological and physico-chemical parameters. In both cases, better efficiency was observed in bed filled with Certyd. Proposed solution is part of the circular economy, treated sewage can be successfully reused.

Keywords: bacterial contamination, domestic sewage, constructed wetlands, subsurface vertical flow system

Acknowledgments: The study was conducted as a research project WZ/WB-IIS/3/2020 in Faculty of Building and Environmental Sciences of BUT and financed by Ministry of Science and Higher Education of Poland.

* s.baginska97@gmail.com

Witold Nocoń, Katarzyna Moraczewska-Majkut, Witold Nocoń, Zuzanna Wielgus, Natalia Ziętarska, Katarzyna Krasoń, Monika Pasternak, Dagmara Szopińska, Piotr Grodzicki*
Silesian University of Technology, Poland

Changes in the microplastic content depending on the changes in the river catchment development structure

Three series of tests of microplastic content in the waters of the Upper Vistula were carried out on the section from the Wisła Czarne (above the dam reservoir) to the town of Ochaby. 6 sampling points were selected. The research material (suspended solids) was collected using a plankton net with a diameter of 0.25 m and a mesh size of 250 μm, each time from 1 m3 of river water. During the tests, the presence of microplastics was found in all the taken samples. The least amount of microplastic was observed at sample points 1 and 2. An increase in the microplastic content in the waters of the Vistula was shown, especially in the cities of Wisła and Skoczów. The increase in microplastic content was also observed downstream of the waste water treatment plant, although it should be noted that it was not as significant as in case of rivers flowing through the central part of the Upper Silesian Agglomeration. Also noticeable is the decrease in the microplastic content in the samples collected in Ochaby. This may be caused by both the dilution of the Vistula waters with streams flowing above this point, as well as the natural processes responsible for the removal of suspended solids from the river (sedimentation, retention of suspended particles on the vegetation growing on the river banks or in natural ponds and fragments of the riverbed with reverse current). Image analysis technique was also used to identify microplastic particles, which allowed to identify microplastic particles based on their colors. From the presented research, it can be concluded that rivers in Poland may be contaminated with microplastics even from their entire length, regardless of whether they flow through legally protected areas, with residual anthropogenic development of the catchment area and the riverbed, or through tourist resorts.

Keywords: microplastics, surface water, suspended solids, Vistula river, anthropopression

Acknowledgments: The work was carried out and financed under the Project Based Learning program implemented at the Silesian University of Technology in 2022.

* witold.k.nocon@polsl.pl

Szymon Stocki, Rafał Hübner*
Poznań University of Economics and Business, Poland

Innovative solutions in the energy sector

The assumptions of the European Green Deal indicate the importance of transforming the energy sector to achieve climate neutrality in Europe by 2050. Innovative solutions in the energy sector are an integral part of market development and allow to streamline processes, for instance by implementing technologies from other sectors. An example is the introduction of the Smart Grid as a distribution network and the use of supercapacitors in the low-voltage network for energy storage to reduce flickering light. In addition to constantly increasing energy costs and depleting fossil fuel resources, climate changes make it necessary to look for new, ecological, widely available and efficient methods of energy generation. They are based on renewable energy sources (RES), such as water, air, land, sun and biomass. New solutions for the energy sector also include the use of blockchain technology to execute transactions directly between market participants. Blockchain solutions facilitate and improve, e.g. transactions on the energy market, development of RES or the Tradable Green Certificates system.

The aim of the work is to present and characterize selected innovative solutions in the energy sector in Europe. An analysis of the literature was carried out and on this basis it was found that the energy sector is dynamically developing the structure of distribution and implements various innovations from other sectors, e.g. financial.

Keywords: innovations, energy sector, energy storage, energy distribution

* szymonstocki.info@gmail.com

Rafał Hübner, Szymon Stocki*
Poznań University of Economics and Business, Poland

Perception of the European Green Deal in Poland

Climate change is increasingly affecting the quality of life of societies and the condition of national economies, including Poland. The European Green Deal is a new concept, but it is a consequence of the current development of EU energy and climate policy. This new European Union investment policy is a blueprint for a more efficient use of resources through the transition to a clean, circular economy, stopping climate change, combating biodiversity loss and reducing pollution. The main goal is to reduce CO_2 emissions in the European Union by 55% by 2030 (compared to 1990 levels), and to achieve climate neutrality by 2050. This gives Poland an opportunity to transition to economic development in the spirit of sustainable development through the transformation of emission-intensive economic sectors, especially the energy sector. On the other hand, the changes may pose a significant threat for failing to meet the criteria of the European Green Deal.

The aim of the work was to present of strengths, weaknesses, opportunities and threats for Poland resulting from the EU policy aimed at implementing the European Green Deal. An analysis of the literature was carried out and on this basis it was found that the concept of a climate-neutral economy is a major challenge. Poland's weakness is the dominance of coal, which makes it difficult to decarbonize the industry. The strengths include the potential for low-emission transport. Opportunities include, among others: EU subsidies to be used for the transformation towards a climate-neutral economy. A threat is the conditionality of EU funds, which may be partially withdrawn if the objectives are not met.

Keywords: European Green Deal, SWOT analysis, sustainable development, climate neutrality

* rafal.hubner@wp.pl

Monika Czop, Magdalena Bogacka*
Silesian University of Technology, Poland

Plastic waste in the circular economy

Plastics were created in the belief that these are innovative materials with a wide range of applications and would play a key role in the resource-efficient and sustainable economy. Universal properties make them suitable for use in each sector of the economy. Light, chemically resistant, cheap and versatile plastics contribute to saving Energy and natural resources in strategic sectors of the economy, such as commerce, the construction industry, the automobile industry and the production of renewable energy. Due to the plastics' versatility, the market offers a wide range of plastics with all types of additives. Global production of plastics in 2021 reached a level of 367 million Mg. Compared to the year 2002 it increased by about 80%. Nowadays, plastics are considered excessive and problematic waste, becoming a nuisance to the environment. It is estimated that each year about 8 million Mg of plastics are directed to the seas and oceans uncontrollably. Looking at plastics from this perspective we may say that the management of plastics is a global challenge.

At present, in the EU market, 20 types of plastics are in use with all sorts of additives and modifications. On one hand, it allows for their universal use but on the other hand, it makes their optimum management difficult. In 2018 in the EU countries, 29,1 M Mg of plastic waste were collected for their management. In the same year, in Poland, about 1,9 M Mg of plastic waste was collected, out of which 27,4% was recycled, 30,3% was directed for energy recovery and the remaining 42,3% was stored at landfills. Plastic wastes shall be considered, above all, as precious resources which may be transferred in a safe and controlled way in raw materials, suitable for the production of new polymers, chemicals or energy. In order to take full advantage of the plastics' potential, they should be viewed holistically. Their whole life circle should be considered. It is possible to close the circulation of plastics but it is necessary to increase the rentability of recycling and intensify investments and innovations which would enable the maximum return of the plastics into circulation.

Keywords: plastic waste, circular economy, End-of-life, Recycling and Recovery

* Monika.Czop@polsl.pl

Wojciech Derej, Angelika Kantor*
University of Economics in Katowice, Poland

Innovativeness of the Visegrad Group countries in the context of the circular economy model implementation

The study concerns the innovativeness assessment of the Visegrad Group countries in relation to the implementation of the circular economy model. The aspect of innovation is currently one of the key factors in economic development. Moreover, this factor determines the implementation of modern development concepts of the European Union. This applies in particular to the European Green Deal, which assumes the implementation of a circular economy model. Innovativeness in relation to the European Union countries is assessed annually in the form of indicators presented in the European Innovation Scoreboard. The aim of this study was to present the level of innovativeness of the Visegrad Group countries in relation to the circular economy model implementation, based on the effectiveness of waste management. The study presents the above-mentioned issues within the framework of mutual relations between the Visegrad Group countries (Poland, Czech Republic, Slovakia, Hungary) and with other countries of the European Union.

Keywords: Visegrad Group, European Green Deal, Innovation, European Innovation Scoreboard, Circular Economy

* wojciech.derej@edu.uekat.pl

*Agata Rosińska**
Częstochowa University of Technology, Poland

The impact of biochar on sorption of polycyclic aromatic hydrocarbons in water

Biochar can be a relatively inexpensive and effective material for removing polycyclic aromatic hydrocarbons (PAHs) from aquatic environment. An evaluation of the sorptive possibilities of biochar to remove PAHs from the aquatic environment was conducted. To evaluate the PAH removal efficiency, water was modified with PAH MIX A standard solution to obtain a total concentration of normalized PAHs higher than that allowed in water intended for human consumption. The documents regulating the permissible concentration of PAHs in water intended for human consumption are Directive of the European Parliament and of the Council (EU) 2020/2184, 2020 and the Regulation of the Minister of Health (2017) on the quality of water intended for human consumption. Both documents standardize the content of benzo(a)pyrene and the sum of four PAHs, such as benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene and indeno(1,2,3,-c,d)pyrene. The sorption process was carried out for biochar doses of 25, 50 and 100 mg/dm3. For each biochar dose, the contact time with PAHs was: 30, 60 and 90 minutes. The best results were obtained for a biochar dose of 100 mg and a contact time of 90 minutes. For benzo(a)pyrene, the concentration decreased up to 56%, while for the four recommended PAHs, the greatest changes were shown for benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene, whose concentrations decreased by 62%. For the remaining PAHs, greater sorption was observed for dibenzo(a,h)anthracene, the concentration of this compound decreased by 50%. The smallest changes were shown for naphthalene, the concentration of which decreased by 26%.

Keywords: biochar, polycyclic aromatic hydrocarbons, removal efficiency

Acknowledgments: This research was funded by grant number BS/PB-400-301/22.

* agata.rosinska@pcz.pl

Jakub Drewnowski[1], Jan Marjanowski[2], Maciej Sadej[2], Bartosz Szeląg[3], Joanna Szulżyk-Cieplak[4], Grzegorz Łagód[4]*
[1]Gdansk University of Technology, Poland
[2]MARCOR Company Ltd., United Kingdom
[3]Kielce University of Technology, Poland
[4]Lublin University of Technologym Poland

The strategies towards membrane technology application UF/RO for the recovery of process water from brewery wastewater in Green Deal Implementation

The possibilities of membrane technology application – ultrafiltration (UF) and reverse osmosis (RO) – for the recovery of process water from brewery wastewater were presented. The feed for the UF/RO were pre-treated wastewater in the process BIOPAQ®-IC. Raw wastewater, after averaging the parameters have been treated by fermentation in an anaerobic reactor and then oxidized in the post-treating tank in order to deprive odour and oxidation of sulphides to sulphates. The recovered water from the pre-treated brewery wastewater, by the use of membrane techniques UF and RO were consider to apply for boiler feed system, the cooling and the washing process technology without direct cleaning of beer bottles. In this study were used capillary immersion ultrafiltration module ZeeWeed working in a vacuum pressure and equipped with a reverse osmosis membrane generating osmotic pressure Filmtec XLE 2125. This technology improved the efficiency of removal of pollutions, to afford the purified and high quality water towards Green Deal Implementations.

Keywords: Green Deal Implementations, brewery wastewater; ultrafiltration; reverse osmosis; reuse of process water

Acknowledgments: The authors thank the management of the MARCOR Company Ltd. For the access to data.

* jdrewnow@pg.edu.pl

PROGRAMME

I Day of Conference 5.12.2022

Plenary session

"Green Deal Strategies"

10.00-12.00 CET

[in English]

Chair of the session: ***Marzena Smol***
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Magdalena Wdowin, Vice-director of the Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
Opening of ICGreenDeal2022 - Importance of the Green Deal Strategies

Paweł Rowiński Vice-president of the Polish Academy of Sciences, Institute of Geophysics, Polish Academy of Sciences, Poland
Opening of ICGreenDeal2022 - Importance of the Green Deal Strategies

Marzena Smol, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
Introduction – Inventory of Green Deal Strategies

Oliver Loebel, Secretary General in EurEau, Belgium
The perspective of Water sector in green deal strategies

Ludwig Hermann, President of the European Sustainable Phosphorus Platform (ESPP), Proman Management GmbH, Austria
Importance of Raw materials – current trends and future perspectives

Jiří Jaromír Klemeš, Brno University of Technology, Czech Republic
Importance of Energy – current trends and future perspectives

Joanna Napierala, European Centre for the Development of Vocational Training (CEDEFOP)
Implementation of European Green Deal and implications for labour markets and demanded skills in EU

Lunch break
12.00-13.00 CET

Iceland Liechtenstein Norway grants

Parallel session
As part of the waterCEmanagement project
"Water in Circular Economy - water reuse"
13.00-14.45 CET
[in English]

Chair of the session: ***Marzena Smol***
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Marzena Smol, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland
Water-CE-management in practice – key role of water in the transformation process towards a circular economy (CE)

Rafael Casielles, BIOAZUL, Spain
Water reuse in Spain - good examples

Klara Ramm, EurEau & Chamber of Commerce Polish Waterworks, Belgium - Poland
Water reuse in Poland - good examples

Māris Kļaviņš, University of Latvia, Latvia
Water reuse in Latvia - good examples

Beata Szatkowska & Renata Tomczak-Wandzel, Aquateam COWI, Norway – Poland
Water reuse in Norway - good examples

Małgorzata Szlachta, GTK - Geological Survey of Finland
Water reuse in Finland - good examples

Ahmad Elmoll, Univesite Libanaise, Lebanon
Eco-innovative technology for wastewater treatment and reuse in Eastern Mediterranean region: Case of Lebanon

Parallel session

"Circular Economy & Green Deal challenges"

13.00-14.45 CET

[in English]

Chair of the session: ***Monika Sady****, Cracow University of Economics, Poland*
Jolita Kruopienė*, Kaunas University of Technology, Lithuania*

David Knäble, Hochschule Offenburg, Germany, **Konstantinos Tsagarakis**, Technical University of Crete, Greece
German companies engagement in Circular Economy: A LinkedIn approach

George Tsironis, Democritus university of Thrace, Greece, **Theodoros Daglis**, University of the Aegean, Greece, **Konstantinos Tsagarakis**, Technical University of Crete, Greece
Circular economy companies in LinkedIn

Hanna Tiutiunnyk, State Organization "Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine", Ukraine
Blue and green zones in Circular Economy in the context of aquaculture development

Szymon Kilian, **Katarzyna Pawęska, Aleksandra Bawiec**, University of Environmental and Life Sciences, Poland
Green and blue infrastructure in cities

Wioletta Wrzaszcz, **Konrad Prandecki**, Institute of Agricultural and Food Economics National Research Institute, Poland
Opportunities and threats to achieve the strategic objectives of the European Green Deal in agricultural sector in Poland

Session

"Bioeconomy & Climate"

15.00-16.30 CET

[in English]

Chair of the session: ***Beata Szatkowska****, Aquateam COWI, Norway-Poland*

Olga Iermakova, State Organization "Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine", Ukraine
Factors of ecological interactions of the aquaculture sector and the environment

Majeeti Narasimha Vara Prasad, University of Hyderabad, India
Plant diversity for environmental cleanup and bioeconomy

Adam Nawrocki, **Robert Popek, Arkadiusz Przybysz**, Warsaw University of Life Science, Poland
We are what we breathe – urban meadow as a promising solution for clean air in the vicinity of roads

German Smetana, **Anna Grosser**, Częstochowa University of Technology, Poland
Kinetic study of high-solids anaerobic co-digestion of pre-treated organic waste in terms of methane production

Dominika Bar-Michalczyk, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
Nitrogen leaching losses from agricultural area in central Europe under climate changes scenarios

II Day of Conference 6.12.2022

Parallel session

"Raw materials & Sustainability"

9.00-10.45 CET

[in English]

Chair of the session: ***Renata Tomczak-Wandzel****, Aquateam COWI, Norway – Poland*
Dariusz Włóka*, GreenBack Ltd., Poland*

Jolita Kruopienė, **Inga Gurauskienė, Aušra Randė**, Kaunas University of Technology, Lithuania
Lithuanian situation in the context of planetary boundaries for biochemical flows of P

Tejaswini Dash, **K. Sowjanya Sree**, Central University of Kerala, India
Sustainable shrimp culture effluent remediation by duckweed

Oleksandr Laiko, State Organization "Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine", Ukraine
Sustainable manufacturing development and its effect on cohesion policy realization in Ukrainian economic system

Weronika Muszyńska, SGH Warsaw School of Economics, Poland
Sustainable human resource management from the perspective of people holding managerial positions in Polish enterprises

Parallel session

"Energy and Raw Materials in Green Deal"

9.00-10.45 CET

[in English]

*Chair of the session: **Sebastian Werle**, Silesian University of Technology, Poland*

Māris Kļaviņš, **Linda Ansone-Bertina, Lauris Arbidans, Una Celma**, University of Latvia, Latvia
Progress at development of carbon capture technologies a tool to achieve carbon neutrality aims

Bartosz Sobik, SGH Warsaw School of Economics, Poland
Challenges related to Polish Energy Transition – technical, financial and social aspects

Irina Kliopova, Ugnė Jomantienė, Kaunas University of Technology, Lithuania
Energy efficiency opportunities in industrial sector: case study

Baibhaw Kumar, **Gábor L. Szepesi, Zoltán Szamosi, Gyula Krámer,** University of Miskolc, Hungary
Combined solar drying analysis of wood-chips, sawdust and pellets

Pinar Kocabey Çiftçi, Gaziantep University, Turkey
The Importance of Energy Efficiency Efforts for Textile Industry via Corporate Carbon Footprint Analysis

Session

"Sustainable waste management"

11.00-12.30 CET

[in English]

*Chair of the session: **Idiano D'Adamo,** Spienza University of Rome, Italy*
***Konstantinos Tsagarakis**, Democritus University of Thrace, Greece*

Irina Kliopova, **Ieva Martinaitytė**, Kaunas University of Technology, Poland
Application of the principles of Integrated Waste Management to paper mill sludge: case study in Lithuania

Rosa Nascimento, NOVA University Lisbon, Portugal, **Emmanouil Papaioannou**, Lancaster University, United Kingdom, **Teresa Brás**, Alentejo Biotechnology Center for Agriculture and Agro-food (CEBAL), Portugal; MED – Mediterranean Institute for Agriculture, Portugal, **João Crespo, Luísa A. Neves**, NOVA School of Science and Technology, Portugal
From agriculture and food industry wastes to biopolymers: cellulose extraction from banana plant pseudostem and beetroot pulp

Anna Bogush, Coventry University, United Kingdom, **Ondřej Masek**, **Wolfram Buss**, University of Edinburgh, United Kingdom, **Konstantin Ignatyev**, Diamond Light Source, United Kingdom
Residues from Biomass Thermal Treatment and Wastewater Treatment Plants as Agricultural Fertiliser: Nutrients Harvesting from Waste

Wiktoria Piątek-Gołda, Justyna Sulej, Monika Osińska-Jaroszuk, Maria Curie-Sklodowska University, Poland
Antimicrobial properties of lactobionic acid

Lunch break
12.30-13.00 CET

Session
"Water in Circular Economy"
13.00-15.00 CET
[in English]

*Chair of the session: **Edyta Kudlek**, Silesian University of Technology, Poland*
***Aleksandros Stefanakis**, Technical University of Crete, Greece*

Markus Hjort, CONCAWE Environmental Science for European Refining, Belgium
Upcoming Water Challenges for EU Fuel Manufacturing Sector – in Light of a Dynamic Legislative Environment

Anna Gierek-Ożóg, **Małgorzata Cimochowicz-Rybicka**, Cracow University of Technology, Poland, **Tadeusz Żaba**, Kraków Water, Poland; Cracow University of Technology, Poland
Water safety in internal water supply system

Beena Kouser, The Indira Gandhi National Open University (IGNOU), India
Assessment of groundwater quality for agriculture purposes in the part of Kathua region, Jammu and Kashmir, India

Joanna Bąk, Cracow University of Technology, Poland, **Sondre Meland**, Norwegian Institute for Water Research, Norway
Comparative analysis of rainwater quality in selected European cities as a next step towards the implementation of circular water management and the accomplishment of selected sustainable development goals

Arun Lal Srivastav, Lata Rani, Prakriti Sharda, **Ajay Sharma, Varinder Singh Kanwar**, Chitkara University Himachal Pradesh, India
Application of biochar adsorbents in the removal of synthetic dyes from water: State of art, challenges and future

Paulina Pietrzyk, **Agnieszka Pregowska, Magdalena Osial**, Institute of Fundamental Technological Research, Polish Academy of Sciences, Poland
Current trends of removal dyes from water by magnetic nanomaterials application

III Day of Conference 7.12.2022

Parallel Session

"Wastewater & Sewage sludge"

9.00-10.30 CET

[in English]

*Chair of the session: **Klara Ramm**, EurEau & Chamber of Commerce Polish Waterworks, Belgium - Poland*
***Magdalena Zabochnicka**, Czestochowa University of Technology, Poland*

Małgorzata Komorowska-Kaufman, Poznan University of Technology, Poland
Treated municipal wastewater as a reliable source of water in selected industrial plants

Klaudia Całus-Makowska, **Anna Grosser, Anna Grobelak**, Czestochowa University of Technology, Poland
High-Performance Liquid Chromatography (HPLC) in the determination of pharmaceuticals in wastewater and sewage sludge

Katarzyna Pawęska, Aleksandra Bawiec, **Ewa Burszta-Adamiak, Wiesław Fiałkiewicz**, Wrocław University of Environmental and Life Sciences, Poland
Municipal and industrial wastewater as a source of water - opportunities, threats and barriers to wastewater reuse on the example of Polish experience

Ewa Neczaj, **Anna Grosser**, Czestochowa University of Technology, Poland
Reuse of municipal wastewater treatment plant effluents – challenges and barriers

Kinga Marek, **Aleksandra Bawiec, Katarzyna Pawęska**, Wroclaw University of Environmental and Life Sciences, Poland
Analysis of the granulometric composition of wastewater flowing out of the third stage of treatment - the case of the hydroponic lagoon

Marek Klimasz, **Anna Grobelak**, Częstochowa University of Technology, Poland
Wastewater treatment plant as a source of soil contamination with microplastics

Bogna Śniatała, **Dominika Sobotka, Jacek Mąkinia,** Gdańsk University of Technology, Poland
Intensified nitrogen recovery from anaerobic digester liquors through the use of gas permeable membranes

Parallel Session

"Wyzwania i perspektywy wdrażania Europejskiego Zielonego Ładu i Gospodarki o obiegu zamkniętym"

9.00-10.45 CET

[in Polish]

*Chair of the session: **Maria Włodarczyk-Makuła**, Czestochowa University of Technology, Poland*

Michał Bodzek, Institute of Environmental Engineering Polish Academy of Sciences, Poland, **Anna Kwiecińska-Mydlak**, Institute for Chemical Processing of Coal, Poland
Dezynfekcja wody i ścieków metodą nano-fotokatalizy

Justyna Górka, **Dominika Poproch**, **Małgorzata Cimochowicz-Rybicka**, Cracow University of Technology, Poland, **Bartosz Łuszczek, Ewelina Chrapusta-Srebrny**, Krakow Water, Poland
Gospodarka o obiegu zamkniętym w oczyszczalni ścieków Kraków-Płaszów – wybrane aspekty

Iwona Francuziak, **Marzena Smol**, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
Analiza społeczno-ekonomiczna ponownego wykorzystania wody do celów rolniczych i innych

Mateusz Rychlak, Jagiellonian University, Poland
Normatywne pojęcie bezpieczeństwa energetycznego w kontekście założeń Europejskiego Zielonego Ładu

Przemysław Ogarek, Doctoral School of Engineering and Technical Sciences at the Rzeszów University of Technology, Poland
Wytwarzanie wodoru dla stabilizacji pracy systemów energetycznych: osiągnięcia i perspektywy

Aleksandra Wypart-Pawul, Ewa Neczaj, Anna Grobelak, Częstochowa University of Technology, Poland
Zaawansowane procesy utleniania w usuwaniu mikrozanieczyszczeń organicznych ze ścieków

Angelika Skorupa, **Małgorzata Worwąg**, Częstochowa University of Technology , Poland
Gospodarka i wykorzystanie produktów ubocznych z przetwórstwa ziaren kawy
Maria Włodarczyk-Makuła, Czestochowa University of Technology, Poland
Podsumowanie sesji - 3W - WODA : WODÓR : WĘGIEL

Parallel Session

Cross-H2020-seminar LEX4BIO & FERTIMANURE

"Bio-based fertilisers of the Future"

11.00-12.30 CET

[in English]

Marzena Smol, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
Introduction - Bio-based fertilisers of the Future

Kari Ylivainio, Natural Resources Institute Finland (Luke)
LEX4BIO project scope

Laia Llenas Argelaguet, BETA Technological Center
FertiManure project scope

Ivona Sigurnjak, University of Ghent, Belgium
Agronomic performance of the use of BBFs

Boris Jansen, University of Amsterdam, Netherlands, **Nicolas Estoppey**, Norwegian Geotechnical Institute, Norway
Potential risks related to the use of BBFs

Laia Llenas Argelaguet, BETA Technological Center
Promotion and disseminarion based on experience with Nutrient Recycling Community

Discussion

Parallel Session

"Pollutants and micropollutants in Environment"

10.45-12.45 CET

[in English]

Edyta Kudlek, Silesian University of Technology, Poland
Decomposition of organic micropollutants under the influence of solar radiation

Marta Gmurek, Lodz University of Technology, Poland
Toxicity Assessment Of Contaminants Of Emerging Concern After Photochemical Treatment

Kaouthar Benahdach, **Aoulad El Hadj Ali Youssef, El Laghdach Anas, El Mail Rachad**, Abdelmalek Essaâdi University, Morocco
Removal of congo red from aqueous solution using activated carbon based pomegranate peel

~~**Rupak Kumar**, The Central Drugs Standard Control Organisation(CDSCO), India~~
~~*Low-cost adsorbent for the removal xenobiotic pollutant morpholine: a proof of concept*~~

Sanaa El Aggadi, **Mariem Ennouhi, Amale Boutakiout**, Abderrahim El HourchMohammed V University, Morocco
Electrocatalytic Decomposition of Reactive Yellow 14 by Fe/C-Doped Lead Dioxide Modified Anode

Lata Rani, **Jyotsna Kaushal, Arun Lal Srivastav**, Chitkara University Himachal Pradesh, India
Modified biochar as efficient adsorbent for the removal cadmium from water

Award Ceremony & Closing

"Green Deal for the Future"

Summary session

13.00-14.30 CET

[in English]

Chair of the session: ***Marzena Smol***
Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland

Małgorzata Cimochowicz-Rybicka, Cracow University of Technology, Poland
Summary - Water & Raw Materials in Green Deal Strategies

Sebastian Werle, Silesian University of Technology, Poland
Summary – Importance of Energy in Green Deal Strategies

Bartosz Łuszczek, Krakow Water Utility, Poland
The perspective of the industry in Green Deal Strategies - Water, Raw materials & Energy

Magdalena Głogowska, National Centre for Research and Development (NCBiR), Poland
Financing the Green Deal in Horizon Europe

Marzena Smol, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland
Closing

Poster Session
Posters with abstract will be available throughout the conference in the "poster session" tab

[in English]

Agnieszka Bus, **Kamila Budzanowska**, Warsaw University of Life Sciences, Poland *Comparison of the sorption capacity of raw and calcinated eggshells as a reactive material for phosphate removal from wastewater*
Marzena Smol, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland, **Alfonso Mejia**, **Marina Howarth**, The Pennsylvania State University, USA *Business approaches in the water and wastewater sector – CircuWater project*
Dominika Szołdrowska, Marzena Smol, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland *Sewage sludge treatment methods in the context of nutrients recovery and heavy metals reduction*
Paulina Marcinek, **Marzena Smol**, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland *Grey water as an alternative solution for a sustainable management of water resources*
Remigiusz Gut, Wiktor Jasiński, Andrzej Duszyński, Aleksander Czapla, Jakub Drewnowski, Gdańsk University of Technology, Poland *Analysis of the influence of wall thickness on the fatigue of the soil-shell structure with a non-circular cross-section, made of a polymer-glass composite (GRP)*
Joanna Witkowska-Dobrev, Olga Szlachetka, Justyna Dzięcioł, Marek Dohojda, Warsaw University of Life Sciences, Poland *Effect of slurry on the compressive strength of concrete and its geometric surface structure*
Katarzyna Maj-Zajezierska, Academy of Applied Sciences in Tarnów, Poland *Analysis of the proposal to adopt air quality standards in the EU in accordance with the WHO recommendations*

Magdalena Budych-Górzna, Aquanet S.A., Poland, **Małgorzata Komorowska-Kaufman, Piotr Oleśkowicz-Popiel**, Poznan University of Technology, Poland *Application of waste activated sludge mid-temperature alkaline pre-treatment for increasing biogas production at wastewater treatment plant*
Magdalena Bilińska, Lucyna Bilińska, Marta Gmurek, Lodz University of Technology, Poland *Industrial ozone installation for textile wastewater reuse. The study of optimal ozone dose*
Noura Fathy Adel Salam, Sara Mohamed Elhosary, Magdi F. Abadir, Cairo University, Egypt **Magdalena Zabochnicka**, Czestochowa University of Technology, Poland *Optimization of methyl orange removal from textile wastewater by electro-coagulation cell using RSM*
Paulina Bąk-Patyna, **Hubert Patyna**, Kielce University of Technology, Poland *Examination of light reflection and luminance of mineral-asphalt mixtures*
Paweł Kut, **Katarzyna Pietrucha-Urbanik**, Rzeszow University of Technology, Poland *Operation and Failure Analysis of Photovoltaic Installations*
Weronika Urbańska, Wrocław University of Science and Technology, Poland *The potential of recovering critical raw materials from polymetallic waste*
Ewa Gawlak, Jagoda Worek, Katarzyna Styszko, AGH University of Science and Technology, Poland *Microplastics in sewage samples – the content and the origin*
Achraf Berradi, **Laila Mandi, Faissal Aziz**, Cadi Ayyad University, Morocco *Biobased hydrogels for a smart irrigation*
Alina Pruss, Poznan University of Technology, Poland, **Agata Pruss**, Technical University of Denmark, Denmark, **Jacek Karolczak**, Poznan University of Technology, Poland, **Paweł Pruss,** AQUA S.A., Poland, **Beata Mądrecka-Witkowska, Małgorzata Komorowska-Kaufman**, Poznan University of Technology, Poland *Sustainability between trees*
Aleksandra Kozłowska-Woszczycka, **Katarzyna Pactwa,** Wrocław University of Science and Technology, Poland *Public Participation Geographic Information System in post-mining management in the face of Just Transition*
Anna Jasińska, **Anna Grosser**, Częstochowa University of Technology, Poland *Biochemical methane potential (BMP) study of anaerobic co-digestion of sewage sludge, poultry manure and selected local organic waste*
Asmae Ben Abdelhadi, **Rachid Ouarsal**, Mohammed Lachkar, University Sidi Mohamed Ben Abdellah, Morocco, **Michal Dusek, Brahim El Bali**, Independent Scientist, Morocco *New hybrid organic-inorganic phosphite $(N_2H_5)_2Co(H_2PO_3)_4.2H_2O$: Synthesis, Structural characterization, physicochimical application and catalytic activity*
Deepti Negi, **Achlesh Daverey**, Doon University, India, **Punyasloke Bhadury**, Indian Institute of Science Education and Research Kolkata, India *Rice husk biochar augmentation in Cyperus alternifolius and Acorus calamus planted CWs for nitrogen removal a preliminary study*
Dorota Babilas, **Piotr Dydo**, Silesian University of Technology, Poland *Influence of [Bmim]+ ion concentration and linear flow velocity on the limiting current density during electrodialysis process*
Ghizlane Akhouy, **Lhoucine Gebrati**, Cadi Ayyad University, Morocco

Olive Pomace: a renewable resource for developing bio-based and biodegradable food packaging
Imane Haydari, Faissal Aziz, Naaila Ouazzani, Laila Mandi, Cadi Ayyad University, Marrakech *Facile preparation of novel low-cost sorbent for olive mill wastewater treatment and phenol recovery*
Imane Adouar, **Smaiel Herradi, Souad Rakib, Brahim El Bali, Mohammed Lachkar,** University Sidi Mohamed Ben Abdellah, Morocco *Comparative study of hydroxyapatite nanocomposites used as slow release fertilizers*
Iwona Deska, Czestochowa University of Technology, Poland *The role of extensive green roofs in rainwater management and climate changes mitigation in urban areas*
Izba Ali, KU Leuven, Belgium *Production of hydrogen peroxide in a photo-electrocatalytic system*
Jakub Copik, Edyta Kudlek, Mariusz Dudziak, Silesian University of Technology, Poland *Sonocatalysis - effective method of organic micropollutants removal from water*
Juris Burlakovs, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland, **Zane Vincevica-Gaile**, University of Latvia, Latvia, **Mait Kriipsalu**, Estonian University of Life Sciences, Estonia, **Magdalena Wdowin**, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland *Rejected by Waste Recycling Material for Enhancing Methane Degradation in Landfill Biocovers*
Justyna Dzięcioł, **Wojciech Sas**, Warsaw University of Life Sciences, Poland *Machine Learning as a Component of a Sustainability Policy for the Civil Engineering Sector on the Example of Permeability Coefficient Estimation*
Justyna Cader, Renata Koneczna, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, Poland *Compilation and comparison of hydrogen economy indicators*
Katarzyna Gabryś, Warsaw University of Life Sciences, Poland *Cyclic behavior of recycled concrete aggregate – recycled tire waste mixture*
Maciej Miturski, Warsaw University of Life Sciences, Poland *Dispersed reinforcement as a factor in reducing the amount of cement in stabilised soils*
Maria del Mar Cerrillo-Gonzalez, Maria Villen Guzman, **Juan Manuel Paz-Garcia, José Miguel Rodríguez Maroto**, University of Malaga, Spain *Critical Raw Materials as a Limiting Factor in Lithium-Ion battery market*
Maria del Mar Cerrillo-Gonzalez, Maria Muñoz-Espinosa, Maria Villen-Guzman, University of Malaga, Spain *Role of Citric Acid and Cupper in the leaching of $LiCoO_2$*
Meryem Idboumlik, University Sidi Mohamed Ben Abdellah, Morocco, **Ivan da Silva**, Rutherford Appleton Laboratory – UKRI, United Kingdom, **Brahim El Bali**, Independent Scientist, Morocco, **Mohammed Lachkar**, University Sidi Mohamed Ben Abdellah, Morocco *Structural characterization and catalytic activity of a novel hybrid decavanadates material for methylene blue oxidation*
Olga Szlachetka, Justyna Dzięcioł, Marek Dohojda, Warsaw University of Life Sciences, Poland *Perlite-concrete as a construction material, basic properties and prospects for sustainable application*

Oskars Purmalis, Māris Kļaviņš, University of Latvia, Latvia *Thermogravimetric characteristics of invasive plant biomass*
Paulina Sowik, Katarzyna Kowalska, Silesian University of Technology, Poland *Solar-driven TiO_2-based photocatalysis -as a method to treat wastewater contaminated by anti-microbial drugs*
Piotr Kanarek, Barbara Breza-Boruta, Wojciech Poćwiardowski, Anna Ligocka, Justyna Bauza-Kaszewska, Bydgoszcz University of Science and Technology, Poland *A study of the effects of silver ions and hydrogen peroxide on selected waterborne pathogens and the possibility of using these disinfectants for sanitizing swimming pool water*
Ruchi Upadhyay, Silesian University of Technology, Poland *Mycoremediation: A remedy for alleviation of Ecotoxicity Risk of wastewater contaminated with Synthetic dye?*
Mehdi Sharif Shourjeh, Przemysław Kowal, Gdansk University of Technology, **Bartosz Szeląg,** Kielce University of Technology, Poland, **Jakub Drewnowski**, Gdansk University of Technology, Poland *Effect of free ammonia and free nitrous acid on inhibition NOB activity in the SBR under elevated temperatures for lower energy strategies*
Safaa Hidaoui, Najlaa Hamdi, Mohamed Akouibaa, Mohammed Lachkar, University Sidi Mohamed Ben Abdellah, Morocco, **Eigner Vaclav, Michal Dusek**, Institute of Physics AS CR, Czech Republic, **Brahim El Bali**, Independent Scientist, Oujda, Morocco *Synthesis, crystal structure and Application of $(C_4H_{12}N_2)[Co(H_2O)_6](HPO_4)_2$ for the reduction reaction of the three*
Smaiel Herradi, Imane Adouar, Sara Bouhazma, Sanae Chajri, Mohammed Khaldia, Brahim El Bali, Mohammed Lachkar, University Sidi Mohamed Ben Abdellah, Morocco *Synthesis of a pure hydroxyapatite by microwave-assisted sol–gel technique using triethylamine (TEA) as a chelating agent*
Victor Adebiyi, Anna Bogush, Coventry University, United Kingdom *Microplastics in Bottled Drinking Water*
Wioleta Bolesta, AGH University of Science and Technology in Krakow, Poland, **Marcin Głodniok**, GIG Research Institute Katowice, Poland, **Katarzyna Styszko**, AGH University of Science and Technology, Poland *Pharmacological Contamination in Sewage Sludge: An Update on the Status of Agricultural Use*
Mohammed Zerrouk, Rachid Ouarsal, Mohammed Khaldi, University Sidi Mohamed Ben Abdellah, Morocco, **Brahim El Bali**, Independent Scientist, Oujda, Morocco, **Mohammed Lachkar**, University Sidi Mohamed Ben Abdellah, Morocco *Synthesis, Structural Characterization, and Biological Activities of New Organic–Inorganic Hybrid Phosphite $(C_2H_{10}N_2)Ni(H_2PO_3)_2Cl_2$*
Joanna Antos, Aleksandra Makała, Joanna Zembrzuska, Joanna Jeż-Walkowiak, Dobrochna Ginter-Kramarczyk, Izabela Kruszelnicka, Poznan University of Technology, Poland *Analysis of contamination of the Warta River by selected drugs*
Joanna Witkowska-Dobrev, Olga Szlachetka, Marek Dohojda, Warsaw University of Life Sciences, Poland *Chloride corrosion of paving blocks*
Yosura El Mouine, **Amal El Hamdi**, Avignon University, France; Abdelmalek Essaâdi University, Morocco; National Institute of Agricultural Research (INRA), Morocco,

Moad Morarech, Abdelmalek Essaâdi University, Morocco, **Vincent Valle**, Avignon University, France, **Hasna Yachou, Houria Dakak, Abdelmajid Zouahri**, National Institute of Agricultural Research (INRA), Morocco *Impact of landfill leachate on the groundwater quality — a case study of Tadla Plain*
Mariem Ennouhi, **Sanaa El Aggadi, Jamal Mabrouki, Amale Boutakiout, Mohammed Dahou, Mohammed Alaoui El Belghiti**, Mohammed V University, Rabat, Morocco *Efficiency in optimizing the pre-treatment process in water desalination*
Bidisha Mondal, Ishita Sarkar, Vellore Institute of Technology, India, **Aleksander Czapla, Jakub Drewnowski**, Gdansk University of Technology, Poland, **Mahesh Ganesapillai**, Vellore Institute of Technology, India *Sustainable resource recovery in agriculture and animal husbandry along with reduction in ammonia volatilization*

Poster Session

Posters with abstract will be available throughout the conference in the "poster session" tab

[in Polish]

Dariusz Boruszko, **Ada Wojciula**, Bialystok University of Technology, Poland *Ocena skuteczności usuwania WWA z odcieków po ATAD metodą osadu czynnego z wykorzystaniem metody*
Anna Kowalik-Klimczak, **Maciej Życki,** Łukasiewicz Research Network - Institute for Sustainable Technologies, Poland, **Anna Gajewska-Midziałek, Zofia Buczko**, Łukasiewicz Research Network - Institute of Precision Mechanics, Poland, **Tadeusz Gorewoda, Jadwiga Charasińska,** Łukasiewicz Research Network - Institute of Non-Ferrous Metals, Poland, **Jacek Jurczyk,** Fabryka Drutu Gliwice S.A., Poland *Zastosowanie procesów membranowych do odzyskiwania wody z poprodukcyjnych kąpieli galwanicznych*
Anna Marszałek, **Mariusz Dudziak, Edyta Kudlek**, Silesian University of Technology, Poland *Oczyszczanie wód opadowych z autostradowego zbiornika retencyjnego z wykorzystaniem procesów membranowych*
Edyta Nartowska, Marta Styś-Maniara, Tomasz Kozłowski, Kielce University of Technology, Poland *Potencjalny wpływ środowiskowy i społeczny hydratów soli nieorganicznych stosowanych jako materiał zmiennofazowy do magazynowania energii cieplnej w instalacjach fotowoltaicznych*
Anna Piotrowska, **Dariusz Boruszko**, Białystok Technical University, Poland *Rola efektywnych mikroorganizmów w świetle gospodarki o obiegu zamkniętym*
Artur Kuźniacki, ESV S.A., Poland *Technologia wysokosprawnej kogeneracji jako skuteczny komponent stabilizacji kosztów zaopatrzenia w energię elektryczną i ciepło przy jednoczesnej poprawie efektywności energetycznej przedsiębiorstwa produkcyjnego*

Monika Metryka-Telka, Robert Kowalik, Marta Styś-Maniara, Jarosław Gawdzik, Kielce University of Technology, Poland *Wpływ budowy geologicznej na aktywność ^{222}Rn w wodzie*
Barbara Pieczykolan, Silesian University of Technology, Poland *Kinetyka adsorpcji błękitu metylenowego oraz czerwieni bezpośredniej 81 na osadach powstałych w procesach uzdatniania wody*
Edyta Łaskawiec, Silesian University of Technology, Poland *Przyrost biomasy roślinnej w obecności popłuczyn z obiektów basenowych: wybrane wskaźniki w kontekście możliwości recyklingu ścieków*
Ewa Okoniewska, Częstochowa University of Technology, Poland *Metody usuwania barwników – przegląd*
Ewa Puszczało, Silesian University of Technology, Poland *Ocena skuteczności uzdatniania wody w butelkach filtracyjnych*
Ewa Łobos-Moysa, **Edyta Kudlek, Ewa Felis**, Silesian University of Technology, Poland *Niebezpieczna akumulacja składników powszechnych produktów: ocena sorpcji AHTN i HHCB na materiałach naturalnych w środowisku wodnym*
Jagoda Worek, **Ewa Gawlak**, **Kamil Kawoń, Wioleta Bolesta, Joanna Chwiej, Katarzyna Styszko**, AGH University of Science and Technology, Poland *Gospodarka o obiegu zamkniętym – ryzyko stosowania nawozów z osadów ściekowych*
Joanna Wyczarska-Kokot, **Karolina Oszek**, Silesian University of Technology, Poland *Jakość i możliwości zagospodarowania popłuczyn odprowadzanych z filtrów basenowych ze złożem zeolitowo-węglowym*
Krzysztof Wiśniewski, Gabriela Rutkowska, Katarzyna Jeleniewicz, Norbert Dąbkowski, Jarosław Wójt, Warsaw University of Life Sciences, Poland *Ekologiczne materiały budowlane na przykładzie kompozytu glinowo-popiołowego jako dobre zagospodarowanie popiołów lotnych z termicznej konwersji osadów ściekowych*
Katarzyna Pactwa, **Michał Cytryński**, Wroclaw University of Science and Technology, Poland *Górnictwo oczami studentów – zielona przemiana czy stagnacja?*
Paweł Wolski, Częstochowa University of Technology, Poland *Właściwości filtracyjne kondycjonowanych osadów ściekowych*
Sebastian Górecki, **Dorota Babilas,** Silesian University of Technology, Poland *Zastosowanie procesów membranowych w odzyskiwaniu wybranych metali z roztworów wodnych*
Sylwia Sady, Poznań University of Economics and Business, Poland, **Anna Muzykiewicz-Szymańska**, Pomeranian Medical University in Szczecin, Poland, **Małgorzata Krzywonos**, Wroclaw University of Economics and Business, Poland, **Alfred Błaszczyk**, **Bogdan Pachołek**, Poznań University of Economics and Business, Poland *Projektowanie eksperymentów w optymalizacji procesu ekstrakcji winogronowych produktów ubocznych*
Paweł Malinowski, Wojciech Dąbrowski, Sylwia Bagińska, Białystok Technical University, Poland, **Beata Karolinczak**, Warsaw University of Technology, Poland *Eliminacja skażenia bakteryjnego ze ścieków bytowych za pomocą mokradła o przepływie pionowym*

Witold Nocoń, Katarzyna Moraczewska-Majkut, Zuzanna Wielgus, Natalia Ziętarska, Katarzyna Krasoń, Monika Pasternak, Dagmara Szopińska, Silesian University of Technology, Poland, **Piotr Grodzicki,** Academic Secondary School of the Silesian University of Technology, Poland *Zmiany zawartości mikroplastiku w zależności od zmian struktury użytkowania zlewni rzeki*
Szymon Stocki, Rafał Hübner, Poznań University of Economics and Business, Poland *Innowacyjne rozwiązania w energetyce*
Rafał Hübner, Szymon Stocki, Poznań University of Economics and Business, Poland *Postrzeganie Europejskiego Zielonego Ładu w Polsce*
Monika Czop, **Magdalena Bogacka**, Silesian University of Technology, Poland *Odpady z tworzyw sztucznych w gospodarce o obiegu zamkniętym*
Wojciech Derej, **Angelika Kantor**, University of Economics in Katowice, Poland *Innovativeness of the Visegrad Group countries in the context of the circular economy model implementation*
Agata Rosińska, Częstochowa University of Technology, Poland *The impact of biochar on sorption of polycyclic aromatic hydrocarbons in water*
Jakub Drewnowski, Gdansk University of Technology, Poland, **Jan Marjanowski, Maciej Sadej**, MARCOR Company Ltd., United Kingdom, **Bartosz Szeląg**, Kielce University of Technology, Poland, **Joanna Szulżyk-Cieplak, Grzegorz Łagód**, Lublin University of Technologym Poland *The strategies towards membrane technology application UF/RO for the recovery of process water from brewery wastewater in Green Deal Implementation*

3rd International Conference

Strategies toward Green Deal Implementation

Water, Raw Materials & Energy

Mineral and Energy Economy Research Institute
Polish Academy of Sciences

Iceland Liechtenstein Norway grants

AMU
Polish Young Academy
POLISH ACADEMY OF SCIENCES

Ministerstwo Klimatu i Środowiska

FUNDACJA OPTIMUS

IWA
the international water association

Trener Nauki
Dr Justyna Małkuch-Świtalska

NCBR
National Centre for Research and Development

FORUM EKSPLOATATORA

ISBN 978-83-67606-00-4