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Polish Academy of Sciences

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Strategies toward Green Deal Implementation

Water, Raw Materials & Energy

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Division of Biogenic Raw Materials

Mineral and Energy Economy Research Institute
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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 specializes in the analysis and assessment of specific problems and phenomena related to the management of fertilizer 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 optimize the use of resources at the local, regional, national and international levels.

The division's work includes development of management strategies and recommendations (roadmaps) regarding the sustainable and circular management of fertilizer raw materials (from primary and secondary sources) with the identification of market, technological, legal, environmental and social conditions, developing strategies for preventing food waste at the stages of production and consumption. Team has experience in developing strategies for water protection against nitrogen and phosphorus pollution from anthropogenic sources, determining directions for counteracting eutrophication and recommendations for the management of waste from the water and sewage sector in the context of water, raw materials and energy recovery. The division conducts activities in the field of identification and assessment of saturation of soils and surface waters (lakes, rivers) with fertilizer components and development of the concept of environmentally safe fertilizers, based on model studies on the transfer of phosphates and nitrates to surface waters and soils. In addition, the division conducts research in the field of searching for new materials (including nanomaterials) that may be used in the processes of municipal and industrial wastewater and soils treatment.

Division of Biogenic Raw Materials participates in international projects (Horizon 2020, EIT Raw Materials, NAWA) 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, fertilizer and agri-food sectors.

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Introduction

We currently live in a world in which we have to face one of the greatest civilization threats of the 21st century, resulting from the coronavirus pandemic that has started in the beginning of 2020. Globally, regions, countries and cities needed to change their priorities and direct all their efforts and resources to protect the health and well-being of their inhabitants. In this context, the coronavirus pandemic has endangered the implementation of the Green Deal Strategies (GDSs) in various regions and countries. However, various international organisations, as the European Commission (EC) recognised this crisis as the opportunity to rebuild the economies and make them more resilient. Therefore, the further development of green solutions - technological, legal, organizational, economic, social and environmental - under the GDSs may turn out to be crucial for building the resilience of individual economies to various threats that may arise in the future, both climatic and epidemiological.

The purpose of the 2nd International Conference on Strategies toward Green Deal Implementation – Water, Raw Materials & Energy (ICGreenDeal2021) was to present possible solutions that fit into the green economy and can be implemented under the Green Deal Strategies. This event was a continuation of the 1st International Conference Strategies toward Gren Deal Implementation – Water and Raw Materials, which turned out to be a great success with almost 500 Participants from all over the world.

ICGreenDeal2021 aimed to exchange of good practices and knowledge transfer between Participants representing all sides of the Quadruple Helix - society, entrepreneurs, scientists and educators, and administration. Sharing of multidisciplinary knowledge with high scientific and practical importance could accelerate the implementation of the Green Deal Strategies, and through this contribute to improving the quality of the environment and achieving a balance between People and Environment in our Planet.

This publication includes papers presented at the ICGreenDeal2021 that took place 8-10 December 2021, 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 198 papers in 14 thematic sessions during this 3-days online Conference.

In this edition we go one step further - Together we can save the Planet!

Prof. Marzena Smol
ICGreenDeal2021 Chairwoman

GREEN DEAL STRATEGIES

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Importance of Green Deal strategies in the 21st century

Green Deal Strategies (GDSs) have developed dynamically in recent years as a response to the progressive climate change around the world. The main objective of the GDSs is to improve the well-being of citizens by integrating environmental, economic and social aspects in all economic activities. Therefore, the GDS can be indicated as a tool for achieving Sustainable Development (SD). The pursuit of climate neutrality and the protection of the environment are the main challenges for the implementation of measures under the GDSs, which refer to green solutions in all sectors of our economy, including for example energy sector (decarbonisation of the energy sector), construction sector (renovation of buildings to help people lower their energy bills and reduce energy consumption), manufacturing and services sector (supporting industry in the development of innovation and building a green economy), mobility sector (introducing cleaner, cheaper and healthier forms of private and public transport), bioeconomy (mobilising industry for a clean and circular economy). The objective of the research was to conduct an overview of the "green deal" definitions through an analysis of the available published papers with the use of desk research method. The scope of research included analysis of the green deal definition and the GDSs in terms of their goals, territorial and temporal scope. The term "green deal" has its origins in the Unites Stated (U.S.) and it refers to the New Deal that was lunched as a response to the Great Depression in 1930s. In late 2000s, as an answer for the global financial crisis of 2007–2008, the concepts of "green deal", "green new deal" and "global green new deal" were developed and presented by various environmental organisations in the world. Currently, the GDSs have started to increase in importance again, especially in the context of the green recovery of individual regions (the European Union – the European Green Deal) and countries (the U.S., Australia) in the face of the COVID-19 crisis.

Keywords: Green Deal, Green Deal strategies (GDSs), sustainable development (SD)

Acknowledgments: Research carried out under the Subvention of the Division of Biogenic Raw Materials at the Mineral and Energy Economy Research Institute, Polish Academy of Sciences.

SUSTAINABLE
AND CIRCULAR WASTE MANAGEMENT

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Humic substances and their role in waste management

Sustainable development requires diminishment of pollution and focusing on possible recycling of waste. Municipal waste, wastewater sludge and agricultural waste might be an opportunity considering potential use of organic constituents. Humic substances are important part of biological waste, characterized with high molecular weight and refractory properties, constitute a physically and chemically heterogeneous mixture of macromolecular organic compounds of mixed aliphatic and aromatic nature. Humic substances through humification process has passed complex biochemical processes of plant and animal residue decomposition and mineralization of organic matter with additional microbial effects on it. They influence contaminants mobility processes in waste, the protective function of humic substances may also act as a "geochemical barrier", capable of binding metal ions with carboxyl, amino and hydroxylgroups. The potentiometry with ion selective electrodes can be used as one of tools to measure complex forming capacity of humic substances. Advanced studies lead the attention to humic substances and their key role in reaching sustainable goals and valorization for waste and its effluent by conversion of organic waste into raw material and products as well as protection from leaching out contaminants of already landfilled masses.

Keywords: humic substances, biomolecules, potentiometry, mobility of contaminants

Acknowledgments: This study was supported by the project No.1.1.1.2/VIAA/3/19/531 ‘Innovative technologies for stabilization of landfills – diminishing of environmental impact and resources potential in frames of circular economy’.

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Sustainable approach towards waste usage in brick development

Brick is one of the most common building material that is utilized worldwide. Due to its flexibility, accessibility and cost, it is one of the most acceptable elements of building construction. According to the published studies, India is the second-largest producer of bricks with an overall capacity of 236 billion units a year with an overall increment of 5-10% annually.

However contemporary brick made out of fertile clayey soil possesses severe environmental challenges like high energy consumption. Excessive natural resource utilization failing to prove a sustainable goal. Considering the importance, heavy usage and environmental challenges the sustainable approach of waste utilisation in the form of locally available fly ash was used with plastic waste to formulate a geopolymer concrete bricks. The brick density and performance were tested using the non-destructive testing using ultrasonic pulse velocity test. The test result showed an overall enhancement of 12% when compared with the conventional bricks.

Keywords: sustainability, geopolymer brick, local waste material, NDT, UPV testing

Acknowledgments: I would like to acknowledge the support of Department of Civil Engineering NITTTR Chandigarh and Dr. Hemant Sood for his valuable knowledge and feedback.

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Assessing the contribution of high-density polyethylene recovery from residual household waste for the transformation towards the circular economy and sustainable development

Every year thousands of households worldwide generate municipal solid waste (MSW) that is being sent to landfills, incinerated or recycled. The latter scenario is still more common in developed countries. However, recyclable materials, for example, plastics still exist in residual household waste (RHW).

The goal of the study is to evaluate the quantities of high-density polyethylene (HDPE) that is being found in RHW stream. The feasibility of a last minute plastics recovery from residual waste just before the incineration is evaluated, taking into account positive and negative impacts on the environment. The environmental impacts of two scenarios – incineration of the whole RHW flow and sorting the HDPE bottle-shaped plastics out from the RHW flow for recycling – are compared through life cycle assessment, in order to understand the environmental characteristics of the different scenarios.

According to data of waste sorting in recycling center in Bad Segeberg, RHW contains only 0.6– 0.5% of HDPE items (packaging and non-packaging) and 0.2% of HDPE bottles based on clean and dry mass balance. The scenario of RHW incineration involving sorting of HDPE bottles shows a better performance regarding evaluated environmental impact categories – climate change, human toxicity and acidification potential. Even though burdains on the environment are just a few percent smaller in the categories of climate change and human toxicity, it is noticable an about 15% better performance of scenario when HDPE bottles are sorted out from RHW regarding the environmental impact of acidification potential. In this case, the material recycling should be the superior waste treatment alternative.

Keywords: plastics, high-density polyethylene, residual household waste, life cycle assessment

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Fermentation as a way of glycerin waste management towards the production of lactic acid – PLA mer

Glycerin waste from biofuel production or food waste in the form of molasses, whey and other raw materials is an excellent material for further use in chemical processes. Various paths enabling the maximum management of waste or its transformation into chemically and universally useful products have been searched for a long time.

So far, the most attractive solution is the production of lactic acid as a mer for polymerization into polylactic acid (PLA). This fits perfectly into the circular economy idea, because looking at waste disposal, it tries to add a new technology for their processing to the already existing technologies for obtaining main products. The paper presents the example of the entire cycle of glycerine.

Keywords: biotechnology, lactic acid, waste management, environmental protection

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India on Circular Economy and e-waste management

The current rate at which natural resources are being extracted to meet the demands of the growing population is not sustainable for future generations. The linear economy approach based on the take-make-dispose ideology is being replaced by the circular economy (CE) approach to manage the demand and create a balance between the available resources. The concept of the CE is believed to be very relevant for the e-products and e-waste as it strives to design out the waste by better products, practices and business models.

This paper aims to study how the CE can be useful in e-waste management with the implementation of various concepts like the 3Rs, reverse logistics and urban mining. As the study is focused on India, the current e-waste management practices and legislation supporting have been discussed in this paper. The paper further explains the complexities prevalent in the e-waste management system in India due to the presence of a huge informal sector primarily responsible for the collection and disposal of e-waste. Finally, the paper presents certain strategies that could be helpful to overcome the challenges in the successful implementation of the CE in the e-waste management in India.

Keywords: e-waste, circular economy, urban mining, 3Rs, e-waste management, India

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Evaluation of the fertilizing capacity of composts produced from bio-waste and phosphate additive in deficient soils

The agricultural sector faces environmental challenges that limit its development. Many arable lands are currently uncultivable due to a lack of soil fertilizing elements (nutrients, organic matter, and beneficial bacteria), and a further sharp decline is expected in the coming years. Applying compost can improve organic matter content, and provide nutrients and beneficial bacteria to the soil-plant system. In this study, the fertilizing capacity of composts produced from biowaste and a phosphate additive in the form of phosphate sludge was investigated. The total and available content of macro- and micronutrients, as well as the number of microorganisms, germination index, and plant growth, were analyzed. The composts are characterized as rich in nutrients such as MgO, CaO, and P_2O_5 and beneficial microorganisms with a germination index ranging between 57.2 and 167.5%. The application of the 5, 10 and 20% of composts as a fertilizer significantly improved plant growth more than the control of only deficient soil. In addition, they have demonstrated a high efficiency compared to NPK fertilizer in deficit soils. Finally, this study demonstrated the effectiveness of the composts produced in addressing deficient soil problems in a sustainable way aimed at reducing the excessive utilization of chemical fertilizers.

Keywords: fertilization, micronutrients, soil, Africa, plant

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Application of biofertilizers on tomatoes: targeting Circular Economy

Tomato Solanum lycopersicum plants were grown under greenhouse located on a research platform in Murcia (Spain). Tomatoes plant were fed with bio-fertilizers issued from anaerobic digestion of olive mill wastewater (OMW) without and with 1%, 5% of phosphate residues (PR) in mesophilic conditions for 25 days in batch reactors. 1% of Substrates (OMW initial, OMW+1%PR initial, OMW+5%PR initial and PR) and digestates (OMW final, OMW+1%PR final and OMW+5%PR final) was provided fortnightly to the plants. Reclaimed water from the same wastewater treatment plant was used for automatic controlled irrigation. It contained low level of chemical fertilizers in order to compare tomato plant growth, leaf analysis, steam water potential, production yield and fruit quality results to plants fed with bio-fertilizers. Generally, parameters and results were positively increased during growing and harvesting stage, which refer to the presence of essential elements that cover plants need. Plants fed with biofertilizers showed the highest plant height (OMW+5% PR initial), and better accumulation of essential elements in leaves (OMW+1%PR final and OMW+5%PR final). The maximum average fruit weight per treatment was obtained when applying (OMW+5% PR final) and the maximum yield production per plant was obtained when applying phosphates residues. Biofertilizers (digestates) showed good performances, high fruit quality and perfect tomato yield production.

Keywords: anaerobic digestion, biofertilizers, olive mill wastewater, phosphate residues, reclaimed water

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Application of polymer inclusion membranes for the selective removal of copper from model leach liquors of waste printed circuit boards (PCBs)

This work shows the application of polymer inclusion membranes (PIMs) containing ionic liquids for the removal of copper (II) ions from leach liquor of waste printed circuit boards (PCBs). The main components of aqueous solution obtaining after leaching of PCBs are heavy metals such as copper (II) and nickel (II). The aim of this study is the selective extraction of copper (II) from the aqueous solution containing nickel (II) using polymer membrane with trihexyl (tetradecyl) phosphonium thiosalicylate [PR4][TS] as the carrier. [PR4][TS] belongs to the ionic liquids (ILs) which are considered to be "green solvents" and can be proposed as new extracting agents of heavy metal ions for synthesis of PIMs. Cellulose triacetate (CTA) is the polymer matrix in this type of membranes. This work shows the influence of the hydrochloric acid concentration in the aqueous source phase on the competitive transport of Cu (II) over Ni (II). The results of the presented investigations prove that transport Cu (II) into 0.5 M sulphuric acid as the receiving phase is very fast and efficient. The initial flux of Cu (II) was much higher than for Ni (II) which enabled the selective transport of copper (II). The obtained results show that recovery factor of Cu (II) ions from mixture containing Ni (II) was over 91 %. The highest selectivity coefficients for Cu (II) towards Ni (II) was 52.2.

Keywords: copper (II), trihexyl (tetradecyl) phosphonium thiosalicylate [PR4][TS], polymer inclusion membrane (PIM), ionic liquids (ILs)

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Lawns vs meadows. What is better to accumulation particulate matter in an urbanized area?

Road transport is the main source of particulate matter (PM) emissions in cities. One way to improve air quality is through phytoremediation. The ability of plants (shrubs and trees) to purify the air from PM has been recognized. However, little is known about the accumulation of PM by herbaceous plants found in urban meadows and lawns. The aim of study was to compare the phytoremediation properties of urban meadows and lawns. For this purpose, the plant material was collected two times (in June and August) at different distances from the edge of the road (1 m, 8 m, 1 m). The temperature, humidity of the soil and concentration of PM in the air were assessed. In order to compare the efficiency of PM accumulation by meadows and lawns, the obtained results were expressed into PM accumulated by $1m^2$. The results show that meadows maintain higher humidity and lower soil temperature than lawns. The meadows accumulated greater amount of PM than the lawns. The results of this research suggest that urban meadows are much more effective in removing PM from the air than lawns.

Keywords: herbaceous plants, lawn, meadow, PM, phytoremediation

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Our Phosphorus Raw Materials. Our Food. Our Future - V4's resilience in the face of pandemic

Phos4V Workshop

PhosV4
PHOSPHORUS FRIENDS CLUB IN V4

Visegrad Fund

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Phosphorus raw materials in the Visegrad Group (V4) countries

One of the most important raw material needed for the food production is phosphorus (P), which cannot be replaced by any other element. Phosphorus is an element essential for human nutrition, used for fertilizer production and limited resource. The key importance of P for people's lives is shown by the fact that if there was no sufficient amount of P in fertilizers, we would be able to exploit only 1/3 of the world's population. The importance of P-raw materials is strongly underlined by the European Commission (EC) which included phosphate rock and white phosphorus on the list of the Critical Raw Materials for the European Union (EU). The individual regions of the Europe have no primary phosphorus deposits, including the countries belonging to the Visegrad Group (V4) - Poland, the Czech Republic, Slovakia, and Hungary. Due to the lack of a mineral deposits of phosphate rock, the V4 countries need to cover the demand for the P by import from countries of varying stability, both economic and political as Russia, China, Morocco. It is risky, if the borders for deliveries of goods are closed, it may be impossible to meet the needs of P. On the other hand, the V4 countries have large secondary P resources in P-rich waste, which are lost due to P is not recovered and directed to fertilizers. Project “How to stay alive in V4? Phosphorus Friends Club builds V4's resilience” aims to build P management roadmap in V4 to secure enough P for food production.

Keywords: phosphorus (P), Visegrad Group (V4), roadmap, Circular Economy

Acknowledgments: Research conducted as the part of the project ”How to stay alive in V4? Phosphorus Friends Club builds V4's resilience” that is financed by Visegrad Fund, project no. 22110364 (2021-2023).

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Importance of phosphorus raw materials – trends and perspectives

Phosphorus (P) is essential for food and feed production. Its function as crop nutrient, cannot be replaced by any other element. According to (van Dijk, Lesschen, & Oenema, 2016), the food system of the EU27 imports about 2.4 Mt P of which 1.4 Mt P as fertiliser. It exports close to 1.5 Mt P of which 1.2 Mt as waste. 0.9 Mt P remain in the soil as so-called legacy P. Each year, 0.16 t P are mined from the EU's only phosphorus mine in Siilinjärvi, Finland. P use has transgressed the Planetary Boundaries (Steffen, et al., 2015), is the main cause of bad water quality (algae blooms) and thus indirectly contributing to global warming. Yet, (Dawson & Hilton, 2011) estimate that without P, only 20% of the global population could be fed.

To mitigate these global challenges, policy makers have developed the European Green Deal . It includes strategies - Farm-to-Fork Strategy, Biodiversity Strategy, Chemicals Strategy, action plans - Zero Pollution, Circular Economy and finance. The European Commission has made a pledge to mobilise one trillion Euro in sustainable investments over the next decade. The first finance pillar of the European Green Deal is the 672.5 billion € Recovery and Resilience Facility. Member States must use at least 37% of their share to support climate objectives.

The Farm-to-Fork Strategy wants to achieve ambitious goals by 2030 : to reduce pesticide use and nutrient – nitrogen and phosphorus – losses by 50%; to increase the share of organic farming in the EU to 25%. Also, agricultural greenhouse gas emissions from livestock rearing must be reduced. Achievement of these goals depends, among others, on P use efficiency. Livestock manure contains nitrogen (N) and P. While N is frequently lost to the environment, P is in oversupply when farmers use untreated manure as fertiliser. Separation of N and P is necessary to adapt both nutrients to crop demand. For this and other Farm-to-Fork Strategy purposes, Member States must assign 25% of the 1st Pillar payments of the Common Agricultural Policy to eco-schemes. Eco-schemes may be agricultural practices enhancing biodiversity, mitigating soil erosion and preventing P losses to rivers and lakes.

The new Fertilising Products Regulation (EU) 2019/1009 will enter into force in July 2022. It is a flagship regulation of the Circular Economy and covers all fertilising products, including recovered P derived from human and animal excrements in wastewater and manure. Products compliant with the Fertilising Products Regulation (FPR) will have ceased to be waste across the EU. The FPR serves as a model for EU-wide end-of-waste criteria and status for other recovered materials.

Ambitious goals like reducing nutrient losses by 50% are a challenge for farmers and industry. Farmers need to maximise crop yields and industry wants to maximise profits. Degrowth, reducing outputs and sales is not an option for both groups. Efficiency may be the key to master the challenges. If technology could double nutrient use efficiency, farmers may achieve similar yields with half the material input. Price could be twice as high. Both, costs for farmers and sales for industry would remain unchanged. Additional revenues may come from saved greenhouse gas emissions, e.g. by CO2-certificates under the EU Emissions Trading Scheme (EU ETS) . The fertiliser industry may save CO2-certificates by replacing fossil products by recovered nutrients. Farmers may receive payments

for organic carbon stored in soils to the full buffer capacity. Tax-payers may contribute to farmers' income by paying for eco-services under the CAP eco-schemes. If farmers provide services for soil health, water quality and biodiversity, eco-schemes should reward them directly. Restoring water quality of dead rivers, lakes and seas retroactively will be more expensive. Ten billion € were assigned to Horizon Europe for co-financing research and innovation actions in the EU and beyond. These funds may serve to enhance P-use efficiency by using IT, chemistry, crop and soil science.

In conclusion the European Green Deal with its strategies and action plans provides a favourable framework for P stewardship. The Fertilising Product Regulation facilitates making recovered products available on the market. The CAP and the EU ETS may provide attractive rewarding systems to achieve the goals. It is time for action.

Keywords: European Green Deal, phosphorus, raw materials, farm to fork, Circular Economy

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Phosphorus raw materials in Poland

Over 90% of phosphorus obtained from the primary source - phosphorus rocks, which are non-renewable resources, goes to the agricultural sector. Phosphorus is an essential nutrient for plants and, in the form of mineral fertilizers, finds its way to farmland areas, increasing yields. Poland is at the forefront of the European Union (EU) member states in terms of agricultural land area. In 2019, agricultural land in Poland accounted for more than half of the total area of the country (approximately 60%). The consumption of mineral (phosphorus) fertilizers, in the form available to plants, in Poland in 2020 amounted to 358,8 thousand Mg. Therefore, it is necessary to rationally manage phosphorus raw material and search for alternative sources, due to the exhaustion of its primary sources.

The paper presents the primary and secondary sources of phosphorus in Poland. Secondary sources of phosphorus in Poland, such as municipal and industrial wastewater, sewage sludge (SS), sewage sludge ash (SSA) and agricultural waste was characterized. Due to the high content of phosphorus, the presented types of waste are a very good raw material for the production of organic and organic-mineral fertilizers. The activities presented in the paper are compatible with the concept of the circular economy (CE) model, according to which the generation of waste should be minimized as much as possible, and the resulting waste should be treated as secondary raw materials that can be reused.

Keywords: phosphorus (P), raw materials, primary sources, secondary sources, Circular Economy (CE), critical raw materials (CRM)

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Management of Phosphorus in the Czech Republic

The presentation deals with major issues about phosphorus. It has a concentration in the Earth's crust of about 1 g/kg and is the 11th most common element. However, it is not found free in nature but is widely distributed in many minerals. There is a danger that we may soon face a critical phosphorus deficiency. Phosphorus (P) is an essential element for plant and animal growth. It also can increase the biological productivity of surface waters by accelerating eutrophication. But too much phosphorus can cause increased growth of algae and large aquatic plants, which can result in decreased levels of dissolved oxygen – a process called eutrophication. High levels of phosphorus can also lead to algae blooms that produce algal toxins, which can be harmful to human and animal health.

As for human health, some scientists call phosphorus cholesterol of the 21st century. Excess phosphorus is harmful to blood vessels - cholesterol tends to clog blood vessels, phosphorus reduces their elasticity. The less phosphorus the body contains, the longer it lives, researchers found.

Czech Phosphorus Platform (CPP) is an organisation that brings together private companies, government agencies, academic institutions and individuals. The most important phosphorus processors in the Czech Republic are Fosfa Poštorná and Lovochemie Lovosice. An example of good practice of phosphorus regulation is the cleaning of the Brno lake from excess phosphorus.

Keywords: Phosphorus – human health – phosphorus deficiency – Czech Phosphorus Platform – phosphorus regulation – excess phosphorus - example of good practice – cleaning of Brno lake

Acknowledgments: Research conducted as the part of the project "How to stay alive in V4? Phosphorus Friends Club builds V4's resilience" that is financed by Visegrad Fund, project no. 22110364 (2021-2023).

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Phosphorus raw materials in Hungary

The agriculture takes up most of the phosphorus production: fertilizers add more than 80% of the industrial phosphorus consumption (the rest distributes among feed additives and detergents) . The amount of phosphorus used per hectare of fertilised utilised agricultural area averaged 8.6 kg per hectare for Europe in 2018. Several countries, especially in southern and eastern Europe, are above the European average. The highest values of more than 12 kg P per ha can be observed for Cyprus, Croatia and Hungary . It can be seen that Hungary has one of the most intensive agricultural consumption on Phosphorus.

Hungary is a major player in agricultural production at EU level. Agricultural area of Hungary in 2019 5.309 thousand hectares (57% of the total area of Hungary).

In the last 20 years, an average of 61 ktons of phosphorus has been applied annually in Hungarian agriculture. Of this, an average of 58% (35 ktons) comes from fertilizer application.

Overall phosphorus outtake has varied between 40 and 80 kilotons/year over the past 20 years, with varying intensity. Average annual phosphorus outtake is 67.561 tons.

The further fate of the amount of phosphorus fertilizer/organic fertilizer active ingredient in the soil is mainly influenced by the nutrient uptake of the crops. To take this into account, we use the concept and values of the phosphorus and potassium nutrient balance, which is calculated as the difference between the amount of fertiliser/organic fertiliser active ingredient applied to the soil and the amount of nutrient taken up by the crops

The paper presents the phosphorus in and outtake of phosphorus in Hungarian agriculture and also the main players of the Hungarian fertiliser production.

Keywords: phosphorus, agriculture, fertilizer, raw materials, primary sources, secondary sources, Circular Economy (CE), critical raw materials (CRM)

Acknowledgment: Research conducted as the part of the project ”How to stay alive in V4? Phosphorus Friends Club builds V4's resilience” that is financed by Visegrad Fund, project no. 22110364 (2021-2023).

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Present situation with phosphorus in Slovakia

The average phosphorus content in stream sediments in Slovakia is 896 ± 786 mg.kg-1. The distribution of phosphorus is rather highly variable and presumably affected also by man-made dispersal. The most important possible natural sources of phosphorus are mainly alkali basalts, whose areal extent, however, is limited. For this reason, the biggest natural sources of phosphorus are other Neogene volcanics and granitoids. There is no phosphorus as a raw material mined at deposit. There is only one minor deposit in the south of Slovakia (locality: Gočaltovo). The import of phosphorus to Slovakia ranged from 11 kg to 43 t during the last 10 years. The export of phosphorus during the last 10 years from Slovakia was only recorded in two years 2010 (65 t) and 2013 (4 t). The national average phosphorus content in arable land is about 68.7 mg P.kg-1. For the above-mentioned reasons, the only available source of phosphorus might be wastewater, though the amount of P in wastewater has been decreasing during last 10 years. The limit value of the indicator total phosphorus is 0.4 mg/L in surface water. During last 10 years, the limit has been exceeded, but in view of the progress of the values of this indicator in the future steady state with of not exceeding the limit or slight and occasional exceeding of the limit value can be expected.

Keywords: phosphorus, Slovakia, export, import, wastewater

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ENERGY IN GREEN DEAL

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The impact of coal prices on wind-power-related metal prices

The energy transition gather pace. In the light of ambitious plans for further use of renewable energy sources (RES) with wind-power, the strong demand for non-energy materials critical for RES is highly expected. Also, energy production is currently more and more substitutable, i.e. electricity can be produced by burning coal or for example from wind farms as well. Hence, the main purpose of this study is to examine the impact of coal prices on selected wind-power-related metal prices. Thus, we are looking for new insights in terms of relationships between coal prices and significant metals for wind-power-technology, that potentially have been established or strengthened in the recent years. In the light of increasing uncertainty and significant risk of price volatility there is a widespread belief that it is necessary to study such relationships. However, vast literature devoted to this matter focus mostly on oil and clean energy metal prices. Hence, the econometric models such as VAR-VECM models are employed to examine the Granger causality between coal and selected wind-power-related metal prices. The research provides clear evidence of causal links of this kind between coal and metal prices.

Keywords: coal, metals, wind energy, VAR, VEC

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Financing Green Deal and effectiveness of investment in renewable energy stocks in Poland

In the contemporary free market economy, the capital market plays a significant role in financing green investments and energy transformation, constituting a Green Deal milestone. However, the primary goal of equity investment is maximize return for a given level of risk or minimize risk for a given level of return. Consequently, only if green investments were as effective as traditional investments, would investors be willing to finance them. The purpose of this study was to compare effectiveness of investing in renewable and conventional energy stocks listed on the Warsaw Stock Exchange Main Market and NewConnect in years 2013-2020. The research included a comparison of performance, risk and risk-adjusted performance measures of portfolios consisted of renewable and conventional energy stocks. The study proved that renewable energy stocks, especially those noted on the NewConnect were characterised with higher volatility. Furthermore, effectiveness of portfolios clearly differ, indicating the advantage of renewable energy stocks. The results obtained suggest that, in the long term, investments in renewable energy stocks listed on the WSE Main Market and NewConnect did not show lower effectiveness than conventional energy stocks, and sometimes demonstrated even better results, which, from the perspective of Green Deal financing, should be considered a strongly positive phenomenon.

Keywords: financing energy transformation, renewable energy stocks, investment effectiveness

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Investment in the shift towards green energy in Poland – selected aspects of energy security and energy prices

The energy transition in Poland, which is related to the decarbonisation of the energy sector and increasing the share of low- and zero-carbon technologies, has an impact on energy security, covering the investment gap in the power sector, as well as influencing electricity prices. Most of the coal-fired power units in the National Power System (NPS) are obsolete and will have to be replaced in the short term. The shift towards green energy in Poland must ensure a diversified structure of the energy mix - using not only renewable energy sources (RES), but also gas and nuclear sources. Coal power generation, due to the climate and energy policy of the European Union and the introduced EU ETS model, is a problem for the Polish energy sector and affects the growing energy prices on the wholesale market in Poland. However, in the structure of electricity generation, in addition to RES, controllable energy sources will be needed, capable of operating both in the base and peak load. Therefore, investments in new low- and zero-emission energy sources will be a key element to ensure energy security, competitiveness of the Polish electricity sector and to reduce the link between electricity prices and the EU ETS market.

Keywords: sustainable development, energy prices, energy security, EU ETS, investment gap

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Green hydrogen production in Poland - strategic and legal perspectives

Poland is one of the largest producers and consumers of hydrogen in Europe. However, the production of hydrogen in Poland is associated with a high level of carbon dioxide emissions - most of the local hydrogen is produced either in refineries and chemical plants as a by-product or using steam reforming processes. Due to its position as a producer and consumer of hydrogen, Poland may have significant opportunities to become a leader in the use of new technologies related to the so-called green hydrogen or low-emission hydrogen. Plans for the development of hydrogen technologies in Poland are presented in the Polish Hydrogen Strategy until 2030 with an outlook until 2040, which was adopted by a resolution of the Council of Ministers on November 2, 2021.

In this context, our work discusses the vision of the Polish government regarding the development of low-emission and zero-emission hydrogen technologies in Poland, including which of these technologies will be supported in the future and what kind of support schemes for these technologies are envisaged. We also intend to review the legislative plans outlined in the Strategy concerning, inter alia, hydrogen definition, support systems and the possibility of using existing gas infrastructure to transport hydrogen. Moreover, we assess whether the presented assumptions of the Strategy will be sufficient to develop technologies for the production and use of green hydrogen in Poland.

Keywords: energy policy, green hydrogen, legislation, hydrogen strategy, gas infrastructure

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Solar-hydrogen system site selection using a GIS-MCDM-based approach with an application in Sus-Massa region - Morocco

Hydrogen production from sustainable energy sources appears to be an intriguing possibility for lowering greenhouse gas emissions while preserving energy stability. This study presents an interactive technique for assessing site suitability for solar-powered hydrogen generation in the Sous Massa Region / Morocco. The method employed mixes multi-criteria decision making (MCDM) with geographic information systems (GIS). Two types of parameters are considered: Technical and Economic, and ten different factors are used: Hydrogen production potential, Hydrogen demand, Distance to the groundwater zone, Proximity to the shoreline, Slope, Elevation, Proximity to roads, Proximity to industries, Proximity to agricultural lands and Proximity to the power grid. Social and environmental parameters are considered as constraints. The Analytical Hierarchy Process (AHP) is used to analyse and estimate the weights of the selected parameters. The obtained weights suggest that the Hydrogen production potential, Hydrogen demand, and Distance to the groundwater zone are the most important parameters in solar hydrogen production site selection, with percentages of 30.46%, 19.84%, and 13.07%, respectively. However, instead of their low weights, the remaining variables must be examined in every research to avoid unwanted consequences during the planning or operational stages. The final suitability index is classified as follows: "Unsuitable," "Low suitability," "Moderate suitability," "Suitable," and "Very appropriate." which represent respectively 0.02%, 75.51%, 24.23%, 0.24%, and 0% of the area occupation. The integration of the geographic information system and the analytical hierarchy approach showed a potent tool for identifying, weighting, and selecting the most suitable sites for hydrogen power plants in the Sous Massa Region. These findings could help stakeholders in Morocco handle solar-hydrogen energy planning more efficiently.

Keywords: hydrogen energy, geographical information system (GIS), multi-criteria decision making (MCDM), site selection, solar energy

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Seawater greenhouse, a sustainable system for using renewable energy

Seawater greenhouse is one of the sustainable production systems, which uses seawater and renewable energy to grow plants in controlled environments. In this technology, seawater is used in two processes. First, seawater is used to increase humidity and lower the temperature inside greenhouses. In the second process, seawater is evaporated using solar heating and then cooling; consequently freshwater is obtained. This fresh water can be used for vegetables growing in the greenhouse. Seawater greenhouse technology was developed in 1990 by Charlie Paton, and the first experimental project was carried out in 1994 in Tenerife, Spain. The technology revitalizes the environment by mimicking natural processes, while costing less than conventional greenhouses. Due to the design and operation of this kind of greenhouse, the entering air is cleaned of any suspended particles, pests, insects, salt particles, pollen and other contaminants. According to the indoor and outdoor air circulation system, seawater greenhouses play a large-scale role in air purifiers of the surroundings. Around the greenhouse is a good space for growing halophyte plants such as salicornia, due higher air humidity and saline water output from the system. The success of seawater greenhouses depends greatly on the environmental conditions surrounding the greenhouse, which hot, sunny and dry coastal areas with constant winds are more suitable. Although the infrastructure for setting up such greenhouses is expensive compared to conventional greenhouses, it has better economic efficiency in the long-term. Further research is needed to identify the opportunities and limitations of these greenhouses.

Keywords: biosaline agriculture, sustainability, haloculture, halophyte, saline water

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Comparative analysis of support tools for biogas plants development based on the example of selected European countries

The ambitious plans outlined in international strategies for climate change mitigation point to significant potential for facilitating the transformation process within local power generation sectors, e.g. through the development of renewable energy infrastructure. The most popular low-carbon alternative fuel that fits into this kind of objective, characterised by regional production, is biogas. It is a renewable fuel produced by the decomposition of a wide range of organic matter. The aim of this paper is to compare the development potential of the biogas market in the context of introducing support instruments, implementing public-private partnerships, and the final modelling of local biogas plants in the territories of selected local government units in Poland, Germany and Sweden. The following research questions have been formulated to address the objectives set: How is the expansion of local biogas markets supported in the countries chosen? Are biogas plants in local government areas being built with public-private funds? What substrates found locally are used for biogas production? The research hypothesis was defined that supporting the construction of local biogas plants, as well as increasing the versatility of their operation through the rational use of waste flows, will significantly contribute to supporting climate change neutralisation efforts.

Keywords: biogas, energy transition, local governments

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Energy efficiency solutions in end-of-life tyres recycling process: case study in Lithuania

In 2019, the amount of end-of-life tyres generated in the European Union amounted to 3.56 million tonnes, and around 28.3 thousand tonnes in Lithuania. In the EU, on average 55% of this waste is recycled for material recovery and 40% for energy recovery. Only 33.7% of end-of-life tyres are recycled in Lithuania, the rest part is used for energy recovery or for export purposes. Generally this is based by 2 aspects: the high energy intensity of the recycling processes; and the difficulties in marketing the products. Energy efficiency has a significant impact on reducing GHG emissions and it is one of the key factors in climate change mitigation strategies. The EU has set itself the goal of improving energy efficiency at the EU level by at least 32.5% by 2030. In this case particular attention is paid to the manufacturing industry.

The experiment was carried out in a waste management company where end-of-life tyres are recycled by widely applied methods - mechanical treatment, separation of metal and textile waste, in order to produce the rubber pellets or scraps in different fractions. The aim of the study is to identify the causes of inefficient energy use and propose a solutions by applying the Industry Cleaner Production methodology. During the initial assessment was found, that the energy intensity of the production of rubber pellets (<1 mm) is up to 105 kWh/tonne of waste (including >63% of energy for shredding). Consumption of energy can be significantly reduced by using energy efficiency solutions:

- Up to 15.7% of current electricity consumption by optimising existing technology;
- Up to 20% of current electricity consumption by modernization some equipment's of technologic line;
- Up to 40% of electricity through technology change.

The implementation of the process optimization proposal would reduce CO_2 emissions from 58.8 to 49.5 tCO_2e per tonne of rubber pellets.

Keywords: energy efficiency solutions, circular economy, end-of-life tyres recycling

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TOXIC-FREE ENVIRONMENT

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The innovative method for the lakes and ponds remediation

Eutrophication is considered one of the most important problems of modern environmental protection. It is based on the increased growth of water microorganisms, which is caused by the so-called over-fertility of the local environment. This type of phenomenon may occur naturally, e.g. after a seasonal change in temperature, when nutrients accumulated at the bottom of a water reservoir are mixed with the surface layers. It should be noted, however, that natural eutrophication processes are usually limited in time and do not have a large impact on the overall ecosystem. This situation changes significantly when the origin of excessive amounts of nutrients, including phosphorus (P) and nitrogen (N) compounds are associated with human activity.

Technologies allowing to reduce the negative consequences of eutrophication can be used at many stages of nutrient circulation in the environment. One of the new innovative approached that can address this problem is the use of specially selected mineral mixtures that can bound the biogenic substances directly within the affected system. This method can be implemented directly on-site and as a dedicated passive filtration solution. The aim of this work is focused on the close evaluation of mentioned above concept with regard of its environmental, social and economic potential.

Keywords: water remediation, eutrophication, lake, pond, bioagent, phosphorus reduction

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Leucas aspera in crude oil polluted soil: enzymatic defence of the herb and changes in soil properties

The enzymatic defence of a medicinal herb Leucas aspera was studied in the crude oil contaminated soil. The productivity, antioxidants, phytochemical and functional group profiles of the plant species in stress conditions were investigated. Besides, changes in enzymes, beneficial bacterial population, physico-chemical and total oil and grease (TOG) profiles in the contaminated soil were also studied. The results showed improvement in physico-chemical conditions, increase in beneficial bacterial population (4.1-5.4 folds) and decrease in TOG (31.3%) level of the contaminated soil by end of the experimental trials. The Leucas aspera treated contaminated soil showed enhancement in dehydrogenase (32.3%), urease (102.8%), alkaline phosphatase (174.4%), catalase (68.5%), amylase (76.16%) and cellulase (23.6%) activities by end of the experimental trials. Further, there were significant variations in leaf area index, chlorophyll and biomass contents of the experimental plant as against the initial level and control. Besides, the significant reduction in IC 50 values (24-27.4%) of Leucas aspera samples grown in contaminated soil confirms the strong antioxidant enzymatic defence of the plant species against the crude oil associated abiotic stress. The fourier-transform infrared (FT-IR) analysis confirmed the uptake and metabolism of aliphatic hydrocarbons, aldehydes, alkyl halides, nitro compounds by the experimental plant from the contaminated soil.

Keywords: leucas aspera, oil pollution, abiotic stress, antioxidants, soil properties

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Determination of compounds of emerging concern in surface water from agricultural land

The literature indicated the increasing occurrence of contaminants that potentially can be harmful to the environment in the whole aquatic ecosystem. These compounds are referred to as Contaminants of Emerging Concern (CECs). The aim of the undertaken research was the identification of CECs in small natural ponds. The object of research was a pond located between arable fields in the Silesian Voivodeship. The pond was fed mainly by groundwater and surface runoff from the surrounding fields. The samples were collected both, at the early stage of plant vegetation - spring period, and immediately before harvest - autumn season. Before the chromatographic analysis, the samples were subjected to a pre-treatment step, which allows for the separation of undesirable undissolved ingredients which can block the extraction cartridges used during the solid phase extraction process (SPE). The primary purification process involved filtration through a glass microfiber filter with a pore size of 0.45 μm and 0.20 μm. The SPE was carried out by the use of two types of extraction cartridges: SupelcleanTM ENVITM-18 SPE tube and SupelTM Tox AflaZea tube. The GC-MS(EI) analysis showed the presence of micropollutants from the group of pesticides in the samples. The presence of trace amounts of zearalenone - a nonsteroidal estrogenic mycotoxin was also confirmed in samples collected during the autumn season. The toxicological analyses conducted on vascular plants Lemna minor and saltwater bacteria Aliivibrio fischeri, indicated low toxicity of the water towards plants and a toxic character towards bacteria, regardless of the season.

Keywords: surface water, agricultural land, GC-MS, pesticides, zearalenone

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Development of methods for identification and quantification of fluorene, carbazole, dibenzothiophene and various indigenous PAHs and heterocyclics in petroleum refinery wastewater for monitoring their degradation by pseudomonas aeruginosa RS1

Emission of polynuclear aromatic hydrocarbons (PAH) are often associated with release of heterocyclic PAHs. They pose significant ecotoxic effects on various animals and plants at oil contaminated sites. Higher polarity and aqueous solubility of the low molecular weight heterocyclic PAHs enhance their bioavailability. Hence, it is very important to develop their identification and quantification techniques for monitoring their concentration in various environmental matrices for conducting risk assessment studies.

The current study focuses on developing HPLC, GC-FID and GC×GC-TOFMS methods for identification and quantification of various PAHs and heterocyclics individually and in mixtures. The HPLC method was further used for monitoring the degradation of fluorene, carbazole, dibenzothiophene and various indigenous PAHs and heterocyclics by an efficient PAH degrading bacterial strain, Pseudomonas aeruginosa RS1, in petroleum refinery wastewater (PRW) collected from the equalized influent entering the wastewater treatment plant in a refinery in Mumbai. One method was also developed using an UHPLC HRMS Orbitrap to identify the biodegradation intermediates of a nitrogen heterocyclic PAH compound, carbazole.

The mobile phase program developed using the HPLC could clearly separate the peaks of the PAHs and heterocyclics in the mixtures even when applied at low concentrations (about 1 mg/L or less). Acclimatization of the bacterial strain to the PAH and heterocyclics enhanced the degradation of several indigenous PAHs and heterocyclics in the PRW. A mobile phase program could effectively separate the metabolites of carbazole using the UHPLC system and the HRMS Orbitrap system could effectively detect the metabolites using the optimized operating parameters.

Keywords: petroleum refinery wastewater, carbazole, fluorene, dibenzothiophene, pseudomonas aeruginosa RS1

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Research and evaluation of the effectiveness of the developed design solution of a hybrid filter limiting the emission of dust from fireplaces and low-power solid fuel heating boilers

There are upward trends all over the world in terms of coal production. It is required to produce electricity and to heat buildings. The emission of harmful substances such as CO2, SO2, NO2 and suspended dust PM forces the search for ways to reduce these products already at the stage of exit from the chimney. The annual dust emission influences the scale of pollution, therefore it is so important to reduce the emission of harmful substances, monitor pollutants and care for the environment. The key issue seems to be the dissemination of renewable and alternative energy sources. They should be compatible with fossil fuels. On the other hand, the implementation of new technologies that will support the reduction of gas emissions gives great hope for improving air quality. One of the ideas is to use a hybrid filter (electro filter + cyclone filter). The aim of the work is to show the above-mentioned filter made according to original idea. The activities that will be carried out are to analyze the impact of the application of the this filter for solid fuel stoves in households that use stoves up to 30 kW. It is an innovative idea, pending for a patent. It will be checked whether even better device parameters will be obtained by combining two filters. Such a comprehensive study has not been described in the literature.

Keywords: hybrid filter, electro filter, cyclone filter, suspended dust PM

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Removal of dyes and cadmium using graphene oxide by NaOH and H_2SO_4 activation: isotherm and kinetic studies

Graphene oxide has excellent adsorption capacity as an adsorbent due to its huge surface area and large number of oxygen-functional groups. In this study, graphene oxide (GO) was used as a high-efficiency adsorbent, activated by acid and base solutions to remove dyes and Cadmium (II) from aqueous solutions. The optimized adsorption conditions have been studied by measuring the activation temperature, time and impregnation ratio, removal rate and its uptake. Morphological analysis showed that a large uniform distribution of carbon and oxygen elements on the surface of graphene oxide (GO). The maximum capacities of adsorbent for effective removal of dyes and Cd (II) were 654.88, 751.63 and 69.39 mg g-1 based on Freundlich and Langmuir isotherms, respectively. The results showed that the experimental data were well-fitted with a pseudo-second-order model for both dyes and Cd (II). Thermodynamic study showed that the enthalpy (ΔH) and Gibbs free energy (ΔG) values of the adsorption process for both pollutants were negative, indicating that the process was spontaneous and exothermic in nature. This study showed that the presence of active sites and functional groups on the GO adsorbent (carboxyl, hydroxyl, alkoxy and π–π) contributed to a huge enhancement in removal of dyes and Cd (II) from an aqueous solution. The findings show that GO can be considered as a promising and cost-effective adsorbent to remove dyes and metal ions from industrial wastewater.

Keywords: graphene oxide, adsorption, wastewater treatment, dyes removal, heavy metal ions removal

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Bio-based fertilizers of the Future

Cross-H2020-seminar
LEX4BIO & FERTIMANURE

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LEX4BIO – Optimising bio-based fertilisers in agriculture – Providing a knowledge basis for new policies

Europe is dependent on imported mineral fertilisers, both on finite and imported, apatite-based phosphorus (P) and energy-intensive mineral nitrogen (N) fertilisers. However, at the same time nutrient-rich side-streams (NRSS) are inefficiently utilized in agriculture, leading to regions with surplus of nutrients, such as western-Europe, whereas eastern part of Europe is dependent on mineral fertilisers for securing productivity of agriculture. Main NRSS are manures, sewage sludges, biowaste and animal by-products. These NRSS contains more N and P than is used as mineral fertilisers in Europe. Optimising the use of NRSS in Europe provides means for closing nutrient cycles and reducing nutrient losses to the environment.

Potential of NRSS as a bio-based fertiliser (BBF) in agriculture is studied in a H2020-project, LEX4BIO. The overall objective of LEX4BIO, Optimising bio-based fertilisers in agriculture – Providing a knowledge basis for new policies, is to realise this potential by developing a profound knowledge basis and new coherent methods to take full advantage of BBFs. For this purpose, LEX4BIO will focus on the most promising technologies for BBF production by evaluating their fertilisation potential. LEX4BIO will provide a policy framework for the EU's transition to maximising fertiliser self-sufficiency by using BBFs, while minimising risks to the environment, ensuring food and feed safety and supply, and protecting human health.

Keywords: bio-based fertilisers, safety, agronomic efficiency, phosphorus, nitrogen

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Concentrations of organic contaminants in bio-based fertilizer treated soil

The use of bio-based fertilizer (BBF) for agricultural soil treatment can reduce the dependency on chemical fertilizer and improve sustainability by recycling nutrient-rich side-streams. However, the presence of organic contaminants in BBFs may lead to the occurrence of residues in the treated soil. Thus, the objective of this study was to evaluate the risk of BBFs application in agricultural soil. In this work, first we validated a simple QuEChERS-based extraction and liquid chromatography quadrupole time of flight mass spectrometry (LC-qToF) method for the simultaneous quantitative analysis of 77 organic contaminants, including pesticides, pharmaceuticals, personal care products and per- and polyfluoroalkyl substances in agricultural soil. The validated workflow was then applied to screen organic contaminants in agricultural soil treated with BBFs to compare the risk of different BBFs treatment and highlight suspects of environmental concern.

Keywords: bio-based fertilizer, soil, pharmaceuticals, pesticides

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Barriers and drivers for usage of bio-basted fertilisers – perspective of stakeholders

Different types of organic waste could be a source of secondary nutrients. Recovery from these streams is an opportunity to reduce the use of non-renewable resources. The production and use of bio-based fertilizers can contribute to better management of organic waste and reduction in environmental pollution. However, to become products available for official sale, bio-based fertilizers should be accepted by the main stakeholders such as farmers. The profitability of unconventional fertilizers production will depend on potential buyers attitude. Determining which fertilizers' features are considered beneficial by farmers will help to clarify their expectations. An important method of obtaining this type of information is conducting surveys among farmers. Farmers' surveys have already been conducted in some countries and the results are available as publications. Currently, as part of the Lex4Bio Project, the survey of Polish farmers is currently underway.

The conducted desk research was aimed at obtaining information on the incentives and barriers, identified by farmers, for the use of bio-based fertilizers. The tool used in the analysis of the collected information was the PESTEL method. The PESTEL analysis makes it possible to determine the impact of external factors on the undertaking of replacing nutrients from primary sources with those from recycling. In analysis there were taken into account 5 aspects: political/legal, economic, social, technological and environmental. The factors assigned to each of these areas are related and result from each other. Therefore, overcoming barriers and taking advantage of opportunities requires comprehensive actions in each aspect of the analysis.

Keywords: bio-based fertilizers, farmers' attitude, nutrient recycling, survey

Acknowledgments: Research carried out under the Subvention of the Division of Biogenic Raw Materials at the Mineral and Energy Economy Research Institute, Polish Academy of Sciences. The survey of farmers' attitudes, currently conducted in Poland, is part of the Lex4Bio project. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818309 (LEX4BIO).

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FERTIMANURE project – goals and assumptions

The current dependency of EU agriculture on fossil-based mineral fertilisers can only be regarded as an extremely serious threat to future food security. Not only does the present linear economy rely on scarce resources, such as natural gas, limited phosphate reserves and fresh water for its agricultural production, the import of feed from outside the EU and the production of fertilisers are causing an imbalance in many EU regions. There is therefore now a need to reutilise valuable components from all types of waste streams in order to enable a move towards a circular economy.

The mission of the FERTIMANURE project is to provide innovative solutions (technology, end-products, and business models) that solve the problems related with manure management, helping farmers with the challenges that they are currently facing. FERTIMANURE will develop, integrate, test and validate innovative nutrient management strategies so as to efficiently recover and reuse nutrients and other products with agronomic value from manure, to ultimately obtain reliable and safe bio-based fertilisers that can compete in the EU fertiliser market. FERTIMANURE focuses on "how to improve the agronomic use of recycled nutrients from livestock manure" to reconnect nutrient flows between crop production and the rearing of livestock.

In the long-term, FERTIMANURE will contribute to the development of new business models that are synergetic with other economic sectors and will, therefore, create wealth and high-quality jobs in rural areas.

Keywords: manure management, nutrient recovery, bio-based fertilisers, business models

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FERTIMANURE Spanish on-farm pilot. Recovery of bio-basted fertilisers from pig slurry

FERTIMANURE project aims to develop, integrate, evaluate and validate innovative strategies for nutrient management, that allow recovering efficiently mineral nutrients and other elements with agronomic potential (organic amendments and biostimulants) from animal manure. The final aim is to produce reliable and safe bio-based fertilizers able to compete in the European fertilizers market. FERTIMANURE proposes 5 different biorefinery configurations to valorise animal manure in Europe and one of them has been implemented in a pig farm in Catalonia (Spain).

The technologies making up the biorefinery of the FERTIMANURE project in Spain allow reducing the volume of the flows to be transported, being able to concentrate the elements of interest in less than half of the initial volume and also produce a water suitable for reuse. Thanks to the combination of different technologies applied in a cascade approach, the following bio-based fertilising products are obtained in the Spanish on-farm pilot: (1) Dry organic amendment with values above 1% for the main nutrients (Nitrogen, phosphorus and potassium in dry basis); (2) Phosphoric acid from the ashes generated from the energetic valorisation of the dry solid fraction of livestock manure; (3) Liquid concentrate rich in NPK and organic matter; (4) Plant biostimulants rich in amino acids; (5) Ammonium sulphate (concentration up to 8%).

These bio-based fertilisers obtained can be used directly as fertilising products, but also as main ingredients for the formulation of tailor-made fertilisers, to cover specific needs of various crop-soil pairs. Obtaining tailor-made fertilising products will allow the transport of high-added value fertilising products further away, which will help on solving current inter-regional nutrient imbalances.

Keywords: nutrient recovery, bio-based fertilisers, biofuels, manure management, pig slurry

Acknowledgments: FERTIMANURE has received funding from the European Union's Horizon2020 research & innovation programme under grant agreement No 862849.

WATER RESOURCES MANAGEMENT

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Adsorption kinetics, isotherm and reusability studies for the removal of cationic dye from aqueous medium using activated carbon

In the present work, we have successfully developed activated carbon from prickly pear seed cake, biomass after essential oil extraction, for the effective removal of methyl green (MG) dye from aqueous medium. The adsorbent was characterized using different instrumental techniques viz., SEM, FTIR, and Bohem titration. The influence of different parameters such as: pH, initial MG concentration, contact time and adsorbent dose on the adsorption capacity was investigated. The maximum adsorption capacity of MG of on the activated carbon was found at pH 2 and 240 min. Langmuir and Freundlich adsorption models were employed to provide a description of the equilibrium isotherm. The adsorption process was found to obey to Langmuir, which indicates that the Murexide had formed a monolayer onto activated carbon. Furthermore, according to the regression coefficients, it was observed that the kinetic adsorption data can fit better by the pseudo-second-order model compared to the first-order Lagergren's model. The thermodynamic studies indicated that the adsorption of Murexide occurs in a spontaneous and exothermic process. The regeneration process of the exhausted adsorbent was studied to assess the economic and operational feasibility. According to the obtained findings; it is proposed that the activated carbon prepared from prickly pear seed cake retains a high potential for Murexide removal and is suitable for repetitive usage.

Keywords: prickly pear seed cake, methyl green, adsorption, isotherm, regeneration

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Study on temporal and areal variability of pollution indicators in groundwater nearby the landfill

Groundwater pollution caused by landfill leachate has been found as a global problem which can cause several nuisances to the natural environment and human health. Due to that, plenty of research worldwide is devoted to the landfill monitoring and the evaluation of their impact on the components of the environment, especially on water resources. The aim of this study was to analyse the variability of groundwater pollution indicators in the area of the old municipal waste landfill. The practical part of the work concerned the analysis of the results of the long-term groundwater monitoring, considering the impact of the reclamation works on the changes of analysed parameters. The results were presented graphically in the form of pollutant isoline maps in selected time intervals, for the periods before and after the reclamation. The results were also statistically analysed. On the basis of the numerical simulations performed, the "hot-spots" with the highest concentrations of pollutants were identified. The directions of the movement of pollutants with groundwater flow were estimated. In results, the conclusions were drawn regarding the impact of the municipal waste landfill on groundwater quality, as well as on the extent of pollutants' migration and spread.

Keywords: water quality, pollution plume, reclamation, vertical barrier

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The use of ecohydrological biotechnologies and NBS for the elimination of xenobiotics from the aquatic environment

Due to the constantly progressing development of industry and insufficiently balanced waste management, more and more pollutants, of which xenobiotic substances play a significant role, end up in surface waters. About one million products are produced annually in the world, of which 100,000 are chemical compounds. Of these, 15 thousand are potential xenobiotic substances. Among them there can be distinguished dyes, pharmaceuticals and personal care products, endocrine-active compounds, pesticides and polycyclic aromatic hydrocarbons.

The main routes of transfer of these pollutants to aquatic ecosystems are discharges of industrial and municipal wastewater, and also waste from households and agriculture. The wide application of xenobiotics, their complex structure, low biodegradability and high toxicity causes a negative impact on biodiversity. Therefore, it is extremely important not only to identify xenobiotics in the environment and to assess the impact of these substances on individual levels of the trophic chain, but also to search for new and effective methods of environmental remediation.

High hopes are associated with ecohydrological and Nature-Based Solutions (NBS). These solutions use natural processes taking place in ecosystems and their properties, thanks to which they are not only low-cost and low-energy, but also minimally invasive methods of environmental reclamation. In addition to supporting the circular economy, NBS also support green economy concepts based on the sustainable use of natural resources.

The purpose of this speech is to present the latest knowledge on contamination of surface waters with xenobiotics and to characterize methods in the field of ecohydrological biotechnologies and NBS used for the remediation of water resources.

Keywords: xenobiotics, ecohydrology, nature-based solutions, remediation, surface waters

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The removal of cationic and anionic pollutions from water solutions using Ukrainian limestones: comparative analysis

Removal of cationic and anionic contaminants from surface waters with the same natural material is relevant both from an environmental and economic points of view. Cationic can be removed by the adsorption mechanism, and anions by the formation of insoluble calcium salts. Nickel was taken as an example of a cationic pollutant and phosphate as an anionic pollutant. To compare the efficiency of these substances removal the natural limestone and the thermally activated dispersed limestone were taken. Dispersed, thermally activated limestone gave better results of removal Ni^{2+} and PO_4^{3-} than natural limestone from all water solutions. This was due to its dispersion and subsequent heating to 240-250°C. As a result, the limestone decryption occurred and the crystal of calcite cracked. The dose of limestone was 2.0 and 4.0 g/L, initial pH 5 and 7, TDS 0.02 and 0.55 g/L by study limestones. Simultaneously with the control of changes in the concentrations of Ni^{2+} and $PO_4^{3-}$the measurements of changes in the values of pH, Eh and TDS were carried out. At an increase in the pH of water, the efficiency of Ni^{2+} removal decreased, while the efficiency of PO_4^{3-} increased. For purification of surface water by limestone, the choice of its type and dose depends on usage specifics of the water body.

Keyword: limestone, phosphate, nickel, adsorption, calcite, surface water

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Sponge City – the rainwater management concept in Polish cities/sponge city

The scientific goal is to investigate the impact of natural compensation, understood as comprehensive actions to restore the natural balance in a given area, in this case, based on rainwater management, on creating the city's resilience to extreme atmospheric phenomena related to climate change. The research methods necessary to define and solve the scientific problem that were applied included: analysis and criticism of source literature, observation without intervention, case study, intuitive method based on the author's personal experience.

As the research results have shown, conscious rainwater management minimizes the effects of climate change, including droughts or torrential rains that lead to area flooding and urban floods. Undoubtedly, the problem provides one of the most significant future challenges, both natural and in terms of social and economic issues. Improving retention and strengthening blue-green infrastructure can be based on technical, semi-natural, and natural, i.e., less invasive methods. Instead of being uselessly drained, the rainwater can be retained and used through various solutions. These include green roofs (extensive and intensive) and walls, rain gardens (dry, wet, box-based), greenery areas (natural retention areas), water reservoirs, water-permeable surfaces. Various forms are used in the city space: flow control, detention, retention, filtration, infiltration, treatment.

Hence, it may be concluded that rainwater can support urban spaces in response to climate change rather than being a threat to the city. The city may absorb water, store it, and return it when needed. The fulfillment of this condition/postulate requires interdisciplinary cooperation. The study was concluded with recommendations in the discussed problem area.

Keywords: sponge city, flow control, detention, retention, filtration, infiltration, treatment

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Eutrophication mitigation strategies – environmental effects of taken measures in terms of water resources protection

The introduction of eutrophication mitigation strategies began in the first half of the 1970s' when in many regions evidence of severe surface water trophic state increase were observed. Overfertilization, rapid urbanization and high phosphate content in commercial products such as detergents led to eutrophication of such water bodies as Lake Michigan, Chesapeake Bay, Constance Lake, Taihu Lake, the Baltic Sea and many others.

As the counteraction in many countries new policies aimed at limiting nutrients loads introduced to surface waters were implemented based on: a maximum dose of mineral fertilizers applied on a unit of land, effluent standards in terms of nutrient concentration and banning phosphate additives in laundry detergents.

The paper presents an overview of eutrophication mitigation strategies taken by many regulative bodies in various countries and analyses their environmental effects based on the changes in water quality in the studied water bodies. Due to specific regional factors influencing eutrophication processes such as climate and hydrographic conditions, various cases studies within a wide geographical range were analyzed. In several identified cases, the taken regulative measure turned to be efficient in preventing irreversible water ecosystem damage.

Keywords: eutrophication, nutrients, phosphorus, nitrogen, water resources

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Water retention in the process of re-urbanization – planning for urban resilience and sustainable urban landscape

Re-urbanization is an integrated process of permanent changes in the structure of the city landscape, in terms of functionality, composition, nature, infrastructure and society. The subject of the analyses is the re-urbanization process of shaping the urban resilience solutions based on the blue infrastructure and water retention. The specificity of the analyzed issues is connected with floods or droughts, thus extreme phenomena which have a significant impact on the urban structure, social and ecosystem functioning. The research identified additional categories and factors important for shaping the urban resilience and water retention. The aim of the research is to indicate an analytical model, identified additional categories and factors important for creating the urban resilience in connection with water management. The methodology derived from the analysis of selected examples in order to determine the guidelines for the model of actions recommended in the process of re-urbanization taking into account the dependencies and effects on the resilience of urban areas in adaptation to climate changes. The result of the research is to indicate the possibility of evaluation synergy in planning the sustainable development of the adaptability city landscape in a view of blue infrastructure and urban water management.

Keywords: water retention, urban resilience, re-urbanization, sustainable development, urban landscape

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Climate change impacts on water resources

In the last few years there has been significant interest in climate change. It has found the direct impact on surrounding world as well as on water resources. The rise in temperature associated with climate change results in a general decrease in the proportion of precipitation falling as snow and, as a result, a decrease in the duration of snow cover in many areas. With a shift from spring snow melt to winter runoff, this has implications for the timing of streamflow in such areas. The number of people living in water-stressed countries would rise. These changes threaten the quality of drinking water, rising water levels, and drying up, which also has implications for quality of life and food production. All of the above have a devastating effect on our ecosystem. It should be noted that the impact of climate change on water resources is also the impact of the community, such as environmental or social (health security, future existence). Scientists from all across the world already agree that the global climate change is the result of human activity.

Keywords: climate change, water resources, ecosystem, social life, human activity

WASTEWATER AND SLUDGE MANAGEMENT

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Circularity of wastewater sector in Lithuania

The wastewater sector in Lithuania has undergone many changes and developed significantly over the last quarter of a century. This was due to the need to protect the country's natural environment, the requirements of the EU Wastewater Directive, and the availability of EU financial support to implement the changes. However, new needs and trends are emerging over time and the circularity of the wastewater sector is now being considered. The assessment of the circularity of the Lithuanian wastewater sector (both for wastewater and for sludge treatment) was performed according to the indicators proposed by MonGOS („Monitoring of water and sewage management in the context of the implementation of the circular economy assumptions“) project. Assessment shows a diverse picture: there are areas where Lithuanian wastewater sector is doing pretty well (e.g. nutrient removal efficiency), while there are other aspects where possibility to close cycles has so far not been used at all (e.g. reuse of treated waste water for irrigation).

Keywords: wastewater treatment, Circular Economy indicators, WWTP in CE

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Characteristics of sewage sludge thermal processing – Kraków WWTP case study

Handling of sludge produced as a result of municipal wastewater treatment comprises approximately 50 to 60% of the total costs of a wastewater treatment plant operation. Proper treatment and disposal of this wastes appears to be one of the most significant challenges in operation of a contemporary wastewater plant. Though considered a valuable fertilizer, sludge is often contaminated with heavy metals, micro-organisms and a wide range of hazardous organic substances.

Paper is focused on problems related to thermal processing of wastewater sludge, with a special emphasis on influence of energetic characteristics on operation of this part of wastewater treatment plant. Review part summarizes operational data from numerous countries worldwide showing broad range of unit sludge production. Specific analysis of trends of changes has been presented for Poland which has the lowest unit value in European Union. Second part of sludge characteristics i.e. sludge calorific value and impact of various sludge processing methods on parameters of combustion/incineration. The work shows that self-sustained combustion can be maintained at lower organic matter contents (or higher ash contents) and also with relatively higher moisture content.

The case study illustrates the problems and possible influence on operational conditions is based on measurements on existing wastewater treatment plant Krakow-Płaszow which operates Station of Thermal Sludge Utilization.

Keywords: wastewater sludge processing, energy recovery, thermal utilization

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Sludge management in the wastewater treatment plant – Kraków-Płaszów case study

Municipal wastewater treatment plants are good examples of facilities where the concept of the circular economy model can be effectively implemented by recovery of energy, as well as secondary and natural materials. That's why anaerobic co-digestion has become one of the most appealing renewable energy pathways and gained a significant position within the sludge recovery process.

The research determined feasibility of utilization of water treatment sludge from a water treatment plant in anaerobic co-digestion of sewage sludge. The experiments confirmed that anaerobic stabilization of sewage sludge together with water treatment sludge significantly improved biogas production. The best results were observed when water treatment sludge constituted 30% of the mass of sewage sludge (as the dry organic matter content). At this ratio, approximately 20% more biogas was produced in laboratory experiments, comparing to the biogas production from sewage sludge only. The results were confirmed on a semi-technical scale, where biogas production was 5,3% higher than during fermentation of sewage sludge only. Based on the results, the sequence of processes was developed which would help to increase fermentation gas production. Both the technology and the final product provide a comprehensive solution for waste generated at water and wastewater treatment plants. The innovative approach allows for use the various waste best features streams and their combined processing, in accordance with the principle of the circular economy.

Keywords: technological waste, wastewater treatment, water treatment, Circular Economy

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Evaluating environmental performance of membrane-based wastewater treatment system

Wastewater reclamation has become a popular trend across variety of industries and countries, particularly in water-stressed areas where significant water scarcity exists. Commonly used membranes are based on pressure-driven and non-equilibrium system which utilizes several types of membranes including nanofiltration, ultrafiltration and reverse osmosis. Assessing the environmental impacts of the energy and materials used and discharged to the environment can be done through life cycle assessment (LCA). Studies on evaluating the environmental impact of wastewater treatment system has increased in the last decade but previous studies focus on membrane bioreactor (MBR) with their various configurations. However, the environmental performance and long-term viability of integrated membranes with adsorption and electro-oxidation processes are rarely studied. Thus, this study aims to determine the environmental hotspots linked with combining adsorption and electro-oxidation processes with membrane treatment to treat palm oil mill effluent (POME). The LCA was performed in accordance with the ISO 14040 and 14044 guidelines by using SimaPro software adopting the ReCiPe 2016 methodology and database from EcoInvent 3.6 to calculate its impacts. At the midpoint level, the findings found that the adsorption integrated membrane contributed higher environmental impact than the electro-oxidation process in terms of Global Warming Potential (GWP), Terrestrial Ecotoxicity (TETP) and Human non-Carcinogenic Toxicity (HTPnc) at 570.60 kg CO2-eq, 428.56 kg 1,4-DCB. and 185.37 kg 1,4-DCB, respectively. As for the endpoint level, 0.0008 DALY, 2.075E-06 species year and 16.57 USD2013 were reported. This study helps to propose a sustainable wastewater reclamation system to achieve Agenda 2030 and the Sustainable Development Goals.

Keywords: life cycle assessment, environmental hotspots, cleaner production, water management

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Olive mill wastewater isolate for its bioprospect to the production of laccase and the removal of phenolic compound

The sustainable solution is an ancient core concept (ACC) that continues to be the only solution for healthy and productive life into a distant future. It is a multidimensional and multidisciplinary concept covering almost all spheres of human activity at global, national, local and individual scale. A prospective solution for environmental sustainability is achieved through the biological route which is considered as one of the cleaner, greener and safer, way of sustainable waste management practices for decontaminating wide range of pollutants and its mitigation. Phenolic compounds are among the pollutants of major concern due to its high biotoxicity and persistent in nature. The penetration of phenolic compounds into environment comes from natural, industrial, domestic and agricultural sources In this study, specific emphasis is placed for the removal of phenol and gallic acid as model phenolic compounds through the route of microbes isolated from olive mill wastewater (OMWW) which is enrich in organic load. Molecular characterizations reveal that the bacterial isolate pertains to Acinetobacter REY as being closest to Acinetobacter pittii. The isolate underwent constitutive production of extracellular laccase with an activity of 1.5 and 1.3 U ml-1 when supplemented with inducers CuSO4 and CuSO4+phenol, respectively. However, without any inducer, laccase activity showed no significant change throughout the experiment. To characterize the ability to remove of phenolic compound, batch degradation experiments with phenol or gallic acid were performed and found to biodegrade up to 200 mg l-1 of phenol and gallic acid after 10 and 72 h, respectively.

Keywords: ancient core concept, olive mill wastewater, biotoxicity, phenolic compounds

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Sustainable and circular management of wastewater in eastern Mediterranean region under the current climate changes

The Mediterranean region is one of the areas in the world most vulnerable to climate change as well as one of the most impacted by human water demand. In addition, water stress is a major concern, where a large part of the world's "water poor" population lives in the region where increasing urban population has serious implications for water demand. The increase in water use will also lead to an increase in wastewater and water pollution. Climate change is further exacerbating pre-existing water stresses and is already having a measurable effect on the water cycle in the Mediterranean, changing the quantity, distribution, timing and quality of water available. In this context, the transition and actions towards the circular economy could be a positive way for nature to promote a sustainable future of water. Indeed, unconventional water reuse, NCWR, offer great potential as a means of tackling water scarcity. Through a demonstration on the link between water resources and climate change we will expose in this presentation three parts:

- The need now for a "circular revolution" in water resources,
- The economy approach of reusing treated wastewater: the potential benefits,
- How wastewater's circular economy can help fight climate change.

The central part of this presentation will focus on the contribution of the European project in the sustainable reuse of wastewater in the Mediterranean region and the innovative technologies that offer an additional resource, unconventional water resources, NCWR and the role on the one hand, in the fight against global climate change and on the other hand its use in the agricultural sector

The last part concerns the benefits of agroecology and its effective role in the fight against global warming. Indeed, the capacity to accelerate the restoration of carbon and nutrients in degraded soils, makes it possible to increase soil fertility and improve productivity. In addition, agroforestry-based ecosystems are the main benefits achieved on a large scale from the way trees on the farm interact with soil and water, carbon storage and biodiversity. This will directly contribute to the mitigation of climate variability and the protection of soil and water resources.

Keywords: wastewater, water management, climate change, sustainability, Circular Economy, NCWR, management

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A novel areobic constructed wetland for oil refinery wastewater treatment and reuse

Wetlands are nature-based and cost-effective solutions for treating wastewater. A novel "Racetrack" constructed wetland (CW) was applied and tested for oil refinery effluent in a single-stage design (i.e., horizontal flow). The system's new perspective is combining aerobic and anaerobic environments together for getting a better treatment performance of industrial wastewater. Also, passive wetland treatment systems cannot make a strong aerobic environment that facilitates the formation of iron, zinc, aluminum, and manganese precipitates. The critical role of the oxyhydroxide compounds in the further co-precipitation and heavy metals removal such as copper, nickel, chromium, and lead that can improve the overall treatment of industrial wastewater is inadequately understood, thus more research investigation is needed. This innovative CW brings for the first time artificially aerated sections with non-aerated sections together in a single unit applied for oil refinery wastewater treatment. The study consists of four pilot units with dissimilar designs (i.e., planted/non-planted, aerated/non-aerated) and operational (two different hydraulic loading rates) characteristics to estimate aeration and plants' role and clarify the optimum design configuration. The primary effluent of the oil refinery, i.e., after passing through the dissolved air flotation unit, was applied to the pilot units. High removal rates were obtained for Mn (38-81%), Zn (99-100%), Al (49-73%), and Fe (96-98%) as oxyhydroxide precipitates. The removal of Cu (61-80%), Ni (70-85%), Pb (96-99%), and Cr (60- 41 92%) was also observed under aerobic conditions, likely through co-precipitation, while complete phenols and ammonia nitrogen removal was also found.

This study represents an advanced wetland design that provides effective treatment of refineries effluents using a nature-based solution where only natural components and natural processes are used.

Keywords: nature-based solutions, constructed wetlands, aerated wetland, heavy metals, phenols, refinery effluent

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Application of low-cost materials as the sorbent for removal of pharmaceuticals from contaminated water

In the last decade, one of the biggest environmental challenges is achieving of high purification level of wastewater containing pharmaceuticals, for instance antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs). For this reason, much attention is being focused on finding effective methods to remove these types of organic compounds from polluted water. One of the promising method is using of mineral and waste sorbents, which are relatively low-cost materials. Hence, we propose to apply mineral-based sorbents' composite: halloysite - fly ash. We conducted batch sorption experiments with the use of two pharmaceuticals: ibuprofen and sulfamethoxazole. We also performed preliminary characterization of halloysite and fly ash by implementing the following methods: thermal analysis (TG) coupled with the measurement of evolved gases composition by a mass spectrometer (QMS), scanning electron microscopy (SEM), elemental analysis, and X-ray fluorescence spectroscopy analysis (XRF). The obtained results show that sorbents' composite can remove pharmaceuticals from contaminated water. Moreover, the features of these sorbents, such as the presence of unburned coal, the morphological parameters of sorbents, might be responsible for the immobilization of pharmaceuticals onto the surface of halloysite – fly ash composite.

Keywords: water cleaning, contaminations, sorption

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ENVIRONMENTAL SUSTAINABILITY

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Perception of sustainable development by generation Z. Experience from Poland

The limitation of natural resources and the scale and nature of anthropogenic damage determine a change in the direction of both thinking and action of authorities and the whole society. Therefore, a necessary trend in the development of modern cities is striving for their sustainable development, taking into account the needs of the present inhabitants and future generations.

The aim of this paper is to present the results of a study on the perception of the concept of sustainable development by people from generation Z. The research focuses on generation Z, which at present and in the future will have a decisive influence on the shape and functioning of urban centers, or more broadly, on creating the reality in which we live and will live. Literature studies and computer-assisted online interviews (CAWI) were used as a research method. The survey questionnaire consisted of 22 questions divided into four main thematic blocks. The survey was conducted in November 2021.The sample consisted of 1172 people in the age range of 1995-2010. The results were processed using Microsoft Excel and IBM SPSS.

The study made it possible to identify both positive and negative issues connected with the development of urban centres in line with the concept of sustainable development in the opinion of generation Z and to determine future directions of development which generation Z considered most important and necessary. In addition the study provided up-to-date results regarding generation Z's assessment of sustainable development activities in their immediate environment, as well as on a national and European scale.

Keywords: sustainable development, public awareness

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Sustainability indicators – water, raw materials and energy in the fashion industry based on practices of global fashion brands

The fashion industry is one of the most environmentally degrading industries, which forces the rapid implementation of mechanisms that will enable entities with a global network of stakeholders to effectively monitor problematic aspects and significant environmental and social impacts. Good sustainability strategy helps companies describe and analyse how their organization creates and delivers value, and how it obtains economic value while preserving or restoring natural, social and economic capital. Due to the fact that being a socially responsible entity is difficult to define unequivocally, certain criteria and indicators of sustainable development are important. The advantage of using a fixed framework is that it gives the ability to compare performance and have benchmarks. The aim of the presentation is to define sustainable development indicators for the fashion industry related to water, raw materials, energy and discussion of practices in the fashion market in the context of the sustainable development paradigm. It will be an attempt to analyse sustainable development indicators such as water, raw materials and energy on the example of information provided publicly by global clothing brands and indexes. Companies describe their commitment to sustainable development in many ways, the number of solutions is constantly growing. Good reporting brings a company closer to achieving greater levels of transparency, but transparency does not equal sustainability. Publicizing the challenges and solutions related to water, raw materials and energy benefits global clothing companies, but the trust deficit and the popular greenwashing phenomenon of colouring reality seem to be a big challenge in fashion. The practices of companies and the possibilities of fashion development will be analysed, taking into account the current changes in trends.

Keywords: sustainable development, water, raw materials, energy, fashion industry, sustainability indicators, greenwashing, fashion system, sustainability reporting

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A framework for sustainability of personal and home care products manufacturers with Circular Economy and Green Deal perspectives

Personal and home care products are among the products that are widely used in daily life. Especially in the COVID-19 process, the experts' emphasis on the importance of hygiene has led to an increase in the consumption of personal care products. Although these products are crucial for our daily lives, the sustainability of their production should be discussed due to high water consumption and waste production. Circular economy is a helpful way for sustainability of production systems. However, it can be a complex process, especially for small enterprises to determine where and how to start implementation of this approach. This study aims to discuss the potential future problems for sustainability of these products and present a basic framework for small enterprises to initiate their own circular economy journey for their past and current product design process. The presented framework can be expected help small sized personal and home care products manufacturers by showing a helpful approach to start the implementation of the circular economy.

Keywords: personal and home care products, sustainability, Circular Economy

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Principles of designing water elements locations in public space composition

When designing public spaces in large cities, a number of functional, communication, compositional, infrastructural, environmental and compositional factors should be taken into account, most of them relate to water elements. The appropriate location and form of water elements significantly affect the attractiveness and strengthening of the identity of places in cities. Fountains, artificial and natural urbanized watercourses, artistic installations and sculptures as well as nature-based solutions that utilize water designed in public spaces significantly increase the social and aesthetic value of public spaces. The main aim of the presented research is to present a spectrum of solutions for water elements in public spaces of cities. The summary part describes guidelines and recommendations regarding the principles of designing the location of fountains, watercourses and artistic objects that utilize water in public spaces in cities.

Keywords: urban planning, public space, blue-green infrastructure, sense of place, resilience

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The role of risk assessment and water safety plans in environmental management

The new Directive (EU) 2020/2184 of the European Parliament and of the Council obligates Member States to monitor the quality of water intended for human consumption in accordance with the guidelines of the World Health Organisation. It also indicates the need to conduct a risk analysis at each stage of water production and distribution. Water Safety Plans have been shown to be one of the most effective methods for managing risk. The formal responsibility of waterworks ends at the point of delivery, and the real one is at the point of use and hence the interest of enterprises in this uncontrolled scope. The quality of water in internal water supply systems is usually not tested, and due to a number of factors such as water age, condition of infrastructure, age and type of installation material, number and type of water sources may differ from the quality provided by suppliers. These factors may influence the potential microbiological, chemical, physical or radiological contamination of the water. Krakow Water JSC in cooperation with housing cooperatives introduced a pilot program of water quality testing in selected water supply systems. Research has shown that the quality of water in the installations is fit for consumption. Results will be presented in the article. 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

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Extending the theory of planned behaviour: Factors fostering on the millennial intention to purchase of eco-sustainable products in an emerging market

Based on the Theory of Planned Behaviour model, this exploratory study aims to examine factors fostering millennial' purchasing intentions toward eco-sustainable products in emerging markets and assess the interrelationship between environmental knowledge, environmental concern, subjective norms, green attitude, and perceived behaviour. Data was collected from 446 Indian millennial using snowball and purposive sampling. The data were analyzed using the IBM SPSS and AMOS package using exploratory factor analysis, confirmatory factor analysis, and Structural Equation modelling.

The results revealed that environment knowledge, environmental concern, subjective norms, and perceived behaviour factors significantly fostered green attitude. Millennial green attitude positively affected purchase intention and influenced millennials' purchase behaviour both directly and indirectly. The study variables had a positive interrelationship, except for subjective norms and perceived behaviour. Environmental knowledge and environmental concerns were the strongest determinants of green purchase intention and purchase behaviour. This paper provides practical guidelines to green marketers who are planning to target the Indian green markets.

Keywords: environmental knowledge, perceived behavioural control, subjective norms, green purchase intention, theory of planned behaviour, green attitude

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Assessment of blue and green infrastructure solutions in shaping residential areas – spatial and functional aspects

Residential areas become spaces with a huge potential to mitigate the negative effects of climate change (especially those resulted from droughts and flooding caused by extreme weather events) by implementation of Blue and Green Infrastructure (BGI) solutions.

The aim of the study was to assess the possibilities and limitations in the implementation of 14 BGI solutions (stormwater retention structures and systems) most commonly introduced in residential areas. A comparative analyses has been carried out for each BGI solution in relation to spatial and functional aspects including their main factors. In the spatial context, the size and form of each solution, also their interference with the soil and needed distance from building have been taken into account. The functional aspects included relation of each solution with the type of buildings, the presence of underground infrastructure, retention capacity, and costs of implementation and maintenance. A 2-level rating scale (0–1 for the presence of the factor, or 1-2 for the degree of its participation in retention activities) has been developed as a scoring method. The assessment concerned the ranking of BGI solutions for each of the 2 above-mentioned aspects individually, and then collectively.

The results of the comparative analysis show that BGI solutions such as rainwater gardens, water permeable pavements, green roofs, and retention and infiltration water reservoirs obtained the highest number of points (11 or 12 out of 14 possible). Those solutions are recommended for implementation in residential areas to enhance their functions related to rainwater retention.

Keywords: rainwater retention, blue and green infrastructure, housing estates, resilient cities, urban planning and design

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Airport's sustainability strategy: a Circular Economy comprehensiveness evaluation framework

Global sustainability challenges are reshaping how businesses operate in the 21st century. The necessary condition of ensuring economic, social, and environmental sustainability, also affects the functioning of regulatory authorities and businesses, particularly in the air transport sector, which, by facilitating access to productive services and connectivity to markets, is a critical contributor to the economy. Businesses are increasingly being pressed by decision makers (e.g., stakeholders, shareholders, customers, employees, and society) to assess their socioeconomic impacts and manage their actions sustainably and resiliently. As a result, effective management is a top priority not only for airport operators and authorities, but also for the national and local economies in this competitive and economically sensitive environment. The purpose of this paper is to present an assessment tool for evaluating airport strategic plans and address how corporate actions can promote sustainability in the frame of responsible infrastructure development and circular economy operation of large transport hubs. The assessment methodology is based on a comparative analysis between airports and regulatory authorities' threshold. The role of sustainability in the air transport business ecosystem is depicted using a System of System approach in applying the circular economy concept, demonstrating that its relationship to business performance is a significant barrier to business resilience and competition for planners, managers, and decision makers. The numerical application considers a group of 10 European International airports delivering international flights and business. Conventional wisdom is to provide the evaluation analysis framework for planning and managing capital-intensive transport hubs such as airports.

Keywords: sustainable development, circular economy strategy evaluation, environmental assessment, measuring performance, comprehensiveness evaluation

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Green human resource management – the importance of the concept in the light of own research

The current situation related to the COVID-19 pandemic strengthens the belief that the activities of companies in the area of sustainable development and green human resources management will turn from a demand into an absolute need in the next few years. Moreover, while conducting the literature review, it was found that, although green human resource management is a relatively young concept, it is gaining more and more interest - especially among business practitioners. The aim of the research is to answer the question of what attitude to initiatives in the field of green human resources management is expressed by managers in organizations. The intention of the research is also to indicate how the COVID-19 pandemic influenced the activity of organizations in the field of green human resources management. The qualitative research was carried out with the use of individual in-depth interviews on a group of managers (N=8). It shows that the most desirable initiatives in the analyzed area include the organization and participation in training sessions to develop environmental skills, as well as the introduction of a code of environmental conduct at the level of the entire organization. According to the respondents, the COVID-19 pandemic resulted in limited opportunities for organizations to promote and implement green human resource management initiatives, which does not mean that they gave up on them. The COVID-19 pandemic has reinforced the belief that the task of the organization is to create ecologically responsible attitudes of employees, which will then be reflected in the private sphere.

Keywords: green HRM, managers, organizations, pandemic, ecology

Water in Circular Economy

MonGOS Seminar

MonGOS NAWA POLISH NATIONAL AGENCY FOR ACADEMIC EXCHANGE

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Management of water and wastewater in the Circular Economy

Rationale management of water resources is an integral part the United Nation's 2030 Agenda presenting implementation of sustainable development (SD). Based on the SD principles, the sustainable management of water resources should focus on integrating economic, environmental and social aspects, which are the foundation of sustainability. On the European level, the sustainable management of resources and wastes is indicated as a strategic element in the transition towards the circular economy (CE) which is the European economic policy. This approach assumes that sustainable management of water resources as well as wastes generated in water sector (as wastewater, sewage sludge) may be of key importance in the process of transformation towards CE model. The objective of the research was to present the possible approaches in the transformation towards CE in water and wastewater. In the international project "Monitoring of water and sewage management in the context of the implementation of the circular economy assumptions – MonGOS" which is financed by the Polish National Agency of Academic Exchange (NAWA), the CE model framework for the water and wastewater sector was proposed. The CE model framework in the European water and wastewater sector includes six core actions, as reduction, reclamation (removal), reuse, recycling, recovery and rethink. The novelty of the presented CE model framework is that it provides the possible ways of implementing CE assumptions in the water and wastewater sector, taking into account not only technological and environmental, but also organisational and societal changes.

Keywords: Circular Economy (CE), water and wastewater sector, model

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The use of nanoparticles in water and wastewater technology

The supply of clean and affordable water to meet human needs is the most important challenge of the 21st century. Problems with increasing scarcity of water for drinking, domestic and industrial purposes are exacerbated by rapid population growth, global climate change, deteriorating quality of natural waters and wastewater discharged to the environment. Solving this problem requires implementation of new, innovative water and wastewater treatment technologies. In this context, introduction of nanotechnology into traditional processes, offers new opportunities in the development of advanced processes of water and wastewater technology. Considering the functions of nanotechnology in unit processes of water and wastewater treatment, nanomaterials are used as adsorbents and photocatalysts and in the production of semi-permeable membranes.

Compared to traditional adsorbents, nano-adsorbents are characterized by a very large specific surface area and associated number of active sites, short diffusion paths within the particles, high process kinetics and controllable pore size, and high selectivity. The most commonly used nano-adsorbents are carbon-based (e.g. carbon nanotubes and graphene), metal oxides (Fe2O3, TiO2) and metals (iron, silver), and composite nano-adsorbents.

In semi-permeable membrane fabrication processes, nanomaterials are introduced either onto the membrane surface (polymeric, ceramic) or into the membrane-forming solution and membrane formation takes place from a mixture of polymer and nanomaterial. Proper binding to the polymeric or possibly ceramic matrix, gives the membrane properties much more favorable than unmodified membranes. Nano-membranes can be used in a number of membrane processes, i.e. reverse osmosis, nanofiltration, ultrafiltration, gas separation and pervaporation.

Keywords: adsorption, membranes, carbon nanoparticles, metals/metal oxides

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Water reuse within a circular economy context - case studies of practical implementation in Poland

The water resources in European Union have been increasingly pressurized, leading to deterioration in water quality and water scarcity. The strain on the availability of freshwater is primarily caused by climate change, drought and unforeseeable weather patterns arising from agriculture and urban development.

Extended reuse of wastewater, in compliance with the circular economy principles, could be one of the measures adopted in order to respond to water shortages and increasing pressure on freshwater resources through limiting extraction from surface water bodies and groundwater bodies, promoting water savings through various uses for urban wastewater and lessening the impact of treated wastewater discharge into water bodies.

Case studies of the reclaimed water use in Poland will be presented: the Membrane Bioreactors in Kasina Wielka and Bialka Tatrzanska, both aimed at using reclaimed water as a process water and for artificial snowmaking and watering of green areas, as well as the designed Membrane Bioreactor in Tatra National Park aimed at using reclaimed water for toilet flushing. The aim is to demonstrate the practical implementation of water reuse systems as well as the technical, financial, and environmental potential (and applicability) of water treatment based on the combination of Membrane Bioreactor processes and UV disinfection.

Keywords: MBR, water, wastewater, reclamation, reuse

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Importance of education and key competences for the implementation of CE in the water and wastewater sector

The water sector is facing new challenges related to climate change and civilization pressures on water resources. This requires a change in the mentality and organization of the sector. The priority must be to focus on resource conservation and recovery. Water utilities must therefore respond to this challenge by building new competences, knowledge and skills. In this way, waste water treatment plants become bio-factories producing energy, fertilizers and recovering water. Water treatment plants reduce the environmental impact by minimizing water and energy losses.

Building new competencies requires a diagnosis of the sector. The Sector Skills Council for the Water and Waste water Management and Reclamation commissioned a diagnosis of the sector. Moreover, the Polish Agency for Enterprise Development carried out the Industry Balance of Human Capital, which made it possible to assess the state of competencies in water utilities. In addition, the Polish Waterworks Chamber of Commerce conducted a survey among members of the organization, asking about current and expected competency shortages. The conclusion of the research indicates the need to keep up with the changes concerning the implementation of solutions consistent with the Circular Economy and changes in EU law (new drinking water directive, revision of the urban waste water directive, taxonomy regulations, European Green Deal, etc.). Scenarios for the development of the sector lead towards digital solutions, simultaneous specialization, but also the diversification of knowledge by employees, the need for lifelong learning.

The result of research and surveys is to develop recommendations for the construction of a system for monitoring competency needs in the water sector.

Keywords: water services, lifelong learning, skills council, water professionals

RESEARCH AND IMPLEMENTATION OF INNOVATION

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New cross-linked eco-friendly polymer for environmental applications

Environmental degradation has accelerated in the last half century due to the intensification of industrial and agricultural activities. Water pollution caused by residual dyes has become a delicate subject because of the hazardous effects on both human health and biota. Every year, more than 150,000 tons of residual dyes are discharged as industrial wastes across the world. Therefore, the development of green, sustainable materials able to retain this type of contaminants has received a great focus from researchers. In the current study, we present the synthesis of a new crosslinked eco-friendly polymer based on poly(benzofurane-co-arylacetic acid). The polymer was further used to adsorb crystal violet dye from aqueous solutions. Scanning electron microscopy and Fourier-Transform Infrared spectroscopy have been applied for the morphological and structural analysis of the material, while UV-VIS spectroscopy was employed to determine the dyes. The obtained results showed an improvement in the adsorption efficiency once we increased the crosslinking agent used. High removal performances (up to 100%) were obtained after only 5 minutes of contact time for dyes concentrations between 0.5-10 mg/L.

Keywords: crosslinked polymer, eco-friendly material, environmental applications, water treatment

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How does exogenous silicon attenuate salinity-induced oxidative stress in Medicago sativa-rhizobia symbiosis?

One of the most harmful impacts of salt stress on N2-fixing legumes is the generation of oxidative stress. Silicon (Si) has been reported to have the ability to modulate oxidative stress metabolism in both shoots and roots. Here, for the first time, we investigated the protective effects of exogenous Si on oxidative stress alleviation in nodule of two Moroccan Medicago sativa L. varieties, Oued Lmalah (OL) and Demnate 201 (Dm), and a European variety from Serbia, NS Mediana ZMS V (NS Med) under salt stress. The experiment was conducted in a growth chamber at 25 ± 2°C day/night and a 16 h photoperiod at B2DRN Lab. Nodulated plants were grown under 200 mM NaCl with or without 3 mM Si for one month and analyzed for their oxidative stress. Results indicated that salt stress decreased shoots and roots dry biomass, nodules number and nitrogen content particularly with NS Med exhibiting the highest decrease of all of the mentioned parameters. This constraint increase malonyldialdehyde (MDA) and electrolyte leakage (EL) of nodules especially for NS Med variety where the highest increment rate was noted. However, an addition of Si to salt stressed plants substantially alleviated the adverse effect of NaCl on growth and nodulation as it improved plant biomass nodulation and nitrogen content. In addition, Si application resulted in a decrease of MDA and EL and this was mediated by an increase in the enzymatic and non-enzymatic antioxidant activities. Our findings showed that exogenous Si application could be a promising way to improve alfalfa root-nodule efficiency under salinity.

Keywords: Medicago sativa L., salt stress, silicon, nodulation, antioxidant activities

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Application of flow cytometry in environmental tests

One of the priority tasks of the modern world is to ensure the safe reuse of water. For this to be possible, in addition to the treatment and distribution systems, it is necessary to ensure effective and quick methods of its monitoring. Commonly used methods applied in the analysis of environmental samples have many limitations, especially when it comes to surface water, rainwater and sewage. We are referring among others to labor-consumption, duration or low sensitivity of the analyses used nowadays. The limitations of traditional methods directly translate into the possibility of recycling environmental waters, for example for agricultural purposes. The lack of the capability for a quick microbiological diagnostics, including the determination of pathogens, means a real epidemiological threat. Effective and quick microbiological monitoring would contribute to solving many problems related to the water deficit that the modern world is struggling with. Flow Cytometry (FCM) comes towards those threats. The method known from the beginning of the 20st century, successfully used in medical diagnostics, gradually gained importance in other fields of science: pharmaceuticals, veterinary medicine and the food industry. Due to the multitude of pollutants in environmental tests, performing highly sensitive FCM analysis is a great challenge, but its potential may be a response to the current demand for quick and reliable methods of water monitoring.

In the paper, an attempt was made to answer below questions: what is flow cytometry, what is it characterized by and why it deserves attention. High emphasis was put to the problematic issues - why FCM is a difficult but prospect alternative in monitoring pollutants in environmental trials. Based on an examples, the possibilities and the most important advantages of its use have been demonstrated.

Keywords: FCM, flow cytometry, water, environmental tests

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Valorization of eucalyptus bark for cellulosic ethanol production

Carbon neutrality, climate changes mitigation and waste minimization are three of the main concerns of the century. Accordingly, the energy sector has been overtaking a deep transition in recent years, with governments worldwide promoting a switch from a fossil to a bio-based economy. Advanced biofuels are considered one of the most promising ready-available solutions for enabling the transport sector to comply with GHG emissions and Green Deal targets. In this regard, this work aimed to produce cellulosic ethanol from eucalyptus bark, a widely available forestry residue typically burned for energy generation in pulp and paper mills. For that purpose, several fermentation assays were carried out at the Erlenmeyer scale using a high-concentrated hydrolysate (about 160 g L^{-1} of cellulosic sugars) derived from bark kraft pulp. So far, the main achievement included a maximum ethanol concentration of about 50 g L^{-1}, corresponding to a yield of around 80 %. A scale-up to 5L-bioreactor was also carried out, reaching a comparable performance over flask assays. This work proved that eucalyptus bark kraft pulp could be a promising raw material for producing second-generation ethanol, contributing to sustainable waste management within a circular economy model and boosting market opportunities in the pulp and paper sector.

Keywords: bark, cellulosic ethanol, fermentation, valorization

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Utilization approaches of invasive plants species

Invasive plants can be identified as one of the major threat to biodiversity and ecosystems. These species are characterized with strong environmental adaptability, fast reproduction and spreading capabilities which in result may harm ecosystems, human health and produce economical loses. In regard to these problems most of suggested measures are related to management of invasive species which includes manual eradication, chemical control, biological control and alternative control. Significantly less knowledge were about different application solutions and types of utilization. For that purpose essential are studies of composition of invasive plants and existing utilization solutions. Acquired knowledge of application forms and utilization types can expand management measures and probably even compensate economical loses. Some of invasive plants made individual stands therefore potential for biomass in large quantities is not relevant, but some of species such as Canada goldenrod (Solidago canadensis) Sosnowsky's hogweed (Heracleum sosnowskyi) cover large territories and continue to expand. Those plants can be used not only for small scale extractions, but also used in biomass processing. Therefore aim of study is to identify utilization approaches and their advantages. There is great variety of utilization solutions which includes usage of biomass to prepare compost, gas, fuels (ethanol, biobutanol, biodiesel). Other approaches are to prepare biochar, use as sorbents, extract individual substances, oils and use fibers and even use in food production.

Keywords: invasive plants, utilization, technologies

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Innovating with nature in mining: why is adoption of nature-based technologies in the mining sector so limited?

The circular economy (CE) concept advocates to drastically reduce primary resource extraction in favour of re-using non-virgin material that has already entered the anthroposphere. However, in light of the ongoing 'green transition', the demand for certain raw materials has been increasing rapidly as 'clean-technology' solutions are significantly more material intensive than conventional fossil fuel-based solutions.

This paper explores how, despite the need for increased raw material extraction, the mining sector can make a significant contribution in the transition towards the CE by replacing conventional technologies used in the mining industrial process with more sustainable nature-based technologies (NBTs). The paper presents the NBTs applicable to the mining industrial process which have shown promising evidence of significantly lower material and environmental impact than conventional technologies. It then explores why there has been limited commercial translation or uptake of these NBTs by large-scale mining companies to date.

Drawing on evidence from semi-structured interviews and relevant literatures on CE, innovation, biomimetics and nature-based solutions, the paper identifies the existing gap in our understanding of the required processes to drive the adoption of NBTs in the mining sector. The preliminary results of this study show that knowledge of NBTs and willingness to test and pilot NBTs is increasing within the mining industry, but that the introduction of a clearly defined NBT concept, accompanied with a translation framework that gives practical guidance on how to test, pilot and scale NBTs is necessary to increase the uptake of NBTs within the mining sector.

Keywords: nature-based technologies, sustainable innovation, sustainable management of raw materials, low-emission technologies, circular economy

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COVID 19 pandemic and eye diseases

Eye is main organ which enables vision and allows us to see the world around us. The outermost region of eye has Cornea and Sclera. The next region contains blood vessels including Choroid, iris, pupil and ciliary body. The innermost layer of the eye is Retina. The COVID 19 pandemic not only caused systemic diseases but several eye related ailments. The Ocular surface epithelial cells of both Cornea and conjunctiva possessed high expression of proteins that are vital for SARS-CoV-2 entry such as ACE2, TMPRSS2 protease and Cathepsin BLl activity. Several anterior segment diseases such as Unilateral and Bilateral Conjunctivitis and Keratitis and episcleritis were found in COVID 19 patients either during systemic infection or after viral clearance. The virus has affected ganglion cells of the Retina. In addition to this several health care workers in eye care are infected with the virus and has become occupational hazard. During the prolonged periods of lockdowns lesser patients visited the hospitals for eye care and increased the intensity of the prevailing eye diseases. Several hospitals including our hospital Sankara Nethralaya, a tertiary care hospital had reduced influx of patients compared to pre-covid times. Additionally, there was increased incidence of ‘dry eyes’ due to excessive usage of electronic devices during the pandemic. Further COVID 19 treatments were complicated by the orbital mucormycosis in the patients. Our institution successfully treated the fungal infection during the second wave in Chennai from March to May 2021. The effect of the pandemic on eye disease burden will be discussed.

Keywords: SARS-CoV-2, patient care, ocular surface, retina, mucormycosis

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OCHRONA ŚRODOWISKA

IN POLISH

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Brief introduction to the use of environmental life cycle assessment in the eco-design of new polyurethane materials

Zwięzłe wprowadzenie do wykorzystania środowiskowej oceny cyklu życia w ekoprojektowaniu nowych materiałów poliuretanowych

Plastics, e.g., polyurethanes, are essential in many production systems. At the same time, they are considered to be a serious burden on the environment. Eco-design is an approach to product design with particular emphasis on its impact on the environment and society during entire life cycle. To reduce the negative impact on the environment, each product requires specific actions at various stages of its life. Among the environmental aspects that should be analysed in order to be able to talk about the introduction of eco-design principles to produce new materials, are issues such as:

- using compounds with the lowest possible environmental impact and using the compounds derived from recycling (i.e., right compounds);
- optimization of the amount of the right compounds;
- optimization of the use of utilities (solvent, heat, electricity, or water) during the production process;
- reducing of the amount of pollution.

The main objective of this review is to prevent the use of environmental life cycle assessment in eco-design to produce new polyurethane materials. Environmental life cycle assessment is increasingly becoming a methodological framework for determining the potential environmental impact of a product. The review shows that research on polyurethanes obtained from recycled polyols is an example of a new trend to improve environmental awareness among scientists and industry. An in-depth analysis of the literature has also shown that a higher content of recycled substrates in the product does not necessarily lead to better environmental performance.

Keywords: polyurethane materials, production, eco-design, environmental life cycle assessment

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Saving water and using natural detergents as a form of climate cooperation

Oszczędzanie wody i używanie naturalnych detergentów jako forma współpracy na rzecz klimatu

The purpose of the considerations is to draw attention to the need to save water and its sustainable use. According to The International Resource Panel - report Global Resources Outlook 2019, the global annual extraction of raw materials continues to increase several times, accepting more than 60 billion tons of raw materials per year. The extraction and processing of resources generates more than 11 billion tonnes of waste annually, which significantly affects the loss of drinking water in the world and the destruction of biodiversity. According to the World Resources Institute, essential fresh water is only 4.56% of the Earth's water resources. Although the globe is 71% water, most of it is salt water, so freshwater is a precious source of wealth for the Earth. According to data from the Central Statistical Office of Poland (GUS), the average Polish inhabitant directly consumes approx. 92 l of water, and as a water footprint - a water footprint, approx. 4 l per day. Indirectly, the largest amounts of water consumption in the world - according to data from the United Nations, UNEP, UP Global Compact - about 23% is the use of water in industrial processes, while in Poland, according to the Central Statistical Office, it accounts for about 73% of domestic consumption. Therefore, emphasis should be placed on the efficient use of clean water resources, which is one of the assumptions of the strategy for implementing the Green Deal. One of the conclusions of the implemented solutions is the need to save water and the possibility of using natural detergents that do not pollute water and the environment. This solution saves many liters of reusable water. Among the natural detergents, it is worth mentioning the popular and easily available products, such as vinegar, baking soda and lemon juice. By replacing chemical detergents with natural ingredients, we not only make the water free of toxins, but also clean the soil and the environment. The literature on the subject, specialist studies (reports) and secondary empirical data are the basis of the considerations.

Keywords: water, natural detergent, water saving

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Evaluation of leaching of harmful substances and heavy metals from slag generated in the process of combustion of municipal wastes as an additive to concreto

Ocena wymywalności substancji szkodliwych i metali ciężkich z żużla powstającego w procesie spalania odpadów komunalnych jako dodatku do betonu

Due to the demand of the building industry for materials and the need to decrease the CO2 emission, research was conducted to investigate the use of the slag from the combustion of municipal waste as an additive to the concrete. This subject turned out to be complex, as the slags have various chemical compositions, physical properties and variable content of contaminations. The article deals with two issues – the first is the evaluation of physicochemical properties of slag as an additive to the concrete, whereas the second issue concerns the evaluation of the leaching of harmful substances and heavy metals from cement mortars with the additive of slag which may potentially pose a threat to the environment.

A level of leaching of harmful substances and heavy metals from the tested slag was tested by preparing aqueous extracts with the weight ratio between water and slag of 1/10. Cement mortars were tested with a cement mortar/water weight ratio of 1/2. Content of the determined indexes in aqueous extracts was compared to the permissible values for the introduction of waste into waters or soils. Slag, after combustion of municipal wastes contained mainly chloride compounds (0,37%), sulphates (0,18%) and sodium (0,12%). Heavy metals (Cr, Pb, Ni, Zn) were below the limit of quantification. Once the slag was qualified as a composition of cement, mortars were prepared. They underwent environmental tests. When determining cement mortars with the additive of cement in the light of the environmental impact, it was discovered that the leaching of harmful substances and heavy metals does not pose any potential threat to the environment.

Keywords: waste, slag, leaching, Circular Economy, cement

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Phosphorus removal and recovery from wastewater with the use of marl and travertine as part of a circular economy

Usuwanie i odzysk fosforu ze ścieków z wykorzystaniem margla i trawertynu jako element gospodarki o obiegu zamkniętym

Phosphorus, as one of the most important nutrients, is an essential component for life processes in plant and animal cells. Due to its non-renewable resources and the need to meet the world's food needs, it is considered a strategic resource. As a component of agricultural fertilizers, phosphorus is the main factor causing the eutrophication process, and therefore effective removal from the wastewater is required. The paper presents the analysis of two natural materials, marl and travertine, and the Polonite® (filter material) in terms of phosphorus binding by sorption and precipitation under static conditions. In comparison with the efficiency of the commercialized Polonite® material (95.09%), the analyzed natural materials with the achieved reduction of this element at the level of 89.82% for travertine and 89.98% for marl, are a promising reactive material in wastewater technology. The tested natural materials were additionally subjected to thermal treatment (500–1000°C), which significantly increases their efficiency in phosphorus removal (over 99% reduction of this element in the modification temperature range of 650–1000°C) and extends the possibility of their use in a different range of conditions, phosphorus concentrations and treatment technologies. In terms of the process conditions in static conditions, the shaking speed of 350 rpm and the time of 24 h for marl, travertine and Polonite® turned out to be the most optimal, while the appropriate size of the material fraction is 1-2 mm. Thermally modified materials for all tested process conditions and fraction sizes showed high efficiency - over 99% phosphorus reduction. The tested reactive materials with adsorbed phosphorus can be used as a fertilizer product in agriculture, which will ensure the circulation of this element in the environment and will perfectly meet the assumptions of the circular economy.

Keywords: wastewater treatment, phosphorus sorption, circular economy, phosphorus recovery, ecotechnology

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Prospects for the development of bioeconomy in Poland

Perspektywy rozwoju biogospodarki w Polsce

Food security, the increasing use of natural resources and the ongoing climate changes are currently some of the most important challenges, mainly of a socio-economic nature, that must be faced by the whole world. The form of action that can meet the above-mentioned challenges is the bioeconomy. Poland, like many other European countries, must actively counteract the negative and long-term effects of the most important global changes of the present times. Such challenges currently include, among others food security, environmental pollution, systematic climate changes, demographic problems and negative social changes. A good solution that allows you to counter the above-mentioned threats is to promote the development of a knowledge-based bioeconomy as a modern and innovative source of renewable energy - especially biomass.

The aim of the paper is to present the concept of bioeconomy, its factors and development prospects in Poland. During the preparation of the material, reference was made to the literature on the subject, documents of the European Commission (EC), materials provided by the Organization for Economic Co-operation and Development (OECD) and by other specialized institutions. In the paper, the method of literature review was used and it was subjected to a critical analysis.

Based on the analysis carried out, it was found that the development of the bioeconomy is largely influenced by the cooperation of public institutions with private economic entities as well as production and service entities, which aims to implement pro-innovative policy in the use of natural resources.

Keywords: bioeconomy, raw materials, sustainable development

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Green alternatives for industrial explosives as a mean to reduce environment poisoning with heavy metals

Zielone alternatywy dla przemysłowo stosowanych inicjujących materiałów wybuchowych w kontekście możliwości redukcji zanieczyszczenia środowiska metalami ciężkimi

This work presents the current state of the art relevant to the industrial methods of producing the most commonly used initiating explosives, as well as the impact of their production and civilian-military use on the natural environment. Herein, we discuss the materials that are predicted to be potential alternatives to high-energy materials that are heavy metal compounds, with a particular focus on alternatives to toxic lead compounds (e.g. lead (II) azide). The paper presents the concepts of alternative "green" materials that will allow avoiding the issues of human health risk and environmental contamination caused by heavy metal compounds. These materials are largely coordination compounds, consisting of transition metal atoms and nitrogen-rich ligands. Such compounds have potential applications, among others, in the construction of primers, detonators, and laser igniters as well as NPED detonators. The article investigates examples of substances with the potential for usage in environmentally friendly chemistry highlighting some of the practical problems that disqualify their industrial mass production.

Keywords: lead (II) azide, coordination primary explosives, energetic coordination compounds, “green” explosive, laser detonators, NPED detonator

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The RaVeN project - an example of university education for the Green Deal

Projekt RaVeN – przykład edukacji uniwersyteckiej dla wdrażania Zielonego Ładu

Currently, the development strategies of the European Union and its major initiatives related to the Green Deal and Energy transition take into account raw materials industry. Significant resources of various raw materials identified in the countries of Northern as well as South-Eastern Europe constitute raw material deposits and at the same time a base for supplies from the internal market for EU.

The raw materials industry in Europe has to be modern and innovative in terms not only of the processes affecting the economic efficiency of the business but also of its sustainability aspects. The social and environmental aspects are of particular importance in the demanding operating conditions on the continent, which are heavily weighted towards other parts of the world. Responsible business and its modern perception is the basis for the development of innovations whether in terms of product, technology or its organization.

The funds, e.g. the Horizon programme, or programmes within the EIT Raw Materials, have been involved in initiatives to create start-ups aimed at developing innovative commercial projects between scientific units and mining businesses, or educational projects. The mentioned projects are aimed at training and development of competences of employees, which can be used in European companies and monetize their benefits in various regions of the world.

An example of such training and qualification development can be the RaVeN master project, which aims to train engineers for the needs of the raw materials industry operating within advanced value chains and the Green Deal.

Keywords: education for sustainable development, circularity, academic curricula, knowledge triangle integration, master programme

WODA-SUROWCE-ENERGIA

IN POLISH

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Comparison of tap water softening technologies

Porównanie technologii zmiękczania wody wodociągowej

The aim of the study was to compare commonly used techniques of water softening and to draw attention to the legitimacy of promoting a conscious and responsible, based on scientific knowledge, pro-ecological attitude. Using results obtained in the laboratory, the authors prove that cartridges used in overflow filters are an effective method of water softening. Moreover, the article presents the results of research indicating a high percentage of adsorption of secondary pollutants appearing in tap water (iron and manganese compounds). The authors also points out the advantages of self-filtering water at home with filter jugs or bottles instead of buying bottled water. They point out not only the financial aspects, but also the health aspects. The article deals also with the effectiveness of the removal of general hardness from tap water using the following methods: chemical softening by lime and sodium method, and high-pressure membrane filtration. The scale of application of the aforementioned technology is also discussed. The authors emphasize the importance of the development of the technology with the use of polymeric membranes indicating the dynamic development and wide application of this technology in many branches of industry - not only related to water filtration. Moreover, the history of development of the technology of chemical softening of tap water is presented. Advantages and disadvantages of the presented methods are discussed and examples of industrial plants using particular methods are given. The authors perform a comparative analysis of the methods discussed in the article in order to try to choose the technology most conducive to environmental protection.

Keywords: water softening, pitcher filters, chemical softening, high pressure membrane filtration

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Photocatalysis of pharmaceutical pollutants

Fotoliza zanieczyszczeń pochodzenia farmaceutycznego

Due to the high consumption of pharmaceuticals, pollution of the environment is increasing. Pharmacological compounds and their metabolites accumulate in ecosystems, negatively affecting the fauna and flora. One of the main sources of drug emissions are wastewater treatment plants, which do not cope with difficult-to-degrade pharmaceuticals sufficiently. Searching for new methods to reduce these pollutants belongs to the area of priority research.

The aim of the research was to develop an effective method allowing for the degradation of selected pharmaceuticals, which were diclofenac and carbamazepine. The influence of the photocatalytic method consisting of UV-C radiation and titanium (IV) oxide was investigated. The method effectiveness was analyzed by means of high performance liquid chromatography (HPLC) with a spectrophotometric detector. The characteristics of the produced catalyst were checked by means of infrared spectroscopy, ATR FTIR (Fourier transform infrared spectroscopy - attenuated total reflectance) and by means of XRD (X-ray powder diffraction). The ATR spectra analysis showed the presence of Ti-O and O-Ti-O bonds in the prepared catalyst. By XRD analysis, fine titanium oxide crystallites were revealed. Thanks to the developed method, it was possible to 100% degrade diclofenac within a few minutes. For carbamazepine, over 73% reduction was achieved, which is also a satisfactory result. The proposed solution is characterized by high degradation efficiency of pharmaceuticals that are difficult to decompose.

Keywords: environmental pollution, pharmaceuticals, photocatalysis, UV-C radiation, pollution degradation

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Influence of atrium glazing on energy performance of the building – case study

Wpływ przeszklenia atrium na bilans energetyczny budynków – studium przypadku

The research aims to investigate the impact exerted by covering the atrium with glazing on the energy balance of the building. The issues were limited to examining the primary energy, delivered energy, and usable energy indicator values, i.e., the indicators that characterize the energy performance of buildings. Two original kindergarten building designs, developed by the Authors, are presented in the article. One of the projects comes with an open atrium, whereas the other is equipped with a glazed atrium, creating a usable building interior space. In order to illustrate the broad scope of the discussed issues, general differences between the two solutions were analyzed, while the main focus was placed on energy and utility aspects. However, comparative calculations were made for one of the buildings, thus eliminating the unnecessary variables by which the buildings differ, as these may impact the energy behavior of the building (e.g., building compactness, facade glazing ratio). Therefore, the research constitutes a simulation based on two variants of the same building, one of which is a theoretical - virtual variant. The calculations were made for Warsaw climatic (meteorological station "Warszawa-Okęcie"). The research results prove that by covering the atrium with a glazed roof, a significant impact may be exerted on the energy performance of the building. Being a greenhouse structure, such an atrium increases the passive thermal gains from insolation, which constitute an essential factor for the energy performance of the building. The research results may be applied to design decisions at the initial construction stages, i.e., planning and building concepts. The results are intended for low-rise, early-school buildings with an area of 2000-3000 sq. m. and may prove useful for facilities located in Central Europe.

Keywords: energy indicators, energy-saving architecture, atrium, greenhouse structures, passive solar solutions, kindergartens

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Critical study of the legal concept of the functioning of energy cooperatives in Poland

Studium krytyczne koncepcji prawnej funkcjonowania spółdzielni energetycznych w Polsce

Law on renewable energetic sources announced at 20 february 2015 introduced the concept, defined the method of operation and the procedure for establishing and running energy cooperatives. Six years after the announcement of this regulation, the list of energy cooperatives includes only one energy cooperative approved on May 11, 2021. Due to the modest achievements of economic practice in Poland in establishing energy cooperatives, it can be concluded that the cooperative construct proposed by the legislator is defective or not competitive in relation to other solutions available on the market. It is puzzling that despite such visible tendencies aimed at supporting initiatives in the field of building an energy system in Poland based on renewable energy sources, an important element of which could be energy cooperatives, the legislator constructed (and has not amended it) such inaccessible and unadapted to socio-economic realities concept of an association of prosumers.

The main goal of the study is to answer the question why such a concept of energy cooperatives has in fact not been adopted in the last 6 years in Poland. The following study will focus on the characterization of the main problems of the concept of an energy cooperative in Polish conditions in the current legal state. In particular, economic, legal and social factors considered by the authors to be of particular importance will be taken into account. The basis for the analysis will be mainly legislation, because in the field of energy cooperatives, the achievements of the practice, on which a wider analysis could be based, are negligible for the reasons mentioned above.

Keywords: renewable energy, legislation, energetic cooperatives, legal and economic analysis

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The Polish wind energy sector compared to the world wind energy

Sektor polskiej energetyki wiatrowej na tle światowej energetyki wiatrowej

The aim of the work was to present the wind energy sector in Poland against the background of the wind energy sector in the world. Wind energy is playing an increasingly important role in the global energy mix – only in 2020, 93 GW was added, reaching a total capacity of 743 GW. Using meteorological data, the technical potential of wind energy in Poland was calculated. The obtained results show that only 0.02% of the territory of Poland meets the requirements of the so-called "The distance act". Currently, the wind energy sector in Poland has been stagnating compared to the wind energy sector in the world for 5 years. Liberalization of the "distance act" and the development of offshore wind energy should contribute to a significant increase in wind energy capacity in Poland. Wind energy, along with other renewable energy sources, will allow Poland to transform energy into low-emission and zero-emission energy sources.

Keywords: renewable energy, wind energy, technical potential, Poland, world

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Photovoltaic power plants may positively impact the changes of biological diversity

Elektrownie fotowoltaiczne mogą pozytywnie wpływać na zmiany różnorodności biologicznej na terenach przez nie zajęte

The favourable government policy and the introduction of supporting instruments are conducive to the development of renewable energy sources, especially photovoltaic. Unabated for several years, interest in this solution transfers into a record number of power plants built and proceeded by the administrative units. Public administration do not have at their disposal the materials considering the nature protection in the areas covered by solar farms what causes that the realization of these investments is very often blocked. Solar farms are accused of reducing the amount of open areas and creating migration barriers. The field observations indicate the increase in biological diversity on the lands converted to PV. The land directly zoned for installations is fenced off and is of minimal human impact, what results in the creation of safe feeding grounds for many animal species, including partridge, red-backed shrike, common shrike and whinchat. Power plants are usually located in agricultural areas, characterized by low species richness. As a result of the implementation of PV, flower meadows with an increased food base are created, which are conducive to the existence of herpetofauna and entomofauna.

The current regulations of environmental protection law prohibit the localization of new objects within a strip of land up to 100 m from the borders of water reservoirs. Analysing the specificity of the area of the PV, excluding the ponds from the boundaries of the project may be inappropriate. The above facts clearly indicate that a properly designed photovoltaic installation can foster the increase in biological diversity.

Keywords: solar power plant, photovoltaics, biological diversity, renewable energy

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Hydroxy derivatives of polycyclic aromatic hydrocarbons as emerging contaminants

Hydroksypochodne wielopierścieniowych węglowodorów aromatycznych jako nowoidentyfikowane zanieczyszczenia środowiska

Polycyclic aromatic hydrocarbons (PAHs) belong to the group of chemicals responsible for environmental pollution. They are formed in a wide temperature range during incomplete combustion of organic matter. Their main anthropogenic sources are energy based on the combustion of solid fuels, wood, illegal waste incineration, and transport. For many years, PAHs have been the subject of special attention of scientists, because they occur in all elements of the environment, and most of all, some of these compounds are highly carcinogenic or mutagenic. Among the derivatives of PAHs, hydroxy derivatives (OH-PAH) can be distinguished. OH-PAHs are emitted directly into the atmosphere from combustion sources, including from diesel engines, are formed in the photo-oxidation of PAHs and as products of PAH metabolism in the human body. It is believed that OH-PAHs are much more toxic than their starting compounds. The conducted tests were aimed at determining whether selected OH-PAHs are emitted into the environment along with treated sewage. An analytical method was developed that allows the determination of 1-hydroxynaphthalene, 2-hydroxynaphthalene and 2-hydroxyfluorene using the HPLC/UV-Vis technique. The detection limits for the mentioned compounds were between 75 and 300 µg/L. Wastewater samples collected from the sewage treatment plant in Krakow were analyzed. The qualitative analysis confirmed the presence of selected OH-PAHs in treated sewage. Due to the toxicity of OH-PAHs, it is believed that their release to the aquatic environment along with treated sewage is dangerous for living organisms.

Keywords: hydroxy derivatives of polycyclic aromatic hydrocarbons, emerging contaminants, treated sewage, high performance liquid chromatography

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The importance of small hydropower in Poland's climate and energy transformation

Znaczenie małej energetyki wodnej w transformacji klimatyczno-energetycznej Polski

Climate change and environmental degradation pose a threat to Europe and the rest of the world. To meet these challenges, the European Green Deal (EGD) action plan was developed. It aims to help transform the EU into a modern, efficient and competitive economy. Reducing greenhouse gas emissions by at least 55% by 2030 requires increasing the share of renewable energy. Poland's energy policy (PEP 2040) assumes that by 2040 RES will generate about 21-23% of energy. The EU Commission is proposing to raise the binding target for the share of renewable energy in the energy mix to 40%. These are goals that can be achieved by Poland, incl. through currently conducted intensive activities in the field of offshore wind energy, dynamic development of solar energy (photovoltaics) and the unused hydropower potential of small hydropower (SHP). According to the latest data, the power of photovoltaic installations this year exceeded 6.1 GW, and the PEP 2040 strategy assumed achieving this goal at a similar level (5-7 GW) only in 2030. SHP also fits very well with the EGD climate and energy goals . In Poland, SHP facilities include power plants with an installed capacity not exceeding 5 MW, and in the EU up to 10 MW. According to RESTOR Hydro and its own research and inventory, there are currently about 8,560 locations on Polish rivers (closed hydropower plants, weirs, thresholds, small steps and other barriers) with enormous hydropower potential. Among them, only 784 sites are currently used, where 16 large power plants with a capacity of over 5 MW and 768 small hydropower plants with a capacity of less than 5 MW are in operation. The remaining 7,776 locations are energy unused, which accounts for approximately 90% of the hydropower potential that can be used. SHP as a clean and renewable energy source contributes to counteracting air pollution and enables additional benefits, both for the economy and the environment. 1 MWh of energy produced by SHP enables the reduction of harmful substances, including 1 ton of CO_2, 10 kg of SO_2, 2.4 kg of NO_x, 2 kg of dust and 115 kg of ashes and slags. SHP also improves the operation of distribution networks (lower transmission losses) and the security of power supply to local consumers. Thanks to the SHP, small water reservoirs (microretention) are created, which are currently even indispensable for local needs, during frequently occurring dry periods, as a result of global climate changes. They create good conditions for the development of recreation, water sports, agritourism, etc. Moisture conditions in the adjacent soils, both cultivated and forested, are also improving. SHP has a positive effect on the quality of water in watercourses through their oxygenation and treatment. The EU Directive on the promotion of the use of energy from renewable sources of 2018, the Water Framework Directive of 2000, PEP 2040 and Polish Water Law Act of 2017 treat small hydropower as an investment that directly serves people and protects the environment. The authors conducted their own research, inventories and calculations, and assessed the current and possible to use hydropower potential of watercourses in the Dolnośląskie, Opolskie and Lubuskie voivodships. An interesting analysis was also made of the 100% unused hydropower potential of the Oława River (tributary of the Odra River), based on the existing hydraulic structures and dammmings.

GREEN DEAL FOR THE FUTURE

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Treasure from toxins – role of plants in environmental decontamination

Prevention of pollution and resource recovery involving wide variety of biological interventions using biodiversity is an emerging area of biobased economy. This lecture will highlight the importance of biodiversity such as plant growth promoting bacteria, pteridophytes, and higher plants that accumulate and hyper accumulate heavy metals. Brassicaceae, Cyperaceae, Cunoniaceae, Caryophyllaceae, Fabaceae, Flacourtiaceae, Euphorbiaceae, Lamiaceae, Poaceae and Violaceae are predominated by metallophytes. Often these occur as endemics in metal rich areas such as ultramafic and serpentine soils. Therefore, metallophytes are also called as "serpentinophytes". Serpentine soils (= soil shine like the skin of snake) are distributed all over the world. In India Andaman and Nicobar islands is one of the classic examples. In general serpentine soils contain heavy metals in including nickel (averaging 10 mg per gram soil), cobalt, chromium, iron and magnesium with low nutrient levels.

Metallophytes plants serve as invaluable plant resources for phytoextraction of metals. Recently Noccaea caerulescens and Anthyllis vulneraria have been used as starting raw materials to prepare novel poly-metallic catalysts that have been found to be useful for Lewis acid catalyzed reactions. The synergetic catalysis of these systems leads to efficient syntheses of complex biomolecules. These new polymetallic catalysts bring new possibilities in Green Catalysis, and are named as "Ecological Catalysis".

In this presentation the following examples Alternanthera philoxeroides, Astragalus racemosus, Azolla pinnata, Brassica juncea Ceratophyllum demersum, Cynodon dactylon, Datura innoxia, Eichhornia crassipes Elodea densa. Lemna minor, Lemna polyrrhiza, Phragmites australis, Pteris vittata, Typha latifolia, Vallisneria spiralis, Vetiveria zizanoides including some selected medicinal plants shall be discussed for thier role in turning toxins into treasure.

Keywords: bio remediation, phytoremediation, air, water, soil, cash from trash

POSTER SESSION

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Influence of Fenton's reagent on the intensification of the hydrolysis phase of the methane fermentation of excess sludge and microbiological indicators

As a result of oxidation of the sludge with Fenton's reagent, hydroxyl radicals are produced, which are a strong oxidizing agent and thus reduce the time of final degradation of organic pollutants that are difficult to decompose. The aim of the study was to demonstrate the effectiveness of the in-depth oxidation with Fenton's reagent on the course of hydrolysis and the microbiological indicators of excess sludge subjected to methane fermentation, in relation to the conventional fermentation process. In the case of oxidation of excess sludge with Fenton's reagent, the iron ion dose of 0.08 gFe^{2+}/g TS was considered the most favorable process conditions and a Fe^{2}+: H_2O_2 ratio of 1: 5. The obtained was a 28% degree of sludge disintegration, a 7-fold increase in the value of SCOD and a 3-fold increase in the concentration of VFAs, compared to the initial values. The use of higher doses of Fe^{2+} ions, i.e. 0.1 and 0.12 $gFe^{2+/}$g TS, as well as a greater proportion of Fe^{2+}: H_2O_2 than 1: 5 did not increase the efficiency of the process. The process of disintegration of excess sludge with Fenton's reagent using a dose of 0.08 g of Fe^{2+} ions and hydrogen peroxide in the proportion of 1:5 resulted in the reduction of the number of individual groups of microorganisms. The highest decrease was recorded in the group of mesophilic microorganisms, from the initial value of 70 × 104 JTK/cm^3 before the process to the value of 30 × 104 JTK/cm^3 after the disintegration process.

Keywords: Fenton's reagent, excess sludge, hydrolysis, methane fermentation, microbial indicator

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Potassium recovery as K-struvite – challenges and potential applications

Recovery of ammonium nitrogen as a struvite ($MgNH_4PO_4.6H_2O$) has been until now widely researched, which is connected with the fact that this process allows for recovery of both N and P from wastewater. As a result we obtain valuable fertilizer for use in agriculture. Less is known on the recovery of another phosphorus salt – K-struvite ($MgKPO_4.6H_2O$), whereas recovery of the potassium and phosphorus as alternative or simultaneous technology in wastewater treatment plants (WWTPs) is very promising. This salt has a great potential for use as a by-product in husbandry. In municipal wastewater concentrations of potassium are not very high compared to ammonium nitrogen and phosphorus. In municipal wastewater concentration of potassium reaches 10 – 30 mgK/L. However in other types of wastewater, the concentrations are significantly higher, e.g. effluents from cheese processing or potato processing can reach 1500 mgK/L. The concentration of potassium can be increased if co-digestion of wastes is applied in WWTPs. Various types of wastes, including e.g. food ones can increase the concentration of potassium in wastewater up to levels making it attractive for potassium recovery. The paper presents the advantages and disadvantages of potassium recovery from wastewater and reject water, in form of K-struvite. Technological parameters and economic conditions for successfully conducting this process are discussed. Recommendations for the use of K-potassium recovery are formulated including types of wastes that are preferable for increasing the concentration of this element in reject waters separated after the digestion process.

Keywords: K-struvite, potassium recovery, wastewater treatment plant

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Intelligent energy efficiency as the main trend in the construction and operation of “green” buildings

The latest technologies are becoming the main driving force of socio-economic development. Innovative methods of collecting and analyzing data are gradually taking the place of established mechanisms for managing the city and its infrastructure. Unlike statistical samples, which are outdated by the time they are analyzed, Big Data can be processed in real time, which increases the quality and speed of decision making.

Industry 4.0, “smart” building, “smart” transport system, “smart” city, “smart” energy system no longer surprise us, and we understand that this is not the future, but the present. It can be argued that the word "smart - smart, intelligent" is the key word of the 21st century. The creation of modern management models for an energy efficient building is a new reality in which it is already necessary to act. The paper describes one of the options for a "smart" approach to the implementation of an intelligent and energy efficient building. We have developed the TechDom building energy modeling system, which provides, in particular, the optimization of the building's energy consumption according to the specified parameters.

Keywords: energy efficiency, smart house, smart city, artificial intelligence

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Environmental assessment based on embodied energy and carbon footprint on phosphorus recovery from incinerated waste streams

Less than 20% of the P used in the food and feed production sectors are anthropogenically consumed. Therefore, by focusing on the major losses (mostly associated with meat production and crop farming), among the principal waste streams, animal manure and sewage sludge represent important secondary sources of P under the European Commission. A promising way to efficiently recover P is to address incinerated waste streams (P enriched sources) as potential substitute of phosphate rocks. Considering the multiple strategies proposed by scientists and stakeholders to manage properly wastes and critical resources, indicator for evaluating the environmental impact at preliminary stage (low technology readiness level) are of great importance. We report a simplified and novel approach, conceptualized as preliminary study to Life Cycle Assessment study, for sustainability evaluation of new technologies, based on the use of two parameters (i.e. embodied energy and CO_2 footprint) that account for the energy and emissions involved in the formation of a material. A dimensionless index, defined as SUB-RAW index, compares the results about the environmental impact of selected substituting material/process. This method is applied at laboratory scale processes reported from literature in the context of P recovery technologies, comparing chemical leaching approaches with thermal based techniques, i.e., carbothermic and thermochemical approaches. Some considerations are highlighted on the geolocation of the application. The sustainability evaluation tool aims to represent a milestone in the design of strategies to cope with resources depletion and to suggest opportunities for legislative evolution, in support of sustainable alternative to raw materials.

Keywords: sustainability, phosphorus, sewage sludge ash, poultry litter ash, ESCAPE approach

Acknowledgments: This research was under the scope of the Program ERA-MIN2 of the European Commission, Project DEASPHOR entitled “Design of a product for substitution of phosphate rocks”.

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Optimization of eco materials synthesis by the alkaine activation of natural Moroccan metakaolin and blast furnce slag waste using mixture design

Because of its environmental and economic benefits, geopolymers have sparked a lot of attention in recent years. The diversity of aluminosilicate sources and the design of compositions, on the other hand, must be regulated. Indeed, the use of analytical techniques for material evaluation and mix design optimization is now possible and efficient. To improve the geopolymer mixture design and forecast compressive strength, this work used two aluminosilicate sources, metakaolin as a first natural source and blast furnace slag as industrial waste.

The test findings revealed that the experimental Fisher values are higher than the Fisher-Snedecor critical value in the analysis of variance ANOVA, indicating that the components employed for modeling are globally meaningful. As a result, there were rather good correlations between the computed values and the predicted values (R2 = 95 percent for setting time and R2 = 96 percent for compressive strength), indicating that the established models were validated. Similarly, visualizing the designs in the variables space allowed us to identify the highest constituent qualities, resulting in a geopolymer with a compressive strength of 35.31 MPa.

Keywords: geopolymers, blast furnace slag, setting time, compressive strength, mixture design, response surface methodology

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The importance of reusing water in offshore platforms

Oil and gas platforms employ every year a huge amount of water (millions of m3) in their processes. Therefore, in order to reduce the environmental impacts and the logistics costs, water reuse inside the platforms has become a new reality with many benefits. Thus, this work aims to present the importance and methods of reusing water on offshore platforms. There are several types of water inside offshore platforms from potable water, sea water, produced water and discharge water. Potable water is employed in some processes and also for the maintenance of the workers, while sea water is often applied for desalination or water reinjection. Produced water is known as the main by-product of the extraction process due to the volume extracted, which is three to five times higher than the amount of oil and gas obtained. Discharge water is the effluent treated according to each country´s law and disposed back to the oceans. On-site water treatment must be developed, however, depending on the application of the reused water, different types of treatments are required. Not all platforms can implement this solution due to limited space, but it can be easily overcome with the aid of auxiliary ships that can be the basis for the treatments. So, instead of discharging the water back to the oceans, reusing this water should be more encouraged and employed, because although this water receive treatment before being discharged, it still contains traces of oil and other contaminants.

Keywords: reused water, produced water, oilrig

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The sustainability analysis of a zero-waste process combined with a statistical optimization: the case of rice husk poultry litter ash for phosphorous and silica recovery

This study proposes a novel strategy to evaluate the sustainability of a recent recovery process of raw materials from a biological waste. The integration of statistical analysis and the sustainability indicator, so-called SUB-RAW index, allowed to use an interdisciplinary approach for the process optimization. This method was applied to assess the recovery of phosphorous (P) and silica (SiO_2) from rice husk poultry litter ash (RHPLA). With a view to sustainable management of RHPLA, and in accordance with the zero-waste principles, both recovery processes were investigated. A design of experiment (DoE) was employed to perform 17 laboratory tests, for the chemical wet-extraction of P, using hydrochloric acid (HCl). Different molar concentrations of HCl and liquid to solid (L/S) ratio between the acid and RHPLA, were set as independent variables to optimize the operating parameters. With the aim of maximizing the P extraction efficiency (PEE) and at the same time minimizing the contamination by zinc (leachable heavy metal present in RHPLA), the SUB-RAW index was also calculated for each test. An HCl concentration of 0.34 mol/L and a L/S ratio of 50 were the best conditions from the statistical analysis, with a maximum PEE equal to 61.3%. On the other side, the sustainability evaluation showed that adopting 1 mol/L of HCl and a L/S ratio of 10 and starting from a minimum P content of 10% in RHPLA, the process would be more sustainable. SiO_2 recovery was found to be sustainably advantageous only if its content in RHPLA is higher than 80%.

Keywords: zero waste generation, sustainability analysis, Circular Economy, poultry litter ash, phosphorus recovery

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Assessment of metallurgical plant impact on the sea of Azov

Metallurgical industry has a negative impact on the air, soil and water environment. The activities of metallurgy enterprises includes a wide range of production processes (from metals extraction from ore to obtaining finished products) and generates large amounts of hazardous waste. Industrial wastewater discharge is the main source of aquatic area pollution. The purpose of the study is the assessment of industrial wastewater impact discharged from Azovstal Iron & Steel Works (Mariupol, Ukraine) on the state of the coastal waters of the Sea of Azov. The assessment was carried out in accordance with the current Ukrainian legislation and the adopted methodology for water state classification. The assessment was based on the monitoring data of sea water in the area of wastewater discharges for the period 2016–2020. The assessment was based on the aggregated numerical indices with consideration of the "limiting criterion principle". Such methodological approach allowed for a comprehensive assessment of the sea water quality as well as its sanitary and ecological condition. The results of the assessment confirmed the negative impact of industrial wastewater from the metallurgical plant on the coastal zone of the Sea of Azov, which contributed to the loss of its consumption values (communal and recreational purposes) and ecological functions.

Keywords: the sea of Azov, industrial wastewater, Water Quality Index (WQI), Water Pollution Index (WPI), Ecological State Index (ESI)

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Exogenous silicon application improves fenugreek (*Trigonella foenum-graecum L.)* tolerance to low phosphorus availability

In the present study, we investigate the beneficial effects of exogenous silicon (Si), as inorganic biostimulant, on fenugreek (*Trigonella foenum-graecum L.*) growth under low phosphorus (P) availability. The experiment was carried out in a growth chamber at 25 ± 1°C, 60% - 80% relative humidity and a photoperiod of 16h at the Polydisciplinary Faculty of Beni-Mellal, Morocco. After germination, the fenugreek seedlings were treated with 3 mM Si and submitted to P deficiency. After 25 days of stress, the plants were harvested and subjected to some agrophysiological and biochemical analyses associated with the tolerance to this abiotic stress. Results showed that P stress significantly reduced plant biomass, plant height, relative water content and total chlorophyll content. However, exogenous Si supplementation contracted these negative impacts of P stress and significantly improved all of the parameters studied. Furthermore, P deficiency also induced an oxidative stress reflected by high malonyldialdehyde content and electrolyte leakage percentage. Though, P stress-mediated oxidative stress was alleviated by Si through a significant increase in the activity of non-enzymatic and enzymatic antioxidant systems, suggesting that 3 mM Si application was directly involved in the central defensive mechanisms to enhance the tolerance of fenugreek to low P availability.

Keywords: fenugreek, growth, silicon, phosphorus deficiency, antioxidant activity

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Opportunity production solid recovery fuel from refuse derived fuel and use it as an alternative fuel for the cement industry of Lithuania

The amount of municipal solid waste (MSW) has increased significantly over the past decade and has grown steadily worldwide. However, it is possible to produce alternative fuel from waste. The refuse derived fuel (RDF) is a fuel produced from energy-rich, not recyclable fraction MSW materials separated at the mechanical biological treatment (MBT) plant. However, if we improve the quality of RDF, we can get solid recovery fuel (SRF) that can be used as an alternative for conventional fossil fuels in industrial sectors. This fuel can be obtained by multi-stage treatment of high-calorific fractions of non-hazardous materials extracted from MSW. Today, the cement industry is considered one of the largest energy consumers in the world construction industry. The use of SRF as a substitute for alternative fuels in the cement industry can reduce waste, greenhouse gas emissions and raw material consumption. The main objective was to examine the opportunity to produce SRF from RDF as an alternative fuel for the cement industry in Lithuania. It was found that the produced SRF from RDF could be used as an alternative fuel for clinker burning in the amount of 5% to 25%. This amount of replacement fuel will not lead to deterioration in the quality of the resulting clinker. Ash obtained after refuse derived fuel incineration has pozzolanic properties. The ash received after incineration of SRF can be used to produce binders materials since, in the presence of high temperatures, the amorphous phases turn into crystalline ones.

Keywords: municipal solid waste, refuse derived fuel, solid recovery fuel, energy consumption, cement industry

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Synthesis of sustainable porous materials to improve air quality entrapping particulate matter

High particulate matter (PM) concentrations recorded in cities due to traffic and domestic heating are cause of concern for the risks related to human health. The need for policies that aim to reduce PM concentration is mandatory. Besides, the current environmental situation and the large scale waste generation require methods that allow to minimise wastes' impact according to circular economy principles. To meet these needs, SUNSPACE ("SUstaiNable materials Synthesized from by-Products and Alginates for Clean air and better Environment"), a sustainable porous material, and its modification were developed. These materials are synthetized from industrial by-products like silica fume (SF) and bottom ash (BA). Different formulations were proposed changing the pore former, from sodium bicarbonate to hydrogen peroxide, to avoid the thermal treatment and obtain a more sustainable material. Two different hydrogen peroxide concentrations were used. Materials were fully characterized through structural and porosimetric analysis. The adsorption capacity of these materials was assessed using an aerosol nanoparticles generator and a TiO_2 suspension to simulate PM source. Tests revealed that samples with lower hydrogen peroxide concentration had the best performance. This result is doubly positive: on the one hand it ensures the reduction of PM concentrations, on the other the material is even more sustainable. Research is on-going to improve their characteristics with the main purpose of apply these materials as plaster on buildings' facades or tiles on roof.

Keywords: SUNSPACE, Circular Economy, PM entrapment, sustainable materials, industrial by-products

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Transition towards a circular economy: a case study of Wielkopolska region, Poland

One of the main pillars of the European Green Deal is the new Circular Economy (CE) Action Plan. The CE model, perceived as a new way of developing society, indicates that the current system requires transformation. The transition to the CE involves the development of guidelines that should be closely related to the regional strategy.

The research attempts to assess the level of implementation of the CE concept at the regional level, based on the example of the Wielkopolskie voivodeship (Poland). Taking into account the complexity of the CE model, it is vital to identify its key development areas in the region. For this purpose, various research methods were used, i.e. desk research, interviews with experts, surveying entrepreneurs, and statistical analyzes. The following sectors were distinguished in the study: agriculture, industrial processing, waste management, energy, and transport.

The role of innovation in the transformation was also emphasized. The implementation of the CE model among the surveyed companies from the Wielkopolska region required innovative activities, services, and products. The directions of innovation development include processing of bio-waste into energy and biofuels, sustainable construction, and intelligent packaging. To define the prospects for further CE implementation, it was also necessary to identify progress barriers, such as organizational, financial, human resources, market, and infrastructural barriers as well as those related to the lack of awareness.

The study indicates specific opportunities for the development of the CE model in the Wielkopolskie voivodeship, hence the results can be used by local government administration, residents, and entrepreneurs.

Keywords: Circular Economy, regional case study, Wielkopolskie voivodeship

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Influence of ultrasonic field parameters on the biochemical activity of leachates from the composting process

Re-use of leachates by recycling it for composting is part of the circular economy. However direct returning the compost leachates to the mixture might increase concentration of contaminants in the stabilized mass. The application of ultrasonic modification of leachate was aimed at increasing the activity of microorganisms and the availability of nutrients and reducing the number of pathogenic species. Low-intensity waves can accelerate cell metabolism by improving the permeation of various substrates across cell membranes and increasing the rate of substrate transfer to the enzyme's active site. On the other hand, ultrasonic waves of higher intensity cause denaturation and destruction of the activity of biocatalysts, changes in the charge on the cell surface as well as disruption and fragmentation of the cell membrane. The purpose of the work was to determine the impact of variable ultrasonic (time and amplitude) field parameters on the biochemical properties and number of selected groups of microorganisms of leachates from the composting process. The tests used short sonication times 15, 30, 60, 90, 120 s and vibration amplitude: 15.25, 30.5, 46 μm. The assessment was made on the basis of changes in numbers of microbial communities (mesophilic, thermophilic, Escherichia coli, Salmonella spp. and fungi) and enzymatic activity (dehydrogenases-DHA), as well of respiratory activity (AR). Due to the results of the conducted microbiological tests, it was found that the leachates sonication time of 60 seconds and amplitude 30.5μm were the most effective, on the increase in the number of the analyzed groups of microorganisms. The above parameters were considered borderline, above which there were no significant differences in the values of the analyzed indicators.

Keywords: leachates, ultrasounds, dehydrogenases, respiratory activity, microbial communities (mesophilic, thermophilic, Escherichia coli, Salmonella spp., fungi)

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The application of electrodialysis in [Emim] Cl and [Omim] Cl ionic liquid recovery from wastewaters

The 1,3-dialkylimidazolium based ionic liquids (ILs) can be used as an appropriate medium for various chemical applications. However, they are often diluted to a low concentration, during their application in chemical processes. Moreover, they can have an toxic impact on environment, therefore, it is very important to elaborate the methods of their disposal and recovery. In this study the effectiveness of 1-ethyl-3-methylimidazolium chloride ([Emim]Cl) and 1-methyl-3-octylimidazolium chloride ([Omim]Cl) recovery from wastewater by electrodialysis (ED) method was investigated. The influence of the ILs concentration on the recovery ratio and concentration degree were examined. The experiments were conducted using a laboratory EDR-Z/10-0.8 module supplied by MemBrain, Czech Republic, equipped with Ralex AM(H)-CM(H) membranes. The obtained results proved that, ED allows for [Emim]Cl, as well as [Omim]Cl concentration and recovery from wastewater. It was found that, the highest [Emim]Cl and [Omim]Cl recovery were obtained at 2 V applied potential per one membrane pair, 2 cm/s linear flow velocity, 0.2 M and 0.1 M IL in the feed solution, respectively. It was noted that, by application of ED method a 2.4, and 2-fold concentration of [Emim]Cl and [Omim]Cl, respectively can be obtained, with a recovery ratio above 80%. It was also found that, due to the difference in the cation size, the [Emim]+ ions migrate more easily across ion-exchange membranes than the [Omim]+ ions.

Keywords: ionic liquids recovery, 1-ethyl-3-methylimidazolium chloride, 1-methyl-3-octylimidazolium chloride, electrodialysis, membrane processes

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Metal-organic framework composite sorbents on clays for carbon capture

The most important factor driving global warming is increasing emissions of CO_2, requiring mitigation as well as adaptation to climate change as stated in EU climate initiatives and European Green Deal. Carbon Capture (CC) is a set of technologies that can effectively decrease CO_2 concentrations in atmosphere and amongst other methods use of sorbents seems to be promising and efficient. Metal-organic frameworks (MOF) are a class of organic compounds, that consists of metal ions and organic ligands, forming network with one-, two- or three-dimensional structures with presence of pores and channels being able to hold CO_2. Due to physiochemical properties, MOFs work as a molecular sieve with high capacity for CO_2 sorption, thus providing more efficient and cost-effective alternative to traditional CC methods. Although, MOFs are promising for CC, their properties can be further improved by modifications with different high surface area materials to provide higher yields for sorption, higher stability. Clay is one of the most abundant minerals with very small particle size and high surface area, that can be used as a cheap material improving MOF based sorbent functions. The aim of this study is to develop MOF based composite sorbents with different clay minerals as carriers, thus improving various MOF properties maintaining high sorption capacity. Thermogravimetric results from CO_2 sorption analysis for CuBTC MOF on montmorillonite shows slight increase of adsorbed CO_2 (from 2,4 to 2,6 mmol/g) compared with raw CuBTC MOF material. Clay minerals can be considered as a potential substance for MOF sorbent enhancement.

Keywords: carbon capture, metal-organic framework, composite sorbents, clay

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The use of ultrasound to removal of 4-tert octylphenol by hydrogen peroxide assistance

Endocrine disrupting compounds (EDCs) was recognized as a large group of diverse contaminants which are widely spread in environmental compartments. According to the literature reports, they have a significant impact on human health even in very small doses thus recently, removing EDCs from the aquatic environment attract the attention of many researchers. 4-tert octylphenol (OP) is a compound identified as EDCs that causes many harmful health effects such as reduction of testosterone and sperm production. Moreover, it can significantly affect the reproductive system. OP is widely used in dispersants, detergents, emulsifiers, wetting agents, and solubilizers. Literature data shown, that conventional wastewater treatment methods can be not sufficiently effective in EDCs removal, so other techniques should be developed.

In this study, the removal effectiveness of OP from the urban sewage treatment plant synthetic effluent by using ultrasound was evaluated. Furthermore, the effect of hydrogen peroxide addition was determined. Research revealed that the degradation rate of OP was proportional to the amplitude, sonication time, and hydrogen peroxide dosage. To evaluate the process effectiveness, the gas chromatography method (GC-MS) was used preceded by solid phase extraction (SPE). The analysis has shown that after 45 min of sonication removal of OP reached 88%. Research revealed also that combined ultrasonication and hydrogen peroxide dosage were more effective than these methods used as a single processes. At the dosage of 12 mgL^{-1} hydrogen peroxide, OP removal was 57% while in the combined process it was enhanced by 10% during 1 min sonication.

Keywords: ultrasound, hydrogen peroxide, endocrine disrupting compounds, wastewater treatment, advanced oxidation processes

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Characterization, physico-chemical study of municipal sewage sludge and its potential use as fertilizers: case of Tetouan city in Morocco

Annually, a large amount of residual sludge is created as a result of the development of urban water treatment plants. Usually, this sludge is widely dispersed in the digested state after anaerobic digestion or in a pasty form without passing through a digester. By spreading dehydrated sludge over agricultural land, the sludge preserves its properties and provides for the best agronomic recovery. Indeed their contribution increases the productivity of degraded Mediterranean soils or sandy soils in Saharan regions, which are characterised by low fertility due to low nutritional supply and low organic matter content. Because sewage sludge from Tetouan city is a good soil conditioner, its use in agriculture is particularly desirable. Its role as a fertilizer is mainly attributed to the almost basic pH and the presence of vital plant elements (N, P, Ca, organic matter, etc...).Trace elements such as Zn, Cu, Fe, etc ..., necessary for plant growth, are also reported. The study carried out on the residual sludge from the treatment plant enabled us to assess their fertilizing potential and their degree of pollution by heavy metals. Thus, their valorization in agriculture gives for 100 g of dehydrated sludge 40.8% Calcium and 25.08% Iron. The sludge's specific composition varies based on the source of the wastewater, the time of year, and the type of treatment and conditioning used in the treatment plant. The objective of this work is to improve the operational processes of the M'diq-Fnideq "Tamauda Bay" wastewater treatment plant as well as the recovery of residual urban sludge from the plant. To do this, we report here the physico-chemical characterization that was carried out on certain specimens during the spring season.

Keywords: wastewater, environment, pollution, sludge, trace elements, pH

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From sewage sludge to soil – sorption of pharmaceuticals

Sewage sludge produced in the process of wastewater treatment, managed for agriculture, poses the risk of disseminating all the pollutants contained in it. Therefore, such sediments are tested for the content of heavy metals or the presence of parasites. However, the concentration of pharmaceuticals in sewage sludge is not controlled. The presence of these micropollutants in sludge have been proved and there is no doubt about their negative impact on the environment. An interesting issue is the fate of these micropollutants in the soil. Due to this knowledge, it will be possible to finally assess the safety or lack of safety in the agricultural use of sewage sludge.

The article discusses the issues related to the groups of pharmaceuticals and their derivatives and their physicochemical properties that determine the processes to which the compounds are subject. In particular, attention should be paid to the potential sorption capacity of these micropollutants in soil. This is important from the point of view of implementing a circular economy, which perfectly fits the agricultural use of stabilized sewage sludge. Research should be undertaken that will clearly show that there is no risk from pharmaceuticals, or vice versa: they will contribute to the strict determination of the maximum permissible concentrations in sludge, which will become an additional criterion applicable in the legal acts on municipal sewage sludge.

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

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Enhanced nature-based solutions by reactive materials for protection of urban water bodies

Nature-based solutions (NBS) are defined as supported and inspired by nature solutions that are cost-effective and simultaneously provide environmental, social and economic benefits that help build resilience. In case of water resources, NBS increase quantitative of water resources but also on the other hand, contribute to water quality improvement by limitation and inhibition of eutrophication process. The aim of the study was to assess the efficiency of opoka rock (carbonate–siliceous rock) for phosphorus (P) removal and pointed its potential application in NBS for protection of urban water bodies. The batch reactor studies were taken for three different initial $P\text{-}PO_4$ concentrations: 0.996, 5.113 and 10.815 mg/L that corresponded to sorption: 0.084, 0.464 and 1.018 $mgP\text{-}PO_4/g$. The research investigated also sorption mechanisms by different kinetic models: pseudo-first and pseudo-second kinetic order models, Elovich and intra-particle diffusion model. The most likely mechanism of P removal in the case of tested reactive material (RM) is chemisorption, which is confirmed by the highest fit to the pseudo-second kinetic and Elovich models. The implementation aspects of presented study was the nomogram indicating sorption at a given initial $P\text{-}PO_4$ concentration. The study presented also the potential application of tested RM to enhanced NBS for protection of urban water bodies pointed to reduce $P\text{-}PO_4$ concentration.

Keywords: kinetic models, nature-based solutions, phosphorus, reactive materials, water treatment

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Environmental and economic effect of upgrading of on-site wastewater treatment plant

The aim of the study was to estimate both environmental and economic effect of upgrading of the activated sludge container on-site wastewater treatment plant. Two forms of upgrades were tested: (i) an implementation of fluidal bed and (ii) implementation of sand vertical filter before discharging sewage into the receiver. The efficiency of each upgrade was evaluated by selected wastewater quality indicators (BOD_5, solids, EC, pH and colour). Environmental effect was calculated based on the BOD_5. Results showed that the implementation of fluidal bed, what resulted in the change of the type of container wastewater treatment plant from activated sludge to hybrid one, improved the efficiency of BOD_5 removal and at the same time increased the average values of other tested parameters. Upgrading of container plant by addition of vertical sand filter resulted in lower BOD_5, solids and colour of the effluent. Environmental effect calculated based on BOD_5 was positive for both upgrades, but higher value was obtained for vertical sand filter. The actual values of both upgrades (calculated for 10 years of operation time and discount rate = 5%) expressed as a cost by environmental effect are of 0.004 and 0.014 $ per 1 mg of BOD_5. The ecosystem service of BOD_5 reduction is valued at 1.79 and 2.56 $/mg for first and second upgrade, respectively.

Keywords: on-site treatment, wastewater, activated sludge, fluidal bed, sand filter

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Experimental research on compressibility characteristics of recycled concrete aggregate – recycled tire waste mixtures

The number of civil engineering projects is increasing, improving the quality of life worldwide, but the finite amounts of natural materials are limiting their use for construction activities. By promoting sustainable use of materials, anthropogenic soils like recycled concrete aggregates, solid waste such as discarded tires, fly or bottom ashes, or others have been reused in construction. The continuous growth of transportation needs is accompanied by important progress in highway transportation networks and consequently produces a huge amount of car tires waste, and causes numerous environmental problems. However, due to their lightweight and high damping performance, the addition of rubber in soil could improve significantly its seismic performance. Therefore, in the last two decades, many types of research have been conducted on the engineering properties of soil-rubber mixtures. In this study, a series of laboratory tests are conducted on composite materials that consist of recycled concrete aggregate (RCA) and crushed pieces of recycled tire waste (RTW). Oedometer tests are carried out to explore the influence of rubber particles on the compressibility parameters of RCA-RTW mixtures. Eight loose mixtures of variable grain-size distribution, rubber inclusion (RC), and fine fraction (FF) content are tested. The results show that the compressibility of the RCA-RTW mixtures generally increases with an increasing proportion of rubber waste. It is also noticeable that the increase of average void ratio for the mixtures M5-M8 has been developed in the power function. All RCA-RTW blends tested are characterized by higher values of the compression index (CC) and swelling index (CS) compared to the pure RCA specimens. It is shown that the mixtures including rubber have the oedometric modulus less than 42MPa and 96MPa, primary and secondary, respectively. The consolidation process in all analyzed mixes is fast; the consolidation curves have a similar path; the thresholds of change to subsequent phases of the consolidation process are clear. In most cases, as the rubber content of the mixtures increases, the consolidation index (cv) increases too.

Keywords: recycling, environment, waste, anthropogenic soil, oedometer tests

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Studies on the caffeine occurrence in swimming pool water

The consumption of caffeine-containing products as a stimulating agent improving cognitive functions and physical performance is a well-known and accepted phenomena in the vast majority of the human population. The presented research was focused on the identification of caffeine and its metabolites in swimming pool water. Swimming pool water samples were collected from a public swimming pool complex within one day of its use. The samples were subjected to chromatographic analysis preceded by solid phase extraction. The occurrence of caffeine was confirmed in all tested samples. The concentration of this organic micropollutant depends on the number and age range of pool users. The highest concentrations, which ranged from 250 to 335 ng/dm^3, were noted in samples collected from the indoor training pool used by adults. Whereas, the lowest concentration, which did not exceed 25 ng/dm^3, was noted in samples from the indoor children pool. Additionally, the chromatographic analysis indicated the presence of trace amounts of theobromine. This compound is a primary caffeine metabolite formed in the liver.

Keywords: swimming pool water, caffeine, monitoring

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Reduction of energy costs associated with ventilation at the Queen Luisa Adit – case study

The Queen Luiza Adit is an underground facility used for tourist traffic. For that purpose, two fan stations with air duct fans were applied, which endure the flow of air in the museum at the level of 12 m^3/s (6 m^3/s per a fan). The daily cost of the energy fed to the fan stations is approximately 50 euro. In the study in concern, an appraisal, an assessment of ventilation of the facility was conducted, aimed at the reduction of ventilation costs. The conducted activities aimed at decreasing the amount of air and sealing some of the inlets, allowed for decreasing the costs of fan operation while ensuring proper aerological safety level of tourists and employees of the Museum. The savings achieved by changing the fan operational parameters were approximately 6 Euro a day. Assuming the cost of purchasing the inverters for approximately 5000 Euro, the expected return time of costs shall be 30 months.

Keywords: ventilation, tourist traffic, cost of the energy

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Impact of the revision of the legislation on limit values for nitrogen oxides on the design of ventilation in excavated tunnels – case study

In this article, a case study was conducted, where the impact of a change in the regulations concerning the maximum permissible concentrations and intensities of factors harmful to health in the working environment that may occur during tunnelling using mining techniques was discussed. According to the legislation "for the underground mining and tunnel boring sector, until 21 August 2023, the maximum permissible concentration limit values of 3.5 mg/m^3 and the instantaneous maximum permissible concentration limit of 7 mg/m^3 apply for nitrogen oxide". After that date, the maximum allowable concentrations will change to a maximum allowable concentration of 0.7 mg/m^3 and an instantaneous maximum allowable concentration of 1.5 mg/m^3 respectively. This may entail the necessity to change the ventilation method and the selection of appropriate ventilation equipment. The analysis included calculations of the maximum power of machinery and equipment operating in a 500 m long tunnel with a cross-section of 100 m^2 during its tunnelling, using the emission standards for diesel trucks for the European exhaust emission standard EURO 4, EURO 5 and EURO 6, respectively.

Keywords: tunnel ventilation, nitrogen oxides, exhaust emission standards

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Development of an innovative, environment-friendly production technology of large-format, deeply structured ceramic tiles using a pioneering method of recycling green scraps generated at the product forming stage

The subject of the Project co-financed by the European Regional Development Fund under Measure 1.1 "R&D projects of enterprises", Sub-measure 1.1.1 "Industrial research and development works carried out by enterprises" of the Intelligent Development Operational Program 2014 - 2020 is the development of an innovative, environment-friendly production technology of large-format, deeply structured ceramic tiles using a pioneering method of recycling green scraps generated at the product forming stage. Breakthrough process solutions have been developed (transition from the "wet" method to the "dry" method), enabling the return of all soft waste generated during the product formation stage, and then using this waste to produce full-value, high physical, chemical and strength parameters and the manufacture of a ceramic product in accordance with the industry standard EN 14411.

The research effort will also be devoted to creating new knowledge in the field of production technology, which will be verified by conducting test production on a pilot technological line. Its construction is necessary to confirm the achievement of the Project objectives - obtaining the assumed parameters of the new product. The planned result will be obtained through industrial research and development works divided into three stages. Stage 1 research work gave positive parameters for the final product. Changing the technological process will affect the quality and efficiency of production. Thanks to the introduced innovation, it is estimated that water consumption will be saved at the level of 750 m^3 per month and gas savings at the level of 43,000 m^3 per month. The use of the "dry" method of turning back soft defects also gives a very important pro-environmental aspect. The reduction of water consumption will contribute to the reduction of CO_2 emissions produced during the drying of the wet body composition by traditional methods.

Keywords: ceramic tiles, recycling all green scraps, environment-friendly production technology

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LumiMARA as an indicator of water quality in the Świętokrzyskie voivodeship

The area of Świętokrzyskie voivodeship is located within the range of several macro-regions, the parent rocks are highly differentiated, which affects the diversity of soil and water conditions. and water conditions. The weakest soils occur in the central and northern parts, the best soils in the eastern and southern parts of the Świętokrzyskie Voivodeship. The study presents selected physicochemical properties of groundwaters captured by borehole wells and spring waters in selected areas of the and spring waters in selected areas of the Świętokrzyskie voivodeship. The analysed water was subjected to toxicity analysis using multispecies LumiMARA test (Microbial Assay for Risk Assessment) and physicochemical parameters were determined - pH, carbonate hardness and total hardness, conductivity, OWO and chlorides. The water samples for the study were collected at different times of the year 2021- January, April, July, November. The conductivity of the tested waters, regardless of the source of origin, varies by location. The aim of the study was to analyze the quality of water due to ground and water conditions and very high interest and use of water from the studied sources by the inhabitants of the regions.

Keywords: LumiMARA, water quality, underground water, spring water, physicochemical parameters of water

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Recovery of bioactive compounds from distillery stillage using acetone with conventional solid-liquid extraction

Production of 1L alcohol generates about 15L by-products (so-called distillery stillage), containing hardly biodegradable organic substances. Distillery stillage is a source of antioxidant compounds, the recovery of which is one of the ways to valorize this waste. The aim of the study was to determine the efficiency of polyphenol recovery from distillery stillage by conventional solid-liquid extraction with acetone.

Extraction was using 40, 60, 80 and 100% acetone at 15, 30, 45, 60 and 90min. Total polyphenols content (TPC) and total flavonoids content (TFC) were determined in extracts. Chromatographic separation of phenolic acids was using HPLC at 260 and 320nm. Antioxidant activity of the extracts was measured with three assays (ABTS, DPPH and FRAP). The highest TPC, TFC and total concentration of phenolic acids were obtained using 60% acetone at 60min (2.13mg GAE/g DM, 0.40mg QUE/g DM, 1.18µg/g DM, respectively), the lowest - 100% acetone at 15min (0.49mg GAE/g DM, 0.10mg QUE/g DM, 0.43µg/g DM, respectively). Ferulic acid (0.54µg/g DM) and p-coumaric acid (0.28µg/g DM) were mostly recovered. Syringic acid was recovered at the lowest concentration (0.02µg/g DM). The highest antioxidant activity was obtained using 60% acetone at 60min (ABTS: 5.47µmol TE/g DM, DPPH: 2.64µmol TE/g DM, FRAP: 1.65µmol FeSO4/g DM), the lowest - 100% acetone at 15 min (ABTS: 2.43µmol TE/g DM, DPPH: 1.09µmol TE/g DM, FRAP: 0.79µmol FeSO4/g DM). The best solvent for the extraction of polyphenols with high antioxidant activity was 60% acetone during 60min. Optimizing extraction conditions allows for obtaining high-value extracts from the distillery stillage.

Keywords: antioxidant activity, HPLC, phenolic acids, valorization, bioeconomy

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Management of salt hydrates from photovoltaic installations in the light of existing environmental legislation in the light of existing environmental legislation

Technologies used for photovoltaic-based power generation are still evolving. This paper discusses the environmental criterion, rarely addressed in the literature, for the selection of salt hydrates for use in photovoltaic installations as PCM materials. The aim of the paper is to assess the possibility of utilization of used salt hydrates from photovoltaic installations according to current Polish legal requirements concerning the environment. The properties of the composition components of hydrated salts were discussed in terms of their safety for the environment before and after the period of exploitation in photovoltaic panels. A method of dealing with used salt hydrates was proposed and a waste code was assigned. It has been established that spent salt hydrates (waste code 161002) will be allowed to be collected in no-outflow tanks and accepted at liquid waste collection points, which operate at water supply and sewerage companies. Pursuant to the Regulation of the Minister of the Environment (Journal of Laws, 2019, item 1311) the load of permitted pollutants should not exceed the values for industrial wastewater.

Keywords: salt hydrates, waste management, photovoltaic installation, environmental protection

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Towards the circular economy – an integrated system of thermal hydrolysis/membrane processes for recovery of chromium from wastes to reuse in tannery practise

The depletion of non-renewable resources, including chromium, and the dwindling clean water resources are the main factors driving the search for solutions enabling the tanning industry to move from a linear economy model to a circular economy model. The paper presents the results of research on a new method of chromium recovery from solid waste generated during tanning of raw hides. In the first stage, the shredded mixture of useless leather scraps (cuttings, shavings, grinding dust) is decomposed in the process of thermal hydrolysis in nitric acid using appropriate process conditions (temperature 160^{o}C, time 60 minute). Then the liquid product of this process (hydrolysate) is fractionated using membrane separation techniques. The microfiltration process enables the initial purification of the hydrolysate by concentrating the organic matter (fats, proteins). On the other hand, the nanofiltration process enables the concentrated of total chromium 3 times in the pre-purified hydrolysate. The total chromium concentrate prepared in the above manner was successfully used in model tanning processes. They were carried out using bovine hides after the pickling operation and a mixture of commercial chromium tannin and concentrate after the nanofiltration process. The reference sample was bovine leather traditionally tanned with a commercial chrome tanning agent. Based on the results of physical tests (thickness, tensile strength, elongation) and chemical tests (determination of total chromium content), it was found that the properties of leathers tanned with the use of chromium recovered from waste are similar to those of leathers traditionally tanned with a commercially available chromium tannin.

Keywords: tannery wastes, thermal hydrolysis, membrane processes, recovery of chromium, circular economy

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Biotechnological perspectives of food packaging production based on biodegradable polymers

Plastics have been a part of everyone's lives for many years. For a long while polymers were the perfect solution for packaging due to their many benefits, such as lightness, transparency, flexibility, low production cost and their widespread availability. However, plastics are compounds based on polymers and various other chemicals such as stabilizers or colorants and due to their composition and properties like non-biodegradability they have caused a severe ecological issues. With growing safety and environmental concerns, biopolymers, which can be used in many branches of industry, have received increasing attention compared to conventional plastics. Biodegradable polymers are non-toxic, environmentally friendly biopolymers that can be easily degraded in home or industrial composting conditions. Nowadays, biopolymers used for food packaging applications are more and more popular for their neutral environmental impact and ability to inhibit food spoiling. The following work reviews the latest state of the art on different biodegradable polymers currently being used in food packaging production and discusses properties and limitations of the most common ones.

Keywords: biopolymers, food packaging, bio-based materials

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Social license for closure – consequences of closing mining enterprises

Meeting the requirements of the European Union's policy under the European Green Deal requires Poland to take decisive transformational measures aimed at total decarbonisation. Poland's achievement of climate neutrality is a challenge, given the special role of coal in the Polish economy. The complete abandonment of the use of coal is the greatest challenge for the local communities of mining regions, where the labor market depends on the functioning of the mine. The closure of mining enterprises is now a key issue in meeting the obligations imposed by international agreements and initiatives. It is therefore necessary to define the proper management of decommissioning processes, taking into account the key risks arising from them, so as to minimize the social cost of closure in the first place. For this purpose, the authors of this article introduce the concept of a social license for closure (SLC) granted to mining enterprises. By engaging the community, the SLC gives it a voice, allowing it to take into account the individual needs of mining regions and ensure a successful and just transition. The article reviews the literature in the field of decarbonisation, threats related to mine closures and social acceptance of liquidation. The example of Wałbrzych, a Polish post-mining town, in which liquidation processes led to a socio-economic collapse was presented. The authors attempted to define the assumptions and framework for the functioning of the SLC and to answer the question whether the involved community is able to reduce the negative effects of the liquidation.

Keywords: mine closure, decarbonisation, social license for closure

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Machine learning algorithms as a modern tool for geotechnical parameters determination of combustion slag in the context of sustainable development policy for the civil engineering sector

The development of the construction sector in recent decades has not been environmentally indifferent, although an increasing amount is being done in this direction. One of the policy objectives of the European Union is sustainable development directed at the need to re-use available supplies. Systematic reduction of natural aggregate resources obliges to search for alternative solutions and substitutes of these key materials for the construction industry. Combustion slag (CS) could be one of these substitutes. Combustion slag as a post-industrial waste material is stored in landfills in heaps, which poses a risk of smaller fractions being carried with the air and polluting the surrounding areas. The use of combustion slag in civil engineering reduces the number of landfills for this material and reduces the need to use natural aggregates. Due to the origin of CS, this material varies from one batch or place of origin to another. Therefore, it is important to create tools that can safely estimate the parameters of this material while minimizing risks. Machine Learning algorithms are widely used in various fields of management. Using the example of permeability coefficient, which is an important geotechnical parameter, the possibility of using Machine Learning algorithms in determining this parameter was tested. In this study, Artificial Neural Network (ANN) algorithms were used and compared with a nonparametric k-Nearest Neighbor (kNN) algorithm. The algorithms were compared with each other and the kNN algorithm obtained a better fit to the source results. This algorithm achieved an R2 fit of 0.97. This allowed conclusions for further application of machine learning algorithms as a tool to support activities related to sustainable development of the construction sector.

Keywords: sustainability development, combustion slag, machine learning, artificial neural network, k-nearest neighbor

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Reuse – reduce – recycle: responsible water and wastewater management in swimming pool facilities

The main objective of the study is to analyse the quality of washings produced as a result of backwashing filter beds in the selected swimming pool facility in terms of the possibility of their discharge into the ground or surface water bodies or return to the swimming pool water circulation, and thus rationalization of water and wastewater management in the swimming pool under consideration. The quality of the washings samples was tested in laboratory conditions in three stages. In stage 1, the washings were subjected to the sedimentation process, then the supernatant water was subjected to the jar coagulation process (stage 2) and in stage 3 to the pressure membrane filtration process (ultrafiltration with the use of a polymer and ceramic membrane). After each test stage, based on physico-chemical analysis (pH, temperature, free chlorine, combined chlorine, turbidity, total suspended solids TSS, chemical oxygen demand COD, nitrates, chlorides, total organic carbon TOC, hardness, aluminium) and bacteriological (total number of mesophilic bacteria) of washings samples, the degree of their contamination was determined and compared with the guidelines of the ordinance on substances particularly harmful to the aquatic environment and the conditions to be met when discharging wastewater into surface waters or soil (Journal of Laws of 2019, item 1311) and with the guidelines of the regulation on swimming pool water quality (Journal of Laws of 2015, item 2016). Discharge of raw washings from the tested swimming pool object to the surface water or drainage into the ground is not possible, mainly due to the TSS content above 35 mg/L (138-156 mg/L) and free chlorine concentration above 0.2 mgCl_2/L (0,24-0,32 mg Cl_2/L). As a result of sedimentation, the amount of suspended solids decreased by about 67% (to 48 mg/L) and the concentration of free chlorine by about 28% (to 0,20 mgCl_2/L). After the coagulation process (with the applied optimal dose of polyaluminium chloride 1,50 mg Al/L), the amount of suspensions (compared to stage 1) decreased by 75% (to 11,7 mg/L) and the concentration of free chlorine by 55% (to 0,09 mg Cl_2/L). After the ultrafiltration process, the amount of TSS was reduced by 34% -54% (to 5,3-7,7 mg/L) and free chlorine by 70% -85% (to 0,01-0,03 mg Cl_2/L) compared to stage 2 and depending on the type of membrane used. The total number of mesophilic bacteria > 100 CFU/1mL was not found in the supernatant water samples after the 1st, 2nd and 3rd stage of the study. The use of a 3-stage washings treatment process makes it possible to use supernatant water from the washings as water to replenish losses in the swimming pool water treatment circuit. For the tested swimming pool, the recovery of approx. 75% of water from the washings would allow for an annual reduction of costs for the discharge of sewage to the sewage system by approx. 30 976 PLN (including VAT and the price in PLN per m^3 of sewage on November 21, 2021).

Keywords: rational water and wastewater management, swimming pool, washings, sedimentation, coagulation, ultrafiltration

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Nematodes inhabiting recultivated municipal sludge and its biological microbiome activity

Soil nematode communities were analyzed (total abundance, number of taxa, diversity indices of genera and species, number of taxa, diversity indices of genera and species, trophic structure) on triplicate observations during 2 years experiment in reclaimed municipal waste dumps covered with natural soil planted with grass and used as pasture. The samples of each of the combinations (1m2plots) were taken three times during the experiment: twice in the autumn and once in the spring. Criconemoides informis, Mesocriconema curvatum, Loofia thienemanni, Hemicyclophora triangulum build higher population densities on the heavy clay, medium clay and medium clay plots. Trophic nematode populations: fungivores, omnivores and predators build higher population densities in plots of medium sand and light/medium clay. Bottom gasometry was also analyzed for each of the combinations. A higher density and proportion of bacterial nematodes indicates large amounts of easily degradable organic matter. The analysis of the composition and activity of the microbiome shows that the method used is recommended to preserve the biological activity of the reclaimed areas.

Keywords: plant parasitic nematodes, reclamation, landfills

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Removal of heavy metals in ultrafiltration with clay based mixed matrix nanocomposite membranes – mechanism and performance

Clay based mixed matrix nanocomposite membranes are a new group of membranes characterized by improved rejection characteristics, higher permeability, and better antifouling performance. They can be used in ultrafiltration for removal of different water pollutants such as NOM, dyes, heavy metals from water matrices. The aim of this study was to compare of performance of three different clay-based nanocomposite membranes in removal of Ni^{2+}i and Pb^{2+} from rainwater. Montmorillonite (MM), halloysite nanoclays (Hal) or metakaolin (MK) in the amount of 0.05%wt. were used as nanofillers in membranes. The highest removal degree of both Ni^{2+} (91%) and Pb^{2+} (100%) was obtained for Hal-membrane. Increase in the transmembrane pressure increased removal degree of Ni. Retention mechanism of Ni^{2+} was related to Donnan effect, while for Pb^{2+} - adsorption plays a crucial role.

Keywords: clay, mixed matrix nanocomposite membranes, heavy metals

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

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EU's policies for lithium ion batteries – an overview

Lithium ion batteries (LIBs) are a key technology in the transition to a decarbonised and clean energy system due to their application in the power sector and electric transport. Their development and production are a strategic imperative for Europe in the context of energy transition. However, a growing demand of these batteries lead to an equivalent increase in the demand of raw material and in the generation of waste, with a high environmental impact. Hence, to make LIBs a true enabler of the green transition, new policies must be put in place. Currently, the existing EU Batteries Directive dates to 2006, and has not been updated since then. It should be noted that LIBs are considered as "Others batteries". In the last year, new socio-economic conditions, technological developments, markets, and battery uses have come out, and the environmental challenges that we must face are driving to modernize the EU's legislative framework for batteries.

In this work, an overview of different initiatives made by European Commission for updating the Batteries Directive (2006/66/EC) are presented. In December 2020, the European Commission publicized a new Batteries Regulation to ensure the sustainability and safety of batteries place in the EU market, as a result of different initiatives announced in the new Circular Economy Action Plan, in the European Green Deal and in the new Industrial Strategy for Europe. In these new rules, new objectives for collection and recycling efficiency of lithium batteries are introduce, focused on recovery targets for valuable metals.

Keywords: lithium-ion batteries, recycling, policies, batteries regulation

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PM10 and PM2.5 concentrations in winter periods of smog episodes in Poland

The ambient air is a component of the environment that influences directly to the other elements, which means that any air pollution emitted to the atmosphere may have a negative impact on surface and underground waters, soil, vegetation, living organisms, including human health. Air pollution in urban agglomerations has many components, but currently the main problem of the atmospheric air is particulate matter. Dust particles with an aerodynamic diameter below 10 μm enter the respiratory tract with the inhaled air, and can cause pathological changes, e.g. allergic and inflammatory reactions. Particles with an aerodynamic diameter below 2.5 μm are much finer, and therefore more harmful to health, as they enter the deeper parts of the human lungs.

The smog episodes are usually correlated with very high levels of particulate meter concentrations in the urban air. The study identified winter smog episodes based on the analysis of PM10 levels. It was assumed that it is possible to indicate periods of winter smog based only on the analysis of the concentrations PM10 monitored continuously, without consideration for the meteorological data. The aim of the study was to compare PM10 and PM2.5 levels in selected cities in Poland in periods of winter smog episodes.

It was found that in Poland the concentrations of PM2.5 constitute approx. 70-80% of PM10, and in some smog episodes as high as 90%. These dependencies can be used to assess the share of PM2.5 in PM10 in similar areas in other cities, where only PM10 dust concentrations are measured.

Keywords: PM2.5, PM10, winter, smog, episodes

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Contribution of GHG emissions from bioreactors to the total carbon footprint (CF) of municipal wastewater treatment plants (WWTP)

A conventional wastewater treatment plant (WTTP) contributes to greenhouse gas (GHG) emissions, as part of the anthropogenic activities. Almost 3.5% of the global GHG production linked to human liveliness, has its source in waste and wastewater sector. Recently, N_2O has received growing attention in WWTPs due to high GWP and enhanced production/emission observed at the biological stage. Moreover, municipal wastewater is also characterised by high concentrations of organic compounds. This leads to increased CH_4 and N_2O emissions linked to anaerobic compartments of the biological stage, which are released to the atmosphere in aerated chambers of bioreactors. The lack of interest in CH_4, may be also caused by IPCC (2006 with 2019 Refinement) instructions, which assume that for centralized WTTPs methane production is irrelevant and can be omitted.

This paper is an attempt to assess contribution of GHG (CH_4 vs. N_2O) emissions from bioreactors to the total carbon footprint (CF) of municipal WWTP with capacity of 1.000.000 PE. Calculations, based on the GHG Protocol, were carried out with the determined factors (FTIR method) and then compared with the results based on literature data. The comparative analysis indicated that the emissions from bioreactors may contribute up to 74% (in-situ measurements) and 94% (literature data) of CF (Scope 1 and 2). This suggests that the bioreactors are hot spots in terms of GHG emissions from WWTPs.

Keywords: carbon footprint, full-scale wastewater treatment plant, methane, sustainability, GHG emission factors

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Green jobs as a factor supporting of the European Green Deal implementation

In the current development of the European Union, there is a growing awareness of the relationship between economic development and the condition of the natural environment. This is especially visible in contemporary concepts of economic development, where very much attention is focused on environmental issues. There are several reasons for this situation, including pollution of the natural environment, limited natural resources and development of an ecological lifestyle. These aspects are visible in the development concepts of the European Union, which include sustainable development, circular economy, green growth and green economy. These concepts assume the interaction of the economy with the natural environment and indicate that this development should not cause damage to the environment. One of the newest ideas for the economic development is the European Green Deal. At the same time, this idea covers the most fully environmental issues, assuming among others, the decoupling of economic growth from resource consumption, and thus the full implementation of the circular economy. The effect of adopting such a strategy is an increasingly restrictive policy in the field of various environmental standards, including those related to waste management and the assumed recycling levels. Among the factors supporting the achievement of environmental goals are the impact of green jobs.The aim of the study is to present selected aspects of green jobs impact in EU countries in the context of their innovation index, effectiveness in waste management (circular economy) and quality of life.

Keywords: European Green Deal, green jobs, waste management, innovation, quality of life

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Pesticide remediation behaviour of magnetite-clay composites from water

Globally, rampant use of pesticide has become an evil issue and so is the persistence of its residues in the surface and groundwater bodies. To eliminate these micro pollutants from water, magnetite was combined with a surface modified nano-organoclay(35-45 wt% Dimethyl Dialkyl Amine modified) using simple co-precipitation method. The prepared composite was characterized by Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM) and applied for removal of twelve mostly used pesticides (chlorantraniliprole, clothianidine, azoxystrobin, acetamiprid, fipronil, imidacloprid, thiamethoxam, dinotefuran, thiacloprid, tricyclazole and nitenpyram). The pesticide removal potential of the prepared composite was found to be in the range of ~90-100% for most of the pesticides except clothianidin(82%) and imidacloprid(83%). Further, the sorption experiments suggested that 10 mg of prepared material with 4 hours of contact time in a 5 mL of pesticide mixture solution at a fortification level of 1 µg/mL gives the optimum adsorption. The kinetic studies revealed that 2000-2500 µg/g was the maximum adsorption capacity of the composite and multiple steps including the intraparticle diffusion was involved in adsorption phenomena. Moreover, the regeneration and re-usability of the composite was valid up to three cycles with over 80% retention of adsorption capacity. For the validation purpose, two natural water samples from IARI institutional area were collected and looked for the presence of the selected pesticides. After application of our magnetite-clay composite, nearly ~100% removal was found for all the selected pesticides. Thus, such organic-inorganic hybrid materials will find huge applicability in future water remediation processes.

Keywords: pesticide, persistence, diffusion, remediation, composite

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Application of the FSW method in joining metal components of car seats

In thesis describes an innovative method of joining sheets using the FSW method. This process is less energy intensive than traditional sheet metal joining methods. As a result, it has a lower environmental impact. The research used an aluminum alloy used in the aviation industry 2024 - T3. The subject of research in the work was to check the strength properties of the weld, more specifically, the tensile strength of 2024 - T3 aluminum alloy sheets joined by friction stir welding technology and the selection of optimal parameters for which the welded connection is made will reach maximum strength. The joined sheets were 1 mm thick, it was analyzed lap joint made by friction welding. The purpose of implementing the technology was to introduce a new method of joining sheets in the automotive industry, enabling the maintenance of the highest quality of the product delivered to customers, and thus minimizing the risk of defects associated with this effect. In the future, the above-mentioned process will naturally contribute to the optimization of process costs, increasing the effectiveness of the Company's operations and reducing the negative impact on the natural environment.

The effect of the implementation of the FSW process should be an increase in the efficiency of joining sheets. It should also result in a reduction of the energy consumption of the process, which will translate into lower production costs of the final product. Strength tests were carried out on eighteen samples of joined sheets. The best results were obtained with the feed speed of 100 [mm / min] and the rotational speed [rpm].

Keywords: FSW, automotive, environmental protection, welding

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The environmental risk of using filter waste from the seasonal bathing area

As part of the research work, the phytotoxic properties of sludge from diatomaceous earth vacuum filters were analysed, the operation of which was supported by powdered coal. The filters were located in a seasonal facility, in the joint water purification circuit of the sports pool and the water playground. 10 test series were performed, 10 litres of sludge were collected in each of them. The sludges were sieved and then dried for 24 h at 105 C. Ecotoxicological analysis was conducted based on macroscopic evaluation of morphological parameters (frond growth inhibition, germination index, root growth rate) of selected plant organisms: Lepidium sativum, Sinapis alba, Raphanus sativus, Lemna minor. Phytotoxicological analysis in all tests was carried out for the percentage of the sediment volume in deionized water: 5, 10, 20, 30, 40%. It was shown that the highest applied doses of filter sludge contributed to inhibiting the growth of Lepidium sativum and Raphanus sativus. Stimulation of the growth of Lemna minor fronds was noted in a low percentage share range of sediments. It is necessary to conduct further analysis regarding the possibility of using diatom-carbon filter sludge as a valuable raw material for plant cultivation in long-term tests.

Keywords: diatomaceous earth filtration, waste recovery, phytotoxicity, diatomite sludge, swimming pool

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Numerical simulation based design of photovoltaic installations

The European Union's policies and the growing regulations on greenhouse gas emissions focus on increasing the proportion of renewable energy sources in the energy sector of the Member States. As a result, we have seen a significant growth in the annual production of renewable sources of energy. Renewable energy sources, particularly solar energy, represent the fastest developing segments of energy production. Consequently, the development of solar installations on private properties is rapidly growing as a result of a variety of government incentives. The study examines a number of issues related to photovoltaic installation failure modes, as well as a comparison of projected and observed electrical generation from the operating solar installations. Numerical modelling software helps in optimizing the performance of a photovoltaic installation by taking into consideration the shadowing of the panels, the tilt angle, and the specification of all installation's elements and components. On the basis of the measurements of the quantity of energy produced by a solar installation, it could be established that numerical modelling and simulation applying NASA-SSE databases may deviate significantly from measured values. There is a discrepancy of fifteen percent in the amount of electricity generated in the scenarios studied. It's also worth noting that the systems' databases are dependent on measured values between to 2005. Because of the change in climate, more up-to-date datasets should be used to determine the specific amount of electricity produced by solar panels.

Keywords: energy, design, failure, numerical, simulations

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Phosphorous removal from antequera WWTP using ferric chloride: a pilot - scale study

The municipal wastewater treatment plants (WWTP) must ensure that the effluent water complies with the quality values required in the legislation. According to Spain regulations, Antequera WWTP is situated in a vulnerable region, in which the discharge limit for phosphate must be below 2 mg P L^{-1}. The WWTP was equipped with an extended aeration activation sludge system as biological treatment. The WWTP generates a low amount of sludge; the treated water exits WWTP after the decantation step. The sludge is stored in a gravity thickener to reduce the total sludge volume.

The objective of this pilot-scale study was to investigate the effect of Fe:P molar ratio in chemical precipitation of phosphorus, alkalinity, and pH using ferric chloride to remove phosphorus from the thickener's liquid fraction. The thickener overflow water is fed to the pilot-scale installation at a flow rate of 1000 L h^{-1} (residence time in the reactor of 6 minutes) with an initial concentration of 28.3 and 41.1 mg P-PO_4 L^{-1}. To this incoming wastewater flow, a flow rate of 2.46 L h^{-1} of a ferric chloride solution (40 % w/w) of the established concentration is added to the reactor to achieve the desired Fe / P molar ratio of 2.5:1 and 1:1. All the pilot-scale experiment was carried out without pH adjustment. The removal of P-PO_4 reaches values of up to 98.5 and 66.3%, and the alkalinity decreases from 226 and 287 mg $CaCO_3$ L^{-1} to 35 and 180 mg $CaCO_3$ L^{-1}, for Fe / P-PO_4 of 2.5 and 1.1, respectively. After $FeCl_3$ addition, only a slight drop of pH value was detected due to the high buffer capacity of sludge in the thickener overflow water. These results serve as for full-scale experiments.

Keywords: phosphorous removal, chemical precipitation, pilot-scale, ferric chloride, wastewater treatment plant

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Climate change narrative in Latvia: marketing communication evaluation in retail sector

The European Green Deal is the European Union's latest expression of its ambition to become a world leader in addressing climate change.1 Adaptation to climate change (CCh) is key priority of the European Union (EU), exemplified by EU's efforts to become "the first climate-neutral continent"2 in the world by 2050. The focus of the research is set on the stories or "narratives" about CCh that are produced and reproduced in Latvia, as they more adequately than facts attach meaning to events and embody the perception of the problem in time (past, present and future), which encourages (or discourages) certain set of activities. This study seeks to examine climate change narrative integration in retail companies' marketing communication in Latvia, to research the context of climate change narrative in retail companies' public communication. Overall, this study illuminates that retail companies in Latvia do communicate about processes related to climate change – mostly they use such terminology as "environment friendly", "CO_2 emissions" and "sustainability" thus creating a narrative. It has been observed that retail companies use simple language and avoid to mention CCh as a whole. Moreover, they invite consumers to be more environmentally friendly by telling the new initiatives they have been implementing in their business model.

Keywords: climate change, Latvia, strategic narrative, retail sector, marketing communication

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Toxicity of products of two-stage biological and chemical municipal landfill leachate treatment towards selected model organisms

Despite the efforts to reduce the stream of municipal waste directed to landfilling, landfill leachate (LL) still poses one of the main environmental hazards. There are many technological solutions to LL disposal, however, due to the time-varying and complex chemical composition with a significant share of refractive compounds, multi-stage systems including biological and physio-chemical methods are recently proposed to increase the treatment efficiency. Although there is a certain amount of data on the harmfulness of raw leachates on organisms, including humans, there is still a gap of knowledge on the toxic effect of their treatment products. Selected model organisms, representing three trophic levels: producers (Raphidocelis subcapitata), consumers (Thamnocephalus platyurus), and reducers (Allivibrio fischeri) were exposed to samples of raw LL (R), the outflow from 1st stage sequential biological reactor (B), and 2nd stage advanced oxidation process by the Fenton's reagent with various Fe^{2+}/H_2O_2 proportions (F10, F20, and F30). The highest differences of sensitivity were demonstrated by Thamnocephalus with aTU ranging from 5.64 to 158.73, and the acute toxicity of LL treatment products increased in the order B<F2<F10<R<F33. In turn, the sensitivity of Allivibrio (aTU from 1.4 to 138.9) increased in the order F20<F10<B<F33<R. The lowest differences in the toxicity were observed in algae Raphidocelis (1.84 to 4.06) and the toxicity was increasing as follows F10<F20<B<R<F33. As can be seen therefore, the representatives of different trophic levels did not react equally for products of subsequent stages, however in all cases raw LL and the highest Fe^{2+}/H_2O_2 ratio were the most harmful.

Keywords: landfill leachate, municipal waste, acute toxicity, toxicology, Fenton reagent, SBR

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Sulfur bearing glasses as potential sulfur glassy carriers for soil environment

The purpose of the paper is presenting results of studies of chemical activity of the silicate-phosphate glasses containing sulfur in "in vitro" conditions. In vitro evaluation of chemical activity of the sulfur containing silicate-phosphate glasses encompass extraction of components by means of: citric acid, hydrochloric acid, and water. Due to reduction in SO_2 emission and intensification of cultivation, on the Polish soil, similarly to other countries in the world, a significant deficiency in sulfur has been detected. The applied fertilisers that introduce sulfur to the soil are characterised by a large solubility in water, causing an easy leaching of this element from the upper layers of soil, which results in a low concentration of sulfate sulfur that can be absorbed by plants. Taking the above into consideration, it has been expected that the silicate-phosphate glasses modified with sulfur will act as soil fertilizers fighting against the above-mentioned phenomenon which relates to sulfur deficiency in soil. These sulfur glassy carriers will be poorly soluble in water, but soluble in soil solutions and that can be controlled by their chemical composition.

Keywords: glassy fertilizer, silicate-phosphate glasses, sulphur

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Integrating NBS – constructed wetland in sustainable sanitation

Constructed wetlands (CWs) is the application of Nature Based Solution (NBS) technology to treat different types of wastewaters. several benefits like low construction and operational costs, low energy requirements, easy to operate, and other co-benefits such as carbon sequestration and biodiversity restoration make CWs considered as a sustainable treatment option, whether combined with or alternative to conventional treatment systems, especially for small communities and rural areas. For developing countries such as Jordan, water scarcity are well known and the country is highly affected by the climate change, for that Jordan considers treated wastewater as a water resource in their water budget, but in the other hand only 65% of the Jordanian are connected to sewer and waste water treatment plants, while the remaining are living in rural areas without proper sanitation solutions. CWs technology can provide a sustainable sanitation solution for the Jordanian case, a step towered achieving many goals such as protecting health, adaptation to climate change and enhancing the reuse of treated wastewater. Hence, this research aims to study the integrating NBS – CWs as a sustainable solutions, by analyzing the performance and application of CWs through a comprehensive review of CWs' application in the Mediterranean context case study of Jordan. Firstly, a brief summary on the definition, classification and application of current CWs will be presented, analyzing the sustainability of CWs. Secondly a brief summary about the Jordanian water and sanitation. Lastly the future perspectives of integrating CWs as a sustainable sanitation using knowledge from other Mediterranean cases.

Keywords: nature based solution, constructed wetlands, sustainable sanitation, wastewater treatment plants, climate change

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Municipal sewage sludge in a circular economy

A circular economy assumes an efficient use of resources at all stages of a product's life. By treating waste as a resource, the circular economy requires fundamental changes in the way waste is managed. In a circular economy, resources should be used for as long as possible. The concept of the circular economy is particularly applicable to the water, wastewater and sludge industry and also contributes to reducing climate change. In wastewater and sludge systems, in addition to their traditional role of wastewater treatment and sludge treatment, a new role is becoming resource production, such as nutrient recovery, and energy production, that is, energy recovery from sewage sludge.

The paper presents the results of sewage sludge research, such as the content of: heavy metals, nitrogen, phosphorus, and the organic part, in terms of their further use. The benefits of using sewage sludge as a raw material, including its energetic use, are presented. Sewage sludge should be looked upon as a material (phosphorus, nitrogen) and energy resource. Sewage sludge is part of the circular economy concept.

Keywords: Circular Economy, sewage sludge, wastewater treatment

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Repair of cement mortars by applying a microbial healing agent

Concrete and mortars, which are one of the main construction materials, are based on cement. Their main disadvantage is their susceptibility to the formation of microcrack networks even throughout all service life. Cement production is related to significant CO_2 emissions, while the standard crack repair agents are produced based on chemicals and cement based materials. One of the alternative cracks repair technique is microbially induced calcium carbonate precipitation (MICP). This method can contribute to the reduction of cement production and negative impact of chemicals on the environment.

The aim of this study was to evaluate the self-healing capacity of cement mortars with the addition of healing-agent in form of bacterial spores of Bacillus subtilis strain immobilized on porous diatomite particles. Diatomite was used as a 10% cement mass replacement. The addition of immobilized bacteria and nutrients, needed for bacterial growth, to the mortar improved the compressive strength by about 8% compared to the control sample. The effect of self-healing was evaluated by the strength recovery and area repair rate of cracks of the pre-damaged specimens after treatment in two different environments: water and nutrients solution. The percentage of compressive strength recovery for biological samples was higher for treatment in nutrients solution and was more than 30%. In contrast, specimens treated in water showed a greater degree of healed cracks (up to 93% after 7 days of treatment). The obtained results confirmed the application potential of diatomite as a bacterial carrier in the self-healing concrete technology.

Keywords: self-healing, environmental friendly biocementation, cement composites, bacteria

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Emission of bioaerosol from a composting facilities and the microbiological composition of the air in its surroundings

The aim of this study was to estimate the concentration level and microbiological composition of bioaerosol around composting facilities and evaluation of its harmful effect on the environment. The influence of composting facilities on microbial contamination in the air has been found in the distance of 1000 m. Air samples for microbiological analyses were collected with the compaction method using the Merck MAS – 100 EcoTM type impactor. Diagnostics of microorganisms was carried out based on macro- and microscopic analyses and with the using VITEK® 2 Compact System (bioMérieux). The highest concentration of total bacteria and actinomycetes in the air was noticed in the distance of 200 m from composting facilities. The highest percentage of bacterial aerosol comprised Gram-positive cocci, and then G+ and G- bacilli. The microorganisms identified included potentially pathogenic bacteria from the genera Staphylococcus (S. vitulinus, S. xylosus, S. auricularis), Enterococcus (E. faecium, E. faecalis), Salmonella and Pseudomonas fluorescens. Concentration of mould fungi reached up to 2080 cfu·m^{-3}, which indicated unpolluted air at all stands tested. Mycological analyses confirmed the presence in the studied air of fungi with potentially allergic and mycotoxinogenic properties from the genera: Aspergillus (A. fumigatus, A. terreus), Cladosporium (C. herbarum), Alternaria, Fusarium. Although the level of microorganism concentration in the air around the monitored facilities was not high, may pose a threat to the environment and health of the local residents. Potentially pathogenic microorganisms transmitted with wind can also settle and pollute soil, water and plants in cultivated fields or plots located in the neighbourhood of municipal waste processing facilities.

Keywords: air pollution bioaerosol, composting facilities, microorganisms

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Impact of sonication on the extraction process of bioactive compounds contained in by-products of chokeberry processing

The use of sonification seems to be an interesting alternative in comparison to physico-chemical processes including coagulation or chemical precipitation. The use of the ultrasonic field in the technology of obtaining biologically active substances with health-promoting properties from fruit processing by-products does not require the addition of oxidants or catalysts and does not generate additional waste streams. Ultrasound can be treated as "green" techniques due to its high efficiency, low instrumental requirements as well as allows to significantly shorten the duration of unit processes compared to other known techniques. The aim of the study is to analyze the impact of the ultrasonic field in terms of the energy input on the total content of phenolic compounds, anthocyanins and antioxidant activity from by-products of chokeberry processing. The research material was chokeberry pomace, from which ten extracts were prepared. The samples were sonicated with a Sonics vibro cell type disintegrator with a frequency of 40 kHz. During the sonication of the samples, the amount of energy introduced to the sample was monitored and the derived energy values of the ultrasonic field were calculated. Then, the total content of phenolic compounds, anthocyanins and antioxidant activity were determined in the samples. On the basis of the conducted research, it was found that the effect of the ultrasonic field as a result of the sonication process at the appropriate concentration of ethanol affects the bioactive substances contained in the extracts of chokeberry pomace. It causes their release to the liquid phase and increases the availability of the substrate, which leads to an increase in the total content of phenolic compounds, anthocyanins and antioxidant activity.

Keywords: chokeberry, sonication, fruit processing by-products, bioactive compounds, green techniques

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Assessment of the influence of MICP process conditions on the sandy soil hydraulic conductivity

Microbially induced calcium carbonate precipitation (MICP) has been studied in terms of soil cementation. The main objective of the research was the determination of the process conditions, concerning solution components and application pattern, which may affect bioconsolidation and hydraulic conductivity of sandy soil. The tests were performed with the use of environmental strain of Bacillus subtilis which turned out to be the most suitable (concerning amount and characteristics of carbonates) of the 22 different strains tested. The column tests were carried out by percolation the samples with following solutions: (1) multi-component solution containing bacteria, nutrients, urea and calcium source; (2) solution with bacteria and nutrient medium followed by solution with urea and calcium source, (3) fixing solution between the bacterial and cementing solutions. Additionally, control tests with water, bacteria or urea with calcium source were carried out. The cycles number was set to 5 and 10 with reaction time of 72 hours for each variant. The samples cementation was observed in variants percolated with solutions containing components necessary for the reaction. Increased pH values (up to approx. 9.1) and electrolytical conductivity may indicate the occurrence of ureolysis and precipitation of carbonates. Consolidation was confirmed by the tests of hydraulic conductivity of soil samples carried out using the constant head method. Hydraulic conductivity of the samples percolated with bacterial and cementation solutions (regardless of the injection sequence) in relation to the control sample with distilled water decreased by two orders of magnitude. Moreover, heterogeneous biocementation was observed in the sample profile.

Keywords: MICP, calcium carbonate, sandy soil, biocementation

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Enabling circular bioeconomy via estimating biowaste and food loss valorisation potential in Latvia

Biowaste and food loss management in Latvia has not been efficient enough. Currently, a significant proportion of biowaste ends up in landfills, limiting their further valorisation. Also, the more homogenous food loss is left underutilised. Valorisation of biowaste and food loss (FL) into higher added-value products is not considered in the National Waste Management Plan of Latvia at all. FL estimation has been difficult due to lack of uniform guidelines for monitoring and measuring FL, and no obligation or system for reporting. However, FL generation is associated with various environmental, economic, and social burdens. Thus, its prevention, reduction and valorisation play a crucial role within the circular bioeconomy. Our study aims to (1) estimate the extent of FL for the top 10 most-produced food products in Latvia, (2) identify the current valorisation pathways, (3) estimate the potential amount of valorisable FL, and (4) identify the obtainable value-added products based on the emerging biological valorisation approaches reported in scientific literature to sustainably close the bio-based material and resource loop. Understanding the amount, composition, seasonal variability, and geographical distribution of generated FL and other biowaste in Latvia is important to make better forecasts of possible recycling and valorisation capacities. Knowledge and data availability on the FL flows is an essential precondition not only for implementing FL valorisation pathways at an industrial scale, but also for developing sustainable circular bioeconomy strategies at local and national scales. This study is the first attempt to estimate the valorisable FL and obtainable value-added products in Latvia.

Keywords: biowaste, data availability, food loss, valorisation, value-added products

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The impact of negative effects of urbanization on Park Dolina Służewiecka in Warsaw: a regeneration project

Beside urban greenery (green infrastructure), key ecological and social role has water in the cities (blue infrastructure). Considering together as Blue-Green Infrastructure (BGI), it is recognised internationally as a design approach for cities under environmental crisis. Moreover green and blue networks can be used to transform polluted industrial and urban sites into "fertile public ecosystems". The main purpose of the research is to: (i) examine actual condition of the Dolinka Służewskiej Park in Warsaw, (ii) develop design guidelines considering ecological recommendations for this area, (iii) propose a regeneration project of the park. The aim of landscape architecture part of the paper is to elaborate a general concept of the Dolinka Służewiecka remediation, that is environmentally responsible and contribute to society.

Keywords: blue-green infrastructure, public park, urban greenery

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Spatial and strategic planning in the cross-border area to support green transformation

The energy transition requires detailed identification of local conditions and limitations. Cross-border areas needs special attention in this case because they are subject to various territorial affiliation and legal orders. An example of such areas are Usedom and Wollin islands. The islands' surrounding waters of a sea and a lagoon have made this region intensively used for tourism and health resorts on both sides of the border. The spread of pollutants knows no national boundaries and usually has a wide area of influence. Therefore, actions for the environment, including the energy transition, require stakeholders cooperation across borders. The MoRE project – Model Renewable Energy Region of the Usedom and Wollin Islands, aims to present a set of activities, research outcomes and recommended solutions for conscious energy transition of the area in accordance with EU, German and Polish requirements. The project essence is to develop a manner of incorporating RES into common goals for the cross-border region in German and Polish documents such as spatial and strategical planning. The main goal to be achieved is to increase renewable energy in the islands' energy mix. The work was preceded by a thorough analysis of the islands' area and pilot studies: the thermal quality of existing buildings, air quality in characteristic seasons of the year and the energy potential of surface waters. The proposed approach to the preparation of energy transition, carried out on both sides of the border, but within the common environmental space, constitutes a new approach in the energy transition process.

Keywords: energy transition, cross-border region, Usedom and Wollin islands, MoRE project, special planning

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Preliminary analysis of the potential of using surface water for cooling purposes – case study

The authors present the results of preliminary field research and analysis of the use of surface water as the lower heat source for cooling purposes. The research concerns the water reservoirs of Usedom and Wollin islands. Samples of water were taken from 25 different locations. Preliminary field research of physicochemical and biological properties in terms of heat exchangers corrosion, biological changes in a tank and energy efficiency of cooling devices using surface water tanks as the lower energy source were carried out. The value of a few parameters of the water, allow for preliminary estimation aggressive/incrustative water potentials, were measured. Special attention was paid to the temperature gradient towards the bottom of the reservoir. The measured values of water temperature allow the authors to conclude about the high potential of heat discharge in the analysed area, provided that only open surface waters, excluding closed inland reservoirs or with low mass exchange (flow), can be used for cooling and air conditioning purposes. Several variants of the heat pump installation were considered. All solutions are characterized by a high coefficient of performance (COP). As it results from the research of water reservoirs and the air temperature measurements in selected pilot studies, the use of water heat pumps for cooling purposes is a favourable solution in terms of energy efficiency and reduction of CO_2 emissions. Increasing the share of heat pumps in the total number of devices supplying cold or heat in the island area may have positive effects on the environment.

Keywords: energy transition, field research of surface water, water heat pumps, Usedom and Wollin islands, MoRE project

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Opportunities and challenges of methodology of pyrolysis of biomass

The most pyrolysis reactors require small sizes of biomass particles to achieve high-quality products. Moreover, to shed more understand base on usefulness of high-pressure systems in pyrolysis is important, given the operational challenges they exhibit specific to various biomass materials. To actualize these aspects, the authors first checked previous reviews involving pyrolysis on different biomass and different conditions/situations with their respective objectives and subsections. From these already existing reviews, the team found that there has not been much emphasis on high-pressure fast pyrolysis and its potential in biomass conversion, showing that it is a novel direction in the pyrolysis technology development. Therefore, this paper aims to shed more light on methodology required on pyrolysis process in general, drawing from (a) classification of pyrolysis; (b) reactors used in fast pyrolysis; (c) heat transfer in pyrolysis feedstock; (d) fast pyrolysis parameters; (e) properties/yields of fast pyrolysis products; (f) high pressure on pyrolysis process; (g) catalyst types and their application; and (h) problems to overcome in the pyrolysis process. This review increases the understanding regarding high-pressure fast pyrolysis. An attempt has been made to demonstrate how high-pressure fast pyrolysis can bring about high-quality biomass conversion into new products. It has been shown that fluidized bed (bubbling and circulating) reactors are most suitable and profitable in terms of product yield. The high-pressure, especially combined with the fast-heating rate, may be more efficient and beneficial than working under ambient pressure. However, the challenges of pyrolysis method on a technical scale appear to be associated with obtaining high product quality and yield. The direction of future work should focus on the design of high-pressure process reactors and material types that might have greater biomass promise, as well understanding the impact of pyrolysis technology on the various output products, especially those with lower energy demands. We propose that the increase of process pressure and biomass particle size decrease should be considered as variables for optimization.

Keywords: temperature, feedstock, pressure, pyrolysis process, reactors, liquid fraction, heat transfer, biochar, catalysts, biorefineries

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Acrylamide as by-product of wastewater and sewage sludge treatment

Work concerned the potential for the formation of acrylamide as a by-product of wastewater and sewage sludge treatment processes and the associated risks to human health. In recent years, the attention of the scientific community has attracted the presence of acrylamide in wastewater, processed food and in the natural environment. The possibility of penetrating acrylamide along with sewage purified to surface waters and the environment was also sought.

Another potentially dangerous phenomenon is the possibility of penetration of these substances into sewage sludge as a result of sewage sludge conditioning. Sewage sludge conditioning can be carried out using various methods: chemical, mechanical (addition of building substances), thermal and other (ultrasounds, electromagnetic field, washing).

The most popular is the use of chemical conditioning consisting in the addition of inorganic substances - coagulants (so-called conventional coagulation) and organic polymers (polymeric coagulation). As a result of environmental conditions and physico-chemical changes, polyelectrolytes used in the coagulation process may undergo depolymerization, which results in the formation of monomers containing acrylamide. Studies on the toxicity of acrylamide and its metabolite, glycidide, confirm the neurotoxic, genotoxic and carcinogenic activity of these compounds. So far, only the neurotoxic effects of acrylamide on the human body have been proven. The carcinogenic effect of acrylamide has been unequivocally demonstrated only in animal studies. The presence of carcinogenic acrylamide in municipal wastewater and sewage sludge is a serious problem for both humans and the environment.

Keywords: sewage sludge, conditioning, polyelectrolytes, acrylamide, toxicity

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Determination of the toxic concentration of PAHs for mesophilic biocenosis

Methane fermentation depends on micro and macronutrients availability, lack of toxic substances and microorganisms. The process might be inhibited by changes in pH, temperature and accidental oxygen presence. Microorganism involved in fermentation could be limited by toxic substance presence in introduced sewage sludge (external source) or in products resulting from the transformation of organic compounds during the process (internal). Inhibitory effects in the group of compounds present in sewage sludge are shown by, among others, heavy metals, plant protection products and polycyclic aromatic hydrocarbons (PAHs). Microorganisms taking part in fermentation process, however, have adaptive abilities and show tolerance to constant values of some toxic substances. The aim of this research was to designate threshold concentration of PAHs for fermentation microorganisms. Fermentation of municipal sewage (control sample) and a mix of municipal sludge and coke sewage sludge in different proportions was conducted in the temperature of 37°C. During the research the amount of biogas in fermentation of mix of municipal sludge and coke sewage sludge was lower than in fermentation of municipal sludge. It can be concluded that coke sewage sludge included compounds toxic for microorganisms. On the other hand, microorganisms that occur in municipal sludge do not adapt to such contamination which occur in coke sewage sludge, including PAHs. Conducted research has proven that the highest concentration of PAHs under which fermentation took place undisturbed amounts to 2700 µg/kg d.m. and 4,5 µg/L in supernatants.

Keywords: PAHs, fermentation, toxicity, sewage sludge; supernatants

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The use of renewable energy sources in refrigeration and air conditioning

The authors present the case of photovoltaic cells use to power cooling devices of cold stores and to power heat pumps used as a source of heat and cold for centralized air-conditioning systems, which are a combination of devices that use renewable energy in order to minimize the energy consumption for heat and cold generation processes. Climate changes cause an annual increase in average temperatures in the summer period and thus an increase in the energy demand to power cooling and air-conditioning systems. Currently, every newly built large public facility has at least one centralized air conditioning system. There exist already air conditioning systems that recover heat by means of a rotary heat exchanger and use a heat pump to heat and cool the air. They are energy-efficient, but also are the main consumer of electricity in buildings. The highest cooling load occurs in the summer period, when devices operate at full capacity to ensure thermal comfort for users. Such air-conditioning systems use nearly 20% of the electricity consumed in the world, so supplying them from renewable energy sources, such as a photovoltaic installation is crucial. The authors also discussed the concept of the power supply system for the cooling device of a large-area cold store by a photovoltaic installation. So the integration of two systems is able to bring large tangible energy benefits. The article presents conceptual diagrams of such systems based on real objects, and indicates proposed solutions advantages and disadvantages.

Keywords: renewable energy sources, photovoltaic systems, heat pumps, air conditioning systems

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The impact of fly ashes from thermal conversion of sewage sludge on properties of natural building materials on the example of clay

The reduction of carbon dioxide emissions, introduced by the European Union, opened the possibility of conducting experimental works on a new generation of materials ecological and environmentally friendly. One type of such materials is those which combine raw natural resources with waste subject to disposal.

Economic development, industrialization and urbanization require dynamic development of sewage networks. The worldwide wastewater treatment produces large amounts of sewage sludge. Choice of a method of utilization of the generated sewage sludge depends on its physical and chemical properties and the content of heavy metal oxides. The thermal methods seem to be the best, as ecologically safe and economically justified. The advantage of this process is reduction of the sludge volume and reduction of the content of sulfur and nitrogen compounds in the exhaust gases. The secondary waste material generated in this process is the fly ash (waste), which also requires an appropriate management.

The paper proposes a method of enrichment of clay with fly ash, what would lead to the neutralization of heavy metals in the burnt matrix, possible oxidation of organic substances present in the ashes or destruction of pathogens, as well as an increase of the resistance of the clay ceramics to low temperatures. Four types of samples were prepared: clay samples without additions and samples with the addition of fly ash from the treatment plants in Łódź, Cracow and Warsaw. All samples have the same ash-to-clay ratio from 40% to 60%.

The collected results of investigations enabled to compare the properties of clay samples produced with the fly ash from three wastewater treatment plants. The obtained test results confirm the possibility of manufacturing a product modified with the fly ash from thermal treatment of sewage sludge.

Keywords: fly ash, clay-ash composite, compression strength

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Reduction of cement in road sub-bases as a result of dispersed reinforcement

One of the most common techniques used for road sub-bases is the stabilization of soil with cement. Because cement production is the third most important anthropogenic source of carbon dioxide (CO_2), and carbon dioxide emissions are planned to be reduced by 2050, it is necessary to look for solutions to reduce cement consumption. Thus, a study was conducted to determine the effect of dispersed reinforcement on the strength of stabilized soils. The results obtained show a more than twofold increase in compressive strength without cement reduction. This resulted in an increase in strength class from C0.8/1 to C1.5/2. This study investigated the possibility of reducing the amount of cement in the road sub-base by using dispersed reinforcement while maintaining the same strength class.

Keywords: distributed reinforcement, road sub-base, unconfined compressive strength, cement

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The importance of precipitation in the process of air purification by plants

One of the most dangerous pollutant created by traffic is particular matter – PM. It can be suspended in the air even for weeks as aerosols, and when inhaled can have carcinogenic, allergic and mutagenic effects. Plants can effectively capture PM from air through phytoremediation, but this ability varies with leaf traits, such as waxy cuticles, leaf hairs, and canopy scale differences. Not only is more information needed on species choice, but also on the dynamics of PM accumulation, in particular, how it changes over time and how it is influenced by the weather, especially precipitation.

Our study evaluated the effects of rain on the dynamics of PM deposition, wash off and re-suspension. Quercus robur, Betula pendula and Tilia cordata were used in the experiment. The experiment predicted exposure of individuals of the studied species to different weather conditions: (i) natural, (ii) increased amount of precipitation, (iii) no precipitation. On leaves of each species amount of PM was measured in two categories (surface-PM and in wax-PM) and three size fraction (10-100µm, 2.5-10µm and 0.2-2.5µm).

We found significant differences in PM amount between plants growing in different conditions. A greater amount of suspended particles was found on the leaves of plants that were not exposed to rain. Data has shown that rain has a significant role in air phytoremediation because increases the potential of plants to purify the atmosphere. New research about this topic are in progress.

Keywords: precipitation, phytoremediation, trees, particulate matter, PM

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Modeling chemical precipitation removal in Antequera's WWTP by STOAT software

The excess of phosphorus in effluent water can be responsible for eutrophication, which puts the aquatic fauna life in danger. Giving, the imposed strict limit to phosphorus concentration in vulnerable regions (< 2 mg/l), the municipal treatment plants can overcome the excess of this nutrient in discharge effluent by biological or chemical elimination methods. This study simulates the operation of the chemical precipitation of phosphorus in a wastewater treatment plant (WWTP). The simulation of the chemical precipitation of phosphorus in the Antequera WWTP (Malaga, Spain) was carried by STOAT software. Firstly, the simulation of good performance and parameters of WWTP was checked. Secondly, the chemical post-precipitation method was carried by adding Aluminum Sulfate Hydrate ($Al_2(SO_4)_3$, $18H_2O$) salt. In STOAT, new equipment will be added to the WWTP. Considering the modification of the plant already stated with the operating parameters of the chemical phosphorus removal tank, the simulation of the plant is carried out for an approximate time of 1 month with the activated sludge configuration of the biological reactor. The initial phosphorus concentration in wastewater was 10 mg/L, and the molar ratio (Al_{3+}/ PO_4^3) were 1:1 and 0.7:1. The results show that after the reaction, the phosphorus concentration at the plant's exit for 1:1 and 0.7:1 was 0.1 mg / L and 1.6 mg./L, respectively. In conclusion, the implementation of the chemical post-precipitation method would improve the removal of phosphorus from Antequera's WWTP. A reduction in Al_{3+}/ PO_4^{3-} ratio has been proposed so that the total cost of implementing the method is not so high.

Keywords: phosphorus, wastewater treatment plant, chemical precipitation, STOAT, simulation

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Implementation in STOAT's simulator and biological removal of phosphorus of Antequera's WWTP

The eutrophication of rivers and lakes is currently a problem due to the many nutrients (nitrogen and phosphorus) that the channels receive. These nutrients favor the growth of algae, which causes a decrease in available and necessary oxygen for aquatic fauna. Biological removal of phosphorus is based on the enrichment of phosphorus accumulating organisms (PAOs). Therefore, it is a more sustainable and economical method. In parallel, the use of simulation programs to automate the design and improve in the treatment processes in wastewater treatment plants (WWTP) is becoming more extended. The simulation study was carried out using STOAT software (Sewage Treatment Operation and Analysis over Time). The wastewater treatment plant 's operation in Antequera (Malaga, Spain) was carried out under the usual conditions. Firstly, each equipment of the WWTP has been implemented in the simulator, with its corresponding design parameters. Secondly, the plant has been simulated for the design conditions and was checked if it works correctly. Finally, the biological removal of phosphorus was studied. The results show a lower phosphorus concentration at the outlet (1.4 mg L^{-1}) than with the activated sludge method and compare them with the legislation, establishing a value lower than 2 mg L^{-1}. A change of the configuration of the biological reactor of Antequera's WWTP so that it has an anaerobic volume before the aeration zone maintains the dimensions of the biological reactor, simplifying the possibilities of carrying it out in reality since it would not entail any work costs.

Keywords: phosphorus, wastewater treatment plant, biological removal, STOAT, dynamic simulation

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Sustainable way of managing rainwater with composite systems in Green Deal implementation

The main goal of the European Green Deal is to achieve climate neutrality in Europe by 2050. The Green Deal also aims to help people in the EU reconnect with nature, especially those living in cities, which is important to increase political support for nature conservation. The social and health benefits of nature are increasingly better understood, especially in urban areas, for example through local climate regulation - providing a range of ecosystem services such as natural water retention. In the last 40 years, as a result of climate change, the area of our planet affected by drought has more than doubled. This also applies to our continent, where the warming of the climate causing drought alternates with torrential rains, causing a lot of damage to agriculture, but also to urban areas, causing flooding and damaging the infrastructure. The way to stop this situation is certainly to care for the drainage infrastructure of fields in rural areas, as well as to build retention reservoirs in urban areas. Retentions should be understood not only as large engineering structures such as dams and large, open retention reservoirs, but above all - at the level of micro-retention, both home and local retention regarding squares, parking lots, schools, workplaces, shopping centres and their nearby surroundings. The article describes modern methods of rainwater storage using retention reservoirs based on composite pipes as a water-friendly, non-corrosive material with an estimated 150-year durability.

Keywords: water retention, tanks, rain water treatment, micro-retention, flow regulators

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Urban farms in residential areas – water and food in cities

The paper describes some relevant housing estate ideas that integrate cities with food production, such as agrarian cooperatives. In the first part, modernist projects of residential areas linked with urban farms are reviewed, considering cooperative movement and industrial revolution. This review shows that the aim of these projects was self-sufficiency and sustainability based on local food production and broad areas covered by vegetation. In the second part of this paper are shown contemporary projects of farms within housing estates. Urban farms also provide groundwater retention. In results and conclusions, the concept of establishing farms in estates has a potential for sustainable development today.

Keywords: urban farm, urban agriculture, blue and green infrastructure, public space

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Adsorbent based on bentonite and carbon nanotubes for removing bisphenol A from water

The present study aims to investigate the adsorption of bisphenol A (BPA) which is a known endocrine disruptor and widespread pollutant in the aquatic environment onto bentonite clay (Ben) and bentonite-carbon nanotubes composite (Ben+SWCNT). The initial concentration of BPA in water was 1 and 2 mg/lit. The kinetics date could be correlated well to pseudo-second order while the isothermal data could be correlated to Dubinin- Raduskevich isotherm in case of pure bentonite, while they were best fitted to the Fruendlich isotherm in case of bentonite-carbon nanotubes composite. The resulting adsorption capacity was about 1.56 and 3.55 mg g^{-1} for bentonite and bentonite-carbon nanotubes composites respectively. The removal percentage of BPA onto bentonite clay was improved from about 17 % to reach 80 % after adding CNT for adsorbent dose of 0.25 gm.

Keywords: bentonite, water, bisphenol A, nanotubes, adsorption

Acknowledgments: We are grateful to Prof . M.F. Abadir, Chemical engineering professor, faculty of engineering, Cairo University for his support, guidance and thoughtful encouragement.

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Industrial wastewater treatment using simultaneous sorption by microalgae and zeolite

The present work focused on the development of an method for the ammonium nitrogen removal from industrial wastewater in the proces of simultaneous sorption by microalgae that belong to the species of Chlorella vulgaris or Scenedesmus armatus and clinoptilolite. Microalgae can assimilate ammonium nitrogen in the processes of photosynthesis and biosorption, whereas clinoptilolite removes ammonium nitrogen from wastewater in the processes of adsorption and ion exchange. The removal of ammonium nitrogen performed with selected sorbents showed different efficiency that depended on: (i) the initial concentration of ammonium nitrogen, (ii) the dosage and type of a sorbent, (iii) the process time, (iv) the process conditions, (v) and also the methods and conditions for growing microalgae. The rate and efficiency of the ammonium nitrogen removal from wastewater, irrespective of the process conditions, was dependent on the dosage of the sorbent. The efficiency of the ammonium nitrogen removal was observed to be in parallel to the time, whereas the rate of ammonium nitrogen removal in static conditions was independent of the time. The time required for lowering the concentration of ammonium nitrogen in coking wastewater depends on the wastewater composition, the methods and conditions of the process and the sorbents applied. The study demonstrated that the removal of high concentrations of ammonium nitrogen from industrial wastewater by microalgae, clinoptilolite and their combinations can be an alternative method to the conventional methods for the removal of ammonium nitrogen from wastewater. Moreover, the use of natural sorbents such as microalgae and zeolite is an environmentally beneficial way of supporting industrial wastewater treatment by reducing the use of chemical compounds.

Keywords: industrial wastewater treatment, microalgae, C. vulgaris, S. armatus

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Polymeric hydrogel materials as a sustainable platform for advanced biomedical and environmental applications

An increasingly important role in the sustainable development of modern society is played by environmentally friendly polymeric materials. Particularly interesting in this aspect are hydrogels, colloidal systems consisting of a dispersed phase (water) and a dispersion phase (synthetic or natural polymers). Their properties, especially flexibility and specific structure, allow to use them in many fields, from biological and medical to industrial.

Hydrogel polymeric materials used as biomaterials are used among others as drug carriers. For this purpose, biologically safe polymers such as poly(vinylpyrrolidone), poly(ethylene glycol) or collagen are used. By controlling the degree of matrix cross-linking, it is possible to develop intelligent delivery systems for e.g. drugs or biomolecules and their controlled release in the patient's body. Additionally, on the basis of hydrogel materials it is possible to develop composites by their modification with, for example, bioactive hydroxyapatite ceramics. Such composites may find application in bone tissue regeneration.

In the environmental aspect, it is interesting to use hydrogels to remove toxic heavy metals from water. For this purpose, polyacrylic hydrogels are mostly used, which are able to purify the medium from heavy metal ions by adsorption process. Furthermore, due to the impressive sorption capacity of hydrogels, they find applications in agriculture, loosening the soil and thus improving its physical as well as chemical properties.

Keywords: hydrogels, polymers, hydroxyapatite

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Strategies of AOB-NOB activity control with free ammonia and free nitrous acid under short-cut nitrogen removal for energy-neutrality in WWTPs towards Green Deal implementation

The main goal of the Green Deal Implementation is to achieve climate neutrality in Europe by 2050. In this circumstances energy-neutrality in wastewater treatment plants (WWTPs) can be achieved if nitrogen (N) removal does not rely on organic carbon, such as chemical oxygen demand (COD). Short-cut N removal technologies such as partial nitritation/anammox and nitritation/denitritation are therefore essential, enabling carbon- and energy-lean to N removal, that maximum of the COD could be converted to energy recovery. Consequently, the COD/N removal ratio of 2.3 ± 0.7 demonstrated shortcut N removal almost three times lower than the currently applied conventional nitrification/denitrification systems in WWTPs. The 4 dm^3 batch tests reactors were operated with activated sludge and synthetic sewage at various temperature T = 11, 16 and 30°C. The both reactors were equipped with the on-line systems for continuous monitoring and control of pH, temperature and DO concentration. Selective suppression of unwanted nitrite-oxidizing bacteria (NOB) over ammonium-oxidizing bacteria (AOB) was achieved with strict dissolved oxygen (DO) set-point management: 0.4; 0.7 and 1.0 g O_2/m^3. In the first scenario, ammonium constituted sole nitrogen source, whereas ammonium and nitrite were added to the reactor at the ratio 1:1 in the second scenario. At the beginning of the tests with the ammonium only, its concentration was increased to approximately 25 g N/m^3. After finishing the test with ammonium, the sludge was kept in the reactor overnight at the same DO level, combined with aeration control, resulting in a minimal nitrate production ratio. In this study, further strategies of AOB-NOB activity control with free ammonia (FA) and free nitrous acid (FNA) under short-cut N removal for energy-neutrality in wastewater treatment systems towards Green Deal Implementation was demonstrated. The novel development was focus on mathematical modelling and computer simulations for exploring more FA-FNA options under variable DO/T in case of process kinetic and gene activity data from experimental study.

Keywords: WWTP, short-cut N removal, AOB-NOB, FA-FNA, energy-neutrality

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POSTER SESSION

IN POLISH

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Evaluation of thickening and dewatering of the digested sludge preconditioned by sonication

Ocena zagęszczania i odwadniania osadów przefermentowanych wstępnie kondycjonowanych polem ultradźwiękowym

Sludge conditioning is a process aimed at the modification of the structure and properties of the sludge, leading to a significant weakening of the forces that bind water to the surface of the particles of the solid phase and, consequently, to easier removal of water through thickening and dewatering.

This study aimed to determine whether, and to what extent, preconditioning of excess sludge subjected to digestion can improve the final thickening and dewatering of sewage sludge by reducing the use of chemical conditioning agents.

The substrate used in the study was excess sewage sludge. Sonication was conducted under static conditions in five test cycles for selected values of vibration amplitude: 7.88 μm (1.6 W/cm^2), 15.77 μm (2.2 W/cm^2), 23.65 μm (2.7 W/cm^2), 31.54 μm (3.2 W/cm^2), and 39.42 μm (3.8 W/cm^2). Sonication time ranged from 0 to 600 s. After sonication, the sludge was subjected to digestion, and capillary suction time, final water content, specific resistance, thickening curves, and thickening velocities were determined.

The application of ultrasonic field in sewage sludge conditioning led to an increase in capillary suction time in proportion to increases in wavelength and operating time. Stabilization of sewage sludge preconditioned by sonication improved the filtration capacity of the sludge by reducing the capillary suction time. The final water content on each day of the digestion process also decreased. Sonication had a very positive effect on sludge thickening. Single, fragmented flocs were better packed and released free water.

Keywords: sludge, sonication, digestion, dewatering

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Phytoremediation – plants as a "green" way to a toxin-free environment

Fitoremediacja – rośliny jako "zielony" sposób na środowisko wolne od toksyn

The development of civilization causes significant pollution of the environment with organic and inorganic contaminants. Phytoremediation could be the answer to this growing problem. The procedure is to reduce the concentration of pollutants (heavy metals, pharmaceuticals etc.) by the use of green plants. The paper presents the characterization of chemical pollutants which are removed by this method and examples of plant species that can be used in phytoremediation. One of the aspects of the presentation is the management of used plants.

Keywords: phytoremediation, chemical pollution, municipal wastewater

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Methods of recovering metals from waste Li-ion batteries - current state and prospects

Metody odzyskiwania metali ze zużytych baterii Li-ion – stan obecny i perspektywy

Lithium-ion batteries (LiBs) are the basic source of electric current needed to power a variety of electrical and electronic devices, including hybrid and electric vehicles. The growing demand for this type of energy source determines the constantly icreasing amount of their waste. Due to the variety of chemicals contanined in Li-ion batteries, this type of waste must be properly managed. A number of different technologies are used to process spent Li-ion batteries, based on three basic methods of recovering metals contained in them, i.e. mechanical, hydrometallurgical and pyrometallurgical. However, solutions that are not only technologically effective, but also beneficial to the environment are constantly being sought. A promising alternative in the recovery of metals contained in spent Li-ion batteries are biological methods using a variety of microorganisms. Due to the constantly growing demand for comprehensive and effective processing of waste Li-ion batteries, a thorough review of the state of currently used industrial recycling technologies was carried out, as well as laboratory tests in the field of recovering metals contained in this type of waste.

Keywords: Li-ion batteries, recovery of metals, waste management, Circular Economy

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Green hydrogen is the future of renewable energy and energetics

Zielony wodór jako przyszłość odnawialnych źródeł energii i energetyki

The European Green Deal assumes that Europe will be climate neutral by 2050. This means that a balance will be maintained between emitted greenhouse gases and absorbed gases from the atmosphere into the so-called carbon sinks. The main natural carbon sinks are soil, forests and oceans. In order to achieve this goal, it is necessary to transform the socio-economic zone in Europe. For the production of low-emission energy, it is necessary to implement new technologies that would allow for the identification, planning and expansion of opportunities offered by renewable energy sources (RES). In recent years, hydrogen has been referred to as the fuel of the future. The most desirable green hydrogen is obtained i.a. by water electrolysis in a process that uses energy from renewable energy sources. Hydrogen is used in industry, energetics, heat engineering and transport. Decarbonising the economy can be achieved with green hydrogen, which is produced without emitting any carbon dioxide. It is used as a raw material, fuel, energy carrier and energy storage. Hydrogen can be stored in the short and long term, which helps to stabilize the energy system. The aim of the study is to characterize green hydrogen and present the possibilities of its use as a future source of renewable energy.

Keywords: hydrogen, renewable energy sources, hydrogen storage, European Green Deal

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The awareness and importance of technical sciences among the society in the context of the climate crisis

Świadomość i znaczenie nauk technicznych wśród społeczeństwa w kontekście kryzysu klimatycznego

Last month, the World Climate Conference (COP) was held in Glasgow. The result of the conference is the reduction of CO_2 emissions by 2030. But does the public know what COP is and what does it mean? On the basis of the survey conducted - among young people - many conclusions can be drawn. Currently, in Poland, many households have changed heating from coal to ecological. However, not everyone can afford it. Replacing such an installation is costly, within range of a dozen thousand zlotys. Society is conscious about the subsidies for replacement of the heating system. However, despite that, our society cannot afford it. Mostly elderly people whose pensions are inadequate and living is expensive. On the other hand, in Western European countries the subsidies are much higher - the countries are better developed, as indicated by for example air quality. The main goal for the next 8 years is to limit the global temperature rise to 1.5°C. This will allow the climate to cool down all over the Earth, not just in specific areas. However, for this to be the case, all countries must change their climate policy in order for it to have the desired effect.

Keywords: public awareness, climate crisis

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Proposal of water intake location in a rural area – case study

Propozycja lokalizacji ujęcia wody na terenie wiejskim – studium przypadku

The location of water intakes in agricultural areas is extremely important due to the possibility of microbiological contamination of source water. The main factors causing pollution are both agriculture and uncontrolled discharge of domestic wastewater into the environment. Therefore, it is essential to delineate an appropriate protection zone around the water intake.

The main aim of the study was to locate water intakes with a connection of several local water supply systems into one. Three intake locations were proposed: on hills, in forests, and away from agricultural areas. The selection of the best localization was preceded by the analysis of the water supply network operation carried out via simulation studies based on the numerical model created in the EPANET software. Out of the proposed locations of water intakes, only one met the requirements for intakes in terms of possibility of supplying water to all consumers under the conditions of domestic water demand and fire flow. Its protection zone was delineated, along with the influence of the parameters of the medium on pollution migration. The well's range of influence was also determined. For this purpose, the simulation studies were carried out using numerical model created in the MIKE Powered by DHI FEFLOW software, based on the finite element method.

Keywords: water intake, water supply network, protection zone

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Activity of ^{222}Rn in tap water in Kielce district

Aktywność ^{222}Rn w wodach wodociągowych w powiecie kieleckim

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. Three selected water intakes in the Kielce district were tested for ^{222}Rn activity in water: Bolechowice, Kołomań and Wola Kopcowa. This type of research was conducted for the first time in the discussed area. The results were analyzed in detail in terms of acceptable concentrations. Next, it was determined whether the geological location of the intakes in question may have an impact on the amount of radon present in the waters.

Keywords: ^{222}Rn, geological substratum, water quality

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Dragonflies of the upper Silesian agglomeration as an indicator of biodiversity and climate change

Ważki Aglomeracji Górnośląskiej jako wskaźnik bioróżnorodności i zmian klimatu

Field research was conducted on the occurrence of dragonflies (Odonata) in the Upper Silesian Agglomeration. Several characteristic objects were selected: a pond in an area degraded by mining activity, which is a post-mining sinkhole, a peat bog located in a forest, a small stream flowing through a decades-old deciduous forest and a garden pond. The research was carried out in 2020 and 2021. The occurrence of over 30 species of dragonflies has been observed, including those that are covered by various forms of species protection. The observations confirm that even within the Agglomeration there are so-called "green islands" with favorable living conditions for living organisms endangered on a national scale. This indicates the need to cover these areas with various forms of protection, in order to preserve biodiversity and protect the residual populations of the most vulnerable and least plastic species. It is also noted that in 2021 the observations of southern species prevailed, which may indicate a progressive warming of the climate.

Keywords: dragonflies (odonata) biodiversity, green islands

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Green building as an element of implementing the idea of sustainable development on the example of beddington zero energy development in London

Budownictwo ekologiczne jako element wdrażania idei zrównoważonego rozwoju na przykładzie osiedla Beddington Zero Energy Development w Londynie

The aim of the paper is to present the main assumptions of the environmentally friendly BedZED housing estate project, in the aspect of reducing the exploitation of natural resources in its use, as well as the introduction of technologies allowing for their recycling and reuse. Since 2002, id est the date of the project implementation, data has been collected on the functioning of the estate, which allows for a real comparison between the project assumptions and the achieved effect in reality. Conclusions gathered from data analysis give the possibility to confirm the rightness of using modern technologies and innovative ways of building objects in relation to reflecting their effects on the environment as well as on the quality of life of users. In addition, the location of the settlement has been considered, also being an element of the balance of development of development areas and natural areas, not exploited by man. After analyzing the data available on the exploitation, it is possible to determine which assumptions and technical solutions brought the expected results and which did not fulfil the defined role or were rejected due to high costs.

Keywords: environment, natural resources, recycling, technology, sustainable development

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The influence of ultrasonic disintegration on the change of properties of sludge from water treatment

Wpływ dezintegracji ultradźwiękowej na zmianę właściwości osadów pochodzących z uzdatniania wody

The main goal of actions related to post-coagulation sludge generated in water treatment plants is to reduce its volume in the thickening and dewatering processes. In order to improve the filtration properties of this sludge, disintegration studies were carried out using ultrasonic waves. Ultrasonic disintegration of sludge is based on the action of an ultrasonic field with strictly defined parameters. Pressure pulses in the form of a shock wave, which are formed during the annihilation of cavitation bubbles, propagate spherically and destroy the structure of the medium, causing deagglomeration of the flocs and destruction of microorganism cells. This may increase the proportion of free water in the sludge, which will then be removed in the thickening or dewatering processes.

Tests of the ultrasonic disintegration process of post-coagulation sludge were carried out using the ultrasonic disintegrator VCX-500 Vibra Cell Ultra Sonic Processor Sonics & Materials Inc. This facility allows to conduct the process at the ultrasonic wave frequency equal to 20 kHz and the vibration amplitude regulated in the range from 20 to 100% of the nominal tip amplitude (60 μm). In the sludge before and after the disintegration process, the contents of total solids, volatile solids, CTS, settlements and COD of the sludge liquid were determined. In addition, the microscopic image was assessed to determine the degree of cell disintegration of the microorganisms.

Keywords: ultrasonic disintegration, post-coagulation sludge

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Directive EU on the quality of water intended for human consumption – new testing and analysis requirements

Dyrektywa UE w sprawie jakości wody pitnej – nowe wymagania badań i analiz

The Directive (EU) 2020/2184 of the European Parliament and of the Council (of 16 December 2020) on the quality of water intended for human consumption, published in December last year, places more emphasis than previous legislation on universal access to water and environmental protection. These "new" rules – require a risk-based approach to water quality monitoring and also set minimum hygiene requirements for materials that come into contact with water intended for human consumption (to improve the quality of these materials and thus protect human health and prevent pollution). The Directive is also part of the circular economy transition plan to help manage drinking water in an economical and sustainable way, thus contributing to the reduction of energy consumption and unnecessary water losses. The Directive's guidelines also update the drinking water quality standards, setting maximum limits for contaminants, both those indicated in previous legislation and new pollutants resulting from new knowledge about the impact of certain substances on human health and life.

This presentation presents the analytical possibilities for the determination of contaminants in drinking water under the provisions of the Directive, especially with regard to new substances the monitoring and analysis of which will be a necessity. This is often associated with the use of modern methodologies, using very sensitive and specific analytical techniques, such as the use of mass spectrometry connected with chromatographic techniques, as well as inductively coupled plasma mass spectrometry techniques. The presentation also shows results of our works to develop new methods that meet the guidelines of the directive.

Keywords: water quality, chromatographic techniques, PFAS, drinking water

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Sealing clay-cement binders for flood protection dikes

Uszczelniające spoiwa iłowo-cementowe dla wałów przeciwpowodziowych

Sealing clay-cement binders are used in the construction of flood protection levees, stabilization of wetlands and construction or repair of various hydro-technical structures. Their ability to change their properties in time from liquid to solid allows them to be introduced to the target places of application in the form of liquid, where after a short period of time they acquire mechanical stiffness strengthening the soil and blocking the water flows. The parameters of the slurries are controlled by changing the ingredients - amount and type of clay mineral, cement and modifiers. The given work concerns the determination of basic application properties of sealing clay-cement suspensions by means of rheological methods. The description of viscoelastic properties and the effects of individual components on the changes of application parameters were carried out by measuring the shear modulus G` and G``, thixotropy, flow limits and apparent viscosities. In the application aspect, the usefulness of suspensions for elastic soil modification for hydro-engineering objects was evaluated. The stages of spatial structure formation of binders in time were determined. Additional knowledge was gained on the curing kinetics of suspensions with cement and the formation of 3D spatial structure.

Keywords: clay-cement binders, clay slurries, flood levees, rheology

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Helactin Blue F2R adsorption on waste sorbent made from post-coagulation sludge

Adsorpcja błękitu helaktynowego F2R na sorbencie odpadowym wytworzonym z osadu pokoagulacyjnego

The research on the use of waste sorbent in the static sorption process to remove the Helactin Blue F2R dye was carried out. Post-coagulation sludge was used as a waste sorbent. For this purpose, the sludge, generated in the process of surface water treatment by means of coagulation with the use of aluminum coagulant, was concentrated, dehydrated, dried and crushed. The waste sorbent prepared according to this procedure was used in the static sorption process. The study was divided into three main stages: 1) selection of the most favorable pH value and assessment of the influence of pH on the effectiveness of the sorption process, 2) determination of the most favorable reaction/contact time between the sorbent and the dye, 3) determination of the adsorption isotherm. Moreover, based on the results obtained in the third stage of the studies, the parameter values of selected models of adsorption isotherms (including Freundlich, Langmuir, Jovanovic, etc.) were calculated. The obtained test results indicate that such a modified post-coagulation sludge can be used as a waste sorbent. It is an interesting alternative to classic sorbents used in wastewater treatment and water renewal processes.

Keywords: post-coagulation sludge, waste sorbent, dye adsorption

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Microplastic in tap water – preliminary tests

Mikroplastik w wodzie wodociągowej – badania wstępne

During preliminary tests an attempt was made to determine the presence of microplastic particles in tap water. Samples were collected from three points within the water supply system of the Upper Silesian Agglomeration. It was shown that microplastic particles were present in each of the points covered by the research in amounts ranging from several dozen to several thousand per cubic meter of water. Contamination by microplastic was present both in water from underground intakes and surface intakes. It is assumed that the microplastic in tap water is a secondary contamination and its origin is the erosion of the plastic pipes in water supply system. This indicates the need for further research in order to accurately determine which elements or fragments of the water supply system may be responsible for the appearance of microplastics in tap water.

Keywords: microplastic, water supply system, tap water

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Removal of copper and lead from rainwater with inexpensive hybrid composite beads based on diatomite and sodium alginate

Absorpcja miedzi i ołowiu z wody opadowej za pomocą absorbentów na bazie diatomitu i alginianu sodu

Contamination of water bodies with toxic heavy metals is one of the major problems in many countries. Copper and lead are harmful toxic metals found in rainwater. Currently, new sorption materials for water treatment are sought that are readily available, economical and environmentally friendly. The present study deals with the removal of these two toxic heavy metal ions with an adsorbent that was prepared by encapsulation with sodium alginate. Alginate is capable of forming hydrogels in the presence of divalent cations. Characterization was determined by measuring the surface area and pore size distribution using the Brunauer, Emmett and Teller (BET) low temperature nitrogen adsorption and desorption technique (BET) and surface imaging by scanning electron microscopy (SEM) and point analysis (EDS). The next stage of the research was to carry out the adsorption process under static conditions, to determine the adsorption isotherms and the adsorption kinetics of copper and lead on the produced capsules. Adsorption showed a high percentage of both copper and lead removal. For the dose of 2 g/L and the adsorption time of 2 h, the efficiency was achieved at the level of 91.2% and 91.6% respectively for copper and lead. The best results were obtained for copper for a rainwater solution of pH 6 and for lead at pH 8. Therefore, encapsulation of diatomite with sodium alginate polymer can be proposed as a solution to avoid problems during adsorption with the recovery of fine particles of diatomite from aqueous solutions.

Keywords: adsorption, diatomite, heavy metals, rainwater

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Assessment of the impact of nanomaterials on the germination of monocotyledonous and dicotyledonous plants in unpolluted and oil contaminated soil

Ocena wpływu nanorurek węglowych na kiełkowanie roślin jedno i dwuliściennych w glebie skażonej przepracowanym olejem silnikowym

Nanomaterials are considered to be the compounds that will dominate the world in the future. They will form the basis for the production of many items and devices in various fields of science and technology. However, when working with these materials, their uncontrolled release into the environment is serious threat. The aim of the study was to determine the influence of carbon nanotubes on flora (Monocotyledon and dicotyledonous plants) in uncontaminated and exhausted engine oil - contaminated soil.. The nanomaterials showed no positive effects on properties of uncontaminated soil. They cause a reduction in the hygroscopic water content in the soil, which is reflected in the plants grown on this substrate. On the other hand, the introduction of nanomaterials into oil-contaminated soil had a beneficial effect since the carbon nanotubesadsorbed the toxic compounds present in the exhausted engine oil. An uptake of water and nutrients by plants from oil-contaminated soil containing carbon nanotubes was higher than from oil-contaminated soil without carbon nanotubes. The study also showed that the flora was not clearly affected by carbon nanotubes in the control soil. It can be concluded that carbon nanotubesare the material that is suitable for the supporting plant growth in contaminated soil environment.

Keywords: nanomaterials, phytotoxicity, monocotyledonous and dicotyledonous plants, soil

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Water reclaim as an alternative source of water

Odnowa wody jako alternatywne źródło wody

Due to climate changes and industrial development current available water sources decreases. Water is a substantial compound that determines every existence and civilization development. Problem with water scarcity has been observed all over the World. It resulted in a need to find alternative methods of water acquire. One of the possible ways to solve this problem is water reclaim which is the next step of water treatment. Thanks to that technology amount of taken tap water as well as the amount of wastewater directed to wastewater treatment plants is lowered. It allows to state that water recycling may be a promising technique to fight the water scarcity problem. The system design is determined by future reclaimed water usage. Processes like ion exchange, sedimentation, coagulation, or membrane techniques can be used. The purest water is needed the more complicated treatment system is supposed to be applied. Multistage technology allows producing water that fulfils even drinking water requirements. Based on available information found in the scientific resources bases - water reclaim state, processes used in water renew and possible ways of reclaimed water usage were shown. Water reclaim in some countries is commonly used for drinking water production. According to the literature state, water reclaim may be able to decrease the water deficit and in the future, it will become more popular.

Keywords: water reclaim, water treatment, water scarcity

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Photopolymerization as an economical and waste-free method of the synthesis of composite materials designed for bone tissue regeneration

Fotopolimeryzacja jako ekonomiczna i bezodpadowa metoda otrzymywania materiałów kompozytowych przeznaczonych do regeneracji tkanki kostnej

Due to the intensive technological progress, the so-called civilization diseases classified as diseases of the 21st century are becoming an increasing problem. Cardiovascular diseases, cancers and osteoporosis are among the main challenges of modern medicine. According to the International Osteoporosis Foundation, the problem of osteoporosis affects about 200 million people. Osteoporosis is a disease characterized by loss of bone mass. As a result, the weakened bone breaks with very small injuries. Untreated or improperly treated osteoporosis leads to disability, or even death. Osteoporosis is often asymptomatic, therefore serious fractures are widely observed. Ob the other hand, a broken bone or a resulting cavity is most often replaced with an appropriate implant.

The main subjects of presented work are bioactive ceramic-polymer composites for applications in regenerative medicine. The innovation of the proposed solution is to obtain a composite that may fill the bone defect imitating its shape and size while releasing simultaneously into the medium active substances supporting the proliferation and growth of bone cells. The basis of the developed materials is a polymer matrix showing excellent strength properties and providing at the same time adequate elasticity. As a bioactive component, hydroxyapatite has been used, which provides perfect osteointegration. Moreover, the apatite ceramics applied shows also osteoinductive and osteoconductive properties thus simulating the osteogenesis process.

The presented bioactive composite materials are obtained in the photopolymerization process, i.e. via UV radiation. This process is a very fast method – a synthesis of a composite material takes only 120 s. Furthermore, proposed method is ecological and economical – no additional by-products are formed that might have a harmful effect. At the same time, the materials are obtained using the minimum input of substrates which is in line with the principles of "green chemistry". The ability to adjust a specific composite to the individual needs of patients is extremely important because depending on the polymerization form used, obtained composites are of various shapes and sizes.

Keywords: photopolymerization, composites, tissue regeneration

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Magnetic nanoparticles in the diagnosis and treatment of neoplastic diseases

Nanocząstki magnetycznych w diagnostyce i leczeniu chorób nowotworowych

Nanotechnology is a versatile field of science which has been used in almost all areas of life including also medicine and the relative areas. This, in turn, has significantly increased the chance of a patients' survival. Achievements in this field have contributed to more effective detection and diagnosis of neoplastic tissues where a significant role is played by magnetic nanoparticles. Traditional methods of cancer detection have many limitations affecting their effectiveness. An example of a technique where magnetic nanoparticles constitute a promising solution is a magnetic resonance imaging (MRI) due to which a good spatial imaging is obtained at the expense of accuracy. Thus the solution to the problem is the synergic use of the traditional detection method with magnetic substances. The combination of magnetic resonance imaging with superparamagnetic iron oxide nanoparticles (Fe_3O_4) as contrast agents is used to visualize the boundaries between pathological and healthy tissue due to which it is possible to remove neoplastic cells more accurately. The first investigations aimed at using the magnetic field to target drugs in the human body date back to the 1990s but their dynamic development took place only during the last decade. Magnetic nanoparticles are most often used in treatment with targeted chemotherapy. Compared to oncological surgery, radiotherapy or traditional chemotherapy, targeted chemotherapy is much less invasive and thus less harmful to the patient. Its application consists in introducing magnetic nanoparticles – which act as a drug carriers of anticancer drugs – into the patient's body, and then directing them to the target site using an external electromagnetic field. Another application of magnetic nanoparticles in the treatment of tumors includes the hyperthermia, i.e. a method which consists in generating the thermal energy by magnetic nanoparticles after directing an alternating magnetic field onto them. Currently, there are more and more research centers working on the development of oncology with the application of magnetic nanoparticles, and due to such studies magnetic nanoparticles have a chance to have a significant impact on the development of innovative methods of cancer treatment.

Keywords: magnetic nanoparticles, targeted drug delivery; hyperthermia; cancer treatment

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Characteristics of magnetic nanoparticles as innovative materials of the 21st century

Charakterystyka nanocząstek magnetycznych jako innowacyjnych materiałów XXI wieku

According to the International Organization for Standardization (ISO), nanomaterials are structures having any external or internal dimensions in the nanoscale (1-100 nm). Magnetic nanoparticles seem to be particularly promising nanomaterials. Due to the magnetic core, it is possible to control them by means of a magnetic field, which means that these nanomaterials may be used for various purposes, e.g. in medicine as drug carriers in non-invasive targeted chemotherapy. As a result of many investigations performed on this research topic, it is possible to obtain magnetic nanoparticles on a large scale, respecting the environment and maintaining simultaneously high efficiency and low production costs. Main application of magnetic nanoparticles is related to medicine therefore their biocompatibility and toxicity are an equally important aspect of the discussion and investigations on these nanomaterials. Biocompatible magnetic nanoparticles are a strong alternative to classic cytostatic drugs currently used in cancer therapies. Nonetheless, the main treat when using the described structures in medicine is their agglomeration in the bloodstream which, in turn, may lead to changes in cell morphology, vascular embolism, genotoxicity or oxidative stress. However, these effects caused by the agglomeration of these nanoparticles are defended by their functionalization, i.e. providing magnetic nanoparticles with new properties while maintaining their original structure through chemical processes. Due to such functionalization, it is also possible to significantly affect the biocompatibility of magnetic nanoparticles, increase the chance of their accumulation at the target site, and reduce their opsonization.

Keywords: magnetic nanoparticles, nanomaterials, functionalization of magnetic nanoparticles, nanomaterials' agglomeration, biocompatible nanoparticles

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Polymer superabsorbents – properties and application

Superabsorbenty polimerowe – właściwości i zastosowanie

Hydrogels are biomaterials that consist of a dispersed phase which is most often water, and a gelling substance which is built of cross-linked polymer chains in a three-dimensional form. A special feature of hydrogels is their ability to absorb a large amount of fluids (water or biological excretions) and the resulting swelling. This process depends both on environmental factors (e.g. pH, temperature) and on the hydrogel structure. Moreover, described polymer superabsorbents show also biodegradability, non-toxicity, biocompatibility, high analogy with soft tissues, modifiability of the amount and rate of fluid absorption. Importantly, a big advantage of these biomaterials is the fact that during their synthesis they may be modified and adapted to the needs it is to meet. By using the radiation method of synthesis, a sterile material may be obtained. All these advantages of hydrogels make them very popular in the medicinal community as well as in cosmetology. They are used in the form of active dressings, the so-called smart transporters of therapeutic substances, as materials for preparation of implants and various structures acting as scaffolds in tissue engineering. At present, the most popular use of hydrogels in medicine is their application as innovative dressing materials, especially designed for burns, long-healing wounds and ulcerative ones. The advantage of hydrogels over the traditional dressings includes the improvement of the patient's treatment comfort by shortening the therapy time, reducing pain sensations, and noticeably minimizing the occurrence of extensive scars. Superabsorbents contribute also to a significant reduction of medical waste which, in turn, has a positive effect on environmental protection. Due to their unique properties, these materials are also very popular in agriculture. Due to the use of very large amounts of synthetic fertilizers, chemical plant protection preparations and ill-considered melioration in recent decades, the natural environment has been degraded. Thus the use of biodegradable superabsorbents allows to reduce the effects of drought and accelerate the revitalization of the natural environment. Due to the ability to expand and reduce their volume, they improve the structure of the soil due to its aeration and loosening. Next, due to the retention of water in the soil they inhibit leaching of fertilizers and preparations used to protect plants. This, in turn, brings measurable effects in terms of increasing the economy of production and environmental protection.

Keywords: hydrogel superabsorbents, hydrogel dressings, environmental protection

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Influence of sewage on concrete elements of sewage treatment plants

Wpływ ścieków na elementy betonowe oczyszczalni ścieków

Reinforced concrete and steel elements of sewage treatment plants are often exposed to corrosive processes. The corrosion of concrete is mainly caused by acidic or alkaline wastewater. Group pressure sewage systems, built mainly as long-dimension pressure pipes, contribute to the longer keeping of sewage in anaerobic conditions, without the possibility of refreshing it. Moreover, in the area of the sewage treatment plant, the tanks are often tightly covered in order to reduce the stench of sewage. The consequence of this is accelerated corrosion of concrete elements in contact with sewage. The aim of the paper is to present the degree of corrosion damage to the concrete surface that may occur in the infrastructure facilities of the sewage treatment plant. The test samples were seasoned in solutions of sewage after the sand trap and from the activated sludge chamber in three different environments: acidic, neutral and alkaline. Compressive strength, weight loss and surface roughness tests were carried out after 270 days of seasoning. A scanning electron microscope and an optical 3D profilograph were used in the study of surface roughness. The results were compared with a control sample not exposed to any aggressive medium. The conducted research will contribute to increasing the knowledge about the influence of municipal sewage on the durability of concrete elements of the sewage treatment plant in specific operating conditions.

Keywords: sewage treatment plant, concrete, acid and alkaline corrosion, microscopic analysis

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