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TECHNICAL FACULTY IN BOR

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8th INTERNATIONAL STUDENT CONFERENCE ON TECHNICAL SCIENCES

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20-21 October, Bor Lake, Serbia

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PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to wish all the participants a warm welcome to the 8th International Student Conference on Technical Sciences (ISC 2023) held at Bor Lake, Serbia, 20 – 21 October 2023.

This year's conference is organized by University of Belgrade, Technical Faculty in Bor in collaboration with the Student Parliament of the Technical Faculty in Bor.

The ISC 2023 is co-organized by:

⇒ University of Zenica, Faculty of Metallurgy and Technology, Zenica, Bosnia and Herzegovina;
⇒ University in Priština, Faculty of Technical Science, Kosovska Mitrovica, Serbia;
⇒ University of Montenegro, Faculty of Metallurgy and Technology, Podgorica, Montenegro;
⇒ University of Tuzla, Faculty of Technology, Tuzla, Bosnia and Herzegovina;
⇒ University of Chemical Technology and Metallurgy, Faculty of Metallurgy and Material Science, Sofia, Bulgaria;

ISC2023 aims to promote scientific research of students of technical sciences from the country and the region, to exchange ideas and experiences, as well as to strengthen cooperation among university students in the country and the region.

At this conference, we remember our dear professor Dragana Živković, who is also the founder of the Student Conference on Technical Sciences "ISC". The organization of this conference can be presented as a continuation of some previous activities in the frame of the so-called SNIRS (Annual Meeting of Students Research Work), which was organized by the Student Researchers Club "1902" at the Technical Faculty in Bor, University of Belgrade, during the period 1992–2006 and coordinated by Prof. Dragana herself.

In this ISC 2023, two awards in honor of Professor Dragana Živković will be introduced for the best papers presented by students in the oral and poster sections. The winners of the Dragana Živković Award will be selected based on several criteria, including creativity and originality of research, clarity of presentation, and level of understanding.

The 8th International Student Conference on Technical Sciences (ISC 2023) will take place within the frame of the 54th International October Conference on Mining and Metallurgy - IOC 2023.

The book of abstracts includes 36 papers from students from four countries: China, Russia, Bosnia and Herzegovina, and Serbia.

We would like to thank all the students and mentors who contributed to the book of abstracts, as well as the members of the scientific and organizing committees, for their support of ISC 2023.

We look forward to welcoming you to the 9th International Student Conference on Technical Sciences (ISC 2024).

On behalf of the 8th ISC Organizing Committee,
Assistant Professor Uroš Stamenković, PhD

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INVITED LECTURE

MICROSTRUCTURAL SIMULATION OF AGEING PRECIPITATION BASED ON THE DIFFUSION STUDY OF THE HCP_A3 PHASE IN Mg-Al-Sn ALLOYS

Students: Yuhui Zhang[1,2], Shuhong Liu[1], Yuling Liu[1]

Mentor: Yong Du[1]

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Abstract

Magnesium alloys are highly potential lightweight materials in structural material field. Thus, it is of great importance to design the high-strength Mg alloys in a highly efficient way. Computational simulations based on the microstructural evolution of precipitated phases during the aging precipitation process are expected to provide important guidance for the composition and heat treatment process design of new aging-strengthened magnesium alloys. Reliable thermodynamic and kinetic information is the basis for the microstructural simulation. For Mg-Al-Sn alloys, the thermodynamic research work has been well investigated, but the diffusion kinetic research is relatively less. In this work, 10 sets of diffusion couples were prepared, and diffusion couples were annealed at 723, 773, and 823 K to measure the diffusion behavior of different elements in the HCP_A3 phase. The composition-distance profiles were obtained by EPMA, and the variation of the interdiffusion coefficients of Al and Sn elements in the HCP_A3 phase with composition and temperature at different temperatures were calculated by the highly efficient software, i.e., CALTPP (CALculation of ThermoPhysical Properties). The atomic mobility parameters of the HCP_A3 phase were evaluated with the reported thermodynamic description of the Mg-Al-Sn system. The optimized atomic mobility parameters coupled with the thermodynamic information and key experimental data contributed to a more accurate prediction of the Mg-5.5Al-(2.5, 5)Sn(wt.%) alloy's microstructural evolution during aging. The present simulations could well predict the volume fraction, number density and particle size of the present experimental results and those determined by others.

Keywords: Magnesium alloys, Diffusivity, Atomic mobility, Microstructural simulation

REMOVAL OF COPPER IONS FROM AQUEOUS SOLUTIONS USING ONION PEELS AS AN ADSORBENT

Student: Marina Marković

Mentor: Prof. dr Milan Gorgievski

University of Belgrade, Technical Faculty in Bor, Bor, Serbia

Abstract

The physical-chemical process of removing substances from a solution using biological material as an adsorbent is called biosorption. The main advantages of biosorption compared to conventional wastewater treatment technologies are low cost, high efficiency, minimization of chemical or biological sludge, the ability to regenerate biosorbents, and the possibility of metal "recovery" after biosorption. In this paper, the biosorption process of copper ions from aqueous solutions onto onion peels is presented. The pH value and conductivity of the solution from rinsing the biosorbent with distilled water were measured, as well as the change in pH value and conductivity during the biosorption process. The results showed that the pH value of the solution increases during the rinsing of the onion peels with distilled water, which is the result of the transfer of H^+ ions from the aqueous phase to the structure of the onion peels. The conductivity of the solution increased during the rinsing of the biosorbent, reaching a maximum value at about 60 mL of water passed, after which it decreased. During the biosorption of Cu^{2+} ions on onion peels, the pH value of the solution decreased due to the deprotonation of functional groups in the biosorbent and the transition of H^+ ions to the aqueous phase, where they exchange with copper ions. As for a change in conductivity during the biosorption of Cu^{2+} ions, a sudden increase was noted in the first 10 minutes of the process, after which the conductivity of the solution changed more slowly.

***Keywords**: Biosorption, Copper ions, Onion peels, pH value, Conductivity*

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I want to thank my mentor for his help and support in writing this paper.

REFERENCES

[1] G.M. Gadd, J. Chem. Technol. Biotechnol., 84 (2008), 13-28.
[2] D. Park, Yun Y.S., Park J.M., Biotechnol. Bioprocess Eng., 15 (2010), 86-102.

INFLUENCE OF GRAPHITE MORPHOLOGY ON THERMAL CONDUCTIVITY

Students: Nizama Baručija, Armin Čaušević, Merjem Delibašić

Mentor: Hasan Avdušinović

University of Zenica, Faculty of engineering and natural sciences, Zenica, Bosnia and Herzegovina

Abstract

The research relates to the determination of the coefficient of thermal conductivity on samples of nodular and lamellar cast iron at different temperatures. Nodular cast iron is a pseudobinary alloy of iron and carbon, which is mainly excreted in the form of spherical graphite, while in cast iron with lamellar graphite, carbon is found in the form of free graphite plates (lamellar scales) after solidification. The thermal conductivity of nodular cast iron is strongly influenced by the graphite morphology. Nodular cast iron contains spherical inclusions dispersed in the metal matrix, which results in relatively high strength and ductility and a lower value of thermal conductivity. Cast iron with lamellar graphite contains graphite inclusions in the form of lamellae or flakes that form an interconnected network, and the connected network of graphite results in a material with higher thermal conductivity. The obtained results show the difference in the coefficient of thermal conductivity of the tested samples. The coefficient of thermal conductivity of cast iron with lamellar graphite is significantly higher compared to the coefficient of thermal conductivity of cast iron with nodular graphite.

***Keywords**: Coefficient of thermal conductivity, Cast iron, Spherical graphite, Lamellar graphite*

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The authors would like to thank their colleagues at the Technical Faculty in Bor for their help in preparing the paper.

REFERENCES

[1] M. Ostojić, A. Beroš, Nodularni liv, Univerzitet u Zenici, Fakultet za metalurgiju i materijale, Zenica, 2008
[2] Z.Glavaš, F.Unkić, Lijevanje željeznih metala, Sveučilište u Zagrebu, Metalurški fakultet, Sisak, 2008
[3] A.Gigović-Gekić, H.Avdušinović, Termička obrada metala, Praktikum s teorijom, Univerzitet u Zenici, Metalurško-tehnološki fakultet, Zenica, 2019.
[4] A.Gigović-Gekić, H.Avdušinović, Termička obrada metala, Zbirka zadataka s teorijom, Univerzitet u Zenici, Metalurško-tehnološki fakultet, Zenica, 2019.

WAYS TO SOLVE ALTERNATIVE ENERGY SOURCES

Student: Alexandr Chesnyak

Mentor: Tamara Tikhomirova

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Abstract

As the world faces increasing concerns about climate change and the need for sustainable energy, alternative energy sources have gained significant attention as potential solutions. This work highlights different ways to address the need for alternative energy sources, including the development and utilization of renewable energy technologies such as solar, wind, hydropower, geothermal, and bioenergy. The abstract emphasizes the advantages of these alternative energy sources, such as their abundance, cleanliness, and renewability. However, it also acknowledges the challenges and considerations associated with each energy source, such as environmental impacts, technological advancements, policy support, and social acceptability. The abstract concludes by highlighting the importance of continued research, innovation, and policy efforts to promote the adoption of alternative energy sources as part of a sustainable energy transition.

As the world faces growing concerns about climate change, diminishing fossil fuel reserves, and increasing energy demands, the search for alternative energy sources has gained significant attention. Alternative energy sources, also known as renewable or sustainable energy, offer promising solutions to address these challenges while reducing greenhouse gas emissions and promoting environmental sustainability. In this work, we will explore various alternative energy sources and their potential as solutions to our energy needs [1].

Solar Energy: Solar energy is a form of renewable or sustainable energy that is generated by harnessing the energy from the sun's radiation. There are two main technologies used to convert solar energy into usable electricity: photovoltaic (PV) cells and solar thermal systems.

Photovoltaic (PV) cells, commonly known as solar panels, are made up of semiconductor materials that can convert sunlight directly into electricity. When sunlight strikes the PV cells, it excites electrons in the semiconductor, generating an electric current that can be captured and used to power electrical devices or stored in batteries for later use. PV cells can be used in a wide range of applications, from small-scale solar panels on rooftops for residential or commercial buildings, to large utility-scale solar farms that generate electricity for the grid [2].

Solar thermal systems, on the other hand, use the sun's heat to generate electricity or heat water for various applications. Solar thermal systems typically use mirrors or lenses to focus sunlight onto a target, such as a fluid or a solid material, which then absorbs the heat and transfers it to a working fluid. The working fluid is then used to generate electricity through a turbine or used directly for heating purposes in homes, businesses, or industries.

Solar energy has several advantages. It is a clean and abundant source of energy that does not produce greenhouse gas emissions, making it environmentally friendly. Solar energy is also a decentralized and domestic source of electricity, reducing dependence on fossil fuels and increasing energy security. Moreover, solar energy can save money on electricity bills over the long term, as it has no fuel costs and requires minimal maintenance.

However, solar energy also has some challenges. It is an intermittent energy source, as it depends on the availability of sunlight, which can vary over time and by location. This requires careful integration with other sources of electricity and energy storage solutions to ensure a stable and reliable power

supply [3]. The cost of solar energy systems, particularly PV cells, has been decreasing over the years, but it still requires an upfront investment. Solar energy projects also need to consider factors such as the orientation and tilt of solar panels, shading, and local regulations when planning for optimal performance.

Despite these challenges, solar energy has been rapidly growing as a promising alternative energy source in many countries worldwide. Advances in solar technology, increasing efficiency of PV cells, and supportive policies and incentives have contributed to the expansion of solar power capacity, making it a significant solution to address the need for clean and sustainable energy.

Wind Energy: Wind energy is a type of renewable or sustainable energy that is generated by harnessing the kinetic energy of moving air, typically through wind turbines. These turbines are designed to capture the energy in the wind and convert it into electricity.

Wind energy has several advantages. First, it is a clean and abundant source of energy that does not produce harmful greenhouse gas emissions, making it environmentally friendly. Wind energy also provides a domestic and decentralized source of electricity, reducing dependence on fossil fuels and increasing energy security. Additionally, wind energy can be a cost-effective solution for power generation, as the operational costs of wind farms are relatively low once the infrastructure is installed [4].

Wind turbines can be installed onshore or offshore, depending on the availability of wind resources and local conditions. Onshore wind farms are typically located in windy areas, such as plains, hills, or coastlines, and can range from small community-scale projects to large utility-scale installations. Offshore wind farms are installed in bodies of water, such as oceans or large lakes, and can take advantage of stronger and more consistent winds.

However, wind energy also has some challenges. Wind power is intermittent, as it depends on the availability of wind, which can vary over time. This requires careful integration with other sources of electricity and energy storage solutions to ensure a stable and reliable power supply. Wind energy projects also need to consider potential environmental and social impacts, such as bird and bat collisions, noise, visual aesthetics, and impacts on local communities and ecosystems.

Despite these challenges, wind energy has been rapidly growing as a viable alternative energy source in many countries around the world. Technological advancements, increased efficiency of wind turbines, and supportive policies have contributed to the expansion of wind power capacity, making it an important solution to address the need for clean and sustainable energy [5].

Hydropower: Hydropower, or hydroelectric power, is generated by capturing the energy of moving water in rivers, tides, or waves and converting it into electricity. Hydropower can be generated through large-scale dams, run-of-river systems, tidal barrages, or ocean wave converters. It is a reliable and mature alternative energy source that has been used for decades to generate electricity. However, it also has potential environmental and social impacts, such as habitat destruction, displacement of communities, and changes in river ecosystems.

Geothermal Energy: Geothermal energy is a form of renewable or sustainable energy that is derived from the heat stored within the Earth's crust. This heat is generated from the natural radioactive decay of elements such as uranium, thorium, and potassium, as well as from residual heat from the planet's formation. Geothermal energy can be harnessed for various applications, including electricity generation, heating, and cooling.

Geothermal power plants typically tap into hot water or steam reservoirs deep within the Earth's crust. Wells are drilled into these reservoirs, and the hot water or steam is brought to the surface through a process called geothermal drilling. The heat from the water or steam is then used to generate electricity by driving a turbine connected to a generator. The used water or steam is then re-injected back into the reservoir to sustain the geothermal resource [6].

Geothermal energy has several advantages. First, it is a reliable and continuous source of energy, as the heat from the Earth's interior is virtually inexhaustible. Geothermal power plants can operate 24/7, providing a stable and consistent power supply without being dependent on external factors such as weather conditions. Geothermal energy is also a clean source of energy, as it produces minimal greenhouse gas emissions and air pollutants compared to fossil fuels. Additionally, geothermal energy has a relatively small land footprint compared to other energy sources, making it suitable for areas with limited available land.

Bioenergy: Bioenergy is derived from organic matter, such as crops, agricultural residues, forestry waste, and livestock manure, through processes such as combustion, fermentation, or gasification. Bioenergy can be used for heat, electricity, or as biofuels for transportation. Bioenergy is considered a renewable energy source, as long as biomass is harvested sustainably and does not contribute to deforestation or biodiversity loss. However, it also requires careful management to avoid negative impacts on food production, land use, and greenhouse gas emissions.

Conclusion: As the world transitions towards more sustainable energy systems, alternative energy sources offer promising solutions to meet our energy needs while reducing greenhouse gas emissions, promoting environmental sustainability, and mitigating the impacts of climate change. Solar energy, wind energy, hydropower, geothermal energy, and bioenergy are among the most widely explored and utilized alternative energy sources, each with their unique advantages and challenges. Continued research, technological advancements, and policy support are needed to further develop and scale up alternative energy sources to achieve a more sustainable and resilient energy future.

***Keywords**: Energy, Wind, Solar, Geothermal, Bioenergy*

REFERENCES

[1] В. Сидорович, Мировая энергетическая революция: Как возобновляемые источники энергии изменят наш мир / Владимир Сидорович — М.: Альпина Паблишер, 2019. — 208 с.
[2] J.T. Kiehl, E. Kevin Trenberth, 1997: Earth's Annual Global Mean Energy Budget. Bull. Amer. Meteor. Soc., 78, p. 197–208.
[3] Пресс-служба «Агентства инвестиционного развития Ростовской области» 2 мар. 2020 / https://www.donland.ru/news/8097 /
[4] П.П. Безруких, Справочник ресурсов возобновляемых источников энергии России и местных видов топлива. Показатели по территориям / П. П. Безруких. — Москва: Энергия, Институт энергетической стратегии, 2007. — 272 с.
[5] В. Германович, Альтернативные источники энергии и энергосбережение. Практические конструкции по использованию энергии ветра, солнца, воды, земли, биомассы / В. А.Германович, Турилин — Санкт-Петербург: Наука и Техника, 2014. — 320 с.
[6] С.Н. Удалов, Возобновляемые источники энергии: учебное пособие / С. Н. Удалов. — Новосибирск: Новосибирский государственный технический университет, 2014. — 460 с.

DEVELOPMENT OF GEOTHERMAL ENERGY IN THE WORLD

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Abstract

According to the materials of the World Geothermal Congress 2015 provides an overview of the development of geothermal energy in the world. Over the past five years, the energy industry began a rapid development: geothermal power installed capacity increased by 16 %, and production of geothermal heat power plants increased by 45 %. Inexhaustibility of the energy source, new technology and drilling technology of geothermal heat in central heating systems has attracted significant investment in this sector. Cost of energy produced by geothermal plants is much lower compared to other renewable energy sources and conventional stations. Geothermal plants are environmentally friendly systems.

Oil and gas will eventually lie in such difficult geological conditions that their production will become more and more expensive. Thus, it is necessary to develop alternative energy industries using renewable energy sources. Such industries include: geothermal energy – the use of the deep heat of the Earth; the use of wind energy; solar energy; the use of tidal energy; bioenergy. When it comes to renewable energy sources, the first thing that comes to mind is solar panels and wind turbines. Geothermal sources are recalled much less often. Meanwhile, they are a powerful and clean source, differing from the wind and sun in greater stability. Geothermal energy is by far the most developed and cost-effective. Geothermal resources represent an almost inexhaustible, renewable and environmentally friendly source of energy that will play a significant role in the energy of the future. One of the important characteristics of geothermal energy is the high load factor, which means that each MW (Megawatt) of power produces significantly more electricity during the year than the MW of a wind or solar power plant. In the last few years, there has been a great interest in the development of geothermal energy in the world, as evidenced by the rapid growth of installed capacity. This is due to the countries' desire for energy independence from the external fuel market. More than 80 countries in the world use geothermal energy to produce heat and electricity. The total capacity of geothermal and electric power plants is almost 83 GW (Gigawatt), of which 15% is for electricity production, and 85% is for heat production.

Electricity production - In 24 countries of the world, geothermal energy is used to generate electricity. The total capacity of all geothermal power plants is 12.6 GW. Annual electricity generation at geothermal power plants in the world in 2014 amounted to 73.55×10^3 GWh [1, 2], which in gas equivalent is 7.94×10^9 m^3 of natural gas. Over the past five years, 2010-2015, the installed capacity of geothermal power plants in the world has increased by 1.7 GW (about 16%), on average about 350 MW per year (in the period 2000 – 2005, the increase in capacity was 200 MW). According to forecasts of the International Geothermal Agency (IGA), by 2020 the installed capacity of geothermal power plants will reach more than 21 GW. The leaders in installed electric capacity of geothermal plants are the USA – 3098 MW, the Philippines – 1931 MW, Mexico – 958 MW, Indonesia – 1197 MW, New Zealand – 762 MW.

Heat production - 82 countries in the world use geothermal energy to produce heat. The installed capacity of heat generating units is 70.38 GW, which produces $163{,}29 \times 10^3$ GWh of heat per year. Compared to 2010, the capacity of thermal power plants increased by almost 45%, heat production increased by 6.8% per year [3]. At a water temperature of less than 100 °C, geothermal energy is used for local heating of buildings and structures, after heating up to 100 °C, it can be used in district heating

systems. By at a temperature of 50-60 °C, geothermal water is used in hot water supply systems, and below 40 °C – for heating greenhouses and in geothermal refrigeration units (heat in cold). In the period from 2010 to 2015, 42 countries had 2,218 wells that have been drilled, and US$ 20 billion has been invested in geothermal projects in 49 countries. Areas of use of geothermal heat. A wide range of applications of heat produced by geothermal systems. The diagram in Fig. 3 shows how the power consumption of geothermal energy increases in various fields of use [3]. The most dynamic development in recent years has received geothermal heat supply and central heating. 11.5% of the generated heat is used for heating the premises. New central geothermal heating systems are being installed; old ones are being reconstructed. For example, a network of geothermal heat stations is being created around Paris. Already 170,000 buildings are heated by geothermal energy, by 2016 it is planned to provide geothermal heat supply to 50 % of the city's population [4,5,6]. Also, heat from geothermal plants is used for heating greenhouses, in industry, in agricultural drying, for sidewalk heating, snow melting, cooling, etc. Technologies for the use of low-potential georesources and geothermal heat pumps are developing at a rapid pace. 55.3% of the geothermal heat produced in the world is used in heat pump technologies (Fig. 4) [3]. The total installed capacity of heat pump systems is 15,723 MW, with annual heat generation of 86673 TJ. In such systems, low-potential thermal water (temperature up to 55 °C) and the energy of the upper layers of the Earth's crust are used as the primary source of heat. When using the heat of the soil, ground heat exchangers are used, placed either in vertical wells up to 300 m deep, or at some depth horizontally. Geothermal heat pump heat supply systems are used in 32 countries of the world with an average conversion coefficient of Kp = 3.5. These technologies have received the greatest development in the USA, Germany, Canada. In the USA, 69% of the total direct use of geothermal resources is realized through the use of heat pumps. In Germany, the total thermal capacity of geothermal systems is 505 MW, of which 400 MW – based on the use of heat pumps using the heat of the soil. Economic indicators of geothermal plants. The production of heat and electricity at geothermal plants depends on many factors, such as the geology and geochemistry of the area, the infrastructure in the construction area and the quality of energy resources (debit, salinity of water, its temperature, etc.). As a rule, the construction of geothermal plants is associated with a long-term strategy and has a certain financial risk. Therefore, when creating geothermal power plants (GEOS), most countries prefer to build medium–power stations – 30-60 MW. Construction GEOS usually takes 3-7 years, depending on the specific conditions and capacity of the station, and its life cycle is 30 years. Table 1 shows an average (minimum-maximum) estimate of the cost of construction of a GeoEC with an electric capacity of 50 MW with a construction period of 7 years [7,8,9]. The total cost of construction is US$ 196 million, or US$ 3,920 per 1 kW of installed capacity, in accordance with the data provided [3].

Areas of use and dynamics of consumption growth of geothermal heat for 20 years - Distribution of the use of geothermal heat for various applications in % in 2015 mi cost of 1 kW of installed capacity GEPP does not exceed the cost of thermal power plants. System of complete purification of combustion products, which today amounts to $ 5,000, the cost of nuclear power plants (with a system for recycling waste products) – $ 5,000, the cost of powerful hydroelectric power plants with a power utilization factor of 60% – $ 4,400. The costs of operating a geo-power plant are quite stable, because they are practically not for- they depend on the conjuncture of market prices for organic energy. With the annual load of the GEPP at the level of 80%, capital and operating costs amount to $444 per 1 kWh of electricity produced. For diesel power plants, this figure is $868. US$ per 1 kWh, for coal – 658 USD. US$ per 1 kWh and for natural gas combined cycle gas turbines – US$ 453 per 1 kWh. Despite the highest capital investments in the use of geothermal energy carriers, the cost of heat produced is the lowest in comparison with other renewable energy sources: 2.5-3.0 cents 5). Compared with traditional power plants, the construction of geothermal plants requires less capex, and the cost of electricity produced is lower than at traditional stations [10,11]. Thus, geothermal energy is competitive with other power plants in terms of cost and construction time. Advantages of geothermal energy. The latest energy technologies using geothermal resources are environmentally friendly and are approaching the traditional ones in efficiency. This is due to the inexhaustibility of this type of energy and the almost constant electrical loading of the GEPP throughout the entire life cycle. At modern geo-power plants,

the coefficient increased to 92% in power, which is 3 or 4 times higher than for technologies using other renewable energy sources and traditional plants (nuclear power in the world – 90%, coal – 85%, wind – 38%, solar – 20%). The main advantages of geothermal energy are relatively low emissions of carbon dioxide and carcinogenic products into the atmosphere - 91 g per 1 kWh, whereas when burning coal at thermal power plants, this value is 955 g per 1 kWh. GEO-power plants using circulation technology and binary the cycle completely eliminates carbon dioxide emissions into the atmosphere, which is the most important environmental advantage of such power plants. In the world, energy savings by geothermal plants amount to 58.3 × 109 m^3 in gas equivalent, 46 million tons of coal, heat production by geothermal plants in the world reduces carbon dioxide emissions by 148 million tons of CO_2 per year [8]. Large areas, on average it occupies 0.4 m^2 per 1 MW · hour of generated electricity, while for coal–fired thermal power plants - this value is 9 to 10 times more.

Conclusions - Currently, the problem of replacing hydrocarbon fuels with renewable energy sources, including geothermal, is extremely urgent. The advantages of geothermal energy are its ubiquity, accessibility and proximity to the consumer. World experience shows that the use of the deep heat of the earth's interior is possible for the production of heat and electricity. Ukraine has all the prerequisites for the development and creation of significant capacities based on geothermal circulation systems. Currently, the direction of research on the extraction of the deep heat of the Earth, the unification of technological schemes and equipment of geothermal circulation systems is poorly developed in Ukraine. The development and development of intensive technologies for the extraction of heat carriers and the creation of efficient systems for the use of subsurface heat is the main scientific and engineering problem of energy, which can partially solve the problem of natural gas substitution.

***Keywords**: Energy, Wind, Solar, Geothermal, Bioenergy*

REFERENCES

[1] R. Bertani, Geothermal Power Generation in the World 2010-2014 Update Report (Electronic resource) / Bertani R. // Proceedings World Geothermal Congress – 19-25 April 2015, Melbourne, Australia. – Mode of access: www. geothermal-energy.org; https://pangea.stanford.edu
[2] World energy council (Electronic resource) – Mode of access: www.worldenergy.org
[3] J.W. Lund, L. Tonya, Boyd Direct Utilization of Geothermal Energy 2015 Worldwide Review (Electronic resource) // – Mode of access: https://pangea.stanford.edu; http://www.geothermalenergy.org
[4] French know-how in the field of GEOTHERMAL ENERGY District heating and electricity genera-tion systems // – Mode of access: www.ademe.fr
[5] Drilling of the geothermal doublet at Gentilly: marking the rebirth of geothermal in France (Electronic resource) // – Mode of access: www.engie. com/geothermal l'expert de la géothermie au service des villes durables (Electronic resource) // – Mode of access: http://www.cofelyreseaux-gdfsuez.com
[6] Geothermal_Handbook (Electronic resource) // – Mode of a access: http://www.esmap.org/esmap/ Geothermal_Handbook
[7] Medium-Term Renewable Energy. Market Report 2014 (Electronic resource) – Mode of access: http://www.bp.com/statisticalreview; www.iea. Org
[8] Walter Gerardi, Stephen Hinchliffe. Valuing Geothermal Projects Using an Enhanced Levelised Cost Framework (Electronic resource) // Proceedings World Geothermal Congress – 19-25 April 2015, Melbourne, Australia. – Mode of access: http://www. geothermal-energy.org/
[9] Electronic resource – Mode of access: http:// www.bp.com/statisticalreview.
[10] V.E. Fortov, O.S. Popel, Renewable energy in the world and in Russia // Proceedings of the First International Forum "Renewable Energy. Ways to improve the energy and economic efficien-cy REENFOR-2013." 22-23 October 2013 / ed. dts OS Popiel - M .: High Temperatures Russian Academy of Sciences, 2013. - S. 12-22. (Rus.)

THE USE OF BIOENERGY RESOURCES IN THE PRODUCTION OF ELECTRICITY

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Abstract

The use of bioenergy resources in electricity production is a relevant and effective direction in the field of renewable energy sources. Bioenergy is based on the utilization of organic material, such as plant residues, animal manure, biomass, for the production of electricity. This process reduces dependence on fossil fuels and mitigates harmful impacts on the environment. The article discusses various methods of bioenergy production, such as biogas, bioethanol, biodiesel, and their advantages and limitations. Global experiences and examples of successful utilization of bioenergy resources are analyzed, highlighting the economic and environmental feasibility of bioenergy utilization in electricity production. Research findings confirm that the use of bioenergy resources represents a promising solution for diversifying and enhancing the resilience of the energy sector and contributes to the achievement of sustainable development goals.

Bioenergy resources, the most common of which are biomass and its derivative biogas, are one of the current alternative ways to obtain energy, including electricity. However, their use, particularly biomass utilization, until recently involved burning fuel either in open fires or in furnaces, resulting in relatively low energy efficiency.

It should be noted that this method is extremely environmentally friendly, which is crucial in today's world with its focus on environmental conservation. The use of biomass for energy production through modern technologies is environmentally safer compared to traditional organic resources such as coal and oil. Biomass-based electricity production is considered to be the most environmentally reliable sector of the energy industry, as it contributes to reducing environmental pollution [1].

Let us consider bioenergy resources. Biomass in bioenergy refers to organic matter formed in plants through photosynthesis that can be used to generate energy, including all types of vegetation, agricultural and forestry waste, and other types of industrial waste. Moreover, with a broad approach to the issue, biomass can also include non-vegetable household and industrial waste that can be utilized using the same principles [2].

Biomass can be classified into primary biomass and secondary biomass depending on its use and sources of renewal. Ground and aquatic plant worlds are the sources of primary biomass, while secondary biomass includes waste biomass generated after the collection and processing of primary biomass into finished products, as well as waste generated during human and animal activities [3, 4].

Therefore, modern bioenergy allows for energy production using various types of biomass, such as:

1. Logging and wood processing residues
2. Agricultural residues - plant and animal
3. Aquatic plant biomass.

Biomass, primarily in the form of wood fuel, is a fundamental source of energy for nearly a quarter of the world's population. It is often the only available energy source for rural areas. Additionally, biomass as an energy source plays a significant role in developed countries, accounting for about one-seventh

of the world's fuel volume and ranking third in terms of energy production, along with natural gas. Notably, biomass generates four times more energy than nuclear power [5]. In addition to direct use in energy production, biomass is used in the production of biogas from agricultural and household waste. Thus, the processing of biomass through anaerobic fermentation to produce biogas, which contains about three-quarters methane, and organic fertilizers, holds a significant place in unconventional energy production. The biogas produced is a mixture of methane and carbon dioxide formed during the anaerobic digestion in so-called methane tanks, designed and operated to maximize the extraction of methane. The energy obtained from burning biogas can be comparable to the energy from fossil fuels. Another important note is that the process of converting biomass into biogas results in much lower levels of harmful microorganisms in the waste compared to the original material.

It is also noted that the production of biogas is economically justified and preferable for processing a continuous stream of waste, such as livestock manure, slaughterhouse waste, plant residues, etc. The economic benefits include the elimination of the need for pre-collection of waste and the organization and management of waste delivery; it is known how much and when waste will be received. Biogas production, possible in installations of various scales, is particularly effective in agro-industrial complexes, where there is the possibility of a complete ecological cycle [5]. Biogas can be used in household applications such as cooking, heating buildings, lighting, as well as for operating various machinery, transportation, and power generators.

The relevance and effectiveness of biogas utilization in the modern world are demonstrated by the experience of countries lacking natural gas, such as the People's Republic of China. For example, China's experience indicates that remote rural areas can be reasonably gasified using small bio-installations that operate on organic waste from private households and agro-industrial enterprises [6].

In addition, bioenergy can also include the use of other technologies such as thermal processing of biomass (pyrolysis, gasification), or the use of agricultural crop residues, forestry residues, and food industry waste as fuel for electricity production.

One of the main advantages of using bioenergy resources for electricity production is their renewability. Bioenergy is based on the use of organic materials that can be replenished in natural cycles, making this form of energy sustainable and environmentally friendly.

Furthermore, the use of bioenergy resources also contributes to reducing greenhouse gas emissions, as bioenergy is based on the use of organic material that, when burned, releases an amount of carbon dioxide that can be absorbed by plants during photosynthesis, creating a carbon-neutral cycle of greenhouse gas emissions.

Bioenergy also helps reduce dependence on oil and other fossil fuels, as biomass can be produced locally and used on-site for electricity production, which can reduce the reliance on fuel imports and improve regional energy security.

However, like other energy sources, bioenergy also has its drawbacks. Bioenergy production from biomass can compete with food production, as it uses agricultural crops and land resources. Therefore, it is important to maintain a balance between bioenergy production and food security.

It is also important to consider the environmental aspects of bioenergy production, as uncontrolled use of biomass can have negative consequences, such as soil degradation, loss of biodiversity, and emissions of harmful substances into the atmosphere.

Thus, the use of bioenergy resources for biogas production and the production of high-quality fertilizers associated with it is currently relevant and highly effective.

***Keywords**: Energy, Biomass, Biogas, Bioenergy*

REFERENCES

[1] С.М. Говорушко, Энергия биомассы: направления использования и экологические проблемы /С.М. Говорушко // Альтернативная энергетика и экология. – 2011. – №3. – С. 73-76.
[2] В.И. Бондаренко, Энергетика: история, настоящее и будущее. Книга 5: Электроэнергетика и охрана окружающей среды. Функционирование энергетики в окружающем мире / В.И. Бондаренко и др; науч. ред. И.Н. Карп. – Киев, 2005. – 304 с.
[3] Е.В. Логинова, Гидроэкология: курс лекций / Е.В. Логинова, П.С. Лопух. – Минск: изд-во БГУ, 2011. – 300 с.
[4] С.С.Маглыш, Биология: учебное пособие для учреждений с русским языком обучения / С.С. Маглыш, В.А. Кравченко, Т.Я. Довгун. – Минск: Народная асвета, 2020. – 280 с.
[5] Е. Хрусталев, Биоэнергетические установки [Электронный ресурс] / Е. Хрусталев. – Электрон. Текстовые дан. – СПб., 2002. – Режим доступа: https://www.eprussia.ru/epr/25/1697.htm
[6] Е. Хвостик, Китай развивает индустрию биотоплива на государственном уровне [Электронный ресурс] / Е. Хвостик. – Электрон. Текстовые дан. – М.: Коммерсантъ., 2017. – Режим доступа: https://www.kommersant.ru/doc/3409510

SAFETY AND HEALTH IN COKING PLANTS THROUGH THE APPLICATION OF ENGINEERING MEASURES

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Abstract

Coke plants are plants where coal is carbonized for the manufacture of coke in slot or beehive ovens. To make steel in a blast furnace, coal must first be turned into coke. Coke has a dual role in the steelmaking process. First, it provides the heat needed to melt the ore, and second, when it is burnt, it has the effect of 'stealing' the oxygen from the iron ore, leaving only the pure iron behind. In the coking plant, coal is heated in the absence of oxygen to 1250c. This removes any impurities in the coal, resulting in coke, which is a porous substance that is nearly all carbon. As we can conclude from the above, the process in the coking plant is quite complex but useful. From that complexity comes numerous dangers. In order to check and reduce these dangers, this is where occupational safety comes into play. Most of the health hazards in coke production come from volatile chemicals that are released from the coal during coking, and dust from the production process causes respiratory illnesses. In addition, the heat required for production causes heat stress. Safety hazards in coke production also include mobile equipment, burns, fire and explosion.

This paper presents the most common hazards and dangers and engineering measures to prevent themin the coke oven. Along with the theory, the research that was done in a coke plant in Bosnia and Herzegovina was also presented.

***Keywords**: Coke plant, Hazards, Prevention, Engineering*

REFERENCES

[1] S. Muhamedagić, Metalurški koks: Proivodnja i primjena, Fakultet za metalurgiju i materijale, Zenica, 2012.
[2] A. Adilović, Ž. Knežiček, A.Regent, Lična i kolektivna zaštitna oprema, Univerzitet u Tuzli, Tuzla, 2015.
[3] International Labour Organization, Code of practice on safety and health in the iron and steel industry, Geneva, 2005.

METHODS FOR PRIORITISATION OF SUSTAINABLE DEVELOPMENT GOALS (SDGs) - AN OVERVIEW

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Abstract

Sustainable Development Goals (SDGs) represent a contemporary approach for realizing the vision of sustainable development. This is a series of 17 targets more closely defined through 169 targets and a large number of indicators. These goals aim to achieve sustainability in the field of at least three components, known as three pillars, precisely ecological, economic and social components.

According to the United Nations, the SDGs are indivisible and do not imply prioritisation that would take greater importance of one goal over another. And yet, the question arises whether the SDGs will be globally achieved by 2030 according to the previously defined target values. The COVID-19 pandemic, instability caused by war conflicts, as well as the consequences of these unpleasant events, such as damage to the world economy and trade, contributed to this. SDGs prioritisation is needed after all of these happenings.

The aim of this paper is to present an overview of the techniques used to prioritize SDG targets at global, national or corporate level. After the introductory considerations, a literature review follows in which is explained from which the need for prioritizing the goals of sustainable development arises. The third part refers to the overview of the previous results of the application of SDGs prioritisation methods and techniques. For these purposes, the analysis of the content of scientific works and partly bibliometric analysis were used. The papers were selected from the Scopus, Science Direct and Google Scholar databases based on the keyword SDGs prioritisation. After collecting the relevant literature, the papers were analyzed in terms of context (corporate, national, regional or global), the methodology used and the type of methodology (namely, whether the methodology used was in the field of well-known existing methodology or was it a methodology developed by the authors). In the discussion part, basic observations, limiting factors of previous research as well as proposals for overcoming them through future research are presented. Finally, concluding remarks were made.

***Keywords**: Sustainable Development Goals, Prioritisation, Overview*

REFERENCES

[1] J. Adhikari, J. Timsina, S.R. Khadka, Y. Ghale, H. Ojha, COVID-19 impacts on agriculture and food systems in Nepal: Implications for SDGs, Agricultural Systems, 186 (2021), 102990.
[2] C. Allen, G. Metternicht, T. Wiedmann, Prioritising SDG targets: Assessing baselines, gaps and interlinkages, Sustainability Science, 14 (2019), 421-438.
[3] M. Ameli, Z.S. Esfandabadi, S. Sadeghi, M. Ranjbari, M.C. Zanetti, COVID-19 and Sustainable Development Goals (SDGs): Scenario analysis through fuzzy cognitive map modeling, Gondwana Research, 114 (2023), 138-155.
[4] A. Asadikia, A. Rajabifard, M. Kalantari, Systematic prioritisation of SDGs: Machine learning approach, World Development, 140 (2021), 105269.

[5] L. Coscieme, L.F. Mortensen, S. Anderson, J. Ward, I. Donohue, P.C. Sutton, Going beyond Gross Domestic Product as an indicator to bring coherence to the Sustainable Development Goals, Journal of Cleaner Production, 248 (2020), 119232.
[6] R. Costa, T. Menichini, G. Salierno, Do SDGs really matter for business? Using GRI sustainability reporting to answer the question, European Journal of Sustainable Development, 11(1) (2022), 113-113.
[7] R. Costanza, L. Daly, L. Fioramonti, E. Giovannini, I. Kubiszewski, L.F. Mortensen, R. Wilkinson, Modelling and measuring sustainable wellbeing in connection with the UN Sustainable Development Goals, Ecological economics, 130 (2016), 350-355.
[8] J.P. Da Costa, A.L. Silva, D. Barcelò, T. Rocha-Santos, A. Duarte, Threats to sustainability in face of post-pandemic scenarios and the war in Ukraine, Science of The Total Environment, 892 (2023), 164509.
[9] I. D'Adamo, M. Gastaldi, P. Morone, Economic sustainable development goals: Assessments and perspectives in Europe, Journal of Cleaner Production, 354 (2022), 131730.
[10] R.M. Elavarasan, R. Pugazhendhi, T. Jamal, J. Dyduch, M.T. Arif, N.M. Kumar, M. Nadarajah, Envisioning the UN Sustainable Development Goals (SDGs) through the lens of energy sustainability (SDG 7) in the post-COVID-19 world, Applied Energy, 292 (2021), 116665.
[11] F. Fagbemi, COVID-19 and sustainable development goals (SDGs): An appraisal of the emanating effects in Nigeria, Research in Globalization, 3 (2021), 100047.
[12] O. Forestier, R.E. Kim, Cherry-picking the Sustainable Development Goals: Goal prioritization by national governments and implications for global governance, Sustainable Development, 28(5) (2020), 1269-1278.
[13] M. Grzebyk, M. Stec, P. Hejdukova, Implementation of sustainable development goal 8 in European Union countries–A measurement concept and a multivariate comparative analysis, Sustainable Development, 31(4) (2023), 2758-2769.
[14] I. Heras-Saizarbitoria, L. Urbieta, O. Boiral, Organizations' engagement with sustainable development goals: From cherry-picking to SDG-washing?, Corporate Social Responsibility and Environmental Management, 29(2) (2022), 316-328.
[15] Y. Huan, L. Wang, M. Burgman, H. Li, Y. Yu, J. Zhang, T. Liang, A multi-perspective composite assessment framework for prioritizing targets of sustainable development goals, Sustainable Development, 30(5) (2022), 833-847.
[16] A. Karaşan, C. Kahraman, A novel interval-valued neutrosophic EDAS method: prioritization of the United Nations national sustainable development goal, Soft Computing, 22 (2018), 4891-4906.
[17] K. Koasidis, T. Koutsellis, G. Xexakis, A. Nikas, H. Doukas, Understanding expectations from and capabilities of climate-economy models for measuring the impact of crises on sustainability, Journal of Cleaner Production, 414 (2023), 137585.
[18] O. Kostoska, L.Kocarev, A novel ICT framework for sustainable development goals, Sustainability, 11(7) (2019), 1961.
[19] H. Kreinin, E. Aigner, From "Decent work and economic growth" to "Sustainable work and economic degrowth": a new framework for SDG 8, Empirica, 49(2) (2022), 281-311.
[20] O. Lavrinenko, S. Ignatjeva, A. Ohotina, O. Rybalkin, D. Lazdans, The role of green economy in sustainable development (case study: the EU states), Entrepreneurship and sustainability issues, 6 (2019), 1113-1126.
[21] S. Lodhia, A. Kaur, S.C. Kuruppu, The disclosure of sustainable development goals (SDGs) by the top 50 Australian companies: substantive or symbolic legitimation?, Meditari Accountancy Research, Online first (2022). https://doi.org/10.1108/MEDAR-05-2021-1297
[22] F. Martins, A. Lima, L. Diep, L. Cezarino, L. Liboni, R. Tostes, P. Parikh, COVID-19, SDGs and public health systems: Linkages in Brazil, Health Policy OPEN, 4 (2023), 100090.
[23] M. Shupler, J. Mwitari, A. Gohole, R.A. de Cuevas, E. Puzzolo, I. Čukić, D. Pope, COVID-19 impacts on household energy & food security in a Kenyan informal settlement: The need for integrated approaches to the SDGs, Renewable and Sustainable Energy Reviews, 144 (2021), 111018.

[24] E. Suárez-Serrano, P.L. González-Torre, E. Covián-Regales, A business prioritisation of the sustainable development goals indicators: Building bridges between academics and practitioners in the Spanish case, Environmental Development, 46 (2023), 100827.
[25] R.B. Swain, S. Ranganathan, Modeling interlinkages between sustainable development goals using network analysis, World Development, 138 (2021), 105136.
[26] Q. Wang, R. Huang, The impact of COVID-19 pandemic on sustainable development goals–a survey, Environmental Research, 202 (2021), 111637.

NON-DESTRUCTIVE TESTING OF INORGANIC MATERIALS AS DECISION TOOL IN CULTURAL HERITAGE

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Abstract

Non-destructive testing (NDT) methods are one of the most used examination methods in modern materials analysis because of their capacity to investigate material properties without causing chemical alterations. This characteristic is highly advantageous not only in advanced materials analysis, but also in the context of cultural heritage preservation. These methods serve as very useful decision-making tools for conservators and contribute to multidisciplinary approach within the field. Preserving cultural heritage materials, such as glass, mortars, binders and bricks, is complex because of historical significance and potential fragility. Analyzing these materials can be challenging, primarily because traditional destructive testing methods are often unacceptable. These materials can be fragile and prone to damage from physical contact or invasive testing analysis, which makes these methods of analysis often inadequate in this field. Variations in composition, surface degradation, and multilayered structures are the difficulties in examination, and these difficulties can be avoided with NDT methods and adequate methodology of testing materials. Non-destructive testing methods such as FTIR, Raman spectroscopy, colorimetry, and XRF can offer valuable information for conservators. Also, they can offer *in-situ* analysis in case of portable devices, which is very useful in this field. For conservators, results of these methods can play crucial role in determining techniques of preservation, cleaning and protection for cultural heritage objects.

Keywords: *Non-destructive testing, Inorganic materials, Cultural heritage, Spectroscopy*

HYDROPHOBIC DEEP EUTECTIC SOLVENTS: PROMISING GREEN MEDIA FOR BIOMASS TREATMENT

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Abstract

Among various types of biomass, microalgal biomass is recently considered one of the promising resources of different high-added value products such as pigments, proteins, carbohydrates and lipids, that have various applications in food, cosmetics, and pharmaceuticals industries [1]. However, the extraction and purification of microalgae compounds can be challenging due to their complex chemical composition and the low concentrations of the desired compounds in the biomass. It is well known that classic methods of extraction include long-term processes that require large amounts of energy, high temperatures, and have a negative impact on the environment [2]. In recent decades, the growth of the pharmaceutical industry, especially in areas containing bioactive components, has resulted in rapid development more environmentally friendly methods for the extraction, isolation and recovery of bioactive components using “green solvents” with the aim of preserving their properties during the process. Due to their low toxicity, biodegradability, and possibility for reuse, deep eutectic solvents, have great potential in order to replace conventional organic solvents for biomass processing [3,4]. Deep eutectic solvents based on natural ingredients are a promising alternative for extraction those compounds compared to conventional organic solvents. Such solvents consist terpenes, sugars, organic acids, etc. The possibility of adjusting the physico-chemical properties enables the optimization of their selectivity for bioactive compounds. In this paper, hydrophobic deep eutectic solvents were prepared from natural neutral ingredients. Physico-chemical characterization was performed on deep eutectic solvents that were chemically stable. This study aims to determine whether hydrophobic deep eutectic solvents can be used in accordance with principles of "green chemistry" for biomass treatment in order to extract a variety of bioactive compounds while preserving their properties and minimizing adverse environmental effects.

***Keywords**: Biomass, Solid-liquid extraction, Pigments, Deep eutectic solvents*

REFERENCES

[1] G. Markou, E. Nerantzis, Microalgae for high-value compounds and biofuels production: A review with focus on cultivation under stress conditions, Biotechnology Advances,Volume 31 (8) (2013),1532-1542

[2] S. A. Heleno, P. Diz, M. A, Prieto, L. Barros, A. Rodrigues, M. F, Barreiro, & I. C, Ferreira., Optimization of ultrasound-assisted extraction to obtain mycosterols from Agaricus bisporus L. by response surface methodology and comparison with conventional Soxhlet extraction. Food Chemistry, 197, (2016), 1054–1063.

[3] C. Florindo, L.C. Branco, I.M. Marrucho., Fluid Phase Equilibria 448, 135-142.

[4] M. Tuzen, Green and Deep Eutectic Solvent Microextraction Method for FAAS Determination of Trace Level Cadmium in Water Samples Using Multivariate Strategic Approach. Atomic Spectroscopy 2016, 37 (6), 244–251.

CONSIDERATION OF THE INFLUENCE OF STIR CASTING PROCESS PARAMETERS ON OBTAINING MMC CASTINGS

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Abstract

Metal matrix composites (MMC) are materials in which metal represents the base to which various inorganic and organic materials (reinforcers) are added which contribute to the improvement of the properties of the base. The advantages of the Stir Casting process are reflected in its simplicity, flexibility and application possibilities in the production of MMC in industrial conditions. Obtaining a quality product by stir casting process is conditioned by numerous process parameters, which directly or indirectly affect the course of the process and the final characteristics of the composite. This paper presents an insight into the basic process parameters of the stir casting process and the characteristics of MMC castings.

Stir casting method implies adding the reinforcing particles into a melted metal by a mixing. During mixing, a vortex is formed which ensures the insertion of poorly wettable particles into the melt and their uniform distribution. With the increase of the mixing speed, a more homogeneous composite is formed, because thanks to the mixing, a more even distribution of the reinforcing particles in the base alloy is performed. The time interval in which the composites are mixed should be as long as possible, in order to distribute the reinforcements evenly. As the process temperature increases, the viscosity of the melt decreases and the homogenization of the composite is better. Composites with a metal matrix are characterized by high values of hardness, strength, stiffness, good corrosion resistance, wear resistance, low density, the ability to work at elevated temperatures.

***Keywords**: Composite, Stir casting, Process parameters*

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REFERENCES

[1] R. Arunachalama, P. Krishnanb and R. Muraliraja, Journal manifektoring Ptocesing, vol. 42 (2019) 213-245.
[2] J. Hashim, L. Looney, M.J. Hashim, Journal of Materials Processing Technology, 92-93 (1999) 1-7.
[3] N. Singh, R. Belokar, R. Walia, Silicon, 14 (2022) 335–358.
[4] M.Y. Zhou, L.B. Ren, L.L. Fan, Y.W.X. Zhang, T.H. Lu, G. F. Quan, M. Gupta, Journal of Alloys and Compounds, 838 (2020) 1-40.
[5] K. Almadhoni, S. Khan, Journal of Mechanical and Civil Engineering, 12(6) (2015) 22-40.
[6] A. Pal, S.S. Saxena, A. Verma, B.C. Kandpal, International Journal of Computer & Mathematical Sciences, 4 (2015) 2347-8527.
[7] G.G. Sozhamannan, S.B. Prabu, V.S.K. Venkatagalapathy, Journal of Surface Engineered Materials and Advanced Technology 2(1) (2012) 11-15.

INFLUENCE OF MIXING OF QUENCHING MEDIA ON MICROSTRUCTURE AND HARDNESS OF STEEL 23MnB4

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Abstract

Steel cooling is an important technological operation because the final microstructure of the steel, and therefore its properties, depends on the cooling rate. In practice, three methods of cooling are usually distinguished; slow, normal and fast. Slow cooling is the cooling of samples in the furnace and is most often used in annealing process. Normal cooling is carried out in air, as in the case of normalization. Rapid cooling is applied during quenching and has the greatest impact on microstructure and properties. The speed of steel cooling depends on numerous factors, one of which is the movement of the quenching media. This paper presents the results of testing the influence of the water mixing as the quenching media on the microstructure and hardness of 23MnB4 steel. The samples were cooled in an unstirred media and in a stirred media with six different stirring speeds (500, 750, 1000, 1250, 1500 and 1750 rpm). The results showed that mixing the media has influence on the microstructure and hardness of steel. Samples that were cooled in a mixed medium had a higher hardness. Microstructure after cooling in the water was martensite-bainite. With increasing cooling rate, the ratio of martensite in microstructure increases.

***Keywords**: Quenching, Water, Mixing, Microstructure, Hardness*

REFERENCES

[1] Steel Heat Treatment Handbook: Steel Heat Treatment Metallurgy and Technologies, Edited by G.E. Totten, Taylor & Francis Group, 2006.
[2] K.E.Thelning, Steel and its heat treatment, Butterworth-Heinemann, Oxford, Second edition 1984, Reprinted 2000.
[3] A.Gigović-Gekić, H.Avdušinović, Termička obrada metala, Praktikum s teorijom, Univerzitet u Zenici, Metalurško-tehnološki fakultet, Zenica, 2019.
[4] https://www.lucefin.com/wp-content/files_mf/152336964123MnB4.pdf [13.02.2023.]

TESTING OF WELDED JOINTS WITH LIQUID PENETRANTS

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Abstract

Liquid penetrant examination is one of the most popular Nondestructive Examination (NDE) methods in the industry. It is economical, versatile, and requires minimal training when compared to other NDE methods. This method is used to detect surface defects such as micro and macro cracks on the surface, porosity and the similar defects on non-porous materials. Testing with liquid penetrants is based on capillary phenomena, i.e. the property of liquid to rise and penetrate into narrow free spaces-capillaries. The test procedure consists of cleaning the surface to be tested, then applying a liquid penetrant with high wetting ability and capillarity that penetrates on surface discontinuities. Excess liquid is removed from the surface, then a developer (powder) is applied to "draw" the trapped penetrant from the discontinuity to the surface of the component where it becomes visible. This paper presents the results of testing of welded joints obtained from Nitronic 60 stainless steel. The tested samples were intended for mechanical tensile testing and impact energy. The test was carried out on samples before and after machine processing of the samples. Surface cracks were observed on the samples that were tested before machining. No cracks were observed on the machined samples.

***Keywords**: NDE methods, Liquid penetrant examination, Welded joints, Stainless steel*

REFERENCES

[1] M. Oruč, R. Sunulahpašić, Ispitivanje metalnih materijala II (defektoskopija), Univerzitet u Zenici, Fakultet za metalurgiju i materijale, Zenica, 2012
[2] E. Agović, Ispitivanje zavarljivosti čelika Nitronic 60, magistarski rad, Univerzitet u Zenici, Metalurško-tehnološki fakultet, Zenica, 2022.
[3] A.G. Gekić, M.Oruč, R. Sunulahpašić, H. Avdušinović, A. Mujkanović, Materijali, Univerzitet u Zenici, Metalurško-tehnološki fakultet, Zenica, 2022.

REMOVAL OF CHLORPYRIFOS AND MALATHION USING SPENT COFFEE GROUNDS – ISOTHERM STUDY

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Abstract

In recent years, the extensive use of chlorpyrifos (CHP) and malathion (MLT), two common organophosphate (OP) insecticides, has raised concerns about their adverse effects on the environment and human health [1]. These pesticides can contaminate water bodies, soil, and food, posing potential risks to non-target organisms and human populations [2, 3]. Therefore, there is a growing demand for effective and sustainable methods to remove these pesticides from the environment [4]. Spent coffee grounds (SCG), a readily available agricultural waste, have shown promising potential as an adsorbent [3]. The aim of this study was to investigate the removal of CHP and MLT using SCG as an adsorbent and to examine the adsorption behavior through isotherm analysis.

Isotherm analysis was performed using four isotherm models: Freundlich, Langmuir, Temkin, and Dubinin-Radushkevich. The experimental data best fit the Langmuir isotherm model, suggesting a monolayer adsorption process on homogeneous adsorption sites. According to the Langmuir isotherm, the maximum adsorption capacity of SCG for CHP and MLT is 2.34 mg/g and 7.04 mg/g, respectively. Additionally, the Freundlich isotherm model fitted the experimental data for MLT adsorption on SCG very well, implying multilayer physisorption even after all adsorption sites are occupied. These findings provide valuable insights into the feasibility of SCG as an eco-friendly approach for the removal of CHP and MLT from the environment. The energy of adsorption obtained from the Dubinin-Radushkevich isotherm confirmed that in the case of CHP adsorption the binding is stronger than in the case of MLT adsorption.

***Keywords**: Organophosphorous pesticides, Adsorption, Biowaste, Spent Coffee Grounds, Isotherms*

ACKNOWLEDGEMENT

This work was supported by the Serbian Ministry of Education, Science, and Technological Development (contract number: 451-03-47/2023-01/200017).

REFERENCES

[1] V. Milanković, T. Lazarević-Pašti, Targeting Cellular Signalling Pathways in Lung diseases, Springer, 2021, p. 625-660.
[2] T. Tasić, V. Milanković, K. Batalović, S. Breitenbach, C. Unterweger, C. Fürst, I. Pašti, T. Lazarević-Pašti, Foods, 12 (12) (2023) 2362.
[3] V. Milanković, T. Tasić, M. Pejčić, I. Pašti, T. Lazarević-Pašti, Foods, 12 (12) (2023) 2397.
[4] V. Anićijević, T. Tasić, V. Milanković, S. Breitenbach, C. Unterweger, C. Fürst, D. Bajuk-Bogdanović, I. Pašti, T. Lazarević-Pašti, Int. J. of Enviro. Res. And Pub. Health, 20 (5) (2023) 4553.

EFFECT OF THE AUSTENITIZING TEMPERATURE ON THE PROPERTIES OF 51CrV4 SPRING STEEL

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Abstract

Choosing the correct temperature and duration for the austenitization process is crucial to attaining a consistent, singular-phase state of austenite with evenly dispersed alloying elements. It's important to prevent excessive growth of austenite crystal grains, which could detrimentally impact the mechanical characteristics of the steel. In this paper, the effect of the austenitizing temperature on the properties of 51CrV4 spring steel was investigated. Samples were heated at various austenitizing temperatures (770°C, 800°C, 830°C, 860°C, 890°C, and 920°C) and cooled in still air. The mechanical properties were investigated by measuring hardness and calculating tensile strength. The microstructures of the samples were characterized using optical microscopy. The increase in austenitizing temperature leads to an increment in hardness and tensile strength values. Maximum values of mechanical properties were achieved after austenitizing at 860°C for 30 minutes. In all investigated samples, a ferrite-pearlite microstructure was observed. Three characteristic samples that had the lowest, highest, and optimal austenitizing temperatures were investigated by optical microscopy. The microstructures of the three investigated samples were compared, and the results show that as the austenitizing temperature increases, the grain size decreases continuously.

***Keywords**: 51CrV4, Austenitizing temperature, Spring steel, Heat treatment, Normalization*

ACKNOWLEDGEMENT

The research presented in this paper was done with the financial support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-47/2023-01/200131.

REFERENCES

[1] T. Kang, Z. Zhao, J. Liang, J. Guo, Y. Zhao, Effect of the austenitizing temperature on the microstructure evolution and mechanical properties of Q&P steel, Mater. Sci. Eng., 771 (2020) 138584.
[2] X.D. Zhang, D.X. Xia, S.R. Wang, Effect of Austenitizing Temperature on the Quenching Microstructure and Properties of 51CrV4, Mater. Sci. Forum, 944 (2019) 357-363.
[3] A. Bajželj, J. Burja, Influence of Austenitisation Time and Temperature on Grain Size and Martensite Start of 51CrV4 Spring Steel, Crystals, 12 (2022) 1449.

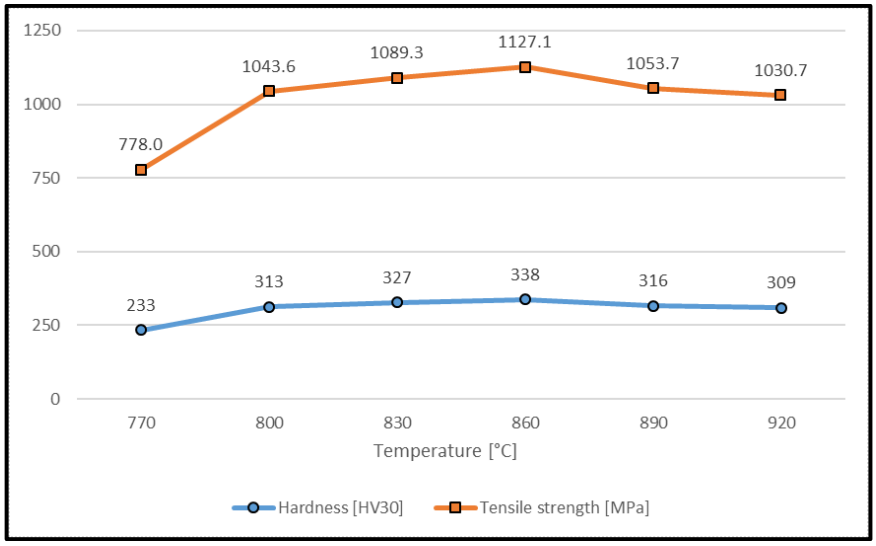

Figure 1 *- The mechanical properties of the investigated samples as a function of austenitizing temperature*

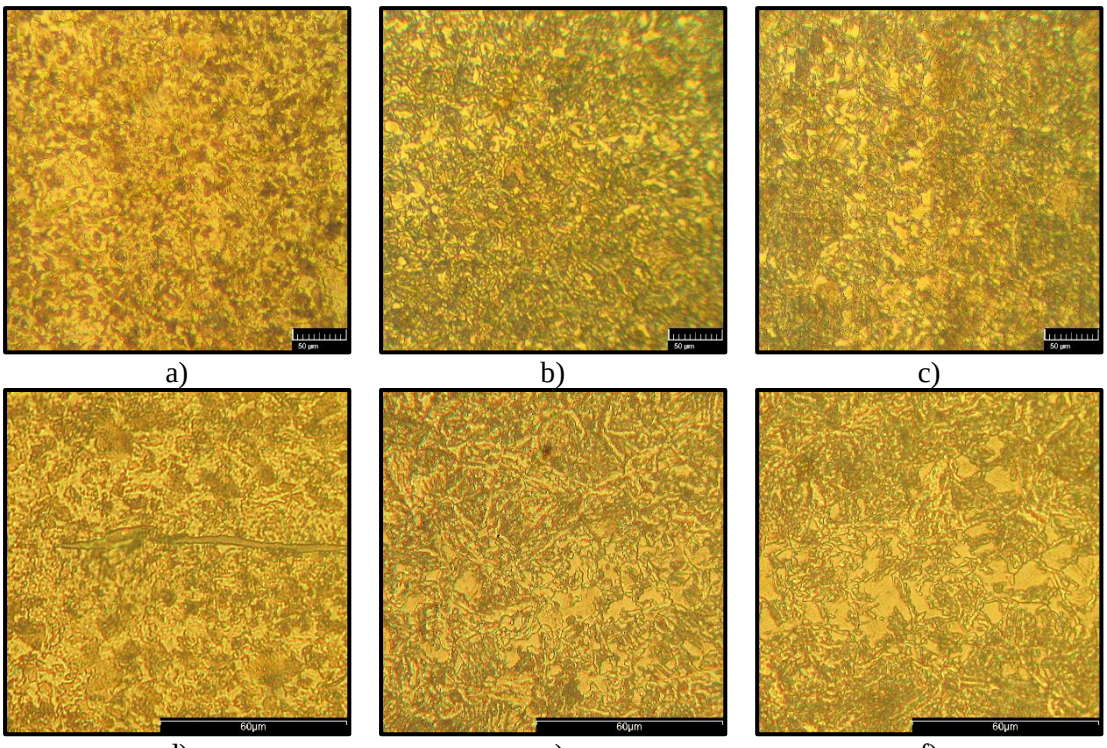

Figure 2 *- Microstructures of the investigated samples as a function of austenitizing temperature at different magnifications: a) 770°C (x500); b) 860°C (x500); c) 920°C (x500); d) 770°C (x1000); e) 860°C (x1000); f) 920°C (x1000)*

WHY SHOULD USED CREOSOT IMPREGNATED WOOD WASTE BE CHARACTERIZED AS HAZARDOUS?

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Abstract

- **Introduction and objective**

Creosote is used as wood preservative all over the world. Over 1500 different chemical compounds are present in creosote [1]. Most of these molecules have render toxic, carcinogenic and mutagenic effects. Impregnated wood, as construction material for bridges, railroad ties, utility poles, have an environmental impact through the polycyclic aromatic hydrocarbons (PAHs), phenolic compounds, N-, O- and S- heterocycles emissions [2]. The aim of this review is to draw attention on waste management of creosote impregnated wood.

- **Review and results**

PAHs constitutes approximately 85 % of creosote content. U.S. Environmental Protection Agency (EPA) in 1976. made up a list of 16 PAHs to estimate risks to human health from drinking water [3]. Those 16 "priority PAHs" represent only 15 % from all of those present in creosote [4]. EU directives 75/442/EEC, 91/156/EEC, and 94/67/EEC, order that any waste that exceeds the critical creosote limit should be regarded as hazardous [4]. PAHs content over 100 mg/kgdm in solid waste classified that waste as hazardous, according to Law on Waste Management in Serbia (Regulation on categories, examination and classification of waste, Official Gazette of RS, No. 56/2010) [5].

- **Conclusion**

Can we and should we underestimate phenolic compounds and N-, O- and S- heterocycles which are also present in creosote impregnated wood among PAHs? Toxicological effects and environmental impact of every single compound in creosote composition are not known. Into addition to over 1500 chemicals following PAHs in creosote, each ones waste creosote impregnated wood should be regarded as hazardous.

***Keywords**: Creosote, Legal regulation, Waste management, Impregnated wood*

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REFERENCES

[1] C. Gallacher, R. Thomas, C. Taylor, R. Lord, R. M. Kalin, Comprehensive composition of Creosote using comprehensive two-dimensional gas chromatography time-of-flight mass spectrometry (GCxGC-TOFMS), Chemosphere, 178 (2017) 34-41.

[2] S. Lebow, K. Brooks, J. Simonsen, Environmental Impact of Treated Wood in Service, Enhancing the Durability of Lumber and Engineered Wood Products, Kissimme (Orlando), Florida, February 11-13, 2002, 205-215.
[3] J.T. Andersson, C. Achten, Time to Say Goodbye to the 16 EPA PAHs? Toward an Up-to-Date Use of PACs for Environmental Purposes, Polycyclic Aromatic Compounds, 35:2-4 (2015) 330-354.
[4] T. Thierfeldera, E. Sandströmb, The creosote content of used railway crossties as compared with European stipulations for hazardous waste, Science of Total Environment 402 (2008) 106-112.
[5] Law on Waste Management ("Official Gazette of the Republic of Serbia" No. 36/2009, 88/2010, 14/2016, 95/2018 and 35/2023) (Serbian).

CAPTURING SULFUR DIOXIDE AT ITS SOURCE: SIMPLE AND EFFICIENT METHOD FOR SAMPLING AND QUANTIFICATION

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Abstract

- **Introduction and scope**

Sulfur dioxide (SO_2) is a widespread pollutant gas that releases during many industrial processes [1]. SO_2 has significant environmental and health implications [2], making its accurate quantification essential. The aim of this paper was to develop a simple and efficient laboratory-scale method for the sampling and quantification of SO_2 at its source.

- **Methodology**

SO_2, generated in the reaction between sodium metabisulfite and orthophosphoric acid, was routed through a condenser to a recipient vessel containing an absorptive solution of sodium hydroxide. The absorption of the SO_2 was performed with a consistent gas flow rate, facilitated by the use of a vacuum pump within the reaction system. Aqueous solution of potassium dichloroiodate(I) [3] was employed for volumetric determination of sulfite content in the final absorptive solution.

- **Results**

Based on the results of sulfite content determination in the final absorptive solution, which exhibited an analytical recovery of SO_2 ranging from 83% to 96%, the effectiveness of the proposed method is demonstrated.

- **Conclusion**

According to the obtained results and the multifaceted challenges associated with the sampling of gaseous fluids, this study can serve as a valuable guideline for the sampling of gaseous mixtures containing SO_2. Usage of a vacuum pump in the sampling system helps minimize the loss of gaseous components in the final absorptive solution, whereas the described titrimetric method enables a simple and efficient analytical procedure for determining SO_2 content. Further research and refinement of this method could lead to its practical application in environmental monitoring and industrial processes.

***Keywords**: Sulfur dioxide, Simple sampling, Quantification of sulfur dioxide, Potassium dichloroiodate(I)*

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The study was supported by the Ministry of Science, Technological Development and Innovation of Republic of Serbia (Contract number: 451-03-47/2023-01/200168 and 451-03-47/2023-01/200051).

REFERENCES

[1] L. Tao, X. Wang, P. Ning, L. Wang, W. Fan., Fuel Processing Technology., 192 (2019) 36–44.
[2] S. Nurhisanah, H. Hasyim., Heliyon., 8 (5) (2022) e09388.
[3] G. M. Viana, L. C. de Sequeira Aguiar, J. de Araújo Ferrão, A. B. C. Simas, M. G. Vasconcelos., Tetrahedron Letters., 54 (8) (2013) 936–940.

STUDIES OF THE INFLUENCE OF GRAPHENE NANOSHEETS ON THE WETTABILITY OF LEAD-FREE SOLDER ALLOYS

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Abstract

Research and studies on solders were done by many researchers in the hope of developing sustainable lead-free solders. Solders are often made of low melting point alloys since melting is a need for the soldering procedures. The most common solders are Pb-Sn alloys, and research into their characteristics is significant. Unfortunately, lead and its compounds have a harmful influence on both the environment and human health.

This paper presents an overview of research on composite solders based on tin (Sn) reinforced with graphene. Graphene was used in the form of graphene nanosheets (GNSs) with different weight content, and the composite was produced by the powder metallurgy method. The variable mass content of GNS was successfully pressed into lead-free solder using a high-planetary ball mill. This method enabled better homogeneous mixing and consolidation of the powder. After that, the powder that was obtained was sintered. The assumption was that the role of the GNS particles was to improve the mechanical and physical properties of the solder alloys.

Wettability tests were performed on several tin alloys reinforced with GNS, and the results were practically similar. The presence of GNS reduces the interfacial tension between the solder and the surface. As a result, the contact angle decreases, and the wettability of the composite solder increases. Based on past research and a review of the literature, it is possible to conclude that the wettability of lead-free solder alloys reinforced with GNS improves.

***Keywords**: Graphene nanosheets, High-planetary ball mill, Sintering*

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The research presented in this paper was done with the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-47/2023-01/ 200131

REFERENCES

[1] R. A. Islam, B. Y. Wu, M. O. Alam, Y. C. Chan, W. Jillek, Journal of alloys and compounds, 392(1-2) (2005) 149-158.
[2] C. S. Hsi, C.T. Lin, T.C. Chang, M.C. Wang, M.K. Liang, Metallurgical and Materials Transactions A, 41(2) (2010) 275-284.
[3] B.H. Ryu, Y. Choi, H.S. Park, J.H. Byun, K. Kong, J.O. Lee, H. Chang, Colloids and Surfaces A: Physicochemical and Engineering Aspects, 270 (2005) 345-351.
[4] S. M. L. Nai, J. Wei, M. Gupta, Thin Solid Films, 504(1-2) (2006) 401-404.
[5] S. W. Yoon, W. K. Choi, H. M. Lee, Scripta materialia, 40(3) (1999) 327-332.
[6] L.Yin, Z. Zhang, C. Zuo, N. Fang, Z. Yao, Z.Su, Journal of Materials Science: Materials in Electronics, 31(3) (2020) 1861-1867.
[7] X. D. Liu, Y. D. Han, H. Y. Jing, J. Wei, L. Y. Xu, Materials Science and Engineering: A, 562 (2013) 25-32.
[8] L. Yin, Z. Zhang, Z. Su, C. Zuo, Z. Yao, G. Wang, Y. Zhang, Journal of Electronic Materials, 49(12) (2020) 7394-7399.

ACTIVATED POROUS CARBON MATERIALS DERIVED FROM VISCOSE FIBERS FOR CHLORPYRIFOS REMOVAL FROM WATER

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Abstract

The extensive use of the toxic organophosphate chlorpyrifos underscores the need for effective methods to eliminate it from the environment [1]. Chlorpyrifos's acute neurotoxicity stems from its irreversible inhibition of acetylcholinesterase, an enzyme crucial for signal transmission in the nervous system. This inhibition can lead to various neurological disorders [1,2]. While several methods have been explored for removing chlorpyrifos from water, adsorption is one of the most promising approaches [3]. Viscose fibers derived from cellulose are frequently investigated as a potential source for producing activated carbon materials [1]. Our study employed carbon materials derived from viscose fibers as an adsorbent for chlorpyrifos. Our findings revealed that 1 gram of these carbon materials could adsorb 171.53 mg, 169.20 mg, and 175.44 mg of chlorpyrifos at a temperature of 25°C. We also delved into the kinetics of batch adsorption to remove chlorpyrifos from water solutions. Kinetics analysis was performed using pseudo-first-order, pseudo-second-order, and Elovich kinetic models. The results indicated that the adsorption of chlorpyrifos onto the carbon materials best followed the pseudo-second-order kinetics model under the specified experimental conditions. The constant rate values were determined to be 0.217 mg g^{-1} min^{-1}, 0.076 mg g^{-1} min^{-1}, and 0.491 mg g^{-1} min^{-1} under experimental conditions.

***Keywords**: Organophosphates; Carbon materials; Viscose fibers, Adsorption; Kinetics*

ACKNOWLEDGEMENT

This work was supported by the Serbian Ministry of Education, Science, and Technological Development (contract number: 451-03-47/2023-01/200017).

REFERENCES

[1] T. Tasić, V. Milanković, K. Batalović, S. Breitenbach, C. Unterweger, C. Fürst, I. Pašti,T. Lazarević-Pašti, Foods, 12 (12) (2023) 2362.
[2] V. Milanković, T. Tasić, M. Pejčić, I. Pašti, T. Lazarević-Pašti, Foods, 12 (12) (2023) 2397.
[3] V. Anićijević, T. Tasić, V. Milanković, S. Breitenbach, C. Unterweger, C. Fürst, D. Bajuk-Bogdanović, I. Pašti, T. Lazarević-Pašti, Int. J. of Enviro. Res. And Pub. Health, 20 (5) (2023) 4553.

THE EFFICIENCY OF NICKEL ION ADSORPTION FROM SYNTHETIC SOLUTIONS USING MULLEIN

Students: Veljko Pelić, Sandra Milićević

Mentors: Žaklina Tasić, Maja Nujkić

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Abstract

- **Introduction**

The aim of this paper is to determine the biosorption efficiency of the medicinal plant mullein (Verbascum thapsus), which has been used as waste material, in solutions of Ni (II) ions at different pH values.

- **Materials and Methods**

Nickel sulfate hexahydrate ($NiSO_4 \cdot 6H_2O$) was utilized to formulate the Ni(II) ion solutions. A stock solution with a concentration of 100 ppm was prepared. The solution's temperature was upheld at room temperature, as was the concentration of the solution itself. pH values were adjusted within the range of 3 to 7 through the addition of an HNO_3 solution and the utilization of a pH meter. A precise mass of 1g of mullein was weighed on a technical scale and subsequently transferred to a glass container containing the appropriate concentration solution. Following this, the mixture underwent homogenization for 1.5 hours at 400 rpm using a magnetic stirrer. Subsequent to this, filtration was executed using a Büchner funnel. The quantification of the concentration of residual Ni(II) ions in the solution after biosorption was performed using an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES).

- **Results**

Based on the outcomes derived from the ICP-OES analysis, the removal efficiency of Ni(II) ions was computed in relation to the impact of the solution's pH value. The outcomes are as follows: 28.49% at pH = 3; 36.40% at pH = 4; 37.89% at pH = 5; 38.57% at pH = 6; and 39.14% at pH = 7 for an initial Ni(II) concentration of 100 ppm. Barquilha et al. achieved a removal percentage of 29.69% for Ni(II) ions using brown algae as a biosorbent. Meanwhile, in the study conducted by Shah et al., tea leaves from Camellia sinensis were employed as a biosorbent, yielding a removal percentage of 70.20% for Ni(II) ions within the pH range of 3-8. Notably, a decline in the biosorption of Ni(II) ions was observed after reaching pH 7.

- **Conclusion**

Based on the acquired results, it becomes evident that the efficiency of Ni(II) adsorption experiences a linear ascent with increasing pH values within the 3-7 range. The peak efficiency for Ni(II) adsorption is recorded at 39.14% under a pH of 7. But if we compare the results it is evident that mullein at this pH range isn't the best adsorbent for nickel ions.

***Keywords**: Biosorption, ICP-OES analysis*

REFERENCES

[1] C.E.R. Barquilha, E.S. Cossich, C.R.G. Tavares, E.A. da Silva, Biosorption of nickel and copper ions from synthetic solution and electroplating effluent using fixed bed column of immobilized brown algae, Journal of Water Process Engineering 32 (2019) 100904.

[2] J. Shah, M.R. Jan, A. ul Haq, M. Zeeshan, Equilibrium, kinetic and thermodynamic studies for sorption of Ni (II) from aqueous solution using formaldehyde treated waste tea leaves, Journal of Saudi Chemical Society (2015) 19, 301 - 310.

THE EFFICIENCY OF NICKEL ION ADSORPTION FROM SYNTHETIC SOLUTIONS USING MULLEIN

Students: Sandra Milićević, Veljko Pelić

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Abstract

- **Introduction**

The aim of this study is to determine the biosorption efficiency of the medicinal plant mullein (Verbascum thapsus), which is repurposed as waste material, in solutions containing Zn (II) ions at various pH values.

- **Materials and Methods**

Zinc chloride ($ZnCl_2$) was utilized to prepare the Zn(II) ion solutions. A baseline solution with a concentration of 100 ppm was prepared. The solution's temperature and concentration were maintained at room levels. pH values were adjusted from 3 to 7 using an HNO_3 solution. Exactly 1g of mullein was weighed on a technical scale and transferred to a glass container containing the appropriate concentration of Zn(II) ion solution. The mixture was then homogenized for 90 min. at 400 rpm using a magnetic stirrer, followed by filtration using a Büchner funnel. The concentration of residual Zn(II) ions in the solution after biosorption was determined using an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES).

- **Results**

Based on the results obtained from the ICP-OES analysis, the calculation of the efficiency of Zn(II) ion removal was performed with respect to the influence of the solution's pH value. The results were as follows: 63.77% at pH = 3; 65.575% at pH = 4; 63.07% at pH = 5; 59.255% at pH = 6; and 61.47% at pH = 7, for an initial Zn(II) concentration of 100 ppm. Gu and Lan achieved a removal percentage of 38.32% for Zn (II) ions, investigating the pH range of 2-7 and using algae as a biosorbent. Conversely, in the work of Sheikh et al., onion seeds were employed as a biosorbent, resulting in a 59% removal rate for Zn(II) ions within the pH range of 2-10. The study by Sheikh et al. revealed that maximum adsorption was attained at pH 7, while in the study by Gu and Lan, adsorption was significantly more efficient within the pH range of 2-4.

- **Conclusion**

Anomalies were observed, indicating non-linear growth or decline in the efficiency values of Zn (II) adsorption with an increase in pH values within the range of 3-7. The maximum efficiency for Zn (II) adsorption is 65.575% at pH = 4. If we compare zinc with other results it is evident that mullein at this pH range is a better adsorbent for zinc ions, and much better results were produced then for adsorption nickel ions.

***Keywords**: Biosorption, ICP-OES analysis*

REFERENCES

[1] S. Gu, C.Q. Lan, Biosorption of heavy metal ions by green alga Neochloris oleabundans: Effects of metal ion properties and cell wall structure, Journal of Hazardous Materials, 418 (2021) 126336.

[2] Z. Sheikh, A. Muhammad, N. Khan, M.N. Khan, S.S. Kamran, S.B. Khan, I. Hafeez, S.A. Khan, E. M. Bakhsh, C.K. Cheng, Potential application of Allium Cepa seed as a novel biosorbent for efficient biosorption of heavy metals ions from aqueous solution, Chemosphere, 279 (2021) 130545.

APPLICATION OF SOFTWARE PACKAGES IN THE VISUALIZATION OF THE CASTING PROCESS-EXPERIENCE

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Abstract

Several software packages are used today to model the casting process when designing castings technology of concrete castings is in matter. In this way, modern design procedures enable a digital check of the influence of all stages of designing and making castings, and it is also possible to analyze the influence of different casting parameters on obtaining the final casting. In this paper, the influence of the position and dimensions of the pouring system on the occurrence of blowhole during the production of a concrete casting was analyzed, using the appropriate software and by producing the casting in real conditions.

***Keywords**: Simulation, Casting Process*

REFERENCES

[1] B. Ravi, Indian Foundry Journal, 54 (1) (2008), Special Issue.
[2] M. Iqbal, S. Patel, G. Vidyarthee, International Journal of Engineering Sciences & Research Technology, 3(8) (2014), 555-565.

ANALYSIS OF WORKING EFFICIENCY OF THE BUCKET WHEEL EXCAVATOR SCHRS 1400.28/3 ON OPEN CAST MINE FIELD C

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Abstract

The paper analyzes the effectiveness of the bucket wheel excavator SchRs1400.28/3, which is engaged in the exploitation of overburden within the IV BTO system of the open cast mine field C, which is part of the Electric Power Industry of Serbia. The analyzed period is from the beginning of the system operation, during 2016, ending with 2018. Paper observed the structure of the stoppage of the bucket wheel excavator in relation to the stoppage of the system (excavator-belt conveyors-spreader). Comparing the obtained results, it was concluded that in the system downtime structure, even half of the downtimes are related to the excavator. Based on the working time and the total calendar time, was determined the coefficient of time utilization, while the ratio between the realized production and the theoretical capacity of the excavator was given through the coefficient of capacity utilization. The achieved production in the first three years of the systems operation had an exponential growth trend. The coefficient of time utilization had a downward trend in the second year, due to the fact that the system was in the revitalization process. The capacity coefficient utilization had a growth trend in the second year, which is in full agreement with production jump. Figure 1 present system downtime structure, Figure 2 realized production, Figure 3 is given working and calendar time and Figure 4 Time and Capacity utilization of bucket wheel excavator.

Keywords: *Bucket wheel excavator, Electric Power Industry of Serbia, overburden*

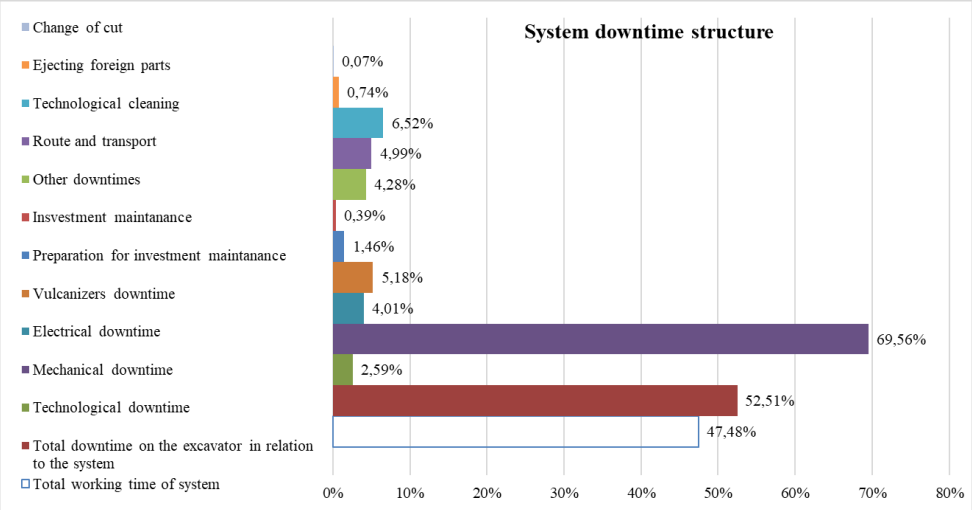

Figure 1 *- System downtime structure [1]*

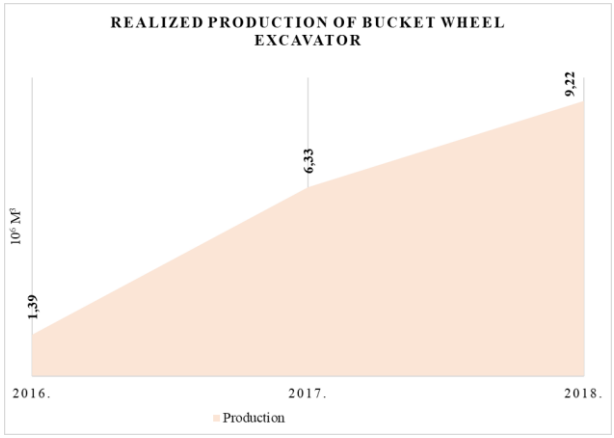

Figure 2 *- Realized production of bucket wheel excavator [1]*

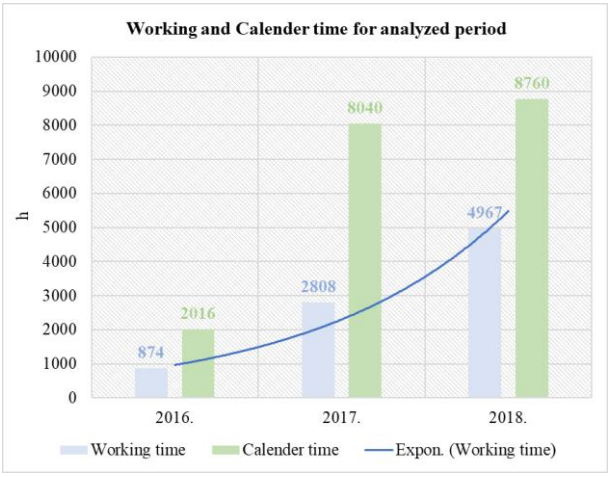

Figure 3 *- Working and Calender time [1]*

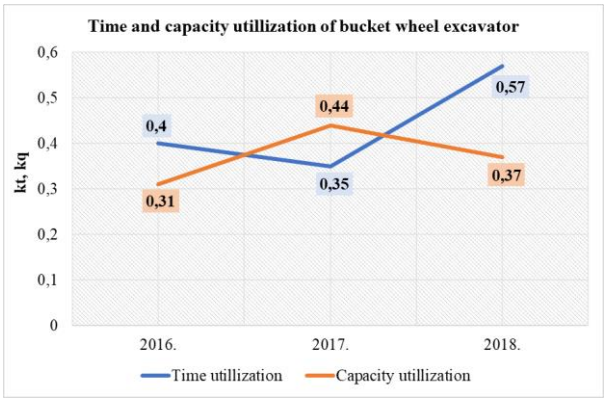

Figure 4 *- Time and capacity utilization of bucket wheel excavator [1]*

REFERENCES

[1] Techical documentation of Electric Power Industry of Serbia

INVESTIGATION ON THE CO_2 BREAKTHROUGH BEHAVIOUR OF DIFFERENT MATERIALS

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Abstract

The fabrication and manufacturing processes of industrial commodities such as iron, glass, and cement are carbon-intensive, accounting for 23% of global CO_2 emissions. Chemical absorption is one of the most promising technologies for CO_2 capture. The development of adsorption-based technologies for CO_2 capture in the post combustion processes requires finding materials with high capacity of adsorption and low cost of preparation. In recent years, carbon capture and utilization (CCU) has been proposed as a potential technological solution to the problems of greenhouse-gas emissions and the ever-growing energy demand. To combat climate change and ocean acidification as a result of anthropogenic CO_2 emissions, efforts have already been put forth to capture and sequester CO_2 from large point sources, especially power plants. In this work, zeolite 13X was used as potential materials for CO_2 adsorption. The method used for testing was based on the simulation of air flow of a certain composition using a test station, where it is the flow rate and air humidity can be adjusted. The results are presented in graphs together with adsorption capacities. For the applied conditions in this research, satisfactory results were obtained in a high percentage. Obtained results for 13X illustrate its potential as an effective adsorbent for the selective separation of CO_2 from air. Also, this method may be used for the separation of CO_2 from flue gas exhaust or other greenhouse gas emissions, and may have important applications in the pressing areas of sustainability and climate change mitigation.

***Keywords**: Adsorption CO_2, Zeolite, CCU, Climate change*

ACKNOWLEDGEMENT

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REFERENCES

[1] C.Y. Chuah, W. Li, Y. Yang, T.-H. Bae, Evaluation of porous adsorbents for CO_2 capture under humid conditions: The importance of recyclability, Chemical Engineering Journal Advances, 3 (2020), 100021.
[2] N. Konduru, P. Lindner, N. Marie Assaf-Anid, Curbing the greenhouse effect by carbon dioxide adsorption with Zeolite 13X, AlChE Journal, 53(12) (2007), p. 3137-3143.
[3] C. Chen, D.-W. Park, W.-S. Ahn, CO_2 capture using zeolite 13X prepared from bentonite, Applied Surface Science, 292 (2014), p. 63-67.

TRACKING THE ABSORPTION ABILITY OF EXHAUST GASES MODEL MIXTURE USING AN AQUEOUS SOLUTIONS OF NaOH AND KOH

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Abstract

- **Introduction and objective**

Emission from vehicles is one of anthropogenic sources of air pollution [1]. Major pollutants emitted from fossil-fuel internal combustion engine are carbon monoxide (CO), carbon dioxide (CO_2), oxides of nitrogen (NOx), particulate matter (PM) and hydrocarbons (HC) including volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) [2,3]. The aim of this probe was to examine the absorption ability of exhaust gases model mixture with an aqueous solutions of sodium hydroxide (NaOH) and potassium hydrokside (KOH).

- **Methodology**

Components of exhaust gases model mixture were CO, CO_2, methane, ethene and ethane. Gaseous mixture was introduced in aqueous solutions of NaOH and KOH through glass diffuser [4,5]. During the introduction of gases turbidity occurrence and the change in alkalinity were monitored. Changes in gas concentrations by passing through the hydrokside solution were measured by separation technique Gas Chromatography (GC) with Thermal Conductivity Detector (TCD) and Flame Ionization Detector (FID).

- **Results**

During the introduction of gaseous mixture in aqueous solutions of NaOH and KOH turbidity and precipitation occur in proportion to the time. There was no measurable change in alkalinity of solutions in time for 160 min. The signal from CO_2 is descended below measurable value while signals from CO, CH_4, C_2H_4 and C_2H_6 shown the same value prior to absorption.

- **Conclusions**

Difference in composition of exhaust gases model mixture indicates that an aqueous solutions of NaOH and KOH completely absorbs CO_2 until complete saturation. However, compounds CO, CH_4, C_2H_4 and C_2H_6 were not absorbed at all with these solutions.

***Keywords**: Exhaust gases, Gaseous pollutants, Air quality, Environment protection, Fossi- fuels*

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REFERENCES

[1] M. Hasan, S. Rahman, N. Paul, P. K. Halder, M. Alam, M. A. Raquib, M. A. Islam, P. A. Khan, Analysis of Exhaust Emission of Vehicles in Dhaka City of Bangladesh, Global Journal of Science Frontier Research 13 (2013) 51-55.

[2] S. Srivastava, Dr. AK Shukla, Vehicular Emission Estimates of Various Air Pollutants in Residential Region of Lucknow, International Research Journal of Engineering and Technology, 8 (2021) 18-22.

[3] S. Nilrit,P. Sampanpanish, S. Bualert, Comparison of CO2 Emissions from Vehicles in Thailand, App. Envi. Res. 39 (2017) 65-74.

[4] S. K Saxena, V. Drozd, A. Durygin, A fossil-fuel based recipe for clean energy, International Journal of Hydrogen Energy 33 (2008) 3625– 3631.

[5] S. Saxena, S. Kumar, V. Drozd, A modified steam-methane-reformation reaction for hydrogen production, International Journal of Hydrogen Energy 36 (2011) 4366-4369.

MANAGING THE HAZARDOUS CHEMICAL WASTE IN LABORATORIES: ARE WE ON THE RIGHT PATH?

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Abstract

- **Introduction and scope**

The use of hazardous chemicals during laboratory analyses, experiments, and research leads to the generation of hazardous waste [1]. Proper primary sorting of this waste can be challenging due to the necessity of preventing unwanted interactions and the formation of even more hazardous secondary substances [2]. The aim of this study is to provide insight into the management of hazardous chemical waste in Serbian laboratories.

- **Methodology**

A preliminary survey conducted in August 2023 with chemists and physical chemists (n=11) employed in different laboratories in Serbia was based on two fundamental questions: (1) How do you sort hazardous chemical waste, and (2) Do you believe it is necessary to have additional education and training on this issue?

- **Results**

The survey results are as follows: 73% of participants primarily sort liquid hazardous chemical waste into three categories: inorganic, halogenated organic, and non-halogenated organic waste. In addition, 100% of respondents consider it would be necessary to have additional education on laboratory hazardous chemical waste and its primary categorization since it is a part of their daily work.

- **Conclusion**

From presented results and after studying the existing Serbian legal regulations in the field of hazardous waste management [3] [4], a lack of clear and unambiguous protocols defining precise methods for the primary sorting of laboratory hazardous chemical waste can be observed. In the context of future studies, a more in-depth exploration of this subject is warranted, with a particular emphasis on offering recommendations for the enhancement of the legal framework within this domain [5].

***Keywords**: Hazardous chemical waste, Laboratory waste, Primary sorting, Legal regulation, Waste management*

ACKNOWLEDGEMENT

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REFERENCES

[1] E. de S. Nascimento, A. Tenuta Filho., Braz. J. Pharm. Sci., 46 (2) (2010) 187–198.
[2] P. C. Ashbrook., Chem. Health Saf., 8 (5) (2001) 27–29.

[3] Law on Waste Management ("Official Gazette of the Republic of Serbia" No. 36/2009, 88/2010, 14/2016, 95/2018 and 35/2023) (Serbian)
[4] Waste Management Program of the Republic of Serbia for the Period 2022-2031. ("Official Gazette of the Republic of Serbia" No. 12, February 1, 2022)
[5] E. Salmerón-Manzano, A. Alcayde, F. Manzano-Agugliaro., in Handbook of Environmental Materials Management (C. M. Hussain), Springer International Publishing, Cham, 2020, p. 1–17.

MODELLING AND STRESS ANALYSIS OF MACHINE ELEMENTS IN SOLIDWORKS SOFTWARE

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Abstract

Springs are machine elements that are used to create elastic joints. They are capable of being elastically deformed under the influence of external load and of converting the absorbed energy into mechanical work again. Paper presents analysis of the stress state of the torsion spring. Considered were two cases. The first, when the spring is fixed on the side and loaded with a force of 100 N and the second, when it is fixed at the root and loaded with the same force intensity. Spring modelling was perform in Solidworks software and further analysis of the stress state. The finite element method was used as the basis for the analysis of the stress state. The results are shown through displacement trend, spring deformation and Von Misses Stress. From the aspect of displacement, it can be concluded that the more dangerous case is when the spring is fixed at the root. The displacement values are much more pronounced with this load. The same situation is repeated with deformations. Deformations are more pronounced in the case when the spring is fixed at the root and loaded with a force of 100 N. According to the results of the previous analyzes for displacement and deformations, it is concluded that the Von Mises stress value is higher when the spring is fixed on the side compared to the situation when the spring is fixed at the root.

***Keywords**: Machine elements, Springs, Stress analysis, Solidworks*

REFERENCES

[1] M. Tanasijevic, S. Ivkovic, Machine elements, University of Belgrade, Faculty of Mining and Geology, Belgrade, 2023, p.130.
[2] M. Ognjanovic, Machine elements, University of Belgrade, Faculty of Mechanical Engineering, 2014, p.375.

VISIBLE-LIGHT PHOTOCATALYTIC DEGRADATION OF MODEL POLLUTANT (MO-METHYL ORANGE) IN SOLID-STATE

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Abstract

In the last few years, the demands placed in the field of environmental protection have been increasing, resulting in a reduction of pollutant emissions. Exhaust gases and atmospheric pollutants significantly affect the pollution and pollution of construction facilities, which significantly reduces their durability. The goal of the work is the synthesis and development of photocatalytically materials active in visible light for self-cleaning of external and internal walls. A series of TiO_2_ZnAl layered double hydroxides (LDHs) based composites were synthesized and their photocatalytic efficiency of the Methyl orange photodegradation reaction under visible light irradiation was tested [1]. Synthesis of concentrated suspension based on anionic clays (titanium dioxide doping method) under controlled pH conditions - TiO_2_ZnAl_LDH doped with (1, 2, 5 and 10 wt.% ($(NH_4)_2WO_4$). The optimal pH value was found to be 8 [2]. The concentrated suspension was diluted and stabilized with the addition of suitable dispersants. Methyl orange (MO) of optimized concentration was used as a pollutant.

The photocatalytic suspension was characterized by SEM- Scanning electron microscopy, XRD- X-ray diffraction, UV-VIS- Ultraviolet visible spectroscopy and FTIR- Fourier-transform infrared spectroscopy. Samples for photocatalytic tests were prepared by applying the suspension and model pollutant to the stone surface. Samples were placed under a visible light source and the degradation of the model pollutant and self-cleaning ability were confirmed using FTIR- Fourier-transform infrared spectroscopy.

***Keywords**: Photocatalysis, Methyl-orange, Layered double hydroxides, Visible-light*

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REFERENCES

[1] G. Morales-Mendoza, F. Tzompantzi, C. García-Mendoza, R. López, V. De la Luz, S.-W. Lee, R. Gómez, Appl. Clay Sci., 118 (2015) 38–47.
[2] R. Cerc Korošec, B. Miljević, P. Umek, J. M. van der Bergh, S. Vučetić, J. Ranogajec, Ceram. Int. 46 (2020) 6756-6766.

COMPARATIVE ANALYSIS OF TENSILE STRENGTH IN EN-AW 7075 ALUMINUM ALLOY: EMPIRICAL VS. THEORETICAL ASSESSMENT

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Abstract

The tensile strength and hardness of materials are properties which show strong correlation. Both represent critical parameters in engineering and material science. Our study aims to compare empirical and theoretical results, providing insights into the accuracy of theoretical predictions for tensile strength of EN-AW 7075 aluminum alloy under different conditions. In this study, the tensile strength of given aluminum alloy is investigated under: annealed (Temper O), aged (Temper T6), pre-deformed (Temper T8) and post-deformed (Temper T9) condition. The empirical results revealed a significant variation for different conditions, with values of 370 MPa, 506 MPa, 595 MPa, and 651 MPa, respectively. To complement the experimental findings, the theoretical tensile strength of the alloy was calculated based on Vickers hardness measurements using equation presented in M. Tiryakioğlu's work. Measured hardness values were: 91 HV_{15} for annealed, 158.5 HV_{15} for aged, 180.5 HV_{15} for pre-deformed and 198.2 HV_{15} for post-deformed samples. The calculated values of tensile strength were found to be 334 MPa, 497 MPa, 551, and 593 MPa, respectively. Relative differences between experimental and theoretical results for given conditions are 10.78%, 1.81%, 7.99%, 9.79%. The findings not only contribute to our understanding of material behavior but also have practical implications in various engineering applications. This research highlights the importance of considering both experimental and theoretical approaches when assessing material properties, offering valuable lessons for future materials science investigations.

***Keywords**: EN-AW 7075, Aluminum, Tensile strength, Hardness, Comparative study*

ACKNOWLEDGEMENT

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REFERENCES

[1] M. Tiryakioğlu, J. Robinson, M. Salazar-Guapuriche., Mat. Sci. and Eng., 631 A (2015) 196–200.
[2] P. Zhang, S. Li, Z. Zhang., Mat. Sci. and Eng., 529 A (2011) 62–73.
[3] M. Salazar-Guapuriche, Y. Zhao, A Pitman., Materials Science Forum. 853(8) 2006 519–521.
[4] A. Rao, V. Vasu, M. Govindaraju., Proc. Mat. Sci. 5 (2014) 86-95.
[5] G. Chen, Q. Chen, B.Wang., Met. And Mat. Intern. 21 (2015) 897-906.
[6] A. Fallahi, H. Hosseini-Toudeshky, S. Ghalehbandi., Adv. Mat. Res. 829 (2013)

PROPERTIES OF SOME COINS IN CIRCULATION FROM SERBIA

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Abstract

Own currency of a country is one of the symbol of its power and the sovereignty [1]. The production of coins has a deep tradition on the territory of today Serbia [2]. The oldest found coins were from the 6th-5th centuries BC. King Radoslav (1227–1234) is considered as the first Serbian ruler who minted his own money. In 1875, dinar as national monetary unit was established [3,4]. Today's coins from 1 dinar are in circulation from 2003 by the National Bank of Serbia. During those 20 years, the material for coins was changed for 3 times. 1 dinar from 2003 and 2004 was made from Cu-18Zn-12Ni alloy. 1 dinar from 2005 to 2009 was made from Cu-24.5Zn-0.5Ni alloy. 1 dinar from 2009 to 2021 was made from low carbon steel coated with a layer of copper and a layer of brass [5]. In this paper, the microstructure (using scanning electron microscopy (SEM) by energy dispersive spectroscopy (EDS)) and mechanical properties (hardness and tensile strength) of the 1 dinar coins from 2004, 2006 and 2021 (with different chemical composition) were studied. 1 dinar from 2004 shows the microstructure of α solid solution with polygonal grains with twins similar to the microstructure of 1 dinar from 2006. Investigated microstructure of 1 dinar from 2021 consists of elongated coarse grains of α ferrite, perlite was not found. Steel was coated with copper layer, over which a brass layer was applied. The best mechanical properties show 1 dinar from 2006 (hardness of 130 HV and tensile strength of 720 MPa).

***Keywords**: Coin, Dinar, Chemical composition*

REFERENCES

[1] J. Šerák, Manuf. Technol., 18 (4) (2018) 667-373.
[2] P. Grierson, Byzantine Coinage, Dumbarton Oaks, Washington, D.C, 1999.
[3] https://nbs.rs/sr/novac-i-placanja/numizmatika_str/istorijat-novca/
[4] D. Nedvidek, Serbian medieval coinage from the kingdom period, Museum of Vojvodina, Novi Sad, 2017.
[5] https://nbs.rs/en/novac-i-placanja/kovanice/index.html

STUDY OF ISOTHERMAL AGEING IN Cu-Al-Ni-Fe ALLOY

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Abstract

Nickel-aluminum bronzes are widely applicable engineering materials with high strength and good corrosion resistance. Their mechanical properties can be additionally improved by precipitation strengthening, which achieves greater hardness, toughness, and elasticity compared to tin bronzes [1-8]. The cast Cu-Al-Ni-Fe alloy was produced by melting the pure metals and casting the melt into the sand mold. After the casting, the ingot was heated to 900 °C for 2 h and quenched in cold water. Quenched samples were further strengthened by ageing at 400 °C and 450 °C. Isothermal ageing was performed at listed temperatures for different times up to 10 h. After each stage of heat treatment, the hardness and microhardness values of all presented microstructural phases were examined, while the microstructure was analyzed using optical and SEM microscopy with EDS. The α, β', and ƙ phases were visible in the microstructure of all isothermally aged samples. The sample aged at 400 °C for 1 h – 3 h showed the highest values of hardness and microhardness of β' phase.

***Keywords**: Nickel-aluminum bronzes, Isothermal ageing, K phases*

REFERENCES

[1] Y. Lv, M. Hu, L. Wang, X. Xu, Y. Han, W. Lu, J. Mater. Res., 30 (20) (2015) 3041–3048.
[2] P. Sláma, J. Dlouhý, M. Kövér, Mater. Technol., 48 (2014) 599–604.
[3] R. Vl. Gavrilova, R. I. Petkov, Bulg. Chem. Commun., 45 (4) (2013) 644–648.
[4] I.C. Ocejo, M.V. Biezma Moraleda, P. Linhardt, Metals, 12 (2022) 380.
[5] B. Thossatheppitak, S. Suranuntchai, V. Uthaisangsuk, A. Manonukul, P. Mungsuntisuk, Adv. Mater. Res., 683 (2013) 82-89.
[6] S. Zeng, S. Hu, G. Cheng, Mater. Today Commun., 33 (2022) 104767.
[7] S. Ma, X. Yang, L. Fu, A. Shan, Mater. Lett., 333 (2023) 133661.
[8] S.S.M. Tavares, N.M. Mota, H.R. da Igreja, C. Barbosa, J.M. Pardal, Eng. Fail. Anal., 128 (2021) 105606.

INVESTIGATION OF THE EFFECTS OF Ca/P RATIO AND DIFFERENT POLYMER-BASED COATINGS ON THE PROPERTIES OF MACROPOROUS CALCIUM PHOSPHATE MATERIALS

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Abstract

Osteoconductive porous scaffolds coated with different coatings based on biodegradable polymers could be used in bone tissue engineering. A key prerequisite for hard tissue engineering is the design of biocompatible scaffolds that are amenable to the proliferation, differentiation and attachment of osteogenic cells [1]. Hydroxyapatite (HAp) has a structure very similar to biological bone, which makes it an ideal candidate for bone grafts. HAp has properties of biocompatibility, non-toxicity, non-immunogenicity, bioactivity, osteoconductivity, osteoinductivity [2,3]. The goal of the study was to find out how different Ca/P molar ratios and gelatine-based polymer coatings affect the mechanical properties and microstructure of hydroxyapatite-based scaffolds for regrowing bone tissue. Solutions for the synthesis of initial particles of hydroxyapatite (HAp) were formed at Ca/P molar ratios of 1.52 and 1.67. Magnesium, zinc and copper ions were incorporated into both hydroxyapatite powders during synthesis by the hydrothermal method. The precipitated powders were further calcined. Macroporous bioceramic samples obtained by the sponge replica technique (the execution procedure involved applying a paste to the surface of the scaffold obtained by mixing calcined particles, water and polyvinyl alcohol) were sintered at 1370 °C and 1430 °C. The formed bioceramic macroporous samples were further impregnated with different solutions of gelatin, starch and hydroxypropyl methylcellulose, and then frozen and lyophilized or dried at room temperature. In the paper, powders and scaffolds were characterized by energy dispersive spectroscopy, scanning electron microscopy, X-ray diffraction analysis and mechanical characterization. *In vitro* tests of the bioactivity and biodegradability of the obtained materials were performed in a simulated body fluid at 37 °C. Elemental analysis detected dopant ions (magnesium, copper and zinc ions) in the structure of nano-rod particles of hydroxyapatite. Diffractograms of synthesized hydroxyapatite powders showed the presence of hydroxyapatite as a single crystalline phase, while during the thermal treatment of calcination an incomplete phase transformation of HAp into β-tricalcium-phosphate (β-TCP) took place. Diffractograms of macroporous scaffolds obtained at a Ca/P ratio of 1.52 showed the presence of two phases, HAp and dominant β-TCP, while a partial phase transformation to α-TCP occurred in the case of scaffolds with a molar ratio of Ca/P of 1.67. Scaffolds based on hydroxyapatite powder with a molar ratio of Ca/P of 1.52, sintered at 1430 °C, had the highest value of compressive strength. Different biodegradable polymer coatings have initiated additional improvement of the mechanical properties and affected differences in biodegradable properties and bioactivity.

Keywords: *Hydroxyapatite, Polymer coatings, Bone tissue regeneration*

REFERENCES

[1] V. R. Jokanovic, B. Petrovic, Z. Markovic, Coupling Agents and Biomimetic Methods of Calcium Hydroxyapatites Design as Basic Elements of the Hierarchically Structured Bone Scaffold, Stomatoloski glasnik Srbije, 56(3), (2009), p 130-138.

[2] Dj. Veljovic, T. Matic, T. Stamenic, V. Kojic, S. Dimitrijevic-Brankovic, M. Lukuc, S. Jevtic, Z. Rdovanovic, R. Petrovic, Dj. Janakovic, Mg/Cu co-substituted hydroxyapatite–Biocompatibility, mechanical properties and antimicrobial activity, Ceramics International, 45(17), (2019), p 22029-22039.

[3] S.S.A. Abidi, Q. Murtaza, Hydroxyapatite: Synthesis and Characterization, Journal of Materials Science & Technology, 30(4), (2014), p 307-310.

THE FAVORABLE INFLUENCE OF Ni ON THE REDUCTION OF SEGREGATIONS DURING SOLIDIFICATION OF LEAD-TIN BRONZES CuSn10Pb10

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Abstract

Alloys from the group of lead-tin bronzes (CuSn10Pb10) are most often used for the production of sliding bearings with significantly improved sliding (anti-friction) characteristics in difficult lubrication conditions in the exploitation process itself.

These bronzes are characterized by pronounced inhomogeneity caused, on the one hand, by the decrease in the solubility of lead in a solid copper solution with a decrease in temperature, and on the other, by the difference in density. The aim of this work is to examine the impact of nickel on the reduction of segregation, i.e. the distribution of lead, which has the greatest influence on inhomogeneity in the process of solidification of the mentioned alloys throughout the entire volume.

Three alloys with different nickel content were tested: 0%, 0.48%, 2.12%. Alloys are melted in a pot flame furnace with a blue flame at the furnace mouth in a slightly oxidizing atmosphere. The melting temperature was 1135 0C. Sliding bearings were gravity casted in molds made from a molding mixture of bentonite and silicon dioxide. A scanning electron microscope was used for microstructural tests. Test samples of identical shape and size were taken from the same casting zones. The problem that caused the inhomogeneity is primarily the decrease in the solubility of lead in copper during the solidification of the alloy. Namely, the solubility of lead in copper at a temperature above 1083 °C is 38%, while at room temperature it is 0.002%. Additional inhomogeneity is caused by the difference in the density of the base and alloy elements, which causes gravitational segregation. The basic characteristic of nickel as an alloying element in copper alloys is that it creates a dendritic microstructure during the crystallization process. The addition of nickel to lead-tin bronze alloys affects the even distribution of lead in the interdendritic space throughout the entire volume of the casting. In this way, a uniform distribution of lead is obtained, which has the basic function of improving the sliding properties of these alloys, and thus the uniformity of the sliding properties and mechanical characteristics of the sliding bearing is obtained.

CHARACTERIZATION OF COPPER ALLOYS MANUFACTURED IN SEVOJNO COPPER MILL

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Abstract

Copper is widely used in electrical engineering for the production of conductors due to its excellent electrical and thermal conductivity, in the mechanical industry, construction, and architecture due to its high plasticity and the ability to produce a large number of technical alloys with good mechanical and technological properties [1]. In this research, we focused on analyzing various characteristics of copper and brass materials obtained at the Sevojno Copper Rolling Mill to better understand their properties and applications. These investigations included a range of techniques and methods, each essential to understanding different aspects of materials and their properties. In the first phase of the research, the chemical composition of each sample was analyzed. This analysis showed that the chemical compositions of the samples are very similar to those obtained at the Sevojno Copper Mill and at the Technical Faculty in Bor using the XRF method. The next phase of our research focused on a detailed analysis of the material's microstructure. Using optical and scanning electron microscopy with X-ray energy diffraction (SEM-EDS), we investigated how the material's microstructure develops depending on various factors, including chemical composition and thermomechanical processing. Using the light pulse method, we measured materials' thermal diffusivity, specific heat capacity, and thermal conductivity in a wide temperature range. Using DSC analysis, we investigated the thermal characteristics of copper and brass samples to determine the melting point and detect phase changes in the system. Measuring the electrical conductivity of the sample, it can be seen that pure, electrolytic copper has the highest electrical conductivity, almost 101%, according to the IACS standard. As the zinc content in the alloy increases, the electrical conductivity decreases. Microhardness measurement by the Vickers method: We observe that the sample (CuZn28) has the highest microhardness.

***Keywords**: Copper, Brass, Microscopy, Conductivity, Microhardness*

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REFERENCES

[1] L. Balanović, D. Manasijevic, and V. Milojkovic, “Bakar,” vol. 44, 2019.

RECYCLING OF END-OF-LIFE VEHICLES

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Abstract

End-of-life vehicles (ELV) have become a global problem as the number of vehicles is constantly increasing. ELV are vehicles that have reached the end of life because of obsoletion or as a result of traffic accidents or natural disasters. The management of ELV across the world is regulated by various policies mainly based on extended producer responsibility, and the base principles of circular economy. In the European Union, the Directive 2000/53/EC covers vehicles, and end-of-life vehicles, including their components and materials, as well as spare and replacement parts. Circular economy plays a key role in sustainable management of ELVs, as it encompasses end-of-life strategies (EoL), which include reuse, reparation, remanufacturing, and recycling, used in handling ELV waste. Despite regulations, the recycling flow of ELV can be attributed to the following six steps: collection, depollution, dismantling, shredding, separation, and refining/landfilling. A component presenting the major problem in the ELV management is automotive shredding residue (ASR), which is left after the separation of all recyclable materials, consisting of textile, plastics, various metals (such as Pb, Cr, Cd, Hg, As), rubber, cellulose, and fine particles less than 10 μm with heterogeneous composition. Tackling the issue of recycling ELVs requires revisiting the entire process of vehicle production, from the design phase and material selection for components manufacturing to the waste handling and treatment of ELVs. Additionally, by properly labelling components, the entire recycling process of ELVs can be improved, subsequently leading to reduction of ASR as well.

***Keywords**: End-of-life vehicles, Circular economy, Recycling, Automotive shredder residue*

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REFERENCES

[1] V.J. Inglezakis, A.A. Zorpas, WIT Trans. Ecol. Environ., 120 (2009) 835-843.
[2] I. D'Adamo, M. Gastaldi, P. Rosa, Technol. Forecast. Soc. Change, 152 (2020) 119887.
[3] O.-C. Modoi, F.-C. Mihai, Energies, 15 (3) (2022) 1120.
[4] M. Despeisse, Y. Kishita, M. Nakano, M. Barwood, Procedia CIRP 29 (2015) 668-673.
[5] R. Cossu, T. Lai, Waste Manag., 45 (2015) 143-151.
[6] Official Journal of the European Communities, Directive 2000/53/EC, L 269/34, Available on the following link: https://eur-lex.europa.eu/resource.html?uri=cellar:02fa83cf-bf28-4afc-8f9f-eb201bd61813.0005.02/DOC_1&format=PDF

REMOVAL OF COPPER IONS FROM AQUEOUS SOLUTIONS USING HAZELNUT SHELLS AS AN ADSORBENT

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Abstract

Removal of heavy metals from industrial wastewaters can be achieved by various methods, such as chemical precipitation, coagulation, complexation, adsorption with activated carbon, ion exchange, solvent extraction, electrodeposition, cementation, etc. In addition to the processes listed above, it is necessary to mention the process of biosorption. Biosorption represents an efficient method of purification and removal of heavy metals from aqueous solutions with corresponding advantages such as specific affinity, low cost, and simple design. This paper presents a kinetic analysis of copper ions adsorption onto hazelnut shells. The experimental kinetic data were analyzed using four kinetic models: the pseudo first-order kinetic model, the pseudo second-order kinetic model, the interparticle diffusion kinetic model, and the Elovich kinetic model. The obtained results indicate that the biosorption of copper ions onto hazelnut shells follows the pseudo second-order kinetic model, with a correlation coefficient of $R^2 = 0.9613$. This indicates that the chemical interaction between the surface functional groups is the limiting factor of the process rate.

***Keywords**: Biosorption, Copper ions, Hazelnut shells, Adsorption kinetics*

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REFERENCES

[1] S.K. Gunatilake, Methods of Removing Heavy Metals from Industrial Wastewater, Journal of Multidisciplinary Engineering Science Studies, 1 (2015) 12-18.

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