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Ljubiša Balanović
Dejan Tanikić

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PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to welcome all esteemed participants of the 54th International October Conference on Mining and Metallurgy (IOC 2023), scheduled to take place at the picturesque Bor Lake, Serbia, from October18th to 21st 2023.

The collaborative efforts of the University of Belgrade, the Technical Faculty in Bor, and the Mining and Metallurgy Institute Bor have meticulously organized this year's IOC. Our focus remains unwavering on showcasing the latest research findings and advancements in geology, mining, metallurgy, materials science, technology, environmental protection, and other engineering disciplines. Our primary objective is to foster a dynamic environment where academics, researchers, and industry professionals can come together to share their knowledge, experiences, and innovative ideas while exploring opportunities for collaborative research endeavors.

Our conference agenda is rich and diverse, encompassing plenary sessions, engaging invited lectures, technical presentations, enlightening oral and poster sessions, informative technical tours, a diverse exhibition, and memorable social gatherings. At the heart of this event lies our strong commitment to sustainable development within the mining and metallurgy sector. We are dedicated to exploring ecologically conscious methodologies, responsible resource extraction practices, and cutting-edge technologies that reduce the industry's environmental impact and enhance the well-being of local communities.

The conference proceedings comprise 129 papers authored by individuals from universities, research institutes, and industries in 22 countries. We are proud to welcome participants from Bosnia and Herzegovina, Bulgaria, Canada, China, Croatia, Germany, Greece, India, Iran, Kazakhstan, Libya, North Macedonia, Montenegro, Morocco, Romania, Russia, Slovakia, South Africa, Spain, Turkey, United States, and, of course, Serbia.

We are excited to host the 8th International Student Conference on Technical Sciences (ISC 2023) as part of IOC 2023. This event offers students from Serbia and the wider region a unique chance to showcase their research and discuss the future of their fields with experts.

We sincerely thank the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia for their generous financial support. In addition, we express our profound gratitude to all our sponsors, exhibitors, and friends of the Conference for their contributions and unwavering support for playing a pivotal role in ensuring the success of IOC 2023.

We would like to express our heartfelt thanks to all authors, committees, reviewers, speakers, and chairpersons for their invaluable contributions in shaping IOC 2023.

We look forward to welcoming you to the 55th International October Conference on Mining and Metallurgy (IOC 2024), which will be held in October 2024.

On behalf of the 54th IOC Organizing Committee,

Prof. dr Ljubiša Balanović

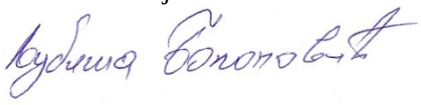

TABLE OF CONTENTS

Plenary Lectures

Velimir R. Radmilović *(SERBIA)*
Energy: One of the biggest challenges in 21st century 3-3

Jing Yu, Mingshui Luo, Junyi Xiang, Yang You, Zhixiong You, Xuewei Lv *(CHINA)*
Efficient extraction of vanadium from vanadium slag 4-8

Invited Lectures

Batrić Pešić *(UNITED STATES)*
The ongoing restructuring of universities to adopt the sophistication offered by internet 11-19

Yaima Filiberto, Alberto Montenegro, Eugenio Alvarez *(SPAIN)*
Machine learning applied to improving the scrap recycling and melting process in all types of ferrous alloys and steel 20-22

Slobodan Kostić, Qi Fenglai, Savo Pirgić, Nenad Botić, Dobrica Milovanović, Čedomir Sušić, Igor Zlatković *(SERBIA)*
Construction of a new sintering plant 180 m2 within the HBIS Group Serbia Iron & Steel 23-26

Satyananda Patra *(INDIA)*
Acid activation of bentonite: Physico-Chemical characterization and application in goethitic iron ore green pelletization 27-35

Ridvan Yamanoglu *(TURKEY)*
Production of metal-based powders by atomization techniques 36-45

Yong Du, Rainer Schmid-Fetzer, Jincheng Wang, Shuhong Liu, Jianchuan Wang, Qiang Lu, Yuhui Zhang, Kai Li *(CHINA, GERMANY)*
Computational design of engineering materials: case studies for a cemented carbide and a heat resistant Al alloy 46-46

Conference Papers

Ordinartsev Denis, Nadezhda Pechischeva, Svetlana Estemirova, Andrey Rempel *(RUSSIA)*
Cr(VI) photosorption on composite sorbent of montmorillonite with amorphous TiO2 49-52

Mikhail Korovkin, Ludmila Ananyeva, Andrey Zherlitsyn, Sergey Kondratyev, Olesya Savinova *(RUSSIA)*
Electro-pulse crushing in high-purity quartz production 53-55

Žarko Radović, Nebojša Tadić *(MONTENEGRO)*
Analytical simulation of EAF dust enrichment 56-59

Nebojša Tadić, Žarko Radović *(MONTENEGRO)*
Thermal and mechanical relaxation of residual streses in cold rolled aluminium alloy strips *60-63*

Dragan Šabaz, Miloš Stojanović, Dejan Petrović *(SERBIA)*
Selection of anchor type using AHP method *64-67*

Miloš Stojanović, Veljko Lapčević, Ivica Vojinović *(SERBIA)*
Blast fragmentation analysis in Jama Bor by using WipFrag software *68-71*

Veljko Lapčević, Toma Jovičić, Slavko Torbica *(SERBIA)*
Mine ventilation model validation by PQ survey *72-75*

Jelena Đorđević, Jelena Stefanović, Sandra Guševac, Ivan Jelić, Stefan Trujić *(SERBIA)*
Life cycle analysis (LCA) of asphalt layers containing recycled asphalt pavement *76-79*

Jelena Ivaz, Dejan Petrović, Predrag Stolić, Mladen Radovanović, Dragan Zlatanović, Saša Stojadinović, Pavle Stojković *(SERBIA)*
Occupational injuries in underground coal mining: statistical analysis of data *80-83*

Jelena Ivaz, Dejan Petrović, Mladen Radovanović, Dragan Zlatanović, Saša Stojadinović, Pavle Stojković *(SERBIA)*
Prediction of methane emissions in coalmine - Soko *84-87*

C. Prochaska, E. Kokkinos, D. Merachtsaki, A. Lampou, E. Peleka, K. Simeonidis, G. Vourlias, A. Zouboulis *(GREECE)*
Recovery of metallic fractions from medical products labelled for single use *88-91*

Nataša Sarap, Marija Janković, Vojislav Stanić, Ivana Jelić, Marija Šljivić-Ivanović *(SERBIA)*
Analysis of gross alpha and gross beta activity in samples around former uranium mine Gabrovnica *92-95*

Dragan Manasijević, Ljubiša Balanović, Ivana Marković, Uroš Stamenković *(SERBIA)*
Latent heat of some aluminium based phase change alloys for thermal energy storage *96-99*

Anđelka Stojanović, Ivica Nikolić, Isidora Milošević *(SERBIA)*
Position of European countries in sustainable resource management *100-103*

Aleksandar Đorđević, Duško Minić, Milena Zečević, Dragan Manasijević *(SERBIA)*
Mechanical and electrical properties of the ternary Ag-Ge-Sn alloys *104-107*

Milena Zečević, Duško Minić, Aleksandar Đorđević, Dragan Manasijević *(SERBIA)*
Effect of chemical composition on the corrosion resistance of the ternary Ag-Ge-Sn alloys *108-111*

Tatiana Aleksandrova, Nadezhda Nikolaeva *(RUSSIA)*
Extraction of low-dimensional structures of nonferrous and noble metals from refractory raw materials *112-115*

Viša Tasić, Tatjana Apostolovski-Trujić, Bojan Radović, Nevena Ristić, Tamara Urošević, Vladan Kamenović, Zvonko Damnjanović *(SERBIA)*
Air quality measurements in the Bor city during the reconstruction of the copper smelter Bor in 2022 *116-119*

Slavica Miletić, Biserka Trumić, Suzana Stanković *(SERBIA)*
Application of control charts in the laboratory for testing the metallic materials *120-123*

Alexey M. Amdur, Sergei A. Fedorov, Andrey A. Forshev, Nikolay V. Grevtsev, Vera V. Yurak *(RUSSIA)*
Technological aspects of the use of peat as a component of pulverated coal fuel for blast furnaces *124-127*

Ljiljana Avramović, Zoran Stevanović, Vanja Trifunović, Radmila Marković, Dragana Božić, Daniela Urošević, Silvana Dimitrijević *(SERBIA)*
Hydrometallurgical treatment of mining waste from Bor - Serbia in aim of copper recovery *128-131*

Daniel Kržanović, Radmilo Rajković, Ivana Jovanović, Milenko Jovanović, Miomir Mikić *(SERBIA)*
Determination the final contour of the open pit Veliki Krivelj for the mining capacity 23.1 million tons of ore *132-135*

Vladan Marinković, Miroslava Maksimović, Milenko Jovanović, Goran Pačkovski *(SERBIA)*
The use of unmanned aerial vehicles for making the precise 3D topo models and orthophoto images *136-140*

Dejan Tanikić, Anđela Stojić, Jelena Đoković, Miloš Stoljiljković *(SERBIA)*
Mechanical characteristics of the shape memory alloy Cu-Zn-Al *141-144*

Ljiljana Avramović, Vanja Trifunović, Zoran Stevanović, Radmila Marković, Dragana Božić, Dejan Bugarin, Silvana Dimitrijević *(SERBIA)*
Copper recovery from RE-flotation tailings by combined process *145-148*

Milenko Jovanović, Daniel Kržanović, Radmilo Rajković, Vladan Marinković, Miroslava Maksimović, Miomir Mikić *(SERBIA)*
Application of hybrid geogrids in mining *149-153*

Stefan Trujić, Miroslava Maksimović, Vladan Marinković, Ljiljana Avramović, Vanja Trifunović, Dragana Božić *(SERBIA)*
Geological exploration of the technogenic deposit - old flotation tailing pit - Bor with the possibility of leaching *154-157*

Zoran Stevanović, Radmila Marković, Ljiljana Avramović, Vojka Gardić, Jelena Petrović, Dragana Božić *(SERBIA)*
Sustainable and smart mining *158-161*

Snežana Ignjatović, Ivana Vasiljević, Branisav Sretković, Milanka Negovanović *(SERBIA)*
Using gravity data to define structural correlation affecting the formation of Neogene basins *162-165*

Deniz Eylül Akpınar, Batuhan Turgut, Ugur Gurol, Savas Dilibal *(TURKEY)*
Characterization of wire arc additively manufactured wear-resistant bimetallic component *166-169*

Mistreanu Sebastian, Ramona Cimpoeșu, Dragoș Achiței, Mihai Popa, Daniela Lucia Chicet, Vasile Manole, Ana-Maria Scripcariu, Nicanor Cimpoesu *(ROMANIA)*
Sandblasting process influence on stainless steel cutting element properties *170-174*

Đorđe Petrović, Katarina Stanković, Latinka Slavković Beškoski, Ksenija Kumrić *(SERBIA)*
Removal of Cu(II) from aqueous solutions using adsorbent based on chitosan hydrogel beads *175-178*

Jovan P. Šetrajčić, Siniša M. Vučenović *(BOSNIA AND HERZEGOVINA)*
Modified basic properties of electrons in layered nanocrystals with a complex lattice *179-182*

Irena Nikolić, Milena Tadić, Dijana Đurović, Nevena Cupara, Ivana Milašević *(MONTENEGRO)*
Kinetic and thermodynamic aspects of strontium adsorption by steelmaking slag *183-186*

Miomir Mikić, Milenko Jovanović, Sandra Milutonović, Daniel Kržanović, Radmilo Rajković *(SERBIA)*
New flotation plant Veliki Krivelj monitoring plan *187-190*

Miomir Mikić, Radmilo Rajković, Daniel Kržanović, Sandra Milutinović *(SERBIA)*
Recultivation of open pit Veliki Krivelj *191-194*

Farzet Bikić, Khaola Awad, Halim Prcanović, Mirnes Duraković *(BOSNIA AND HERZEGOVINA)*
Analysis of influenced factors on tropospheric ozone content in the city of Zenica during 2020 *195-198*

Sandra Milutinović, Ljubiša Obradović, Daniel Kržanović, Miomir Mikić, Radmilo Rajković *(SERBIA)*
Flotation tail storage methods *199-202*

Sandra Milutinović, Milena Kostović, Ljubiša Obradović, Srđana Magdalinović, Sanja Petrović *(SERBIA)*
Methods of transportation and discharge of tails to flotation tailings pond *203-206*

Uğur Gürol, Ceren Çelik, Müesser Göçmen, Mustafa Koçak *(TURKEY)*
Microstructural and mechanical characterization of armor steel joint welded with sandwich design *207-210*

Branka Pešovski, Milan Radovanović, Vesna Krstić, Danijela Simonović, Silvana Dimitrijević *(SERBIA)*
Electrochemical characteristics of the anodized titanium oxide films in sulfuric acid *211-215*

Duško Đukanović, Nemanja Đokić, Zoran Aksentijević, Daniel Radivojević, Branisal Stakić *(SERBIA)*
Methane as an untapped energy potential of the "Soko" brown coal mine *216-220*

Žaklina Tasić, Marija Petrović Mihajlović, Ana Simonović, Milan Radovanović, Maja Nujkić, Milan Antonijević *(SERBIA)*
Electrochemical methods for the determination of tryptophan and caffeine *221-224*

Isidora Milošević, Anđelka Stojanović, Sanela Arsić, Ivica Nikolić, Ana Rakić *(SERBIA)*
Circular economy in the era of Industry 5.0 *225-228*

Almaida Gigović-Gekić, Elvis Agović, Belma Fakić, Hasan Avdušinović *(BOSNIA AND HERZEGOVINA)*
Effect of delta ferrite on microstructure and hardness welded joints of steel S21800 229-232

Radmila Marković, Dragana Bozić, Zoran Stevanović, Tatjana Apostolovski Trujić, Vojka Gardić, Ljiljana Avramović, Vesna Marjanović *(SERBIA)*
Combining neutralization and adsorption methods for metals removal from Saraka stream 233-236

Ana Petrović, Radmila Marković, Emina Požega *(SERBIA)*
CNTs as potential material for wastewater purification: a review 237-240

Zdenka Stanojević Šimšić, Ana Kostov, Aleksandra Milosavljević, Slavica Miletić *(SERBIA)*
Experimental investigations of cualag alloys with 70 at%Cu 241-244

Ana Kostov, Aleksandra Milosavljević, Zdenka Stanojević Šimšić, Ivan Jovanović *(SERBIA)*
Determination of melt properties in Cu-Fe alloys 245-248

Vladimir Nikolić, Milan Trumić *(SERBIA)*
A simple method of determining of bond work index for finer samples 249-252

Ivan Jovanović, Novica Staletović *(SERBIA)*
Management of risk assessment in environmental protection in surface copper mine 253-256

Jovan P. Šetrajčić, Stevo K. Jaćimovski, Siniša M. Vučenović *(BOSNIA AND HERZEGOVINA)*
Possibility of localized electron states appearance in ultrathin layered crystalline structures 257-260

Jovica Sokolović, Ivana Ilić, Dragiša Stanujkić, Zoran Štirbanović *(SERBIA)*
Application of VIKOR method for comparison of the washability of coals 261-264

Vladimir Jovanović, Dejan Todorović, Branislav Ivošević, Dragan Radulović, Sonja Milićević, Marija Ercegović, Slavica Mihajlović *(SERBIA)*
The process of obtaining biochar and the development of the products thus obtained 265-269

Jelena Petrović, Marija Ercegović, Marija Simić, Marija Koprivica, Jelena Dimitrijević, Marija Marković *(SERBIA)*
Mg/Fe-modified hydrochar with promoted adsorption performances 270-273

Esra Dokumaci Alkan, Nurdan Ari, Murat Alkan *(TURKEY)*
A coating application of IN718 via self-propagating high-temperature synthesis method 274-277

Murat Alkan, Esra Dokumaci Alkan, Dilan Ugurluer, Aslihan Karakanat *(TURKEY)*
Production of AlCoCrCuXFeNi alloys via self-propagating high-temperature synthesis method 278-281

Jarmila Trpčevská, Iveta Vasková, Katarína Pauerová, Martina Laubertová, Dušan Oráč *(SLOVAKIA)*
Zinc volatilization in the primary and the secondary zinc production 282-286

Dragan Ignjatović, Lidija Đurđevac Ignjatović, Vanja Đurđevac, Katarina Milivojević, Ivan Jovanović *(SERBIA)*
Application of the numerical method in the definition of a substrate of circular cross section *287-291*

Dragan Ignjatović, Lidija Đurđevac Ignjatović, Vanja Đurđevac, Mlađen Supić, Dušan Tašić *(SERBIA)*
Influence of the subsoil bearing capacity during formation of high landsfills *292-296*

Bojana Živković, Jelisaveta Marjanović, Jelena Đokić, Maja Petrović *(SERBIA)*
Soil and rock properties as a basis for the sanitary lanfill settings *297-300*

Milan Gorgievski, Miljan Marković, Nada Štrbac, Vesna Grekulović, Kristina Božinović, Milica Zdravković, Marina Marković *(SERBIA)*
Adsorption kinetics for copper ions adsorption onto onion peels *301-304*

Saba Nourozi, Fatemeh Pourasgharian, Ahmad Khodadadi Darban *(IRAN)*
Recovery of copper from low-grade copper ore using organic acid *305-308*

Maria Krasteva *(BULGARIA)*
Metodology and equipment for researchung corrosion cracking processes in steel 3H14L (BDS 3692-78) *309-312*

Jasmina Nešković, Pavle Stjepanović, Nenad Milojković, Dejan Lazić, Klara Konc Janković, Svetlana Polavder, Ivana Jovanović *(SERBIA)*
Testing the Bond work index on limestone from flue gas desulphurization plant in TPP Ugljevik *313-317*

Biljana Zlatičanin, Sandra Kovačević *(MONTENEGRO)*
Impact of titanium addition on microstructure and properties of as-cast Al-Cu15 alloys *318-321*

Biljana Zlatičanin, Sandra Kovačević *(MONTENEGRO)*
Effect of cooling rate on mechanical properties of binary Al-Cu23 alloys *322-324*

Desislav Ivanov, Irena Peytcheva, Marko Holma *(BULGARIA)*
Horizon Europe AGEMERA project - Agile Exploration and Geo-modelling for European Critical Raw Materials: The potential of Assarel porphyry copper deposit for critical raw materials *325-328*

Shehret Tilvaldyev, Uzziel Caldiño Herrera, Jose Omar Davalos, Manuel Alejandro Lira Martinez, Marlenne Alejandra Hernandez Lira, Diego Adan Villordo Melendez *(CANADA)*
Problems of anthropogenic pollution of space *329-334*

Mohammed Derqaoui, Abdelmoughit Abidi, Abdelrani Yaacoubi, Khalid El Amari, Omar Oabi, Abdelaziz Bacaoui *(MOROCCO)*
Apatite flotation from low-grade sedimentary phosphate ore *335-338*

Nadezhda Kazakova, Alexandar Popov, Georgi Chernev *(BULGARIA)*
Influence of the distribution and content of limestone particles on the properties of blended cements *339-342*

Daniel Ogochukwu Okanigbe, Shade Rouxzeta Van Der Merwe *(SOUTH AFRICA)*
Rocks of Obafemi Awolowo University and Environ, Nigeria: structural analysis of geological contact *343-347*

Vladan Kašić, Ana Radosavljević Mihajlović, Jovica Stojanović, Slavica Mihajlović, Melina Vukadinović, Nataša Đorđević, Ivana Jelić *(SERBIA)*
Study of thermally treated zeolitic tuffs of Serbia, deposits "Zlatokop" and "Općište"-Beočin *348-352*

Vesna Grekulović, Aleksandra Mitovski, Milica Zdravković, Nada Štrbac, Milan Gorgievski, Milovan Vuković, Miljan Marković *(SERBIA)*
Electrochemical behavior of copper in chloride medium in the presence of nettle extract *353-356*

Marko Pavlović, Marina Dojčinović, Muhamed Harbinja, Atif Hođić, Dragan Radulović, Mirjana Stojanović, Zagorka Aćimović *(SERBIA, BOSNIA AND HERZEGOVINA)*
Effects of the application of pyrophylite in the composition of protective coatings *357-360*

Tamara Ristić, Nenad Milosavljević, Dobrica Milovanović *(SERBIA)*
Measures for the processing of iron with a higher incoming phosphorus content at the steel shop *361-365*

Ivana Mikavica, Dragana Ranđelović, Milena Obradović, Jovica Stojanović, Jelena Mutić *(SERBIA)*
Microplastic textile fibers in urban soils of Serbia *366-369*

Jianbo Zhao, Xinnan Zhao, Donglai Ma, Yang You, Zhixiong You, Xuewei Lv *(CHINA)*
Preparation of ferronickel by semi-molten smelting a mixture of two types of laterite ore *370-374*

Mladen Radovanović, Dejan Petrović, Jelena Ivaz, Dragan Zlatanović *(SERBIA)*
Possibility of copper ores exploitation using in situ leaching method *375-378*

Ivan Jelić, Nikola Lekić, Nikola Stanić, Miomir Mikić *(SERBIA)*
Selection of an optimal route for relocation of the Ćehotina river bed *379-382*

Milica Zdravković, Vesna Grekulović, Bojan Zdravković, Nada Štrbac, Milan Gorgievski, Miljan Marković *(SERBIA)*
Electrochemical behavior of steel in 0.1 mol/dm3 HCl in the presence of potato peel juice *383-386*

Ivana Marković, Dalibor Jović, Uroš Stamenković, Dragan Manasijević, Ljubiša Balanović, Milan Gorgievski *(SERBIA)*
Microstructure and thermal properties of leaded brass after quenching *387-390*

Mehmet Ali Yildiz *(SERBIA)*
Hot strip mill walking beam slab reheating project *391-394*

Peter Polyak *(SERBIA)*
Finishing mill automation upgrade at hot strip mill *395-400*

Branislav Potić, Ana Arifović *(SERBIA)*
The metallurgical testing results of the boron mineralized material from Valjevo-Mionica basin *401-406*

Uroš Stamenković, Ivana Marković, Srba Mladenović, Saša Marjanović, Avram Kovačević, Milijana Mitrović, Filip Basarabić *(SERBIA)*
The influence of quenching media on different properties of C45 carbon steel *407-413*

Yang You, Jiabao Guo, Zhixiong You, Xuewei Lv *(CHINA)*
Investigation of the mixing and granulation behavior of iron ore fines in horizontal high-shear granulator *414-417*

Jovica Sokolović, Grozdanka Bogdanović, Velizar Stanković, Gracijan Strainović, Ivana Ilić, Milan Gorgievski, Miljan Marković *(SERBIA)*
Investigation on beneficiation of iron from copper ore of Mauritania Copper Mine (MCM) by magnetic separation *418-421*

Essen Suleimenov, Rustam Sharipov, Galymzhan Maldybayev, Zhibek Orazaliyeva *(KAZAKHSTAN)*
Investigation of the influence of pulsed electric current on the efficiency of decomposition of aluminate solution *422-423*

Lovro Liverić, Tamara Holjevac Grgurić, Sunčana Smokvina Hanza, Wojciech Sitek, Vedrana Špada, Marko Kršulja *(CROATIA)*
Influence of silver content on martensitic transformation of Cu-Al-Ag alloy *424-427*

Hasan Ali Taner, Vildan Onen *(TURKEY)*
Evaluation of the efficiency of different collectors in the chalcopyrite flotation *428-434*

Vesna Conić, Dragana Božić, Miloš Janošević, Ljiljana Avramović, Vanja Trifunović, Dejan Bugarin, Ivana Jovanović *(SERBIA)*
A pyro-hydrometallurgical process for the recovery of zinc from jarosite waste *435-438*

Maria Krasteva, Rumen Petkov *(BULGARIA)*
Research the rate of chemical corrosion of steel 3X14H2 (BDS 3692-78) *439-442*

Srba Mladenović, Bojan Novaković, Ivana Marković, Uroš Stamenković *(SERBIA)*
Effect of casting speed and water flow on tensile strength, elongation and microstructure of continuous cast copper wire *443-447*

Nadira Bušatlić, Ilhan Bušatlić, Dženana Smajić-Terzić *(BOSNIA AND HERZEGOVINA)*
Dependence of compressive strength of geopolymer based on fly ash and alkaline activator ratio *448-451*

Gergana Meracheva, Efrosima Zaneva-Dobranova, Nikolay Hristov *(BULGARIA)*
Hydrocarbon potential of the Lower Paleozoic sediments in NE Bulgaria by geochemistry and well-logging *452-455*

Dragana Marilović, Grozdanka Bogdanović, Sanja Petrović *(SERBIA)*
Leaching of flotation tailings with a solution of sulfuric acid and ionic liquid *456-459*

Ivana Jovanović, Vesna Conić, Dragan Milanović, Daniel Kržanović, Tanja Stanković, Daniela Urošević, Miloš Janošević *(SERBIA)*
Determination of Bond rod mill work index of a very low-grade copper ore *460-463*

Hasan Ali Taner, Ali Aras, Muhammad Hashim Rasa *(TURKEY)*
Investigation of the effect of depressant and collector conditioning times on cobalt recovery by flotation *464-467*

Aleksandar Cvetković, Žaklina Tasić, Marija Petrović Mihajlović, Maja Nujkić, Milan Radovanović, Ana Simonović *(SERBIA)*
Microplastics *468-471*

Sanja Petrović, Srđana Magdalinović, Ljubiša Obradović, Sandra Milutinović, Bojan Drobnjaković, Slađana Krstić *(SERBIA)*
Tailing management: tailings filtering equipment *472-475*

Jelena Stefanović, Jelena Đorđević, Sandra Guševac *(SERBIA)*
XRD analysis of corrosion product formed in industrial aggressive environment *476-480*

Muhamad Ghulam Isaq Khan, Filip Rajković, Miljana Popović, Dejan Prelević, Aleksandar Ćitić, Tamara Radetić *(SERBIA)*
Initiation of abnormal grain growth in cold-rolled sheet of AA5182 Al-Mg alloy: role of texture *481-484*

Danijela Voza, Hesam Dehghani, Milica Veličković *(SERBIA)*
The dissolved oxygen prediction based on the machine learning techniques *485-488*

Hasan Açan, Hasan Ergin *(TURKEY)*
A novel model for minimizing mine closure costs and the optimum final quarry boundry *489-492*

Ivana Jovanović, Dragan Milanović, Oliver Dimitrijević, Vesna Conić, Igor Svrkota *(SERBIA)*
Role of wing tank in DMS process. Suspension velocity through the seal leg orifice – case study *493-496*

Dejan Petrović, Jelena Ivaz, Saša Stojadinović, Predrag Stolić, Dragan Zlatanović *(SERBIA)*
Risk management and mining machines maintenance – a brief review *497-500*

Stefan Đorđievski, Dragana Adamović *(SERBIA)*
History of surface water pollution by mining and metallurgical activities in Bor, Serbia *501-504*

Olivera Dragutinović, Vaso Manojlović, Đorđe Veljović, Stefan Dikić, Marko Simić *(SERBIA)*
Investigation of the properties of Co-Cr-W and Co-Cr-Mo alloys coated with hydroxyapatite for use in dental implants *505-509*

Zoran Karastojković, Dragoslav Gusković, Ognjen Ristić, Zorica Kovačević *(SERBIA)*
About the "relative plasticity" between steel matrix and non-metallic inclusions *510-513*

Aleksandar Jovanović, Mladen Bugarčić, Milena Milošević, Marija Vuksanović, Muna Abdualatif Abduarahman, Miroslav Sokić, Aleksandar Marinković *(SERBIA, LIBYA)*
Modified hybrid cellulose membrane for Nickel(II) ions removal from industrial wastewater *514-517*

Elena Todorova, Nadezhda Kazakova, Georgi Chernev *(BULGARIA)*
Structural investigation via SEM analysis of silica hybrid materials *518-521*

Tanja Kalinović, Jelena Kalinović, Jelena Milosavljević, Ana Radojević, Snežana Šerbula *(SERBIA)*
Atmosperic bulk deposition as environmental quality indicator *522-526*

Gordana Marković, Vaso Manojlović, Miroslav Sokić, Jovana Ružić, Dušan Milojkov *(SERBIA)*
Designing biocompatible high entropy alloys using Monte Carlo simulations *527-530*

Tatjana Volkov-Husović, Sanja Martinović, Ana Alil, Milica Vlahović *(SERBIA)*
Application of image analysis for cavitation erosion resistance monitoring of some engineering materials *531-534*

Milan Nedeljković, Srba Mladenović, Jasmina Petrović, Milijana Mitrović *(SERBIA)*
Changes in the structure and density of copper during the refining smelting process *535-538*

Jasmina Petrović, Srba Mladenović, Ivana Marković, Milan Nedeljković, Milijana Mitrović *(SERBIA)*
Microstructure analysis of EN AW 6061 alloy using a SEM microscope after artificial aging *539-542*

Milijana Mitrović, Saša Marjanović, Biserka Trumić, Jasmina Petrović, Milan Nedeljković *(SERBIA)*
Effects of cold rolling and annealing processes on the microstructure and properties of micro-alloyed copper *543-546*

Makedonka Dimitrova, Jasminka Dimitrova Kapac *(NORTH MACEDONIA)*
Unlocking energy efficiency: financing preferences for SMEs in the Republic of North Macedonia *547-555*

Zoran Štirbanović, Vesna Vojinović, Jovica Sokolović, Maja Trumić *(SERBIA)*
Analysis of the effectiveness of different methods for cutting samples *556-559*

Ivica Nikolić, Isidola Milošević, Anđelka Stojanović *(SERBIA)*
Land turnover increases due to mining: An empirical analysis of Bor, Serbia, 2013-2022. *560-563*

DONORS *565-590*

AUTHOR INDEX *591-596*

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ELECTROCHEMICAL BEHAVIOR OF STEEL IN 0.1 mol/dm^3 HCl IN THE PRESENCE OF POTATO PEEL JUICE

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Abstract

Corrosion control is possible by adding a small amount of a compound that opposes the anodic or cathodic corrosion reaction or both. This paper presents the results of investigating the electrochemical behavior of steel with 0.1 mol/dm^3 HCl in the absence and presence of potato peel juice (2 mL-10 mL). Electrochemical methods of open circuit potential measurement and cyclic voltammetry were applied. The results show that in the presence of potato peel juice (PPJ), there is a shift towards more positive values of the open circuit potential and that value is increasingly positive with the increase in the PPJ concentration. The results obtained by cyclic voltammetry indicate that there are no clearly expressed current peaks on the cyclic voltammogram. With all the PPJ additions the current strength values are lower compared to the current strength values without the addition. The lowest value of the current strength was obtained with the addition of 10 mL PPJ. Lower current values in the presence of PPJ indicate that the potato peel juice slows down both anodic and cathodic processes to a certain extent. Potato peel juice acts as a mixed type of steel corrosion inhibitor in 0.1 mol/dm^3 HCl.

Keywords *steel, electrochemical behavior, chloride medium, potato peel*

1. INTRODUCTION

Steel C15 belongs to the group of low-carbon steels for cementation. The carbon content in C15 steel is up to 0.2%. Steel C15 is used for making parts of small dimensions and simple shapes, exposed to wear and low loads, where high hardness of the core is not required (handles, levers, sleeves, joints) [1].

Industrial food by-products are attracting the attention of researchers as possible green corrosion inhibitors. A large amount of by-products is obtained from potato processing. Potato (*Solanum tuberosum L.*) is one of the most important foods in the world. This food originated in South America, around 500 BC. Over time, the potato has become an important food item in the human diet, which can be attributed to its nutritional value [2]. Potato processing by-products, like other food by-products, are organic materials whose disposal is very important for environmental reasons. Potato peel requires additional processing, especially if it is used for animal feed due to the high fiber content [3].

This paper presents the results of investigating the effect of potato peel juice (*Solanum tuberosum L.*) on the steel corrosion in 0.1 mol/dm^3 HCl.

2. EXPERIMENTAL

The experiments were carried out in a system consisting of an three-electrode electrochemical cell and hardware interface for computerized control and data acquisition. The steel C15 was used as working electrode, the saturated calomel electrode (SCE) as reference electode and platinum foil as a counter electrode. The computerized control (National Instruments card, NI-6251) and data acquisition software (LabVIEW 8.2 platform), fully developed at Technical Faculty in Bor [4], was used to run the electrochemical experiments.

Investigation of the steel C15 electrochemical behavior in 0.1 mol/dm^3 HCl without and with the addition of PPJ was performed by measuring the open circuit potential in relation to a saturated calomel electrode for 1800 s and using the cyclic voltammetry method. Cyclic voltammograms were recorded using the cyclic voltammetry method in the potential range from -1 to 0.2 V in relation to SCE in 0.1 mol/dm^3 HCl.

The 37% HCl produced by "VWR Chemicals Prolabo BDH" was used to prepare a 0.1 mol/dm^3 HCl solution. Solutions were prepared from chemicals p.a. purity and distilled water in the amount of 1000 mL. The working solutions were obtained by adding PPJ. Before peeling, the potatoes were washed with plain water, then with distilled water to remove impurities from the potatoes surface. After peeling, the juice of the potato peel was obtained using a Philips HR1853 juicer. The resulting PPJ was filtered on a Bichner apparatus.

The working electrode was obtained from C15 steel melted in epoxy resin. The electrode working surface was wire cross-section with a diameter of 3 mm.

3. RESULTS AND DISCUSSION

The results of measuring the open circuit potential for steel in 0.1 mol/dm^3 HCl without and with the addition of PPJ are shown in Figure 1. The change in the open circuit potential was monitored during 1800 s. The open circuit potential for steel in 0.1 mol/dm^3 HCl without the addition drops sharply in the first 60 s, then rises sharply until about 250 s, after which it decreases, fluctuates, and stabilizes at about 1600 s. The stabilized value of the open circuit potential obtained in 0.1 mol/dm^3 HCl without the addition of PPJ is E = -0.565 V vs. SCE.

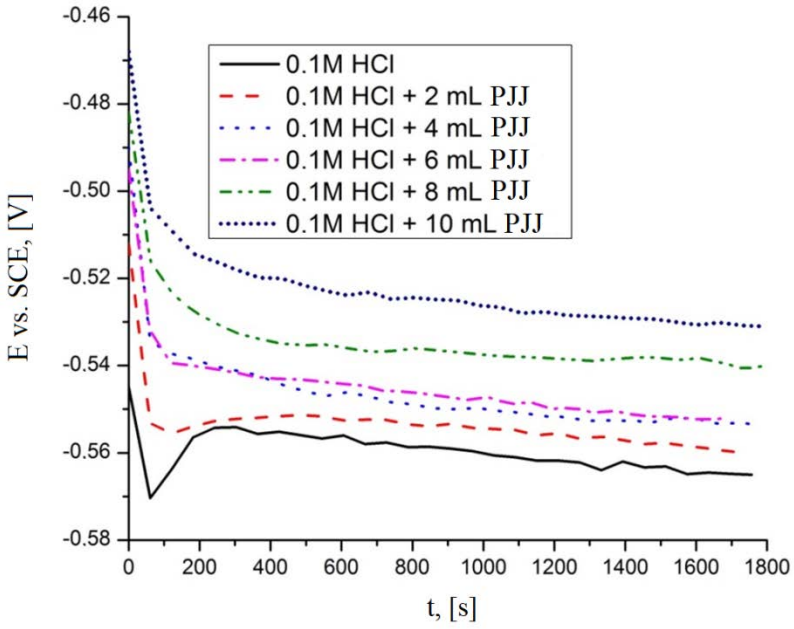

Figure 1 - Results of measuring the open circuit potential for steel in 0.1 mol/dm^3 HCl without and with the addition of PPJ for 1800 s

With the addition of 2 mL, 4 mL, 6 mL, 8 mL and 10 mL PPJ, there is a sudden drop in the potential in the first 50 s. With the addition of 2 mL PPJ after 50 s, the potential value begins to rise slightly until 500 s, then falls slightly, after which it stabilizes at around 1500 s and amounts to E = -0.560 V vs. SCE. The open circuit potential with the addition of 4 mL and 6 mL PPJ after a sharp drop in the first 50 s, continues to decrease slightly and stabilizes at about 1400 s. The potential values are approximately equal, and after stabilization with the addition of 4 mL PPJ, it amounts to E = -

0.554 V vs. SCE, and with the addition of 6 mL PPJ is E = -0.553 V vs. SCE. With the addition of 8 mL and 10 mL PPJ, the potential drop after 50 s is less pronounced compared to the potential values without the addition and with the addition of 2 mL, 4 mL, and 6 mL PPJ . The open circuit potential with the addition of 8 mL and 10 mL PPJ stabilizes after 1600 s, and amounts to E = -0.540 V vs. SCE and E = -0.531 V vs. SCE, respectively.

At all concentrations of PPJ the values of the open circuit potential for steel in 0.1 mol/dm^3 HCl are more positive compared to the value of the open circuit potential without the addition. The value of the open circuit potential is increasingly positive with the increase in the PPJ concentration.

The results obtained by the cyclic voltammetry are shown in Figure 2. Cyclic voltammograms were recorded in the potential range from -1 V in relation to SCE to 0.2 V in relation to SCE at a potential change rate of 50 mV/s. There are no clearly defined current peaks on the voltammogram without the addition of PPJ, as well as on the voltammograms with the addition of juice.

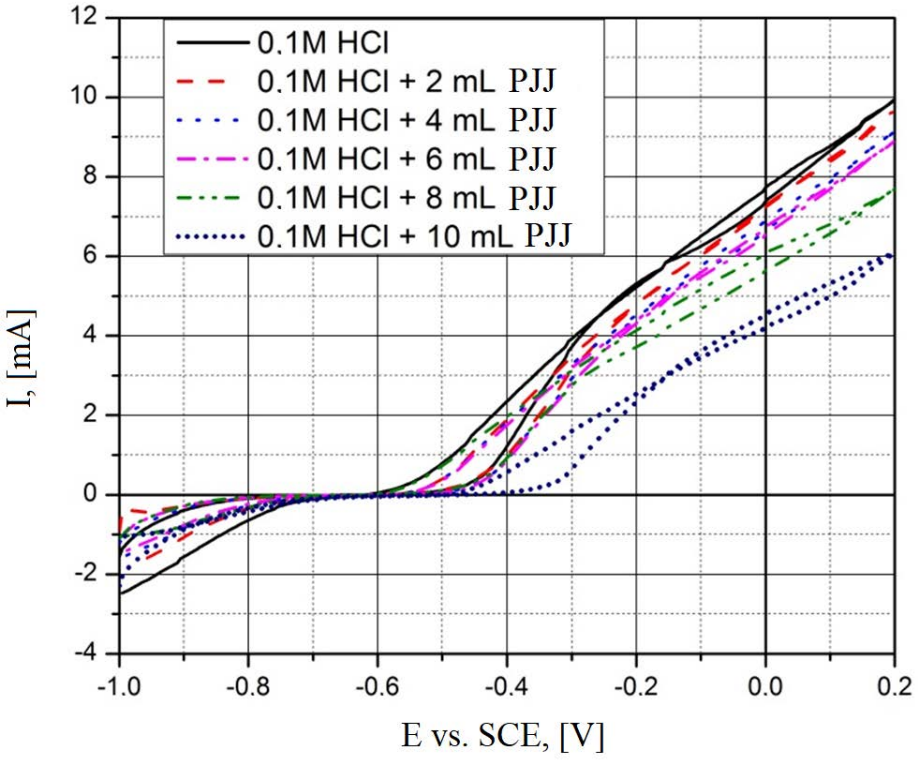

Figure 2 - Cyclic voltammograms obtained for steel in 0.1 mol/dm^3 HCl without addition and with the addition of PPJ at a potential change rate of 50 mV/s, surface of the working electrode 0.07 cm^2

In the anodic part of the cyclic voltammogram, it can be seen that with the addition of 2 mL PPJ, the current strength values are approximately equal to the current strength values for steel in 0.1 mol/dm^3 HCl without the addition. At potentials more positive than -0.5 V vs. SCE leads to an increase in current strength, which means that the corrosion process is taking place. With the addition of 4 mL, 6 mL, 8 mL and 10 mL PPJ, the current strength values are lower compared to the current strength values without the addition. The lowest value of the current strength was obtained with the addition of 10 mL PPJ.

In the cathodic part of the cyclic voltammogram, it is clearly seen that in the entire potential range, the current strength values in the PPJ presence are lower compared to the current strength values

without the addition. The lowest value of the current strength was obtained with the addition of 10 mL PPJ. Lower current values in the presence of PPJ indicate that the addition slows down both anodic and cathodic processes to a certain extent. Which means that PPJ acts as a mixed type of steel corrosion inhibitor in 0.1 mol/dm^3 HCl.

4. CONCLUSION

Based on the obtained results of measuring the open circuit potential, it can be concluded that with the addition of PPJ (*Solanum tuberosum L.*) in a 0.1 mol/dm^3 HCl solution, the open circuit potential of steel C15 moves towards more positive values. The value of the open circuit potential is more positive with increasing concentration of PPJ.

The results of investigating the electrochemical behavior of steel using cyclic voltammetry in 0.1 mol/dm^3 HCl without and in the presence PPJ (*Solanum tuberosum L.*) indicate the effect of PPJ as steel corrosion inhibitor. The value of the current strength in the presence of PPJ decreases and this decrease is more significant with the increase in the PPJ concentration. Potato peel juice acts as a mixed corrosion inhibitor C15 steel in 0.1 mol/dm^3 HCl. It is assumed that protection against corrosion is achieved by the protective film formation on the steel surface, which is a consequence of the adsorption of ingredients present in the juice.

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