University of Belgrade
Technical Faculty in Bor,
Mining and Metallurgy
Institute Bor

54th International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:
Ljubiša Balanović
Dejan Tanikić

18-21 October 2023, Bor Lake, Serbia

PROCEEDINGS,

54th INTERNATIONAL OCTOBER CONFERNCE

on Mining and Metallurgy

Editors:

Prof. dr Ljubiša Balanović

Prof. dr Dejan Tanikić

University of Belgrade, Technical Faculty in Bor

Technical Editor:

M. Sc. Miljan Marković

University of Belgrade, Technical Faculty in Bor

Publisher: University of Belgrade, Technical Faculty in Bor

For the publisher: Dean Prof. dr Dejan Tanikić

Circulation: 200 copies

CIP - Каталогизација у публикацији Народна библиотека Србије, Београд

622(082)(0.034.2)
669(082)(0.034.2)

INTERNATIONAL October Conference on Mining and Metallurgy (54 ; 2023 ; Borsko jezero)
Proceedings [Elektronski izvor] / 54th International October Conference on Mining and Metallurgy - IOC 2023, 18-21 October 2023, Bor Lake, Serbia ; [organized by] University of Belgrade, Technical Faculty in Bor and Mining and Metallurgy Institute Bor ; editors Ljubiša Balanović, Dejan Tanikić. - Bor : University of Belgrade, Technical Faculty, 2023 (Niš : Grafika Galeb). - 1 USB fleš memorija ; 1 x 1 x 5 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 200. - Preface / Ljubiša Balanović. - Bibliografija uz svaki rad.

ISBN 978-86-6305-140-9

a) Рударство -- Зборници b) Металургија -- Зборници

COBISS.SR-ID 126659849

Bor Lake, Serbia, October 18-21, 2023

Conference is financially supported by
The Ministry of Science, Technological
Development and Inovation
of the Republic of Serbia

SCIENTIFIC COMMITTEE

Prof. Dr Dejan Tanikić *(Serbia) - president*
Prof. Dr Nada Štrbac *(Serbia) - vice-president*
Prof. Dr Radoje Pantović *(Serbia) - vice-president*

Dr Ana Kostov *(Serbia)*
Prof. Dr Adam Grajcar *(Poland)*
Prof. Dr Adina Negrea *(Romania)*
Dr Andrei Rotaru *(Romania)*
Prof. Dr Batrić Pešić *(USA)*
Dr Biserka Trumić *(Serbia)*
Prof. Dr Boštjan Markoli *(Slovenia)*
Dr Branislav Marković *(Serbia)*
Prof. Dr Cornelia Muntean *(Romania)*
Prof. Dr Daniela Grigorova *(Bulgaria)*
Prof. Dr Dejan Ivezić *(Serbia)*
Prof. Dr Desimir Marković *(Serbia)*
Prof. Dr Dimitris Panias *(**Greece**)*
Prof. Dr Dimitriu Sorin *(Romania)*
Prof. Dr Dmitry Vasilyev *(Russia)*
Dr Dragan Komljenović *(Canada)*
Prof. Dr Dragan Manasijević *(Serbia)*
Dr Dragan Milanović *(Serbia)*
Prof. Dr Dragan Milovanović *(Serbia)*
Prof. Dr Dragoslav Gusković *(Serbia)*
Prof. Dr Dušan Oráč *(Slovakia)*
Prof. Dr Duško Minić *(Serbia)*
Prof. Dr Endre Romhanji *(Serbia)*
Prof. Dr Essen Suleimenov *(Kazakhstan)*
Prof. Dr Farzet Bikić *(Bosnia and Herzegovina)*
Prof. Emeritus Fathi Habashi *(Canada)*
Prof. Dr Grozdanka Bogdanović *(Serbia)*
Prof. Dr György Kaptay *(Hungary)*
Prof. Dr Ivan Mihajlović *(Serbia)*
Prof. Dr Iveta Vaskova *(Slovakia)*
Prof. Dr Jakob Lamut *(Slovenia)*
Prof. Dr Jasmin Suljagić *(Bosnia and Herzegovina)*
Dr Jasmina Stevanović *(Serbia)*
Dr Jasna Stajić Trošić *(Serbia)*
Prof. Dr Jovica Sokolović *(Serbia)*
Prof. Dr Jožef Medved *(Slovenia)*
Prof. Dr Kaikun Wang *(China)*
Prof. Dr Karl Heinz Spitzer *(Germany)*
Prof. Emeritus Karlo Raić *(Serbia)*
Prof. Dr Kemal Delijić *(Montenegro)*
Prof. Dr Komnitsas Konstantinos *(Greece)*
Prof. Dr Kostas Matis *(Greece)*
Prof. Dr Krzysztof Fitzner *(Poland)*
Prof. Dr Luis Filipe Malheiros *(Portugal)*
Prof. Dr Milan Antonijevic *(Serbia)*
Prof. Dr Milan Trumić *(Serbia)*
Dr Mile Bugarin *(Serbia)*
Dr Milenko Ljubojev *(Serbia)*
Prof. Dr Milovan Vuković *(Serbia)*
Prof. Dr Mira Cocić *(Serbia)*
Mirjam Jan-Blažić *(Slovenia)*
Prof. Dr Mirjana Rajčić Vujasinović *(Serbia)*
Prof. Dr Mirko Gojić *(*Croatia*)*
Dr Miroslav Sokić *(Serbia)*
Prof. Dr Mirsada Oruč *(Bosnia and Herzegovina)*
Dr Nadežda Talijan *(Serbia)*
Prof. Dr Natalija Dolić *(*Croatia*)*
Prof. Dr Nedeljko Magdalinović *(Serbia)*
Prof. Dr Nenad Radović *(Serbia)*
Prof. Dr Nenad Vušović *(Serbia)*
Prof. Dr Nicanor Cimpoesu *(Romania)*
Prof. Dr Nobuyuki Masuda *(*Japan*)*
Prof. Dr Onuralp Yucel *(*Turkey*)*
Prof. Dr Pavel Broz *(*Czech Republic*)*
Prof. Dr Petr Solozhenkin *(*Russia*)*
Prof. Dr Petrica Vizureanu *(Romania)*
Dr Sun Zhongmei *(**China**)*
Prof. Dr Ridvan Yamanoglu *(*Turkey*)*
Prof. Dr Rodoljub Stanojlović *(Serbia)*
Prof. Dr Rositsa Paunova *(**Bulgaria**)*
Prof. Dr Sead Ćatić *(Bosnia* and *Herzegovina)*
Prof. Dr Sergey Krasikov *(*Russia*)*
Dr Slavomír Hredzák *(*Slovakia*)*
Prof. Dr Snežana Milić *(Serbia)*
Prof. Dr Snežana Šerbula *(Serbia)*
Prof. Dr Srba Mladenović *(Serbia)*
Dr Srećko Stopić *(Germany)*
Prof. Dr Stojan Groudev *(Bulgaria)*
Prof. Dr Sulejman Muhamedagić *(Bosnia and Herzegovina)*
Prof. Dr Svetlana Ivanov *(Serbia)*
Prof. Dr Tatjana Volkov-Husović *(Serbia)*
Prof. Dr Tomaš Havlik *(Slovakia)*
Prof. Dr Velimir Radmilović *(Serbia)*
Prof. Dr Velizar Stanković *(Serbia)*
Prof. Dr Vesna Grekulović *(Serbia)*
Dr Vladan Ćosović *(Serbia)*
Vladan Mihailović *(Serbia)*
Dr Vladan Kašić *(Serbia)*
Prof. Dr Vladimir Krstić *(Canada)*
Prof. Dr Vladislav Kecojević *(USA)*
Dr Walter Valery *(Australia)*
Prof. Dr Xuewei Lv *(China)*
Prof. Dr Yong Du *(China)*
Prof. Dr Žarko Radović *(Montenegro)*
Prof. Dr Zdenka Zovko Brodarac *(Croatia)*
Dr Zoran Stevanović *(Serbia)*
Prof. Dr Željko Kamberović *(Serbia)*

ORGANIZING COMMITTEE

Prof. dr Ljubiša Balanović, Full Professor *(UB TF Bor) - president*
Prof. dr Saša Stojadinović, Full Professor *(UB TF Bor) - vice-president*
Prof. dr Srba Mladenović, Full Professor *(UB TF Bor) - vice-president*
Dr Ana Kostov, Principal Research Fellow *(MMI Bor) - vice-president*

Prof. dr Nada Štrbac, *Full Professor (UB TF Bor)*
Prof. dr Dragan Manasijević, *Full Professor (UB TF Bor)*
Prof. dr Vesna Grekulović, *Full Professor (UB TF Bor)*
Prof. dr Đorđe Nikolić, *Full Professor (UB TF Bor)*
Prof. dr Milan Radovanović, *Full Professor (UB TF Bor)*
Prof. dr Marija Petrović Mihajlović, *Full Professor (UB TF Bor)*
Prof. dr Zoran Štirbanović, *Associate Professor (UB TF Bor)*
Prof. dr Milan Gorgievski, *Associate Professor (UB TF Bor)*
Prof. dr Saša Marjanović, *Associate Professor (UB TF Bor)*
Prof. dr Ivana Marković, *Associate Professor (UB TF Bor)*
Prof. dr Žaklina Tasić, *Associate Professor (UB TF Bor)*
Doc. dr Dejan Petrović, *Assistant Professor (UB TF Bor)*
Doc. dr Anđelka Stojanović, *Assistant Professor (UB TF Bor)*
Doc. dr Uroš Stamenković, *Assistant Professor (UB TF Bor)*
Dr Jasmina Petrović, *Assistant with PhD (UB TF Bor)*
Vladimir Nikolić, *Assistant (UB TF Bor)*
Milica Zdravković, *Assistant (UB TF Bor)*
Miljan Marković, *Assistant (UB TF Bor)*
Milijana Mitrović, *Assistant (UB TF Bor)*
Milan Nedeljković, *Assistant (UB TF Bor)*
Avram Kovačević, *Teaching Assistant (UB TF Bor)*
Sandra Vasković, *English Lecturer (UB TF Bor)*
Oliver Marković, *IT service (UB TF Bor)*
Violeta Aleksić, *Liquidator (UB TF Bor)*

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

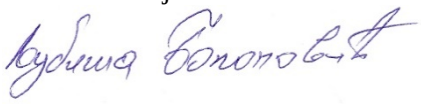

TABLE OF CONTENTS

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*

COMBINING NEUTRALIZATION AND ADSORPTION METHODS FOR METALS REMOVAL FROM SARAKA STREAM

Radmila Marković, Dragana Bozić, Zoran Stevanović, Tatjana Apostolovski Trujić, Vojka Gardić, Ljiljana Avramović, Vesna Marjanović

Mining and Metallurgy Institute Bor, Zeleni bulevar 35, 19210 Bor, Serbia

Abstract

The possibility of metals removal from real acid mine drainage from the Saraka stream, that flow near the plant for copper ore mine treatment in Serbia, was investigated by combination of neutralization and adsorption methods. A new approach of metals removal from acid mine drainage is in a two-step neutralization method by controlling the pH value aiming to obtain a different type of sludge during each step of neutralization process. The results are confirmed that the concentration of Cu and Fe is maximally reduced during the first neutralization step on pH 7. Values for the concentration of the other elements on pH 7 is as following: Mg>Mn>Ni>Cd>Co. On pH 10 (second neutralization step) removal mass percentage is the same for all elements (more than 99 mass%). As an alternative to metal removal at pH values above 7, a method of adsorption with the crosslinked hydrogel obtained by crosslinking the Type B gelatin and chitosan with glutaraldehyde is used. Studies have shown that the highest adsorption removal rate of 81.43% is achieved for Co.

Keywords: *real acid mine drainage, metal, removal, neutralization, adsorption*

1. INTRODUCTION

Active and passive treatment methods are the common methods for purification of acid mine drainage (AMD) that causes water and soil systems pollution around the mine. Mine waters originating from active or closed copper mines contain copper ions sometimes in a considerable concentration usually associated with an equivalent or even a two times higher concentration of Fe^{2+}/Fe^{3+} ions. The presence of the other heavy metal ions such as Mn, Cd, Zn, Pb, Ni, etc. in mine water depends on the mineralization of an ore body but their concentration is much lower than the concentration of copper or iron. Mine waters are acidic with pH value mostly between 2.5 and 4. The most environmentally effective techniques available for AMD are internal neutralization methods, water-covers and biological/natural degradation processes [1].

The aim of this paper is to investigate the multistep neutralization process of acid mine drainage from Saraka stream aim to precipitate the present metal ions in a different sludge type. First neutralization step was realized on pH 7 and second neutralization step was realized on pH 11. According to the literature data [2,3], the pH value for Mn recovery is greater than 7, and for the above reason, the second step of neutralization process (pH 10) is applied. Crosslinked hydrogels were used aim to investigate the possibility of removal the metal ions after the first neutralization step [4].

2. EXPERIMENTAL

2.1. Neutralization process procedure

- Laboratory tests

Neutralization process is curried out with 1000 ml of real Saraka samples to reached pH 7; 7.5 and 8. As a neutralizing agent is used lime milk, concentration 25 g/L. After reached the pH 7, 7.5 and 8, solution is filtered by vacuum filtration with aim to separate solid from liquid phase. Dewatered sludge was dried on 40^{o}C to constant mass. AMD neutralized on pH 7; 7.5 and 8 was used as start samples for neutralization on pH 9 and 10. As in the first neutralization stage, liquid and solid

phase are separated by vacuum filtration. Liquid phase is used for the chemical analyses and solid phase is dried on 40°C and measured after reaching the constant mass value.

- Two-stage pH control on pilot plant

Approximately 1800 l of AMD was feed to the pilot plant and pH was set: for a first step on pH 7 and for a second step on pH 10. Waste water pump with constant flow rate of 5 l/min is used for waste water transport to pH control tank A. In the same time, in pH control tank A is continually added 2.5 mass% lime milk from lime slurry tank by lime slurry pump. In pH control tank A is immersed pH meter aim to control first neutralization step pH value. Suspension from pH control tank A overflows in flocculation tank A. Flocculant, type Accoflock A-95 (0.05 mass %) is pumped by flocculant pump A with constant flow rate of 0.025 l min^{-1} to flocculation tank A. The solid-liquid separation is followed in thickener A. Supernatant that overflows from thickener A is going to pH control tank B for second neutralization step pH control (according to the second set pH value of 10). Flocculation is followed in flocculation tank B thereafter, and then solid-liquid separation is occurrence in thickener B. Supernatant that overflows from thickener B is taken for the chemical analysis and discharged continuously by gravity as treated water. Thickener A/B are discharged one by one aim to dewater the sludge on a filter press.

2.2. Adsorption tests with cross-linked hydrogels

Adsorption tests for a metal removal using crosslinked hydrogels prepared from gelatin Type B and chitosan, which are crosslinked with glutaraldehyde, were performed with next type of real waste water: 1. original AMD sample (saraka stream sample), 2. AMD sample after first neutralization step and 3. AMD sample after second neutralization step. Cross-linked hydrogel sheets (8 cm-square shape) were used as adsorbent. Incubation time of each adsorption test was (h): 0.5; 1; 2; 4; 6; 24; 48. Mass of the gelatin hydrogel sample was measured on the start and on the end of each test.

3. RESULTS AND DISCUSION

3.1. Neutralization process

- *Laboratory experiments*

Saraka stream is the branch of the Krivelj River located down-stream of over burden damp site. The over burden contains oxidized copper minerals as well as pyrite. It suggests that the seepage water from the dump contains copper. It is confirmed by chemical composition of the sample from Saraka stream: Al – 71.005 mg/l; Ca – 529.715 mg/l; Fe – 46.169; Mg – 250.295 mg/l; Mn – 16.145 mg/l; Zn – 1.782 mg/l; Cu – 88.237 mg/l; Co – 1.178 mg/l; Ni – 248.3 μg/l; As – 4.1 μg/l; Se – 29.1 μg/l; Sr – 591.8 μg/l and Cd – 17.9 μg/l. Concentration of Pb, Cr and Cs was below the sensitivity limit of used analytical method. In the Table 1 are presented the results of the first and second neutralization steps.

Table 1 - Concentration of the elements in the AMD after first and second neutralization step

From pH start value: 3.8	Concentration of elements, mg/l						
	Ca	Cd	Co	Cu	Fe	Mn	Ni
to pH 7	626.2	0.0123	0.471	0.842	<0.1	12.500	0.075
to pH 7.5	638.3	0.0071	0.215	0.521	<0.1	11.300	<0.01
to pH 8	646.6	0.0030	0.03	0.1	<0.1	7.600	<0.01
Neutralization from pH 7 to	Concentration of elements, mg/l						
	Ca	Cd	Co	Cu	Fe	Mn	Ni
pH 9	638.2	0.004	0.138	0.28	<0.1	5.8	<0.01
pH 10	845.2	0.0038	0.007	<0.1	<0.1	0.193	<0.01

Neutralization from pH 7.5 to:	Concentration of elements, mg/l						
	Ca	Cd	Co	Cu	Fe	Mn	Ni
pH 9	701.6	0.007	0.0025	<0.1	<0.1	5.8	<0.01
pH 10	782.1	<0.0001	0.0001	<0.1	<0.1	0.006	<0.01
Neutralization from pH 8 to:	Concentration of elements, mg/l						
	Ca	Cd	Co	Cu	Fe	Mn	Ni
pH 9	653.9	<0.0001	0.0015	<0.1	<0.1	0.9	<0.01
pH 10	800.7	<0.0001	<0.0001	<0.1	<0.1	0.006	<0.01

- *Two-stage pH control on pilot plant*

According to the obtained laboratory data for chemical composition and lime milk consumption, test on pilot plant is curried out as following: first neutralization step: on pH 7 and second neutralization step: on pH 10 (Table 2).

Table 2 - Content of the elements after two neutralization steps

From pH start value of 4.3 to:	Concentration of elements, mg/l						
	Ca	Cd	Co	Cu	Fe	Mn	Ni
pH 7	626.2	0.0123	0.471	0.842	<0.1	12.500	0.075
pH 10	701.7	0.00014	0.0052	0.036	< 0.007	0.18	0.018

2.2. Adsorption tests with cross-linked hydrogels

In the Table 3 are presented the results of metals adsorption degree from different AMD samples.

Table 3 - Adsorption degree of Cu, Co, Cd and Mn

Adsorption time, h	0.5	1	2	4	6	24	48
Cu, mass %							
Real Saraka water	-	5.53	8.6	15.89	17.11	31.26	30.06
Co, mass %							
Neutralized on pH 7	7.78		13.2	14.64	16.89	21.56	27.9
Neutralized on pH 10	51.43	57.14	58.57	62.86	67.14	68.57	81.43
Cd, mass %							
Real Saraka water			4.81	7.21	11.54		
Neutralized on pH 7	13.56		30.51	33.9	47.46	64.41	71.19
Mn, mass %							
Real Saraka water	7.81	6.52	15.69	10.18	12.23	12.95	15.07
Neutralized on pH 7		5.89	7.12	11.64	15.26	21.88	21.39
Neutralized on pH 10	10.17	9.75	16.1	15.68	18.22	13.98	17.8

4. CONCLUSION

A new approach of metals recovery from acid mine drainage in combination with adsorption method gives the satisfactory results regarding to reduce the metals concentration. Using two-step neutralization method is obtained a different type of sludge during each step of neutralization process. Concentration of the elements on pH 7 is as follows: Mg> Mn> Ni> Cd> Co>Cu>Fe. On pH 10 (second neutralization step) recovery mass percentage is the same for all elements (more than 99 mass %). Based on data for lime consumption at pH values above 7, method of adsorption with the crosslinked hydrogel obtained by crosslinking the Type B gelatin and chitosan with glutaraldehyde is used. Studies have shown that the highest recovery rate of 81.43% is achieved for Co.

ACKNOWLEDGEMENTS

The authors are grateful for funding by the Minister of Science, Technological Development and Innovation of the Republic Serbia, the Grant No. 451-03-47/2023-01/ 200052. Also, this work is financially supported by the EU under Program 2nd EIT-HEI call: Building Ecosystem Integration Labs at HEI to foster Smart Specialization and Innovation on Sustainable Raw Materials - HEI4S3-RM.

REFERENCES

[1] Z. Stevanović, Lj. Obradović, R. Marković, R. Jonović, Lj. Avramović, M. Bugarin, J. Stevanović, Waste Water - Treatment Technologies and Recent Analytical Developments, InTech, Rijeka, 2013, p.41.

[2] Z. Štirbanović, V. Gardić, D. Stanujkić, R. Marković, J. Sokolović, Z. Stevanović, Water Resour. Manag, 35 (2021) 3737–3753.

[3] E.Y. Seo, Y.W. Cheong, G.J. Yim, K.W. Min, J.N. Geroni, Catena 148 (2017) 11–16.

[4] R. Markovic, M. Bessho, N. Masuda, Z. Stevanovic, T. Apostolovski-Trujic, V.Gardic, Appl. Sci., 10 (17) (2020) 5925.

AUTHOR INDEX

A

Abduarahman Muna Abdualatif 514
Abidi Abdelmoughit 335
Açan Hasan 489
Achiței Dragoș 170
Aćimović Zagorka 357
Adamović Dragana 501
Agović Elvis 229
Akpınar Deniz Eylül 166
Aksentijević Zoran 216
Aleksandrova Tatiana 112
Alil Ana 531
Alkan Esra 274, 278
Alkan Murat 274, 278
Alvarez Eugenio 20
Amari Khalid El 335
Amdur Alexey M. 124
Ananyeva Ludmila 53
Antonijević Milan 221
Apostolovski Trujić Tatjana 116, 233
Aras Ali 464
Ari Nurdan 274
Arifović Ana 401
Arsić Sanela 225
Avdušinović Hasan 229
Avramović Ljiljana 128, 145, 154, 158, 233
Awad Khaola 195

B

Bacaoui Abdelaziz 335
Balanović Ljubiša 96, 387
Basarabić Filip 407
Beškoski Latinka Slavković 175
Bikić Farzet 195
Bogdanović Grozdanka 418, 456
Botić Nenad 23
Bozić Dragana 128, 145, 154, 158, 233, 435
Božinović Kristina 301
Bugarčić Mladen 514
Bugarin Dejan 145, 435
Bušatlić Ilhan 448
Bušatlić Nadira 448

C

Çelik Ceren 207
Chernev Georgi 339, 518
Chicet Daniela Lucia 170
Cimpoesu Nicanor 170
Cimpoeșu Ramona 170
Conić Vesna 435, 460, 493
Cupara Nevena 183
Cvetković Aleksandar 468

Ć

Ćitić Aleksandar 481

D

Damnjanović Zvonko 116
Darban Ahmad Khodadadi 305
Davalos Jose Omar 329
Dehghani Hesam 485
Denis Ordinartsev 49
Derqaoui Mohammed 335
Dikić Stefan 505
Dilibal Savas 166
Dimitrijević Jelena 270

Dimitrijević Oliver 493
Dimitrijević Silvana 128, 145, 211
Dimitrova Makedonka 547
Dimitrova Kapac Jasminka 547
Dojčinović Marina 357
Dragutinović Olivera 505
Drobnjaković Bojan 472
Du Yong 46
Duraković Mirnes 195
Dušan Oráč 282

Đ

Đokić Jelena 297
Đokić Nemanja 216
Đoković Jelena 141
Đorđević Aleksandar 104, 108
Đorđević Jelena 76, 476
Đorđević Nataša 348
Đorđievski Stefan 501
Đukanović Duško 216
Đurđevac Vanja 287, 292
Đurđevac Ignjatović Lidija 287, 292
Đurović Dijana 183

E

Ercegović Marija 265, 270
Ergin Hasan 489
Estemirova Svetlana 49

F

Fakić Belma 229
Fedorov Sergei A. 124
Fenglai Qi 23
Filiberto Yaima 20
Forshev Andrey A. 124

G

Gardić Vojka 158, 233
Gigović-Gekić Almaida 229
Göçmen Müesser 207
Gorgievski Milan 301, 353, 383, 387, 418
Grekulović Vesna 301, 353, 383
Grevtsev Nikolay V. 124
Guo Jiabao 414
Gurol Ugur 166, 207
Gusković Dragoslav 510
Guševac Sandra 76, 476

H

Harbinja Muhamed 357
Herrera Uzziel Caldiño 329
Hođić Atif 357
Holma Marko 325
Holjevac Grgurić Tamara 424
Hristov Nikolay 452

I

Ignjatović Dragan 287, 292
Ignjatović Snežana 162
Ilić Ivana 261, 418
Ivanov Desislav 325
Ivaz Jelena 80, 84, 375, 497
Iveta Vasková 282
Ivošević Branislav 265

J

Jaćimovski Stevo K. 257
Janković Klara Konc 313
Janković Marija 92
Janošević Miloš 435, 460
Jarmila Trpčevská 282
Jelić Ivan 76, 379
Jelić Ivana 92, 348
Jovanović Aleksandar 514
Jovanović Ivan 245, 253, 287

Jovanović Ivana 132, 313, 435, 460, 493
Jovanović Milenko 132, 136, 149, 187
Jovanović Vladimir 265
Jovičić Toma 72
Jović Dalibor 387

K

Kalinović Jelena 522
Kalinović Tanja 522
Kamenović Vladan 116
Karakanat Aslihan 278
Karastojković Zoran 510
Kašić Vladan 348
Katarína Pauerová 282
Kazakova Nadezhda 339, 518
Khan Muhamad Ghulam Isaq 481
Koçak Mustafa 207
Kokkinos E. 88
Kondratyev Sergey 53
Koprivica Marija 270
Korovkin Mikhail 53
Kostić Slobodan 23
Kostov Ana 241, 245
Kostović Milena 203
Kovačević Avram 407
Kovačević Sandra 318, 322
Kovačević Zorica 510
Krasteva Maria 309, 439
Krstić Slađana 472
Krstić Vesna 211
Kršulja Marko 424
Kržanović Daniel 132, 149, 187, 191, 199, 460
Kumrić Ksenija 175

L

Lampou A. 88
Lapčević Veljko 68, 72
Lazić Dejan 313
Lekić Nikola 379
Li Kai 46
Lira Marlenne Alejandra Hernandez 329
Liu Shuhong 46
Liverić Lovro 424
Lu Qiang 46
Luo Mingshui 4
Lv Xuewei 4, 370

M

Ma Donglai 370
Magdalinović Srđana 203, 472
Maksimović Miroslava 136, 149
Maldybayev Galymzhan 422
Manasijević Dragan 96, 104, 108, 387
Manojlović Vaso 505, 527
Manole Vasile 170
Marilović Dragana 456
Marinković Aleksandar 514
Marinković Vladan 136, 149, 154
Marjanović Jelisaveta 297
Marjanović Saša 407, 543
Marjanović Vesna 233
Marković Gordana 527
Marković Ivana 96, 387, 407, 443, 539
Marković Marija 270
Marković Marina 301
Marković Miljan 301, 353, 383, 418
Marković Radmila 128, 145, 158, 233, 237
Martina Laubertová 282
Martinez Manuel Alejandro Lira 329
Martinović Sanja 531
Melendez Diego Adan Villordo 329
Meracheva Gergana 452
Merachtsaki D. 88
Merwe Shade Rouxzeta Van Der 343
Mihajlović Slavica 265, 348
Mikavica Ivana 366

Mikić Miomir 132, 149, 187, 191, 199, 379
Milanović Dragan 460, 493
Milašević Ivana 183
Miletić Slavica 120, 241
Milićević Sonja 265
Milivojević Katarina 287
Milojkov Dušan 527
Milojković Nenad 313
Milosavljević Aleksandra 241, 245
Milosavljević Jelena 522
Milosavljević Nenad 361
Milošević Isidora 100, 225, 560
Milošević Milena 514
Milovanović Dobrica 23, 361
Milutinović Sandra 191, 199, 203, 472, 187
Minić Duško 104, 108
Mitovski Aleksandra 353
Mitrović Milijana 407, 535, 539, 543
Mladenović Srba 407, 443, 535, 539
Montenegro Alberto 20
Mutić Jelena 366

N

Nedeljković Milan 535, 539, 543
Negovanović Milanka 162
Nešković Jasmina 313
Nikolaeva Nadezhda 112
Nikolić Irena 183
Nikolić Ivica 100, 225, 560
Nikolić Vladimir 249
Nourozi Saba 305
Novaković Bojan 443
Nujkić Maja 221, 468

O

Oabi Omar 335
Obradović Ljubiša 199, 203, 472
Obradović Milena 366
Okanigbe Daniel Ogochukwu 343
Onen Vildan 428
Orazaliyeva Zhibek 422

P

Pačkovski Goran 136
Patra Satyananda 27
Pavlović Marko 357
Pechischeva Nadezhda 49
Peleka E. 88
Pešić Batrić 11
Pešovski Branka 211
Petkov Rumen 439
Petrović Ana 237
Petrović Dejan 64, 80, 84, 375, 497
Petrović Đorđe 175
Petrović Jasmina 535, 539, 543
Petrović Jelena 158, 270
Petrović Maja 297
Petrović Sanja 203, 456, 472
Petrović Mihajlović Marija 221, 468
Peytcheva Irena 325
Pirgić Savo 23
Polavder Svetlana 313
Polyak Peter 395
Popa Mihai 170
Popov Alexandar 339
Popović Miljana 481
Potić Branislav 401
Pourasgharian Fatemeh 305
Požega Emina 237
Prcanović Halim 195
Prelević Dejan 481
Prochaska C. 88

R

Radetić Tamara 481
Radivojević Daniel 216

Radmilović Velimir R. 3
Radojević Ana 522
Radosavljević Mihajlović Ana 348
Radovanović Milan 211, 221, 468
Radovanović Mladen 80, 84, 375
Radović Bojan 116
Radović Žarko 56, 60
Radulović Dragan 265, 357
Rajković Filip 481
Rajković Radmilo 132, 149, 187, 191, 199
Rakić Ana 225
Ranđelović Dragana 366
Rasa Muhammad Hashim 464
Rempel Andrey 49
Ristić Nevena 116
Ristić Ognjen 510
Ristić Tamara 361
Ružić Jovana 527

S

Sarap Nataša 92
Savinova Olesya 53
Schmid-Fetzer Rainer 46
Scripcariu Ana-Maria 170
Sebastian Mistreanu 170
Sharipov Rustam 422
Simeonidis K. 88
Simić Marija 270
Simić Marko 505
Simonović Ana 221, 468
Simonović Danijela 211
Sitek Wojciech 424
Smajić-Terzić Dženana 448
Smokvina Hanza Sunčana 424
Sokić Miroslav 514, 527
Sokolović Jovica 261, 418, 556
Sretković Branisav 162
Stakić Branisal 216
Staletović Novica 253
Stamenković Uroš 96, 387, 407, 443
Stanić Nikola 379
Stanić Vojislav 92
Stanković Katarina 175
Stanković Suzana 120
Stanković Tanja 460
Stanković Velizar 418
Stanojević Šimšić Zdenka 241, 245
Stanujkić Dragiša 261
Stefanović Jelena 76, 476
Stevanović Zoran 128, 145, 158, 233
Stjepanović Pavle 313
Stojadinović Saša 80, 84, 497
Stojanović Anđelka 100, 225, 560
Stojanović Jovica 348, 366
Stojanović Miloš 64, 68
Stojanović Mirjana 357
Stojić Anđela 141
Stojković Pavle 80, 84
Stolić Predrag 80, 497
Stoljiljković Miloš 141
Strainović Gracijan 418
Suleimenov Essen 422
Supić Mlađen 292
Sušić Čedomir 23
Svrkota Igor 493

Š

Šabaz Dragan 64
Šerbula Snežana 522
Šetrajčić Jovan P. 179, 257
Šljivić-Ivanović Marija 92
Špada Vedrana 424
Štirbanović Zoran 261, 556
Štrbac Nada 301, 353, 383

T

Tadić Milena 183
Tadić Nebojša 56, 60
Taner Hasan Ali 428, 464
Tanikić Dejan 141
Tasić Viša 116
Tasić Žaklina 221, 468
Tašić Dušan 292
Tilvaldyev Shehret 329
Todorova Elena 518
Todorović Dejan 265
Torbica Slavko 72
Trifunović Vanja 128, 145, 154, 435
Trujić Stefan 76, 154
Trumić Biserka 120, 543
Trumić Maja 556
Trumić Milan 249
Turgut Batuhan 166

U

Ugurluer Dilan 278
Urošević Daniela 128, 460
Urošević Tamara 116

V

Vasiljević Ivana 162
Veličković Milica 485
Veljović Đorđe 505
Vlahović Milica 531
Vojinović Ivica 68
Vojinović Vesna 556
Volkov-Husović Tatjana 531
Vourlias G. 88
Voza Danijela 485
Vučenović Siniša M. 179, 257
Vukadinović Melina 348
Vuković Milovan 353
Vuksanović Marija 514
Wang Jianchuan 46
Wang Jincheng 46

X

Xiang Junyi 4

Y

Yaacoubi Abdelrani 335
Yamanoglu Ridvan 36
Yildiz Mehmet Ali 391
You Yang 4, 370, 414
You Zhixiong 4, 370, 414
Yu Jing 4
Yurak Vera V. 124

Z

Zaneva-Dobranova Efrosima 452
Zdravković Bojan 383
Zdravković Milica 301, 353, 383
Zečević Milena 104, 108
Zhang Yuhui 46
Zhao Jianbo 370
Zhao Xinnan 370
Zherlitsyn Andrey 53
Zlatanović Dragan 80, 84, 375, 497
Zlatičanin Biljana 318, 322
Zlatković Igor 23
Zouboulis A. 88

Ž

Živković Bojana 297

ISBN-978-86-6305-140-9

IOC M&M 2023

IOC M&M 2023

Proceedings IOC M&M 2023

УНИВЕРЗИТЕТ У БЕОГРАДУ
ТЕХНИЧКИ ФАКУЛТЕТ У БОРУ
1961

INSTITUT